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The influence of multiple occupational exposures on absence from work in pregnancy: a prospective cohort study

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Objectives Many women experience absence periods from work during pregnancy. Several single risk factors for absence are identified, whereas the impact of multiple concurrent exposures has been sparsely studied. We hypothesized that the presence of multiple occupational exposures would be associated with an increased risk of absence from work during pregnancy.

Methods We included women from the Danish National Birth Cohort (1996–2002), pregnant with one child and working ≥30 hours/week at interview (mean gestational week 17 (standard deviation 4.0); N=50 142). Information about five occupational exposures (job demands, job control, work posture, work shift, lifting) were retrieved from the interview, each assigned values of 0/1, and summed into an index (0–5). The woman's first absence from work (both regular and related to pregnancy) after the interview was available from a nationwide administrative register. We analyzed data with Cox regression using gestational age as the underlying time-variable.

Results Few women experienced none of the occupational exposures (3.6%) and most experienced two exposures (34.7%). Only 24.3% of the women were absent from work before gestational week 31. The number of occupational exposures was associated with an increasing risk of absence. The adjusted hazard ratio for absence increased from 1.3 [95% confidence interval (CI) 1.1–1.5] for one exposure to 2.9 (95% CI 2.5–3.3) for four to five exposures compared to no occupational exposure.

Conclusion The higher the number of potentially adverse occupational exposures pregnant women experienced, the higher the risk for absence from work during pregnancy.

Key terms epidemiology; pregnancy-related absence; job control; job demand; lifting; work posture; work shift.

A large proportion of women experience absence from work during pregnancy. In Denmark, two thirds of all pregnant women were absent from work at some point during pregnancy, and almost one third of the pregnant women were absent for >8 weeks during pregnancy. Furthermore, absence from work in pregnancy seems to increase (1). In 2016, the employment rate was 72% for Danish women in the reproductive age (18–44 years) (2), and each year around 60 000 children are born in Denmark. The societal costs due to absence from work are therefore high due to payment of benefits and reduction of manpower. Absence from work is also problematic for pregnant women because work is perceived as an important part of life. Reduction of absence from work during pregnancy therefore encompasses economic as well as individual advantages. It is therefore important

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to study how occupational exposures may be associated with absence from work during pregnancy to enable formulation of efficient preventive measures.

A number of occupational factors have been described as risk factors for absence from work during pregnancy. Previous studies have investigated occupational exposures such as job strain [defined by the combination of job demands and job control (3)], work posture, lifting, and work shift. These were each associated with the first episode of absence during gestational week (GW) 10–29 of pregnancy in a previous Danish study (4); while another study found similar exposures to be associated to absence for >10% of the scheduled work time during pregnancy among hospital employees (5). The relationship between occupational exposures and absence from work during pregnancy has mostly been assessed for individual factors, one at a time, rather than for combinations of exposures. However, one cross-sectional study investigated an index of occupational exposures and showed that, with an increasing number of exposures, the risk of self-reported sickness absence during pregnancy increased (6). Findings described in a Danish report indicated that pregnant women concurrently exposed to several occupational exposures had more absences from work than pregnant women with fewer or no exposures at work (7). This study was cross-sectional, sickness absence was self-reported, and details of the analyses were not available. Hence, in research of associations between occupational exposures and absence from work during pregnancy, there is a need to use prospective study designs and register rather than self-reported data on the outcome.

We hypothesized that exposure to multiple concurrent occupational exposures would increase the risk of absence from work. We constructed an index of several occupational exposures (4) with the hypothesis that exposures, which have been indicated to relate to absence from work during pregnancy, will also increase the risk of absence when they are present concurrently and that the risk will increase for additional exposures, ie, the higher the number of exposures the higher the risk of absence.

Methods

Study population

We used data from the Danish National Birth Cohort (DNBC) with 100 418 pregnancies (1996–2002) (8). During the first antenatal visit, the general practitioner invited the pregnant women to participate in the cohort if they planned to complete the pregnancy, lived in Denmark, and could carry out a comprehensive telephone interview in Danish. For more details, see elsewhere (8).

