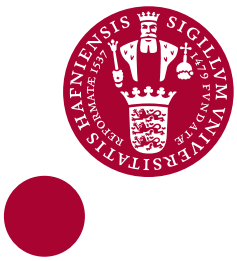

Working time characteristics and long-term sickness absence among Danish and Finnish nurses

A register-based study

Larsen, Ann Dyreborg; Ropponen, Annina; Hansen, Johnni; Hansen, Åse Marie; Kolstad, Henrik A.; Koskinen, Aki; Härmä, Mikko I.; Garde, Anne Helene

Published in:
International Journal of Nursing Studies

DOI:
10.1016/j.ijnurstu.2020.103639

Publication date:
2020

Document version
Publisher's PDF, also known as Version of record

International Journal of Nursing Studies 112 (2020) 103639

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/ijns

Working time characteristics and long-term sickness absence among Danish and Finnish nurses: A register-based study

Ann Dyreborg Larsen[a,*], Annina Ropponen[b], Johnni Hansen[c], Åse Marie Hansen[a,d], Henrik A. Kolstad[e], Aki Koskinen[b], Mikko I. Härmä[b], Anne Helene Garde[a,d]

[a] The National Research Center for the Working Environment, Lersoe Parkalle 105, DK-2100 Copenhagen, Denmark
[b] Finnish Institute of Occupation Health, P.O.Box 40, FI-00032 Työterveyslaitos, Finland
[c] Danish Cancer Society Research Center, Strandboulevarden 49, DK-2100 Copenhagen, Denmark
[d] Department of Public Health, Copenhagen University, Gothersgade 160, DK-1123 Copenhagen, Denmark
[e] Department of Occupational Medicine, Danish Ramazzini Centre, Palle Juul-Jensens Boulevard 99, Aarhus University Hospital, DK-8200 Aarhus, Denmark

ARTICLE INFO

Article history:
Received 15 November 2019
Received in revised form 1 May 2020
Accepted 2 May 2020

Keywords:
Cohort study
Health personnel
Prospective study
Shift work
Shift work schedule
Sick days
Sick leave

ABSTRACT

Background: Working time regimes in Denmark and Finland share many similarities such as nursing personnel working in highly irregular shift systems. Yet, there are also differences for example in policy on when and how the employers are compensated for sickness absence.
Objective: We aimed to investigate the association between different working hour characteristics and long-term sickness absence and whether these associations differed within various age groups in two large datasets of nursing personnel from Denmark and Finland.
Design: Based on objective payroll data we used Poisson regression models to calculate incidence rate ratios with 95% confidence intervals to prospectively assess the risk of long-term sickness absence in relation to annual working hour characteristics. The analyses were adjusted for age, sex, short-term sickness absence, and weekly working hours.
Setting(s): Danish and Finnish nursing personnel.
Participants: 31,729 Danish and 6970 Finnish nursing personnel with ≥ 0.5 Whole-Time Equivalent, registered in the database ≥ 1 year, 18–67 years of age with less than 30 days sickness absence in baseline year 2008.
Methods: Working hour characteristics were assessed for 2008: time of day; day; evening; night. Duration of shift; long shifts (9–12 h); very long shifts (12–24 h); quick returns (< 11 h between two shifts); long weeks (> 40 h/week); very long weeks (> 48 h/week); and consecutive night shifts (≥ 5 night shifts). Long-term sickness absence was assessed as first incidence of 30 or more consecutive days off in 2009–2015.
Results: The Danish data showed having evening work or five or more consecutive night shifts were associated with higher risk of long-term sickness absence. When excluding pregnant women, night work was also associated to higher risk of sickness absence. When stratifying on age groups, we observed a lower risk of sickness absence in the youngest age groups and a higher risk among the oldest. The Finnish results showed a higher risk of sickness absence when working nights, longs shifts, quick returns, and long work weeks. When stratifying on age groups, the results showed similar tendencies as the Danish.
Conclusions: The results show that the scheduling of working hours is likely to affect the risk of long-term sickness absence and that the risk differs in different age groups. No consistent picture was found for the results from Denmark and Finland. Differences may be due to contextual differences thus comparison of risk of sickness absence in relation to working hours between countries should be performed with caution.
Tweetable abstract: A recent study from Denmark and Finland shows higher risk for long sickness absence among nurses with five or more consecutive night shifts

* Corresponding author.
E-mail address: adl@nrcewe.dk (A.D. Larsen).
Social media: (A. Ropponen), (M.I. Härmä)

https://doi.org/10.1016/j.ijnurstu.2020.103639

What is already known about the topic?

- Previous studies indicate an association between working time arrangements and sickness absence but evidence is not well-established as some studies also report no associations or decreased risk of sickness absence.
- With many studies based on self-reported working time and sickness absence there is a call for studies of high quality with objective, detailed assessment of shift work exposure for example by use of payroll data.

What this paper adds

- Results show that the scheduling of working hours is likely to affect risk of long-term sickness absence and that the risk is higher among older nurses.
- There were differences in the association of working hours and sickness absences between Denmark and Finland which may be due to differences in compensation policy.

1. Background

1.1. Objective

Shiftwork including nights and long working hours are common in a society with 24 hours' availability. Based on numbers from the European Working Condition Survey (2015), shift and night work were estimated to affect nearly 20% of the working population where long weekly working hours could affect up to 40% (Eurofound 2015). Shift and night work have been associated with cardiovascular diseases, diabetes, injuries and cancer (Puttonen et al., 2010; Gan et al., 2015; Larsen et al., 2017; Nielsen et al., 2018; Hansen, 2017) whereas long working hours have been associated with cardiovascular diseases and depression and sleep disturbances (Virtanen and Kivimaki, 2018; Virtanen et al., 2018; Virtanen et al., 2009). In turn, some evidence indicates that shift and night work and long working hours are associated with both short- and long-term consequences of the chronic diseases such as sickness absence (Karkkainen et al., 2017; Ropponen et al., 2018; Dall'Ora et al., 2018).

Increasing numbers of days with sickness absence from work due to illness is an increasing problem in most European countries. In Denmark and Finland, numbers of days with sickness absence per year have increased from 6.7 (Denmark) and 8.4 (Finland) in 2000 to 9.0 (Denmark) and 9.3 (Finland) in 2016 (OECD.stat 2019). Sickness absence and long-term sickness absence in particular have large social consequences in terms of lost productivity and economical compensations (Stromberg et al., 2017) as well as individual consequences in terms of affected health, social exclusion, financial difficulties and exit from the workforce (Sieurin et al., 2009; Vingard et al., 2004; Bryngelson, 2009). Further, previous studies have shown long-term sickness absence to be a predictor of early retirement and disability pension (Salonen et al., 2018; Kivimaki et al., 2004). Denmark and Finland share to a large extent similar working life structures, working hour regulations and health care system. However, previous studies including payroll data from Denmark and Finland revealed differences in working hour characteristics and distribution of type of work schedules (Garde et al., 2019; Karhula et al., 2018a). Both Denmark and Finland are covered by the Nordic welfare model including a national social security scheme for sickness absence but there are differences e.g. in relation to compensation, disability pensions and when an employer can discharge an employee.

