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Changes in psychosocial and physical working conditions and subsequent psychotropic medication in ageing public sector employees

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Abstract

Objectives: To investigate whether changes in psychosocial and physical working conditions are associated with subsequent psychotropic medication in ageing employees.

Methods: Data were from the Helsinki Health Study, a cohort study of Finnish municipal employees, aged 40-60 years at Phase 1 (2000-2002). Changes in psychosocial and physical working conditions were measured between Phase 1 and Phase 2 (2007). Survey data were longitudinally linked to data on prescribed, reimbursed psychotropic medication purchases (ATC) obtained from the registers of the Social Insurance Institution of Finland between the Phase 2 survey and December 2013 (N=3587; 80% women). Outcomes were any psychotropic medication; antidepressants (N06A); anxiolytics (N05B); and sedatives and hypnotics (N05C). Cox regression analyses were performed.

Results: During the follow-up 28% of the participants were prescribed psychotropic medication. Repeated exposures to low job control, high job demands and high physical work load were associated with an increased risk of subsequent antidepressant and anxiolytic medication. Increased and repeated exposure to high physical work load, increased job control and repeated high job demands were associated with subsequent sedative and hypnotic medication. Age and sex adjusted hazard ratios varied from 1.18 to 1.66. Improvement in job control was associated with a lower risk of anxiolytic, but with a higher risk of sedatives and hypnotic medication. Decreased physical work load was associated with a lower risk of antidepressant and anxiolytic medication.

Conclusion: Improvement in working conditions could lower the risk of mental ill-health indicated by psychotropic medication.

Keywords: mental health; longitudinal studies; work stress

Abbreviations: ATC, Anatomical Therapeutic Chemical; BMI, body mass index; CI, confidence interval; DDD, defined daily dose; HR, hazard ratio; WHO, World Health Organization

Strengths and limitations of this study

- Unlike previous studies, we were able to examine changes in both psychosocial and physical working conditions.
- Data were derived from a well characterised occupational cohort which was deterministically linked to administrative medication records.
- The use of register-based medication data allowed us to remove the prevalent cases and helped avoid the problems related to use of self-report measures such as recall and common method bias.
- Due to relatively long interval between the two working conditions measurements, the study could have underestimated the effect of changing working conditions on subsequent psychotropic medication.
- We did not have information about clinical indication the examined medication was prescribed for.

INTRODUCTION

Mental ill-health is a growing concern in working populations.[1] Adverse working conditions have been proposed as potentially modifiable risk factors for mental ill-health.[2] Indeed, there is evidence that exposure to adverse psychosocial working conditions such as low job control and high job demands, are associated with an increased risk of mental ill-health.[3–5] However, the majority of earlier studies have measured both exposure and outcome using self-reports, which can lead to inflated associations and common method bias.[6] Other studies have avoided these problems by using register-based outcomes such as psychotropic medication, which is a commonly used marker of mental ill-health in a population.[7–12]

Most of the earlier studies have assessed exposure to adverse working conditions only at one time point, and there is a paucity of large-scale studies examining the association between changes in psychosocial working conditions and mental ill-health. Of a few studies that have separately assessed the effects of changes in job control and job demands on mental ill-health, three found that adverse changes in job demands had a stronger effect on the risk of self-reported mental ill-health than adverse changes in job control, whereas positive changes in these domains did not result in improvement in mental health.[5,13,14] In a recent study within-person increase in job control was associated with better self-reported mental health;[15] and in another study both improvements and deterioration in job demands and job control predicted change in mental health.[16] However, studies assessing the association between changes in job control and job demands and a more objective measure of mental ill-health, such as recorded psychotropic medication, are lacking.

Moreover, psychosocial working conditions have dominated discussion about the work-related determinants of poor mental health, even though there is evidence that also physical working

conditions are associated with mental ill-health. In the present cohort, increased and repeated exposure to repetitive movements and repeated exposure to awkward postures and rotation of back was associated with an increased likelihood of common mental disorders,[14] desktop work was associated with purchases of sleeping pills among women,[17] and computer work was a risk factor for disability retirement due to mental causes.[18] In another study deteriorating physical working conditions increased perceived mental strain.[19] A review of the impact of working environment on mood disorders discussed the potential mechanisms; however actual studies conducted in employee cohorts were rare.[20] In a study among blue-collar workers exposure to noise intensified anxiety and depression in women.[21]

We set out this study to examine the associations between changes in psychosocial and physical working conditions and subsequent psychotropic medication.

METHODS

Data

The data came from the Helsinki Health Study, which is a cohort study designed to investigate social and work-related determinants of health and well-being.[22] The target population is the staff of the City of Helsinki, Finland. Phase 1 questionnaire surveys were collected in 2000, 2001 and 2002 among employees turning 40, 45, 50, 55 or 60 each year (N=8960, response rate 67%; 80% of participants women). Phase 2 survey data were collected in 2007 (N=7332, response rate 83%). Earlier non-response analysis showed that the participants broadly represent the target population.[22] Survey data were linked to national records using a unique personal identification number for those respondents who had given written consent for the linkage (74%; N=6498).

Consenting for the data linkage followed a similar pattern as the non-response, except that men provided consent slightly more often than women.[22,23]

In the present study, of those who consented to linkage, only participants who were still employed at Phase 2 were included (N=4207). Men, manual workers and those who reported common mental disorders at Phase 1 had slightly more often left the employment between the two phases (all *p* values < 0.01, data not shown). Because of the age structure of the cohort, the majority (86%) of those who replied at Phase 2 and stated that they were not employed, had retired.

In addition, we excluded those with purchases of psychotropic medication in three months preceding Phase 2 (n=337 for any psychotropic medication). Finally, we excluded those participants who had missing values for any of the study variables (n=283). The exclusions resulted in a final analytic sample of 3587 participants for the analyses examining any psychotropic medication.

Ethics

The Helsinki Health Study protocol was approved by the Ethics Committees of the Department of Public Health, University of Helsinki, and the health authorities of the City of Helsinki. The study conformed to the principles embodied in the Declaration of Helsinki.

Measurements

Working conditions

We used a version of Karasek's Job Content Questionnaire[24] to measure job control and job demands. Job control was assessed by nine and job demands by five items. Missing values were replaced by item modes for those having responded to at least eight job control and four job demands items, respectively. Job control and job demands were both dichotomised at the median.[7,25]

Physical work load was assessed with an 18-item instrument developed at the Finnish Institute of Occupational Health.[26] Missing values were replaced by item modes for those having responded to at least fourteen items. Factor analysis showed that the questions loaded on three factors, of which the first one was interpreted to best measure physical work load. The items with the largest positive standardised scoring coefficients were: awkward working positions; rotation of the back; repetitive movements; and heavy physical effort or lifting and carrying heavy loads. Physical work load factor score was dichotomised at the highest quartile.[27]

Changes in psychosocial and physical working conditions were measured by a four-category variable for each of the three exposure variables: (i) repeated low exposure (low exposure at Phase 1 and low exposure at Phase 2); (ii) increased exposure (low exposure at Phase 1 and high exposure at Phase 2); (iii) decreased exposure (high exposure at Phase 1 and low exposure at Phase 2); (iv) repeated high exposure (high exposure at Phase 1 and high exposure at Phase 2).[28]

Psychotropic medication

Data on psychotropic medication were derived from the Finnish Prescription Register. This register is maintained by the Social Insurance Institution and it includes records of all prescribed psychotropic medication purchases reimbursed to Finnish residents in non-institutional settings. For

each dispensed drug, the record includes the dispensing date, the WHO Anatomical Therapeutic Chemical (ATC) code, and the quantity prescribed and purchased as the number of defined daily doses (DDDs).[29] We extracted information on all purchases of antidepressants, anxiolytics, sedatives and hypnotics (ATC-codes N06A, N05B and N05C, respectively) in our analytic sample, following Phase 2 survey date (index date) during the follow-up until December 31, 2013. Dates of deaths were retrieved from Statistics Finland (the Causes of Death Register).

Covariates

All covariates were survey-based and from Phase 1. We measured age, sex and marital status (married/cohabiting vs. other). Moreover, we measured current smoking (yes vs. no), binge drinking (six or more units of alcohol on one occasion once a month or more often), low physical activity (less than 14 metabolic equivalent hours per week) and body mass index, which was categorosed as non-obese (≤ 30 kg/m^2) and obese (>30 kg/m^2).

Statistical analysis

The associations between sex, age and psychotropic medication during the follow-up were first analysed using the Chi-square test. Cox proportional hazard models were fitted to examine the association between change in psychosocial and physical working conditions between Phase 1 and Phase 2 and subsequent psychotropic medication during the follow-up. We estimated hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for psychotropic medication by changes in each working condition by first controlling for age and sex; then further controlling for marital status, smoking, binge drinking, low physical activity, and obesity. In the first analysis, for each working condition, the reference group was the most favourable working condition (i.e. repeated high control, repeated low demands, and repeated high physical work load, respectively). To

examine the effects of positive changes in working conditions, we conducted an additional analysis using the least favourable working condition as the reference group. The follow-up began from the date of the Phase 2 survey response and ended at the first record of the psychotropic medication purchase, death, or on 31 December, 2013, whichever came first.

The interaction terms between each working condition and logarithm of the follow-up period for any psychotropic medication as well as for each medication group were non-significant, confirming that the proportional-hazards assumption was justified (all $p > 0.05$).

None of the gender interactions were statistically significant (all interaction terms sex*working condition $p>0.05$); we therefore analysed women and men together, adjusting for gender.

All analyses were conducted with the statistical program package SAS 9.4 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Table 1 shows the distribution of the key study variables by any prescribed psychotropic medication during follow-up. The mean age at baseline was 47.5 years. A total of 1008 participants (28%) recorded at least one purchase of prescribed psychotropic medication during the mean follow-up of 5.0 years. Psychotropic medication was more prevalent among women (29%) than among men (23%). Nineteen percent of the participants received antidepressant medication during the follow-up. The corresponding figures for anxiolytics and for hypnotics/sedatives were 7% and 17%, respectively.

As displayed in **Table 2,** after adjustment for age and sex, repeated high job demands (HR=1.22, 95% CI: 1.04-1.42) were associated with any psychotropic medication. The association between repeated high physical work load and any psychotropic medication was marginally statistically significant (HR=1.17, 95% CI: 0.98-1.39).

When the groups of psychotropic medication were examined separately, repeated high job demands (HR=1.20, 95% CI: 1.00-1.45) and repeated high physical work load (HR=1.30, 95% CI: 1.06-1.59) were associated with subsequent antidepressant medication, whereas repeated low job control (1.37, 95% CI: 1.05-1.79), repeated high demands (HR=1.33, 95% CI: 1.00-1.76), and repeated high physical work load (HR=1.66, 95% CI: 1.24-2.23) were associated with subsequent anxiolytic medication. Increased job control and increased physical work load were associated with subsequent sedative and hypnotic medication. Repeated high demands and repeated physical work load showed associations with subsequent sedative and hypnotic medication. Further adjustment for marital status, health behaviours, and obesity only marginally changed the HRs (data not shown).

We additionally tested whether favourable change in working conditions was associated with a lower risk of psychotropic medication, by using the least favourable working conditions as reference categories (Table 3). Compared to repeatedly low job control, increased job control was associated with a lower risk of anxiolytic, but a higher risk of sedative and hypnotic medication. Compared to repeatedly high physical work load, decreased physical load was associated with a lower risk of subsequent antidepressant and anxiolytic medication.

DISCUSSION

In this study, repeated and increased exposure to adverse psychosocial and physical working conditions was associated with subsequent psychotropic medication. It is notable that we found

similar associations for both types of working conditions. However, the associations between adverse working conditions and subsequent psychotropic medication were modest. This is expected: the aetiology of mental disorders – the main indication for psychotropic medication - is complex and multifactorial, involving multiple social, psychological and biological factors.[30] Exposure to adverse working conditions or a positive or negative change in them is only one such factor.

Compared to employees with repeated low job demands, the employees whose job demands had increased had a higher risk of purhasing any psychotropic medication as well as antidepressant medication. Antidepressant medication is likely to reflect depression and other mental disorders. A number of previous studies have shown a link between high job demands and an increased risk of mental ill-health.[13,14,31]

Previous results for job control have been mixed. Null results have been reported,[32] whereas one previous study showed an association between high decision authority and an elevated risk of hospital admissions due to mental disorders.[33] In our study increased job control was associated with a subsequent sedative and hypnotic medication. In a previous study, active jobs, that is, those with high levels of control and demands, were associated with a higher risk of depression and burnout.[34] It is possible that increased decision authority and high responsibility may become a burden for some employees. It is also possible that high job control reflects not only working conditions but also characteristics of a generally more active employee with a higher likelihood of seeking treatment.[33]

When comparing to the least favourable working conditions, increased job control was associated with a lower risk of anxiolytic medication; and decreased physical load was associated with a lower risk of antidepressant and anxiolytic medication. Two earlier studies did not find an association

between favourable changes in psychosocial working conditions and a decreased risk of subsequent mental ill-health.[13,35] However, in one previous study both improvements and deterioration in job demands and control were associated with corresponding improvements or deterioration in mental health,[16] and in another study decrease of job strain was associated with a lower likelihood of repeated insomnia symptoms.[36]

Most of the earlier studies have investigated only psychosocial working conditions. In the present study repeatedly high and increased physical work load were associated with subsequent psychotropic medication. In fact, the strongest association (HR=1.66 for anxiolytic medication) between working conditions and psychotropic medication was found for repeated high physical workload. Our findings thus support the earlier findings in the present and other cohorts, which have shown associations between exposure to adverse physical working conditions and common mental disorders,[14] disability retirement due to mental disorders,[18] purchases of sleeping pills,[17] and perceived mental strain.[19]

Methodological considerations

Certain limitations need to be acknowledged. First, because of the relatively long interval between the two working conditions measurements, this study could have underestimated the effect of changing working conditions on subsequent medication. Moreover, working conditions could have changed several times during the follow-up; this could have resulted in more conservative effect sizes.

Second, we were unable to assess the magnitude of change in working conditions; the use of these crude measures only assessed whether a participant had moved from one category to another. Furthermore, we did not have information about the prior duration of exposure to adverse working

conditions. The use of thresholds may have led to underestimates of true effects of changing working conditions.[5]

Third, we did not have information about clinical indication the examined medication was prescribed for. Even if psychotropic medication is a recommended treatment for a number of mental disorders and prescription data derived from official registers can therefore be considered as a proxy for mental disorders requiring treatment, these medications are prescribed also for other conditions. On the other hand, it has been shown that mental disorders are underdiagnosed and undertreated.[37]

Fourth, participants who left employment between Phase 1 and Phase 2 were not included in the study. It has been suggested that the age-related health selection may result in a more resilient older worker population [35]. A healthy worker effect may thus have led to underestimation of the associations.

Finally, even if the data consisted of a broad range of both manual and non-manual occupations, the study population was not a representative sample of the total working population. Because the Finnish public sector workforce is female-dominated, women were over-represented also in this sample. Moreover, the present sample consisted only of ageing employees with stable and secure long-term employment and working in the capital city. Therefore the results may be generalisable, with caution, to the Finnish municipal sector, but might not be generalisable to other age groups, cohorts and industries.

Despite of these limitations, the present study has a number of strengths. The main strengths are the use of prospective design which enabled us to examine changes in working conditions, data derived

from a well characterised occupational cohort, minor attrition, deterministic linkage to administrative medication records, and an ability to examine changes in both psychosocial and physical working conditions. Psychotropic medication data were based on a physician's prescription and cover virtually all reimbursed psychotropic prescriptions for the analytic sample. The use of register-based medication data allowed us to remove the prevalent cases and helped avoid the problems related to use of self-report measures such as recall and common method bias. Extensive non-response analyses were available and showed only small non-participation bias. We were able to adjust for a number of important covariates such as health behaviours and obesity.

CONCLUSION

To conclude, this study showed that established psychosocial risk factors such as repeated exposure to high job demands and low control are associated with subsequent psychotropic medication in midlife and older employees. Furthermore, the results showed that also repeated and increased exposure to adverse physical working conditions may contribute to subsequent psychotropic medication. Identification of these potentially modifiable risk factors implies possibilities for prevention.[38] Theory-based, organisationally focused interventions to tackle adverse working conditions might be beneficial. Evidence for this is emerging. An intervention study in Canadian hospitals showed an intervention to reduce work stress was able to produce beneficial long-term effects on hospital employees' emotional well-being, in particular through reducing professional burnout.[39] However, well-designed randomized controlled trials with reliable and valid objective indicators of working conditions are needed to reliably test whether intentional workplace interventions can prevent employee mental ill-health.

Conflicts of interest: None declared

Author contributions:

All authors jointly designed and conceptualised the study. Anne Kouvonen directed the implementation of the study, led all aspects of the work, performed the data analysis and drafted the article. Tea Lallukka, Eero Lahelma and Ossi Rahkonen contributed to acquisition of data. Minna Mänty, Tea Lallukka, Eero Lahelma and Ossi Rahkonen contributed to designing the study's analytic strategy, interpreting findings, reviewing the article and revising it critically for important intellectual content. All authors approved the manuscript's submission for publication.

Data sharing statement: No additional data available.

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Table 1. Distribution of demographics (Phase 1; 2000-2002), working conditions (Phase 1 – Phase 2; 2007) and any psychotropic medication* between Phase 2 and 2013, the Helsinki Health Study, Finland (%) (*N*=3587)

	No medication *N* (%)	Medication *N* (%)	Mean DDDs (SD)†
Sex			
Women	2034 (71)	847 (29)	496.0 (773.3)
Men	545 (77)	161 (23)	487.1 (793.0)
Age			
40	632 (72)	247 (28)	587.5 (949.9)
45	636 (68)	298 (32)	537.6 (788.6)
50	664 (72)	259 (28)	429.5 (660.0)
55	627 (76)	196 (24)	391.2 (627.2)
60	20 (71)	8 (29)	666.2 (818.6)
Job control			
High-High	1075 (73)	402 (27)	453.2 (806.6)
High-Low	358 (71)	148 (29)	458.3 (793.9)
Low-High	300 (72)	117 (28)	541.5 (761.1)
Low-Low	846 (71)	341 (29)	543.1 (749.3)
Job demands			
Low-Low	554 (74)	304 (26)	411.6 (647.4)
Low-High	419 (72)	165 (28)	476.1 (716.0)
High-Low	432 (72)	169 (28)	463.7 (694.2)
High-High	844 (70)	370 (30)	585.1 (915.3)
Physical work load			
Low-Low	1718 (73)	633 (27)	500.2 (767.4)
Low-High	248 (869)	112 (31)	455.4 (679.6)
High-Low	255 (71)	104 (29)	428.1 (704.8)
High-High	358 (69)	159 (31)	543.4 (909.2)

*Participants with psychotropic medication purchases in three months preceding Phase 2 were excluded.

† Mean of defined daily doses (DDDs) and their standard deviations (SDs) in those who had psychotropic medication purchases during follow-up.

Table 2. Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000-2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

	Any psychotropic (*N*=3587)			Antidepressants (N06A) (*N*=3660)			Anxiolytics (N05B) (*N*=3867)			Sedatives and hypnotics (N05C) (*N*=3808)		
	N (cases)	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**
Job control												
High-High	1477 (402)	1.00	Reference	1499 (264)	1.00	Reference	1573 (102)	1.00	Reference	1559 (245)	1.00	Reference
High-Low	506 (148)	1.08	0.90-1.31	518 (95)	1.04	0.82-1.32	542 (43)	1.22	0.86-1.74	532 (94)	1.13	0.89-1.43
Low-High	417 (117)	1.03	0.84-1.27	425 (80)	1.06	0.83-1.36	457 (27)	0.90	0.59-1.38	449 (91)	1.33	1.04-1.69
Low-Low	1187 (341)	1.08	0.94-1.25	1218 (244)	1.18	0.99-1.41	1295 (113)	1.37	1.05-1.79	1268 (205)	1.03	0.86-1.24
Job demands												
Low-Low	1188 (304)	1.00	Reference	1208 (205)	1.00	Reference	1267 (83)	1.00	Reference	1254 (185)	1.00	Reference
Low-High	584 (165)	1.09	0.90-1.32	598 (117)	1.10	0.88-1.38	632 (45)	1.05	0.73-1.52	619 (108)	1.20	0.94-1.52
High-Low	601 (169)	1.09	0.91-1.32	610 (106)	1.01	0.80-1.27	649 (41)	0.96	0.66-1.39	639 (110)	1.16	0.92-1.47
High-High	1214 (370)	1.22	1.04-1.42	1244 (255)	1.20	1.00-1.45	1319 (116)	1.33	1.00-1.76	1296 (232)	1.21	0.99-1.47
Physical work load												
Low-Low	2351 (633)	1.00	Reference	2390 (423)	1.00	Reference	2508 (168)	1.00	Reference	2480 (382)	1.00	Reference
Low-High	360 (112)	1.17	0.96-1.43	371 (78)	1.17	0.92-1.49	400 (26)	1.09	0.74-1.62	384 (74)	1.32	1.04-1.69
High-Low	359 (104)	1.07	0.87-1.32	369 (63)	0.93	0.71-1.21	396 (30)	0.95	0.63-1.44	398 (80)	1.25	0.96-1.60
High-High	517 (159)	1.17	0.98-1.39	530 (119)	1.30	1.06-1.59	563 (61)	1.66	1.24-2.23	546 (99)	1.22	0.98-1.52

Note: Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in three months preceding Phase 2 were excluded.

