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2022

Ropponen , A , Koskinen , A , Puttonen , S , Ervasti , J , Kivimäki , M , Oksanen , T , Härmä ,
M & Karhula , K 2022 , ' Association of working hour characteristics and on-call work with
risk of short sickness absence among hospital physicians : A longitudinal cohort study ' ,
Chronobiology International , vol. 39 , no. 2 , pp. 233-240 . <https://doi.org/10.1080/07420528.2021.1993238>

<http://hdl.handle.net/10138/353093>

<https://doi.org/10.1080/07420528.2021.1993238>

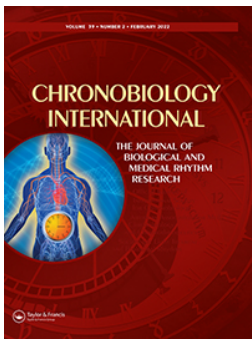
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Chronobiology International

The Journal of Biological and Medical Rhythm Research

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/icbi20>

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To cite this article: Annina Ropponen, Aki Koskinen, Sampsa Puttonen, Jenni Ervasti, Mika Kivimäki, Tuula Oksanen, Mikko Härmä & Kati Karhula (2022) Association of working hour characteristics and on-call work with risk of short sickness absence among hospital physicians: A longitudinal cohort study, *Chronobiology International*, 39:2, 233-240, DOI: [10.1080/07420528.2021.1993238](https://doi.org/10.1080/07420528.2021.1993238)

To link to this article: <https://doi.org/10.1080/07420528.2021.1993238>



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Published online: 01 Nov 2021.



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Association of working hour characteristics and on-call work with risk of short sickness absence among hospital physicians: A longitudinal cohort study

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ABSTRACT

Physicians often work long hours and on-call shifts, which may expose them to circadian misalignment and negative health outcomes. However, few studies have examined whether these working hour characteristics, ascertained using objective working hour records, are associated with the physicians' risk of sickness absence. We investigated the associations of 14 characteristics of payroll-based working hours and on-call work with the risk of short sickness absence among hospital physicians. In this cohort study, 2845 physicians from six Finnish hospital districts were linked to electronic payroll-based records of daily working hours, on-call duty and short (1–3 days) sickness absence between 2005 and 2019. A case-crossover design was applied using conditional logistic regression with the 28 day case and control windows to estimate odds ratios (ORs) and 95% confidence intervals (CI) for short sickness absence. After controlling for weekly working hours and the number of normal (≤ 12 h) shifts, a higher number of long (> 12 h) shifts (ORs for ≥ 5 versus none: 2.54, 95% CI 1.68–3.84), very long (> 24 h) shifts (ORs for ≥ 5 versus none: 2.62, 95% CI 1.61–4.27), and on-call shifts (OR for ≥ 5 versus none: 2.15, 95% CI 1.44–3.21) and a higher number of short (< 11 h) shift intervals (OR for ≥ 5 versus none: 12.61, 95% CI 8.88–17.90) were all associated with the increased risk of short sickness absence. These associations did not differ between male and female physicians or between age groups. To conclude, the findings from objective working hour records show that long work shifts, on-call shifts and short shift intervals are related to the risk of short (1–3 days) sickness absence among hospital physicians.

ARTICLE HISTORY

Received 27 April 2021
Revised 5 October 2021
Accepted 9 October 2021

KEYWORDS

Shift work; on-call work;
physician; sick leave

Introduction

Physician's workload is high due to population ageing (Eurofound 2012), related increased need for care, economic challenges and staff shortage (Smiley et al. 2018). Physicians are often engaged in on-call work and extra hours of work in addition to their normal daily working hours (Rothenberger 2017). Around half of the physicians working in hospitals and healthcare centers work on-call duties (Heponiemi et al. 2014; Parvanne et al. 2016; Rosta et al. 2014) with high work pace and treat critically ill patients who require fast and accurate treatment decisions (Rodriguez-Jareno et al. 2014; Rothenberger 2017). An important societal question is what consequences such working hour related peaks at health care have in terms of increased sickness absence risk among physicians.