We included women if they (i) completed DNBC's first pregnancy interview between the first day in GW 11 and the last day in GW 30 [mean 16.7 (SD 4.0) GW], (ii) were pregnant with their first singleton pregnancy registered in the DNBC, (iii) worked ≥30 hours per week, and (iv) had full information on all exposures of interest, covariables and outcome (figure 1, N=50 142).

The DNBC and the Danish Data Protection Agency permitted use and storage of data at Statistics Denmark where the available data were fully anonymized. According to the Danish legislation, approval from the Ethical Committee was not needed.

Occupational exposures

An index variable constructed, as described by Miranda and colleagues (9), was generated from the five selected occupational exposures: work posture, work shift, lifting, job demands, and job control (table 1). These factors were included in the analyses as they had previously been found to be associated with absence from work during pregnancy, albeit job demands and job control was associated to absence from work as the combined exposure job strain (4). Lifting was constructed from four questions, while the rest of the exposures were based on one question each (table 1). Each heavy and medium lift were assigned values of 22.5 and 15 kg/lift, respectively, and the cumulative burden of lifting was calculated (10). The scoring of lifting, work posture and work shift (0 or 1 point; table 1) was based on the findings in Hansen et al (4). Job demands and job control were included as separate measures, dichotomized and scored (0 or 1 point; table 1) based on Larsen et al (11) and Juhl et al (12). These two questions were dichotomized in order to obtain as much contrast as possible. For the index variable, the points were summarized across the five occupational exposures for each woman. The final index variable ranged from 0–5, where 4 and 5 were combined into one category due to an assumption that few women would experience a high amount of occupational exposures.

Outcome

Information on doctor-certified absence from work was obtained from the Danish Register for Evaluation of Marginalization (DREAM). This register contains data for all types of social payments with unique codes for each benefit, eg, sickness and maternity benefit, educational funds, and retirement pension. The data has a hierarchical structure and is assessed on a weekly basis with one code registered in DREAM per week. Absence from work during pregnancy was registered as either regular or pregnancy-related. Regular sickness absence

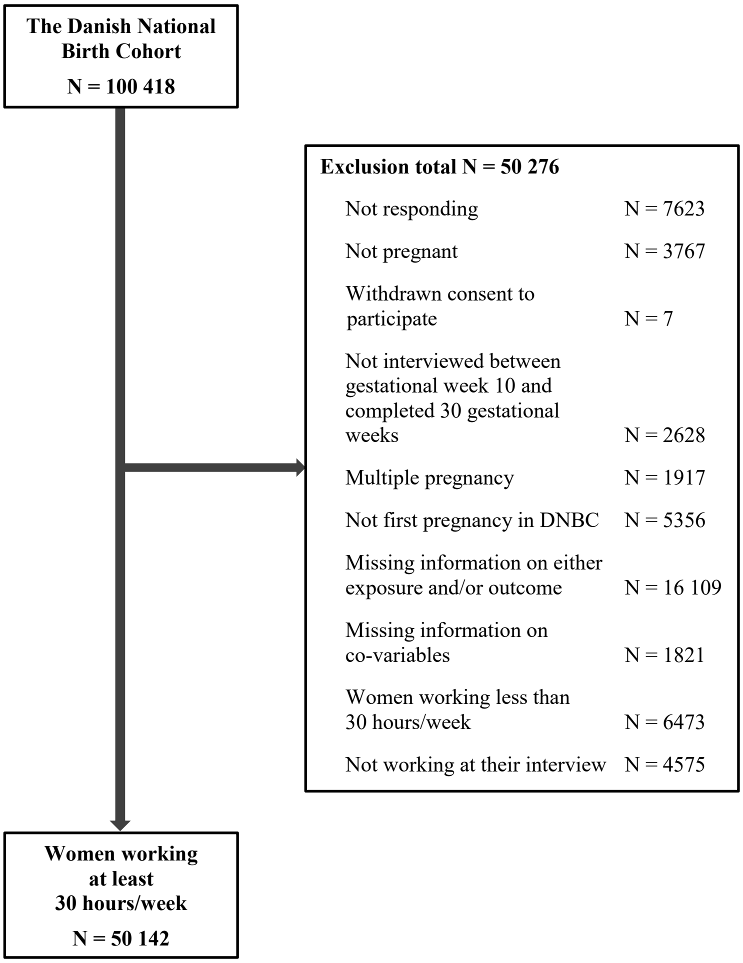


Figure 1. Flowchart of the study population, the Danish National Birth Cohort (DNBC), 1996–2002.