Some studies find that work time schedules are related to sickness absence (Dall'Ora et al., 2018; Ropponen et al., 2019; Fekedulegn et al., 2013), but the associations between work time schedule, including shift and night work, long shifts (i.e. long working hours) and long weekly working hours, are not well-established as other studies have found no associations or decreased risk of sickness absence (Bernstrom, 2018; Laaksonen et al., 2010; van Drongelen et al., 2017). In the review by Merkus et al., the authors considered evidence in regards to sickness absence to be inconclusive with respect to rotating shifts, shift work including nights, fixed night work, and for 8-hour and 12-hour shifts. Call for studies of high quality with detailed assessment of shift work exposure are thus needed (Merkus et al., 2012). Studies using objective working hour data has increased in number during recent years, but they are still scarce in studies on sickness absence (Dall'Ora et al., 2018; Ropponen et al., 2019; Vedaa et al., 2019).

Therefore, based on objective high quality data available from employers' pay-roll based registers with detailed information on working hour characteristics, the present study aims to investigate the association between timing and length of work shifts, short time between shifts (quick returns), number of consecutive night shifts, and weekly working hours and the risk of long-term sickness absence (long-term sickness absence, $\geq$ 30 consecutive days) among female nursing personnel in the public health care sector in Denmark and Finland. Further, we want to test whether the associations would differ in various age groups. As the literature suggest an association between several working hour characteristics and sickness absence, we hypothesize that time of day, duration of shifts and work weeks along with work patterns and number of consecutive night shifts are associated with risk of long-term sickness absence. Further, we hypothesize that the risk increase with the intensity of the shifts: the more shifts per year, the higher risk and with age as age can reflect longer exposure time.

1.2. More specifically, the research questions were

Are working hour characteristics in shift work a predictor for long-term sickness absence? Is time of day (evening shift, night shift), duration of shift (long shift $\geq$ 9 h and $<$ 12 h), very long shift ($\geq$ 12 h and $<$ 24 h)) or work patterns (quick returns ($<$ 11 h between two shifts), long weeks (calendar weeks with $>$ 40 h/week), very long weeks (calendar weeks with $>$ 48 h/week); consecutive night shifts (periods of $\geq$ five night shifts or more in a row) associated with increased risk of long-term sickness absence? Do the associations differ between age groups?

2. Methods

In the current study, we analyze payroll data from Denmark and Finland for the associations between working hour characteristics and risk of long-term sickness absence and further, to test if these associations differ in different age groups.

2.1. Data

Data sources comprise data from two large databases: the Danish Working Hour Database (Garde et al., 2018) and the Working Hours in the Finnish Public Sector Study database (Harma et al., 2015). Both databases include detailed information on working time and absence from work based on daily information from payroll data.

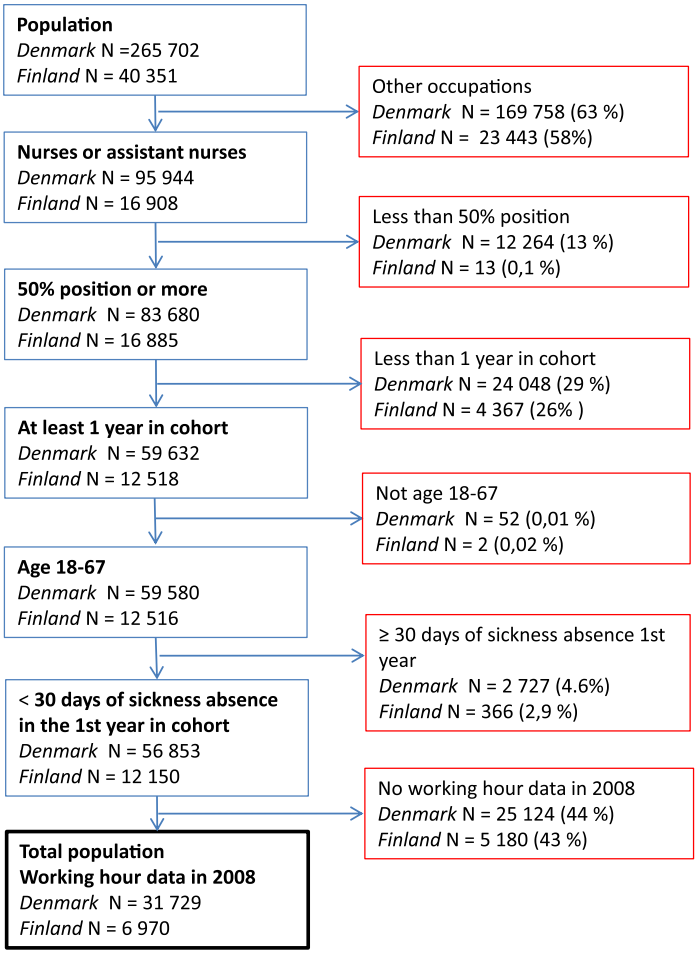

Fig. 1. Flowchart Danish and Finnish data.

The Danish Working Hour Database is a nationwide database with payroll data from the five administrative Danish regions from 2007–2015 with a total of 265 702 unique participants. The regional employees include all public hospital employees. For each participant, the database includes data on starting and ending time for all shifts, age, sex, profession and absence from work (sickness absence, holiday, parental leave, etc.).

The Working Hours in the Finnish Public Sector Study data used in this study includes payroll data from five hospital districts and workers from one social health care department of one town (The Finnish Public Sector Study hospital cohort). Data on working time was retrieved from the historical records of the shift scheduling programme: Titania® (CGI Finland) for 2008–2015 (Harma et al., 2015). A total of 40 351 unique participants were included.

2.2. Study population

To ensure homogeneous study populations for comparison between countries, the datasets were harmonized and we restricted to nurses and assistant nurses only. Further, we restricted to participants with at least a 50% time position to exclude those having part-time jobs due to ill health. Participants were included if they had been registered in the database at least one year to ensure that all participants contributed equally to the exposure assessment and were between 18 and 67 years of age. To minimize the risk of recurrent sickness absence, we excluded all participants who had 30 days or more sickness absence in their first year in the cohort (2008). The flowcharts for the Danish and the Finnish data is shown in Fig. 1. Although varying in size, the two cohorts share many similarities shown as percentage of excluded participants except when it comes to the number of participants with less than 50% positions which is more common in the Danish data than in the Finnish data.

2.3. Working hours

Working hours were coded similarly both in Denmark and Finland based on the joint definitions (Garde et al., 2019; Harma et al., 2015).: Exposure to different working hour characteristics were calculated as 12-month average values based on 2008 data. In the Danish data, when comparing 2008 values of working hour characteristics with the mean values of 2008–2012, estimates generally lies within 5 percentage points why there is no indication that 2008 differs in regards to the distribution of shifts compared to other years. Similarly for the Finnish data, as comparison between years showed working time variables within individuals to be relatively stable in the years 2008–2013 (Harma et al., 2015)

Shifts were classified according to *time of day* including dayshifts (defined as shifts starting after 06:00 h and ending before < 21:00), evening shifts (at least 3 h between ≥ 18:00 and < 02:00) and night shifts (at least 3 h between 23:00–06:00 (both included)). The definitions of day, evening and night shifts were not mutually exclusive but prioritized with night work as the highest priority, then evening and lowest day work. Shifts were also

classified according to duration with *long shifts* (defined as shifts lasting (≥ 9 h and < 12 h) and *very* long shifts (≥ 12 h and < 24 h). Further, we also looked *quick returns* (defined as less than 11 h between two shifts), *long weekly working hours* (calendar weeks with > 40 h/week); *very long weekly working hours* (calendar weeks with > 48 h/week) and *consecutive night shifts* (periods of five or more consecutive night shifts).Exposure information was summed by individuals and grouped into categories: *day shift* (0, 1–100, 101–200 and >200 shifts/person/year); *evening shift, night shift, long shift, very long shift, long weeks*, *very long weeks*, and *quick returns* (0, 1–12, 13–50, and >50 per person/year); and *consecutive night shifts (number of periods with five or more)* (0, 1–12 and >12 per person/year).