Sickness absence rates among many healthcare occupations (such as practical nurses and elderly home care personnel) are higher than in general working population in Finland (Leinonen et al. 2018). However,

physicians seem to have very low sickness absence rates, although studies among physicians are relatively few and mostly based on self-reports (Kivimäki 2001; Kristensen et al. 2010; Ro et al. 2008; Rosta et al. 2014; Rosvold and Bjertness 2001). Working conditions including working hours have been hypothesized to affect sickness absence rates (Pekkalä et al. 2017). Physicians work irregular working hours, i.e. working hours with on-call work, resulting in a non-standard schedule that includes varying start and finish times, shift lengths, and recovery periods between shifts (Parvanne et al. 2016; Rodriguez-Jareno et al. 2014; Rosta and Gerber 2007; Sallinen and Kecklund 2010). On-call work is associated with a number of negative health outcomes, such as work stress, burnout, occupational accidents and sickness absence (Cotter et al. 2020; Lindfors et al. 2006; Mak et al. 2019; Rosta and Gerber 2007). The mechanism underlying these associations include insufficient sleep and recovery and disrupted

circadian, biological rhythms while working the nights or long working hours (Åkerstedt et al. 2017; Sallinen and Kecklund 2010). The mechanism disrupting the biological rhythms has been shown to be active also in studies of physicians (Balch et al. 2010; Kancherla et al. 2020; Nicol and Botterill 2004; Rothenberger 2017; Wada et al. 2010), although the evidence remains uncertain due to methodological limitations.

More specifically, most on-call work studies are based on self-reported data that is prone to memory bias (Harbeck et al. 2015; Petrie et al. 2020; Rebnord et al. 2020), cross-sectional design (Lindfors et al. 2006), or on limited groups of medical specialty (Daniel et al. 2020; Harrison et al. 2019; Lindfors et al. 2006). Studies utilizing objective working hour data from employers' registries have increased in health care (Dall'Ora et al. 2019; Griffiths et al. 2019; Ropponen et al. 2019; Harma et al. 2020), but such studies of physicians' working hour characteristics are sparse (Barger et al. 2019; Su and Ding 2021). Studies among nurses have shown that long working hours, several consecutive night shifts and short (<11 hours) recovery periods between the shifts (i.e. shift intervals) (Dall'Ora et al. 2019; Ropponen et al. 2019) may increase the risk of sickness absence. The same working hour characteristics are associated with fatigue and sleep disturbances among nurses (Harma et al. 2019, 2018). However, it is not known which working hour characteristics are associated with short sickness absences among physicians.

In this study, we aimed to investigate the association of the characteristics of working hours with the risk of short (1–3 days) sickness absence among hospital physicians. We used objective registry data of daily working hours, on-call work and sickness absences of a large number of physicians.

Material and methods

Sample

The data were electronic payroll based working hour and on-call duty records of six Finnish hospital districts. Altogether, the working hour and on-call duty data consisted of 14 704 physicians in public sector from 1 January 2005 to 31 December 2019 with the identification of the hospital districts and participants' age and sex. We selected participants with at least one period of short (1–3 days) sickness absence since the beginning of the data collection and who were at work (i.e. having at least one work shift of any length) during the 28 day case and control windows before the first short sickness absence. The final sample consisted of 2 845 physicians (64% women). We received permission to access working hour

and on-call data including sickness absences without information of their diagnoses and employment information (i.e. work unit) from the hospital districts participating in the study. Since these data comprised register-based employer-owned employment information, ethical approval was not required for the study.

Short sickness absence

The first incidence of a short (1–3 consequent days) sickness absence was identified from the registry-based daily working hour and on-call duty data including the start and end times for work shifts, on-call duties, and absences including days off, sickness and other leaves, which were utilized to identify the case and control windows for the final sample.

Case-cross over design

We applied a case-cross over design where each person with a short sickness absence periods serves as his/her own control. For each physician, there is a 'case window,' the period of time during which the person was a case, and a 'control window,' a period of time during which the physician was a non-case (=control). Risk exposure during the case window is compared to risk exposure during the control window.

The data of employers' electronic working hour records were analysed at the physician-level with each physician representing a matched set of data for both the case and control periods (Maclure and Mittleman 2000). This design enabled us to compare the working hour and on-call characteristics for the 28 day 'case window' immediately prior to the first incidence of a short sickness absence and for the 'control window' 28 days prior to beginning of case window. The case and control windows were selected based on the earlier studies of similar datasets of other hospital employees, mainly nurses (Ropponen et al. 2019, 2020).

Working hour and on-call duty data

Daily working hour and on-call duty data were retrieved from two shift scheduling programs: the Titania® for the records of basic working hours without on-call work and the Titania for physicians®, including the records of the daily on-call duties. The combined data included actual payroll-based working hour data (i.e. start/end time of work and absences including days off, sickness and other leaves), and the same for on-call duties. The following characteristics of the working hours were calculated (Table 1): weekly working hours, shift length and the number of work shifts across various lengths (≤12 h,

Table 1. Descriptions of working hour characteristics evaluated in this study.

