Study protocol for analyses on the prospective association of work-related violence, and decision latitude with risk of depression in The Danish Work Life Course Cohort (DAWCO)

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Introduction

Previous research has shown that psychosocial working conditions are related to an increased risk of depression.[1][2][3] However, the existing literature on the topic is limited by at least four methodological concerns. First, most studies have been based on populations that were not followed from the beginning of their working lives. In those cases the study populations may have been affected by healthy worker selection, which could lead to an underestimation of the associations between psychosocial working conditions and depression. This is because of the exclusion of individuals with depression - possibly related to their working conditions - prior to study baseline from the analyses. Second, results may be biased due to selection of employees into or out of jobs with adverse psychosocial working conditions, a selection which could be related to the health status of the employees. Such selection is probable given previous research linking social circumstances in childhood, such as socioeconomic position and abuse, to adulthood educational attainment, entry to the labour market and psychosocial working conditions.[4][5] If participants with adverse psychosocial working conditions are more likely to have pre-existing risk factors for

depression that have not been accounted for in the analyses, this could lead to an overestimation of the

associations between psychosocial working conditions and depression.[6] Third, in most studies, the duration

of exposure to adverse psychosocial working conditions is unknown. As there are indications that longer

duration may be associated with higher risk than shorter duration of exposure[1 7] this might lead to an

underestimation of the effects of the psychosocial working conditions as individuals with long exposure are

conflated with individuals with brief exposure. Fourth, most existing studies have used self-reported data

for assessing psychosocial working conditions. This may cause reporting bias, because pre-clinical

depressive symptoms may have affected the reporting of the working conditions.[8 9] Such bias could lead to

an overestimation of the associations between psychosocial working conditions and depression.

To address these limitations, we will examine the prospective associations between two specific

psychosocial working conditions (work-related violence and decision latitude) and the risk of depression, in

The Danish work life course cohort (DAWCO), a cohort of all individuals aged 15-30 who entered the Danish

workforce for the first time during the years 1995 to2009. Participants are followed in registers for hospital

diagnosed depression (including both outpatient and inpatient treatments) from the beginning of their

work lives and on average 7 years (range: 1 to 14). To avoid reporting bias, and to assign exposures to the

complete register-based cohort, we assess the working conditions of the participants by job exposure

matrices (JEMs), and record these measures repeatedly to account for the duration of exposure. We focus

on the exposures work-related violence and decision latitude, amongst the many dimensions of the

psychosocial working conditions, because these factors have been associated with depression in previous

research, but due to methodological concerns regarding residual confounding (see p. 3-4 for details), the

causality of the observed associations is unclear. The aim of this protocol is to document the planned

analyses before they are commenced, to avoid post hoc decision making and to document that the

analyses are confirmatory and hypothesis testing.

Background

Work-related violence

Previous studies show that self-reported exposure to violence at work is associated with poor mental health including feelings or symptoms of depression[10 11] and increased risk of antidepressant treatment.[12] A previous Danish register-based case-control study, using a job exposure matrix further found that employees in job groups with high risk of work-related violence have a higher risk of hospital-diagnosed affective disorders.[13] This study, however, could not assess the impact of duration of exposure, and could not rule out that the observed associations were biased by a selection of employees vulnerable to depression into job groups with high exposure to work-related violence.[13] With the planned study we aim to expand the existing knowledge concerning the risk of depression in job groups with high exposure to violence by examining if the risk of depression increases with longer duration of exposure, and by accounting for health- and vulnerability indicators prior to first employment, to accommodate concerns regarding selection.

Decision latitude

Decision latitude, or job control, is a combination of the decision authority (i.e. influence at work) and skill discretion (i.e, possibilities for development) of a job.[14] As one of the dimensions of the hallmark model of psychosocial work environment - the job strain model[14] - decision latitude has been widely examined in relation to depression.[1 2] A recent systematic literature review found that out of all examined psychosocial working conditions, decision latitude was one of two psychosocial working conditions with consistent evidence from a large number of studies, concerning an association with onset of depression.[2] The other condition was job strain, i.e. the combination of low decision latitude and high demands.

