

NECK-SHOULDER PAIN AND WORK STATUS AMONG FORMER SEWING MACHINE OPERATORS – A 14 YEARS FOLLOW UP STUDY

Research Year Report 2016

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Characters in manuscript: 24560

Characters in supplementary information: 24434

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PREFACE

This report is based on my research year project, concerning a cohort of former sewing machine operators. I made this project in 2015-2016 at the Department of Occupational Medicine in Herning. The cohort was established in 1994 for studies conducted at that time by my co-supervisor Anette Kærgaard. This study present is a long-term follow-up on the sewing machine operators. The project had two aims, both concerning the prognosis: 1) the employment-prognosis, and 2) the pain-prognosis. Due to constraints of length, the manuscript in this report only describes results for the employment-prognosis, while results about the pain-prognosis are described in supplementary information. The supplementary information also contains description of choice of methods, strengths and limitations.

The study is evaluating a natural experiment, as the cohort was exposed to outsourcing around 1996. Therefore, it was possible to investigate the long-term outcomes of outsourcing, and to what extend neck-shoulder pain had an impact on the outcomes.

I wish to thank my supervisors for their patience and support, for their readiness and willingness to answer on questions and discuss ideas. Furthermore, I would like to thank colleagues on Department of Occupational Medicine in Herning for their openness and encouragements.

Emma Lise Thorlund Jakobsen, 2016

FUNDING

This study was funded by The Danish Working Environment Research Fund, (project no. 02-2015-09 20150067117).

ETHICS APPROVAL

The study was approved by Danish Data Protection Agency (j. no. 2007-58-0010). All data was collected before the present study was initiated, and studies based on register information without any examination or biological material do not need approval from the Committee System on Biomedical Research Ethics in Denmark.

ABBREVIATIONS

D-ISCO 88: Danish version of the International Standard Classification of Occupations.

DREAM: the Register-based Evaluation of Marginalization

JEM: Job Exposure Matrix

CPR: Social Security Number

ICD-10: International Classification of Diseases, 10th revision.

CONTENTS

ABSTRACT	6
DANSK RESUMÉ	7
MANUSCRIPT	8
Introduction.....	8
Methods	9
Results.....	12
Discussion.....	17
SUPPLEMENTARY INFORMATION.....	22
Sources of errors, strengths, weaknesses and choice of methods.....	22
Additional Analyses.....	25
Background.....	25
Methods	26
Results.....	28
Discussion.....	32
REFERENCES	35
FORSKNINGSÅRSRAPPORTER VED DANSK RAMAZZINI CENTER.....	41

ABSTRACT

OBJECTIVE 243 sewing machine operators lost their jobs in 1996 because of outsourcing. The aim was to investigate the employment status during follow-up 1996-2008 for this cohort, and to estimate to what extent former neck-shoulder pain had an impact on participation in the labor market.

METHODS Assessment of neck-shoulder pain was based on questionnaires from 1994. To describe employment status, we used the DREAM-register. Register data was explored by sequence graphics and sequence analyses, and an odds ratio for the association between neck-shoulder pain in 1994 and work participation in the follow-up period was estimated.

RESULTS 987 working years were lost during follow-up and a sequence index plot revealed interrupted and heterogeneous courses of incomes in this period. The odds ratio between neck-shoulder pain and a work participation score less than 75% was 1.49 (95%-CI 0.84-2.67). If time on health-related benefits was excluded the odds ratio was 1.04 (95% CI 0.58-1.85).

CONCLUSIONS After outsourcing of the textile industry, the former sewing machine operators had decreased participation into the labor market and many transitions between different income types. A tendency for an association between former neck-shoulder pain and poor work participation was seen, probably due to a difference in time spent on health-related benefits. As the sewing machine operators initially had a strong connection to the labor market the results call for counselling of similar unemployed groups and prevention against work-related neck-shoulder pain.

DANSK RESUMÉ

FORMÅL Studiets formål var at undersøge arbejdsmarkedstilknytningen i 1996-2008 for 243 kvinder, der mistede deres job som syerske i 1996 pga. outsourcing, og at undersøge i hvor høj grad nakke-skuldersmerter i syerskejobbet i 1994 påvirkede deres fremtidige arbejdsmarkedstilknytning.

METODE Som mål for nakke-skuldersmerter anvendtes spørgeskemaer fra 1994. Arbejdsmarkedstilknytning blev opgjort vha. DREAM-registret. Registerdata blev analyseret vha. sekvensgrafer og sekvensanalyse. Associationen mellem nakke-skuldersmerter og deltagelse i arbejdsmarkedet blev beregnet vha. logistisk regression.

RESULTATER I løbet af opfølgningsperioden i 1996-2008 havde kohorten i alt 987 tabte arbejdsår, og et sekvens-index-plot viste at kvinderne havde meget afbrudte og forskelligartede forløb mht. indkomst. Antallet af skift mellem forskellige typer indkomst var næsten det dobbelte gennem de tre år efter 1996 i forhold til antal skift i løbet af de tre år før 1996. Odds ratioen mellem nakke-skuldersmerter og en arbejdsdeltagelses-score på under 75% var 1,49 (95% CI 0.84-2.67). Ved udeladelse af tiden på helbredsrelaterede ydelser blev odds ratioen i stedet 1.04 (95% CI 0,58-1.85).

KONKLUSION Efter outsourcing af tekstilindustrien faldt syerskernes tilknytning til arbejdsmarkedet og de havde mange skift mellem forskellige typer af indkomster. Der var tendens til en association mellem nakke-skuldersmerter og mindre deltagelse i arbejdsmarkedet, sandsynligvis pga. en forskel i tid på helbredsrelaterede overførselsindkomster. Da syerskerne oprindeligt havde en stærk tilknytning til arbejdsmarkedet, viser resultaterne et behov for vejledning af tilsvarende grupper af arbejdsløse og for forebyggelse af arbejdsrelaterede nakke-skuldersmerter.

MANUSCRIPT

INTRODUCTION

Neck-shoulder pain is a very common ailment and has large costs due to loss of productivity, disability and increased absenteeism from work (1-3). Certain occupational risk factors further increase the prevalence in some working populations. Among the known risk factors are physical exposures in different job types, including repetitive monotonous tasks, arm elevation, high loads and hand-arm-vibrations (4-6). One of the populations exposed to the known risk factors are sewing machine operators (4).

The Danish textile industry was closed down in the 1990'es because of outsourcing, leading to job loss and unemployment for the former sewing machine operators. From the seventies until start of the 2000-decade, more than 50,000 jobs were lost in the textile and clothing industry in Denmark. An analysis showed that one year after job loss, around one third were unemployed¹. Equally to this situation, other job types carrying an increased risk of neck-shoulder pain have in the recent years been outsourced, and apparently this outsourcing tendency has yet not ceased and will lead to job loss and unemployment for workers in mainly unskilled jobs (7, 8).

Generally, after job loss, a period of unemployment is not unexpected (7, 8). But how are the job prospects for redundant workers when they at the same time have increased prevalence of neck-shoulder pain? The sewing machine operators serve as an example of this, but have not earlier been evaluated according to this question. Results from research on the impact of impaired general health on unemployment overall give the impression that impaired health status increases the occurrence of unemployment (9-20). Few studies are focusing on more specific health conditions and their relation to unemployment. A Swedish cohort-study found that self-reported musculoskeletal pain (including neck, shoulder, extremities or lower back) significantly increased the risk for prolonged unemployment, but did not increase the hazard rate for becoming unemployed (12). Among unemployed with rheumatoid arthritis and/or musculoskeletal disorders, the degree of pain was an important barrier for being in a job at one year after initial assessment (14). These studies are not specifically focusing on neck-shoulder pain but still leads to expectations of an association between neck-shoulder pain and employment prospects among the sewing machine operators (9). This is even more expected because

¹ From a report "*Does outsourcing create unemployment*", Olsen et al. 2004, Department of Economics, Aarhus School of Business.

neck- and shoulder disorders are related to physical limitations (21, 22). Though, in some settings the prospects for neck-shoulder pain has been found to be different from other kinds of musculoskeletal disorders (23), which suggest that studies focusing on specific health conditions should be added to investigate if the same associations are retrieved for employment prospects.

In one study 91 patients with subacromial pain treated with non-invasive interventions were followed one year after treatment regarding their work status. 25% were not working (unemployed, sick listed, disability pension), and in a univariate regression a higher baseline shoulder pain score was associated with lower odds for being at work at follow-up (3). To our knowledge no other studies has been performed about the isolated impact of neck-shoulder pain and disorders on unemployment duration or reemployment chances.

Research about employment prospects can potentially contribute in prevention strategies against exclusion from the labor market which is an important public health concern (24). The aim of this study is to investigate the long-term employment status for Danish sewing machine operators who lost their jobs in 1996 because of outsourcing. Particularly, we want to evaluate to what extent former neck-shoulder pain had an impact on the women's work-participation-score (25), defined as numbers of weeks of employment in 1996-2008 relative to possible weeks in this period of time.