Working hour dimension/variable	Description
Length of working hours	
Weekly working hours (h)	The average weekly (from Monday 00:00 to Sunday 24:00) working hours in the case or control window
Shift length (h)	The average length of all shifts in the case or control window
Number of normal (≤ 12 h) shifts	Number of ≤ 12 h shifts in the case or control window
Number of long (> 12 h) shifts	Number of > 12 h (and ≤ 24 h) shifts in the case or control window
Number of very long (> 24 hours) shifts	Number of > 24 h shifts in the case or control window
Categorized long and very long shifts	The number of long and very long shifts was categorized for thresholds of 0, 1–2, 3–4, and ≥ 5 long or very long shifts within 4 weeks based on the distribution of these working hour characteristics
Length of duty period (h)	The average length of duty periods (i.e. consequent shifts without any rest between) in the case or control window
Shift intensity	
Number of consecutive working days	The average number of consecutive work days (without free days) in the case or control window (starting from and ending to a free day or other absence from work)
Categorized consecutive working days*	The number of consecutive working days was categorized for thresholds of 3–5, 2 or 6, 7, and 1 or ≥ 8 consecutive working days based on the FIOH recommendations (Finnish Institute of Occupational Health 2021) in the case or control window
Number of work shifts in a day	The average number of consecutive work shifts in a day (i.e. within a date) in the case or control window
Number of on-call shifts	The average number of on-call shifts in the case or control window
Categorized on-call shifts	The number of on call shifts was categorized for thresholds of 0, 1–2, 3–4, and ≥ 5 on-call shifts in the case or control window based on the collective bargaining agreement of physicians in Finland
Number of short (< 11 h) shift intervals	Number of shift intervals of < 11 h in the case or control window
Categorized short shift intervals	The number of short shift intervals was categorized for thresholds of 0–1, 2–4, 5–11 and ≥ 12 short shift intervals in the case or control window based on the FIOH recommendations (Finnish Institute of Occupational Health 2021)

*In the categorization of consecutive working days, based on previous research, we assumed that very few (1 or 2) or very many (6, 7, 8 or more) consecutive working would be more strenuous than 3–5 days. The category 3–5 consecutive working days was used as reference, as 3–5 work days mainly resemble regular working hours in day work.

> 12 h, and > 24 h), and shift intensity (the consecutive work shifts and recovery time between the shifts). The length of the duty period was identified including work shifts starting at the same date without any breaks between, but also including any immediately preceding (i.e. on the day before) or immediately subsequent (i.e. the day after) shifts. As an example, we summarized into one duty a day shift that was immediately followed by an on-call duty, which continued with another day shift without any breaks. We included all duty periods, i.e.

work shifts accounting any length within a date. The number of on-call shifts was based on working hour data that was registered to Titania for Physicians' shift scheduling program, and a physician had working hours on that day. Furthermore, we used traditional cut-off points based on recommendations by the Finnish Institute of Occupational Health (FIOH) for consecutive working days and short (< 11 hours) shift intervals (Finnish Institute of Occupational Health 2021). Table 1 shows the definitions of working hour characteristics and the number of on-call shifts.

Statistical analyses

To estimate the association of working hour characteristics with the first onset of short sickness absence, we calculated the working hour characteristics for 28 days before the first incidence separately for the case and control windows. The control window was the immediate 28 days period preceding the case window.

To estimate the mean differences between the case and control windows, we utilized one-way analysis of variance (ANOVA) for continuous variables and Pearson χ^2 -test for categorical variables (Table 2). All differences in categorical variables were non-significant ($p > .05$), and thus, we do not to present the p -values for Pearson's χ^2 test. In supplemental Tables 1–2, we present descriptive statistics separately for those physicians with and without on-call work. We applied conditional logistic regression models to estimate the probability of incident short sickness absence comparing case windows to control windows. Probability was expressed as odds ratios (OR) and their 95% confidence intervals (95%CI). We controlled the clustering effect of hospital districts in the analyses of all working hour characteristics with clusters for hospital districts to adjust the standard errors. Based on a preliminary analysis, both the weekly working hours and/or the number of normal (≤ 12 h) length working hours confounded the effects of the working hour characteristics for the risk of sickness absence due to associations with both exposure and the outcome. Weekly working hours influence the characteristics of the working hours, but our information on the possible sickness absence was also dependent on work shift information. For example, in the case of part-time work with less work shifts, it is more probable that information on a possible sickness absence during day offs is missing. We thus chose to present the results adjusted for both the weekly working hours and the number of normal (≤ 12 h) length shifts at the same time in the models. We ran the analyses for the final sample and separately for those with or without on-call shifts (dichotomized based on 0 on-call shifts or ≥ 1 on-

Table 2. Descriptive statistics (mean, standard deviation [SD]) and frequencies (with proportion, %) of working hour characteristics and on-call shifts in the case and control windows of 28 days.