2.4. Outcome

Long-term sickness absence was defined as ≥ 30 consecutive days of sickness absence, and data was obtained from the Danish Working Hour Database and the Working Hours in the Finnish Public Sector Study database in the years 2009–2015. The analyses were restricted to the first incidence of long-term sickness absence.

2.5. Covariates

The included covariates were based on pay-roll data available in the Danish Working Hour Database and the Working Hours in the Finnish Public Sector Study database: Age (≤ 30 years, >30 and ≤40 years, > 40 and ≤50 years, > 50 years of age), sex (male/female), short-term (<30 consequent days) sickness absence in 2008 (yes/no) (due to the Danish legislation where the municipality and job centers take actions after 30 days) were treated as categorical variables, and mean weekly working hours in 2008 which were treated as a continuous variable.

2.6. Statistical methods

We performed the statistical analyses for Denmark and Finland separately, and used Poisson regression (zero-inflated) models – fulfilling the requirements for this type of model - to calculate the incidence rate ratio (IRR) with 95% confidence intervals (CI) to prospectively assess the risk of long-term sickness absence in relation to working hour characteristics. Annual working hour characteristics were calculated for 2008 and analyses ran to first occurrence of long-term sickness absence in 2009–2015 like previous studies (Garde et al., 2019; Harma et al., 2015).

Three statistical models were tested: Model 1: Working hour characteristics in 2008 and long-term sickness absence in 2009–2015, adjusted for age and sex. Model 2: Model 1 with further adjustment for short-term sickness absence in 2008, and model 3: Model 2 with further adjustment for weekly working hours (not for the analysis of long and very long weekly working hours). The stepwise adjustment did not alter the results significantly, and we therefore only present data from model 3 in the tables. Full tables are presented in the supplementary digital content (A and B). Further, we stratified on age groups (>30, 31–40, 41–49, <50 years of age).

We included secondary analyses where we excluded pregnant women (only applicable for Danish data since this information was not available in the Finnish data). We hypothesized that some long-term sickness absence might be related to pregnancy. If ever a registration of parental leave, the woman was identified as having been pregnant and excluded. And further, in a sensitivity analysis we adjusted for organizational unit (only applicable for the Finnish data) as this might reflect different work tasks and activity levels. However, the risk estimates were similar in direction and magnitude as in the model 3, hence we chose not to present these results (data not shown).

All analyses were conducted in SAS v. 9.4 (Danish data) and Stata 15.1 MP (Finnish data).

2.7. Ethical approval

The databases were approved for research use by the following local data protection agencies: The Danish Data Protection Agency (2015-57-0074) and the ethics committee of the Hospital District of Helsinki and Uusimaa (HUS 1210/2016). The need for individual written consent by participants is deemed unnecessary according to national regulations in Denmark (Databeskyttelsesloven, nr 502 af 23/05/2018) and in Finland when approved by the ethics committee of the Hospital District of Helsinki and Uusimaa (HUS 1210/2016).

3. Results

The descriptive socio-demographic characteristics of the Danish and the Finnish study populations are presented in Table 1. The cohorts consisted primarily of women (88–93%) with a mean age of 42 and 47 years, respectively. With respect to the Danish data, the distribution of age in the smallest group were those under 30 years of age and in the largest group those between 40–50 years of age (19.6 and 31.7%, respectively). Similarly, for the Finnish data, the distribution of age in the smallest group were those under 30 years and in the largest groups those above 50 years of age (6.6 and 43.7%, respectively). Both cohorts had short-term sickness absence of 7–8 days in 2008 (mean: 6.7 days (Denmark), 8.0 days (Finland)). Weekly working hours were on average 29 h in the Danish data and 32 h in the Finnish data. Table 1 further presents the distributions of the working hour characteristics showing similarities in distributions between the two study populations in most of the exposure categories but quick returns were more common in Finland and consecutive night shifts were most common in Denmark.

Table 2 presents the results from the Poisson regression analyses of the Danish Working Hour Database and the Working Hours in the Finnish Public Sector Study database on working hour characteristics and incidence rate ratio (IRR) for long-term sickness absence. In both databases, day shifts were associated with lower risk of long-term sickness absence, only statistically significant in the Danish data though. In the Danish Working Hour Database, working more than 50 evening shifts per year were associated with higher risk of long-term sickness absence. Working less than 50 night shifts per year seems to be associated with lower risk on long-term sickness absence. Working very long shifts, quick returns, long weeks and very long weeks were all associated with lower risk of long-term sickness absence, whereas 12 or more spells a year of consecutive night shifts of five or more shifts were associated with higher risk of long-term sickness absence. In the Working Hours in the Finnish Public Sector Study database more than 50 night shifts per year were associated with a higher risk of long-term sickness absence which also counted for long shifts, quick returns and long weeks.

When stratifying by age groups (Table 3), the Danish data showed a tendency of lower risk of long-term sickness absence in younger age groups (>30, 31–40 years of age) and a higher risk of long-term sickness absence in older age groups (41–50, <50 years of age) for all working hour characteristics except from day work, which still showed that the higher number of day shifts, the lower risk of long-term sickness absence, whereas consecutive night shifts showed increased risk of long-term sickness absence when 30 years of age. In the Finnish data, we saw tendencies, however few results were statistically significant (Table 4).

Table 1
Socio-demographic and work schedules variables.

	Denmark				Finland			
	N	%	Mean	SD	N	%	Mean	SD
Total population	31,729	100			6970	100		
Sex								
Women	28,034	88.4			6485	93.0		
Men	3695	11.6			485	7.0		
Age in 2008			42.3	10.6			46.9	11.2
<= 30 years	6227	19.6			463	6.6		
>30 & <=40 years	8463	26.7			1734	24.8		
> 40 & <=50 years	10,051	31.7			1726	24.7		
> 50 years	6988	22.0			3047	43.7		
Short-term sickness absence (sum of spells with less than 30 consequent days) in 2008			6.7	5.6			8.0	20
Weekly working hours in 2008			29.0	6.1			32.0	6.3
Working hour characteristics								
Day (least 3 *h* ≥ 06:00-and <21:00)								
0 shift/person/year	986	3.1			155	2.2		
1–100	20,752	65.4			1982	28.4		
101–200	7632	24.1			4062	58.3		
>200	2359	7.4			771	11.1		
Evening (least 3 *h* ≥ 18:00 and < 02:00)								
0 shift/person/year	9587	30.2			2205	31.6		
1–12	8363	26.9			2274	32.6		
13–50	8905	28.1			2473	35.5		
>50	4874	15.4			18	0.3		
Night (least 3 *h* ≥ 23:00 and 06:00)								
0 shift/person/year	15,972	50.3			1762	25.2		
1–12	8217	25.9			2728	39.0		
13–50	5258	16.6			2330	33.4		
>50	2282	7.2			150	2.0		
Long shifts (≥ 9 h - < 12 h)								
0 shift/person/year	7233	22.8			683	9.8		
1–12	16,009	50.5			3251	46.6		
13–50	6615	20.8			2883	41.4		
>50	1872	5.9			153	2.2		
Very Long shifts (≥ 12 h - < 24 h)								
0 shift/person/year	18,704	59.0			3071	44.0		
1–12	11,022	34.7			3397	48.7		
13–50	1867	5.9			438	6.3		
>50	136	0.4			64	0.9		
Quick returns (<11 h between shifts)								
0 shift/person/year	12,062	38.0			331	4.7		
1–12	16,150	50.9			1073	15.3		
13–50	3382	10.7			4375	62.8		
>50	135	0.4			1191	17.0		
Long weeks (>40 h/week)								
0 weeks/person/year	8999	28.4			868	12.5		
1–12	19,480	61.4			3788	54.3		
13–50	3250	10.2			2314	33.2		
>50	0	–			0	–		
Very long weeks (>48 h/week)								
0 weeks/person/year	19,024	60.0			3103	44.5		
1–12	12,181	38.4			3688	52.9		
13–50	524	1.7			179	2.6		
>50	0	–			0	–		
Consecutive night shift (≥5)								
0 person/year	29,448	92.8			6585	93.8		
1–12	1784	5.6			340	5.6		
>12	497	1.6			45	0.6		