Table 3. Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000-2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

	Any psychotropic (*N*=3587)			Antidepressants (N06A) (*N*=3660)			Anxiolytics (N05B) (*N*=3867)			Sedatives and hypnotics (N05C) (*N*=3808)		
	N (cases)	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**
Job control												
High-High	1477 (402)	0.92	0.80-1.07	1499 (264)	085	0.71-1.01	1573 (102)	0.73	0.56-0.96	1559 (245)	0.97	0.81-1.17
High-Low	506 (148)	1.00	0.82-1.21	518 (95)	0.88	0.70-1.12	542 (43)	0.89	0.63-1.27	532 (94)	1.09	0.86-1.40
Low-High	417 (117)	0.95	0.77-1.18	425 (80)	0.90	0.70-1.16	457 (27)	0.66	0.43-1.00	449 (91)	1.29	1.00-1.65
Low-Low	1187 (341)	1.00	Reference	1218 (244)	1.00	Reference	1295 (113)	1.00	Reference	1268 (205)	1.00	Reference
Job demands												
Low-Low	1188 (304)	0.82	0.71-0.96	1208 (205)	0.83	0.69-1.00	1267 (83)	0.75	0.57-1.00	1254 (185)	0.83	0.68-1.01
Low-High	584 (165)	0.90	0.75-1.08	598 (117)	0.91	0.73-1.14	632 (45)	0.79	0.56-1.12	619 (108)	0.99	0.79-1.25
High-Low	601 (169)	0.90	0.75-1.08	610 (106)	0.84	0.67-1.05	649 (41)	0.72	0.50-1.03	639 (110)	0.96	0.77-1.21
High-High	1214 (370)	1.00	Reference	1244 (255)	1.00	Reference	1319 (116)	1.00	Reference	1296 (232)	1.00	Reference
Physical work load												
Low-Low	2351 (633)	0.85	0.72-1.02	2390 (423)	0.77	0.63-0.95	2508 (168)	0.60	0.45-0.81	2480 (382)	0.82	0.66-1.03
Low-High	360 (112)	0.91	0.71-1.17	371 (78)	0.90	0.68-1.20	400 (26)	0.66	0.43-1.02	384 (74)	1.09	0.81-1.46
High-Low	359 (104)	1.00	0.78-1.27	369 (63)	0.72	0.53-0.98	396 (30)	0.57	0.36-0.90	398 (80)	1.03	0.76-1.39
High-High	517 (159)	1.00	Reference	530 (119)	1.00	Reference	563 (61)	1.00	Reference	546 (99)	1.00	Reference

Note: Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in three months preceding Phase 2 were excluded.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	page	Recommendation
Title and abstract	1	p1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		p2	(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
			Introduction
Background/rationale	2	p4-5	Explain the scientific background and rationale for the investigation being reported
Objectives	3	p5	State specific objectives, including any prespecified hypotheses
			Methods
Study design	4	p5-6	Present key elements of study design early in the paper
Setting	5	p5-6	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	p5-6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	p6-8	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	p6-8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	p5-6	Describe any efforts to address potential sources of bias
Study size	10	p5-6	Explain how the study size was arrived at
Quantitative variables	11	p6-8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	p8-9	(*a*) Describe all statistical methods, including those used to control for confounding
		p8-9	(*b*) Describe any methods used to examine subgroups and interactions
		p6	(*c*) Explain how missing data were addressed
		p5-6	(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		NA	(*e*) Describe any sensitivity analyses

Continued on next page

		Results	
Participants	13*	p5-6	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		p5-6	(b) Give reasons for non-participation at each stage
		considered	(c) Consider use of a flow diagram
Descriptive data	14*	p9+Table 1	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		p9	(b) Indicate number of participants with missing data for each variable of interest
		p8-9	(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Tables	*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
			Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	p10+Tables 2-3	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		p7-8	(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	p9	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
		Discussion	
Key results	18	p10-11	Summarise key results with reference to study objectives
Limitations	19	p12-14	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	p14	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	p13	Discuss the generalisability (external validity) of the study results
		Other information	
Funding	22	p1	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Changes in psychosocial and physical working conditions and psychotropic medication in ageing public sector employees: a record-linkage follow-up study

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Changes in psychosocial and physical working conditions and psychotropic medication in ageing public sector employees: a record-linkage follow-up study

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Abstract

Objectives: To investigate whether changes in psychosocial and physical working conditions are associated with subsequent psychotropic medication in ageing employees.

Methods: Data were from the Helsinki Health Study, a cohort study of Finnish municipal employees, aged 40-60 years at Phase 1 (2000-2002). Changes in psychosocial and physical working conditions were measured between Phase 1 and Phase 2 (2007). Survey data were longitudinally linked to data on prescribed, reimbursed psychotropic medication purchases (ATC) obtained from the registers of the Social Insurance Institution of Finland between the Phase 2 survey and December 2013 (N=3587; 80% women). Outcomes were any psychotropic medication; antidepressants (N06A); anxiolytics (N05B); and sedatives and hypnotics (N05C). Cox regression analyses were performed.

Results: During the follow-up 28% of the participants were prescribed psychotropic medication. Repeated exposures to low job control, high job demands and high physical work load were associated with an increased risk of subsequent antidepressant and anxiolytic medication. Increased and repeated exposure to high physical work load, increased job control and repeated high job demands were associated with subsequent sedative and hypnotic medication. Age and sex adjusted hazard ratios varied from 1.18 to 1.66. Improvement in job control was associated with a lower risk of anxiolytic, but with a higher risk of sedatives and hypnotic medication. Decreased physical work load was associated with a lower risk of antidepressant and anxiolytic medication.

Conclusion: Improvement in working conditions could lower the risk of mental ill-health indicated by psychotropic medication.

Keywords: mental health; longitudinal studies; work stress

Abbreviations: ATC, Anatomical Therapeutic Chemical; BMI, body mass index; CI, confidence interval; DDD, defined daily dose; HR, hazard ratio; WHO, World Health Organization

Strengths and limitations of this study

- Unlike previous studies, we were able to examine changes in both psychosocial and physical working conditions.
- Data were derived from a well characterised occupational cohort which was deterministically linked to administrative medication records.
- The use of register-based medication data allowed us to remove the prevalent cases and helped avoid the problems related to use of self-report measures such as recall and common method bias.
- Due to relatively long interval between the two working conditions measurements, the study could have underestimated the effect of changing working conditions on subsequent psychotropic medication.
- We did not have information about the clinical indication the examined medication was prescribed for.

INTRODUCTION

Mental ill-health is a growing concern in working populations.[1] Adverse working conditions have been proposed as potentially modifiable risk factors for mental ill-health.[2] Indeed, there is evidence that exposure to adverse psychosocial working conditions including low job control and high job demands, are associated with an increased risk of mental ill-health.[3–7] However, the majority of earlier studies have measured both exposure and outcome using self-reports, which can lead to inflated associations and common method bias.[8] Other studies have avoided these problems by using register-based outcomes such as psychotropic medication, which is a commonly used marker of mental ill-health in a population.[9–14]

Most of the earlier studies have assessed exposure to adverse working conditions only at one time point, and there is a paucity of large-scale studies examining the association between changes in psychosocial working conditions and mental ill-health. Of a few studies that have separately assessed the effects of changes in job control and job demands on mental ill-health, three found that adverse changes in job demands had a stronger effect on the risk of self-reported mental ill-health than adverse changes in job control, whereas positive changes in these domains did not result in improvement in mental health.[5,15,16] In a recent study within-person increase in job control was associated with better self-reported mental health;[17] and in another study both improvements and deterioration in job demands and job control predicted change in mental health.[18] However, studies assessing the association between changes in job control and job demands and a more objective measure of mental ill-health, such as recorded psychotropic medication, are lacking.

Moreover, psychosocial working conditions have dominated discussion about the work-related determinants of poor mental health, even though there is evidence that also physical working

conditions are associated with mental ill-health. In the present cohort, increased and repeated exposure to repetitive movements and repeated exposure to awkward postures and rotation of back was associated with an increased likelihood of common mental disorders,[16] desktop work was associated with purchases of sleeping pills among women,[19] and computer work was a risk factor for disability retirement due to mental causes.[20] In another study deteriorating physical working conditions increased perceived mental strain.[21] A review of the impact of working environment on mood disorders discussed the potential mechanisms; however actual studies conducted in employee cohorts were rare.[22] In a study among blue-collar workers exposure to noise intensified anxiety and depression in women.[23]

We set out this study to examine the associations between changes in psychosocial and physical working conditions and subsequent psychotropic medication.

METHODS

Data

The data came from the Helsinki Health Study, which is a cohort study designed to investigate social and work-related determinants of health and well-being.[24] The target population is the staff of the City of Helsinki, Finland. Phase 1 questionnaire surveys were collected in 2000, 2001 and 2002 among employees turning 40, 45, 50, 55 or 60 each year (N=8960, response rate 67%; 80% of participants women). Phase 2 survey data were collected in 2007 (N=7332, response rate 83%). Earlier non-response analysis showed that the participants broadly represent the target population.[24] Survey data were linked to national records using a unique personal identification number for those respondents who had given written consent for the linkage (74%; N=6498).

Consenting for the data linkage followed a similar pattern as the non-response, except that men provided consent slightly more often than women.[24,25]

In the present study, of those who consented to linkage, only participants who were still employed at Phase 2 were included (N=4207). Men, manual workers and those who reported common mental disorders at Phase 1 had slightly more often left the employment between the two phases (all *p* values < 0.01, data not shown). Because of the age structure of the cohort, the majority (86%) of those who replied at Phase 2 and stated that they were not employed, had retired.

In addition, we excluded those with purchases of psychotropic medication in three months preceding Phase 2 (n=337 for any psychotropic medication). Finally, we excluded those participants who had missing values for any of the study variables (n=283). The exclusions resulted in a final analytic sample of 3587 participants for the analyses examining any psychotropic medication.

Ethics

The Helsinki Health Study protocol was approved by the Ethics Committees of the Department of Public Health, University of Helsinki, and the health authorities of the City of Helsinki. The study conformed to the principles embodied in the Declaration of Helsinki.

Measurements

Working conditions

We used a version of Karasek's Job Content Questionnaire[26] to measure job control and job demands. Job control was assessed by nine and job demands by five items. Missing values were replaced by item modes for those having responded to at least eight job control and four job demands items, respectively. Job control and job demands were both dichotomised at the median.[9,27]

Physical work load was assessed with an 18-item instrument developed at the Finnish Institute of Occupational Health.[28] Missing values were replaced by item modes for those having responded to at least fourteen items. Factor analysis showed that the questions loaded on three factors, of which the first one was interpreted to best measure physical work load. The items with the largest positive standardised scoring coefficients were: awkward working positions; rotation of the back; repetitive movements; and heavy physical effort or lifting and carrying heavy loads. Physical work load factor score was dichotomised at the highest quartile.[29]

Changes in psychosocial and physical working conditions were measured by a four-category variable for each of the three exposure variables: (i) repeated low exposure (low exposure at Phase 1 and low exposure at Phase 2); (ii) increased exposure (low exposure at Phase 1 and high exposure at Phase 2); (iii) decreased exposure (high exposure at Phase 1 and low exposure at Phase 2); (iv) repeated high exposure (high exposure at Phase 1 and high exposure at Phase 2).[30]

Psychotropic medication

Data on psychotropic medication were derived from the Finnish Prescription Register. This register is maintained by the Social Insurance Institution and it includes records of all prescribed psychotropic medication purchases reimbursed to Finnish residents in non-institutional settings. For

each dispensed drug, the record includes the dispensing date, the WHO Anatomical Therapeutic Chemical (ATC) code, and the quantity prescribed and purchased as the number of defined daily doses (DDDs).[31] We extracted information on all purchases of antidepressants, anxiolytics, sedatives and hypnotics (ATC-codes N06A, N05B and N05C, respectively; see Appendix 1) in our analytic sample, following Phase 2 survey date (index date) during the follow-up until December 31, 2013. Dates of deaths were retrieved from Statistics Finland (the Causes of Death Register).

Covariates

All covariates were survey-based and from Phase 1. We measured age, sex and marital status (married/cohabiting vs. other). Moreover, we measured current smoking (yes vs. no), binge drinking (six or more units of alcohol on one occasion once a month or more often), low physical activity (less than 14 metabolic equivalent hours per week) and body mass index, which was categorosed as non-obese (≤ 30 kg/m^2) and obese (>30 kg/m^2).

Statistical analysis

The associations between sex, age and psychotropic medication during the follow-up were first analysed using the Chi-square test. Cox proportional hazard models were fitted to examine the association between change in psychosocial and physical working conditions between Phase 1 and Phase 2 and subsequent psychotropic medication during the follow-up. We estimated hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for psychotropic medication by changes in each working condition by first controlling for age and sex; then further controlling for marital status, smoking, binge drinking, low physical activity, and obesity. In the first analysis, for each working condition, the reference group was the most favourable working condition (i.e. repeated high control, repeated low demands, and repeated high physical work load, respectively). To

examine the effects of positive changes in working conditions, we conducted an additional analysis using the least favourable working condition as the reference group. The follow-up began from the date of the Phase 2 survey response and ended at the first record of the psychotropic medication purchase, death, or on 31 December, 2013, whichever came first.

We conducted the Therneau-Grambsch nonproportional hazards test, complementing it with the smoothed scatter plot of Schoenfeld residuals against explanatory variables. The visual inspection of the scatter plots supports the interpretation that the proportional hazards assumption was met. The scatter plots for any psychotropic medication are presented in Appendix 2. Moreover, the interaction terms between each working condition and logarithm of the follow-up period for any psychotropic medication as well as for each medication group were non-significant (all $p > 0.05$), further confirming that the proportional-hazards assumption was justified

None of the gender interactions were statistically significant (all interaction terms sex*working condition $p>0.05$); we therefore analysed women and men together, adjusting for gender.

The analyses were conducted with SAS 9.4 (SAS Institute, Inc., Cary, North Carolina) and R.

RESULTS

Table 1 shows the distribution of the key study variables by any prescribed psychotropic medication during follow-up. The mean age at baseline was 47.5 years. A total of 1008 participants (28%) recorded at least one purchase of prescribed psychotropic medication during the mean follow-up of 5.0 years. Psychotropic medication was more prevalent among women (29%) than among men (23%). Nineteen percent of the participants received antidepressant medication during

the follow-up. The corresponding figures for anxiolytics and for hypnotics/sedatives were 7% and 17%, respectively.

As displayed in **Table 2,** after adjustment for age and sex, repeated high job demands (HR=1.22, 95% CI: 1.04-1.42) were associated with any psychotropic medication. The association between repeated high physical work load and any psychotropic medication was marginally statistically significant (HR=1.17, 95% CI: 0.98-1.39). Figures 1, 2 and 3 show survival curves for any psychotropic medication by changes in working conditions.

When the groups of psychotropic medication were examined separately, repeated high job demands (HR=1.20, 95% CI: 1.00-1.45) and repeated high physical work load (HR=1.30, 95% CI: 1.06-1.59) were associated with subsequent antidepressant medication, whereas repeated low job control (1.37, 95% CI: 1.05-1.79), repeated high demands (HR=1.33, 95% CI: 1.00-1.76), and repeated high physical work load (HR=1.66, 95% CI: 1.24-2.23) were associated with subsequent anxiolytic medication. Increased job control and increased physical work load were associated with subsequent sedative and hypnotic medication. Repeated high demands and repeated physical work load showed associations with subsequent sedative and hypnotic medication. Further adjustment for marital status, health behaviours, and obesity only marginally changed the HRs (data not shown).

We additionally tested whether favourable change in working conditions was associated with a lower risk of psychotropic medication, by using the least favourable working conditions as reference categories (Table 3). Compared to repeatedly low job control, increased job control was associated with a lower risk of anxiolytic, but a higher risk of sedative and hypnotic medication. Compared to repeatedly high physical work load, decreased physical load was associated with a lower risk of subsequent antidepressant and anxiolytic medication.

DISCUSSION

In this study, repeated and increased exposure to adverse psychosocial and physical working conditions was associated with subsequent psychotropic medication. It is notable that we found similar associations for both types of working conditions. However, the associations between adverse working conditions and subsequent psychotropic medication were modest. This is expected: the aetiology of mental disorders – the main indication for psychotropic medication - is complex and multifactorial, involving multiple social, psychological and biological factors.[32] Exposure to adverse working conditions or a positive or negative change in them is only one such factor.

Compared to employees with repeated low job demands, the employees whose job demands had increased had a higher risk of purhasing any psychotropic medication as well as antidepressant medication. Antidepressant medication is likely to reflect depression and other mental disorders. A number of previous studies have shown a link between high job demands and an increased risk of mental ill-health.[3,15,16,33]

Previous results for job control have been mixed. In a meta-analytic review published in 2006 low decision latitude predicted common mental disorders.[3] In terms of more objective outcomes, null results have been reported for psychotropic prescriptions,[13,34] whereas one previous study showed an association between high decision authority and an elevated risk of hospital admissions due to mental disorders.[35] In our study increased job control was associated with a subsequent sedative and hypnotic medication. In a previous study, active jobs, that is, those with high levels of control and demands, were associated with a higher risk of depression and burnout.[36] It is possible that increased decision authority and high responsibility may become a burden for some employees. It is also possible that high job control reflects not only working conditions but also

characteristics of a generally more active employee with a higher likelihood of seeking treatment.[35]

The result that increased job control was associated with a lower risk of anxiolytic, but a higher risk of sedative and hypnotic medication seems conflicting and is difficult to explain. This result may reflect the fact that some anxiolytics (e.g. lorazepam, diazepam) can be used as hypnotics as well, and a switch between some anxiolytic benzodiazepine and hypnotic benzodiazepine could confound these associations. Unfortunately we had no information about the indication of the medication use.

When comparing to the least favourable working conditions, increased job control was associated with a lower risk of anxiolytic medication; and decreased physical load was associated with a lower risk of antidepressant and anxiolytic medication. Two earlier studies did not find an association between favourable changes in psychosocial working conditions and a decreased risk of subsequent mental ill-health.[15,37] However, in one previous study both improvements and deterioration in job demands and control were associated with corresponding improvements or deterioration in mental health,[18] and in another study decrease of job strain was associated with a lower likelihood of repeated insomnia symptoms.[38]

Most of the earlier studies have investigated only psychosocial working conditions. In the present study repeatedly high and increased physical work load were associated with subsequent psychotropic medication. In fact, the strongest association (HR=1.66 for anxiolytic medication) between working conditions and psychotropic medication was found for repeated high physical workload. Our findings thus support the earlier findings in the present and other cohorts, which have shown associations between exposure to adverse physical working conditions and common

mental disorders,[16] disability retirement due to mental disorders,[20] purchases of sleeping pills,[19] and perceived mental strain.[21]

Methodological considerations

Certain limitations need to be acknowledged. First, because of the relatively long interval between the two working conditions measurements, this study could have underestimated the effect of changing working conditions on subsequent medication. Moreover, working conditions could have changed several times during the follow-up; this could have resulted in more conservative effect sizes.

Second, we were unable to assess the magnitude of change in working conditions; the use of these crude measures only assessed whether a participant had moved from one category to another. Furthermore, we did not have information about the prior duration of exposure to adverse working conditions. The use of thresholds may have led to underestimates of true effects of changing working conditions.[5]

Third, we did not have information about clinical indication the examined medication was prescribed for. Even if psychotropic medication is a recommended treatment for a number of mental disorders and prescription data derived from official registers can therefore be considered as a proxy for mental disorders requiring treatment, these medications are prescribed also for other conditions. On the other hand, it has been shown that mental disorders are underdiagnosed and undertreated.[39]

Fourth, we did not have information about the discontinuation of psychotropic medication. Even if the participants had purchased the prescribed medication from the pharmacy, they could have

discontinued the use. Discontinuation of psychotropic drugs can lead to different meanings: the discontinuation of antidepressants can be associated with either side effects or lack of follow-up controls, whereas sporadic use of anxiolytics and hypnotics can be due to temporary discomfort.

Fifth, participants who left employment between Phase 1 and Phase 2 were not included in the study. It has been suggested that the age-related health selection may result in a more resilient older worker population [37]. A healthy worker effect may thus have led to underestimation of the associations.

Finally, even if the data consisted of a broad range of both manual and non-manual occupations, the study population was not a representative sample of the total working population. Because the Finnish public sector workforce is female-dominated, women were over-represented also in this sample. Moreover, the present sample consisted only of ageing employees with stable and secure long-term employment and working in the capital city. Therefore the results may be generalisable, with caution, to the Finnish municipal sector, but might not be generalisable to other age groups, cohorts and industries.

Despite of these limitations, the present study has a number of strengths. The main strengths are the use of prospective design which enabled us to examine changes in working conditions, data derived from a well characterised occupational cohort, minor attrition, deterministic linkage to administrative medication records, and an ability to examine changes in both psychosocial and physical working conditions. Psychotropic medication data were based on a physician's prescription and cover virtually all reimbursed psychotropic prescriptions for the analytic sample. The use of register-based medication data allowed us to remove the prevalent cases and helped avoid the problems related to use of self-report measures such as recall and common method bias. Extensive

non-response analyses were available and showed only small non-participation bias. We were able to adjust for a number of important covariates such as health behaviours and obesity.

CONCLUSION

To conclude, this study showed that established psychosocial risk factors such as repeated exposure to high job demands and low control are associated with subsequent psychotropic medication in midlife and older employees. Furthermore, the results showed that also repeated and increased exposure to adverse physical working conditions may contribute to subsequent psychotropic medication. Identification of these potentially modifiable risk factors implies possibilities for prevention.[40] Theory-based, organisationally focused interventions to tackle adverse working conditions might be beneficial. Evidence for this is emerging. An intervention study in Canadian hospitals showed an intervention to reduce work stress was able to produce beneficial long-term effects on hospital employees' emotional well-being, in particular through reducing professional burnout.[41] However, well-designed randomized controlled trials with reliable and valid objective indicators of working conditions are needed to reliably test whether intentional workplace interventions can prevent employee mental ill-health.

Conflicts of interest: None declared

Author contributions:

All authors jointly designed and conceptualised the study. Anne Kouvonen directed the implementation of the study, led all aspects of the work, and drafted the article. Anne Kouvonen and Olli Pietiläinen performed the data analysis. Tea Lallukka, Eero Lahelma, Olli Pietiläinen and Ossi Rahkonen contributed to acquisition of data. Minna Mänty, Tea Lallukka, Olli Pietiläinen,

Eero Lahelma and Ossi Rahkonen contributed to designing the study's analytic strategy, interpreting findings, reviewing the article and revising it critically for important intellectual content. All authors approved the manuscript's submission for publication.

Data sharing statement: No additional data available.

Figure legends

Figure 1. Survival curves for any psychotropic medication by changes in job control

Figure 2. Survival curves for any psychotropic medication by changes in job demands

Figure 3. Survival curves for any psychotropic medication by changes in physical working conditions

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Table 1. Distribution of demographics (Phase 1; 2000-2002), working conditions (Phase 1 – Phase 2; 2007) and any psychotropic medication* between Phase 2 and 2013, the Helsinki Health Study, Finland (%) (*N*=3587)

	No medication *N* (%)	Medication *N* (%)	Mean DDDs (SD)†
Sex			
Women	2034 (71)	847 (29)	496.0 (773.3)
Men	545 (77)	161 (23)	487.1 (793.0)
Age			
40	632 (72)	247 (28)	587.5 (949.9)
45	636 (68)	298 (32)	537.6 (788.6)
50	664 (72)	259 (28)	429.5 (660.0)
55	627 (76)	196 (24)	391.2 (627.2)
60	20 (71)	8 (29)	666.2 (818.6)
Job control			
High-High	1075 (73)	402 (27)	453.2 (806.6)
High-Low	358 (71)	148 (29)	458.3 (793.9)
Low-High	300 (72)	117 (28)	541.5 (761.1)
Low-Low	846 (71)	341 (29)	543.1 (749.3)
Job demands			
Low-Low	554 (74)	304 (26)	411.6 (647.4)
Low-High	419 (72)	165 (28)	476.1 (716.0)
High-Low	432 (72)	169 (28)	463.7 (694.2)
High-High	844 (70)	370 (30)	585.1 (915.3)
Physical work load			
Low-Low	1718 (73)	633 (27)	500.2 (767.4)
Low-High	248 (869)	112 (31)	455.4 (679.6)
High-Low	255 (71)	104 (29)	428.1 (704.8)
High-High	358 (69)	159 (31)	543.4 (909.2)

*Participants with psychotropic medication purchases in three months preceding Phase 2 were excluded.

† Mean of defined daily doses (DDDs) and their standard deviations (SDs) in those who had psychotropic medication purchases during follow-up.

