

Shift work and sickness absence at a Norwegian hospital

Citation for published version (APA):

Bernstrom, V. H., & Houkes, I. (2020). Shift work and sickness absence at a Norwegian hospital: a longitudinal multilevel study. *Occupational and Environmental Medicine*, 77(8), 555-563. <https://doi.org/10.1136/oemed-2019-106240>

Document status and date:

Published: 01/08/2020

DOI:

[10.1136/oemed-2019-106240](https://doi.org/10.1136/oemed-2019-106240)

Document Version:

Publisher's PDF, also known as Version of record

Document license:

Taverne

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy

If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

ORIGINAL RESEARCH

Shift work and sickness absence at a Norwegian hospital: a longitudinal multilevel study

Vilde Hoff Bernstrøm ,¹ Inge Houkes ²¹Work Research Institute, Oslo Metropolitan University, Oslo, Norway²Department of Social Medicine, Care and Public Health Research Institute (CAPHRI), Maastricht University, Maastricht, The Netherlands**Correspondence to**

Dr Vilde Hoff Bernstrøm, Work Research Institute, Oslo Metropolitan University, Oslo, Norway; vilde.bernstrom@oslomet.no

Received 2 October 2019

Revised 17 March 2020

Accepted 19 March 2020

Published Online First

23 April 2020

ABSTRACT**Objective** Shift work is known to be related to several negative health consequences and sickness absence. Research results regarding the relationship between types of shift schedules and sickness absence and whether and how individual factors moderate this relationship, are mixed though. The present paper aims to provide more insight in these relationships.**Methods** We used registry data from a large Norwegian hospital gathered for the years 2012–2016, for >14 000 employees. With random effects at the individual and unit levels, we analysed the relationship between shift schedule worked and sickness absence in the same year.**Results** The results showed increased risk of short-term sickness absence for two-shift and three-shift rotations, as well as fixed night shifts compared with fixed-day shifts. We also found an increased number of absence periods for two-shift rotations without nights and three-shift rotations. Results for long-term sickness absence were mixed, with increased odds for two-shift rotations without nights, but reduced odds for three-shift rotations. We found partial support for a moderating influence of age, gender and parental status.**Conclusions** There is a clear relationship between working shifts and increased risk of short-term sickness absence. The relationship persists across gender, age group and parental status. The relationship between shift work and long-term sickness absence appears to be schedule and population specific. These findings may have implications for HR policies and the organisation of shift work in healthcare organisations.**INTRODUCTION**

Numerous studies have linked shift work to negative consequences, such as reduced sleep,^{1 2} cancer,^{3–5} diabetes,⁶ hypertension⁷ and cardiovascular disease.⁸ Consequently, shift work has also been linked to increased risk of sickness absence.⁹ Yet for industries such as the healthcare sector where 24/7 staffing is required, shift work is unavoidable. Sickness absence is a particularly relevant consequence of shift work as an objectively recorded indicator of health,¹⁰ but also because of the impact on staffing. To organise shift work in an optimal way, it is necessary to know more about the adverse consequences of different shift schedules and potential individual moderators.

Shift work is defined as a working-time-arrangement where ‘workers succeed one another at the workplace so that operation hours exceed the hours of work of individual workers’.¹¹ This

Key messages**What is already known about this subject?**

- ▶ Shift work has been linked to increased sickness absence.
- ▶ Previous research suggested the relationship is potentially schedule and population specific.

What are the new findings?

- ▶ For both men and women, shift work is related to increased short-term sickness absence.
- ▶ In particular, two-shift and three-shift rotations, and fixed night shifts are related to increased absence.
- ▶ The relationship between shift rotations and increased sickness absence is generally stronger for older employees.
- ▶ Older employees experience more adverse absence consequences of shift work.

How might this impact on policy or clinical practice in the foreseeable future?

- ▶ The results indicate that shift-related absence could be reduced by HR policies tailoring shift work to employee life phases and needs.

encompasses a spectre of shift schedules, such as fixed evenings, fixed nights, early mornings as well as employees who rotate between two or three time slots. In a systematic review of the relationship between shift work and sick leave, Merkus *et al*⁹ found strong support for a relationship between fixed evening shifts and long-term sick leave for female healthcare workers, but inconclusive findings regarding rotating shifts and night shifts. The authors concluded that there might be a schedule-specific and population-specific association between shift work and sickness absence.

There has, since the review, been increasing support for a negative relationship between different shift types and sickness absence, in particular for fixed night shifts,^{12 13} proportion of shifts worked at night,¹⁴ rotating two shifts (day and evening) and rotating three shifts (morning, evening and night)^{15 16} as well as shift work in general.^{17 18} However, some studies found no significant relationship between shift work and sickness absence,^{19 20} or found a relationship in the opposite direction.²¹ Few studies include more than one or two shift schedules.

To our knowledge, no studies have directly tested the moderating effect of individual demographic differences on the relationship between shift work



© Author(s) (or their employer(s)) 2020. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Bernstrøm VH, Houkes I. *Occup Environ Med* 2020;**77**:555–563.

and sickness absence. Knowledge about which factors moderate this relationship could help guide directed interventions, and tailor shift work to fit employees' life phases. Prior research has supported a moderating effect of age,^{22,23} gender²⁴ and parental status²⁵ for the relationship between shift work and other health consequences.

The aim of the present paper is therefore (1) to describe what shift-work arrangements exist at a large Norwegian hospital, (2) to investigate how these shift schedules relate to employees' sickness absence and (3) to investigate how individual differences in age, gender and parental status moderate the relationship between shift work and sickness absence.

METHOD

Design

This was a longitudinal cohort study. All data were collected from the hospital's personnel records for the years 2012–2016.

Population

We used data from a large Norwegian hospital employing more than 20 000 employees, across multiple location. The hospital was established in 2009 following the merger of all three state-owned university hospitals in the capital city.

The sample consisted of 51 086 unique employee numbers. The sample was restricted to employees who worked full-time ($\geq 80\%$), who logged hours and who had worked at the hospital for at least 12 months the year in question. Furthermore, because changes in shift schedules are often due to health reasons, we restricted the sample to employees who did not change shifts during the study period. This left 14 132 unique employee numbers.

