

BMJ Open Cohort profile: the Danish Work Life Course Cohort study (DaWCo)

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ABSTRACT

Purpose The Danish Work Life Course Cohort (DaWCo) was initiated to study relations between working conditions, health and labour market affiliation using repeated measures of these factors throughout the working life, while accounting for health-differences pre-existing labour market entry.

Participants The cohort encompasses all 15–30-year-old individuals residing in Denmark who entered the labour market during the years 1995–2009 (960 562 individuals and 7 136 188 observations). Data include information on working conditions measured by job exposure matrices linked with registers on health, labour market affiliation and sociodemographics for both the cohort members and their parents. The median age at cohort entry was 20 years and men and women were equally represented.

Findings to date Currently, one study has been published, which found that low job control was associated with increased risk of depressive disorder, independently from indicators of socioeconomic position measured throughout the life-course. The present cohort profile presents data regarding the transitions of cohort members between states of labour market affiliation and data on health services use. All cohort members were employed in their year of entry, but this proportion decreased across the years to 82.4% in the 10th year since cohort entry. The proportion of students peaked at 5 years since cohort entry with 13.9%.

Future plans This large prospective cohort offers the possibility to study associations between psychosocial working conditions and rare outcomes and to examine the potential accumulation of effects while accounting for health-differences pre-existing labour market entry. Currently, we are working on analyses on risk of hospital-diagnosed incident depression and disability pensioning. The study is ongoing, and we are planning to extend the study to include the years 2010–2018 and expand the cohort with individuals entering the Danish workforce during these years.

INTRODUCTION

The Danish Work life Course cohort (DaWCo) is a register-based, prospective cohort study, including all young Danish residents, who entered the workforce during the years 1995–2009. The cohort was established with the objective of investigating health effects due to accumulated exposure to adverse working conditions, while accounting

Strengths and limitations of this study

- The cohort has annual measurements of working conditions from the beginning of the cohort members working lives using job exposure matrices (JEMs). This enables the examination of accumulation of effects and effects of changes in exposure.
- The size of the cohort enables the study of associations between working conditions and rarer outcomes such as hospital diagnoses of mental disorders, while selective dropout is avoided given the register-based nature of the cohort.
- Information on health prior to labour market entry and parental health and socioeconomic status from childhood allows analyses to account for selection into job groups based on childhood and adolescence health and social circumstances.
- A limitation is the use of JEMs containing average exposures in relation to job group, sex and age, to assess working conditions. There may be substantial variation in exposures within job groups which cannot be identified in the JEM, leading to potential misclassification of exposure.

for health-differences pre-existing labour market entry. While many studies have linked adverse psychosocial working conditions with poor mental or physical health,^{1–3} there is a lack of evidence based on studies, which do not rely on self-reported exposure information, and which contain repeated measures of exposures.

In DaWCo, the working conditions are assessed by job exposure matrices (JEMs) consisting of aggregated job group level estimates for the average exposure to specific working conditions within job groups. The matrices are sex-specific and age-specific. The JEM estimates are assigned to the individuals in the cohort based on their job group, sex and age; this enables studies of working conditions for the entire Danish working population. The JEMs are based on self-reported data from a representative sample of the Danish workforce, collected in the Danish Work Environment Cohort Study (DWECS) in the years 2000 and 2005^{4 5} and classified

according to the Danish version of the International Standard Classification of Occupations system (DISCO-88).⁶

JEMs for psychosocial working conditions were first applied in Sweden in the 1980s,⁷ but have rarely been used since, with the availability of larger cohorts with individually assessed exposures.^{8,9} Recently, though, there seems to be a revival of psychosocial JEM studies, with publications on recently developed psychosocial JEMs from Finland, France, The Netherlands and Australia.^{10–13} The use of JEMs is particularly promising in countries, such as Denmark and other Nordic countries, where population based administrative health registers exist. In these countries, JEMs enable the study of the associations between psychosocial working conditions and subsequent risk of disease in nationwide cohorts.