When excluding pregnant women in the analyses on data from the Danish Working Hour Database, for most exposure categories the results were similar to those presented in Table 2. However, an increased risk of long-term sickness absence was found when working more than 50 evening shifts (IRR: 1.26, 95% CI: 1.12–1.42) and more than 50 night shifts (IRR: 1.20, 95% CI: 1.03–1.40). Working few night shifts was, however, associated with lower risk of long-term sickness absence (IRR: 0.89, 95% CI: 0.81–0.99). Similarly, long weeks were associated with lower risk of long-term sickness absence (IRR: 0.84, 95% CI: 0.72–0.97). Five or more consecutive night shifts was associated with an increased risk of long-term sickness absence when pregnant women were excluded (IRR: 1.91, 95% CI: 1.43–2.57) (table placed in the supplementary digital material C). It should be noted that the mean age of the study population increased from 42.3 to 45.4 years when excluding women who were pregnant in 2009–2015.

4. Discussion

This study comprising two large scale, population-based databases from Denmark and Finland with objective daily working hour data in the nursing sector including over 38 000 employees provided a unique possibility to investigate the role of working

Table 2
Poisson regression analyses with Incidence rate ratios for the association of working hour characteristics and 1st incidence of long-term sickness absence adjusted for age, sex, previous short-term sickness absence and weekly working hours in Danish and Finnish data. *not adjusted for weekly working hours. Bold marking represent statistically significant values at a 0.05 level.

	1st incidence of long-term sickness absence							
	Denmark				Finland			
	Cases	Person Years at risk	Incidence Rate Ratio	95% Confidence limits	Cases	Person Years at risk	Incidence Rate Ratio	95% Confidence limits
Day (least 3 *h* ≥ 06:00 <21:00)								
0 shift/person/year	304	4720	1	Ref	12	308	1	ref
1–100	6021	110,166	**0.65**	**0.50–0.85**	308	9706	0.70	0.39- 1.24
101–200	2114	41,427	**0.52**	**0.40–0.69**	947	24,898	0.92	0.52- 1.64
>200	532	13,286	**0.39**	**0.29–0.53**	127	4224	0.75	0.41- 1.37
Evening (least 3 *h* ≥ 18:00 and < 02:00)								
0 shift/person/year	2684	51,117	1	Ref	457	12,299	1	Ref
1–12	2237	45,455	0.96	0.86–1.06	460	12,474	1.05	0.92- 1.20
13–50	2493	48,058	1.00	0.90–1.09	475	14,264	0.94	0.83- 1.07
>50	1557	24,970	**1.18**	**1.06–1.34**	2	99	0.43	0.11- 1.71
Night (least 3 *h* ≥ 23:00 and 06:00)								
0 shift/person/year	4661	83,744	1	Ref	449	11,844	1	ref
1–12	2219	44,998	**0.87**	**0.79–0.95**	464	13,095	1.03	0.90- 1.17
13–50	1409	29,031	**0.89**	**0.81–0.98**	433	13,250	1.02	0.89- 1.16
>50	682	11,826	1.11	0.97–1.27	48	947	**1.41**	**1.05- 1.90**
Long shifts (≥ 9 h - < 12 h)								
0 shift/person/year	2012	38,132	1	Ref	97	2619	1	ref
1–12	4315	85,691	0.99	0.90–1.09	662	18,530	1.04	0.84– 1–29
13–50	1835	35,654	0.89	0.80–1.00	588	17,065	1.06	0.86- 1.32
>50	509	10,122	0.88	0.75–1.04	47	922	**1.42**	**1.00- 2.01**
Very Long shifts (≥ 12 h - < 24 h)								
0 shift/person/year	5398	98,527	1	Ref	623	16,974	1	ref
1–12	3008	59,971	**0.91**	**0.84–0.98**	695	19,707	1.02	0.92- 1.14
13–50	520	10,419	0.92	0.80–1.06	60	2009	0.93	0.71- 1.22
>50	45	683	1.44	0.90–2.31	16	446	1.33	0.81- 2.19
Quick returns (<11 h between shifts)								
0 shift/person/year	3415	63,258	1	Ref	21	886	1	ref
1–12	4609	87,267	0.96	0.89–1.04	116	3492	1.38	0.87- 2.21
13–50	916	18,334	**0.88**	**0.78–0.99**	924	25,250	**1.62**	**1.04- 2.53**
>50	31	740	0.65	0.37–1.13	333	9504	**1.65**	**1.04- 2.60**
Long weeks*(>40 h/week)								
0 shift/person/year	2532	47,120	1	Ref	103	3497	1	ref
1–12	5575	104,555	0.94	0.86–1.03	855	22,013	**1.40**	**1.13- 1.74**
13–50	864	17,925	**0.76**	**0.67–0.86**	436	13,626	1.24	0.98- 1.58
>50	–	–	na	–	0	–	–	na
Very long weeks* (>48 h/week)								
0 shift/person/year	5419	100,569	1	Ref	543	15,315	1	ref
1–12	3395	66,290	**0.91**	**0.84–0.98**	837	23,439	1.08	0.97- 1.21
13–50	157	2741	1.03	0.79–1.34	14	383	1.12	0.66- 1.92
>50	–	–	na	–	0	na	–	na
Consecutive night shift (≥5)								
0 person/year	8281	157,783	1	Ref	1330	37,753	1	ref
1–12	524	9460	1.11	0.96–1.29	79	2110	1.14	0.90–1.43
>12	166	166	**1.88**	**1.43–2.48**	11	272	1.08	0.59–1.95

hour characteristics as predictors of long-term sickness absence. Main analyses of the Danish data showed that participants working evening shifts and participants with five or more consecutive night shifts had higher risk of long-term sickness absence whereas participants with day shifts, few night shifts per year, very long shifts and quick returns had lower risk of long-term sickness absence. Exclusion of all pregnant women analyses (in the Danish data) showed a higher risk of long-term sickness absence among evening and night workers along with participants working five or more consecutive night shifts. When stratifying on age groups, there was a tendency of lower risk of long-term sickness absence in the youngest age groups and higher risk of long-term sickness absence in the oldest age groups. Hence, the association seen between evening, night work and consecutive night work and long-term sickness absence showed increased risk only in the oldest of the age groups.

The results based on the Finnish data showed a higher risk of long-term sickness absence when working nights, longs shifts, quick returns, long work weeks and very long work weeks. When stratifying on age groups, the results showed, however, a similar

Table 3
Danish Working Hour Database: Poisson regression analyses with Incidence Rate Ratios for the association of working hour characteristics and 1st incidence of long-term sickness absence (long-term sickness absence) in age categories in a model adjusted for sex. Bold marking represent statistically significant values at a 0.05 level.