Table 2. Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000-2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

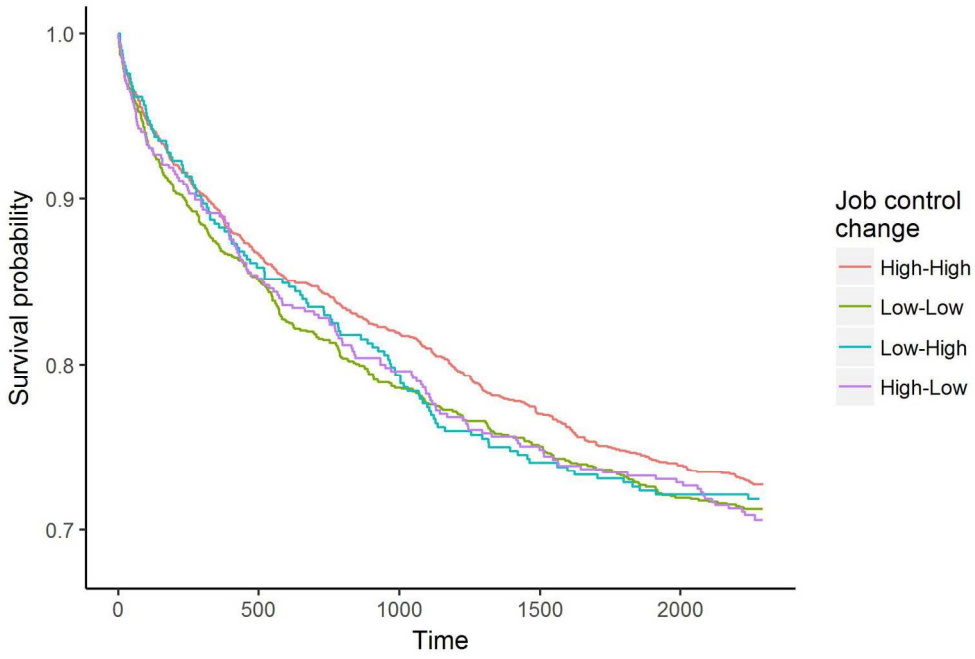
	Any psychotropic (*N*=3587)			Antidepressants (N06A) (*N*=3660)			Anxiolytics (N05B) (*N*=3867)			Sedatives and hypnotics (N05C) (*N*=3808)		
	N (cases)	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**
Job control												
High-High	1477 (402)	1.00	Reference	1499 (264)	1.00	Reference	1573 (102)	1.00	Reference	1559 (245)	1.00	Reference
High-Low	506 (148)	1.08	0.90-1.31	518 (95)	1.04	0.82-1.32	542 (43)	1.22	0.86-1.74	532 (94)	1.13	0.89-1.43
Low-High	417 (117)	1.03	0.84-1.27	425 (80)	1.06	0.83-1.36	457 (27)	0.90	0.59-1.38	449 (91)	1.33	1.04-1.69
Low-Low	1187 (341)	1.08	0.94-1.25	1218 (244)	1.18	0.99-1.41	1295 (113)	1.37	1.05-1.79	1268 (205)	1.03	0.86-1.24
Job demands												
Low-Low	1188 (304)	1.00	Reference	1208 (205)	1.00	Reference	1267 (83)	1.00	Reference	1254 (185)	1.00	Reference
Low-High	584 (165)	1.09	0.90-1.32	598 (117)	1.10	0.88-1.38	632 (45)	1.05	0.73-1.52	619 (108)	1.20	0.94-1.52
High-Low	601 (169)	1.09	0.91-1.32	610 (106)	1.01	0.80-1.27	649 (41)	0.96	0.66-1.39	639 (110)	1.16	0.92-1.47
High-High	1214 (370)	1.22	1.04-1.42	1244 (255)	1.20	1.00-1.45	1319 (116)	1.33	1.00-1.76	1296 (232)	1.21	0.99-1.47
Physical work load												
Low-Low	2351 (633)	1.00	Reference	2390 (423)	1.00	Reference	2508 (168)	1.00	Reference	2480 (382)	1.00	Reference
Low-High	360 (112)	1.17	0.96-1.43	371 (78)	1.17	0.92-1.49	400 (26)	1.09	0.74-1.62	384 (74)	1.32	1.04-1.69
High-Low	359 (104)	1.07	0.87-1.32	369 (63)	0.93	0.71-1.21	396 (30)	0.95	0.63-1.44	398 (80)	1.25	0.96-1.60
High-High	517 (159)	1.17	0.98-1.39	530 (119)	1.30	1.06-1.59	563 (61)	1.66	1.24-2.23	546 (99)	1.22	0.98-1.52

Note: Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in three months preceding Phase 2 were excluded.

Table 3. Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000-2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

	Any psychotropic (*N*=3587)			Antidepressants (N06A) (*N*=3660)			Anxiolytics (N05B) (*N*=3867)			Sedatives and hypnotics (N05C) (*N*=3808)		
	N (cases)	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**
Job control												
High-High	1477 (402)	0.92	0.80-1.07	1499 (264)	085	0.71-1.01	1573 (102)	0.73	0.56-0.96	1559 (245)	0.97	0.81-1.17
High-Low	506 (148)	1.00	0.82-1.21	518 (95)	0.88	0.70-1.12	542 (43)	0.89	0.63-1.27	532 (94)	1.09	0.86-1.40
Low-High	417 (117)	0.95	0.77-1.18	425 (80)	0.90	0.70-1.16	457 (27)	0.66	0.43-1.00	449 (91)	1.29	1.00-1.65
Low-Low	1187 (341)	1.00	Reference	1218 (244)	1.00	Reference	1295 (113)	1.00	Reference	1268 (205)	1.00	Reference
Job demands												
Low-Low	1188 (304)	0.82	0.71-0.96	1208 (205)	0.83	0.69-1.00	1267 (83)	0.75	0.57-1.00	1254 (185)	0.83	0.68-1.01
Low-High	584 (165)	0.90	0.75-1.08	598 (117)	0.91	0.73-1.14	632 (45)	0.79	0.56-1.12	619 (108)	0.99	0.79-1.25
High-Low	601 (169)	0.90	0.75-1.08	610 (106)	0.84	0.67-1.05	649 (41)	0.72	0.50-1.03	639 (110)	0.96	0.77-1.21
High-High	1214 (370)	1.00	Reference	1244 (255)	1.00	Reference	1319 (116)	1.00	Reference	1296 (232)	1.00	Reference
Physical work load												
Low-Low	2351 (633)	0.85	0.72-1.02	2390 (423)	0.77	0.63-0.95	2508 (168)	0.60	0.45-0.81	2480 (382)	0.82	0.66-1.03
Low-High	360 (112)	0.91	0.71-1.17	371 (78)	0.90	0.68-1.20	400 (26)	0.66	0.43-1.02	384 (74)	1.09	0.81-1.46
High-Low	359 (104)	1.00	0.78-1.27	369 (63)	0.72	0.53-0.98	396 (30)	0.57	0.36-0.90	398 (80)	1.03	0.76-1.39
High-High	517 (159)	1.00	Reference	530 (119)	1.00	Reference	563 (61)	1.00	Reference	546 (99)	1.00	Reference

Note: Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in three months preceding Phase 2 were excluded.



Survival curves for any psychotropic medication by changes in job control

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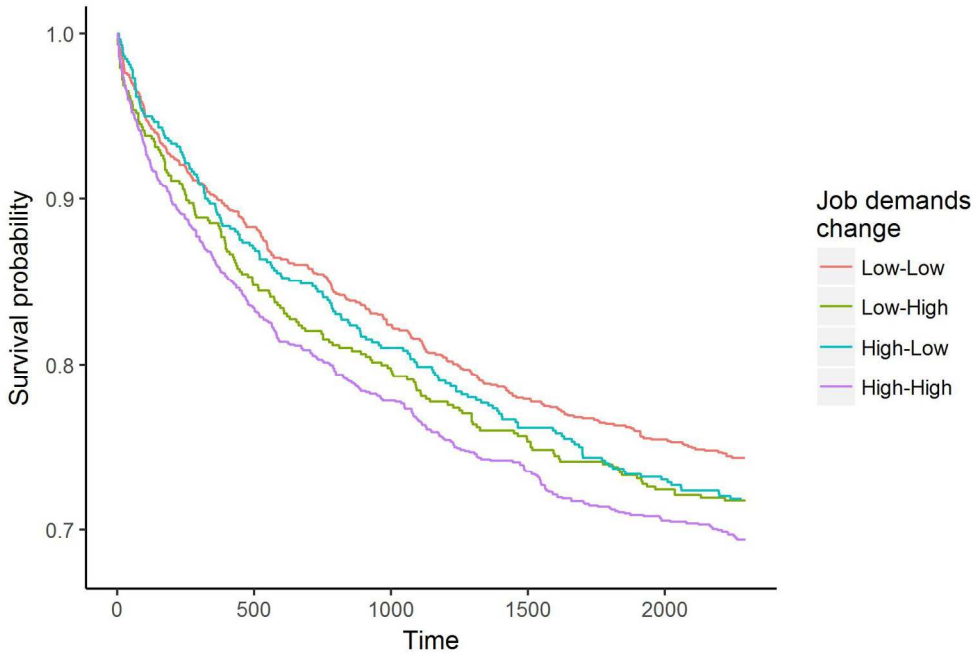

Survival curves for any psychotropic medication by changes in job demands

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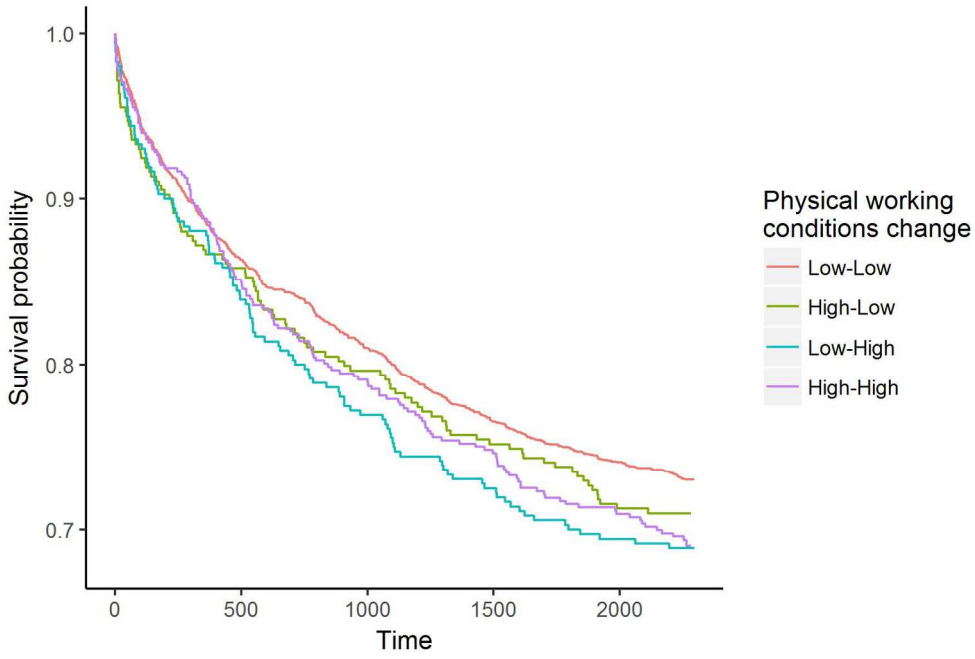


Caption : Survival curves for any psychotropic medication by changes in physical working conditions

152x101mm (300 x 300 DPI)

Appendix 1

1 N06A Antidepressants

- 1.1 N06AA Non-selective monoamine reuptake inhibitors
- 1.2 N06AB Selective serotonin reuptake inhibitors
- 1.3 N06AF Monoamine oxidase inhibitors, non-selective
- 1.4 N06AG Monoamine oxidase A inhibitors
- 1.5 N06AX Other antidepressants

2 N05B Anxiolytics

- 2.1 N05BA Benzodiazepine derivatives
- 2.2 N05BB Diphenylmethane derivatives
- 2.3 N05BC Carbamates
- 2.4 N05BD Dibenzo-bicyclo-octadiene derivatives
- 2.5 N05BE Azaspirodecanedione derivatives
- 2.6 N05BX Other anxiolytics

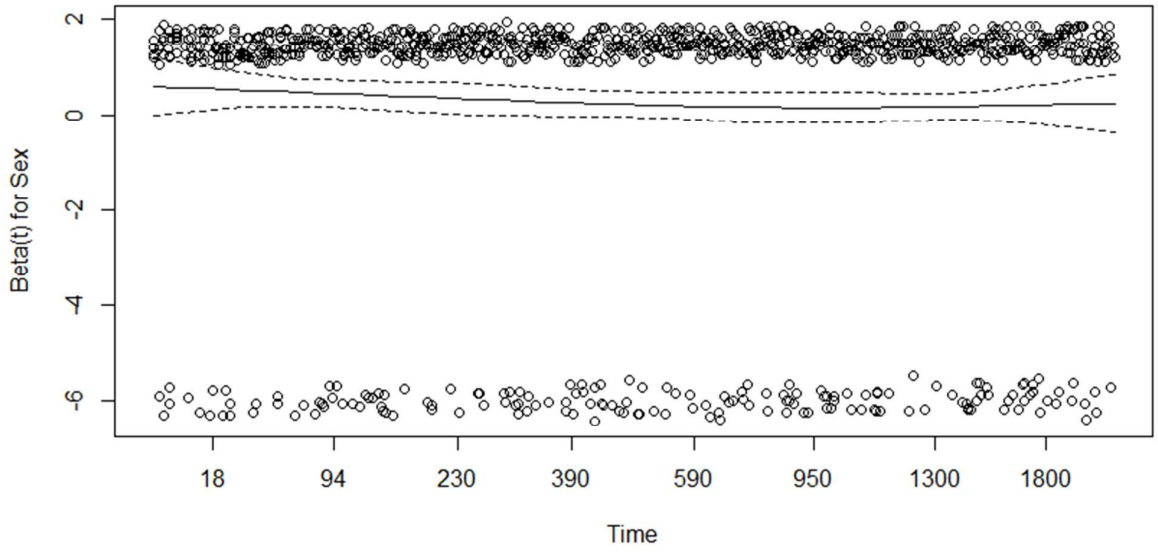
3 N05C Hypnotics and sedatives

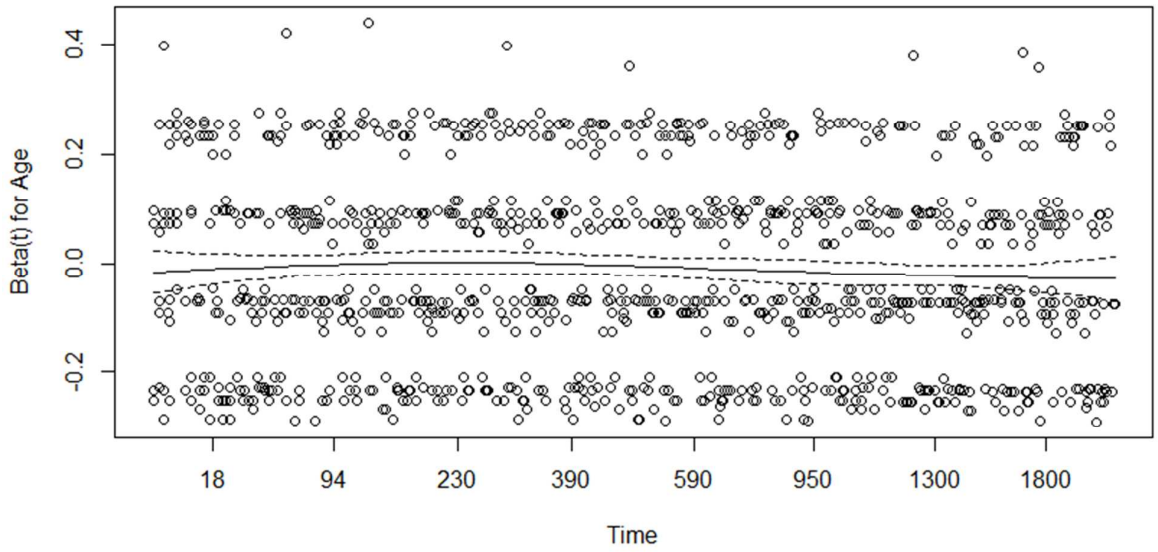
- 3.1 N05CA Barbiturates, plain
- 3.2 N05CB Barbiturates, combinations
- 3.3 N05CC Aldehydes and derivatives
- 3.4 N05CD Benzodiazepine derivatives
- 3.5 N05CE Piperidinedione derivatives
- 3.6 N05CF Benzodiazepine related drugs
- 3.7 N05CH Melatonin receptor agonists
- 3.8 N05CM Other hypnotics and sedatives
- 3.9 N05CX Hypnotics and sedatives in combination, excluding barbiturates

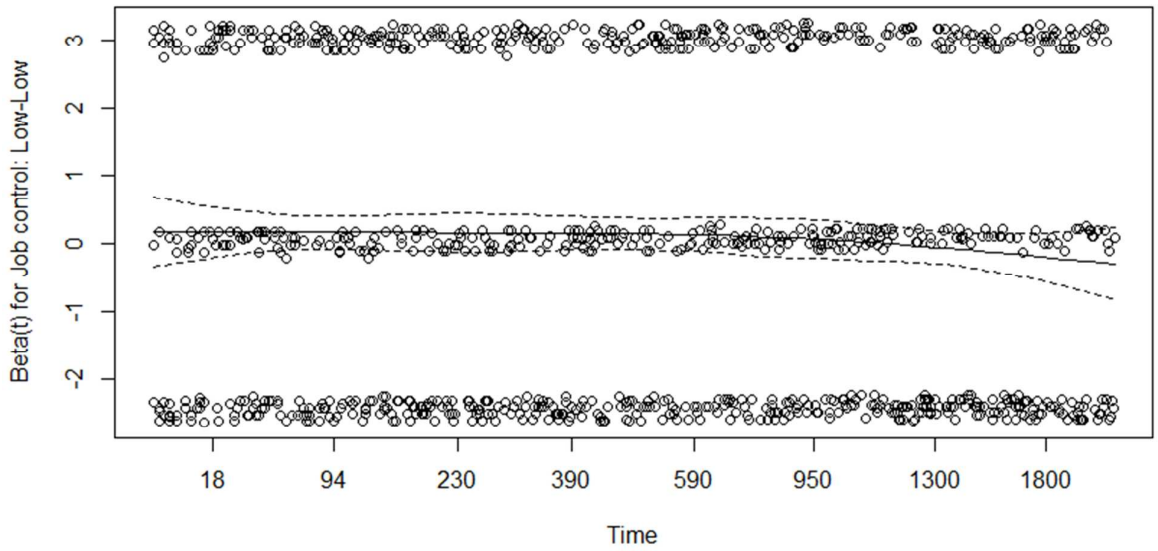
Appendix 2.

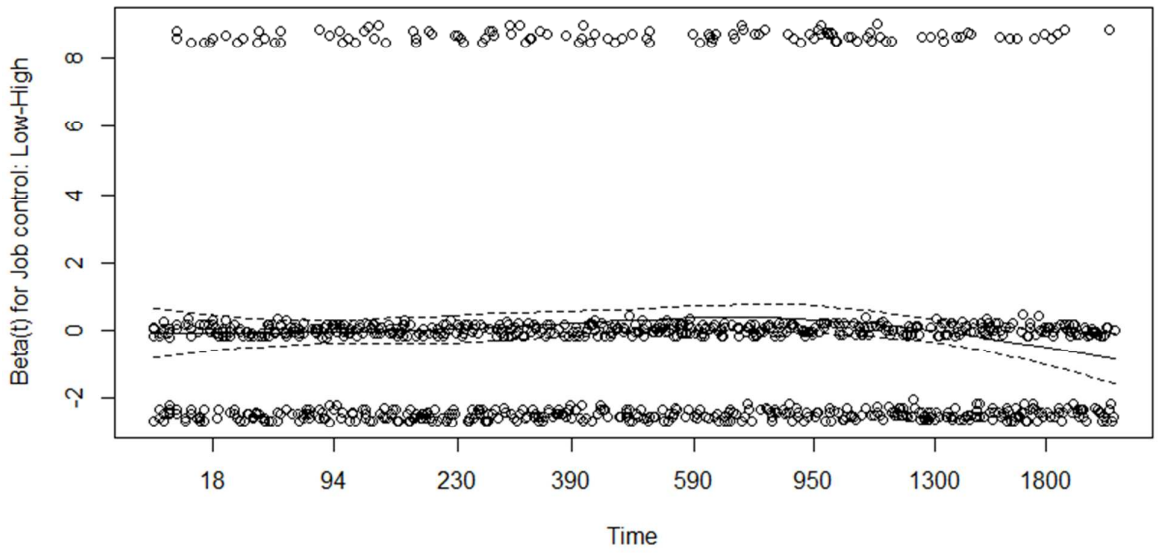
Smoothed scatter plots of Schoenfeld residuals against explanatory variables

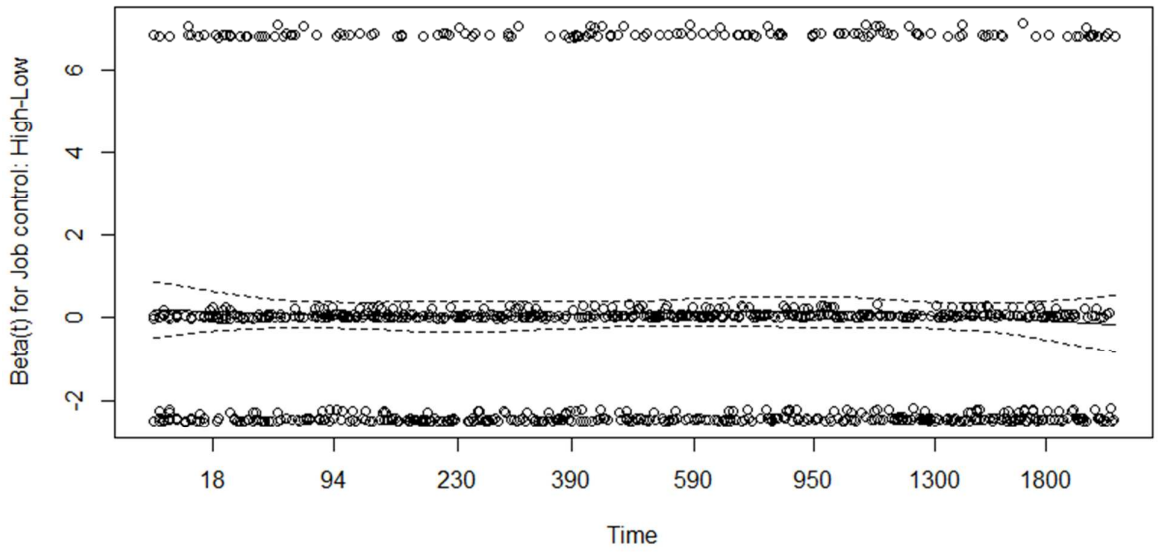
Any psychotropic – change in job control