Measures

We used three datasets from the hospitals HR registries: a registry of all employee absence, a registry of all shifts worked and a registry of employment contracts. The two first registries are continuously recorded by managers at the work unit. The third registry is recorded when employees are hired or their contract changed.

Sickness absence

The first registry contains information on all absences, with start and end dates. We aggregated the data to comprise whether each employee began a short period of sickness absence (1–8 days) or a long period of sickness absence (>9 days), and the number of absence periods (irrespective of length) each year. Overlapping and consecutive periods were merged. We distinguished between short and long spells of absence because shorter spells are, to a greater extent than longer spells, also influenced by factors other than health.^{10,26} Shorter absences were operationalised as 1–8 days, because a medical certificate is necessary only for sick leaves lasting 9 days or more.

Shift work

In the second registry, each shift worked by each employee is recorded with the start and end time, and the organisational unit. The records are used to calculate salaries, and therefore, are expected to be relatively accurate.

We aggregated the data distinguishing four types of shifts: day, evening, night and early morning. A shift was coded as a day shift if it started at 07:00 hours or later, and ended no later than 18:00 hours the same day. A shift that started between 05:00 and 07:00 hours in the morning was coded as an early morning

shift, and a shift that ended between 18:00 and 24:00 hours was coded as an evening shift. If some part of the shift occurred between 24:00 and 05:00 hours in the morning, it was coded as a night shift.

We coded the employees' shift combination based on when 90% of their shifts occurred. If 90% of all shifts worked during a year were day shifts, then the employee was coded as fixed day. An employee was coded as working a two-shift rotation with days and evenings, if 90% of the employee's shifts were days or evenings, and $>10\%$ of the shifts were days and $>10\%$ shifts were evenings. Similarly, an employee was coded as working a three-shift rotation if 90% of the employee's shifts were days, evenings or nights, and $>10\%$ of the shifts were days, $>10\%$ of the shifts were evenings and $>10\%$ of the shifts were nights.

The focus of this paper was on active shifts (ie, shifts when employees are at work, not on-call shifts). However, 8% of the included shifts were combination shifts, shifts that were partially active and partially on-call. Because the shifts were partially active, we treated them as active shifts.

Demographic variables

The third registry contains employment contract and demographic information, including salary, age, gender, country of origin, position and nature of contract (ie, temporary or permanent). Some employees had more than one employment contract. Contract information was summarised when possible (eg, total salary), and it was based on the contract with the highest percentage of a full-time equivalent for variables where summarising across positions was not possible. A dummy variable indicates if the employee holds more than one contract.

To detect whether an individual had a child at home, we used a proxy based on the absence registry. The employee was coded as having children if they had an absence due to parental leave or care benefit days (ie, paid absent from work if their child, or the person who usually looks after their child, is ill). In Norway, employed parents are entitled to 10 days of care benefit each up to and including the calendar year the youngest child in the household turns 12 (or your child turns 18 when you have a chronically ill or disabled child).²⁷ Because we had data over a long time span, this would likely include most parents with young children. We did likely not include parents with children old enough to stay home alone when they were ill or when a third party took care of the sick child.

Analyses

We analysed the employees' shift schedules each year compared with their sickness absences the same year. We used a random effects regression model with a random intercept at the individual and work-unit levels. Fixed day was used as the reference group. We conducted both unadjusted analyses, and adjusted analyses controlling for gender, having children, age, work hours a week, salary, temporary contract, multiple contracts, nationality and position. We expect each of these control variables to potentially impact which shifts employees work and their level of absence. For example, older employees are more likely to be exempt from working nights and have larger health issues and more long-term absence.

We used linear probability models (LPM) to analyse the dichotomous outcome variables (short-term and long-term absence), which implies using linear regression with binary outcomes.²⁸ In LPM, the coefficients are comparable to average marginal effects for logistic regression.²⁸ In this manner, we are able to compare absolute changes in probability, rather than relative.²⁹ Finally,

we also used Poisson regression to analyse number of sickness absence periods (irrespective of length).

RESULTS

Shift-work arrangements at a large Norwegian hospital

Table 1 shows work and demographic characteristics of the study population. The most common shift schedules were fixed days, two-shift rotations without nights and three-shift rotation with nights. Notably, two-shift rotations that involved night work were generally longer shifts, so that two-shifts could cover 24 hours, or the rotations included day shifts and long combinations shifts where part of the shift was on-call.

Physicians most often worked two-shift rotations with nights, nurses most often worked three-shift rotations with nights and administrative personnel most often worked fixed days. The oldest employees were over-represented on fixed night shifts, but under-represented on shift rotations with nights. Men were over-represented on two-shift rotations with nights.

Shift-work arrangements and employees' sickness absence

The results for the relationship between each type of shift work and absence are presented in table 2. Compared with day workers, we found more short-term sickness absences among employees who worked two-shift schedules with days and evenings, two-shift schedules with evenings and nights, three-shift schedules with days, evenings and nights and employees who worked fixed nights. The effect sizes in the linear probability models can be read as marginal effects. For example, there is a 70% probability of short-term absence for employees working fixed day, and 82% (+0.12) for employees working two-shift rotations of day and evening. No statistically significant difference was found for employees working two-shift schedules with days and nights, or early morning shifts. Fewer employees worked these shift schedules, making it harder to find statistically significant differences.

Employees working two-shift schedules with days and evenings and three-shift schedules also had a significant higher number of sickness absence periods. For long-term absences, the results were more mixed. Employees working two-shift schedules with days and evenings had statistically significant more long-term absences than day workers. Employees working three-shift schedules with days, evenings and nights had statistically significantly fewer absences. No other statistically significant relationships between shift work and long-term absence were identified.

Moderating individual differences

For the moderating individual differences, we focused on two-shift workers without night (day and evenings) and three-shift workers (day, evening and nights) compared with day workers, the three most common shift schedules at the hospital. For each combination of shift work and absence a separate interaction-analysis was performed. The control variables remained the same as in table 2. The results of the analyses for moderating individual differences are presented in table 3. Moreover, the predicted probability of absence (based on the results presented in table 3) are presented in tables 4 and 5.