	1st incidence of long-term sickness absence							
	< =30 years of age (n = 6227)		> 30- <=40 years of age (n = 8463)		> 40 - <=50 years of age (n = 10,051)		>50 years of age (n = 6988)	
	Incidence Rate Ratios	95% Confidence limits	Incidence Rate Ratios	95% Confidence limits	Incidence Rate Ratios	95% Confidence limits	Incidence Rate Ratios	95% Confidence limits
Day (least 3 h ≥ 06:00 <21:00)								
0 shift/person/year	1	Ref	1	Ref	1	ref	1	Ref
1–100	1.19	0.75–1.89	0.86	0.58–1.27	0.84	0.62–1.14	0.82	0.60–1.11
101–200	0.81	0.49–1.32	0.74	0.49–1.11	0.76	0.55–1.03	**0.66**	**0.48–0.90**
>200	0.45	0.17–1.20	**0.50**	**0.31–0.83**	0.47	**0.33–0.66**	**0.43**	**0.30–0.61**
Evening (least 3 h ≥ 18:00 and < 02:00)								
0 shift/person/year	1	Ref	1	Ref	1	Ref	1	Ref
1–12	0.92	0.74–1.15	**0.86**	**0.74–1.00**	1.12	0.98–1.28	0.95	0.80–1.14
13–50	0.85	0.69–1.06	0.94	0.81–1.10	**1.24**	**1.09–1.41**	1.11	0.94–1.32
>50	0.93	0.69–1.25	1.09	0.89–1.32	**1.53**	**1.31–1.78**	1.27	**1.07–1.51**
Night (least 3 h ≥ 23:00 and 06:00)								
0 shift/person/year	1	Ref	1	Ref	1	ref	1	ref
1–12	0.85	0.71–1.02	**0.84**	**0.73–0.96**	0.94	0.83–1.14	0.92	0.79–1.08
13–50	**0.71**	**0.58–0.86**	0.86	0.74–1.01	0.98	0.84–0.96	1.22	0.98–1.51
>50	**0.65**	**0.46–0.92**	0.88	0.70–1.11	1.21	0.99–1.48	**1.41**	**1.11–1.80**
Long shifts (≥ 9 h - < 12 h)								
0 shift/person/year	1	Ref	1	Ref	1	Ref	1	ref
1–12	0.99	0.81–1.20	0.94	0.81–1.08	1.12	0.99–1.27	1.14	0.97–1.34
13–50	0.88	0.70–1.12	0.83	0.69–0.99	1.03	0.89–1.20	1.10	0.91–1.33
>50	0.77	0.53–1.10	0.86	0.66–1.14	0.98	0.78–1.23	1.01	0.77–1.34
Very Long shifts (≥ 12 h - < 24 h)								
0 shift/person/year	1	Ref	1	Ref	1	Ref	1	ref
1–12	0.94	0.81–1.10	**0.87**	**0.77–0.99**	**0.87**	**0.79–0.97**	0.96	0.83–1.10
13–50	0.76	0.56–1.03	**0.77**	**0.61–0.98**	1.06	0.85–1.31	1.10	0.80–1.52
>50	0.65	0.05–7.76	0.91	0.42–1.97	1.25	0.63–2.51	2.52	0.91–6.99
Quick returns (<11 h between shifts)								
0 shift/person/year	1	Ref	1	Ref	1	Ref	1	Ref
1–12	0.91	0.77–1.08	0.94	0.83–1.07	1.07	0.96–1.19	1.12	0.97–1.28
13–50	**0.73**	**0.56–0.96**	0.88	0.71–1.08	1.00	0.84–1.18	0.95	0.77–1.18
>50	1.93	0.40–9.31	0.63	0.25–1.60	0.65	0.31–1.36	0.56	0.24–1.30
Long weeks (>40 h/week)								
0 shift/person/year	1	Ref	1	Ref	1	Ref	1	Ref
1–12	0.95	0.79–1.14	0.94	0.82–1.06	1.07	0.95–1.19	1.09	0.94–1.26
13–50	**0.61**	**0.46–0.82**	**0.71**	**0.56–0.90**	0.96	0.81–1.15	0.98	0.79–1.22
>50	–	na	–	na	–	na	–	na
Very long weeks (>48 h/week)								
0 shift/person/year	1	Ref	1	Ref	1	Ref	1	Ref
1–12	**0.78**	**0.67–0.90**	**0.86**	**0.77–0.97**	1.06	0.95–1.18	**1.17**	**1.03–1.34**
13–50	0.43	0.17–1.04	0.85	0.49–1.47	1.18	0.81–1.71	1.25	0.82–1.89
>50	–	na	–	na	–	na	–	na
Consecutive night shift (≥5)								
0 person/year	1	Ref	1	Ref	1	Ref	1	1
1–12	0.86	0.63–1.18	1.01	0.78–1.30	1.19	0.96–1.49	**1.37**	**1.02–1.85**
>12	0.54	0.17–1.65	1.62	0.88–2.97	1.20	0.81–1.77	**1.58**	**1.10–2.29**

tendency as the results from the Danish data, i.e. higher risk of long-term sickness absence in older age groups. However, due to low power in age stratified analyses of Finnish data, these results should be interpreted with caution.

The analyses of the Danish data showed no association between night work and risk of long-term sickness absence, but when excluding women who were pregnant in 2008–2015 or stratifying on age, results showed an association between night work and long-term sickness absence indicating an effect modification of pregnancy and/or age. This might be due to age since exclusion of ever pregnant women, the remaining cohort is on average older (mean age 42.3 vs. 45.4 years). This corresponds to the results in the Finnish data where participants on average are older than the Danish participants.

Previous studies are not fully conclusive in regard to night work and sickness absence. A Finnish study has shown shift work - but not night work - to be associated with increased risk of long-term sickness absence (Airaksinen et al., 2018). An American payroll data study on policemen showed a higher rate of sick leave among night shift workers compared to day workers (Fekedulegn

Table 4
The Working Hours in the Finnish Public Sector Study: Poisson regression analyses with Incidence Rate Ratios for the association of working hour characteristics and 1st incidence of long-term sickness absence (long-term sickness absence) in age categories in a model adjusting for sex. Bold marking represent statistically significant values at a 0.05 level.