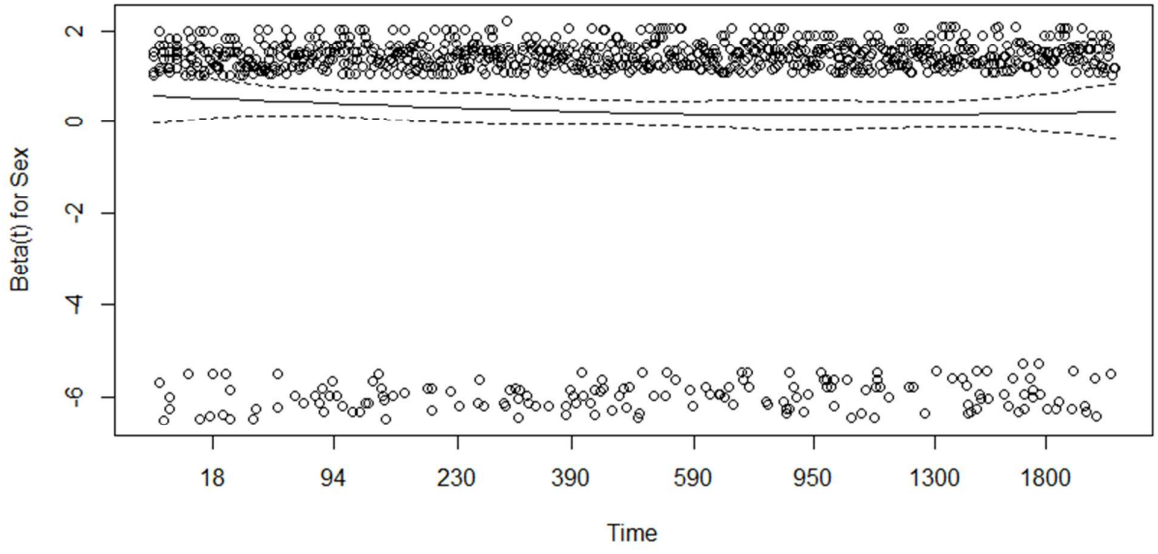


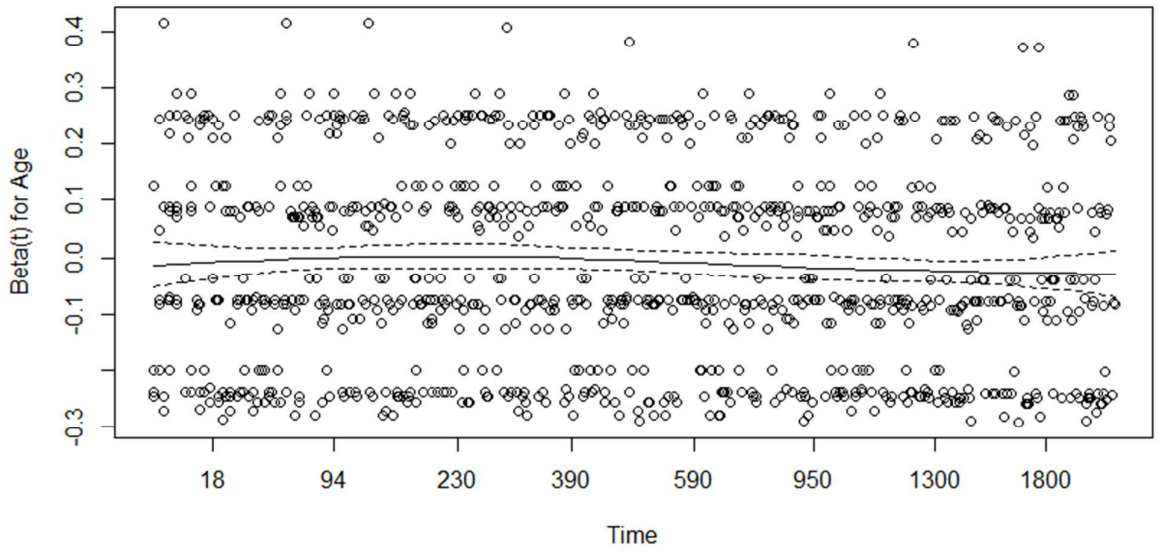


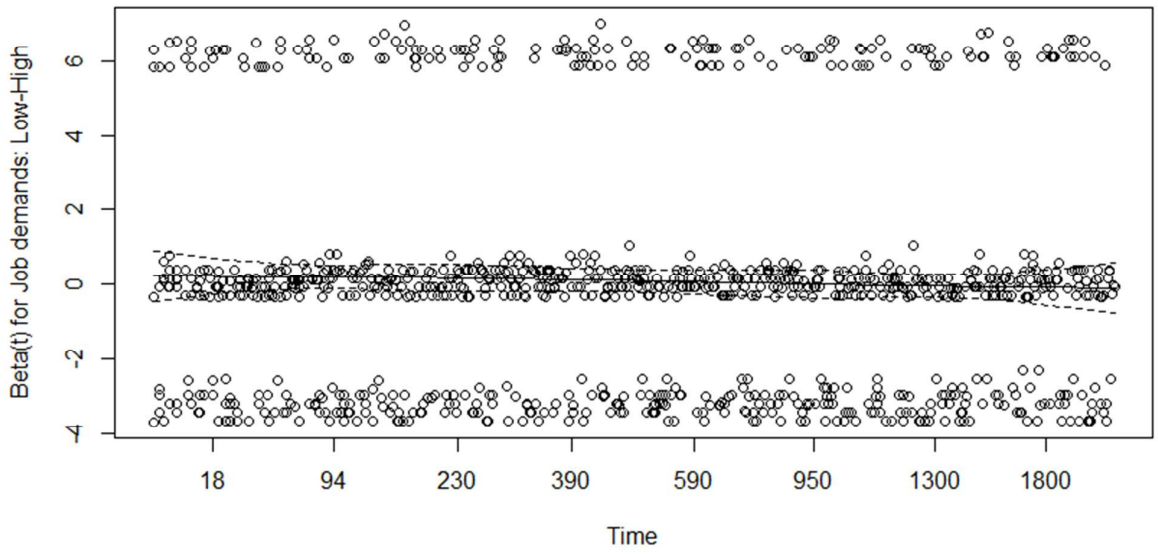


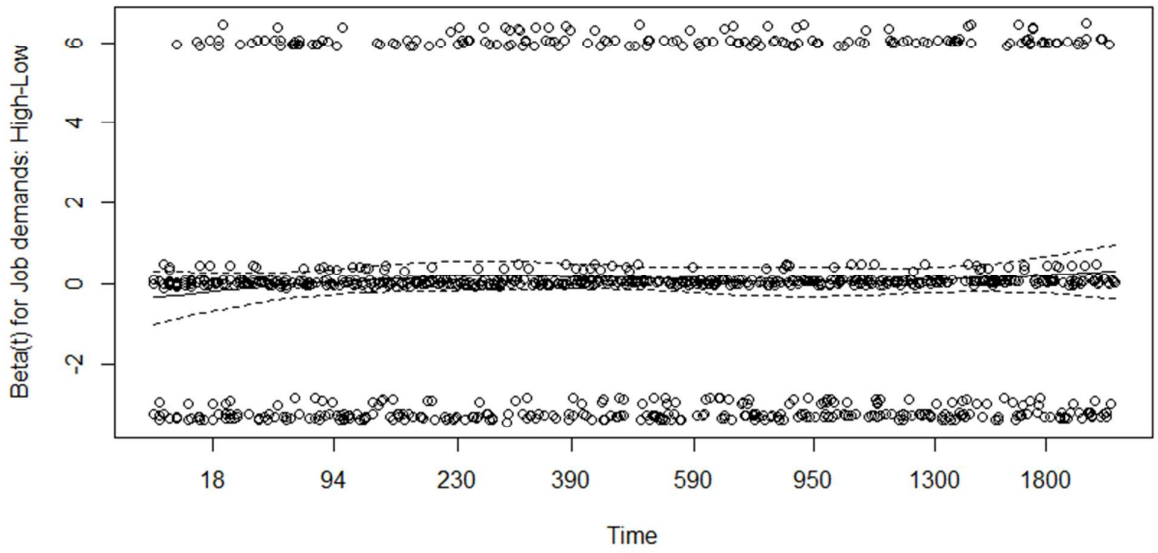


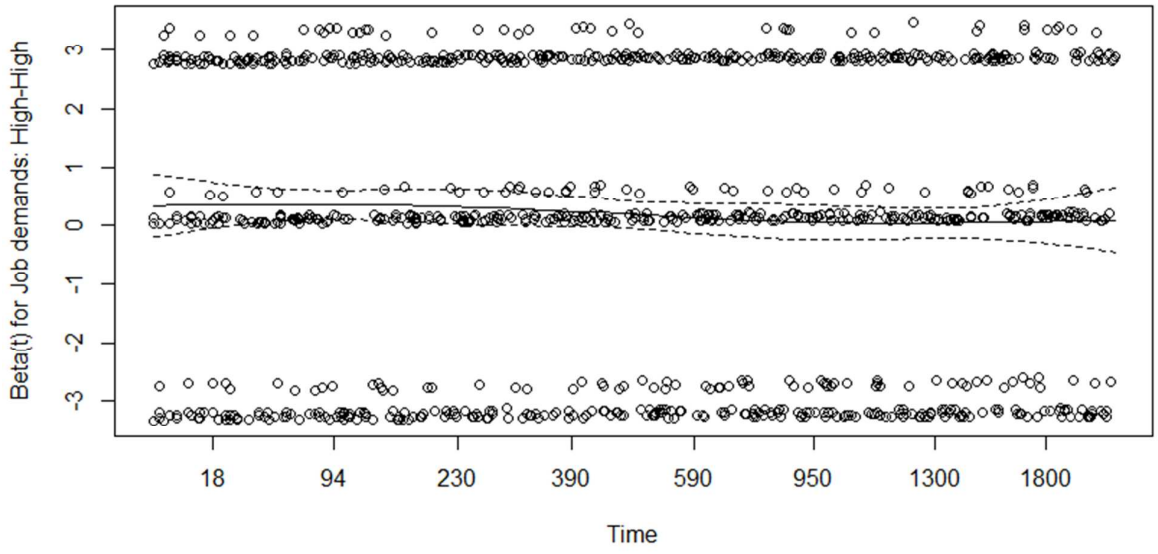
Any psychotropic – change in job demands



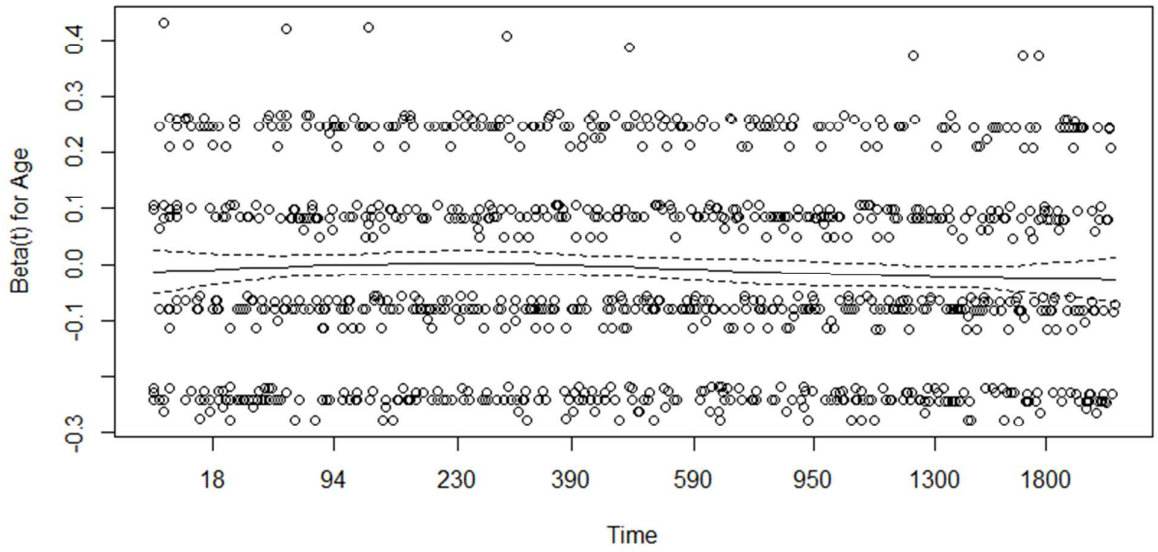


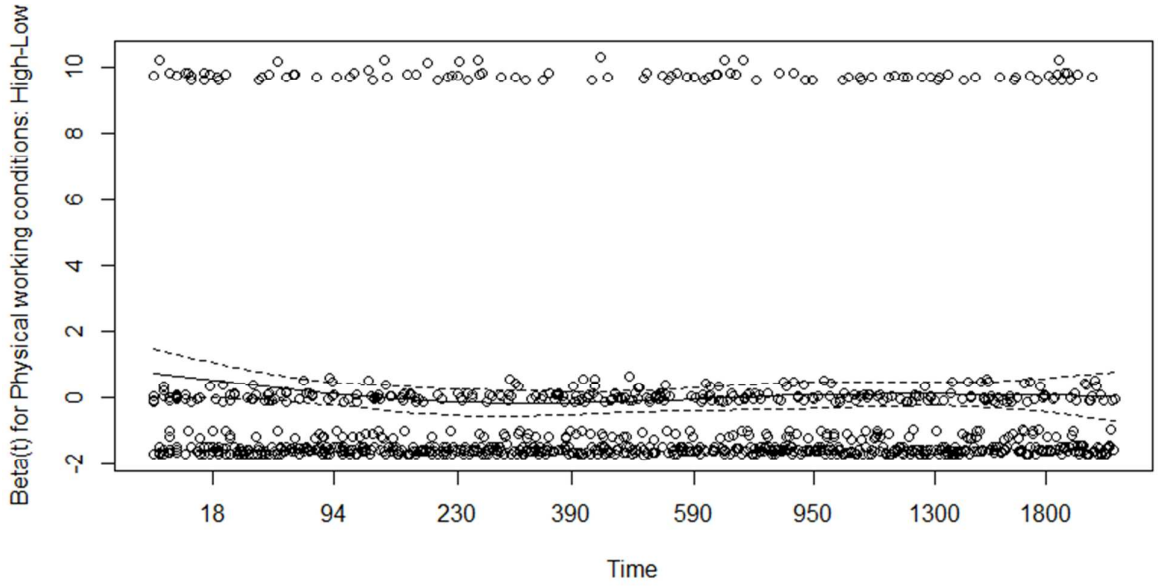


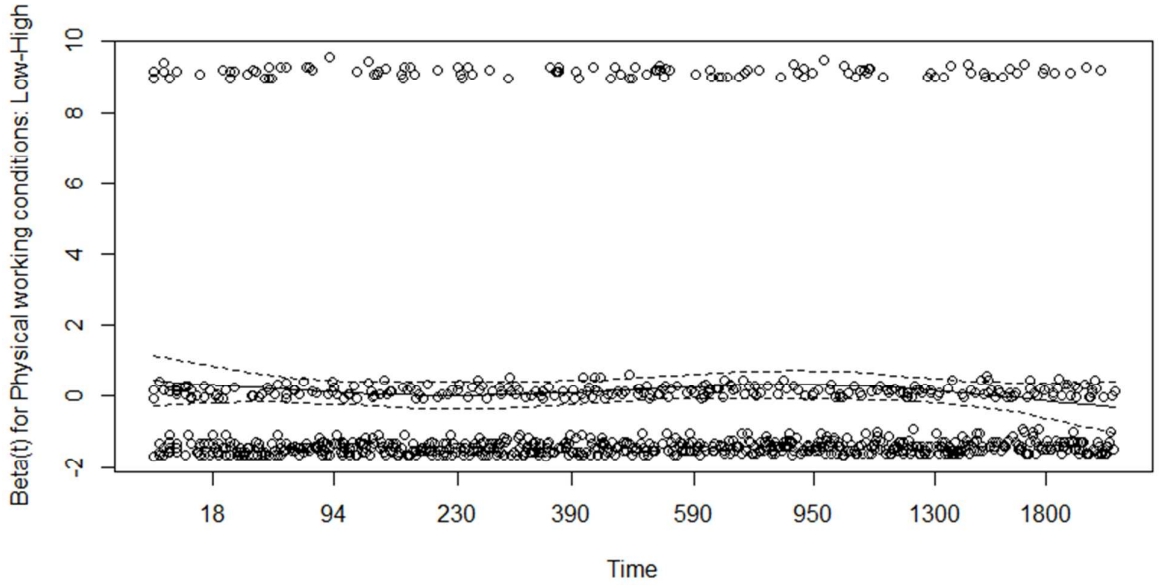


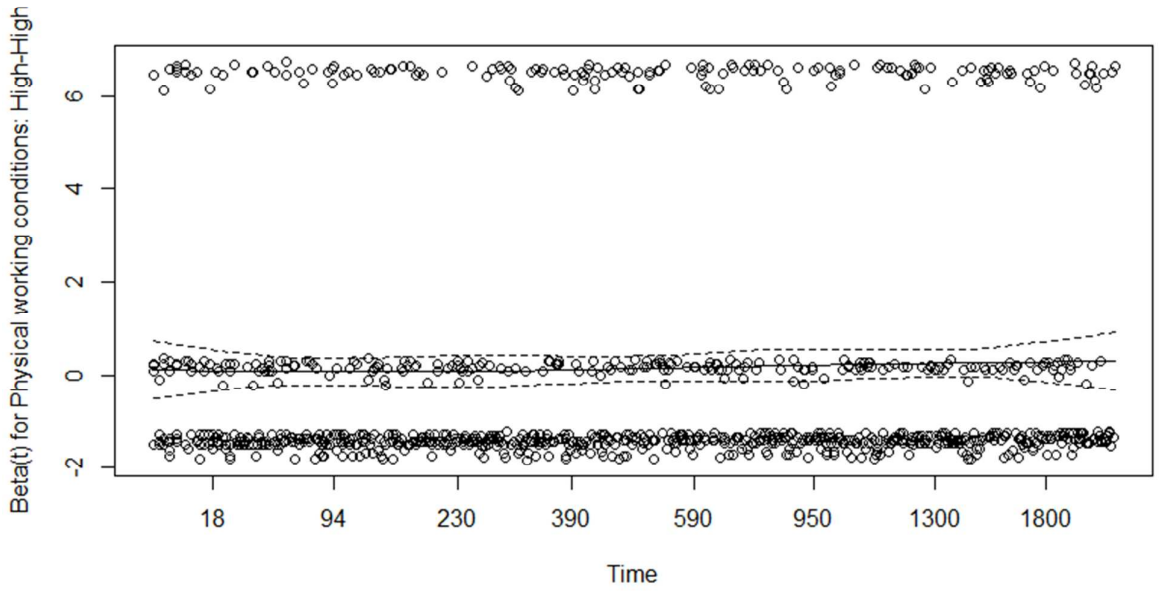


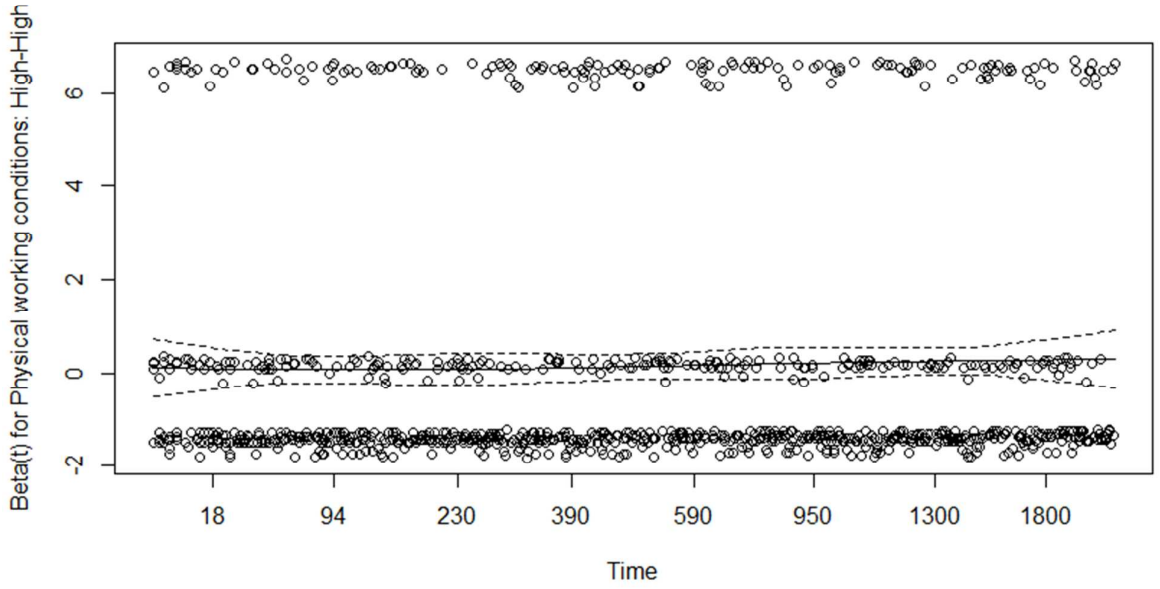
Any psychotropic – change in physical working conditions

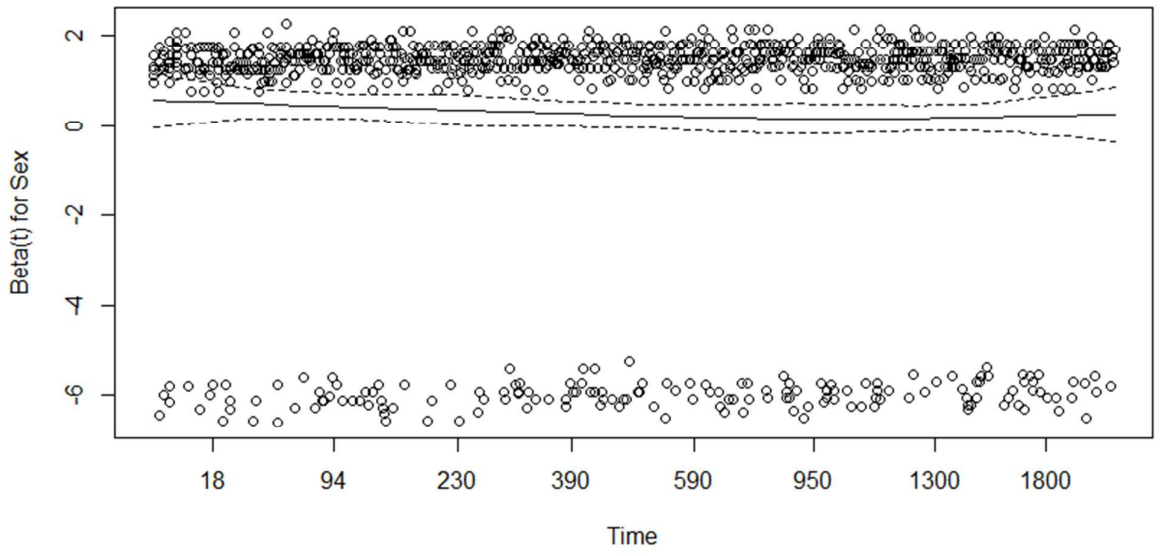












STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	page	Recommendation
Title and abstract	1	p1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		p2	(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/rationale	2	p4-5	Explain the scientific background and rationale for the investigation being reported
Objectives	3	p5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	4	p5-6	Present key elements of study design early in the paper
Setting	5	p5-6	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	p5-6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	p6-8	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	p6-8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	p5-6	Describe any efforts to address potential sources of bias
Study size	10	p5-6	Explain how the study size was arrived at
Quantitative variables	11	p6-8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	p8-9	(*a*) Describe all statistical methods, including those used to control for confounding
		p8-9	(*b*) Describe any methods used to examine subgroups and interactions
		p6	(*c*) Explain how missing data were addressed
		p5-6	(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		NA	(*e*) Describe any sensitivity analyses

Continued on next page

		Results	
Participants	13*	p5-6	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		p5-6	(b) Give reasons for non-participation at each stage
		considered	(c) Consider use of a flow diagram
Descriptive data	14*	p9+Table 1	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		p9	(b) Indicate number of participants with missing data for each variable of interest
		p8-9	(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Tables	*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
			Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	p10+Tables 2-3	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		p7-8	(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	p9	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
		Discussion	
Key results	18	p10-11	Summarise key results with reference to study objectives
Limitations	19	p12-14	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	p14	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	p13	Discuss the generalisability (external validity) of the study results
		Other information	
Funding	22	p1	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Changes in psychosocial and physical working conditions and psychotropic medication in ageing public sector employees: a record-linkage follow-up study

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Keywords:	MENTAL HEALTH, longitudinal studies, work stress

Changes in psychosocial and physical working conditions and psychotropic medication in ageing public sector employees: a record-linkage follow-up study

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Abstract

Objectives: To investigate whether changes in psychosocial and physical working conditions are associated with subsequent psychotropic medication in ageing employees.