METHODS

The study was a cohort study with 14 years' follow up. 243 women employed as sewing machine operators in 1994 in three Danish textile companies comprised a cohort for a former study concerning the development of neck-shoulder pain in women with monotonous, repetitive work (4). The study was part of the Danish PRIM study (Project on Research and Intervention in Monotonous work), initiated in 1994, which had the objective to examine physical and psychological effects of monotonous repetitive work (4, 26-29). This present study was a long-term follow-up on the sewing machine operators, after they lost their jobs in the textile companies in 1996.

Inclusion criteria were sewing machine operators employed in 1994 in one of the three companies. None had inflammatory rheumatic disorders or disorders caused by trauma. Out of 259 invited sewing machine operators, 243 agreed to participate in 1994. The participants answered a questionnaire about current musculoskeletal pain and demographic details and underwent a clinical examination. Follow-up data on

employment until 2008 was retrieved from registers for 242 of the participants. One person could not be identified in registers due to wrong registration of civil registration number.

Exposure

Neck-shoulder pain in 1994 was the exposure of interest. The questionnaire on neck-shoulder pain was a modified form of a questionnaire on chronic pain severity developed by Von Korff et al. 1992 (30). It included a set of four questions for the three regions: neck, right shoulder and left shoulder. The regions were pre-shaded on an illustration. For each region, symptoms during the last three months: 1) worst complaints, 2) average complaints and 3) reduced activity due to complaints were asked, while the last question 4) asked for the worst complaints during the last 7 days. The subjects had to answer the question by marking the degree of complaint on a 0-9 scale. To calculate a measure of neck-shoulder pain, we combined the total score from the regions, giving a range of scores 0-108. The scores were dichotomized into < 24 points for cases of non/mild pain and ≥ 24 points for cases of moderate/severe pain (4). The clinical examination at baseline has been described previously (4), and was a standardized examination of the neck, shoulder and arms. In this study it was used for a supplementary analysis of the association between clinically verified neck-shoulder disorders and employment.

Outcome

The outcome was employment status after job losses from the textile companies in 1996 to 2008. From DREAM (the Register-based Evaluation of Marginalization) data on transfer payment was extracted, using Danish civil registration numbers (CPR) (31). The DREAM database consists of 94 codes (DREAM codebook version 28) for different forms of transfer payment, emigration and death. For weeks without any code, the persons have not received any transfer from Danish authorities (32) but has been self-supporting, most likely because of receiving income from work. Though, other sources for subsistence could not be excluded, but in Denmark only a very small fraction of the population are without personal income.

DREAM-codes were grouped as follows: 1) Working, 2) Education/leave-of-absence/maternity leave, 3) Unemployment, 4) Health-related benefits, 5) Voluntary early retirement/public retirement pension/death/emigration. Weeks spend in active labor market programs, e.g. different kinds of temporary jobs supported by wage subsidies

were not regarded as employment, because our aim was to investigate the work participation score for regular gainfully employment without any subsidies, and not for activation programs. Instead, weeks with this kind of transfer incomes was placed in the group for unemployment. Health-related benefits included e.g. sick-leave, disability pension, flexjobs² and rehabilitation.

Employment status during years of follow up was estimated as a work-participation score, a modified version of a return-to-work measure used by Biering et al. 2012 (25). This work participation score was the cumulated number of weeks of employment relative to the overall number of weeks, excluding weeks of public retirement pension, voluntary early retirement, death and emigration. Weeks of health-related benefits were included in the overall number of weeks. However, an additional analysis was performed with exclusion of weeks on health-related benefits. Time spend on leave-of-absence for childcare or sabbaticals, maternity leave, and education was excluded from the analysis, as these states did neither belong to employment nor unemployment. The work participation score was calculated for the years 1996-2008 and dichotomized at 75%, because it seemed meaningful to interpret less than 75% of employment as a poor outcome for this group of women. Since there were no exact dates for outsourcing of the textile plants, the work participation score is calculated from the beginning of 1996 to capture most of the time of unemployment, as the highest percent of job losses occurred during 1996. Number and length of working periods and number of transitions between different types of income were also counted to give a further description of the employment status.

Other variables

Age was included because it is known to be associated with neck-shoulder pain as well as reemployment chances (33, 34) and because the oldest participants had the possibility to start on public retirement pension or voluntary early retirement instead of staying unemployed after job loss. We also included comorbidity, which might have influenced on work participation. Comorbidity was defined by ICD-10 codes for diseases included in Charlson's comorbidity index (35), and was calculated on data from the Danish National Patient Registry on contacts to hospitals. The participants were dichotomized on having had any such comorbidity in 1994 to 2008 or not. For information of job types after

² Jobs supported with subsidies from society, for workers with limited work capacity (Hjollund 2007).

dismissal we used D-ISCO-codes from Statistics Denmark (Employment Classification module).

Statistical analyses

Descriptive statistics were made and are presented in tables. To analyze transitions between different income types, the egenmore package and SQ-Ados for Stata were used. Status proportions graphs were created to illustrate how the cohort's cumulated proportions of incomes changed over the years. SQ-Ados were used to create sequence index plots, which are plots of horizontal lines showing the sequence of incomes for each participant (36). For an estimate of the association between neck-shoulder pain in 1994 and the 75%-dichotomized work participation score in 1996-2008 we used logistic regression analysis. Those who had left the workforce permanently at the beginning of follow up were excluded (3 persons). Univariate and multivariate regressions were performed, including age and comorbidity as potential confounders. We repeated this analysis after exclusion of weeks on health-related benefits. One supplementary analysis estimated the association between clinically verified neck-shoulder disorders and work participation. Statistical analyses were performed with STATA 13.1 and 14.1 software, StataCorp LP, College Station, Texas, USA.

The study was approved by Danish Data Protection Agency (j. no. 2007-58-0010). All data was collected before the present study was initiated, and studies based on register information without any examination or biological material do not need approval from the Committee System on Biomedical Research Ethics in Denmark.

RESULTS

Descriptive data for the 242 former sewing machine operators with available DREAM-data is shown in table 1. 238 had answered the questions for neck-shoulder pain at baseline, and 82 (34.5%, 95% CI 28.4-40.9) of these had moderate or severe neck-shoulder pain. Work participation score had a left-skewed distribution with median 69.2. Overall, 40 out of the 242 subjects received disability pension at some point in 1994-2008, equivalent to 16.5% (95% CI 12.1-21.8%).

	All (n 242 ^b)			None/mild neck-shoulder pain at baseline (n 156)			Moderate/severe neck-shoulder pain at baseline (n 82)		
	Quartiles	%	95 %-CI	Quartiles	%	95 %-CI	Quartiles	%	95 %-CI
Age ≥ 40 years, 1994	.	45.5	.	.	40.5	.	.	57.3	.
Seniority, years, 1994 ^a	4.5, 11.3, 20	.	.	4.5, 10.0, 17	.	.	5.8, 15.0, 24	.	.
Work participation score 1996-2008 ^{ab}	30.9, 69.2, 88.9	.	.	50.4, 77.6, 91.7	.	.	11.5, 58.3, 82.1	.	.
Frequency of work participation score < 75% 1996-2008 ^b	.	54.4	47.9-60.63	.	49.7	41.5-57.9	.	64.6	53.3-74.9
Disability pension 1994-2008	.	16.5	12.1-21.8	.	9.0	5.0-14.6	.	31.7	21.9-42.9
Comorbidity 1994-2008 ^c	.	13.2	9.2-18.2	.	10.9	6.5-16.9	.	18.3	10.6-28.4

^a DID NOT FOLLOW A NORMAL DISTRIBUTION. ^b 3 PERSONS EXCLUDED FROM CALCULATION OF WORK PARTICIPATION SCORE. ^c PROPORTIONS OF PARTICIPANTS WHO HAD A CHARLSON'S COMORBIDITY IN 1994-2008, EXCLUDING YEARS OF EARLY RETIREMENT, RETIREMENT, DEATH AND EMIGRATION.

The most frequent job types after the women lost their jobs in the textile industry were health care work, laundry work, child care, employment in other textile plants and other industrial jobs. These jobs constitute 50% of the working years after 1997.

Figure 1 reveals status proportion graphs for the two pain groups in 1993-2008. As expected, there was a marked increase of unemployment around 1996 for both groups corresponding to a decrease of work. This unemployment lasted relatively long, only slowly decreasing over the years. Health-related benefits appear to have comprised a larger part among those with moderate/severe pain than among those with none/mild pain while unemployment seems to be a little more frequent in the none/mild pain-group. Working constituted a larger proportion in the graph for the none/mild-pain-group. In 1996-2008 the overall number of lost working years due to unemployment cumulated to 471 years and due to health-related benefits 516 years.