	1st incidence of long-term sickness absence							
	≤30 years of age(n = 463)		> 30- ≤40 years of age (n = 1734)		> 40 - ≤50 years of age (n = 1726)		>50 years of age(n = 3047)	
	Incidence Rate Ratio	95% Confidence limits	Incidence Rate Ratio	95% Confidence limit	Incidence Rate Ratio	95% Confidence limit	Incidece Rate Ratio	95% Confidence limit
Day (least 3 h ≥ 06:00 <21:00)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–100	0.34	0.04, 2.56	0.82	0.36–1.87	0.72	0.26, 1.97	1.45	0.20- 10.37
101–200	0.52	0.07- 4.03	0.89	0.39- 2.00	0.94	0.35- 2.54	2.08	0.29- 14.79
>200	0.30	0.02- 4.82	0.69	0.28- 1.71	0.70	0.24- 2.00	1.55	0.22- 11.16
Evening (least 3 h ≥ 18:00 and < 02:00)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–12	2.33	0.68- 7.98	1.13	0.85- 1.50	**1.35**	**1.03- 1.77**	0.89	0.74- 1.07
13–50	1.93	0.53- 7.07	0.96	0.71- 1.28	1.14	0.86- 1.51	0.88	0.74- 1.04
>50	–	na	–	na			0.63	0.16- 2.54
Night (least 3 h ≥ 23:00 and 06:00)								
0 shift/person/year	1	ref	1	Red	1	ref	1	Ref
1–12	0.40	0.16- 1.05	1.01	0.75- 1.36	1.07	0.81- 1.41	1.05	0.88- 1.25
13–50	0.74	0.29- 1.88	1.00	0.74- 1.34	1.06	0.80- 1.40	0.97	0.80- 1.16
>50	2.58	0.53- 12.42	1.36	0.68- 2.72	1.39	0.68- 2.87	1.40	0.97- 2.06
Long shifts (≥ 9 h - < 12 h)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–12	0.35	0.70- 1.58	1.05	0.70- 1.58	1.06	0.67- 1.67	1.17	0.85- 1.60
13–50	0.57	0.20- 1.61	0.94	0.62- 1.43	1.17	0.74- 1.85	1.18	0.86- 1.62
>50	2.47	0.48- 12.76	0.99	0.41- 2.40	1.29	0.57- 2.92	**1.74**	**1.10- 2.75**
Very Long shifts (≥ 12 h - < 24 h)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–12	1.22	0.58- 2.61	1.03	0.81- 1.30	1.05	0.84- 1.32	1.02	0.88- 1.18
13–50	1.37	0.17- 10.67	1.17	0.73- 1.87	0.86	0.51- 1.45	0.78	0.51- 1.18
>50	–	na	1.41	0.74- 2.68	1.40	0.45- 4.42	0.87	0.28- 2.70
Quick returns (<11 h between shifts)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–12	2.42	0.31- 19.11	1.61	0.72- 3.61	1.13	0.51- 2.49	1.67	0.66- 4.22
13–50	2.34	0.31- 17.69	1.75	0.83- 3.73	1.24	0.61- 2.51	2.34	0.97- 5.65
>50	3.00	0.35- 25.81	1.62	0.75- 3.51	1.20	0.58- 2.49	2.39	0.98- 5.81
Long weeks (>40 h/week)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–12	1.64	0.56- 4.79	**1.68**	**1.11- 2.54**	1.28	0.87- 1.87	**1.52**	**1.12- 2.08**
13–50	1.28	0.37- 4.38	1.25	0.80- 1.94	1.01	0.67- 1.54	**1.41**	**1.02- 1.94**
>50	–	na	–	na	–	na	–	na
Very long weeks (>48 h/week)								
0 shift/person/year	1	ref	1	Ref	1	ref	1	Ref
1–12	2.01	0.90- 4.50	1.24	0.97- 1.58	1.14	0.91- 1.43	1.01	0.87- 1.17
13–50	–	na	**2.59**	**1.05- 6.38**	1.26	0.47- 3.42	0.80	0.33- 1.93
>50	–	na	–	na	–	na	–	na
Consecutive night shift (≥5)								
0 person/year	1	ref	1	Ref	1	ref		
1–12	0.79	0.19–3.31	**1.51**	**1.04–2.18**	1.13	0.73–1.74	1.02	0.68–1.53
>12	4.91	0.67–36.17	1.72	0.55–5.36	0.73	0.18–2.94	1.15	0.47–2.77

et al., 2013). In a Dutch study, night work was not associated with increased risk of sickness absence whereas shift work was associated with lower risk of sickness absence (van Drongelen et al., 2017). The meta-analyses by Merkus et al. found the evidence in regards to night work and long-term sickness absence to be inconclusive but suggest that the association of night work and long-term sickness absence is dependent on the intensity of the night work (Merkus et al., 2012). This is supported in both the Danish and the Finnish data when stratified on age, where associations between night work and long-term sickness absence are only found among those working more than 50 night shifts per year. There are many ways to schedule night work and this may affect how night work is associated with long-term sickness absence.

In the Danish data, we found a higher risk of long-term sickness absence among workers with 50 evening shifts or more per year. When stratifying on age, we saw that this association was only observed among those aged 40+. Effects of evening work have been

observed in other Danish studies of female workers' caring of elderly (Tuchsen et al., 2008). However, in the Finnish data, evening work was not associated with increased risk of long-term sickness absence. The difference between countries could be a result of different distribution of evening workers in Denmark and Finland.

When excluding pregnant women, the lower risk of long-term sickness absence when working very long shifts or long or very long weekly working hours found in the main analyses of the Danish data, only remained statistically significant for long weekly working hours underlining the need for attention to sickness absence related to pregnancy. In the Finnish data, it was not possible to exclude pregnant women due to lack of information.

Working long shifts or long weeks were found to be associated with long-term sickness absence in the Finnish data. This is in line with the finding from an earlier study where the authors conclude in regards to both short-term and long-term sickness absence that "working long shifts on hospital wards is associated with a higher risk of sickness absence for registered nurses and health care assistants" (Dall'Ora et al., 2018). Results from the Danish data did not support this.

Quick returns (less than 11 h between two shifts) were in the Danish data associated with lower risk of long-term sickness absence, and in the Finnish data associated with higher risk. In the Danish data, however, when excluding pregnant women as in the Finnish data, we found a higher risk of long-term sickness absence. The distribution of quick returns is very different in the two countries as seen in Table 1 which to some extent might explain the different results found in the main analyses. Earlier studies have indicated that age might affect the association between quick returns and higher fatigue (both during work and free days) and difficulties to fall asleep (Harma et al., 2018). Further, a study pointed out that changes in quick returns are associated with changes in perceived work-life conflict (Karhula et al., 2018a). Quick returns could reflect higher work demands, but could also be preferred if leading to more consecutive days off.

With respect to the Danish data, five or more consecutive night shifts were associated with increased risk of long-term sickness absence in all age groups and when pregnant women were excluded. The results were not supported by the Finnish data, but as Table 1 indicates, only few of the Finnish workers were in the high exposure group (12 or more periods per year). Five or more consecutive night shifts could reflect the work schedules of permanent night workers. Previous studies have found permanent night workers to report poorer health and more absenteeism (Burch et al., 2009) along with difficulties of falling asleep and fatigue (Karhula et al., 2018b). However, the studies also found higher job satisfaction with colleagues (Karhula et al., 2018b).

In regards to the differences in risk estimates when excluding pregnant women, previous studies have shown pregnancy to be related to higher risk of sick leave (Kaerlev et al., 2004; Melsom, 2014) in particular in relation to night shifts (Hammer et al., 2019). It could be discussed if the exclusion of pregnant women reveals a "truer" effect of night work on long-term sickness absence or if the results simply just reflect another age distribution. In the study we excluded pregnant women, who are typically younger, and we were therefore left with an older study population. When stratifying the analyses on age, we found in both the Danish and the Finnish data that the higher age, the higher risk of long-term sickness absence in several of the working hour characteristics. Older age is a known risk factor for sickness absence (Boschman et al., 2017; Ervasti et al., 2017) but studies of night and shift work and cardiovascular disease and cancer have also linked years of exposure to higher risk of morbidity and mortality (Hansen, 2017; Torquati et al., 2018; Vetter et al., 2016; Jorgensen et al., 2017). As we have no information on years of shift work, we cannot rule out the possibility that higher risk in the older age groups also could reflect more years of exposure.