was registered if the women were absent from work for ≥15 days and subsequently backdated to day 1. Pregnancy-related absence from work relates to absence due to pregnancy factors, eg, pelvic pain or harmful working condition(s) for mother or child and was registered from the first day of absence. In order for the absence period, no matter the type, to be entered into DREAM it had to be doctor-certified. For the two types of absence, the employers were reimbursed for the sickness benefit from day 15 and 1, respectively. Pregnancy-related absence constituted 88.0% and regular sickness absence 12.0% of the total absences from work during pregnancy. These two were in the statistical analyses combined into a single outcome (yes/no) and the term "absence from work" is used for the outcome measure in the following.

Potential confounders

We investigated the previous literature and incorporated the identified potential confounders in a directed acyclic graph (DAG). This served as partial basis for selection of confounders together with the availability of information in the interview and the DREAM register. We included sickness absence during the year prior to pregnancy and during early pregnancy (until the first interview), which were combined into the variable previous sickness absence. The other confounders included were maternal age at conception, parity, fertility treatment, socio-economic status (SES), pre-pregnancy body mass index, during pregnancy smoking and leisure time exercise. SES was based on self-reported job titles converted into the Danish International Standard Classification of Occupations (DISCO-88). The confounders are presented in table 2.

Statistical analysis

In the analyses, we investigated the association between the index variable and absence from work. We analyzed data in Cox proportional hazard regression models with adjustment for covariates with gestational age (days) as the underlying time variable. Calculation of gestational age was based on the self-reported first day of the last menstrual period from the interview. Entry time was

Table 1. Occupational exposures included in the index variable. The questions from the Danish National Birth Cohort, response keys and allocation of points for each exposure.

Exposures	Question	Response key	Points
Job demand	Do you have too much to do when at your work?	Often Sometimes Seldom	Seldom or sometimes=0 Often=1
Job control	Do you have the opportunity to influence your tasks and working conditions?	Often Sometimes Seldom	Often or sometimes=0 Seldom=1
Work posture	In your job, do you sit, stand or walk most of the time, or can you change as you like?	Primarily sitting Primarily standing Primarily walking Primarily standing and walking Changeable Other	Sitting=0 All other responses=1
Work shift	What are your normal working hours, day, evening or night, or do you have shifting working hours?	Fixed day Fixed evening Fixed night Shifting, without night shifts Shifting, with night shifts	Fixed day=0 All other responses=1
Lifting	Heavy: In your job, do you daily lift >20 kg at a time, similar to a case of beer? How many times a day do you lift >20 kg? Medium: Do you have daily lifts 11–20 kg, less than a case of beer and more than a bucket of water? How many times a day do you lift 11–20 kg?	0–1875 kg/day	Not lifting daily (0–14 kg)=0 Yes lifting daily (≥15 kg)=1

the date of the interview, and end time was the date of receiving the first episode of absence from work after the interview. Observations were censored if the women terminated pregnancy, gave birth (stillbirth or preterm birth), emigrated, went on leave other than maternity leave, received other social benefits, or the end of the study period was reached at 30 completed GW, whichever came first.

All variables were tested relative to the proportional hazard assumption by investigating the cumulative proportional hazards and reclassified when needed (see footnotes to table 2).

The results are presented as hazard ratios (HR) with 95% confidence intervals (CI) from the crude and two adjusted models; one model including all potential confounders except SES, and one model also including SES. A third model was included because inclusion of SES might result in over-adjustment.

Previous sickness absence could indicate an inherent propensity for later sickness absence (13). In the subgroup analyses, we therefore conducted the analyses with the women stratified into four groups based on their absence from work prior to pregnancy (0, 1–2, 3–5, and ≥6 weeks absence) and on their absence from work both prior to and during early pregnancy (see categorization in table 2). As a sensitivity analysis, we investigated the index variable with six categories instead of five in relation to absence from work.