In this planned study we will extend existing knowledge concerning the relation between decision latitude and depression, which is mostly based on self-reported data on decision latitude, and where the role of duration of exposure is largely unknown. Decision latitude is inextricably linked with socioeconomic position, as the occupational position (an indicator of socioeconomic position) assigned to a job is determined, amongst other factors, by the level of decision authority of the job.[15] As such, decision latitude presents a particularly interesting case methodologically, because decision latitude cannot readily be disentangled from socioeconomic position when the two factors are measured simultaneously. Thus, analyses of the associations between decision latitude and depression after accounting for education level before entering the workforce will contribute in particular to the disentanglement of effects of decision latitude from those of socioeconomic position.

Hypotheses

We test the following hypotheses:

Analyses on violence:

1a) Employees in job groups with higher predicted probability of work-related violence have a higher risk of onset of incident depression. We include both current and accumulated exposure to work-related violence in the statistical model and consider this hypothesis supported by the data if higher current JEM based levels of work-related violence during one year are statistically significantly associated with a higher risk of depression measured by psychiatric treatment with a diagnosis of depression during the subsequent year.

1b) There is an accumulation of effects of work-related violence, with longer exposure associated with higher risk in a dose-response manner. We consider this hypothesis supported by the data if there is a statistically significant effect of accumulated exposure to work-related violence, after accounting for current exposure and length of work experience.

1c) The association between work-related violence and depression is not explained by health-status prior to entering the workforce. We consider this hypothesis supported by the data if there is a statistically significant association between JEM measured work-related violence (cumulated or present) and depression after accounting for the primary care health services use during the year before entering the workforce, in addition to the covariates included in analyses for hypothesis 1a (see p. 14 for details).

All statistical tests apply a level of significance of $(P<0.05)$.

Analyses on decision latitude:

2a) Employees in job groups with lower predicted levels of decision latitude at work have a higher risk of onset of incident depression. We include both current and accumulated levels of decision latitude in the model and consider this hypothesis supported by the data if lower current JEM based levels of decision latitude during one year are statistically significantly associated with a higher risk of depression measured by psychiatric treatment with a diagnosis of depression during the subsequent year.

2c) There is an accumulation of effects of decision latitude on depression, with longer exposure associated with higher risk in a dose-response manner. We consider this hypothesis supported by the data if there is a statistically significant effect of accumulated levels of decision latitude, after accounting for current level of decision latitude and length of work experience.

2b) The association between decision latitude and depression is not explained by the educational attainment prior to entering the job group. We consider this hypothesis supported by the data if there is a statistically significant association between JEM measured decision latitude and depression after accounting for level of education prior to entering the job group, in addition to the covariates included in analyses for hypothesis 2a (see p. 14 for details).

All statistical tests apply a level of significance of ($P<0.05$).

Material and Methods

Study population and design

The study population consists of all individuals aged 15-30, who lived in Denmark and had gainful employment as their main source of income in Danish registers during at least one of the years 1995-2009 and had not previously been registered with gainful employment as their main source of income (n=979,257). We exclude individuals with missing data on sex and migrant status (n=5,176), and individuals who died (n=71), emigrated (n=13,087) or received disability pensioning (n=361) in their year of entry leaving 960,562 individuals in the cohort. To study incident depression, we exclude participants with hospital diagnosis of depression prior to or in the year of entering the workforce (n=4,850), yielding a final cohort of 955,712 participants who are followed for a total of 6,990,060 person years.

Assessment of exposures

The exposures to work-related violence and decision latitude are assessed using job exposure matrices. These matrices are based on self-reported data from the Danish Work Environment Cohort Study (DWECS) in years 2000 and 2005. The items used to measure the two psychosocial working conditions in DWECS are shown in table 1. The item for work-related violence includes violence regardless of the perpetrator and is dichotomized into yes/no. If respondents have valid responses to at least half of the items on decision latitude, we calculate a scale value ranging 1-5 as the mean of scores on each item equally weighted and higher scores indicating more decision latitude. The individual level measure for decision latitude has been validated against the original measures for decision latitude[16] and has been shown to predict hospital-diagnosed depression.[1]