The differences seen in the Danish and the Finnish results could, however, also be due to differences in legislation and rules in regards to sickness absence benefit (Nordic Social Statistical Committee 2017). The report by the Nordic Social Statistical Committee underlines several differences in rules governing payment of cash assistance to employees in the event of sickness. One example is the length of the employer period which in Denmark are 30 days and in Finland 10 working days (Nordic Social Statistical Committee 2017). In the current study, we have defined long-term sickness absence as 30 consecutive days or more which might collide with the Danish reimbursement period of 30 days which local authorities are involved in after this date. There is therefore the risk that to avoid the involvement of authorities, a person returns to work before being fully recovered. Further, in Denmark, employers are allowed to discharge an employee after 120 days of absence due to illness in one year (Nordic Social Statistical Committee 2015) which also could affect the number of persons with long-term sickness absence.

4.1. Strengths and limitations

The analyses for this study are based on large, representative and registerbased payroll data of high quality, which is a major strength compared to earlier studies based on self-reported or cross-sectional data (Dall'Ora et al., 2018; Tuchsen et al., 2008) . Furthermore, we utilized prospective study design with eight years of follow-up and very precise information on both long-term sickness absence and working hours from registries without recall bias, attrition or selection based on exposure (Harma et al., 2015). As we had access to two national samples, Danish Working Hour Database and the Working Hours in the Finnish Public Sector Study database, we utilized strict protocol for harmonization of samples to unify our definitions and handling of data to make comparable analyses. The distribution of nursing personnel across the week is rather similar in the two countries (Garde et al., 2019) which justifies that we can use the same definitions of working hour characteristics across the data from the two countries. Furthermore, an evident strength is the possibility to analyze irregular shift systems. Hence, this study adds to the existing knowledge based on other types of epidemiological studies which have mainly utilized self-reported working hours or shift types in shift work (Catano and Bissonnette, 2014; Akerstedt and Kecklund, 2017).

We estimated the working hour characteristics based on one year (2008), as this was manageable for both cohorts and provided us follow-up time to identify enough cases for analysis of first incidence of long-term sickness absence. Due to the varying nature of irregular working hours in the public health care sector and no major legislative changes within the 2008–2015, i.e. time of this study, we do expect that any annual effects on the results would be minimal. However, further studies would be warranted to test the findings over several years of working hour data and even with a longer follow-up time. This study has been limited to nine main working hour characteristics for the study, i.e. day, evening, and night shifts, long or very long shifts, long or very long weeks, quick returns, and consecutive night shifts. Assessment of shift combinations or whether long shifts took place during the day, evening or night has been excluded although relevant in future together with specifying sickness absence according to diagnosis. Lastly, the utilization of payroll data only limited us from adjustment for marital status, children or other life situation as our data do not include this. Future studies should account for this. Further, our data was based on mainly female workers which might limit the generalization.

Finally, as stated in the method section analyses showed working hours characteristics to be relative stable over the years in both the Danish and the Finnish data. However, it does not exclude that on an individual level people may shift especially from night work to day work during the years due to ageing and that this could cause bias due to misclassification of exposure.

5. Conclusions

Our results based on register-based, and detailed working hour data of characteristics of shift work add to the rare studies of associations with long-term sickness absence. The results show that the scheduling of working hours is associated with the risk of long-term sickness absence. In the Danish data we found a higher risk when working evening shifts and five or more consecutive night shifts. In addition, night shifts and weekly working hours of more than 48 h were associated with risk of long-term sickness absence among non-pregnant women and in the age group above 50 years. In the Finnish data, we found a higher risk of long-term sickness absence among those working nights, long shifts, quick returns or long weeks. Both cohorts showed the highest risk of long-term sickness absence among those of highest age. The differences in result between the two cohorts may be due to contextual differences, e.g. in the legislations and rules related to sickness absence benefits. Comparison of risk of long-term sickness absence in relation to working hours between countries should thus be performed with caution.

Declaration of Competing Interest

None

Acknowledgement

None

Funding sources

The project is part of the WOW project funded by NordForsk, Nordic Program on Health and Welfare [grant number 74809]. MH, AK and AR are also supported by EU grant no 826266 (CO-ADAPT), and ADL and AHG are also supported by the Danish Working Environment Research Fund [grant number 23-2012-09/20120220951]. Funding organizations have no involvement in study design, the collection of data, analysis and interpretation of data, the writing of the report, or in the decision to submit the article for publication.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijnurstu.2020.103639.

References

Airaksinen, J., Jokela, M., Virtanen, M., Oksanen, T., Koskenvuo, M., Pentti, J., et al., 2018. Prediction of long-term absence due to sickness in employees: development and validation of a multifactorial risk score in two cohort studies. Scand. J. Work Environ. Health 44 (3), 274–282.

Akerstedt, T., Kecklund, G., 2017. What work schedule characteristics constitute a problem to the individual? A representative study of Swedish shift workers. Appl. Ergon. 59 (Pt A), 320–325.

Bernstrom, V.H., 2018. Long working hours and sickness absence-a fixed effects design. BMC Public Health 18 (1), 578.

Boschman, J.S., Noor, A., Sluiter, J.K., Hagberg, M., 2017. The mediating role of recovery opportunities on future sickness absence from a gender- and age-sensitive perspective. PLoS ONE 12 (7), e0179657.

Bryngelson, A., 2009. Long-term sickness absence and social exclusion. Scand. J. Public Health 37 (8), 839–845.

Burch, J.B., Tom, J., Zhai, Y., Criswell, L., Leo, E., Ogoussan, K., 2009. Shiftwork impacts and adaptation among health care workers. Occup. Med. (Lond.) 59 (3), 159–166.

Catano, V.M., Bissonnette, A.B., 2014. Examining paid sickness absence by shift workers. Occup. Med. (Lond.) 64 (4), 287–293.

Dall'Ora, C., Ball, J., Redfern, O., Recio-Saucedo, A., Maruotti, A., Meredith, P., et al., 2019. Are long nursing shifts on hospital wards associated with sickness absence? A longitudinal retrospective observational study. J. Nurs. Manag. 27 (1), 19–26. doi:10.1111/jonm.12643.

Ervasti, J., Joensuu, M., Pentti, J., Oksanen, T., Ahola, K., Vahtera, J., et al., 2017. Prognostic factors for return to work after depression-related work disability: a systematic review and meta-analysis. J. Psychiatr. Res. 95, 28–36.

Eurofound. Sixth European Working Conditions Survey 2015. https://wwweurofoundeuropaeu/surveys/data-visualisation/sixth-european-working-conditions-survey-2015 [Internet]. 2015.

Fekedulegn, D., Burchfiel, C.M., Hartley, T.A., Andrew, M.E., Charles, L.E., Tinney-Zara, C.A., et al., 2013. Shiftwork and sickness absence among police officers: the BCOPS study. Chronobiol. Int. 30 (7), 930–941.

Gan, Y., Yang, C., Tong, X., Sun, H., Cong, Y., Yin, X., et al., 2015. Shift work and diabetes mellitus: a meta-analysis of observational studies. Occup. Environ. Med. 72 (1), 72–78.

Garde, A.H., Hansen, J., Kolstad, H.A., Larsen, A.D., Pedersen, J., Petersen, J.D., et al., 2018. Payroll data based description of working hours in the Danish regions. Chronobiol. Int. 35 (6), 795–800.

Garde, A.H., Harris, A., Vedaa, O., Bjorvatn, B., Hansen, J., Hansen, A.M., et al., 2019. Working hour characteristics and schedules among nurses in three Nordic countries - a comparative study using payroll data. BMC Nurs. 18, 12.

Hammer, P.E.C., Garde, A.H., Begtrup, L.M., Flachs, E.M., Hansen, J., Hansen, A.M., et al., 2019. Night work and sick leave during pregnancy: a national register-based within-worker cohort study. Occup. Environ. Med. 76 (3), 163–168.