Methods: Data were from the Helsinki Health Study, a cohort study of Finnish municipal employees, aged 40-60 years at Phase 1 (2000-2002). Changes in psychosocial and physical working conditions were measured between Phase 1 and Phase 2 (2007). Survey data were longitudinally linked to data on prescribed, reimbursed psychotropic medication purchases (ATC) obtained from the registers of the Social Insurance Institution of Finland between the Phase 2 survey and December 2013 (N=3587; 80% women). Outcomes were any psychotropic medication; antidepressants (N06A); anxiolytics (N05B); and sedatives and hypnotics (N05C). Cox regression analyses were performed.

Results: During the follow-up 28% of the participants were prescribed psychotropic medication. Repeated exposures to low job control, high job demands and high physical work load were associated with an increased risk of subsequent antidepressant and anxiolytic medication. Increased and repeated exposure to high physical work load, increased job control and repeated high job demands were associated with subsequent sedative and hypnotic medication. Age and sex adjusted hazard ratios varied from 1.18 to 1.66. Improvement in job control was associated with a lower risk of anxiolytic, but with a higher risk of sedatives and hypnotic medication. Decreased physical work load was associated with a lower risk of antidepressant and anxiolytic medication.

Conclusion: Improvement in working conditions could lower the risk of mental ill-health indicated by psychotropic medication.

Keywords: mental health; longitudinal studies; work stress

Abbreviations: ATC, Anatomical Therapeutic Chemical; BMI, body mass index; CI, confidence interval; DDD, defined daily dose; HR, hazard ratio; WHO, World Health Organization

Strengths and limitations of this study

- Unlike previous studies, we were able to examine changes in both psychosocial and physical working conditions.
- Data were derived from a well characterised occupational cohort which was deterministically linked to administrative medication records.
- The use of register-based medication data allowed us to remove the prevalent cases and helped avoid the problems related to use of self-report measures such as recall and common method bias.
- Due to relatively long interval between the two working conditions measurements, the study could have underestimated the effect of changing working conditions on subsequent psychotropic medication.
- We did not have information about the clinical indication the examined medication was prescribed for.

INTRODUCTION

Mental ill-health is a growing concern in working populations.[1] Adverse working conditions have been proposed as potentially modifiable risk factors for mental ill-health.[2] Indeed, there is evidence that exposure to adverse psychosocial working conditions including low job control and high job demands, are associated with an increased risk of mental ill-health.[3–7] However, the majority of earlier studies have measured both exposure and outcome using self-reports, which can lead to inflated associations and common method bias.[8] Other studies have avoided these problems by using register-based outcomes such as psychotropic medication, which is a commonly used marker of mental ill-health in a population.[9–14]

Most of the earlier studies have assessed exposure to adverse working conditions only at one time point, and there is a paucity of large-scale studies examining the association between changes in psychosocial working conditions and mental ill-health. Of a few studies that have separately assessed the effects of changes in job control and job demands on mental ill-health, three found that adverse changes in job demands had a stronger effect on the risk of self-reported mental ill-health than adverse changes in job control, whereas positive changes in these domains did not result in improvement in mental health.[5,15,16] In a recent study within-person increase in job control was associated with better self-reported mental health;[17] and in another study both improvements and deterioration in job demands and job control predicted change in mental health.[18] However, studies assessing the association between changes in job control and job demands and a more objective measure of mental ill-health, such as recorded psychotropic medication, are lacking.

Moreover, psychosocial working conditions have dominated discussion about the work-related determinants of poor mental health, even though there is evidence that also physical working

conditions are associated with mental ill-health. In the present cohort, increased and repeated exposure to repetitive movements and repeated exposure to awkward postures and rotation of back was associated with an increased likelihood of common mental disorders,[16] desktop work was associated with purchases of sleeping pills among women,[19] and computer work was a risk factor for disability retirement due to mental causes.[20] In another study deteriorating physical working conditions increased perceived mental strain.[21] A review of the impact of working environment on mood disorders discussed the potential mechanisms; however actual studies conducted in employee cohorts were rare.[22] In a study among blue-collar workers exposure to noise intensified anxiety and depression in women.[23]

We set out this study to examine the associations between changes in psychosocial and physical working conditions and subsequent psychotropic medication.

METHODS

Data

The data came from the Helsinki Health Study, which is a cohort study designed to investigate social and work-related determinants of health and well-being.[24] The target population is the staff of the City of Helsinki, Finland. Phase 1 questionnaire surveys were collected in 2000, 2001 and 2002 among employees turning 40, 45, 50, 55 or 60 each year (N=8960, response rate 67%; 80% of participants women). Phase 2 survey data were collected in 2007 (N=7332, response rate 83%). Earlier non-response analysis showed that the participants broadly represent the target population.[24] Survey data were linked to national records using a unique personal identification number for those respondents who had given written consent for the linkage (74%; N=6498).

Consenting for the data linkage followed a similar pattern as the non-response, except that men provided consent slightly more often than women.[24,25]

In the present study, of those who consented to linkage, only participants who were still employed at Phase 2 were included (N=4207). Men, manual workers and those who reported common mental disorders at Phase 1 had slightly more often left the employment between the two phases (all *p* values < 0.01, data not shown). Because of the age structure of the cohort, the majority (86%) of those who replied at Phase 2 and stated that they were not employed, had retired.

In addition, we excluded those with purchases of psychotropic medication in three months preceding Phase 2 (n=337 for any psychotropic medication). Finally, we excluded those participants who had missing values for any of the study variables (n=283). The exclusions resulted in a final analytic sample of 3587 participants for the analyses examining any psychotropic medication.

Ethics

The Helsinki Health Study protocol was approved by the Ethics Committees of the Department of Public Health, University of Helsinki, and the health authorities of the City of Helsinki. The study conformed to the principles embodied in the Declaration of Helsinki.

Measurements

Working conditions

We used a version of Karasek's Job Content Questionnaire[26] to measure job control and job demands. Job control was assessed by nine and job demands by five items. Job control scale included items measuring skill discretion and decision authority. Job demands items assessed workload and work pace. Missing values were replaced by item modes for those having responded to at least eight job control and four job demands items, respectively. Job control and job demands were both dichotomised at the median.[9,27]

Physical work load, that is, uncomfortable postures, repetitive trunk rotation, repetitive movements, heavy physical exertion and lifting and carrying heavy loads, was assessed with an 18-item instrument developed at the Finnish Institute of Occupational Health.[28] Missing values were replaced by item modes for those having responded to at least fourteen items. Factor analysis showed that the questions loaded on three factors, of which the first one was interpreted to best measure physical work load. The items with the largest positive standardised scoring coefficients were: awkward working positions; rotation of the back; repetitive movements; and heavy physical effort or lifting and carrying heavy loads. Physical work load factor score was dichotomised at the highest quartile.[29]

Changes in psychosocial and physical working conditions were measured by a four-category variable for each of the three exposure variables: (i) repeated low exposure (low exposure at Phase 1 and low exposure at Phase 2); (ii) increased exposure (low exposure at Phase 1 and high exposure at Phase 2); (iii) decreased exposure (high exposure at Phase 1 and low exposure at Phase 2); (iv) repeated high exposure (high exposure at Phase 1 and high exposure at Phase 2).[30]

Psychotropic medication

Data on psychotropic medication were derived from the Finnish Prescription Register. This register is maintained by the Social Insurance Institution and it includes records of all prescribed psychotropic medication purchases reimbursed to Finnish residents in non-institutional settings. For each dispensed drug, the record includes the dispensing date, the WHO Anatomical Therapeutic Chemical (ATC) code, and the quantity prescribed and purchased as the number of defined daily doses (DDDs).[31] We extracted information on all purchases of antidepressants, anxiolytics, sedatives and hypnotics (ATC-codes N06A, N05B and N05C, respectively; see Appendix 1) in our analytic sample, following Phase 2 survey date (index date) during the follow-up until December 31, 2013. Dates of deaths were retrieved from Statistics Finland (the Causes of Death Register).

Covariates

All covariates were survey-based and from Phase 1. We measured age, sex and marital status (married/cohabiting vs. other). Moreover, we measured current smoking (yes vs. no), binge drinking (six or more units of alcohol on one occasion once a month or more often), low physical activity (less than 14 metabolic equivalent hours per week) and body mass index, which was categorosed as non-obese (≤ 30 kg/m^2) and obese (>30 kg/m^2).

Statistical analysis

The associations between sex, age and psychotropic medication during the follow-up were first analysed using the Chi-square test. Cox proportional hazard models were fitted to examine the association between change in psychosocial and physical working conditions between Phase 1 and Phase 2 and subsequent psychotropic medication during the follow-up. We estimated hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for psychotropic medication by changes in each working condition by first controlling for age and sex; then further controlling for marital

status, smoking, binge drinking, low physical activity, and obesity. In the first analysis, for each working condition, the reference group was the most favourable working condition (i.e. repeated high control, repeated low demands, and repeated high physical work load, respectively). To examine the effects of positive changes in working conditions, we conducted an additional analysis using the least favourable working condition as the reference group. The follow-up began from the date of the Phase 2 survey response and ended at the first record of the psychotropic medication purchase, death, or on 31 December, 2013, whichever came first.

We conducted the Therneau-Grambsch nonproportional hazards test, complementing it with the smoothed scatter plot of Schoenfeld residuals against explanatory variables. The visual inspection of the scatter plots supports the interpretation that the proportional hazards assumption was met. The scatter plots for any psychotropic medication are presented in Appendix 2. Moreover, the interaction terms between each working condition and logarithm of the follow-up period for any psychotropic medication as well as for each medication group were non-significant (all $p > 0.05$), further confirming that the proportional-hazards assumption was justified

None of the gender interactions were statistically significant (all interaction terms sex*working condition $p>0.05$); we therefore analysed women and men together, adjusting for gender.

The analyses were conducted with SAS 9.4 (SAS Institute, Inc., Cary, North Carolina) and R.

RESULTS

Table 1 shows the distribution of the key study variables by any prescribed psychotropic medication during follow-up. The mean age at baseline was 47.5 years. A total of 1008 participants (28%) recorded at least one purchase of prescribed psychotropic medication during the mean

follow-up of 5.0 years. Psychotropic medication was more prevalent among women (29%) than among men (23%). Nineteen percent of the participants received antidepressant medication during the follow-up. The corresponding figures for anxiolytics and for hypnotics/sedatives were 7% and 17%, respectively.

As displayed in **Table 2,** after adjustment for age and sex, repeated high job demands (HR=1.22, 95% CI: 1.04-1.42) were associated with any psychotropic medication. The association between repeated high physical work load and any psychotropic medication was marginally statistically significant (HR=1.17, 95% CI: 0.98-1.39). Figures 1, 2 and 3 show survival curves for any psychotropic medication by changes in working conditions.

When the groups of psychotropic medication were examined separately, repeated high job demands (HR=1.20, 95% CI: 1.00-1.45) and repeated high physical work load (HR=1.30, 95% CI: 1.06-1.59) were associated with subsequent antidepressant medication, whereas repeated low job control (1.37, 95% CI: 1.05-1.79), repeated high demands (HR=1.33, 95% CI: 1.00-1.76), and repeated high physical work load (HR=1.66, 95% CI: 1.24-2.23) were associated with subsequent anxiolytic medication. Increased job control and increased physical work load were associated with subsequent sedative and hypnotic medication. Repeated high demands and repeated physical work load showed associations with subsequent sedative and hypnotic medication. Further adjustment for marital status, health behaviours, and obesity only marginally changed the HRs (data not shown).

We additionally tested whether favourable change in working conditions was associated with a lower risk of psychotropic medication, by using the least favourable working conditions as reference categories (Table 3). Compared to repeatedly low job control, increased job control was associated with a lower risk of anxiolytic, but a higher risk of sedative and hypnotic medication. Compared to repeatedly high physical work load, decreased physical load was associated with a lower risk of subsequent antidepressant and anxiolytic medication.

DISCUSSION

In this study, repeated and increased exposure to adverse psychosocial and physical working conditions was associated with subsequent psychotropic medication. It is notable that we found similar associations for both types of working conditions. However, the associations between adverse working conditions and subsequent psychotropic medication were modest. This is expected: the aetiology of mental disorders – the main indication for psychotropic medication - is complex and multifactorial, involving multiple social, psychological and biological factors.[32] Exposure to adverse working conditions or a positive or negative change in them is only one such factor.

Compared to employees with repeated low job demands, the employees whose job demands had increased had a higher risk of purhasing any psychotropic medication as well as antidepressant medication. Moreover, repeated exposure to high job demands was associated with subsequent antidepressant and anxiolytic medication; with anxiolytics showing a slightly stronger association. Antidepressant and anxiolytic medications are likely to reflect depression and other mental disorders such as anxiety disorders (including generalized anxiety disorder and panic disorder). A number of previous studies have shown a link between high job demands and an increased risk of mental ill-health.[3,15,16,33]

Previous results for job control have been mixed. In a meta-analytic review published in 2006 low decision latitude predicted common mental disorders.[3] In terms of more objective outcomes, null results have been reported for psychotropic prescriptions,[13,34] whereas one previous study showed an association between high decision authority and an elevated risk of hospital admissions due to mental disorders.[35] In our study increased job control was associated with a subsequent

sedative and hypnotic medication. In a previous study, active jobs, that is, those with high levels of control and demands, were associated with a higher risk of depression and burnout.[36] It is possible that increased decision authority and high responsibility may become a burden for some employees. It is also possible that high job control reflects not only working conditions but also characteristics of a generally more active employee with a higher likelihood of seeking treatment.[35]

The result that increased job control was associated with a lower risk of anxiolytic, but a higher risk of sedative and hypnotic medication seems conflicting and is difficult to explain. It is possible that a switch between some anxiolytic benzodiazepine and hypnotic benzodiazepine could confound these associations. Unfortunately we had no information about the indication of the medication use.

When comparing to the least favourable working conditions, increased job control was associated with a lower risk of anxiolytic medication; and decreased physical load was associated with a lower risk of antidepressant and anxiolytic medication. Two earlier studies did not find an association between favourable changes in psychosocial working conditions and a decreased risk of subsequent mental ill-health.[15,37] However, in one previous study both improvements and deterioration in job demands and control were associated with corresponding improvements or deterioration in mental health,[18] and in another study decrease of job strain was associated with a lower likelihood of repeated insomnia symptoms.[38]

Most of the earlier studies have investigated only psychosocial working conditions. In the present study repeatedly high and increased physical work load were associated with subsequent psychotropic medication. In fact, the strongest association (HR=1.66 for anxiolytic medication) between working conditions and psychotropic medication was found for repeated high physical

workload. Our findings thus support the earlier findings in the present and other cohorts, which have shown associations between exposure to adverse physical working conditions and common mental disorders,[16] disability retirement due to mental disorders,[20] purchases of sleeping pills,[19] and perceived mental strain.[21]

Methodological considerations

Certain limitations need to be acknowledged. First, because of the relatively long interval between the two working conditions measurements, this study could have underestimated the effect of changing working conditions on subsequent medication. Moreover, working conditions could have changed several times during the follow-up; this could have resulted in more conservative effect sizes.

Second, we were unable to assess the magnitude of change in working conditions; the use of these crude measures only assessed whether a participant had moved from one category to another. Furthermore, we did not have information about the prior duration of exposure to adverse working conditions. The use of thresholds may have led to underestimates of true effects of changing working conditions.[5]

Third, we did not have information about clinical indication the examined medication was prescribed for. Even if psychotropic medication is a recommended treatment for a number of mental disorders and prescription data derived from official registers can therefore be considered as a proxy for mental disorders requiring treatment, these medications are prescribed also for other conditions. On the other hand, it has been shown that mental disorders are underdiagnosed and undertreated.[39]

Fourth, we did not have information about the discontinuation and the pattern of use of psychotropic medication. Even if a participant had purchased the prescribed medication from the pharmacy, they could have discontinued the use. Discontinuation of psychotropic drugs can lead to different meanings: the discontinuation of antidepressants can be associated with either side effects or lack of follow-up controls, whereas sporadic use of anxiolytics and hypnotics can be due to temporary discomfort. Unfortunately we had no information about the pattern of use of the prescribed medication, that is, whether the medication was used sporadically or continuously.

Fifth, participants who left employment between Phase 1 and Phase 2 were not included in the study. It has been suggested that the age-related health selection may result in a more resilient older worker population [37]. A healthy worker effect may thus have led to underestimation of the associations.

Finally, even if the data consisted of a broad range of both manual and non-manual occupations, the study population was not a representative sample of the total working population. Because the Finnish public sector workforce is female-dominated, women were over-represented also in this sample. Moreover, the present sample consisted only of ageing employees with stable and secure long-term employment and working in the capital city. Therefore the results may be generalisable, with caution, to the Finnish municipal sector, but might not be generalisable to other age groups, cohorts and industries.

Despite of these limitations, the present study has a number of strengths. The main strengths are the use of prospective design which enabled us to examine changes in working conditions, data derived from a well characterised occupational cohort, minor attrition, deterministic linkage to administrative medication records, and an ability to examine changes in both psychosocial and

physical working conditions. Psychotropic medication data were based on a physician's prescription and cover virtually all reimbursed psychotropic prescriptions for the analytic sample. The use of register-based medication data allowed us to remove the prevalent cases and helped avoid the problems related to use of self-report measures such as recall and common method bias. Extensive non-response analyses were available and showed only small non-participation bias. We were able to adjust for a number of important covariates such as health behaviours and obesity.

CONCLUSION

To conclude, this study showed that established psychosocial risk factors such as repeated exposure to high job demands and low control are associated with subsequent psychotropic medication in midlife and older employees. Furthermore, the results showed that also repeated and increased exposure to adverse physical working conditions may contribute to subsequent psychotropic medication. Identification of these potentially modifiable risk factors implies possibilities for prevention.[40] Theory-based, organisationally focused interventions to tackle adverse working conditions might be beneficial. Evidence for this is emerging. An intervention study in Canadian hospitals showed an intervention to reduce work stress was able to produce beneficial long-term effects on hospital employees' emotional well-being, in particular through reducing professional burnout.[41] However, well-designed randomized controlled trials with reliable and valid objective indicators of working conditions are needed to reliably test whether intentional workplace interventions can prevent employee mental ill-health.

Conflicts of interest: None declared

Author contributions:

All authors jointly designed and conceptualised the study. Anne Kouvonen directed the implementation of the study, led all aspects of the work, and drafted the article. Anne Kouvonen and Olli Pietiläinen performed the data analysis. Tea Lallukka, Eero Lahelma, Olli Pietiläinen and Ossi Rahkonen contributed to acquisition of data. Minna Mänty, Tea Lallukka, Olli Pietiläinen, Eero Lahelma and Ossi Rahkonen contributed to designing the study's analytic strategy, interpreting findings, reviewing the article and revising it critically for important intellectual content. All authors approved the manuscript's submission for publication.

Data sharing statement: No additional data available.

Figure legends

Figure 1. Survival curves for any psychotropic medication by changes in job control

Figure 2. Survival curves for any psychotropic medication by changes in job demands

Figure 3. Survival curves for any psychotropic medication by changes in physical working conditions

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Table 1. Distribution of demographics (Phase 1; 2000-2002), working conditions (Phase 1 – Phase 2; 2007) and any psychotropic medication* between Phase 2 and 2013, the Helsinki Health Study, Finland (%) (*N*=3587)

	No medication *N* (%)	Medication *N* (%)	Mean DDDs (SD)†
Sex			
Women	2034 (71)	847 (29)	496.0 (773.3)
Men	545 (77)	161 (23)	487.1 (793.0)
Age			
40	632 (72)	247 (28)	587.5 (949.9)
45	636 (68)	298 (32)	537.6 (788.6)
50	664 (72)	259 (28)	429.5 (660.0)
55	627 (76)	196 (24)	391.2 (627.2)
60	20 (71)	8 (29)	666.2 (818.6)
Job control			
High-High	1075 (73)	402 (27)	453.2 (806.6)
High-Low	358 (71)	148 (29)	458.3 (793.9)
Low-High	300 (72)	117 (28)	541.5 (761.1)
Low-Low	846 (71)	341 (29)	543.1 (749.3)
Job demands			
Low-Low	554 (74)	304 (26)	411.6 (647.4)
Low-High	419 (72)	165 (28)	476.1 (716.0)
High-Low	432 (72)	169 (28)	463.7 (694.2)
High-High	844 (70)	370 (30)	585.1 (915.3)
Physical work load			
Low-Low	1718 (73)	633 (27)	500.2 (767.4)
Low-High	248 (869)	112 (31)	455.4 (679.6)
High-Low	255 (71)	104 (29)	428.1 (704.8)
High-High	358 (69)	159 (31)	543.4 (909.2)

*Participants with psychotropic medication purchases in three months preceding Phase 2 were excluded.

† Mean of defined daily doses (DDDs) and their standard deviations (SDs) in those who had psychotropic medication purchases during follow-up.