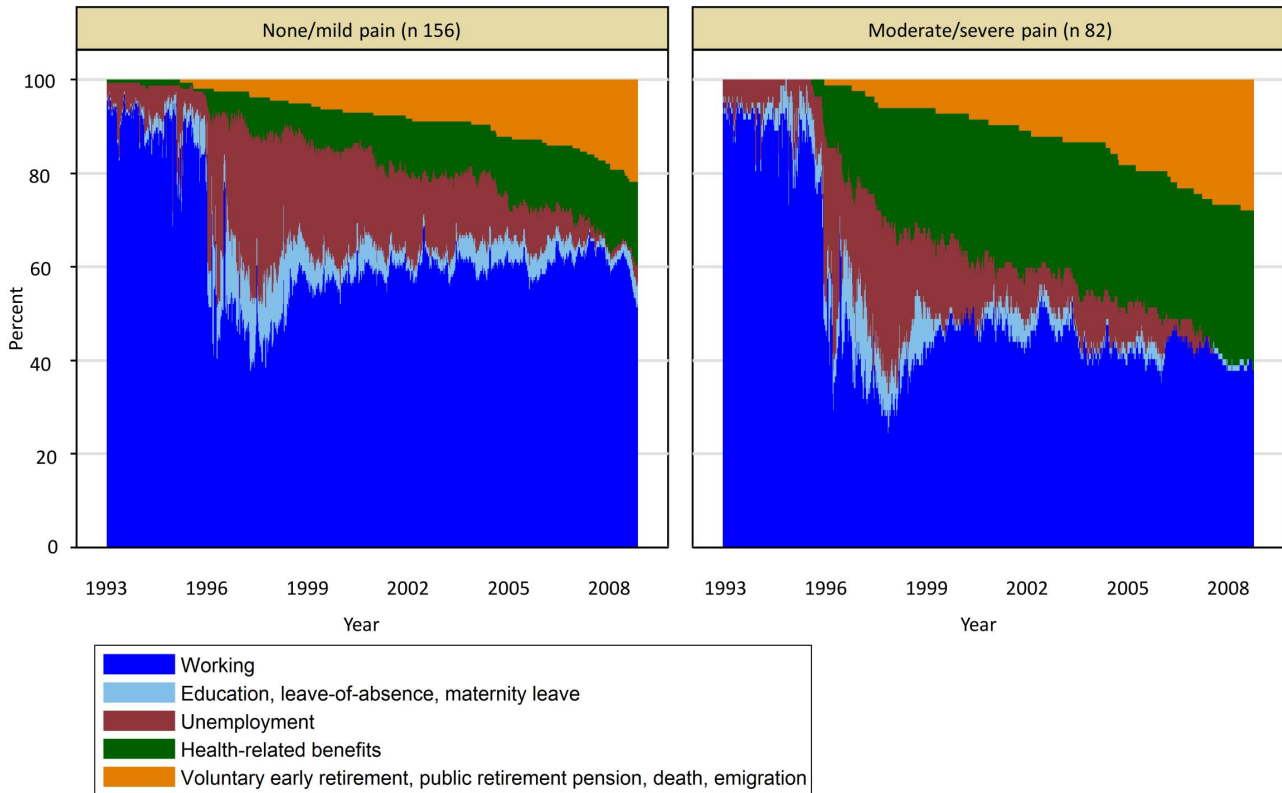


FIGURE 1. STATUS PROPORTION GRAPH OF FOR PROPORTIONS OF INCOME-TYPES 1993-2008, DIVIDED ON PAIN GROUPS.

The sequence index plot in figure 2 shows the sequences for incomes in 1993 to 2008. There is a clear change of incomes at the time of outsourcing in 1996. In the years before 1996, working was largely predominating, while in the years after 1996 the picture shows more other income-types with frequent transitions between the income-types. The number of transitions during the three years before the outsourcing cumulated to 1529 ($n = 242$), while in the three years after it was 2879. Further details on transitions are shown in tables 2 and 3.

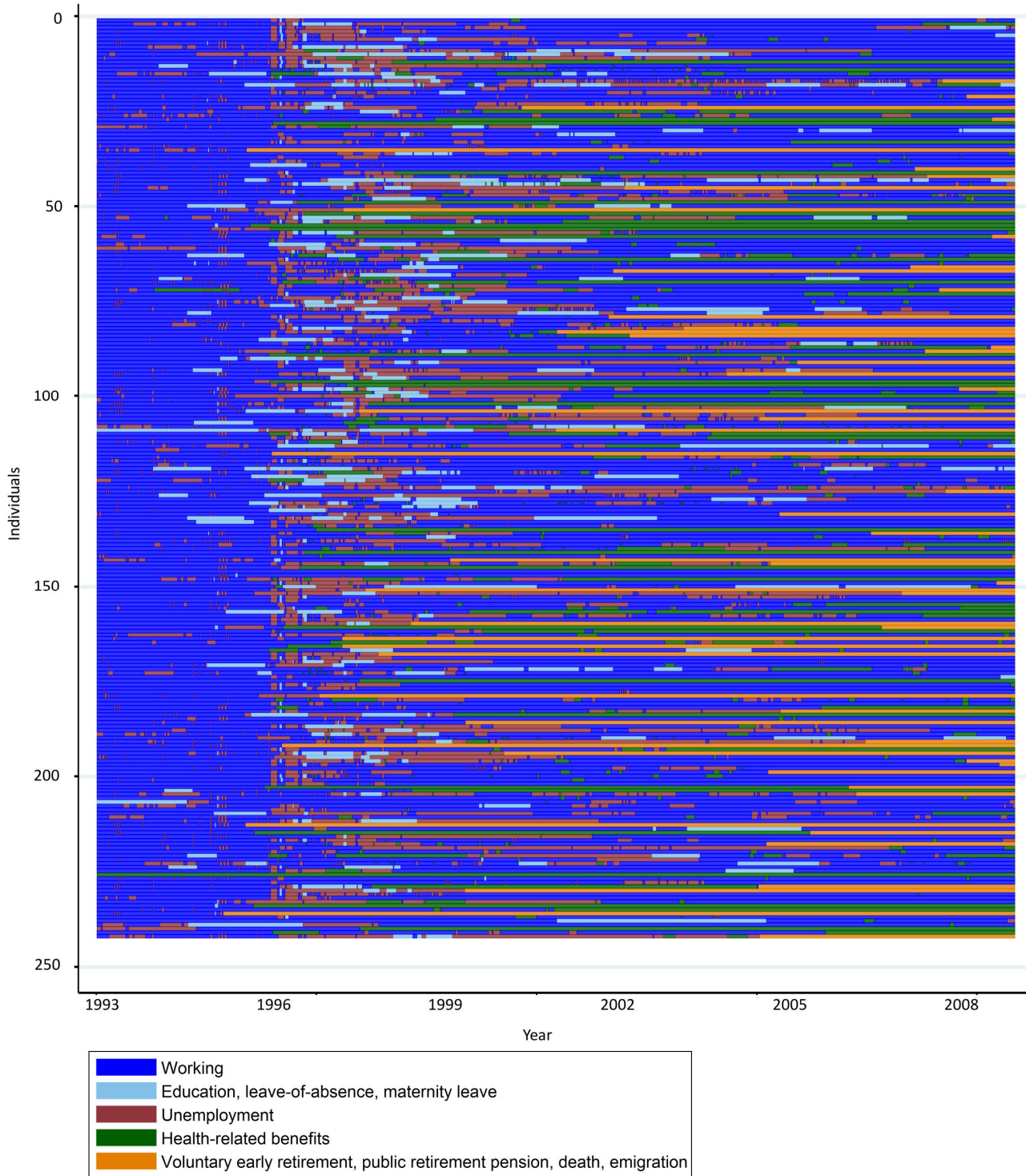


FIGURE 2. SEQUENCE INDEX PLOT FOR INCOME-TYPES GROUPED IN FIVE CATEGORIES. HORIZONTAL LINES REPRESENT INCOME SEQUENCES FOR ALL PARTICIPANTS DURING 1993-2008. INDIVIDUALS ARE IN RANDOM ORDER.

Table 2. Quartiles for number of transitions, number of working periods and durations of working periods. For the entire cohort and divided according to neck-shoulder pain			
	All (n 238)	None/mild neck-shoulder pain (n 156)	Moderate/severe neck-shoulder pain (n 82)
	Quartiles	Quartiles	Quartiles
Number of transitions 1993-1995 ^A	0, 4, 11	0, 4, 12	0.75, 4, 9.25
Number of transitions 1996-1998 ^A	6, 11, 16	5.25, 11, 16	5.75, 11, 16
Number of transitions 1996-2008 ^A	10.75, 18, 30	12, 20, 32	8, 16, 26.25
Number of working periods 1996-2008 ^{AB}	5, 8, 13	5, 9, 15	3, 8, 12
Duration of working periods 1996-2008, weeks ^{AB}	1, 3, 23	2, 4, 26	1, 3, 18

^A DID NOT FOLLOW A NORMAL DISTRIBUTION. ^B 12 PERSONS ARE NOT INCLUDED IN THESE NUMBERS BECAUSE THEY HAD NO PERIODS OF WORK AFTER 1996.