We found a moderating effect of age. The negative relationship between two-shift rotation and short-term sickness absence increases with age. The negative relationship between two-shift and three-shift rotations and number of absence periods also increases with age. Moreover, three-shift rotation were related to increased long-term sickness absence among the older age groups. An employee aged 30 years working a three-shift rotation had 2 percentage points higher probability of long-term

absence compared with fixed days. In comparison, an employee aged 60 years working a three-shift rotation had a 8 percentage points higher probability of long-term absence compared with fixed day.

We found no moderating effect of gender on shift work and short-term absences or number of periods of absence. For long-term absences, the relationship for two-shift rotations was stronger for women, but there was no significant difference for three-shift rotations. While women working two-shift rotations had a 7 percentage points higher probability of long-term absence compared with fixed-day workers, men working two-shift rotations without nights had approximately the same probability of long-term absence as men working fixed-day shifts.

We found a statistically significantly weaker relationship for parents between two-shift work and short-term absences, as well as number of periods of absence. However, we also found a significant stronger relationship between three-shift work and long-term absence.

As the variable for parental status was a proxy constructed based on the absence registry (i.e. absence due to parental leave or a sick child), it warrants further inspection. Thirty-one per cent of the men and 35% of the women were registered as having children. The majority (84%) were in their 30s or 40s. In total, 61% of the employees in their 30s were registered as having children. Men were over-represented among the older parents (12% of men and 5% of women >49 years were registered as having children). These figures support our assumption that the proxy variable captures most parents with young children.

DISCUSSION

The results show a complex structure of different shift schedules co-existing within the hospital. Fixed days and several types of rotating shifts were most common. Generally, employees who worked shifts had more short-term absences and more absence periods than employees who worked fixed-day schedules. It can be concluded that all type of work other than fixed day are associated with an increased risk of short-term absence (although the association was not significant for early morning and day/night shifts). The results are in agreement with our expectations, and previous literature supporting a relationship between shift work and increased short-term sickness absence.^{9 12 13 15 16} The increased absence can be explained by several negative consequences of shift work, such as reduced sleep, disrupted cardiac rhythm and increased work-family conflict impairing employees' health and ability to attend work.³⁰⁻³⁶

Some substantial differences between the unadjusted and adjusted effect sizes reflect that there are also important demographic and work differences between employees working different shift types, and that these differences impact employee absence levels.

For employees working two-shift schedules with days and nights, or early mornings, the difference in absences from day workers was not statistically significant. However, we cannot conclude that these shift schedules are not related to short-term absences. Instead, the lack of statistically significant differences might also suggest that the sample was too small to identify a statistically significant relationship (as these shift types were less common in the hospital).

The results were more mixed for long-term absences. While employees working rotating two-shift schedules of days and evenings had more long-term sickness absences, employees working rotating three-shift solutions had fewer long-term sickness absences. It is unlikely that working three-shift rotations

Table 1 Characteristics of the study population*

	Total subjects N (%)	Subjects with short-term absence N (%)†	Subjects with long-term absence N (%)‡	Fixed day evening	Rotating day and evening night	Rotating day, evening and night	Fixed night	Rotating night	Rotating day and night	Rotating evening and night	Rotating morning and day	Other shift schedules
Total	14 132	11 961	6720	7941	2301	2626	185	841	74	43	121	
Gender												
Male	3731 (26)	2797 (23)	1407 (21)	2047 (26)	546 (24)	526 (20)	92 (50)	405 (48)	43 (58)	19 (44)	53 (44)	
Female	10 401 (74)	9164 (77)	5313 (79)	5894 (74)	1755 (76)	2100 (80)	93 (50)	436 (52)	31 (42)	24 (56)	68 (56)	
Age (years)												
Mean±SD	43 (12)	42 (12)	44 (12)	45 (11)	43 (12)	35 (10)	50 (9)	42 (10)	36 (11)	42 (10)	41 (10)	
<30	2117 (15)	1884 (16)	770 (11)	647 (8)	341 (15)	1034 (39)	3 (2)	46 (5)	30 (41)	5 (12)	11 (9)	
30–39	3964 (28)	3365 (28)	1806 (27)	2050 (26)	617 (27)	810 (31)	21 (11)	387 (46)	19 (26)	13 (30)	47 (39)	
40–49	3272 (23)	2747 (23)	1543 (23)	2070 (26)	483 (21)	405 (15)	50 (27)	203 (24)	14 (19)	13 (30)	34 (28)	
50–59	3197 (23)	2705 (23)	1791 (27)	2049 (26)	594 (26)	297 (11)	71 (38)	146 (17)	8 (11)	11 (26)	21 (17)	
>59	1582 (11)	1260 (11)	810 (12)	1125 (14)	266 (12)	80 (3)	40 (22)	59 (7)	3 (4)	1 (2)	8 (7)	
Have (young) children												
No	9272 (66)	7589 (63)	4136 (62)	5147 (65)	1533 (67)	1836 (70)	128 (69)	469 (56)	56 (76)	32 (74)	71 (59)	
Yes	4860 (34)	4372 (37)	2584 (38)	2794 (35)	768 (33)	790 (30)	57 (31)	372 (44)	18 (24)	11 (26)	50 (41)	
Sickness absence (mean±SD)												
Yearly probability of short-term absence	0.74 (0.4)	0.87 (0.2)	0.84 (0.3)	0.68 (0.4)	0.85 (0.3)	0.87 (0.3)	0.84 (0.3)	0.57 (0.4)	0.86 (0.3)	0.84 (0.3)	0.74 (0.4)	
Yearly probability of long-term absence	0.30 (0.4)	0.33 (0.4)	0.62 (0.3)	0.29 (0.4)	0.37 (0.4)	0.28 (0.4)	0.32 (0.4)	0.15 (0.3)	0.32 (0.4)	0.35 (0.4)	0.27 (0.4)	
Average number of absence periods per year	3.12 (3.1)	3.65 (3.1)	4.48 (3.3)	2.85 (3.1)	4.02 (3.3)	3.61 (2.9)	3.15 (2.2)	1.61 (2.1)	4 (3.3)	3.54 (3.1)	2.83 (2.7)	
Temporary contract												
No	10523 (74)	9188 (77)	5556 (83)	6268 (79)	1891 (82)	1657 (63)	175 (95)	359 (43)	59 (80)	37 (86)	77 (64)	
Yes	3609 (26)	2773 (23)	1164 (17)	1673 (21)	410 (18)	969 (37)	10 (5)	482 (57)	15 (20)	6 (14)	44 (36)	
Multiple contracts												
No	13 604 (96)	11 530 (96)	6490 (97)	7693 (97)	2208 (96)	2489 (95)	174 (94)	811 (96)	69 (93)	42 (98)	118 (98)	
Yes	528 (4)	431 (4)	230 (3)	248 (3)	93 (4)	137 (5)	11 (6)	30 (4)	5 (7)	1 (2)	3 (2)	
Nationality												
Norwegian	13 111 (93)	11 140 (93)	6311 (94)	7363 (93)	2154 (94)	2448 (93)	160 (86)	767 (91)	69 (93)	42 (98)	108 (89)	
Other Nordic countries	490 (3)	440 (4)	211 (3)	214 (3)	94 (4)	122 (5)	18 (10)	35 (4)	1 (1)	0	6 (5)	
Other Western countries	296 (2)	206 (2)	99 (1)	199 (3)	23 (1)	35 (1)	7 (4)	24 (3)	2 (3)	1 (2)	5 (4)	
Non-Western countries	235 (2)	175 (1)	99 (1)	165 (2)	30 (1)	21 (1)	0	15 (2)	2 (3)	0	2 (2)	
Position												
Nurse	4537 (32)	4237 (35)	2329 (35)	945 (12)	1247 (54)	2100 (80)	120 (65)	86 (10)	8 (11)	2 (5)	29 (24)	
Physician	1597 (11)	1084 (9)	426 (6)	686 (9)	168 (7)	48 (2)	0	648 (77)	0	1 (2)	46 (38)	
Patient-focused other	3266 (23)	2990 (25)	1727 (26)	1998 (25)	725 (32)	347 (13)	59 (32)	57 (7)	64 (86)	1 (2)	15 (12)	
Administration/management	2680 (19)	2166 (18)	1256 (19)	2524 (32)	58 (3)	21 (1)	2 (1)	32 (4)	2 (3)	24 (56)	17 (14)	
Other operation/technical personnel	661 (5)	553 (5)	332 (5)	570 (7)	35 (2)	48 (2)	0	1	0	7 (16)	0	