Based on the self-reported data, the predicted risk of exposure to work-related violence in each job group and the predicted level of influence in each job group are estimated. The job groups are classified according

Table 1. Self-reported items on work-related violence and decision latitude

	Item	Response options
Work-related violence	Have you been exposed to physical violence at your workplace within the last 12 months?[17]	No Yes, from colleagues Yes, from a superior Yes, from a subordinate Yes, from clients/ customers/patients
Decision latitude	Do you have any influence on what you do at work? [18]	Always Often Sometimes Seldom Never/almost never
	Does your work require you to take the initiative?? [18]	To a very large extent To a large extent Somewhat To a small extent To a very small extent
	Do you have the possibility of learning new things through your work? [18]	To a very large extent To a large extent Somewhat To a small extent To a very small extent
	Can you use your skills or expertise in your work? [18]	To a very large extent To a large extent Somewhat To a small extent To a very small extent
	Is your work varied? [19]	Yes, indeed To some extent Not so much No, or very seldom

to the Danish version of the ISCO-88 classification (DISCO-88). We include job groups and assign exposures to our study population during the years 1995-2009, because this is a period were job groups were consistently classified in the Danish registers using DISCO-88.

The predicted exposures are estimated using statistical models including sex, age and year of data collection (2000, 2005) to generate job group- sex- and age-specific exposure matrices that account for period effects. The matrices are generating using proc glimmix in SAS version 9.4. For the dichotomous variable work-related violence we estimate the predicted risk using a logistic model, predicting work-related violence as a function of job group, sex, age and year of data collection.

For the continuous measure of decision latitude we predict the expected level as a function of job group, sex, age and year of data collection, with a random intercept for job group, in a linear mixed model. In both models age is included as a piecewise linear spline with knots at the quartiles of the distribution of age in the population.

Handling of small job groups

We require a minimum of five DWECS respondents within each job group for an exposure to be estimated at the job group level, to avoid basing the matrices on very small numbers of respondents, which would lead to an increased uncertainty regarding the predicted exposure. If there are fewer than five DWECS respondents in a job group, this group is collapsed with similar small groups and the participants are reclassified at a higher level of the DISCO code. As an example, participants belonging to groups "1223 Production and operations department managers in construction" and "1226 Production and operations department managers in transport, storage and communications" are grouped together at the level "122 Production and operations department managers". DWECS participants who cannot be grouped in this manner to a group of 5 participants or have missing job group data are combined in the group "missing". Table 2 gives an overview of the constructed matrices and their characteristics. Table 3 gives an overview of the ten job groups most exposed to violence and with the lowest levels of decision latitude.

Table 2 Job exposure matrix characteristics

	Mean across job groups	SD	Range between job groups (5th percentile – 95th percentile)
Predicted probability of exposure to work-related violence	0.02	0.06	<0.001-0.12
Predicted mean level of decision latitude	3.77	0.39	3.06-4.32

Table 3 Ten job groups with highest predicted probability of violence and lowest predicted levels of decision latitude

	Job group	Predicted probability[a]	Predicted level
Violence			
	5163: Prison guards	0.20 - 0.40 <	
	5162: Police officers	0.20 - 0.40 <	
	3330: Special education teaching associate professionals	0.20 - 0.40 <	
	915: Messengers, porters, doorkeepers and related workers	0.20 - 0.40 <	
	3475: Athletes, sportspersons and related associate professionals	0.20 - 0.40 <	
	3310: Primary education teaching associate professionals	0.20 - 0.40 <	
	5132: Institution-based personal care workers	0.20 - 0.40 <	
	7243: Electronics mechanics and servicers	0.20 - 0.40 <	
	2132: Computer programmers	0.20 - 0.40 <	
	5169: Protective services workers not elsewhere classified	0.20 - 0.40 <	
Decision latitude			
	8271: Meat- and fish-processing-machine operators		2.3
	8253: Paper-products machine operators		2.4
	812 : metal-processing-plant operators		2.5
	8120: Metal-processing-plant operators		2.6
	8274: Baked-goods, cereal and chocolate-products machine operators		2.6
	8323: Bus and tram drivers		2.6
	9320: Manufacturing labourers		2.7
	9160: Garbage collectors and related labourers		2.7
	8283: Electronic-equipment assemblers		2.7
	8232: Plastic-products machine operators		2.7

[a]Due to data protection issues the exact probabilities cannot be reported. All top ten groups have specific probabilities that range from 0.20 to more than 0.40.