The DaWCo study is the first to apply JEMs of psychosocial working conditions to a prospective, register-based cohort of young workers, and the cohort addresses four methodological issues: First, the cohort enables research in work environment and health for a nationwide register-based cohort, thus avoiding selective dropout. Second, the register-based assessments of exposure limit reporting bias due to preclinical symptoms of disease affecting the report of working conditions.^{14,15} Third, the cohort's annually repeated measurements of working conditions from the beginning of the individuals' work life allows analyses of the potential accumulation of effects of working conditions on health. Fourth, the cohort minimises bias due to healthy worker selection and pre-existing health-differences between job groups: The cohort includes information on both health prior to labour market entry and parental health and socio-economic status (SES) dating back to the childhood of the cohort members. This information allows analyses to account for selection into job groups based on childhood health and social circumstances.

DaWCo uses Danish administrative register data with annual individual level follow-ups on employment status, job group, health and various sociodemographic variables combined with information on education, and hospital diagnosis of the individuals' parents. The register data are combined with JEMs for both ergonomic working conditions and a range of psychosocial working conditions, including quantitative and emotional demands, decision latitude, job strain and work-related violence. DaWCo was initiated in 2015 by The Danish National Research Centre for the Working Environment (NRCWE) and is funded by the Danish Work Environment Research Fund (grant number 17-2014-03).

COHORT DESCRIPTION

The open cohort was established by combining national Danish registers containing annual information on employment, health and sociodemographics. All data were provided in anonymised form by Statistics Denmark

We retrieved data from Statistics Denmark of all individuals aged 15–30 years residing in Denmark during the

years 1995–2009 (n=1 663 817). We removed individuals with labour market participation before 1995 (n=701 339) and without information in the Employment Classification Register (n=1916), yielding a population of 960 562 individuals (7 136 188 observations, [table 1](#)). Each individual was followed in DaWCo with annual measurements of key factors, including labour market affiliation and working conditions, from the year of their first labour market entry until 2009, yielding up to 15 years with annual exposure measurements per individual. Entry into the labour market was defined by being included in The Integrated Database for Labor Market Research (IDA)¹⁶ and simultaneously having gainful employment as the main source of income for the first time in the Employment Classification Module (AKM).¹⁶ AKM prioritises the individuals' main employment activity in the calendar year based on information on income, education, business, SES and receipts of unemployment or welfare benefits. The cohort was constructed as an open cohort with new individuals entering the cohort annually during the years 1995–2009. The number of repeated measures range from 1 to 15 years and the average number of repeated measures by individual is 7 years. We limited the cohort to individuals entering the Danish workforce during the period 1995–2009 because this is a period for which job groups, a key variable in exposure assignment, was measured consistently using the DISCO-88 coding.⁶

[Table 1](#) shows the entries and exits from the cohort during the inclusion period 1995–2009. On average, approximately 64 000 individuals entered the cohort each year and the number of individuals in the cohort increased from 76 953 in 1995 to 856 106 in 2009. Due to the register-based nature of the cohort, there was very little loss to follow-up for unknown reasons (n=690). Individuals who emigrated were censored at migration (n=94 394) as their exposure status during their years living outside Denmark is unknown. Individuals who received disability a pension (n=6880) were likewise censored as they are unlikely to re-enter paid employment.¹⁷ Individuals who died (n=2492) were censored in the year of their death.

Patient and public involvement

For this occupational health study, which primarily focuses on topics related to primary prevention, key stakeholders include representatives of employer and employee organisations and to a lesser extent patient organisations. Key stakeholders were involved in the development of research questions and design of the study by providing input from the early stages of the grant application and in the final decision to award the grant. The study did not involve recruitment of participants. The results of the study will be discussed with key stakeholder representatives and disseminated to the Danish public by providing Danish summaries of the study results published online and delivered to key stakeholders using newsletters, as well as through public seminars, where we present the results.