The statistical analyses were conducted in SAS 9.4 (SAS Institute Inc, Cary, NC, USA).

Results

In this study, 24.3% of the women had their first spell of absence from work before GW 31, on average at GW 24.0 (SD 4.7). About 80% of the women experienced between 1–3 occupational exposures, while <4% experienced 0 exposure at work of interest for this study. Women in the youngest age group or with lower educational level, more children, more smoking, or higher BMI experienced more exposures at work. Previous sickness absence was also associated with more exposures at work. Women who had received fertility treatment experienced less exposures compared to women without fertility treatment (table 2).

The women were on average followed for 11.6 weeks; women registered with absence from work were followed for 7.6 weeks (mean), while women with no absence from work were followed for 12.9 weeks (mean). Both the crude and adjusted analyses showed that with an increasing number of occupational exposures the risk of absence from work increased (figure 2), albeit adjustment attenuated the findings both from model 1 to 2 and from model 2 to 3. In the fully adjusted analysis, the HR increased from 1.25 (95% CI 1.08–1.45) for one occupational exposure to 2.87 (95% CI 2.49–3.30) for 4–5 compared with 0 occupational exposures (figure 2).

In a sensitivity analysis, we investigated the index as a 6-category variable, ie, without combining 4 and 5 occupational exposures. Being exposed to 4 occupational exposures resulted in the fully adjusted analysis in a HR of 2.77 (95% CI 2.40–3.19) for absence from work, exposure to 5 occupational exposures gave a HR of 3.23 (95% CI 2.77–3.77) for absence from work. Hence, the risk of absence from work further increased when the number of occupational exposures increased from 4 to 5.

We conducted subgroup analyses to test for effect modification by previous sickness absence in two different analyses. First, a test of effect modification by sickness absence prior to pregnancy (0, 1–2, 3–5 and ≥6 weeks) was investigated for the index variable. In each of the subgroups in this variable, we found a pattern with increasing number of occupational exposures the risk of absence from work also increased. For women with no sickness absence prior to pregnancy, the risk

Table 2. Characteristics of the pregnant women by the index variable.

Characteristics	Index variable									
	0		1		2		3		4–5	
	N	%	N	%	N	%	N	%	N	%
Total (N = 50 142)	1780	3.6	9763	19.5	17 410	34.7	12 967	25.9	8222	16.4
Maternal age at birth (years)										
<25	118	2.3	754	15.0	1532	30.4	1489	29.6	1146	22.7
25–29	669	3.1	3985	18.7	7300	34.3	5588	26.2	3756	17.6
30–34	777	4.3	3809	21.1	6458	35.8	4500	24.9	2509	13.9
≥35	216	3.8	1215	21.1	2120	36.9	1390	24.2	811	14.1
Gestational age (weeks) at interview										
<17	924	3.5	4871	18.6	8829	33.8	6763	25.9	4743	18.2
17–30	856	3.6	4892	20.4	8581	35.7	6204	25.8	3479	14.5
Socioeconomic status										
High education	342	5.6	1808	29.5	2402	39.2	1079	17.6	500	8.2
Medium education	415	2.4	2774	16.3	5682	33.3	4630	27.1	3532	20.9
Skilled work	701	6.0	3034	25.9	4838	41.2	2592	22.1	573	4.9
Unskilled work	213	1.7	1582	12.7	3602	28.8	3937	31.5	3158	25.3
Student	109	4.0	565	20.8	886	32.6	729	26.8	429	15.8
Previous sickness absence										
No previous sickness absence	1559	3.9	8230	20.8	14 132	35.7	9764	24.7	5920	15.0
Sickness before pregnancy	131	2.3	833	14.6	1778	31.3	1691	29.7	1256	22.1
Absence in early pregnancy	58	2.0	390	13.5	877	30.2	901	31.1	674	23.2
Sickness absence before and during early pregnancy	32	1.6	310	15.9	623	32.0	611	31.4	372	19.1
Parity										
0	950	3.6	5318	20.1	9216	34.9	6681	25.3	4261	16.1
1	632	3.7	3316	19.5	5981	35.2	4419	26.0	2651	15.6
≥2	198	3.0	1129	16.8	2213	33.0	1867	27.8	1310	19.5
Smoking										
No	1473	3.9	7879	20.7	13 556	35.6	9529	25.0	5696	14.9
Less than daily	156	2.9	917	16.8	1829	33.6	1511	27.7	1039	19.1
Daily	151	2.3	967	14.8	2025	30.9	1927	29.4	1487	22.7
Fertility treatment										
No	1640	3.5	9112	19.4	16 292	34.6	12 210	26.0	7801	16.6
Yes	140	4.5	651	21.1	1118	36.2	757	24.5	421	13.6
Leisure-time physical exercise [a]										
No	1074	3.5	5867	19.1	10 571	34.5	8004	26.1	5159	16.8
Yes	706	3.6	3896	20.0	6839	34.1	4963	25.5	3063	15.7
Body mass index (kg/m^2) [b]										
15–24.9	1382	3.8	7379	20.0	12 937	35.1	9335	25.3	5845	15.9
25–29.9	293	3.1	1755	18.3	3304	34.5	2586	27.0	1644	17.2
30–50	105	2.9	629	17.1	1169	31.8	1046	28.4	733	19.9