continued

Table 1 continued

Kitchen/cleaning/orderly	638 (5)	607 (5)	480 (7)	498 (6)	57 (2)	58 (2)	4 (2)	0	0	8 (19)	13 (11)
Other	753 (5)	324 (3)	170 (3)	720 (9)	11	4	0	17 (2)	0	0	1 (1)
Work hours a week											
<41	13 807 (98)	11 761 (98)	6670 (99)	7867 (99)	2281 (99)	2599 (99)	185 (100)	651 (77)	67 (91)	43 (100)	114 (94)
>41	325 (2)	200 (2)	50 (1)	74 (1)	20 (1)	27 (1)	0	190 (23)	7 (9)	0	7 (6)
Salary (in NOK100 000)	4.6545 (1.5)	4.4632 (1.2)	4.3816 (1.2)	4.8808 (1.6)	4.2326 (0.9)	3.9386 (0.6)	4.113 (0.5)	6.1588 (1.7)	3.4746 (0.4)	3.6838 (0.8)	4.8047 (1.2)
Mean±SD											

* Absence statistics are averages of employee averages. For all other characteristics that vary between years (eg, salary), the first registered value is given. The average shift duration was 8 hours (73%); otherwise, shifts tended to be 10 (7%), 9 (7%), 7 (6%), 4 (1%), 6 (1%) and 12 (1%) hours. A typical day shift can go from 08:00 to 15:30 hours, evening shift from 15:00 to 22:30 hours and night shift from 22:00 to 08:00 hours.

† The hospital has implemented a restrictive policy for permitting new fixed night shift contracts, which is reflected in a skewed age distribution for this shift schedule.

with nights is beneficial for employee health. However, this study is not the first to also find a negative relationship between shift work and sickness absence.²¹ A probable explanation for this difference is a selection effect, with unhealthy employees changing from three-shift rotations with nights to two-shift rotations without nights. As employees who develop more severe health challenges are exempt from working night shifts, a selection effect would likely be particularly relevant for long-term absences.

Moderating individual variables

In line with previous literature, we found a moderating effect of age as the negative relationship between shift work and sickness absences increases with age.^{22 23} The present results support that older employees had a larger increase in short-term absence when working two-shift rotations and in long-term absence when working three-shift rotations. They also had higher number of sickness absence periods when working two-shift or three-shift schedules. It is plausible to expect that the body's resilience to shift work and disruptions of the circadian rhythm, in particular, changes with age. This does not imply that shift work is not harmful for younger employees. For example, some studies have suggested that the increased risk of cancer associated with shift work is particularly pronounced for younger employees.³⁷ The results suggest that older employees are more prone to sickness absences (and the health problems likely to dominate the sickness absence statistics), as a result of shift work.

The results suggest that shift work is related to more short-term sickness absences for both women and men. Gender did not moderate the relation between shift work and short-term sickness absence, nor between shift work and number of sickness absence periods. For long-term absences, the moderating effect of gender was more in line with the finding by Merkus *et al.*⁹ In particular, we found a statistically significant positive relationship only between working two-shifts and long-term absences for women, and no relationship for men. It is possible that the difference occurred because women have a more severe reaction to shift work than men (eg, due to biological or social differences, or gender differences in the type of job held). However, as the difference was present only for long-term absences and two-shift work, it might also represent a gender difference in the selection effect (i.e. in which employees with health challenges are exempt from working nights). This would be the case if men with health challenges largely changed employment out of the hospital, while women changed from three-shift work with nights, to two-shift work without nights.