Assessment of depression

Depression is assessed using register data from The Psychiatric Central Research Register[20] during the years 1969-1994 and The National Patient Register during the years 1995-2010.[21] The register encompasses all psychiatric admissions in Denmark since 1969, and from 1995 onwards including both in- and outpatient treatments.[20] To define depression we include a main diagnosis of F32 or F33 from ICD-10 (for the period from 1994 to 2010), and 296.0, 296.2, 298.0, 300.4 from ICD-8 (for the period 1969 to 1993) from both in- and outpatient treatment. Unlike in other countries, ICD-9 was never used in Denmark. For the exclusion of individuals with depression prior to entering the workforce, we further include the codes F92.0 (ICD-10) and 308.02 (ICD-8) for depression in childhood or adolescence.

Assessment of covariates

We include the following covariates in the analyses: calendar year, sex, age, ethnicity, cohabitation, number of children, income, education, health services use, industrial sector, years of work experience, employment status, years of non-employment, mothers and fathers education and occupational position when the target individual was 15 years old, and mothers and fathers mental or somatic illness prior to the target individual entering the workforce.

We include sex, age, cohabitation, number of children, income, education, non-employment, and parental mental illness as they are known predictors for depression,[22-24] which could be unequally distributed across job groups. Calendar year and ethnicity are both related to psychiatric treatment rates.[20 25] Employment status is categorized as employed, self-employed, unemployed, studying or other types of non-employment. We include years of work experience since cohort entry to account for possible general effects of working on the risk of depression and years of non-employment (unemployed or other types of non-employment) to account for potential effects of non-employment on depression. We include information on parental occupational position and education to adjust for social background factors in the

individuals' childhood that may increase the risk of depression. Parental somatic illness (coronary heart disease and cancer) is included to account for potential early life stress related to the illness of a parent.

We include data on sex, age, ethnicity and cohabitation from The Danish Civil Registration System.[26] Ethnicity is categorized as: Danish, immigrant/descendant. Cohabitation is categorized as single or cohabiting. The annual total income for the individual is included from Statistics Denmark's Income Statistics Register[27] and measured in Danish crowns. We categorize annual disposable income in deciles for each calendar year to account for potential non-linearity of the association with depression. Education is included from Statistics Denmark's Population's Education Register[28] and categorized in six main categories according to the International Standard Classification of Education (ISCED[29]); 1 Primary and lower secondary (ISCED levels 1 and 2), 2 Upper secondary (ISCED level 3), 3 Short cycle tertiary (ISCED level 5), 4 Bachelor or equivalent (ISCED level 6), 5 Master (ISCE level 7), 6 doctoral (ISCED level 8) and a seventh category for missing data. The number of primary care services obtained is included as the number of health services recorded in The Danish National Health Service Register, during the year prior to entering the workforce.[30] We categorize the number of primary care services in deciles for each calendar year to account for potential non-linearity of the association with depression and changes in registration practice during the study period.

Parental education is included from the Statistics Denmark's Student Register[28] according to ISCED and divided into five main categories valid for the period when parental education was measured; 1 Primary and lower secondary (ISCED levels 1 and 2), 2 Upper secondary (ISCED level 3), 3 Short cycle tertiary (ISCED level 5), 4 Bachelor or equivalent (ISCED level 6), 5 Master or doctoral (ISCED levels 7 and 8), and a sixth category for missing data. Parental occupational position is included from Statistics Denmark's Employment Classification Module register,[31] and categorized as employed or unemployed/outside the labour force following the guidelines set by ILO[32], and a third category for missing data. We include parental data from when the study participant was age 15 for education and occupational position as this is the earliest time

where it is possible to link information on parents and study participants. Parental mental (any diagnosis) and somatic (coronary heart disease and cancer) illness is included from hospital registers.[20 21]

Industrial sector is included as the 8 main groups of the Danish version of the Statistical classification of economic activities in the European Community (NACE) [33 34] from Statistics Denmark's Employment Classification Module register. We also include information on disability pensioning from the DREAM database, which contains weekly information on all Danish social benefits payments since 1991.[35] From DREAM, we include the code 783 disability pensioning.