Table 2. Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000-2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

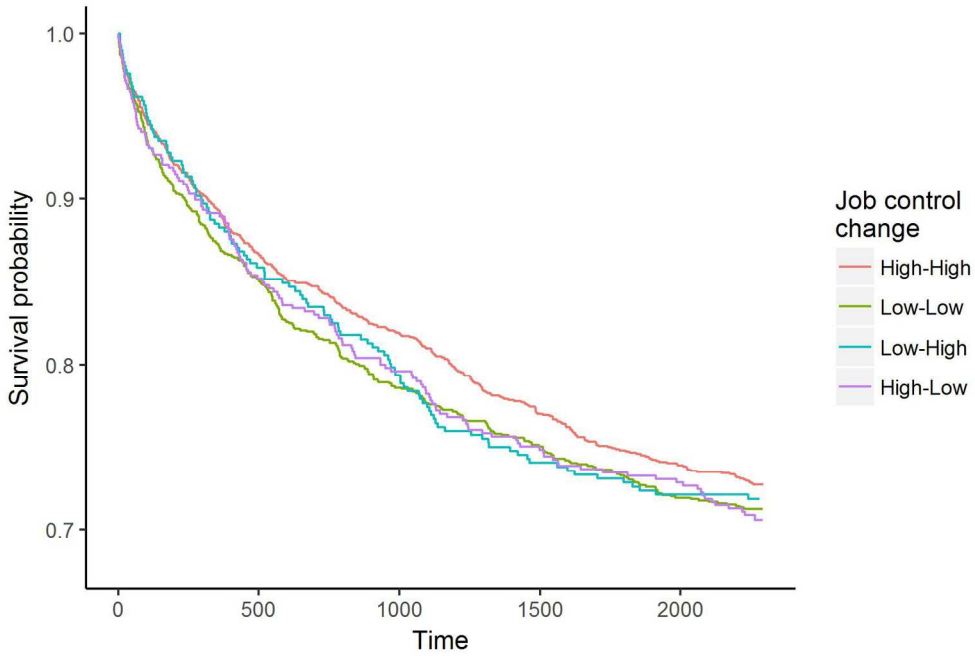
	Any psychotropic (*N*=3587)			Antidepressants (N06A) (*N*=3660)			Anxiolytics (N05B) (*N*=3867)			Sedatives and hypnotics (N05C) (*N*=3808)		
	N (cases)	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**
Job control												
High-High	1477 (402)	1.00	Reference	1499 (264)	1.00	Reference	1573 (102)	1.00	Reference	1559 (245)	1.00	Reference
High-Low	506 (148)	1.08	0.90-1.31	518 (95)	1.04	0.82-1.32	542 (43)	1.22	0.86-1.74	532 (94)	1.13	0.89-1.43
Low-High	417 (117)	1.03	0.84-1.27	425 (80)	1.06	0.83-1.36	457 (27)	0.90	0.59-1.38	449 (91)	1.33	1.04-1.69
Low-Low	1187 (341)	1.08	0.94-1.25	1218 (244)	1.18	0.99-1.41	1295 (113)	1.37	1.05-1.79	1268 (205)	1.03	0.86-1.24
Job demands												
Low-Low	1188 (304)	1.00	Reference	1208 (205)	1.00	Reference	1267 (83)	1.00	Reference	1254 (185)	1.00	Reference
Low-High	584 (165)	1.09	0.90-1.32	598 (117)	1.10	0.88-1.38	632 (45)	1.05	0.73-1.52	619 (108)	1.20	0.94-1.52
High-Low	601 (169)	1.09	0.91-1.32	610 (106)	1.01	0.80-1.27	649 (41)	0.96	0.66-1.39	639 (110)	1.16	0.92-1.47
High-High	1214 (370)	1.22	1.04-1.42	1244 (255)	1.20	1.00-1.45	1319 (116)	1.33	1.00-1.76	1296 (232)	1.21	0.99-1.47
Physical work load												
Low-Low	2351 (633)	1.00	Reference	2390 (423)	1.00	Reference	2508 (168)	1.00	Reference	2480 (382)	1.00	Reference
Low-High	360 (112)	1.17	0.96-1.43	371 (78)	1.17	0.92-1.49	400 (26)	1.09	0.74-1.62	384 (74)	1.32	1.04-1.69
High-Low	359 (104)	1.07	0.87-1.32	369 (63)	0.93	0.71-1.21	396 (30)	0.95	0.63-1.44	398 (80)	1.25	0.96-1.60
High-High	517 (159)	1.17	0.98-1.39	530 (119)	1.30	1.06-1.59	563 (61)	1.66	1.24-2.23	546 (99)	1.22	0.98-1.52

Note: Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in three months preceding Phase 2 were excluded.

Table 3. Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000-2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

	Any psychotropic (*N*=3587)			Antidepressants (N06A) (*N*=3660)			Anxiolytics (N05B) (*N*=3867)			Sedatives and hypnotics (N05C) (*N*=3808)		
	N (cases)	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**	**N (cases)**	**HR**	**95% CI**
Job control												
High-High	1477 (402)	0.92	0.80-1.07	1499 (264)	085	0.71-1.01	1573 (102)	0.73	0.56-0.96	1559 (245)	0.97	0.81-1.17
High-Low	506 (148)	1.00	0.82-1.21	518 (95)	0.88	0.70-1.12	542 (43)	0.89	0.63-1.27	532 (94)	1.09	0.86-1.40
Low-High	417 (117)	0.95	0.77-1.18	425 (80)	0.90	0.70-1.16	457 (27)	0.66	0.43-1.00	449 (91)	1.29	1.00-1.65
Low-Low	1187 (341)	1.00	Reference	1218 (244)	1.00	Reference	1295 (113)	1.00	Reference	1268 (205)	1.00	Reference
Job demands												
Low-Low	1188 (304)	0.82	0.71-0.96	1208 (205)	0.83	0.69-1.00	1267 (83)	0.75	0.57-1.00	1254 (185)	0.83	0.68-1.01
Low-High	584 (165)	0.90	0.75-1.08	598 (117)	0.91	0.73-1.14	632 (45)	0.79	0.56-1.12	619 (108)	0.99	0.79-1.25
High-Low	601 (169)	0.90	0.75-1.08	610 (106)	0.84	0.67-1.05	649 (41)	0.72	0.50-1.03	639 (110)	0.96	0.77-1.21
High-High	1214 (370)	1.00	Reference	1244 (255)	1.00	Reference	1319 (116)	1.00	Reference	1296 (232)	1.00	Reference
Physical work load												
Low-Low	2351 (633)	0.85	0.72-1.02	2390 (423)	0.77	0.63-0.95	2508 (168)	0.60	0.45-0.81	2480 (382)	0.82	0.66-1.03
Low-High	360 (112)	0.91	0.71-1.17	371 (78)	0.90	0.68-1.20	400 (26)	0.66	0.43-1.02	384 (74)	1.09	0.81-1.46
High-Low	359 (104)	1.00	0.78-1.27	369 (63)	0.72	0.53-0.98	396 (30)	0.57	0.36-0.90	398 (80)	1.03	0.76-1.39
High-High	517 (159)	1.00	Reference	530 (119)	1.00	Reference	563 (61)	1.00	Reference	546 (99)	1.00	Reference

Note: Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in three months preceding Phase 2 were excluded.



Survival curves for any psychotropic medication by changes in job control

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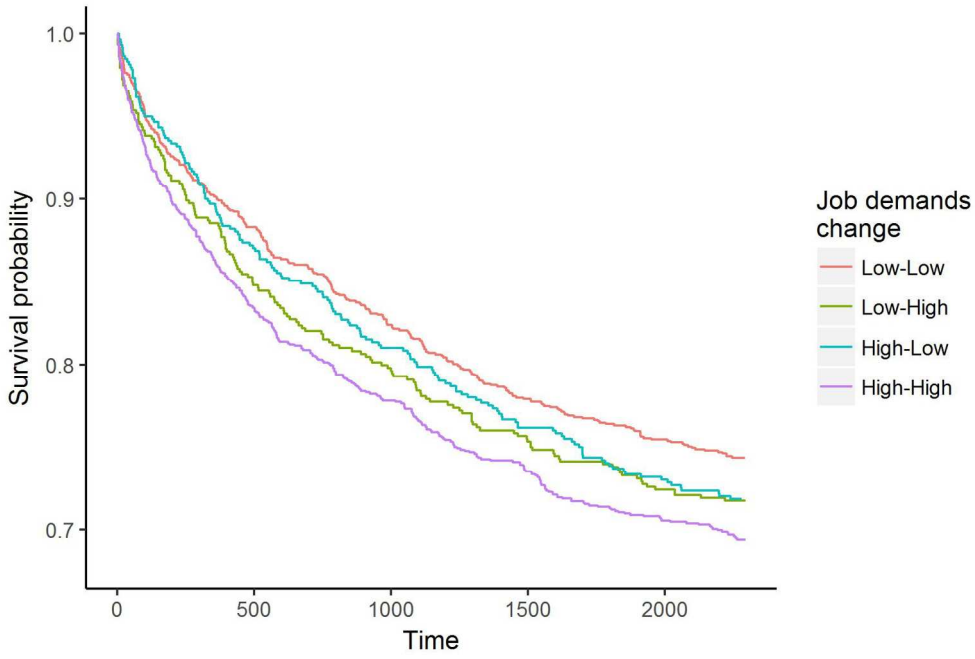

Survival curves for any psychotropic medication by changes in job demands

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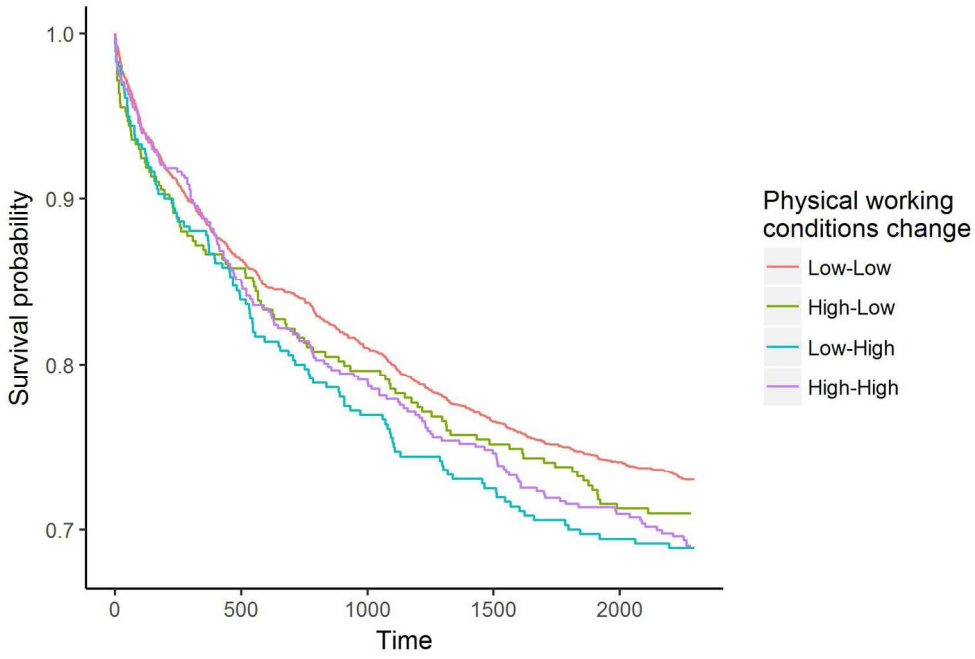


Caption : Survival curves for any psychotropic medication by changes in physical working conditions

152x101mm (300 x 300 DPI)

Appendix 1

1 N06A Antidepressants

- 1.1 N06AA Non-selective monoamine reuptake inhibitors
- 1.2 N06AB Selective serotonin reuptake inhibitors
- 1.3 N06AF Monoamine oxidase inhibitors, non-selective
- 1.4 N06AG Monoamine oxidase A inhibitors
- 1.5 N06AX Other antidepressants

2 N05B Anxiolytics

- 2.1 N05BA Benzodiazepine derivatives
- 2.2 N05BB Diphenylmethane derivatives
- 2.3 N05BC Carbamates
- 2.4 N05BD Dibenzo-bicyclo-octadiene derivatives
- 2.5 N05BE Azaspirodecanedione derivatives
- 2.6 N05BX Other anxiolytics

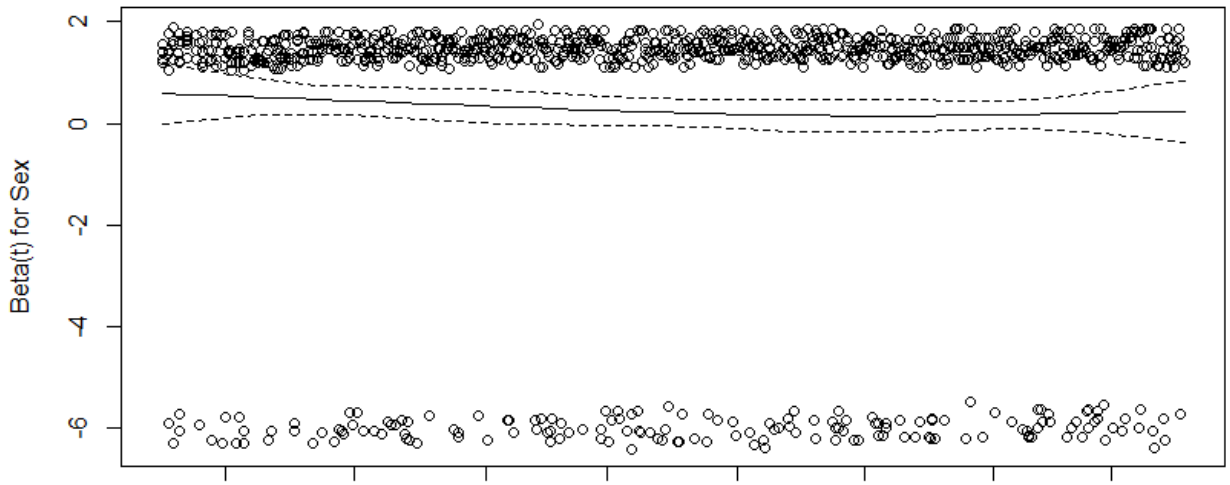
3 N05C Hypnotics and sedatives

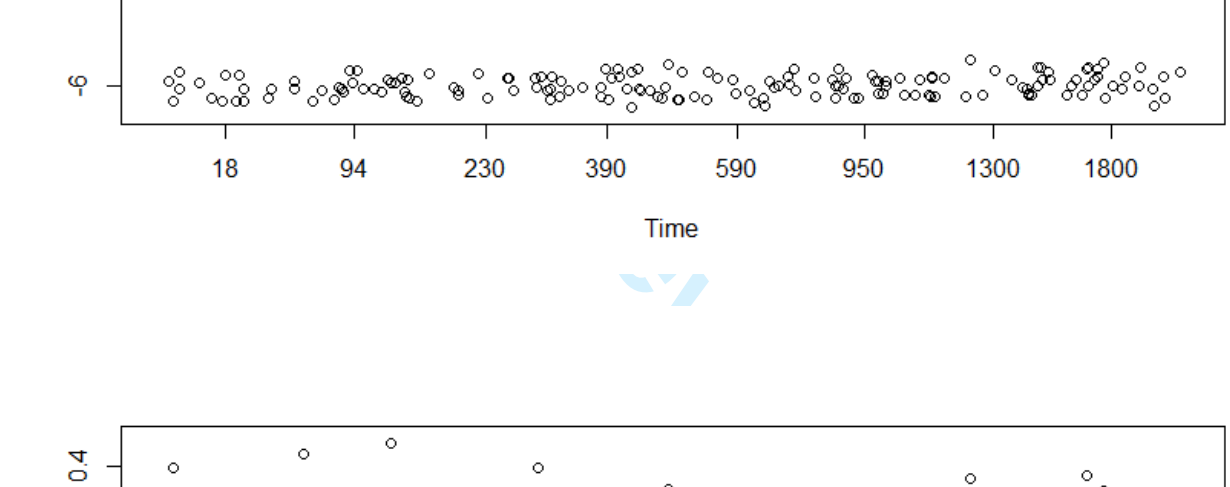
- 3.1 N05CA Barbiturates, plain
- 3.2 N05CB Barbiturates, combinations
- 3.3 N05CC Aldehydes and derivatives
- 3.4 N05CD Benzodiazepine derivatives
- 3.5 N05CE Piperidinedione derivatives
- 3.6 N05CF Benzodiazepine related drugs
- 3.7 N05CH Melatonin receptor agonists
- 3.8 N05CM Other hypnotics and sedatives
- 3.9 N05CX Hypnotics and sedatives in combination, excluding barbiturates

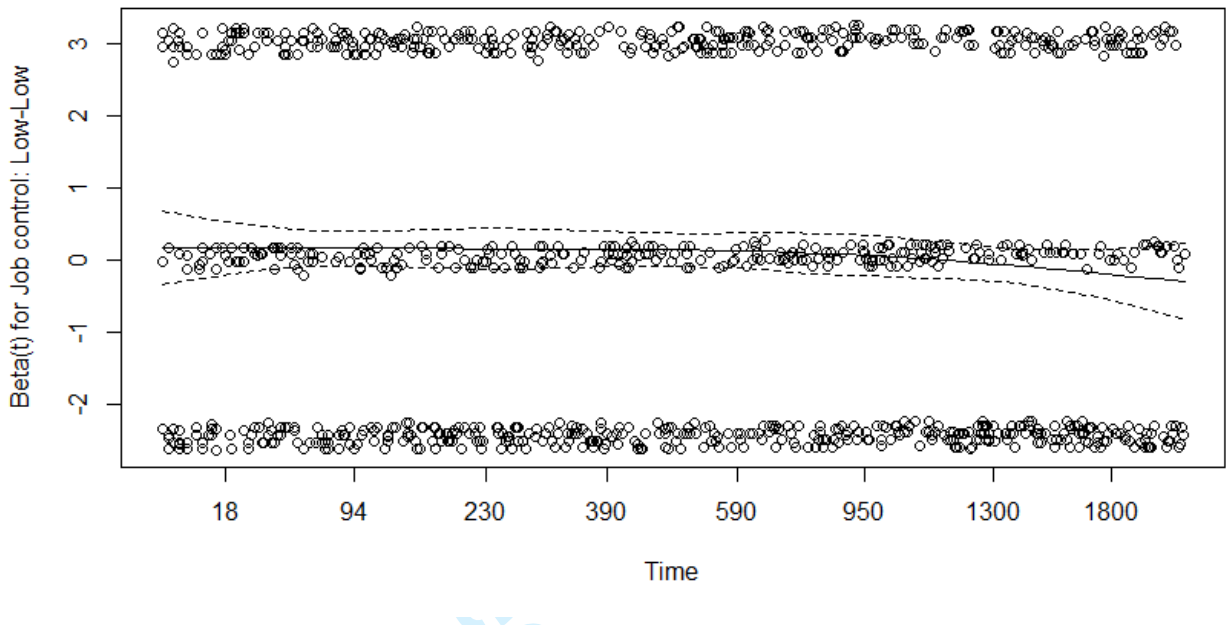
Appendix 2.

Smoothed scatter plots of Schoenfeld residuals against explanatory variables

Any psychotropic – change in job control






Beta(t) for Job control: Low-Low
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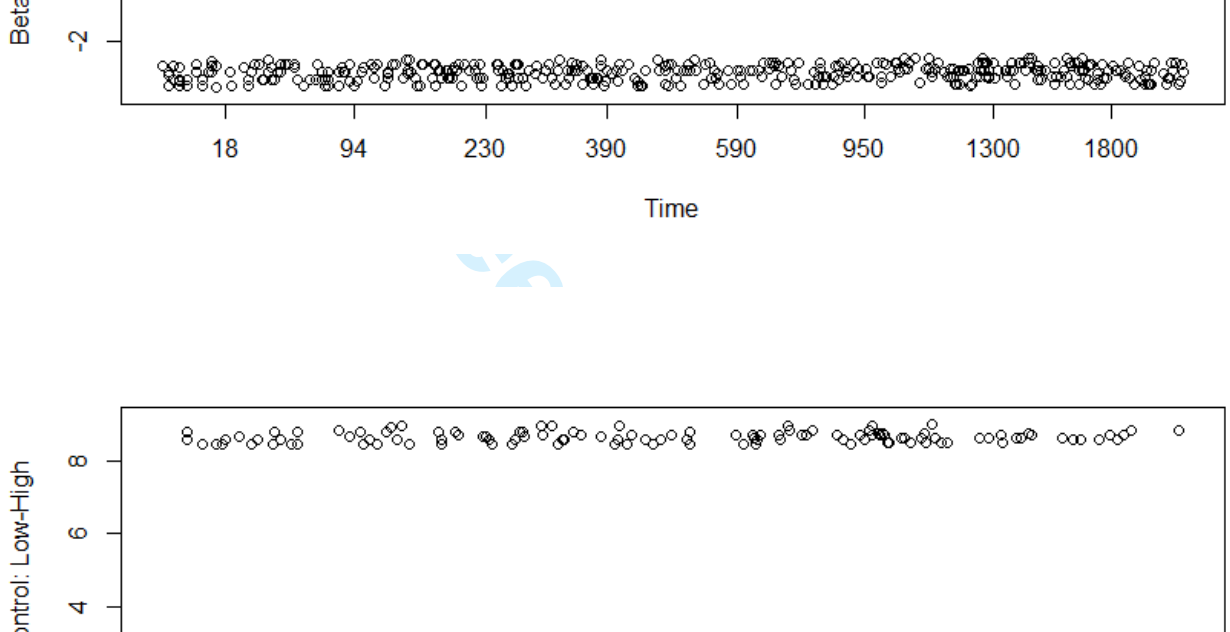
1
2
3
18
94
230
390
590
950
1300
1800
Time


Beta(t) for Job control: Low-High
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18
94
230
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590
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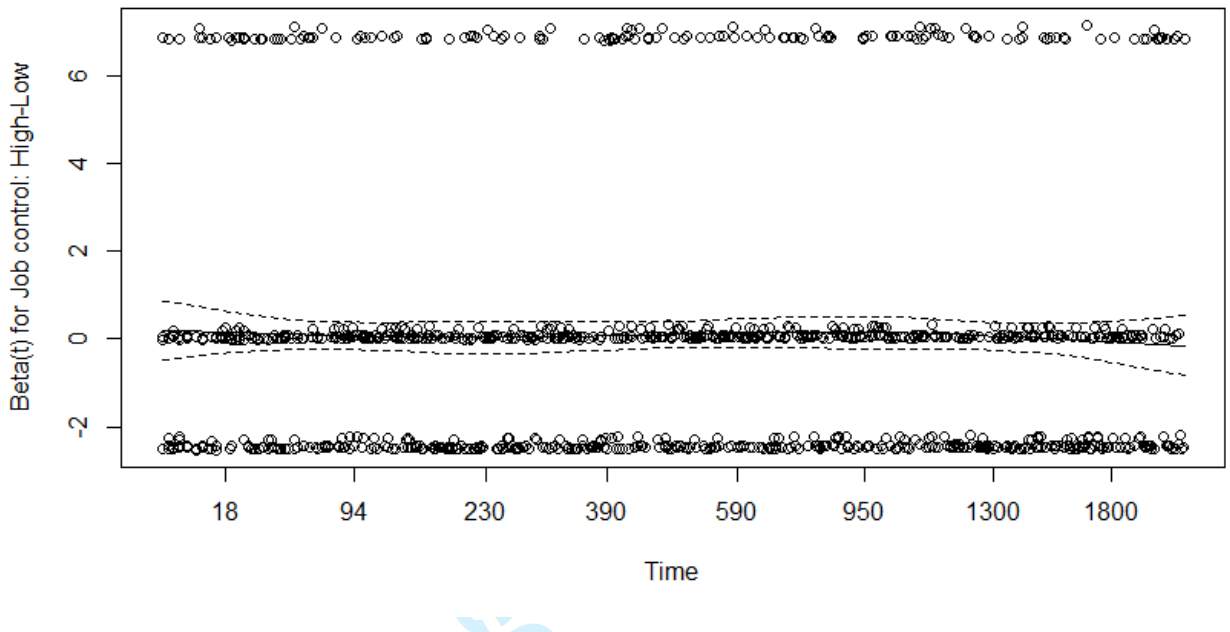
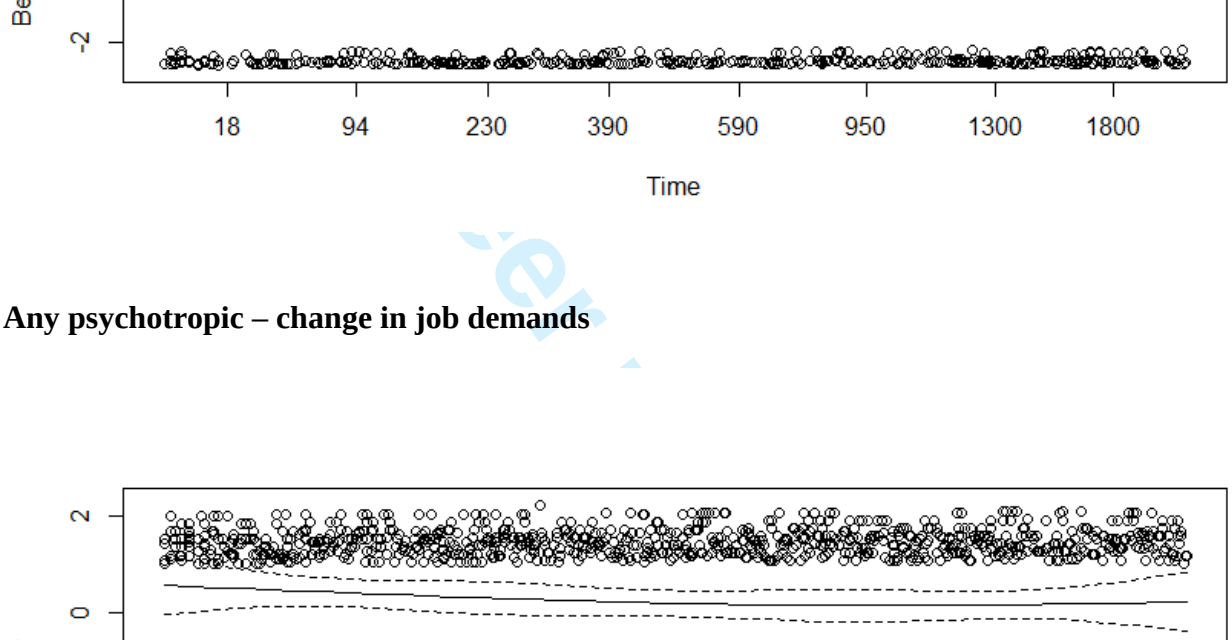
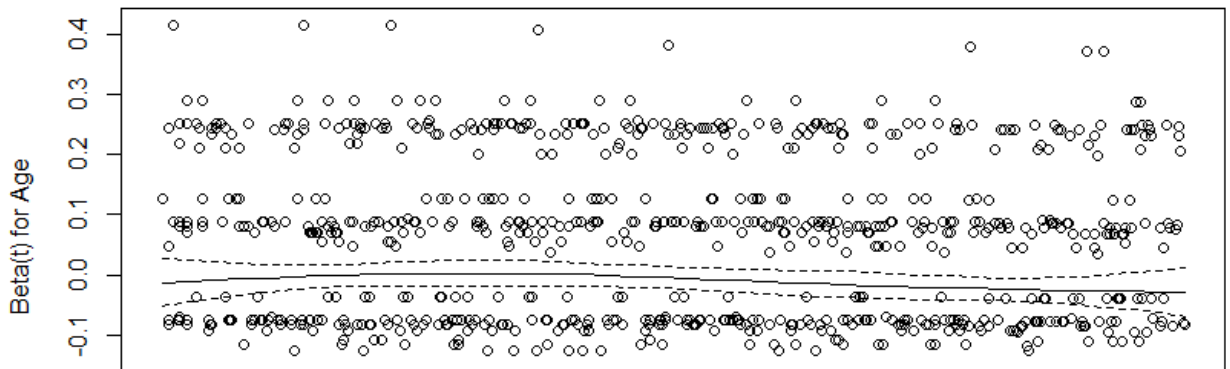
1300
1800
Time