[a] Leisure-time physical exercise was recategorized into two categories in order to obtain the proportional hazard assumption.
[b] Body mass index was recategorized into three categories in order to obtain the proportional hazard assumption.

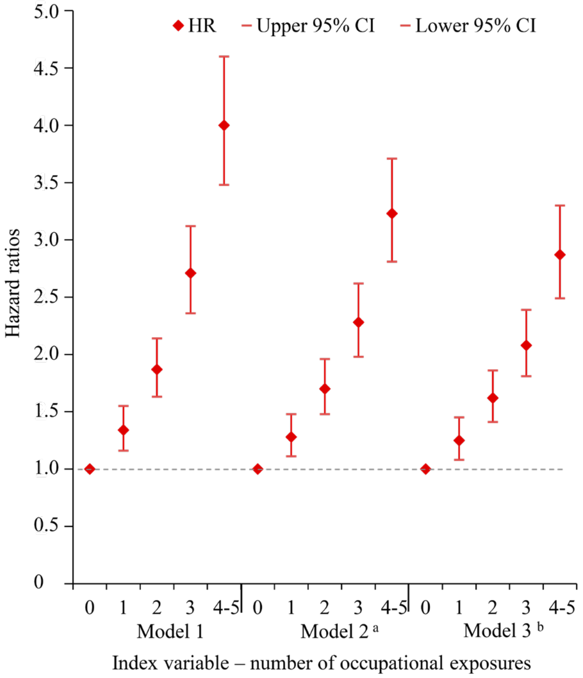
of absence from work increased compared to the main analysis, ie, for 4–5 occupational exposures, the fully adjusted HR was 3.26 (95% CI 2.79–3.81) compared to HR 2.87 (95% CI 2.49–3.30) in the main analysis. In the test including sickness absence prior to and during early pregnancy (no, before, early, and both before and during early pregnancy), we saw a similar pattern, except for the group of women absent from work both before and during pregnancy, where we found no association.

Discussion

Approximately 25% of the pregnant women in the study had ≥1 spell of absence from work during the follow-up until the end of GW 30. We found an increasing risk of absence with an increasing number of occupational exposures when analyzed by use of an index variable including exposures that were earlier shown to be associated with the risk of absence (4). The results supported our hypothesis that more exposures at work led to a higher risk of absence from work.

Our findings were in line with two previous studies; a cross-sectional study showed a dose–response relationship between an cumulated index of occupational exposures and absence from work (6). However, information about both exposures and absence was collected after the women gave birth. A previous Danish report (7) also found that pregnant women exposed to several occupational exposures had an increased risk of absence from work. Our study on the other hand is, as far as we know, the first prospective study to use register information for the outcome investigating the association between combinations of occupational exposures.