In contrast to what we expected, we found mixed results for the moderating effect of having children. Employees with children had a weaker relationship between two-shift work and short-term absences, and number of episodes of sickness absence. However, they had a stronger relationship between three-shift work and long-term absence. While the latter result is in line with what we expected, the former result is surprising because work-family conflict is an important consequence of shift work,^{36 38} and likely an important mediator between shift work and health outcomes.^{17 39} It is natural to expect increased work-home conflict to be stronger for employees with children. It is possible, however, that for some employees, shift work might also be a strategy to balance work and private life. Working at different times than one's partner will increase the amount of time at least one partner is free and available to take care of the children. Some nurses have reported that an advantage of working nights is more flexibility for family activity.⁴⁰

Table 2 Results of the random effects regression models of the association between shift work and short-term and long-term sickness absence

	Short-terms sickness absence (LPM)*		Long-term sickness absence (LPM)*		Number of periods of sickness absence (Poisson)†	
	Unadjusted model	Adjusted model	Unadjusted model	Adjusted model	Unadjusted model	Adjusted model
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
			Reference	Reference	Reference	Reference
Rotating day and evening	0.12 (0.10 to 0.14)	0.07 (0.05 to 0.09)	0.07 (0.05 to 0.09)	0.05 (0.03 to 0.07)	0.36 (0.30 to 0.42)	0.23 (0.18 to 0.29)
Rotating day, evening and night	0.13 (0.10 to 0.15)	0.06 (0.04 to 0.09)	-0.03 (-0.05 to -0.01)	-0.02 (-0.04-0.00)	0.27 (0.21 to 0.33)	0.11 (0.05 to 0.17)
Fixed night	0.09 (0.04 to 0.13)	0.06 (0.01 to 0.11)	0.00 (-0.05 to 0.05)	-0.01 (-0.06 to 0.04)	0.10 (-0.04 to 0.24)	0.05 (-0.09 to 0.18)
Rotating day and night	-0.01 (-0.05 to 0.02)	0.02 (-0.02 to 0.05)	-0.11 (-0.15 to -0.08)	-0.01 (-0.04 to 0.02)	-0.21 (-0.32 to -0.10)	-0.03 (-0.13 to 0.08)
Rotating evening and night	0.18 (0.08 to 0.28)	0.11 (0.02 to 0.20)	0.02 (-0.08 to 0.11)	0.05 (-0.04 to 0.14)	0.41 (0.14 to 0.70)	0.25 (-0.00 to 0.50)
Rotating morning and day	0.07 (-0.06 to 0.19)	0.06 (-0.06 to 0.17)	0.04 (-0.08 to 0.16)	0.01 (-0.10-0.12)	0.04 (-0.32 to 0.40)	0.06 (-0.25 to 0.38)
Other shift schedules	0.06 (-0.01 to 0.12)	0.05 (-0.01 to 0.11)	-0.03 (-0.10 to 0.04)	0.00 (-0.07 to 0.06)	0.09 (-0.11 to 0.27)	0.13 (-0.04 to 0.31)
Male		Reference		Reference		Reference
Female		0.08 (0.06 to 0.09)		0.09 (0.08 to 0.11)		0.29 (0.25 to 0.33)
Age (in 10 years)		-0.01 (-0.01 to 0.00)		0.03 (0.02 to 0.03)		-0.01 (-0.02 to 0.01)
No (small) children		Reference		Reference		Reference
Have (small) children		0.08 (0.07 to 0.09)		0.08 (0.07 to 0.09)		0.24 (0.21 to 0.27)
		Reference		Reference		Reference
41–48 hours		-0.08 (-0.10 to -0.05)		-0.12 (-0.14 to -0.09)		-0.39 (-0.47 to -0.31)
>48 hours		-0.01 (-0.06 to 0.03)		-0.06 (-0.11 to -0.01)		-0.26 (-0.42 to -0.10)
Salary (in NOK100 000)		-0.05 (-0.06 to -0.05)		-0.03 (-0.04 to -0.03)		-0.18 (-0.19 to -0.16)
No		Reference		Reference		Reference
Yes		-0.04 (-0.05 to -0.02)		-0.06 (-0.08 to -0.05)		-0.15 (-0.18 to -0.12)
No		Reference		Reference		Reference
Yes		-0.05 (-0.07 to -0.02)		0.00 (-0.03 to 0.03)		-0.08 (-0.13 to -0.02)
Norwegian		Reference		Reference		Reference
Other Nordic countries		0.04 (0.02 to 0.07)		-0.02 (-0.05 to 0.01)		0.08 (-0.00 to 0.16)
Other Western countries		-0.02 (-0.06 to 0.02)		-0.02 (-0.06 to 0.02)		-0.17 (-0.28 to -0.05)
Non-Western countries		-0.02 (-0.07 to 0.02)		0.01 (-0.04 to 0.05)		-0.03 (-0.15 to 0.09)
Nurse		Reference		Reference		Reference
Physician		-0.10 (-0.13 to -0.07)		-0.03 (-0.05 to 0.00)		-0.31 (-0.40 to -0.22)
Patient-focused other		-0.02 (-0.04 to 0.00)		-0.01 (-0.03 to 0.01)		-0.05 (-0.10 to 0.00)
Administration/management		-0.07 (-0.09 to -0.05)		-0.03 (-0.05 to -0.01)		-0.22 (-0.27 to -0.16)
Other operation/technical personnel‡		-0.05 (-0.08 to -0.02)		0.00 (-0.03 to 0.03)		-0.14 (-0.23 to -0.06)
Kitchen/cleaning/orderly		0.07 (0.03 to 0.11)		0.20 (0.17 to 0.24)		0.38 (0.26 to 0.50)
Other§		-0.33 (-0.37 to -0.30)		-0.07 (-0.10 to -0.04)		-0.95 (-1.05 to -0.84)
	0.65 (0.64 to 0.66)	0.93 (0.90 to 0.96)	0.28 (0.27 to 0.29)	0.32 (0.29 to 0.35)	0.46 (0.41 to 0.51)	1.36 (1.26 to 1.46)

N employees: 14 132; N work units: 1316.