Table 1 Entries, observations and exits in the DaWCo study by year (1995–2009)

Year	Entries		Observations				Exits		Unknown reason for exit	
	Individuals	Individuals	Death	Emigration		Disability pension	Unknown reason for exit			
	N	N	N	%	N	%	N	%		
1995	76953	76953	0	0.00	0	0.00	0	0.00	0	0.00
1996	67627	143053	40	0.03	1457	1.02	30	0.02	0	0.00
1997	65777	206182	56	0.03	2510	1.22	66	0.03	16	0.01
1998	66200	268595	74	0.03	3584	1.33	105	0.04	24	0.01
1999	60298	324031	118	0.04	4615	1.42	95	0.03	34	0.01
2000	59736	377702	145	0.04	5697	1.51	180	0.05	43	0.01
2001	57495	428269	152	0.04	6463	1.51	260	0.06	53	0.01
2002	55460	476084	162	0.03	7075	1.49	340	0.07	68	0.01
2003	53328	521360	215	0.04	7380	1.42	386	0.07	71	0.01
2004	57612	570169	217	0.04	7959	1.40	547	0.10	80	0.01
2005	64406	624835	211	0.03	8741	1.40	716	0.11	72	0.01
2006	73447	687993	221	0.03	9302	1.35	725	0.11	41	0.01
2007	78825	756409	260	0.03	9350	1.24	786	0.10	13	0.00
2008	73357	818447	316	0.04	9828	1.20	1153	0.14	22	0.00
2009	50041	856106	305	0.04	10433	1.22	1491	0.17	153	0.02
Total	960562	7136188	2492	0.03	94394	1.32	6880	0.10	690	0.01

DaWCo, the Danish Work Life Course Cohort study.

MEASUREMENTS

Table 2 gives an overview of the main measures included in the cohort. All measures were registered at entry and annually throughout the study period.

Exposures: job exposure matrices

To measure psychosocial and ergonomic working conditions, we constructed JEMs based on sex, age and self-reported psychosocial and ergonomic working conditions from the DWECS years 2000 and 2005. DWECS was a cohort study of random samples of the Danish working population aged 18–59 years, with data collections every 5 years during 1990–2010. At each wave of data-collection, the cohort was supplemented with additional random samples to account for ageing and migration, in addition to a follow-up of participants who were randomly drawn at previous data collection waves. Details of the DWECS cohorts are published elsewhere.^{4 5} Because the psychosocial working conditions were measured most comprehensively, and similarly, in years 2000 and 2005, we constructed the JEMs using self-reported data from these two waves, reported by 11 098 participants. The JEMs estimated the average level of each working conditions within occupational groups classified according to the Danish version of the ISCO-88 classification (DISCO-88)¹⁸ at the four-digit level. Similar to a previous psychosocial JEM,¹⁹ we constructed the JEMs using multilevel modelling, to account for the clustering of individuals within job groups. We included a random

intercept for job group, and estimated predicted levels of decision latitude, quantitative and emotional demands and adverse ergonomic working conditions as a function of the individual's job group, sex and age. The scales for each included dimension of the working environment consisted of the items shown in online supplementary data table S1. Sample items include 'Do you have any influence on what you do at work?' (decision latitude), 'Do you have to work very fast?' (quantitative demands), 'Does your work put you in emotionally disturbing situations?' (emotional demands). Work-related violence was measured using the item 'Have you been exposed to physical violence at your workplace during the last 12 months?'. Job strain was defined in DWECS as the combination of high quantitative demands (above median) and low decision latitude (below median).

For the dichotomously defined exposures of job strain and work-related violence, we constructed the JEM as the predicted probability of exposure as a function of job group, sex and age. Online supplementary table S2 shows key features regarding the distributions of the JEMs (available as supplementary data online). The JEMs were included annually in the cohort with JEMs from DWECS 2000 applied to years 1995–2003 in the cohort and JEMs from DWECS 2005 applied to years 2004–2009. All exposures were included as time-varying, and each estimated exposure level is specific to the occupation the individual is employed in within a given calendar year, in addition to