Table 3. Number of the 5 most frequent transitions between types of income 1996-2008. Types of income: 1) Working, 2) Education/leave-of-absence/maternity leave, 3) Unemployment, 4) Health-related benefits, 5) Voluntary early retirement/public retirement pension/death/emigration.			
Transition	None/mild pain (n 156)	Moderate/severe pain (n 82)	All (n 238)
1 to 3	1037 (29.5%)	546 (32.1%)	1583 (30.3%)
3 to 1	1021 (29.0%)	542 (31.9%)	1563 (29.9%)
1 to 4	348 (9.9%)	164 (9.6%)	512 (9.8%)
4 to 1	323 (9.2%)	144 (8.5%)	467 (8.9%)
2 to 1	143 (4.1%)	54 (3.2%)	197 (3.8%)
Other	646 (18.4%)	251 (14.8%)	897 (17.2%)
Total	3518 (100%)	1701 (100%)	5219 (100%)

Table 4 shows the results from the logistic regression analysis for the association between neck-shoulder pain and a poor work status with work participation score less than 75%. The unadjusted OR was 1.85 (1.07-3.22), which indicates that women who had moderate/severe neck-shoulder pain at baseline had higher odds for getting a poor work status in subsequent years than women with none/mild pain. After adjustment, the odds ratio decreased to 1.49 (CI 0.84-2.67). Age and comorbidity was likewise associated with a poorer work status.

Table 4. Odds ratios for work participation score < 75%.

Variables	Categories	Univariate, n = 235		Multivariate, n = 235	
		Odds ratio	95% Confidence interval	Odds ratio	95% Confidence interval
Neck-shoulder pain at baseline	None/mild pain	1	Ref.	1	Ref.
	Moderate/severe pain	1.85	1.07-3.22	1.49	0.84-2.67
Age	< 40 years	1	Ref.	1	Ref.
	≥ 40 years	3.04	1.78-5.20	2.77	1.59-4.81
Comorbidity during follow-up	No comorbidity	1	Ref.	1	Ref.
	≥ 1 comorbidity	2.86	1.23-6.66	2.57	1.07-6.13

The above described analyses were repeated after exclusion of weeks on health-related benefits from the denominator of the work participation score, which reduced the adjusted odds ratio to 1.04 (95% CI 0.58-1.85).

A clinical examination was performed in addition to the questionnaire for each of the participants in 1994. 39 of the participant received a clinically verified diagnosis of neck-shoulder disorders based on a combination of clinical findings and self-reported pain, equal to 16.5% (95% CI 12.0-21.8). The women who had a clinically verified diagnosis had an adjusted odds ratio on 1.61 (95% CI 0.75-3.48) for a work participation score less than 75%, compared to those without such diagnosis.

DISCUSSION

Key results

After closure due to outsourcing of the three textile companies in 1996, the former sewing machine operators countered unemployment and difficulties in their job situation in the following years. The median proportion of time of regular working relative to the possible time of working was 69.2% (quartiles 30.9, 88.9) in 1996-2008. Number of lost working years in this period was 471 years of unemployment and 516 years on health-related benefits. Some of the women had turbulent years with a range of transitions between different income types during the years after outsourcing, including relapses into unemployment. The number of transitions nearly doubled during the three years after 1996, compared to the three years before. In 1996-2008, the median length of working periods was 3 weeks (table 2). Lengths of working periods seemed to be a little shorter for the group of women who had moderate to severe neck-shoulder pain in 1994. This group also tended to have more often experienced work-participation score below

75% than the group of women with no or mild pain. However, this association disappeared when time on health-related benefits was excluded from calculation of the work participation score.

Strengths and limitations

Strengths of this study was the complete follow-up of register data, and the homogenous population. The sewing machine operators were all women and had probably very similar socioeconomic background.

Limitations arises from the measures for exposure as well as outcome. The questionnaire on neck-shoulder pain did only include pain during the last three months. When using register information to evaluate an outcome like employment some limitations due to the nature of register information and assumptions exists. However, the feasibility of using the DREAM-register in our study is probably far above the value of e.g. questionnaires for such an outcome.

To assess comorbidity, we used register information on diseases included in Charlson's comorbidity index, which has been proven to be a useful measure and has prediction validity for events like mortality, disability etc. (37).

Interpretation

The sewing machine operators from this study had initially a strong connection to the labor market as seen in figure 2 (4). But after closure of the textile plants in 1996, their employment status was characterized by frequent transitions between different types of incomes with relapses into unemployment and lost working years, which indicates an unstable working life. The overall increased amount of unemployment in the years after outsourcing was to some extent expected (8)³. However, the question if these participants potentially could have contributed more to the labor market if they had got appropriate support for it, or if other employment possibilities had existed might still be relevant to consider. The results for the sewing machine operators in this study maybe points to a need for more prevention against loss of working years and future attention to similar groups with possibilities for dismissal because of outsourcing.

The odds ratio for the association between neck-shoulder pain in 1994 and a work participation score less than 75% during 1996-2008 was 1.49 (95 %-CI 0.84-2.67). When removing time on health-related benefit from the denominator of the work participation score, the odds ratio decreased to 1.04 (95% CI 0.58-1.85). The results therefore suggest

that the overall fraction of employment tended to be lower among those with neck-shoulder pain, but the fraction of employment did not differ during the time they were not on health-related benefits and therefore available and physically capable for employment. This is also in agreement with the distribution seen in fig 1, with a little lower fraction of work but instead more time spend on health-related benefits in the group with moderate/severe pain. The reason to include time on health-related benefits in the denominator of the work participation score was the view, the time on health-related benefits should be seen as lost working time in this study. Some of the health-related benefits might have been possible to avoid by prevention of neck-shoulder pain, and maybe also better counselling for the pain-suffering women could have avoided some of the health-related benefits.

The association between neck-shoulder pain and work participation was the same whether we used questionnaire-information on neck-shoulder pain or clinical examinations, indicating that the clinical examination did not add value in predicting work status. This conclusion is in line with a review concerning the value of using more complex definitions of upper limb disorders versus broader definitions (38).

Only very little research has been made about employment prognosis for unemployed individuals with musculoskeletal complaints. Especially, knowledge is sparse of the effect of neck-shoulder pain in relation to outsourcing. Conclusions from studies on the impact of general health on unemployment duration or reemployment are not completely the same in all populations and settings (9, 10, 16, 17), and comparison of these studies should take into account the differences in outcome measures. Only a few of them used register data (16, 20). However, generally the studies found some degree of association between poor health and longer unemployment duration or decreased reemployment chances, which also was indicated by a tendency in this present study. This tendency was also in line with the few studies having musculoskeletal complaints as exposure (3, 12, 14). Though, one study found that musculoskeletal diseases did not increase the probability of unemployment, but in that study the musculoskeletal diseases were measured by information on in-hospital-periods, which will most likely not capture everyone reporting pain (20).

Stewart (2001) stated three possible explanations for the higher occurrence of impaired health among those unemployed: 1) unemployment could *decrease* health status (causation hypothesis), 2) workers with impaired health are perhaps in higher risk for

becoming unemployed (health selection hypothesis), and 3) it could be more difficult to achieve *reemployment* for unemployed individuals with impaired health (health selection hypothesis) (9, 20). The health selection hypothesis has thus two aspects. Our results contribute possibly with some evidence for the health selection hypothesis, but the work participation score does not distinguish between the two aspects. The quartiles for number and durations of working periods shown in table 2 are though suggesting that the group with neck-shoulder pain had fewer and shorter periods of working. This is however not in accordance with a study by Virtanen et al 2012, who found that musculoskeletal pain significantly increased the risk for prolonged unemployment, but did not increase the hazard rate for becoming unemployed, which means that reemployment should be a larger problem than maintaining a job among workers with musculoskeletal pain (12).

In occupational medicine counseling it is often recommended that patients with musculoskeletal pain maintain working despite the pain, even though their employment includes some degree of exposure to risk factors (39). The results from this study add perhaps some support for this recommendation. The women were able to maintain their work when occupied as sewing machine operators (fig. 2) (4) despite the monotonous repetitive tasks in this job, but after closure of the textile plants they got difficulties in maintaining employment. Maybe counselling with guidance about which jobs to search for, as well as how to adapt to other jobs could have had an impact on their job prospects.