Statistical models

We analyse data using Cox regression using calendar time as underlying time-axis. We analyse data longitudinally, i.e. we relate exposure during year t to events during year t+1. To test for accumulation of effects we include current exposure in year t and a running sum of exposure in year t and all previous years. Both variables are included as time-varying. The outcome for the analyses is first hospital diagnosis with depression, and we censor participants if they die, emigrate or receive disability pensioning, as these events are treated as absorbing states. Participants are followed up from their year of entry in the workforce until first diagnosis of depression, any of the absorbing states, or end of follow up 31/12/2010, whichever comes first.

The JEM estimates for both exposures are included as continuous variables. To ease interpretation of the estimated parameters we apply logarithmic transformation (log2) of the exposures, so that the estimated parameters will yield the risk associated with a doubling of exposure.

We adjust our analyses to test hypotheses 1a-1b and 2a-2b for the individuals' sex, age, cohabitation, ethnicity, number of children, employment status (employed vs. non-employed with studying and self-employment included as dummies), years of non-employment, years of work experience, income, mothers

and fathers education, mothers and fathers occupational position, and mothers and fathers mental and somatic illness, calendar year, and year of JEM assessment (2000 or 2005). For the analyses to test hypothesis 1c we further adjust for health services use in the year prior to entering the workforce, and in the analyses to test hypothesis 2c we further adjust for education in year t-1. Calendar year, age, cohabitation, number of children, education, income, employment status, years of non-employment, years of work experience are included as time-varying variables, while the remaining covariates are included as time-invariant variables.

Sensitivity analyses

As planned sensitivity analysis we will conduct analyses stratified by 1) sex, 2) educational level, 3) industrial sector, 4) migration status. We conduct sensitivity analyses 1-3 to assess the robustness of the findings, and if associations are similar in men and women and across educational level and industrial sectors. We conduct sensitivity analysis 4 because no data are available for migrants prior to their migration to Denmark, and thus these individuals could possibly have worked and/or been diagnosed with depression in a different country, prior to migrating to Denmark.

If we do not detect an association between the two examined exposures and the outcome in the main analysis we will further examine whether there could be non-linearity of the associations. We will do so by categorizing the exposures into quartiles of their distribution to allow for potential non-linearity. If there are no statistically significant associations in the main analysis, the results from this analysis cannot be considered confirmatory but rather hypothesis generating.

Statistical power

Our analyses encompass 955,712 individuals from The Danish work life course cohort who are followed during an average of 7.3 years. The total number of person years is more than 6 million and 16,153 individuals become cases with hospital-treated depression. As an example, we would need 33,357 participants to detect a relative risk of 1.20 with 90% power, if comparing two balanced groups. Because our sample size is more than twenty-fold greater than this number of participants, and we analyse the exposures as continuous variables, it is our assessment that the analyses are sufficiently powered to detect any associations of practical importance.

Methodological discussion

Strengths and limitations

This study is the first to examine the associations between psychosocial working conditions and depression in a nationwide cohort of employees that were followed from the beginning of their working lives. This is a considerable strength of the study, as previous studies have typically been based on populations where exposures were measured at random times during their working lives. Because exposures were not measured from their onset, the populations are likely to be affected by healthy worker selection. Furthermore, we measure exposures repeatedly over an extended period of time allowing us to study cumulated effects of exposure on depression.

Some limitations should be noted. Most notably, the psychosocial working conditions are assessed using a job exposure matrix. This is an ecological design, and the results of the analyses should be interpreted at the job group level, i.e. the associations between working in a job group with high risk of exposure to violence or low average levels of influence in work and onset of depression. Inference from such analyses to the individual level should only be done with caution.

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