Table 2 Measures in the cohort

Main category of information	Main subcategories of information	Data source	Availability
Working conditions (job exposure matrices)	Quantitative demands, emotional demands, decision latitude, job strain, work-related violence, ergonomic working conditions	DWECS ⁴⁵	1995–2009
Somatic health	Number of primary care services obtained, somatic hospital inpatient and outpatient admissions and diagnosis	The National Health Service Register ²³ The National Patient Register ²¹	1992–2014, 1977–2014
Mental health	Psychiatric hospital inpatient and outpatient admissions and diagnosis	The Psychiatric Central Research Register ²²	1969–2014. Outpatient treatments included from 1995
Death	Death date	Statistics Denmark's register on Deaths ²⁴	1986–2015
Parental somatic health	Somatic hospital inpatient and outpatient admissions and diagnosis	The National Patient Register ²¹	1977–2014
Parental mental health	Psychiatric hospital inpatient and outpatient admissions and diagnosis	The Psychiatric Central Research Register	1977–2014. Outpatient treatments included from 1995
Exclusion from the labour market	Receipt of unemployment benefits, welfare benefits, subsidised job benefits, long-term sickness benefits, disability pension, student grant from the Danish students' Grants and Loans Scheme	DREAM ⁴⁰	1991–2016
Demography	Gender, age, ethnicity, country of origin	Danish Civil Registration System ⁴¹	1986–2016
Social background	Parental labour market status, parental marital status, parents' highest level of education	Statistics Denmark's Employment Classification Module register, ¹⁶ Statistics Denmark's Student Register ²⁵	Labour market status 1976–2014, education 1973–2015, marital status 1986–2016
Social context	Family type, yearly disposable family income, yearly individual income, yearly equated disposable family income, highest level of education, socioeconomic status, municipality of residence	Danish Civil Registration System, Statistics Denmark's Income Statistics Register, ⁴² Statistics Denmark's Population's Education Register, ²⁵ Statistics Denmark's Employment Classification Module register	Family type 1986–2016, income 1990–2014, highest level of education 1981–2015, socioeconomic status 1976–2014, municipality of residence 1986–2016

DREAM, the Danish Register for Evaluation of Marginalization; DWECS, Danish Work Environment Cohort Study.

the age of the person at that time. Consequently, if individuals change their occupation, their exposure levels were updated accordingly. For more information on the JEM construction, see Madsen *et al* (2018).²⁰

Main outcomes

DaWCo enables studies of psychosocial working conditions and their association with multiple health outcomes. The cohort contains information by date on all somatic hospital admissions and ICD10 diagnoses from the National Patient Register²¹ during 1977–2010, and all ICD10 psychiatric hospital admissions and ICD10 diagnoses from the Psychiatric Central Research Register²² during 1977–2010. The information on health prior to labour market entry allows for data restrictions on cases in childhood and early youth. Further, information on yearly primary care services was obtained from The National Health Service Register,²³ and information on death came from Statistics Denmark's Death Register²⁴ and was available from 1992 onwards.

Potential confounders

Parental somatic and psychiatric diagnoses

Information on all psychiatric and somatic ICD10 diagnoses and admissions of the cohort members' parents was available in DaWCo from 1969 and 1977, respectively, and onwards.

Social background

DaWCo has information on the cohort members' social background prior to labour market entry. Yearly parental labour market attachment was available from the AKM register¹⁶ from 1976 and onwards, and parental education from Statistics Denmark's Student Register²⁵ from 1973. We included data on parental education and labour market status from when the cohort member was 15 years old, as this was the earliest time-point available for all ages included in the cohort. In cases of missing information, we retrieved data back to birth or up to age 20 to reduce the levels of missingness on the variables.

Other variables: demography, social context and exclusion from the labour market

Detailed information on other variables can be found in [table 2](#). Yearly information on the cohort members' social context included measures of family type, disposable family income, individual income, equated disposable family income, highest level of education, SES and municipality of residence. Exclusion from the labour market was measured with weekly information on all social transfer payments, and demographics included yearly measures of gender, age ethnicity and country of origin.