Each variable included in the index was dichoto-



Index variables: occupational exposures	N	Event	Event/N (%)
0	1780	212	11.9
1	9763	1493	15.3
2	17 410	3595	20.6
3	12 967	3687	28.4
4–5	8222	3218	39.1

Index variables: occupational exposures	HR	95% CI
Model 1		
0	1.00	-
1	1.34	1.16–1.55
2	1.87	1.63–2.14
3	2.71	2.36–3.12
4–5	4.00	3.48–4.60
Model 2 [a]		
0	1.00	-
1	1.28	1.11–1.48
2	1.70	1.48–1.96
3	2.28	1.98–2.62
4–5	3.23	2.81–3.71
Model 2 [b]		
0	1.00	-
1	1.25	1.08–1.45
2	1.62	1.41–1.86
3	2.08	1.81–2.39
4–5	2.87	2.49–3.30

Figure 2. Hazard ratio (HR) and 95% confidence interval (CI) according to the index variable comprised of five occupational exposures for absence from work.
[a] Adjusted for previous sickness absence, age at conception, parity, fertility treatment, smoking, leisure-time exercise, body mass index.
[b] Same as [a] + socioeconomic status.

mized into yes/no and job demands and control was included as separate exposures and not as job strain (3). Albeit the index variable does not distinguish between the included occupational exposures, the results yield information on the consequences of concomitant multiple occupational exposures for absence.

We had decided, a priori, to collapse exposure to four and five occupational exposures into one category as we did not think that many would experience all five at the same time, but subsequently performed the analyses with four and five occupational exposures as separate groups. Both the main and the sensitivity analysis showed a clear dose–response relationship between the index variable and absence from work with the highest risk of absence in the group experiencing five occupational exposures.

One point for discussion is whether the absence we investigate is related to work or pregnancy. The employers were reimbursed for the pregnancy-related absence from day 1 but first from day 15 for general sickness absence. The employer would therefore have had an economical incentive to report absence as pregnancy-related which might explain that regular sickness absence constituted only 12.0% of the total number of absences from work. The lack of information on the reason(s) for the absence from work in DREAM precluded distinction between regular and pregnancy-related absence. Unfortunately, the data did not provide the possibility to investigate this issue further.

In this study, SES was based on the women's self-reported job titles. SES would be expected to be highly correlated to the investigated occupational exposures; perhaps mainly the physical exposures as the types of jobs held by skilled and un-skilled workers would be depicted by more physically straining work (14, 15). In the analyses, we adjusted for SES only in the final statistical models to avoid potential over-adjustment. Sickness absence generally increases with lower SES, in pregnant as well as non-pregnant populations (1, 16–18). An explanation of the influence of SES could be the presence of differential exposure and vulnerability. Differential exposure refers to the number of differential exposures either as type, duration, or amount that varies between the social positions and thereby the health risks (19). The lower the SES, the higher the risk of being exposed to risk factors and not only in the professional life. This might entail that the impact of a single (occupational) exposure could be stronger in groups of lower compared to groups of higher SES, ie, differential vulnerability (19). However, adjustment for SES only discretely attenuated estimates. Another explanation could also be different attitudes towards working during pregnancy and personality, which we could not control for due to lack of data.

The women from the DNBC were probably healthier than the general population. Previously, Jacobsen and colleagues (20) showed that women with low socioeconomic resources were underrepresented in this cohort, and furthermore, we only included women with ≥30 weekly work hours and excluded women receiving sickness benefit due to special circumstances. Less than 25% of the pregnant women were absent from work. Other studies or reports found levels of absence from work in pregnancy of 43–68%, irrespective of weekly working hours and time of absence from work in pregnancy (1, 4, 21, 22). We, on the other hand, investigated the risk of absence from work in a rather healthy cohort and showed that even here the risk of absence increases with an increasing number of occupational exposures.

The study was conducted within the DNBC, which was established between 1996 and 2002, ie, around 20 years ago. The recommendations issued by the Danish Work Environment Authorities on working conditions for pregnant women have not changed much since 2002 (23–25). Only one major change regarding lifting has been introduced over the years, as the recommendation has been eased since 2009: the maximum lifting restriction of 1000 kg per day has been removed (23–26). Psychosocial working conditions were first mentioned in 2002, solely to be considered together in combinations with other factors such as lifting (24).