Generalizability

The results have probably high validity in the Danish society, while generalization to other countries should be done with caution. Differences between countries has been seen for some labor market outcomes (40, 41), which might be due to different welfare regimes and legislation for insurance (24, 40-42). Generalization over different periods of time are probably also constrained by cyclical changes' influence on employment (43).

Only women were included in the cohort, giving the results highest validity for women. The studied population represents manual industrial workers and similar unskilled groups. It also shares features with working groups in the health care sector, where some jobs carry shoulder load and an increased prevalence of neck-shoulder pain too (44, 45). Actually, the fraction of disability pension receivers among nurses' aides during 15 years (16.2%) was similar to the former sewing machine operators in this study (16.5%, 95%-CI

12.1-21.8% over 15 years) (46). However, the accessibility for employment could be different for different groups of workers.

The results from this study warrant that workers in the process of outsourcing should be counseled and initiatives to support workers with different kinds of health related problems could possibly be a good investment. Better counselling, education, planning, in occupational medicine counselling as well as other institutions might have influenced the work participation and connection to the labor market. Apparently long-term planning should be aimed at, as the difficulties these women meet after dismissal from their sewing jobs seemed to be longstanding. This is in particular relevant, because the sewing machine operators in this study had an initially strong connection to the labor market.

SUPPLEMENTARY INFORMATION

This section includes a description of 1) discussion of sources of errors, strengths and weaknesses of the study and argumentation for choice of method, and 2) a description of additional results as well as background methods and discussion for these additional results.

SOURCES OF ERRORS, STRENGTHS, WEAKNESSES AND CHOICE OF METHODS

Assessment of neck-shoulder pain was based on questionnaires asking for pain during the last 3 months. This measure did therefore not capture fluctuations in pain beyond this period, which allows for non-differentiated misclassification and can have weakened the estimated associations.

The reliability of the questionnaire was tested by C. Brauer (2003) who found that participant recall about retrospective pain in the last 3 months was in good to excellent agreement with weekly reporting of pain during the 3 month. Reproducibility of the questionnaire showed kappa coefficients between 0.44 and 0.91 (47).

Some limitations exist when using the DREAM-register for analysis of employment status. Information on sick leave was not registered before 1996, maternity leave was coded inaccurately as sick leave until 1998, and data on cash assistance was not registered before 1994 (DREAM version 28). Lack of records on sick leave before 1996 could be important to our conclusion, but from earlier data on this cohort we know that the occurrence of sickness absence was limited in the textile plants (4). Regarding the lack of information about cash assistance, it has probably neither constituted a huge incidence before 1994 as other kinds of unemployment benefits are limited before 1996 according to figure 2. During follow-up legislation has changed which has added new kinds of transfer incomes, while other has been removed, and criteria for receiving transfers have changed too. However, the overall grouping of income-types is probably not very affected by this. Additionally, some of the shortest periods coded as 'work' are probably not caused by work but instead has been recorded without a transfer income-code for practical and administrative reasons. Some of the shorter periods of unemployment seen in the years before dismissal in figure 2 are due to 'seasonal dismissal', which means that a company dismisses the employees during their holiday, but rehire them afterwards. This phenomenon should not be regarded as real unemployment but is only due to economic advantages, and will add some misclassification to the measure of unemployment. However, a study on the feasibility of DREAM-data for research of

economic consequences of disease concluded that using the register might be superior to self-reported information (32) and the DREAM-register is thought to have high accuracy and completeness (46). Due to the very long follow up period, self-reported data would most likely have been influenced by a large degree of recall bias. The weekly structure of the register combined with long follow-up time will probably reduce the impact of misclassification.

The results about employment status should be seen in the light of the chosen grouping of DREAM-codes in this study. The number of transitions would have been even higher if we had counted them between the exact income types instead of the five income-categories. Though, this would probably not have been meaningful, because lot of such transitions was due to weeks of holiday, shifts between different kinds of unemployment benefits etc. Interpretation of numbers of transitions should consider the fact that grants of permanent incomes like disability pension or retirement will naturally reduce the number of transitions over time.

The chosen date for outsourcing at 1st of January 1996 was based on follow-up questionnaire data (not shown) and the clear transition seen in plots in the beginning of 1996. Similar plots stratified on companies, showed the same for each of the companies (not shown). Many of the sewing machine operators were dismissed at a later date than 1st of January 1996, but most of time as unemployed will be captured anyway, and the contamination of employed time in the textile companies will probably not have changed the results very much because of the long follow-up time. Some had likely left the workplaces earlier than 1996 for other reasons, but common to the entire cohort is the fact that they in 1994 were exposed to the same risk factors for neck-shoulder pain in an industry threatened by outsourcing³. This made the base for a natural experiment of how a group of workers overall is going, when their workplace is closed down.

To adjust for comorbidity, we used register information on contacts to hospitals due to diseases included in Charlson's comorbidity index. Register data on contacts to hospital might be superior to self-reported information because of recall-bias and subjective perceptions about health. Though, we did not distinguish between severity and

³ From the report "*Does outsourcing create unemployment*", Olsen et al. 2004, Department of Economics, Aarhus School of Business.

Charlson's comorbidity index only includes the most severe diseases while other diseases could have been relevant to the analysis as well.

The study was a follow-up on a cohort already defined and described in previous studies, which meant that data on the exposure, neck-shoulder pain and disorders, were available. Only decisions about how to define cases of neck-shoulder pain from these data had to be taken. These decisions were based on the previous studies and the distribution of pain scores. Thus, only a method to measure for outcome had to be chosen. We used the DREAM-register for this, because this register provides great possibilities to evaluate outcomes concerning employment and labor market. It was also far superior to questionnaire data from 2008 on employment status (not included in this study).

The appropriate length of follow-up for research on occupational outcomes has former been discussed. Oyeflaten et al. (2012) studied return to work after sick-leave and suggested that several years are needed to get an appropriate measure for this sort of outcome (48). In the present study the outcome of interest was employment status, but the same considerations should probably be applied to this outcome measure as well, meaning that a long follow up time was preferable. This was possible to achieve because register information for a very long period was available.

The employment situation after the outsourcing can be difficult to capture in a single estimate because labor market outcomes are dynamic and often changing. Different ways to evaluate labor market outcomes exist (49) e.g. by using 'time until return to work'-measures, defined as the first date of being at work after absenteeism or unemployment, or alternatively cross-sectional measures (25). A time-to-event measure would not have been appropriate in the setting of this study, because no matter how the date of reemployment was defined – as one week of work or several weeks – some relevant information would be lost, i.e. information about relapses into unemployment and short initial periods of employment. This conclusion is mainly drawn from the very heterogeneous and interrupted courses of employment seen in figure 2. This heterogeneity includes very short and very long periods of work and varying frequency of transitions between income types. Cross-sectional data on work status would lose a lot of information too. Instead, the work participation score captured all the periods of employment and unemployment over a long period of time and the overall work participation. Time-to-event measures for labor market outcomes has also earlier been assessed to be inappropriate in other studies (12, 25, 41, 48). Complex models have

been developed to analyze multiple work states and transitions between them, but to apply these models larger sample sizes are probably required (50).