PARTICIPANT CHARACTERISTICS

[Table 3](#) shows the sociodemographic characteristics and information on social background and main job groups at year of entry and at 2, 5 and 10 years since cohort entry. The majority of the cohort was born in Denmark and entered the cohort with primary or lower secondary educational level. The educational level increased with the years of cohort membership. The majority worked as service workers and shop and market sales workers and the overall skill level of the cohort increased with years of measurement. Men and women were represented equally. There were relatively high levels of missing parental education data (ranging from 38% for maternal education in year of entry to 61% for paternal education at 10th year in the cohort). This was related to the age and migration status of the cohort members, as parental linkage could not be obtained prior to 1980 and for individuals who had migrated to Denmark. As an example, the level of missing maternal and paternal data was only 0.25% and 1.0%, respectively, for Danes under the age of 25 in year of entry, whereas it was 93.4% and 94.1%, respectively, for non-Danes aged 25 or more in year of entry (data not shown in tables).

Immigrants/descendants of immigrants and individuals of Danish descent had different shares in the main DISCO-88 occupational groups. While the highest share of immigrants/descendants in year of entry was found in the main occupational group Elementary occupations (19.1%), only 13.2% of individuals of Danish descent were employed here. In contrast, the most frequent main occupational group in year of entry among those of Danish descent was Service workers and shop and market sales workers (29.9%) while only 17.8% of immigrants/descendants were employed in this job group (data not shown in table).

FINDINGS TO DATE

Job control and depressive disorder

Currently, one study based on the DaWCo population, examining the association between job control and depressive disorder has been published.²⁶ The study found an association between job control and subsequent depressive disorder, after adjustment for possible confounding by SES, measured in a life-course

Table 3 Participant characteristics at entry

	Year of entry, n=960 562	
	N	%
Women	474 808	49.0
Mean age, years (range)	20.2 (15–30)	
Cohabiting	615 939	64.1
Immigrant/descendant of immigrants	144 370	15.0
Highest level of education		
Primary or lower secondary	690 576	71.9
Upper secondary	173 126	18.0
Short cycle tertiary	4340	0.5
Bachelor or equivalent	13 389	1.4
Master or equivalent	5421	0.6
Doctoral or equivalent	13	0.0
Not classified/unknown	73 697	7.7
Maternal educational level		
Primary or lower secondary	208 647	21.7
Upper secondary	239 719	25.0
Short cycle tertiary	16 416	1.7
Bachelor or equivalent	111 910	11.7
Master or doctoral	22 771	2.4
Not classified/unknown	361 099	37.6
Paternal educational level		
Primary or lower secondary	124 328	12.9
Upper secondary	259 801	27.1
Short cycle tertiary	22 211	2.3
Bachelor or equivalent	55 321	5.8
Master or doctoral	45 622	4.8
Not classified/unknown	453 279	47.2
Maternal labour market status		
Employed	657 429	68.4
Unemployed/non-employed	193 876	20.2
Unknown	109 257	11.4
Paternal labour market status		
Employed	709 067	73.8
Unemployed/non-employed	123 088	12.8
Unknown	128 407	13.4
DISCO-88 major groups (% of employed individuals)		
Legislators, senior officials and managers	683	0.1
Professionals	30 399	3.2
Technicians and associate professionals	33 607	3.5
Clerks	76 197	7.9
Service workers and shop and market sales workers	269 664	28.1
Skilled agricultural and fishery workers	5316	1.0
Craft and related trades workers	86 715	9.0

Continued

**Table 3** Continued

	Year of entry, n=960562	
	N	%
Plant and machine operators and assemblers	40567	4.2
Elementary occupations	135543	14.1
Armed forces	20427	2.1
Not classified	261444	27.2
Employment status*		
Employed	960562	100
Self-employed	0	0
Unemployed	0	0
Studying	0	0
No valid information	0	0

*83 individuals are excluded from the table and these individuals occur in the AKM register¹⁶ or in DREAM⁴⁰ (eg, recipients of subsidised job benefits or long term sickness benefits registered in DREAM) but do not fall under the categories of the table.

AKM, Employment Classification Module; DISCO-88, the Danish version of the International Standard Classification of Occupations system; DREAM, the Danish Register for Evaluation of Marginalization.

perspective. The estimated HR in relation to a halved level of job control was 1.27 (95% CI 1.16 to 1.38) in the fully adjusted model.