*Coefficients/effect sizes should be read as marginal increases in the probability of short-term and long-term absence, a coefficient of 0.12 implies an estimated increase of 12 percentage points. The estimated probability in the reference group (fixed day, all non-shift variables set at mean) is 70% for short-term absence and 29% for long-term absence.

†The estimated probability in the reference group (fixed day, all non-shift variables set at mean) is 2.5 episodes a year in the adjusted model (and 2.6 in the unadjusted model). Coefficients are Poisson coefficients and should be read as increases in the natural logarithm of the incidence rate. With a reference value of 2.6 (or exp(0.95)), a coefficient of 0.36 implies an increase to (exp(0.95+0.36)) 3.7 episodes a year, and an incident risk ratio of (3.7/2.6) 1.4.

‡Other operation/technical personnel includes IT and engineers, among others.
§Other includes research staff, summer temperature and unspecified positions.

Having children is a variable we created based on the employee absence registry (i.e. have employees ever been absent due to sick children or parental leave). It is important to recognise this limitation when interpreting the results. The variable for having children in the dataset most likely encompasses only parents with children who were too young to stay home alone while ill, and where parental leave and care for ill children were not delegated to a third party. Nonetheless, it is still interesting that we did not find, in precisely this group of parents, extra strain manifested as increased short-term absences connected to shift work.

Strengths and limitations

The study used a large and longitudinal dataset with objectively recorded data in an HR registry. The data provided a unique opportunity to study shift work in more detail—differentiating

between different shift work arrangements, eliminating recall bias and using the strengths of employees being measured repeatedly over multiple years. We could not control for selection effects that happened before the start of the project, however.

Another limitation of the present study is that the data were collected from a single hospital, possibly limiting the generalisability of the findings. The latter is a large hospital though, comprising multiple geographical location with employees organised in a variety of different shift schedules. Nevertheless, it is still possible that specific characteristics of this hospital have influenced the results. It is also important to note that Norway has a relatively high level of sickness absence,⁴¹ and a generous sickness absence system.⁴² It is therefore possible that employees to a greater extent respond to shift-related distress and health impairments with increased absence in Norway, compared with

Table 3 Results of the random effects linear probability models of the interaction between shift work and gender, age and parental status for the association with short-term and long-term sickness absence

		Short-term sickness absence	Long-term sickness absence	Number of periods of sickness absence
		Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Gender				
Shift	Fixed day	Reference	Reference	Reference
	Rotating day and evening	0.09 (0.06 to 0.13)	0 (-0.03 to 0.03)	0.24 (0.15 to 0.33)
Gender	Male	Reference	Reference	Reference
	Female	0.08 (0.07 to 0.10)	0.08 (0.07 to 0.10)	0.30 (0.25 to 0.34)
Interaction	Rotating day and evening×female	-0.03 (-0.06 to 0.00)	0.07 (0.04 to 0.11)	-0.01 (-0.10 to 0.09)
Shift	Fixed day	Reference	Reference	Reference
	Rotating day, evening and night	0.08 (0.05 to 0.11)	-0.05 (-0.08 to -0.01)	0.15 (0.05 to 0.25)
Gender	Male	Reference	Reference	Reference
	Female	0.08 (0.07 to 0.09)	0.09 (0.07 to 0.10)	0.30 (0.26 to 0.34)
Interaction	Rotating day, evening and night×female	-0.02 (-0.05 to 0.01)	0.03 (-0.00 to 0.07)	-0.05 (-0.14 to 0.05)
Age (in 10 years, centred at 30 years)				
Shift	Fixed day	Reference	Reference	Reference
	Rotating day and evening	0.05 (0.02 to 0.08)	0.04 (0.01 to 0.07)	0.17 (0.10 to 0.24)
Age	Age	-0.01 (-0.02 to 0.00)	0.03 (0.02 to 0.03)	-0.02 (-0.04 to -0.00)
Interaction	Rotating day and evening×age	0.01 (0.00 to 0.03)	0.01 (-0.00 to 0.02)	0.04 (0.01 to 0.08)
Shift	Fixed day	Reference	Reference	Reference
	Rotating day, evening and night	0.07 (0.05 to 0.09)	-0.04 (-0.07 to -0.02)	0.07 (-0.00 to 0.14)
Age	Age	-0.01 (-0.01 to 0.00)	0.02 (0.02 to 0.03)	-0.02 (-0.03 to 0.00)
Interaction	Rotating day, evening and night×age	-0.01 (-0.02 to 0.01)	0.02 (0.01 to 0.03)	0.05 (0.02 to 0.09)
Parental status				
Shift	Fixed day	Reference	Reference	Reference
	Rotating day and evening	0.09 (0.07 to 0.11)	0.05 (0.03 to 0.07)	0.27 (0.20 to 0.33)
Parental status	No (young) children	Reference	Reference	Reference
	Have (young) children	0.09 (0.08 to 0.10)	0.08 (0.07 to 0.09)	0.26 (0.22 to 0.29)
Interaction	Rotating day and evening×children	-0.05 (-0.08 to -0.02)	0.00 (-0.03 to 0.04)	-0.09 (-0.17 to -0.01)
Shift	Fixed day	Reference	Reference	Reference
	Rotating day evening and night	0.07 (0.04 to 0.09)	-0.04 (-0.07 to -0.02)	0.10 (0.03 to 0.16)
Parental status	No (young) children	Reference	Reference	Reference
	Have (young) children	0.08 (0.07 to 0.09)	0.07 (0.05 to 0.08)	0.23 (0.19 to 0.27)
Interaction	Rotating day, evening and night children	0.00 (-0.03 to 0.03)	0.06 (0.03 to 0.09)	0.05 (-0.03 to 0.13)

Each analysis also contains the following control variables: shift schedule, gender, work hours a week, salary, temporary contract, multiple contract, age, parental status, nationality and position. The predicted values for each employee group are presented in tables 4 and 5.