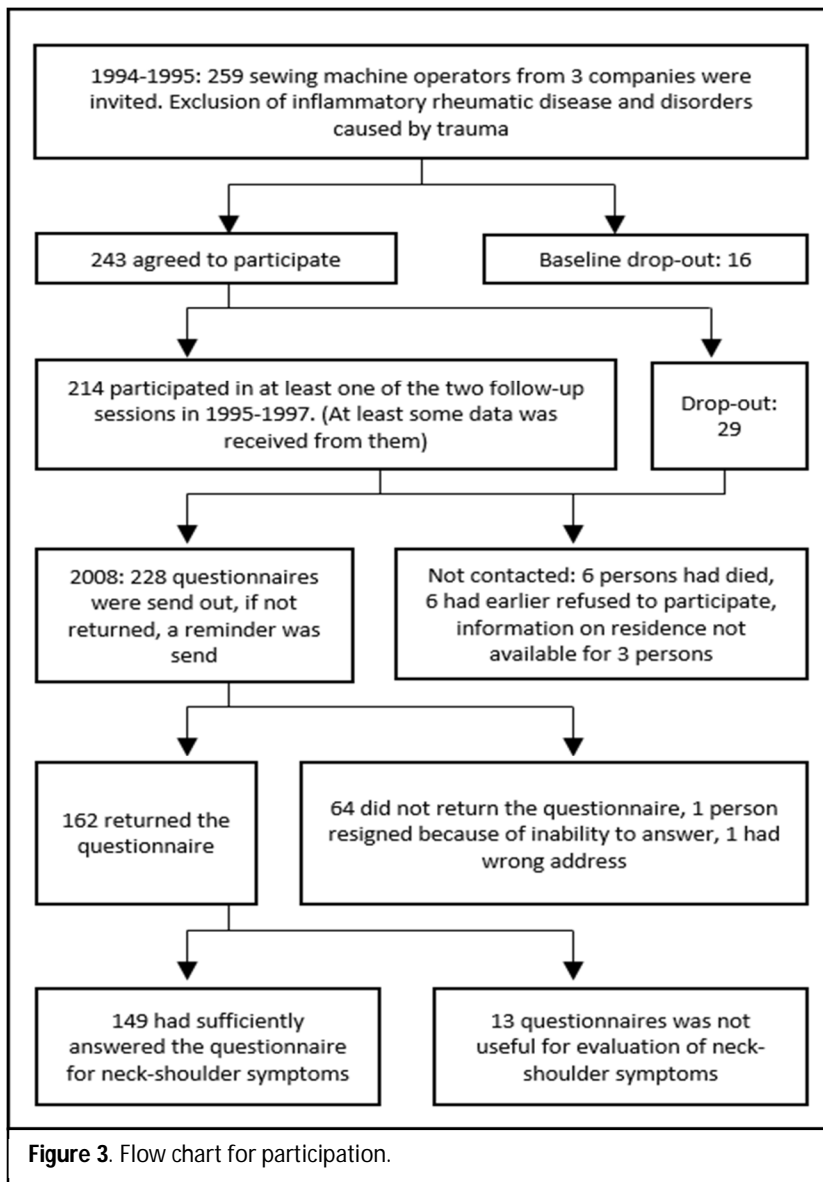
ADDITIONAL ANALYSES

BACKGROUND

The short-term prognosis for neck-shoulder pain and rotator cuff tendinitis is relatively well-described. Luime (2005) found at a 2 year-follow-up, 61 out of 123 initially cases (nursing home employees) of self-reported neck pain had recovered; for the shoulder 49 out of 117 had recovered (51). Van der Windt (1996) found that duration of shoulder complaint of different types, originating from within the shoulder joint had a median duration of 21 weeks from presentation at general practitioner in the Netherlands. Recovery was increasing during the first year after presentation, for rotator cuff tendinitis 20% had recovery after 1 month, 38% after 3 months, 51% after 6 months and 54% after 12 months (52). In the cohort of sewing machine operators used for this study only one of 13 participants with rotator cuff tendinitis had recovered after 1-2 years, while 11 of 15 participants had recovered from neck-shoulder pain with pressure tenderness (4).

However, the long term prognosis i.e. for several years seems to be less understood. Only few studies of pain-prognosis for neck-shoulder pain and disorders have more than 3 years of follow-up (23, 53-57), and the studied populations and outcome-measures are heterogeneous. If symptoms and disorders will persist for maybe a decade or longer, it emphasizes the need for prevention strategies and optimizing of treatment.

Knowledge about the effect of occupational exposure on prognosis is not completely consistent. A systematic review on prognostic factors for shoulder pain prognosis concluded that studies were inconclusive about the impact of physical workload on prognosis (58). Another review, looking at prognostic factors for arm and neck complaints also found that studies about ergonomic risk factors at work were inconclusive (59). For sewing machine operators, a 6-year follow-up study found that for 29% of those who had continued as operators, neck symptoms had disappeared. Among former sewing machine operators who had left the job, neck symptoms had disappeared for 57%. But the estimate is possibly biased from selection bias because those unemployed at follow up after six years were excluded. The same magnitude of values for shoulder symptoms was seen but not further specified (57).



The aim of this part of the report is to investigate the long term prognosis for neck-shoulder pain and disorders in terms of pain and physical functioning 15 years after initial assessment. We want to answer the question whether their symptoms ceased or persisted after end of exposure, adjusting for other job-exposures in the years after closure of the textile industry.

METHODS

The cohort is based on the same population described in the manuscript. Loss to follow-up is shown in figure 3.

Exposure

The questionnaire data on neck-shoulder pain used for the additional results presented here was the same as those described in the manuscript. The clinical examinations were done by trained physicians and included a test for impingement sign (Hawkins and Kennedy 1980) (60), resisted abduction and palpation for tenderness. Cases of two clinically verified disorders which was 1) rotator cuff tendinitis and 2) neck-shoulder pain with pressure tenderness, were defined as a combination of findings from clinical examination and the self-reported pain. Clinical examination was blinded for questionnaire-information. In this report neck-shoulder pain refers to self-reported neck-shoulder pain while neck-shoulder disorders refer to the clinically verified neck-shoulder disorders.

Outcome

In 2008 a questionnaire was sent out again to the former sewing machine operators. The questionnaire included the same questions on neck-shoulder pain used in the questionnaire from 1994 and besides a number of questions considering employment, participation in labor market programs, e.g. job training programs and questions on limitations of physical functioning from SF36. No results based on this questionnaire have former been published. Calculation of neck-shoulder pain was done the same way as for the baseline questionnaire. Some of the questionnaires at follow up and few at baseline as well were only partly answered. For these an assessment was made for each, and for some persons it was decided to deduce the missing values from the other answers. For example, if a person had rated the worst disability in the last three months to be 0, then the average disability during the last 3 months was deduced to be 0.

The questionnaire included ten questions on limitations of physical functioning from the SF36 questionnaire. To calculate the average score from these questions, the RAND 36-item Health Survey 1.0 instrument was used. According to this instrument, a missing value was just let out for that person, and the estimated score for the same person was the average of the remaining and answered questions. The physical functioning questions all had the possible three SF-36 response categories "Yes limited a lot": 0 points, "Yes, limited a little": 50 points, and "No, not limited at all": 100 points. The resulting average of the answers was dichotomized at 85 points for the logistic regression analysis.

In addition to information from 1994 and 2008, questionnaire data for follow-up on neck-shoulder pain in 1995-97 were used for analysis of fluctuations of pain.

Other variables

In this part of the report we again adjusted for age and other diseases, the same way as in the manuscript's regression analysis. To adjust for cumulated occupational neck-shoulder exposure in 1996-2008, we used a recently developed job exposure matrix (JEM) (6, 44). This job exposure matrix is a division of 2042 occupational titles in the Danish version of the International Standard Classification of Occupations (D-ISCO 88) into 172 groups. The job exposure in the 172 groups was then rated by five occupational health physicians. Job exposure was described in a total shoulder load, combining mean force exerted with the hand and arm during a full working day, hours per day with upper-arm elevation > 90°, degree of repetitive work and hand-arm vibrations (44). To calculate the

cumulated job exposure over the entire period, the JEM was combined with D-ISCO 88 codes on every participant, received from Statistics Denmark (Employment Classification Module) and with information on hours worked per week. The total shoulder load has scores between 0-10 for each year. For years with incomplete or missing D-ISCO 88 codes, the shoulder exposure was set to be a mean of the other years. Data on hours worked per week from the Employment Classification Module was multiplied to the exposure estimate to adjust for part-time work. Further details of this job exposure measure is available elsewhere (6).

Statistical analyses

Descriptive statistics was used to describe distribution of neck-shoulder pain, limitations of activities and the dynamic course for neck-shoulder pain and disorders from 1994 until 2008. Logistic regression was made to estimate the association between neck-shoulder disorders in 1994 and neck-shoulder symptoms in 2008. It was adjusted for age, job exposure of the shoulder in the years after closure of the textile-companies and comorbidity. The total job exposure for the period was dichotomized at 30 points for the analysis. Chi-squared tests were performed to analyze loss to follow-up. All statistical analyses were performed with STATA 13.1 and 14.1 software (Stata Corp LP, College Station, Texas, USA?).

RESULTS

Descriptive data are shown in table 5. The prevalence of cases of moderate/severe neck-shoulder symptoms at baseline was 34.7% (95% CI 28.7-41.1). (Results are slightly different from the manuscript because data was available for 243 here). The cases could be assumed to follow a binomial distribution. The prevalence in 2008 was 49.0% (95% CI 40.7-57.3). Prevalence of clinically verified neck-shoulder disorders, i.e. rotator cuff tendinitis or neck-shoulder pain with pressure tenderness at baseline was 16.8% (95% CI 12.3-22.2). The median score of physical functioning in 2008 was 85 with quartiles 70 and 95 respectively. There were no striking differences between responders and non-responders in 2008 in terms of age and other characteristics, only comorbidity seemed to be more pronounced among non-responders (table 5).

Table 5. Characteristics for the cohort in 1994 and 2008.