Transitions between states of labour market affiliation

Tables 3 and 4 show the transitions between states of labour market affiliation of the cohort members during 1995–2009 in relation to the time since inclusion into the cohort. Differences in states of labour market affiliation over time were tested using χ^2 tests. In their year of entry, all cohort members were employed, as this was an inclusion criterion. The proportion of individuals employed was lowest at the 5th year since cohort inclusion ($p<0.001$ for changes over time). The proportion of individuals studying increased over time, but then dropped again to 4% at 10 years since entry ($p<0.001$ for changes over time). Across all years, the majority of individuals were employed (82.2%), few were unemployed (5.8%) or self-employed (1.6%).

The average length of an employment period was 4 years and 53.6% of the individuals were stably employed throughout their years in the cohort (data not shown in table). Less than one in five individuals (17.6%) experienced unemployment during the years of follow-up and the average length of an unemployment period was 1.9 years (data not shown in table).

Health services use

As displayed in table 5, the average number of annual primary care services obtained was 13.7 per person. There were 7214 somatic inpatient and outpatient hospital admissions per 10000 person-years, whereas the rate of psychiatric inpatient and outpatient hospital admissions was 262 per 10000 person-years. The three most frequent

diagnostic groups were 'Injury, poisoning and certain other consequences of external causes', 'Pregnancy, childbirth and the puerperium' and 'Diseases of the musculoskeletal system and connective tissue'. 'Mental and behavioural disorders' was the sixth most frequent diagnostic group.

STRENGTHS AND LIMITATIONS

The main strength of the DaWCo study is the annual measurements of working conditions from the beginning of working lives of the included individuals. The size of the cohort enables studies of associations between working conditions and rarer outcomes such as incident hospital diagnosed depression. Because the cohort is followed from the beginning of their working lives (inception cohort), the DaWCo study minimises healthy worker selection and selective dropout. The longitudinal assessment of psychosocial working conditions and depression provides unique data to analyse cumulated effects of working conditions and changes in exposure over time.

To the best of our knowledge, the level of information on parental health and SES prior to labour market entry in DaWCo is rare compared with other cohorts and allows the analyses to account for selection into job groups based on childhood health and social circumstances. Research suggest that individuals whose parents are afflicted by chronic illness have increased vulnerability to disorders such as depression,²⁷ and that these individuals are selected into certain occupations such as caring professions.²⁸ By including the information on parental diagnosis in analyses of working conditions and health, DaWCo allows for both adjustments for risk factors from prior to workforce entry and selection into certain occupations. Likewise, the information on SES during childhood and yearly measurements of adult SES allows the analyses to account for potential confounding by SES both prior to labour market entry and in adulthood. Research suggests adult SES and SES prior to labour market entry to be an important confounder in the association between psychosocial working conditions and health outcomes. Childhood SES has been linked to adult all-cause and cause specific mortality,^{29–31} cardiovascular outcomes³² and depression,³³ independently of adult SES. Likewise, childhood SES may cause selection into certain professions through educational attainment.³⁴ Thus, DaWCo will contribute to a better understanding of the associations between working conditions and health and can also be used to gain further knowledge on childhood risk factors for health outcomes. Although the parental information in DaWCo is a great strength, caution should be exercised in analyses of immigrants/descendants of immigrants and individuals born before 1970 due missing parental information for a larger share of these individuals.

Although the use of JEMs enables the construction of nationwide cohort studies on working conditions, one limitation of the study is the risk of exposure misclassification. Because the JEM assesses the average exposure

Table 4 Sociodemographic characteristics of individuals at 2nd, 5th and 10th year of measurement