N employees: 14 132; N work units: 1316.

countries with lower absence rates and different social security systems. The study population represent a heterogeneous group in terms of age and education. However, the sample is predominantly female. While we have investigated the gender differences

specifically, we cannot exclude that the results would have been different in a male-dominated sector. Furthermore, we have limited the sample to full-time employees, as a consequence we have also excluded shift-schedules predominantly worked

Table 4 Predicted probabilities of absence for groups of employees working fixed day and day-evening rotations (two-shift rotation)

	Short-term absence			Long-term absence			Number of episodes		
	Fixed day	Day and evening	Difference	Fixed day	Day and evening	Difference	Fixed day	Day and evening	Difference
Male	64%	74%	9 p.p.	23%	23%	0 p.p.	2.1	2.6	0.6
Female	73%	79%	6 p.p.	31%	38%	7 p.p.	2.8	3.5	0.7
No (small) children	67%	76%	9 p.p.	26%	32%	5 p.p.	2.3	3.0	0.7
Have (small) children	76%	80%	4 p.p.	34%	40%	6 p.p.	3.0	3.6	0.6
20 years	70%	78%	8 p.p.	30%	36%	6 p.p.	2.5	3.3	0.7
30 years	69%	78%	9 p.p.	33%	40%	7 p.p.	2.5	3.4	0.9
40 years	68%	79%	11 p.p.	36%	43%	8 p.p.	2.4	3.4	1.0
50 years	67%	79%	12 p.p.	38%	47%	8 p.p.	2.4	3.5	1.1
60 years	66%	80%	14 p.p.	41%	50%	9 p.p.	2.3	3.6	1.3

p.p., percentage points.

Table 5 Predicted probabilities of absence for groups of employees working fixed day and day-evening-night rotations (three-shift rotation)

	Short-term absence			Long-term absence			Number of episodes		
	Fixed day	Day, evening and night	Difference	Fixed day	Day, evening and night	Difference	Fixed day	Day, evening and night	Difference
Male	65%	73%	8 p.p.	23%	18%	-5 p.p.	2.0	2.4	0.3
Female	73%	79%	6 p.p.	31%	30%	-1 p.p.	2.8	3.1	0.3
No (small) children	68%	74%	7 p.p.	27%	23%	-4 p.p.	2.4	2.6	0.2
Have (small) children	76%	82%	6 p.p.	34%	35%	2 p.p.	3.0	3.4	0.5
20 years	70%	76%	6 p.p.	30%	30%	0 p.p.	2.5	3.0	0.5
30 years	69%	75%	5 p.p.	33%	35%	2 p.p.	2.5	3.1	0.6
40 years	69%	74%	5 p.p.	35%	39%	4 p.p.	2.4	3.2	0.8
50 years	68%	72%	4 p.p.	38%	43%	6 p.p.	2.4	3.4	1.0
60 years	68%	71%	4 p.p.	40%	48%	8 p.p.	2.4	3.5	1.1

p.p., percentage points.

by part-time employees (in particular fixed evening shifts). The relationship between part-time work and sickness absence is complicated,⁴³ and could have complicated the interpretation of the results. However, it is important to recognise that the findings might not be generalisable to employees working shorter hours and different shifts. Nonetheless, the general congruence between the present study and prior research indicates that the findings are generalisable.

CONCLUSIONS

In conclusion, we found that several shift work arrangements (with and without nights) were related to increased odds for short-term absences. The difference was present for men and women. However, the relationship seemed to be most pronounced for older workers. The results suggest that absences could be reduced by HR policies tailoring shift work to employee life phases.

Acknowledgements The authors would like to thank the representatives of the hospital who provided invaluable insights and assistance in facilitating access to the data.

Contributors VHB initiated the study. VHB and IH planned the study. VHB prepared the data and executed the statistical analyses. VHB and IH interpreted the results, drafted and revised the manuscript. Both authors read and approved the final manuscript.

Funding This work was supported by the Research Council of Norway (grant number 237784).

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. The datasets analysed during the current study are not publicly available. The data are the property of the participating hospital. On reasonable request, the corresponding author can facilitate contact with the participating hospital.