The findings from the subgroup analyses partly confirmed our main findings for women with no prior absence due to sickness. However, for women with previous sickness absence, the subgroup analyses did not show the same results as the main findings. This might be due to the small numbers, or perhaps women with previous sickness absence become absent during pregnancy earlier than pregnant women without previous sickness absence, and therefore no association was shown in these subgroups.

Our study suggests that absence from work among pregnant women may potentially be reduced by lowering the number of occupational exposures. Studies on absence from work show that women are most often absent due to general pregnancy-related discomfort, which can be exacerbated when doing strenuous work. Hence, job adjustment can help pregnant women to continue working. This is indicated by previous studies, showing that absence can be reduced if job adjustment is considered relevant and implemented (27, 28). At Akershus University Hospital in Oslo, a new approach was implemented where all newly pregnant employees were offered an interview with their leader and a midwife early in pregnancy to explore the need for and implement job adjustment. The hospital subsequently experienced a large reduction in absence among their pregnant employees (29).

A priori, we wished to investigate the combined effect of two specific occupational exposures – lifting and job strain – in relation to absence from work. However, due to power issues when including a 16-category variable of combined lifting (10) and job strain (3) and the two main effects (lifting and job strain) in the same analyses, we did not include these (data not shown).

The major strengths of this study include the large cohort with prospective data collection combined with national register data on the outcome. In addition, we only included women working ≥30 hours/week because fewer weekly work hours could increase recuperation from work-related strain and thereby reduce the need for reduction of work by absence. This is supported by findings of reduced absence from work among pregnant women working ≤30 hours/week (22). In contrast, a previous study on absence during pregnancy based on the DNBC showed that pregnant women working <37 hours/week had an increased risk of absence, while women working >37 hours/week had a decreased the risk of absence, both compared to women working 37 hours/week (4). However, women working >37 hours/week might be a selected group and more robust, hence, their risk of absence during pregnancy is lower.

One limitation relates to the choice of the five occupational exposures included in the index. Other exposures such as social relationships, including quality of leadership and social support, or workplace violence, including physical violence and bullying, could have been included. However, work posture, work shift, and lifting, were previously investigated in relation to absence in pregnancy in DNBC (4). Job strain was also previously studied for this outcome, albeit not with job demands and job control as separate measures (4). Of note, we have not taken the potential correlation of the variables into account. However, the correlations of the variables were tested after the index variable was created. The results showed that only lifting and work posture were moderately to strongly correlated, while the other variables were less correlated. The results for each increment in the index may therefore not be completely independent of each other, but the normal distribution of the index variable as a variable ranging from 0 to 5 is reassuring. The questions used to generate the index were not validated, which could have led to bias. The most likely scenario would be non-differential misclassification and potential bias toward the null.

Notwithstanding these limitations, a cautious recommendation based on the presented findings would be to raise awareness of the *number* of occupational exposures that pregnant women experience. The novelty with the present study is that the number of exposures could possibly be a way to assess the risk of absence in pregnancy. This knowledge may be used to guide the employers on how to reduce absence from work among pregnant employees through an exposure reduction when several concomitant exposures are present at a time. This recommendation aligns well with the guidelines from the Danish Working Environment Authority (23) that the work conditions of pregnant women ought to be assessed as a whole in cases with exposure to high physical strain. Furthermore, initiatives of job adjustment addressing the straining occupational exposure might be one way to decrease absence from work in this group of workers.

Concluding remarks

We found the number of occupational exposures including job demands, job control, work posture, work shift and lifting, associated with an increased risk of absence from work during pregnancy. It may be useful to develop an index of work exposures with suggested adverse effects on absence from work during pregnancy. Thereby, it would be possible to identify pregnant women needing exposure reduction at work or to identify workplaces with a general need for preventive interventions to reduce absence among pregnant employees. Future studies should investigate job adjustment by addressing the number, type, and quality of occupational exposures among pregnant women that might reduce absence from work during pregnancy to reduce discomfort, absence, and societal and personal costs.

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