	2nd year, n=884 536*			5th year, n=663 082*			10th year, n=343 190*		
	N	Range	%	N	Range	%	N	Range	%
Women	436 084		49.3	312 304		49.3	169 260		49.3
Mean age, years (range)		16–31	21.1		19–34	24.0		24–39	29.0
Cohabiting	548 262		62.0	328 332		51.9	210 747		61.4
Immigrant/descendant	120 672		13.6	67 295		10.6	29 529		8.6
Highest level of education									
Primary or lower secondary	476 445		53.9	192 270		30.4	54 459		15.9
Upper secondary	334 137		37.8	377 328		59.6	167 627		48.8
Short cycle tertiary	7808		0.9	12 617		2.0	20 052		5.8
Bachelor or equivalent	20 254		2.3	28 747		4.5	69 338		20.2
Master or equivalent	12 359		1.4	14 700		2.3	28 807		8.4
Doctoral or equivalent	44		0.0	351		0.1	930		0.3
Not classified/unknown	33 489		3.8	7 069		1.1	1 977		0.6
Maternal educational level									
Primary or lower secondary	195 982		22.2	134 873		21.3	50 679		14.8
Upper secondary	218 677		24.7	142 133		22.5	68 173		19.9
Short cycle tertiary	14 825		1.7	9 655		1.5	4 778		1.4
Bachelor or equivalent	101 742		11.5	71 417		11.3	37 346		10.9
Master or doctoral	20 263		2.3	13 414		2.1	6 399		1.9
Not classified/unknown	333 047		37.7	261 590		41.3	175 815		51.2
Paternal educational level									
Primary or lower secondary	114 209		12.9	70 069		11.1	18 889		5.5
Upper secondary	237 848		26.9	157 163		24.8	73 417		21.4
Short cycle tertiary	20 192		2.3	13 752		2.2	7 222		2.1
Bachelor or equivalent	50 408		5.7	36 156		5.7	19 259		5.6
Master or doctoral	41 297		4.7	28 934		4.5	14 575		4.2
Not classified/unknown	420 582		47.6	327 008		51.7	209 828		61.1
Maternal labour market status									
Employed	614 644		69.5	453 435		71.6	248 745		72.5
Unemployed/non-employed	182 197		20.6	129 580		20.5	67 602		19.7
Unknown	87 695		9.9	50 067		7.9	26 843		7.8
Paternal labour market status									
Employed	663 244		75.0	488 316		77.1	265 257		77.3
Unemployed/non-employed	115 511		13.1	81 388		12.9	43 629		12.7
Unknown	105 781		12.0	63 378		10.0	34 304		10.0
DISCO-88 major groups (% of employed individuals)									
Legislators, senior officials and managers	1 686		0.2	3 424		0.5	3 478		1.0
Professionals	33 547		3.8	40 562		6.4	51 976		15.1
Technicians and associate professionals	39 224		4.4	61 393		9.7	66 042		19.2
Clerks	82 950		9.4	70 286		11.1	31 472		9.2
Service workers and shop and market sales workers	250 049		28.3	139 895		22.1	45 114		13.2

Continued

Table 4 Continued

	2nd year, n=884 536*			5th year, n=663 082*			10th year, n=343 190*		
	N	Range	%	N	Range	%	N	Range	%
Skilled agricultural and fishery workers	6040		0.7	3121		0.5	2173		0.6
Craft and related trades workers	98381		11.1	68197		10.8	34588		10.1
Plant and machine operators and assemblers	39575		4.5	29469		4.7	14831		4.3
Elementary occupations	103996		11.8	57313		9.0	19378		5.7
Armed forces	20222		2.3	14426		2.3	3444		1.0
Not classified	208866		23.6	144996		22.9	70694		20.6
Employment status*									
Employed	730048		82.5	479478		75.7	282920		82.4
Self-employed	2938		0.3	8460		1.3	11020		3.2
Unemployed	25272		2.9	45191		7.1	30337		8.8
Studying	95017		10.7	88242		13.9	14209		4.1
Other types of non-employment	26		0.0	35		0.0	22		0.0
No valid information	31235		3.5	11676		1.8	4682		1.4

*83 individuals are excluded from the table and these individuals occur in the AKM register¹⁶ or in DREAM⁴⁰ (eg, recipients of subsidised job benefits or long-term sickness benefits registered in DREAM) but do not fall under the categories of the table. AKM, Employment Classification Module; DISCO-88, the Danish version of the International Standard Classification of Occupations system; DREAM, the Danish Register for Evaluation of Marginalization.