ORCID iDs

Vilde Hoff Bernström <http://orcid.org/0000-0001-6704-7098>

Inge Houkes <http://orcid.org/000-0003-1697-0944>

REFERENCES

- 1 Nea FM, Kearney J, Livingstone MBE, et al. Dietary and lifestyle habits and the associated health risks in shift workers. *Nutr Res Rev* 2015;28:143–66.
- 2 Pilcher JJ, Lambert BJ, Huffcutt AI. Differential effects of permanent and rotating shifts on self-report sleep length: a meta-analytic review. *Sleep* 2000;23:1–9.
- 3 Lin X, Chen W, Wei F, et al. Night-Shift work increases morbidity of breast cancer and all-cause mortality: a meta-analysis of 16 prospective cohort studies. *Sleep Med* 2015;16:1381–7.
- 4 Wang X, Ji A, Zhu Y, et al. A meta-analysis including dose-response relationship between night shift work and the risk of colorectal cancer. *Oncotarget* 2015;6:25046–60.
- 5 Rao D, Yu H, Bai Y, et al. Does night-shift work increase the risk of prostate cancer? A systematic review and meta-analysis. *Oncotargets Ther* 2015;8:2817–26.
- 6 Gan Y, Yang C, Tong X, et al. Shift work and diabetes mellitus: a meta-analysis of observational studies. *Occup Environ Med* 2015;72:72–8.
- 7 Manohar S, Thongprayoon C, Cheungpasitporn W, et al. Associations of rotational shift work and night shift status with hypertension: a systematic review and meta-analysis. *J Hypertens* 2017;35:1929–1937.
- 8 Vyas MV, Garg AX, Iansavichus AV, et al. Shift work and vascular events: systematic review and meta-analysis. 345. *BMJ: British Medical Journal*, 2012.
- 9 Merkus SL, van Drongelen A, Holte KA, et al. The association between shift work and sick leave: a systematic review. *Occup Environ Med* 2012;69:701–12.
- 10 Kivimäki M, Head J, Ferrie JE, et al. Sickness absence as a global measure of health: evidence from mortality in the Whitehall II prospective cohort study. *BMJ* 2003;327:364–8.
- 11 International Labour Organization (ILO). *Conditions of work digest: working time around the world*. Geneva: ILO, 1995.
- 12 Fekedulegn D, Burchfiel CM, Hartley TA, et al. Shiftwork and sickness absence among police officers: the BCOPS study. *Chronobiol Int* 2013;30:930–41.
- 13 van Drongelen A, van der Beek AJ, Penders GBS, et al. Sickness absence and flight type exposure in flight crew members. *Occup Med* 2015;65:kqu169:66.
- 14 Dall'Ora C, Ball J, Redfern O, et al. Are long nursing shifts on hospital wards associated with sickness absence? A longitudinal retrospective observational study. *J Nurs Manag* 2019;27:19–26.
- 15 Peters V, Engels JA, de Rijk AE, et al. Sustainable employability in shiftwork: related to types of work schedule rather than age. *Int Arch Occup Environ Health* 2015;88:881–93.
- 16 Nätti J, Oinas T, Härmä M, et al. Combined effects of shiftwork and individual working time control on long-term sickness absence: a prospective study of Finnish employees. *J Occup Environ Med* 2014;56:732–8.
- 17 Jacobsen DI, Fjeldbraaten EM. Shift work and sickness absence—the mediating roles of work-home conflict and perceived health. *Hum Resour Manage* 2018;57:1145–57.
- 18 Booker LA, Sletten TL, Alvaro PK, et al. Exploring the associations between shift work disorder, depression, anxiety and sick leave taken amongst nurses. *J Sleep Res*;49:e12872.
- 19 Vedaa Øystein, Pallesen S, Waage S, et al. Short rest between shift intervals increases the risk of sick leave: a prospective registry study. *Occup Environ Med* 2017;74:496–501.
- 20 Norder G, Roelen CAM, Büttmann U, et al. Shift work and mental health sickness absence: a 10-year observational cohort study among male production workers. *Scand J Work Environ Health* 2015;41:413–6.
- 21 Catano VM, Bissonnette AB. Examining paid sickness absence by shift workers. *Occup Med* 2014;64:287–93.
- 22 Tucker P, Knowles SR. Review of studies that have used the standard shiftwork index: evidence for the underlying model of shiftwork and health. *Appl Ergon* 2008;39:550–64.
- 23 Ramin C, Devore EE, Wang W, et al. Night shift work at specific age ranges and chronic disease risk factors. *Occup Environ Med* 2015;72:100–7.
- 24 Tuttle R, Garr M. Shift work and work to family fit: does schedule control matter? *J Fam Econ Issues* 2012;33:261–71.
- 25 Korompeli A, Chara T, Chrysoula L, et al. Sleep disturbance in nursing personnel working shifts. *Nurs Forum* 2013;48:45–53.
- 26 Marmot M, Feeney A, Shipley M, et al. Sickness absence as a measure of health status and functioning: from the UK Whitehall II study. *Journal of Epidemiology & Community Health* 1995;49:124–30.
- 27 NAV. Care benefit days n.d. Available: <https://www.nav.no/en/Home/Benefits+and+services/Relatert+informasjon/care-benefit>
- 28 Mood C. Logistic Regression: Why We Cannot Do What We Think We Can Do, and What We Can Do About It. *Eur Sociol Rev* 2010;26:67–82.

- 29 Buis ML. Stata tip 87: interpretation of interactions in nonlinear models. *Stata J* 2010;10:305–8.
- 30 Wang F, Zhang L, Zhang Y, et al. Meta-Analysis on night shift work and risk of metabolic syndrome. *Obes Rev* 2014;15:709–20.
- 31 de Cordova PB, Phibbs CS, Bartel AP, et al. Twenty-four/seven: a mixed-method systematic review of the off-shift literature. *J Adv Nurs* 2012;68:1454–68.
- 32 Hunter CM, Figueiro MG. Measuring light at night and melatonin levels in shift workers: a review of the literature. *Biol Res Nurs* 2017;19:365–74.
- 33 Tüchsen F, Christensen KB, Nabe-Nielsen K, et al. Does evening work predict sickness absence among female carers of the elderly? *Scand J Work Environ Health* 2008;34:483–6.
- 34 Ohayon MM, Lemoine P, Arnaud-Briant V, et al. Prevalence and consequences of sleep disorders in a shift worker population. *J Psychosom Res* 2002;53:577–83.
- 35 Karhula K, Puttonen S, Ropponen A, et al. Objective working hour characteristics and work-life conflict among hospital employees in the Finnish public sector study. *Chronobiol Int* 2017;34:876–85.
- 36 Mauno S, Ruokolainen M, Kinnunen U. Work-family conflict and enrichment from the perspective of psychosocial resources: comparing Finnish healthcare workers by working schedules. *Appl Ergon* 2015;48:86–94.
- 37 Hansen J. Night shift work and risk of breast cancer. *Curr Environ Health Rep* 2017;02.
- 38 van Amelsvoort LGPM, Jansen NWH, Swaen GMH, et al. Direction of shift rotation among three-shift workers in relation to psychological health and work-family conflict. *Scand J Work Environ Health* 2004;30:149–56.
- 39 Cho Y. The effects of nonstandard work schedules on workers' health: a mediating role of work-to-family conflict. *International Journal of Social Welfare* 2017.
- 40 Powell I. Can you see me? experiences of nurses working night shift in Australian regional hospitals: a qualitative case study. *J Adv Nurs* 2013;69:2172–84.
- 41 Organisation for Economic Co-operation and Development (OECD). Health Status: absence from work due to illness: OECD.stat Nd. Available: <https://stats.oecd.org/index.aspx?queryid=30123>
- 42 NAV. Sykepenger til arbeidstakere [sickness benefits to employees] n.d. Available: <https://www.nav.no/Person/Arbeid/Sykmeldt%2C+arbeidsavklaringspenger+og+yркesskade/Sykepenger/Sykepenger+til+arbeidstakere>
- 43 Bernström VH, Houkes I. A systematic literature review of the relationship between work hours and sickness absence. *Work Stress* 2018;32:84–104.