	1994				2008	
	All		Absence of clinically verified neck-shoulder disorder 1994 (n = 198 ^a)	Clinically verified neck-shoulder disorder 1994 (n = 40 ^a)	Available information on neck-shoulder pain (n = 149 ^a).	No information on neck-shoulder pain (n = 94 ^a).
	N (number with available data on variable)	Mean/Quartiles/Proportion	Mean/Quartiles/Prop.	Mean/Quartiles/Prop.	Mean/Quartiles/Prop.	Mean/Quartiles/Prop.
Age 1994, mean	243	38.3 (SD 10.4)	37.4 (SD 10.4)	42.8 (SD 9.4)	38.1 (SD 9.8)	38.5 (SD 11.3)
Seniority (years) 1994, quartiles	243	4.5, 11.5, 20	4.5, 10.25, 18	6.8, 19.5, 26.4	6, 12, 20.3	3, 10, 20
Prevalence for neck-shoulder disorders 1994	238	16.8 % (CI 12.3-22.2)	.	.	15.6 % (CI 10.2-22.5)	18.7 % (CI 11.3-28.2)
Prevalence for moderate/severe neck-shoulder pain 1994	239	34.7 % (CI 28.7-41.1)	.	.	33.8 % (CI 26.2-42.0)	36.3 % (26.4-47.0)
Comorbidity 1994-2008 ^b	242	15.7 % (CI 11.4-20.9)	14.6 % (CI 10.0-20.4)	23.1% (CI 11.1-39.3)	11.4 % (CI 6.8-17.6)	22.6 % (CI 14.6-32.4)
Job exposure 1994-2008 ^c	242	29.3 (CI 27.1-31.6)	31.1 (CI 28.7-33.5)	19.3 (CI 14.2-24.4)	30.9 (CI 28.2-33.7)	26.8 (CI 23.0-30.6)
Employed in 2008 ^d	242	50.4 % (CI 43.9-56.9)	54.0 % (CI 46.8-61.1)	28.2 % (CI 15.0-44.9)	52.3 % (CI 44.1-60.6)	47.3 % (CI 36.9-57.9)
Prevalence for moderate/severe neck-shoulder pain 2008	149	49.0 % (CI 40.7-57.3)	42.7 % (CI 33.9-51.9)	78.3 % (CI 56.3-92.5)	.	.
Physical functioning 2008, quartiles	156	70, 85, 95	70, 90, 95	55, 70 85	.	.

^aMISSING INFORMATION FOR FEW PERSONS IN SOME ROWS. ^b PROPORTIONS OF PARTICIPANTS WHO HAD A CHARLSON'S COMORBIDITY IN 1994-

2008 BOTH YEARS INCLUDED. ^c THE CUMULATED TOTAL SHOULDER SCORE FROM JOB-EXPOSURE 1996-2008, RATED ON A 0-10 SCALE FOR EACH

YEAR. ^d FROM WEEK 45 IN 2008 IN DREAM-REGISTER. CI: 95% CONFIDENCE INTERVAL.

As shown in table 6, only few of the women with neck-shoulder pain or disorders in 1994 were recovered in 2008: 5 (21.7%) of those with a clinically verified disorder and 11 (22.0%) of those with self-reported neck-shoulder pain.

		Neck-shoulder pain 2008		
		None/mild	Moderate/severe	Total
Neck-shoulder disorder 1994	Absence of disorder	71	53	124
	Presence of disorder	5	18	23
	Total	76	71	147
Neck-shoulder pain 1994	None/mild	65	33	98
	Moderate/severe	11	39	50
	Total	76	72	148

Table 7 shows results from the univariate and multivariate logistic regression analyses. Neck-shoulder disorders in 1994 were significantly associated with moderate/severe neck-shoulder pain in 1994 with an adjusted odds ratio of 5.40 (95% CI 1.80-16.24). This means that women who had received a diagnosis of neck-shoulder disorders in 1994 had 5.40 times larger odds for reporting moderate/severe neck-shoulder pain in 2008.

Variables	Categories	Univariate, n = 149 ^a		Multivariate, n = 147	
		Odds ratio	95% Confidence interval	Odds ratio	95% Confidence interval
Neck-shoulder disorder 1994	Absence	1	Ref.	1	Ref.
	Presence	4.82	1.68-13.82	5.40	1.80-16.24
Age	< 40 years	1	Ref.	1	Ref.
	≥ 40 years	1.14	0.60-2.17	0.76	0.35-1.62
Comorbidity ^b 1994-2008	No comorbidity	1	Ref.	1	Ref.
	≥ 1 comorbidity	2.07	0.72-5.93	2.39	0.78-7.30
Jobexposure ^c in 1996-2008	< 30	1	Ref.	1	Ref.
	> 30	0.92	0.48-1.75	1.00	0.49-2.06

^aIn the row for neck-shoulder pain 1994 n = 147. ^b Proportions of participants who had a Charlson's comorbidity in 1994-2008 both years included. ^cThe cumulated total shoulder score from job-exposure 1996-2008, rated on a 0-10 scale for each year.

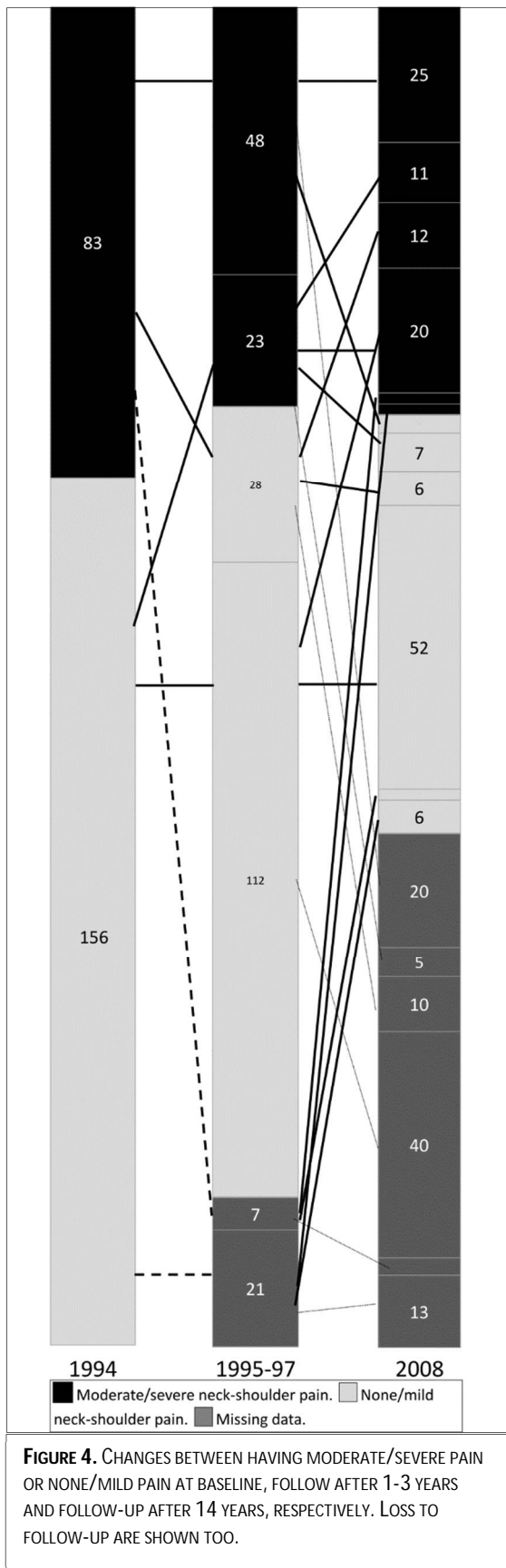
Equal analyses were made with physical functioning as outcome. A physical functioning at 85% or lower was also significantly associated with neck-shoulder disorders in 1994 with an adjusted odds ratio of 4.43 (95% CI 1.36-14.50) (table 8).

Table 8. Odds ratios for physically functioning \leq 85 % in 2008					
Variables	Categories	Univariate, n = 156 ^a		Multivariate, n = 155	
		Odds ratio	95% Confidence interval	Odds ratio	95% Confidence interval
Neck-shoulder disorder 1994	Absence	1	Ref.	1	Ref.
	Presence	5.53	1.78-17.14	4.43	1.36-14.50
Age	< 40 years	1	Ref.	1	Ref.
	\geq 40 years	3.22	1.67-6.22	2.20	1.05-4.62
Comorbidity ^b 1994-2008	No comorbidity	1	Ref.	1	Ref.
	\geq 1 comorbidity	7.06	1.99-25.11	6.21	1.66-23.27
Jobexposure ^c in 1996-2008	< 30	1	Ref.	1	Ref.
	> 30	1.42	0.91-2.22	0.70	0.33-1.45

^aIn the row for neck-shoulder pain 1994 n = 155. ^b Proportions of participants who had a Charlson's comorbidity in 1994-2008 both years included. ^cThe cumulated total shoulder score from job-exposure 1996-2008, rated on a 0-10 scale for each year.

Analyses were repeated with neck-shoulder pain in 1994 instead of neck-shoulder disorders as the exposure. This resulted in adjusted odds ratios of 7.64 (95% CI 3.34-17.50) for moderate/severe neck-shoulder pain in 2008 and 2.02 (95% CI 0.97-4.26) for physical functioning at 85% or lower in 2008.