level in relation to job group, sex and age, there may be individual-level variations in working conditions within job groups, which cannot be captured by the JEM. This

may result in misclassification of exposure by the JEM compared with individual level data. We have previously reported the performance of a JEM similar to that applied

Table 5 Health services use and inpatient and outpatient hospital admissions during 1995–2009

	Annual average per person	Number per 10000 person-years	Number of persons N	%
Number of primary care services obtained	13.7			
Inpatient and outpatient hospital admissions		7214		
Inpatient and outpatient psychiatric hospital admissions		262		
ICD10 main groups*				
Chapter XIX: Injury, poisoning and certain other consequences of external causes			532375	55.4
Chapter XV: Pregnancy, childbirth and the puerperium			199718	20.8
Chapter XIII: Diseases of the musculoskeletal system and connective tissue			135784	14.1
Chapter XIV: Diseases of the genitourinary system			101923	10.6
Chapter XI: Diseases of the digestive system			83917	8.7
Chapter V: Mental and behavioural disorders			71644	7.5
Chapter X: Diseases of the respiratory system			58076	6.1
Chapter XII: Diseases of the skin and subcutaneous tissue			50182	5.2
Chapter I: Certain infectious and parasitic diseases			42804	4.5
Chapter VII: Diseases of the eye and adnexa			29644	3.1

*Excluding ICD10 main groups XVIII Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified and XXI factors influencing health status and contact with health services.

in the DaWCo study and found largely comparable associations with musculoskeletal pain when comparing the JEM to individual level measurements;¹⁹ however, the aggregated nature of the JEM should be kept in mind when interpreting results. Further, in the DaWCo study, it is only possible to study selected psychosocial exposures that can be measured in a meaningful way at the job group level. Some exposures such as organisational justice or work-related social support may vary more at the organisational level than the job group level and thus cannot be measured meaningfully using a JEM. Moreover, while we include the measured exposures as annual time-varying measures, a limitation is that the variation in exposures over calendar years was based on two measurement points in year 2000 and year 2005, which may not provide sufficient detail to model the changes in working conditions throughout the period in a nuanced manner. The decision to include only 2 years of survey data was based on the availability of similar measures for the included working conditions, which were not available in, for example, DWECS 1995 or DWECS 2010.

Additionally, despite its strengths, the clinically based outcomes of all ICD10 hospital diagnoses in the DaWCo study are limited to treated and diagnosed cases and may introduce bias with respect to SES. On one hand, previous studies found higher overall hospital admission rates and diagnoses of cardiovascular disease among individuals with lower SES,^{35–37} and on the other, a Danish study found lower levels of SES to be associated with lower mental healthcare utilisation. Therefore, findings should be interpreted with caution regarding the level of SES, and the direction of bias may depend on the specific health outcome.

A final limitation of the DaWCo study is its sample characteristics of younger workers with lower educational levels. Young individuals in Denmark typically enter the labour market prior to achieving their highest level of education and return to the educational system after a few years of labour. Therefore, DaWCo mainly has information on the lower levels of education among the cohort members before they have obtained their final level of education. Previous research has found increasing levels of education to be associated with higher levels of decision latitude, psychological demands and social support and a decrease in physical demands.^{38 39} This limitation will be mitigated as the cohort matures over time and is updated in future.

COLLABORATION

We welcome potential collaboration with other investigators. Interested researchers should contact the principal investigator, Dr Ida E H Madsen (ihm@nfa.dk). Enquiries of collaboration and data access require additional approval by Statistics Denmark.

Additional information about the study is available at <http://nfa.dk/da/Forskning/Projekt?docId=4b6b3d4f-5620-4f66-8d4d-2f93cc05793d>

Contributors ACS-P and IEHM conceived the present manuscript and analyses with contributions from EF, JKS and RR. ACS-P and IEHM were responsible for data management and data analysis. The DaWCo project was conceived by IEHM. All authors reviewed, critically revised and approved the manuscript.

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Patient consent for publication Obtained.

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