Hansen, J., 2017. Night shift work and risk of breast cancer. Curr. Environ. Health Rep. 10–0155.

Harma, M., Ropponen, A., Hakola, T., Koskinen, A., Vanttola, P., Puttonen, S., et al., 2015. Developing register-based measures for assessment of working time patterns for epidemiologic studies. Scand. J. Work Environ. Health 41 (3), 268–279.

Harma, M., Karhula, K., Ropponen, A., Puttonen, S., Koskinen, A., Ojajarvi, A., et al., 2018. Association of changes in work shifts and shift intensity with change in fatigue and disturbed sleep: a within-subject study. Scand. J. Work Environ. Health 44 (4), 394–402.

Jorgensen, J.T., Karlsen, S., Stayner, L., Andersen, J., Andersen, Z.J., 2017. Shift work and overall and cause-specific mortality in the Danish nurse cohort. Scand. J. Work Environ. Health 43 (2), 117–126.

Kaerlev, L., Jacobsen, L.B., Olsen, J., Bonde, J.P., 2004. Long-term sick leave and its risk factors during pregnancy among Danish hospital employees. Scand. J. Public Health 32 (2), 111–117.

Karhula, K., Koskinen, A., Ojajarvi, A., Ropponen, A., Puttonen, S., Kivimaki, M., et al., 2018. Are changes in objective working hour characteristics associated with changes in work-life conflict among hospital employees working shifts? A 7-year follow-up. Occup. Environ. Med. 75 (6), 407–411.

Karhula, K., Hakola, T., Koskinen, A., Ojajarvi, A., Kivimaki, M., Harma, M., 2018. Permanent night workers sleep and psychosocial factors in hospital work. A comparison to day and shift work. Chronobiol. Int. 35 (6), 785–794.

Karkkainen, S., Ropponen, A., Narusyte, J., Mather, L., Akerstedt, T., Silventoinen, K., et al., 2017. Night work as a risk factor of future disability pension due to musculoskeletal diagnoses: a prospective cohort study of Swedish twins. Eur. J. Public Health 27 (4), 659–664.

Kivimaki, M., Forma, P., Wikstrom, J., Halmeenmaki, T., Pentti, J., Elovainio, M., et al., 2004. Sickness absence as a risk marker of future disability pension: the 10-town study. J Epidemiol. Community Health 58 (8), 710–711.

Laaksonen, M., Pitkaniemi, J., Rahkonen, O., Lahelma, E., 2010. Work arrangements, physical working conditions, and psychosocial working conditions as risk factors for sickness absence: bayesian analysis of prospective data. Ann. Epidemiol. 20 (5), 332–338.

Larsen, A.D., Hannerz, H., Moller, S.V., Dyreborg, J., Bonde, J.P., Hansen, J., et al., 2017. Night work, long work weeks, and risk of accidental injuries. A register-based study. Scand. J. Work Environ. Health..

Melsom, A.M., 2014. Long-term sickness absence during pregnancy and the gender balance of workplaces. Scand. J. Public Health 42 (7), 627–634.

Merkus, S.L., van, D.A., Holte, K.A., Labriola, M., Lund, T., van, M.W., et al., 2012. The association between shift work and sick leave: a systematic review. Occup. Environ. Med. 69 (10), 701–712.

Nielsen, H.B., Larsen, A.D., Dyreborg, J., Hansen, A.M., Pompeii, L.A., Conway, S.H., et al., 2018. Risk of injury after evening and night work - findings from the Danish Working Hour Database. Scand. J. Work Environ. Health 44 (4), 385–393.

Nordic Social Statistical Committee. Sickness absence in the Nordic Countries. 2015.

Nordic Social Statistical Committee. Social Protection in the Nordic Countries - scope, expenditure and financing. 2017.

OECD.stat. OECD.stat Health status. Absence from work due to illness 2019 [cited 2019. Available from: https://stats.oecd.org/index.aspx?queryid=30123.

Puttonen, S., Harma, M., Hublin, C., 2010. Shift work and cardiovascular disease - pathways from circadian stress to morbidity. Scand. J. Work Environ. Health 36 (2), 96–108.

Ropponen, A., Narusyte, J., Mather, L., Mittendorfer-Rutz, E., Akerstedt, T., Svedberg, P., 2018. Night work as a risk factor for future cause-specific disability pension: a prospective twin cohort study in Sweden. Chronobiol. Int. 35 (2), 249–260.

Ropponen, A., Koskinen, A., Puttonen, S., Harma, M., 2019. Exposure to working-hour characteristics and short sickness absence in hospital workers: a case-crossover study using objective data. Int. J. Nurs. Stud. 91, 14–21.

Salonen, L., Blomgren, J., Laaksonen, M., Niemela, M., 2018. Sickness absence as a predictor of disability retirement in different occupational classes: a register-based study of a working-age cohort in Finland in 2007-2014. BMJ Open 8 (5), e020491.

Sieurin, L., Josephson, M., Vingard, E., 2009. Positive and negative consequences of sick leave for the individual, with special focus on part-time sick leave. Scand. J. Public Health 37 (1), 50–56.

Stromberg, C., Aboagye, E., Hagberg, J., Bergstrom, G., Lohela-Karlsson, M., 2017. Estimating the effect and economic impact of absenteeism, presenteeism, and work environment-related problems on reductions in productivity from a managerial perspective. Value Health:J. Int. Soc. Pharmacoecon. Outcomes Res. 20 (8), 1058–1064.

Torquati, L., Mielke, G.I., Brown, W.J., Kolbe-Alexander, T., 2018. Shift work and the risk of cardiovascular disease. A systematic review and meta-analysis including dose-response relationship. Scand. J. Work Environ. Health 44 (3), 229–238.

Tuchsen, F., Christensen, K.B., Nabe-Nielsen, K., Lund, T., 2008. Does evening work predict sickness absence among female carers of the elderly? Scand. J. Work Environ. Health 34 (6), 483–486.

van Drongelen, A., Boot, C.R., Hlobil, H., van der Beek, A.J., Smid, T., 2017. Cumulative exposure to shift work and sickness absence: associations in a five-year historic cohort. BMC Public Health 17 (1), 67.

Vedaa, O., Pallesen, S., Erevik, E.K., Svensen, E., Waage, S., Bjorvatn, B., et al., 2019. Long working hours are inversely related to sick leave in the following 3 months: a 4-year registry study. Int. Arch. Occup. Environ. Health 92 (4), 457–466.

Vetter, C., Devore, E.E., Wegrzyn, L.R., Massa, J., Speizer, F.E., Kawachi, I., et al., 2016. Association between rotating night shift work and risk of coronary heart disease among women. JAMA 315 (16), 1726–1734.

Vingard, E., Alexanderson, K., Norlund, A., 2004. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 9. Consequences of being on sick leave. Scand. J. Public health Suppl. 63, 207–215.

Virtanen, M., Kivimaki, M., 2018. Long working hours and risk of cardiovascular disease. Curr. Cardiol. Rep. 20 (11), 123.

Virtanen, M., Ferrie, J.E., Gimeno, D., Vahtera, J., Elovainio, M., Singh-Manoux, A., et al., 2009. Long working hours and sleep disturbances: the Whitehall II prospective cohort study. Sleep 32 (6), 737–745.

Virtanen, M., Jokela, M., Madsen, I.E., Magnusson Hanson, L.L., Lallukka, T., Nyberg, S.T., et al., 2018. Long working hours and depressive symptoms: systematic review and meta-analysis of published studies and unpublished individual participant data. Scand. J. Work Environ. Health 44 (3), 239–250.