Any psychotropic – change in job demands




Beta(t) for Age
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0.3
0.2
0.1
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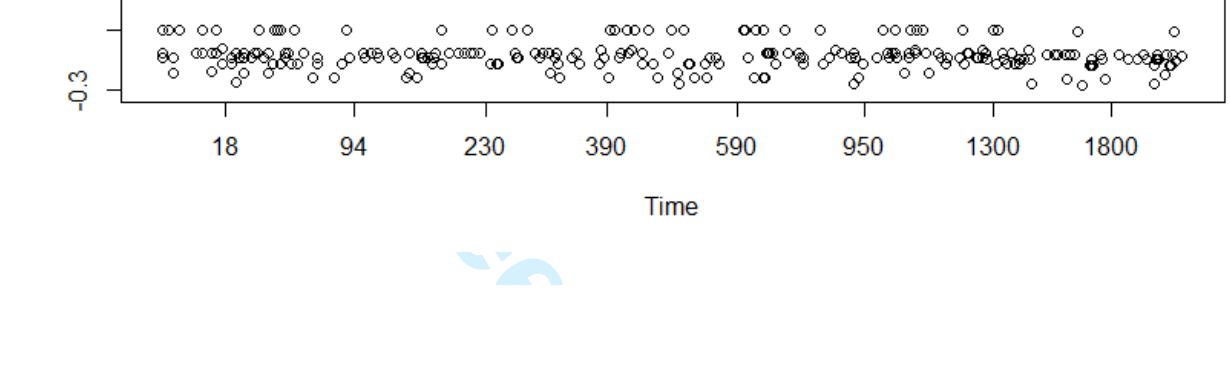
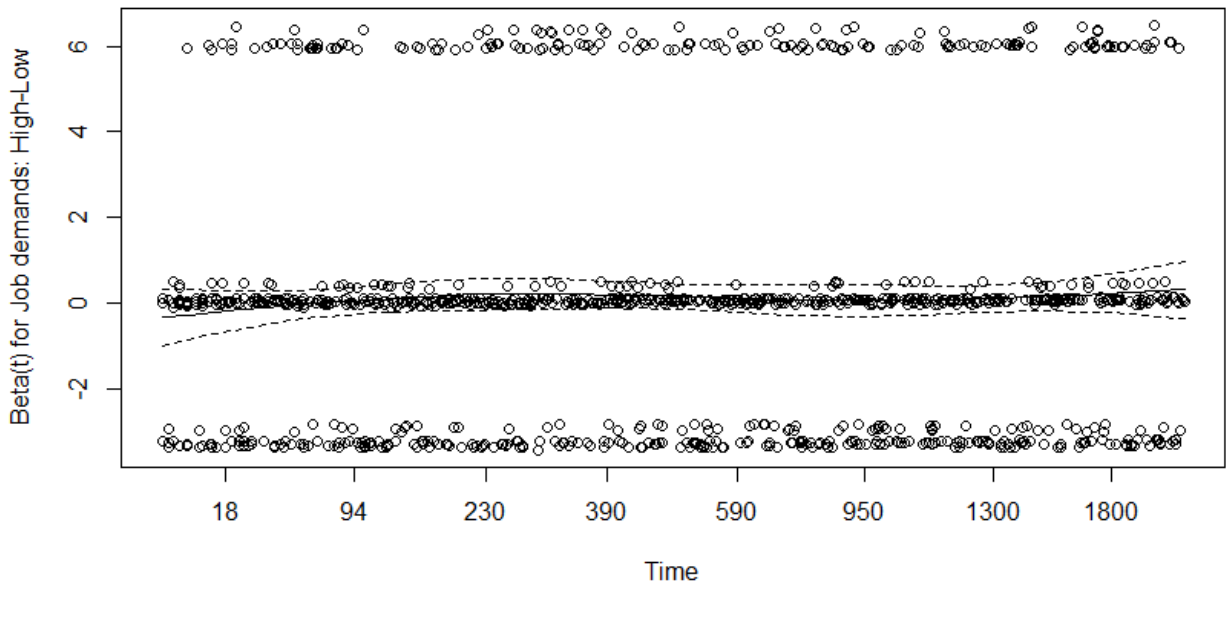
-0.1
-0.3
18
94
230
390
590
950
1300
1800
Time


Beta(t) for Job demands: Low-High
6
4
2
0
-2
-4
18
94
230
390
590
950
1300
1800
Time


Beta(t) for Job demands: High-Low
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-2
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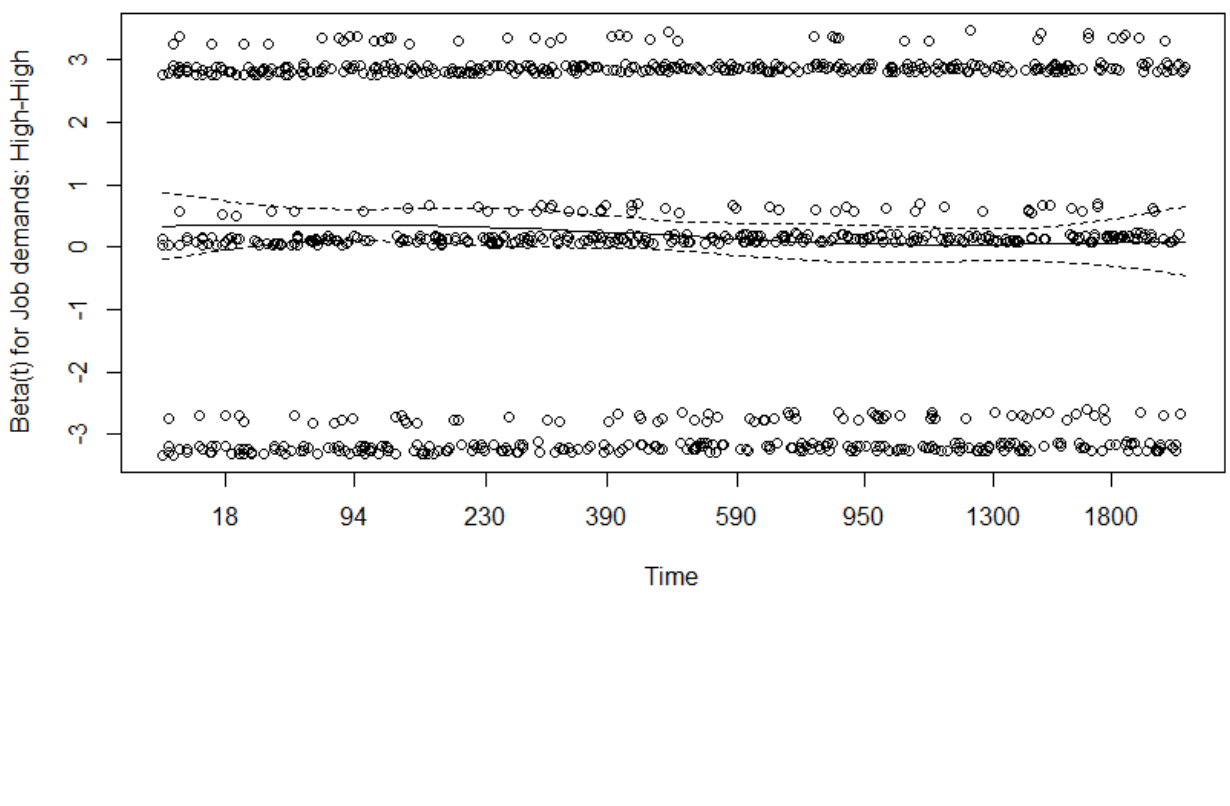
590
950
1300
1800
Time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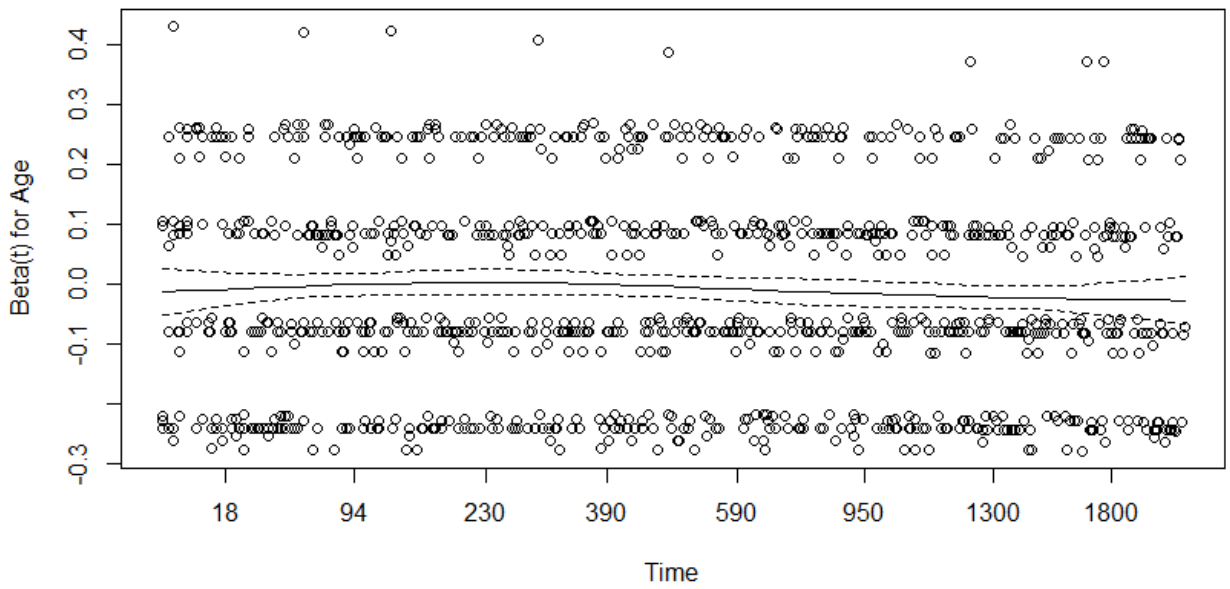
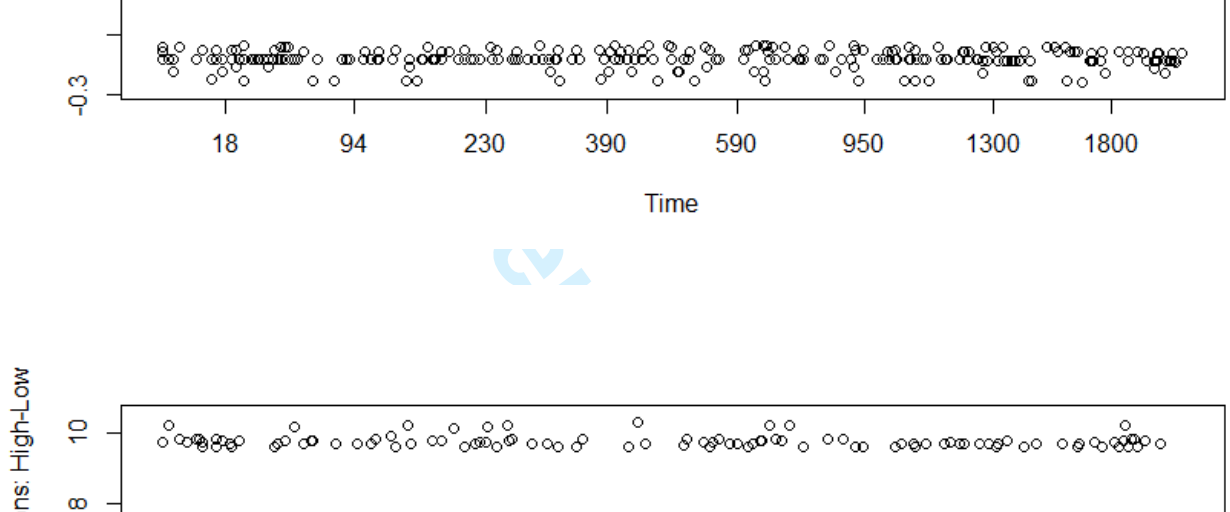
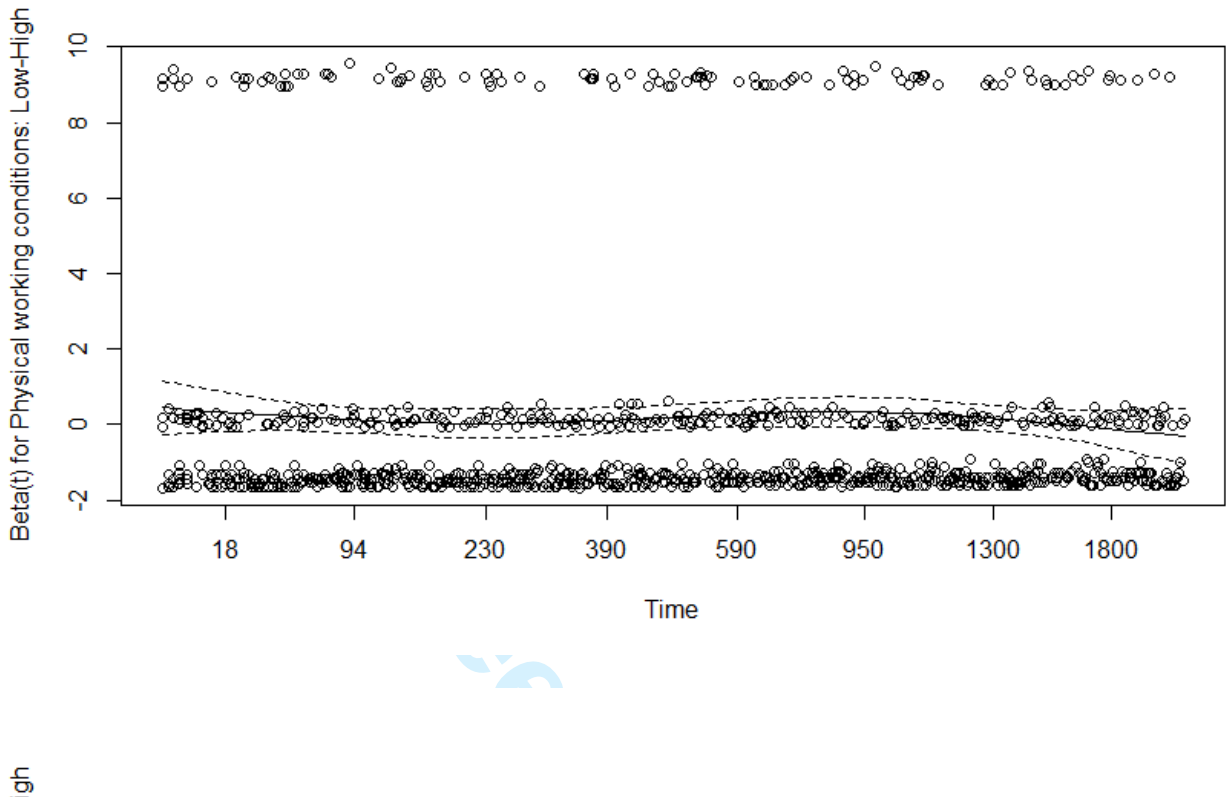
-3
18
94
230
390
590
950
1300
1800
Time

Any psychotropic – change in physical working conditions






Beta(t) for Physical working conditions: Low-High
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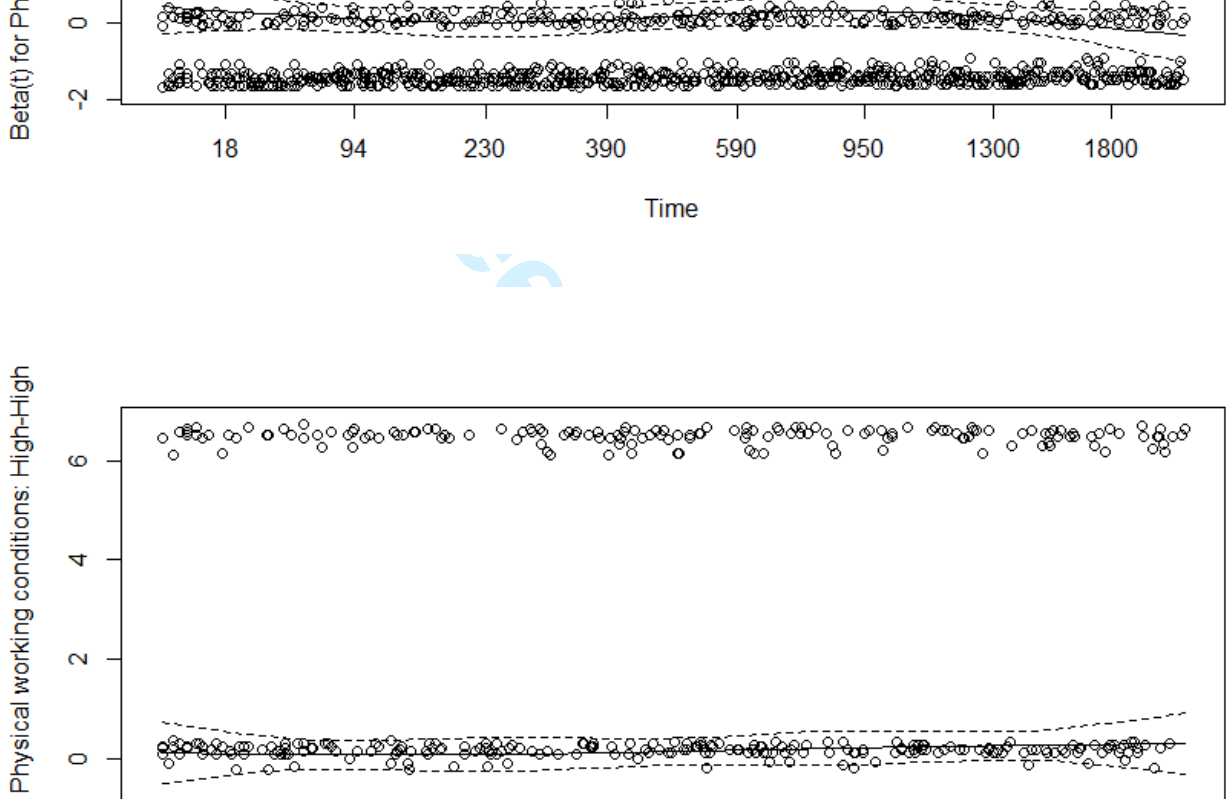
1300
1800
Time


Beta(t) for Physical working conditions: High-High
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18
94
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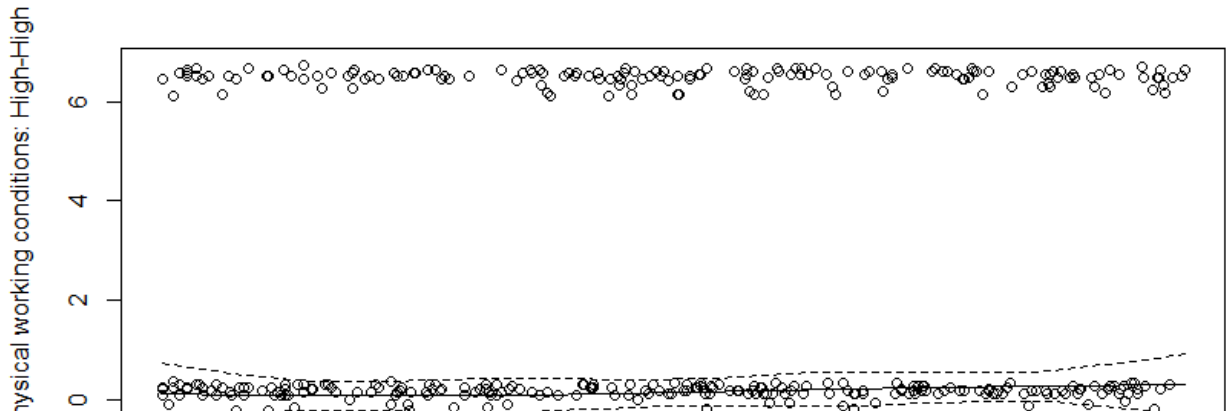
Time


Beta(t) for Physical working conditions: High-High
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94
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390
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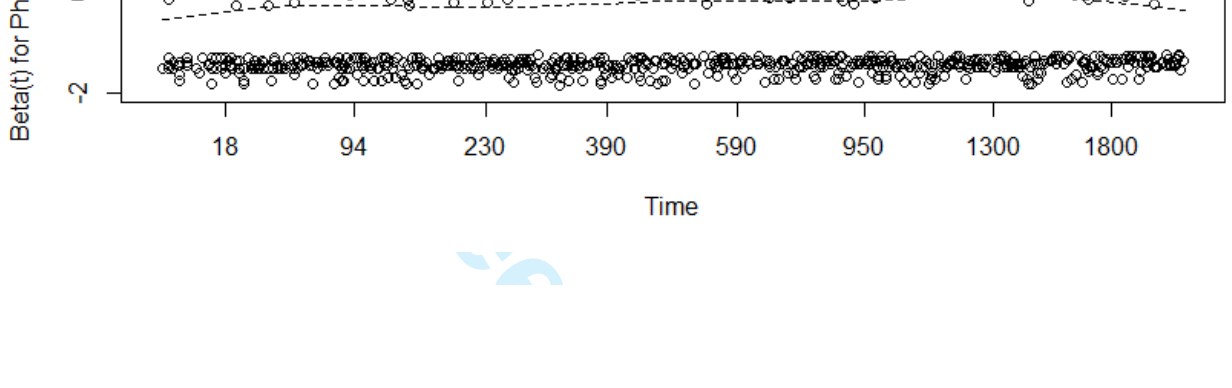
1800
Time


Beta(t) for Sex
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-2
-4
-6
18
94
230
390
590
950
1300
1800
Time

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	page	Recommendation
Title and abstract	1	p1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		p2	(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/rationale	2	p4-5	Explain the scientific background and rationale for the investigation being reported
Objectives	3	p5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	4	p5-6	Present key elements of study design early in the paper
Setting	5	p5-6	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	p5-6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	p6-8	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	p6-8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	p5-6	Describe any efforts to address potential sources of bias
Study size	10	p5-6	Explain how the study size was arrived at
Quantitative variables	11	p6-8	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	p8-9	(*a*) Describe all statistical methods, including those used to control for confounding
		p8-9	(*b*) Describe any methods used to examine subgroups and interactions
		p6	(*c*) Explain how missing data were addressed
		p5-6	(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		NA	(*e*) Describe any sensitivity analyses

Continued on next page

		Results	
Participants	13*	p5-6	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		p5-6	(b) Give reasons for non-participation at each stage
		considered	(c) Consider use of a flow diagram
Descriptive data	14*	p9+Table 1	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		p9	(b) Indicate number of participants with missing data for each variable of interest
		p8-9	(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Tables	*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
			Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	p10+Tables 2-3	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		p7-8	(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	p9	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
		Discussion	
Key results	18	p10-11	Summarise key results with reference to study objectives
Limitations	19	p12-14	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	p14	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	p13	Discuss the generalisability (external validity) of the study results
		Other information	
Funding	22	p1	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Correction: *Changes in psychosocial and physical working conditions and psychotropic medication in ageing public sector employees: a record-linkage follow-up study*

Kouvonen A, Mänty M, Lallukka T, *et al*. Changes in psychosocial and physical working conditions and psychotropic medication in ageing public sector employees: a record-linkage follow-up study. *BMJ Open* 2017;7:e015573. doi: 10.1136/bmjopen-2016-015573.