Figure 4 shows the changes between having moderate/severe or none/mild neck-shoulder pain at three points in time: 1994, one of the years 1995-1997 and 2008. Several individuals change their status one or two times. 77 (60%) with available data at all data-collections did not change their status, 25 had moderate/severe pain each time while 52 had none/mild pain each time. Meanwhile, 51 (40%) of the participants with available data at all data-collections did change pain status at least once. The non-responders constitute a large part in 2008, but there was no difference of pain-status between responders and non-responders in prevalence of neck-shoulder complaints in



1994 or 1995-1996: p-values 0.7 and 0.9 from chi-squared tests. Data for complaints in 1995-97 was the primarily data from the second follow up in 1996-1997, which was available for 186 individuals. If no data on complaints from this follow-up was available, information on complaints in the first follow-up in 1995-1996 was used to replace the missing information, if data was available from this data collection instead. Thus, the second column of the diagram is based on questionnaires answered 1-3 years after baseline.

DISCUSSION

Key results

In 1994 all participants worked as sewing machine operators, and had at that time a prevalence of neck-shoulder pain on 34.7% (CI 28.7-41.1). Around 14 years later, in 2008, the prevalence was 49.0% (95% CI 40.7-57.3). After adjustment for potential confounders, clinically verified neck-shoulder disorders were associated with neck-shoulder pain in 2008. Also, neck-shoulder disorders were associated with limited physical functioning in 2008. There was an association between neck-shoulder pain in 1994 and neck-shoulder pain in 2008, while the odds ratio between neck-shoulder pain in 1994 and physical functioning in 2008 did not reach statistical significance, but showed a tendency.

Despite these associations, many of the participants had fluctuating symptoms (fig 4),

with 40% of those with available information about neck-shoulder pain at three data-

collections (1994, one of the data-collections 1995-97, and 2008) did change their pain status at least once.

Limitations

A validation study for the questionnaire about neck and shoulder symptoms was made as a part of PRIM (26). It showed that the questionnaire had a sensitivity of 90% and 67% to detect the clinical signs of rotator cuff tendinitis and myofascial pain syndrome respectively at baseline. In a follow-up examination one year later, a similar cross-sectional calculation was made, and found the same level of sensitivity and specificity. Specificity ranged from 0.68 to 0.84.

There was a relatively large loss to follow-up in 2008, though in consideration of the long interval between initial assessment and the last follow-up questionnaire, the loss-to-follow-up was not beyond our expectations. A chi-squared test showed no difference in neck-shoulder pain between responders and non-responders, and for characteristics shown in table 5, only comorbidity seemed to be more prevalent among non-responders, but a difference in comorbidity could suggest occurrence of some degree of selection bias.

The JEM was developed by expert ratings of shoulder exposure in the groups of jobs. The experts were familiar with assessment of job exposures (44). Validation of the expert-rated job exposures is ongoing, using technical measurements but the JEM has shown high predictive validity in other studies (6, 44). The years with missing D-ISCO 88 codes were assigned an exposure equal to the average of the other years even though missing D-ISCO-codes could also be due to sick-leave and unemployment. And D-ISCO 88 codes are registered on a yearly basis, but the employment situation has according to figure 2 in the manuscript often changed within the same years for many of the women. This could therefore lead to some misclassification about job exposure, but the long follow-up period has probably reduced the impact of this. Also, registration of D-ISCO 88 codes for jobs are likely superior to self-reported information, which was also our experience after examination of the questionnaires from 2008. These questionnaires actually asked for jobs since 1994, but answers were highly influenced by missing data, mistakes and inconsistency (data not shown).

The method and value of adjustment for comorbidity was discussed in the manuscript.

Interpretation

Apparently, many of the women had not recovered from their neck-shoulder pain in 2008 despite the fact that exposure to the risk factors for neck-shoulder pain in the textile industry had ended around 1996. Almost half the women reported moderate/severe neck-shoulder pain in 2008, so the prevalence seemed even to be a little higher than in 1994, and associations between complaints in 1994 and 2008 were found. As we adjusted for shoulder exposure during the years in between, the associations should not be caused by other jobs. The high prevalence of neck-shoulder pain in 2008 could partly be due to higher age (33) and the job exposures in other jobs, which some of the women actually were exposed to (table 5). Nevertheless, the shown associations and high occurrence of neck-shoulder pain in 2008 indicate a very long-term adverse prognosis for neck-shoulder pain and disorders. Furthermore, this prognosis was also characterized by limited physical functioning, even though the clinically verified disorders showed stronger association to this outcome than self-reported pain. This limited physical functioning might be an explanation of the tendency for lower work participation among those with neck-shoulder pain in 1994, which was the topic in the manuscript of this report.

Neck-shoulder pain has earlier been described to have a fluctuating level of pain with recoveries, recurrences and pain-episodes of different lengths (4, 51). This characterization is also supported by the results from our study and is of importance in research of prognosis as well as clinical practice.

Generalizability

As the cohort only consisted of women, the results have highest validity for similar women of same age, which means workers that has been exposed to risk factors for neck-shoulder pain in former jobs. Examples of jobs carrying risk factors for neck-shoulder pain are slaughter house workers, cleaners, postal workers and nurses (44). However, the results have probably also validity for the prognosis for neck-shoulder pain not related to work because the women did not continue in the textile industry and we adjusted for exposure to shoulder load from work during follow-up.

The results call for attention about the long-term prognosis of neck-shoulder pain and for prevention against development of this condition. This long-term prognosis for neck-shoulder pain should be integrated in considerations of treatment and advises given to this kind of patients and workers.

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FORSKNINGSÅRSRAPPORTER VED DANSK RAMAZZINI CENTER

Christine Cramer Christiansen 2015-2016

"A long-term follow-up study of interstitial lung diseases among pigeon breeders"
Arbejdsmedicinsk Klinik, Århus Universitetshospital

Saga Elsie Marinsdatter 2014-2015

"Pre-pregnancy BMI and reproductive health of sons and daughters in young adulthood "
Institut for Folkesundhed, Miljø Arbejde og Sundhed.

Nina Margrethe Raunkjær 2013-2014

"A 7-year follow-up study of occupational noise exposure and the use of antidepressant medicine: a model of long-term stress and depression"
Arbejdsmedicinsk Klinik, Århus Universitetshospital

Karen Guldbrandsen 2013-2014

"Age of menarche and time to pregnancy – a study within the Danish National Birth Cohort"
Arbejdsmedicinsk Klinik, Århus Universitetshospital

Julie Lyngsø 2012-2013

"Menstrual cycle characteristics in European and Inuit women exposed to perfluorinated chemicals"
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Tine Sommer 2012-2013

"Multi- and single site musculoskeletal pain – prevalence and association to multi- and single-site occupational mechanical exposures and to risk of disability"
Arbejdsmedicinsk Klinik, Herning

Maria Hee Jung Sejersén 2012-2013

"Molecular pathogenesis of rotator cuff related shoulder disorders: a methodological study including discovery-based proteomics"
Arbejdsmedicinsk Klinik, Herning

Martin Rune Hansen 2012-2013

"Helbredseffekter af længerevarende pyrethroid-eksponering på bolivianske sprøjtearbejdere involveret i vektorbekæmpelsesprogrammer"
Institut for Folkesundhed, Miljø Arbejde og Sundhed, Århus Universitet.

Marie Louise Hounsgaard 2011-2012

"Er mors overvægt under graviditet årsag til ændret alder for pubertetsstart hos sønner?"
Arbejdsmedicinsk Klinik, Århus Universitetshospital

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"Maternal smoking during pregnancy and reproductive health in daughters"
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Linn Berger Håkonsen 2010-2011

"Vægttab og mandlig reproduktion"

Arbejdsmedicinsk Klinik, Århus Universitetshospital

Marie Vestergaard Vad 2010-2011

"Impact of physical workload on risk of lateral and medial hernia repair: a population-based male cohort study"

Arbejdsmedicinsk Klinik, Århus Universitetshospital og Arbejdsmedicinsk Klinik, Herning

Pernille Gabel 2008-2009

"En registerbaseret undersøgelse af risikoen for kryptorkisme blandt drengebørn, hvis mødre har været udsat for pesticider under graviditeten"

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Jane Lausten Hansen 2008-2009

"Spiller amning af drengebørn en rolle for disses frugtbarhed? Et follow-up studie om sammenhængen mellem amning og sædkvalitet"

Arbejdsmedicinsk Klinik, Århus Universitetshospital

Anneli Clea Bolund 2007-2008

"SUS12 lungefunktion i et landligt perspektiv. 15 års followup studie af unge danske landmænd"

Institut for Folkesundhed, Miljø Arbejde og Sundhed, Århus Universitet.