This article was previously published with some errors.
In review of their article the authors found an error in the equation of their measurement of physical work load. In factor analysis, the items indicating physical work load were loaded on Factor one and not on Factor two, as they had erroneously interpreted earlier (Factor two was hazardous exposures).

This error is corrected by re-running all analyses using the correct factor (physical work load). The authors re-conducted the analyses and found only minor differences compared with the original figures given, and it was also found that the error did not alter the conclusions drawn.

The following corrections should be incorporated into any future analysis of the original article:

In Results section, under Abstract, Age and sex-adjusted HR varied from 1.18 to 1.54, instead of 1.66. In addition, the last sentence of the Results in Abstract (Decreased physical work load was associated with lower risk of antidepressant and anxiolytic medications) should be deleted.

In Results section, under the main text, the following should be corrected:
Paragraph 2: :"The association between repeated high physical work load and any psychotropic medication was also statistically significant (HR=1.27, 95% CI: 1.08 to 1.49)." rather than "The association between repeated high physical work load and any psychotropic medication was marginally statistically significant (HR=1.17, 95% CI: 0.98 to 1.39)."

Paragraph 3: "repeated high physical work load HR=1.54 (95% CI: 1.15 to 2.06)" instead of "HR=1.66 (95% CI: 1.24 to 2.23)." In addition, "Increased job control and physical work load were associated with subsequent sedative and hypnotic medication." should read "Increased job control was associated with subsequent sedative and hypnotic medication."

Paragraph 4: The last sentence "Compared with repeatedly high physical work load, decreased physical work load was associated with a lower risk of subsequent antidepressant and anxiolytic medication" should be deleted.

In Discussion, paragraph 6 should have HR=1.54 instead of HR=1.66.

The review led also the three tables, figure 3 and online appendix 2 to be slightly revised. The revised tables are available with this article as tables 1, 2 and 3, figure 3, and appendix 2. The revised figures in tables have been highlighted in red.

Table 1 Distribution of demographics (Phase 1; 2000–2002), working conditions (Phase 1 – Phase 2; 2007) and any psychotropic medication* between Phase 2 and 2013, the Helsinki Health Study, Finland (%) (n=3587)

	No medication *N* (%)	Medication *N* (%)	Mean DDDs (SD)†
Sex			
Women	2034 (71)	847 (29)	496.0 (773.3)
Men	545 (77)	161 (23)	487.1 (793.0)
Age			
40	632 (72)	247 (28)	587.5 (949.9)
45	636 (68)	298 (32)	537.6 (788.6)
50	664 (72)	259 (28)	429.5 (660.0)
55	627 (76)	196 (24)	391.2 (627.2)
60	20 (71)	8 (29)	662.1 (818.6)
Job control			
High-High	1075 (73)	402 (27)	453.2 (749.3)
High-Low	358 (71)	148 (29)	458.3 (761.1)
Low-High	300 (72)	117 (28)	541.5 (793.9)
Low-Low	846 (71)	341 (29)	543.1 (806.6)
Job demands			
Low-Low	884 (74)	304 (26)	411.6 (647.4)
Low-High	419 (72)	165 (28)	476.1 (716.0)
High-Low	432 (72)	169 (28)	463.7 (694.2)
High-High	844 (70)	370 (30)	585.1 (915.3)
Physical work load			
Low-Low	1763 (73)	644 (27)	465.4 (728.0)
Low-High	222 (70)	93 (30)	539.6 (798.4)
High-Low	222 (71)	86 (29)	588.1 (997.3)
High-High	382 (67)	185 (33)	530.0 (810.5)

*Participants with psychotropic medication purchases in 3 months preceding Phase 2 were excluded.
†Mean of defined daily doses (DDDs) and their standard deviations (SDs) in those who had psychotropic medication purchases during follow-up.

Table 2 Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000–2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

	Any psychotropic (n=3587)			Antidepressants (N06A) (n=3660)			Anxiolytics (N05B) (n=3867)			Sedatives and hypnotics (N05C) (n=3808)		
	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI
Job control												
High-High	1477 (402)	1.00	Reference	1499 (264)	1.00	Reference	1573 (102)	1.00	Reference	1559 (245)	1.00	Reference
High-Low	506 (148)	1.08	0.90 to 1.31	518 (95)	1.04	0.82 to 1.32	542 (43)	1.22	0.86 to 1.74	532 (94)	1.13	0.89 to 1.43
Low-High	417 (117)	1.03	0.84 to 1.27	425 (80)	1.06	0.83 to 1.36	457 (27)	0.90	0.59 to 1.38	449 (91)	1.33	1.04 to 1.69
Low-Low	1187 (341)	1.08	0.94 to 1.25	1218 (244)	1.18	0.99 to 1.41	1295 (113)	1.37	1.05 to 1.79	1268 (205)	1.03	0.86 to 1.24

	Any psychotropic (n=3587)			Antidepressants (N06A) (n=3660)			Anxiolytics (N05B) (n=3867)			Sedatives and hypnotics (N05C) (n=3808)		
	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI
Job demands												
Low-Low	1188 (304)	1.00	Reference	1208 (205)	1.00	Reference	1267 (83)	1.00	Reference	1254 (185)	1.00	Reference
Low-High	584 (165)	1.09	0.90 to 1.32	598 (117)	1.10	0.88 to 1.38	632 (45)	1.05	0.73 to 1.52	619 (108)	1.20	0.94 to 1.52
High-Low	601 (169)	1.09	0.91 to 1.32	610 (106)	1.01	0.80 to 1.27	649 (41)	0.96	0.66 to 1.39	639 (110)	1.16	0.92 to 1.47
High-High	1214 (370)	1.22	1.04 to 1.42	1244 (255)	1.20	1.00 to 1.45	1319 (116)	1.33	1.00 to 1.76	1296 (232)	1.21	0.99 to 1.47
Physical work load												
Low-Low	2407 (644)	1.00	Reference	2451 (427)	1.00	Reference	2575 (170)	1.00	Reference	2546 (412)	1.00	Reference
Low-High	315 (93)	1.13	0.91 to 1.41	322 (66)	1.22	0.94 to 1.58	341 (23)	1.04	0.67 to 1.60	337 (58)	1.07	0.82 to 1.41
High-Low	298 (86)	1.09	0.87 to 1.37	305 (62)	1.17	0.90 to 1.52	333 (30)	1.39	0.94 to 2.05	323 (50)	0.95	0.71 to 1.28
High-High	567 (185)	1.27	1.08 to 1.49	582 (128)	1.30	1.07 to 1.59	618 (62)	1.54	1.15 to 2.06	602 (115)	1.20	0.97 to 1.47

Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in 3 months preceding Phase 2 were excluded.

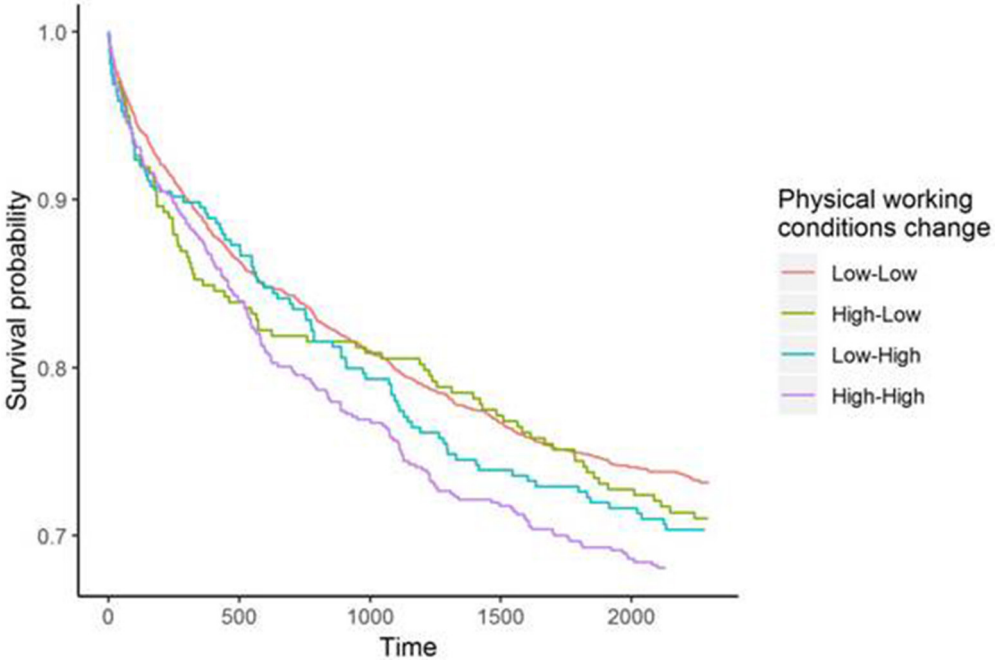
Table 3 Age and sex adjusted hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for associations of changes in working conditions between Phase 1 (2000–2002) and Phase 2 (2007) and subsequent psychotropic medication between Phase 2 and the end of 2013, the Helsinki Health Study, Finland

	Any psychotropic (n=3587)			Antidepressants (N06A) (n=3660)			Anxiolytics (N05B) (n=3867)			Sedatives and hypnotics (N05C) (n=3808)		
	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI
Job control												
High-High	1477 (402)	0.92	0.80 to 1.07	1499 (264)	085	0.71 to 1.01	1573 (102)	0.73	0.56 to 0.96	1559 (245)	0.97	0.81 to 1.17
High-Low	506 (148)	1.00	0.82 to 1.21	518 (95)	0.88	0.70 to 1.12	542 (43)	0.89	0.63 to 1.27	532 (94)	1.09	0.86 to 1.40
Low-High	417 (117)	0.95	0.77 to 1.18	425 (80)	0.90	0.70 to 1.16	457 (27)	0.66	0.43 to 1.00	449 (91)	1.29	1.00 to 1.65
Low-Low	1187 (341)	1.00	Reference	1218 (244)	1.00	Reference	1295 (113)	1.00	Reference	1268 (205)	1.00	Reference
Job demands												
Low-Low	1188 (304)	0.82	0.71 to 0.96	1208 (205)	0.83	0.69 to 1.00	1267 (83)	0.75	0.57 to 1.00	1254 (185)	0.83	0.68 to 1.01
Low-High	584 (165)	0.90	0.75 to 1.08	598 (117)	0.91	0.73 to 1.14	632 (45)	0.79	0.56 to 1.12	619 (108)	0.99	0.79 to 1.25
High-Low	601 (169)	0.90	0.75 to 1.08	610 (106)	0.84	0.67 to 1.05	649 (41)	0.72	0.50 to 1.03	639 (110)	0.96	0.77 to 1.21
High-High	1214 (370)	1.00	Reference	1244 (255)	1.00	Reference	1319 (116)	1.00	Reference	1296 (232)	1.00	Reference
Physical work load												
Low-Low	2407 (644)	0.79	0.67 to 0.93	2451 (427)	0.77	0.63 to 0.94	2575 (170)	0.65	0.49 to 0.87	2546 (412)	0.84	0.68 to 1.03
Low-High	315 (93)	0.89	0.70 to 1.15	322 (66)	0.94	0.70 to 1.26	341 (23)	0.67	0.42 to 1.08	337 (58)	0.90	0.65 to 1.23
High-Low	298 (86)	0.86	0.67 to 1.12	305 (62)	0.90	0.66 to 1.21	333 (30)	0.90	0.58 to 1.40	323 (50)	0.80	0.57 to 1.11
High-High	567 (185)	1.00	Reference	582 (128)	1.00	Reference	618 (62)	1.00	Reference	602 (115)	1.00	Reference

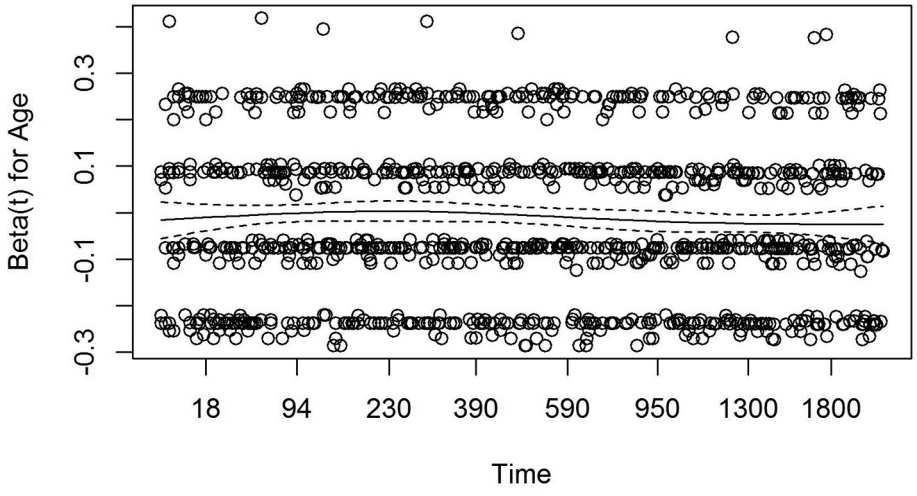
	Any psychotropic (n=3587)			Antidepressants (N06A) (n=3660)			Anxiolytics (N05B) (n=3867)			Sedatives and hypnotics (N05C) (n=3808)		
	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI	N (cases)	HR	95% CI

Participants with psychotropic medication purchases in question (the medication groups were not mutually exclusive) in 3 months preceding Phase 2 were excluded.

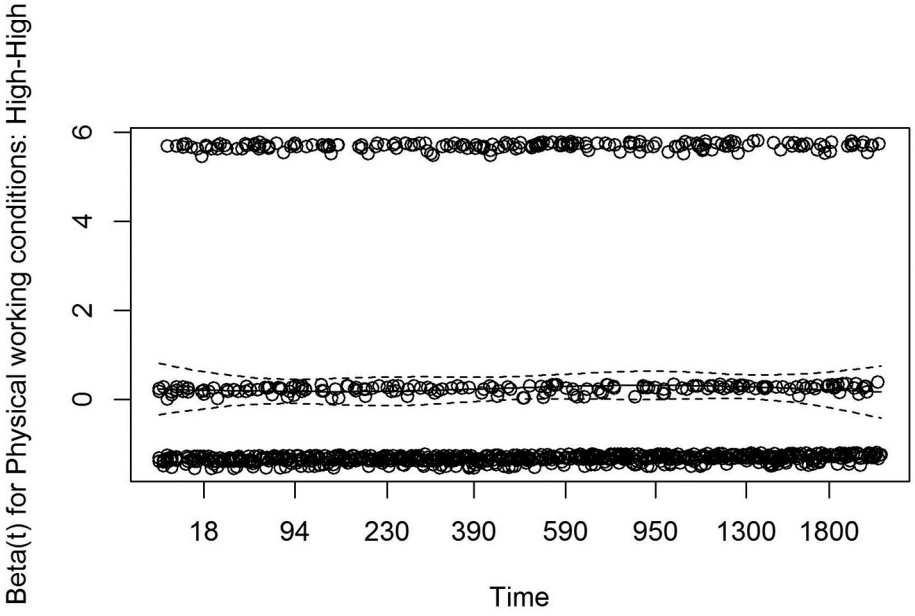
Figure 3 Survival curves for any psychotropic medication by changes in physical working conditions.



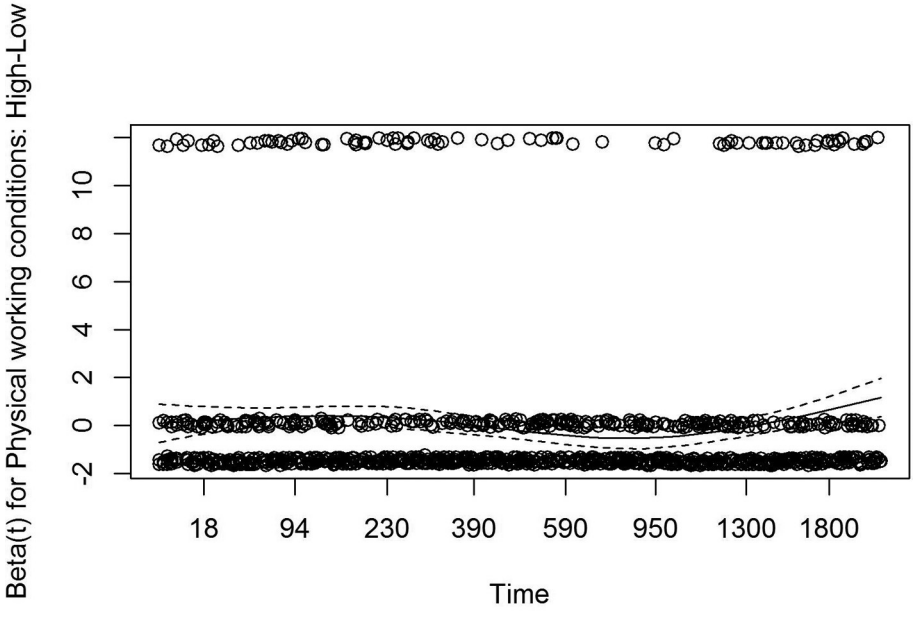
Appendix 2 Physical working conditions - age



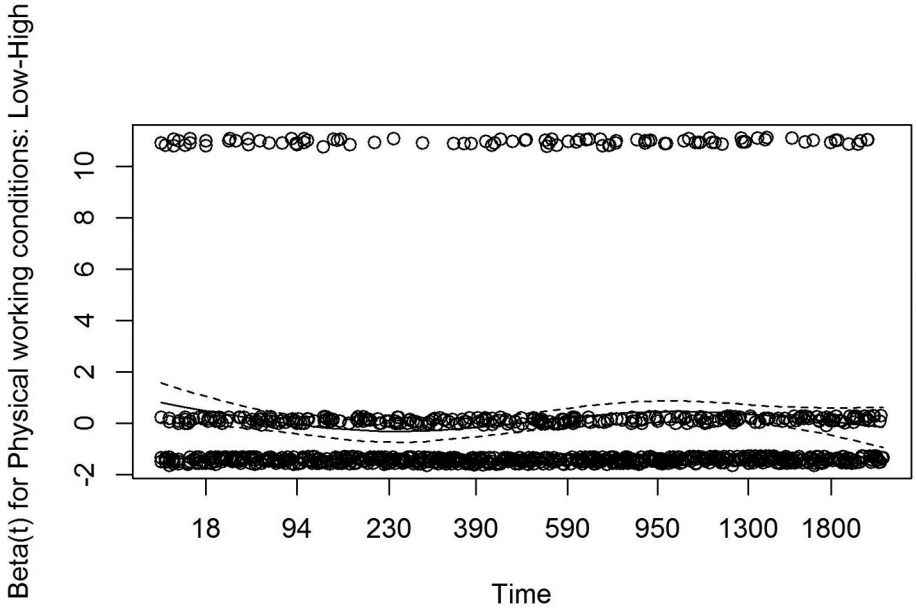
Appendix 2 Physical working conditions - high-high



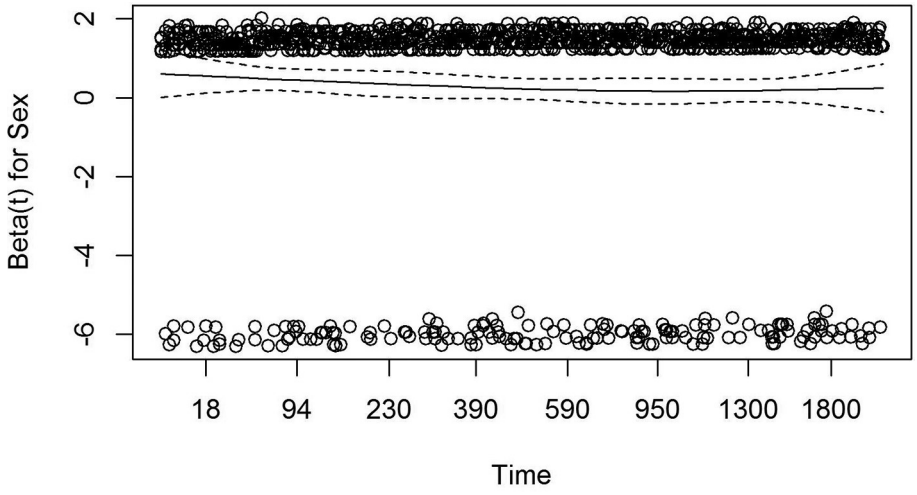
Appendix 2 Physical working conditions - high-low



Appendix 2 Physical working conditions - low-high



Appendix 2 Physical working conditions - sex



BMJ Open 2019;**9**:e015573corr1. doi:10.1136/bmjopen-2016-015573corr1