Working hour characteristics	Physicians, n = 2845			
	Case window		Control window	
	mean	SD	mean	SD
Length of working hours				
Weekly working hours (h)	20.9	2.1	20.5	8.6
Shift length (h)	8.7	1.5	8.7	1.6
Number of normal (≤ 12 h) shifts	14.8	4.8	14.0	5.2
Number of long (> 12 h) shifts	1.5	1.9	1.5	2.2
Number of very long (> 24 hours) shifts	0.7	1.1	0.6	1.1
Length of duty period (h)	9.7	2.0	9.8	2.2
Shift intensity				
Number of consecutive working days	4.1	1.4	4.3	1.8
Number of work shifts in a day	1.7	0.5	1.7	0.5
Number of on-call shifts	1.6	1.8	1.6	2.2
Number of short (< 11 h) shift intervals	4.0	1.6	3.3	1.5
Thresholds for working hour characteristics [#]	n	%	n	%
Number of long (> 12 h) shifts ³				
0	1140	40	1174	41
1–2	1073	38	1072	38
3–4	443	16	410	14
≥ 5	189	7	189	7
Number of very long (> 24 hours) shifts ³				
0	1782	63	1803	63
1–2	820	29	829	29
3–4	206	7	188	7
≥ 5	37	1	25	1
Shift intensity				
Number of consecutive working days ¹				
3–5	2264	80	2178	78
2 or 6	387	14	385	14
7	51	2	68	2
1 or ≥ 8	114	4	149	5
Number of work shifts in a day ³				
1	957	34	959	34
2	1814	64	1779	64
3	48	2	42	2
4*	1	0	0	0
Number of on-call shifts ²				
0	1003	35	1055	37
1–2	1109	39	1135	40
3–4	571	20	494	17
≥ 5	162	6	161	6
Number of short shift intervals (4 weeks) ¹				
0–1	148	5	339	12
2–4	1672	59	2089	73
5–11	1023	36	417	15
$\geq 12^*$	2	0	0	0

[#]Where available, we have utilized the traffic light recommendations of FIOH¹ for thresholds of working hour characteristics and, for on-call shifts, we based the categorization on collective bargaining agreement of physicians² or on distribution³

* For statistical analyses, this category was collapsed with preceding category

call shifts in the exposure and control windows), men and women, and age groups based on the distribution of age (categorized into ≤ 35 years, 36–50 years, and ≥ 51 years). These sex- and age-specific analyses are presented in supplemental Tables 3–4.

As a sensitivity analysis, we tested the effect of the very low amount of work (i.e. the 0–7 average weekly working hours) in the case and control windows since the range was very wide (0–65 h in which 0 represents < 1 h). Here, we excluded first those with < 1 weekly working

hours (n = 119 physicians) and second those with < 7 weekly working hours (n = 343 physicians) from the analyses. All point estimates retained the direction and magnitude, and hence, we chose to present the results of the sample without such limitations. Stata MP version 15.1 (StataCorp., College Station, Texas, USA) was used for the analyses.

Results

The mean age of the participants was 40.8 years among the 1018 men (SD 10.0) and 39.8 years (SD 9.2) among the 1827 women. The working hour characteristics and on-call shifts are described in Table 2 and they show no differences in means between exposure and control windows except for the number of normal (< 12 h) shifts, number of consecutive working days and number of short shift intervals (p -values ≤ 0.001).

Among all physicians, the shift length, number of long (> 12 h) and very long (> 24 h) shifts, number of on-call shifts, and number of short shift intervals were associated with increased odds of short sickness absence in dose-response manner, particularly after controlling weekly working hours and the number of normal (≤ 12 h) shifts (Table 3). Also, the length of the duty period and the number of work shifts in a day increased the risk of short sickness absence in the adjusted model.

The descriptives for the working hour characteristics of physicians both with and without on-call work showed differences as expected (Supplemental Table 1), i.e. physicians with on-call work had longer shift length, more very long shifts, and longer duty periods than those without on-call shifts. The analysis of associations with short sickness absence indicated that a number of very long shifts have a dose-response effect on the odds of short sickness absence irrespective of on-call work (Table 4). The associations were also robust for the length of the duty period, the number of shifts in a day, and the number of short shift intervals. The additional analyses for men and women and age groups in the supplemental material confirm the findings of all physicians, indicating no sex- or age-specific effects of working hour characteristics on the risk of short sickness absence (supplemental Tables 3–4).

Discussion

This study with objective working hour data of six hospital districts in Finland enabled us to investigate physicians' working hour characteristics and on-call work in relation to incident short (1–3 days) sickness absence. The shift length, number of long (> 12 h) and

Table 3. Conditional logistic regression (odds ratio, OR, with 95% confidence intervals, CI) for the associations between working hour characteristics and on-call shifts in the 28 days case and control windows and first incident sickness absence of physicians.

	Crude model		Adjusted model*	
	OR	95% CI	OR	95% CI
Length of working hours				
Weekly working hours (h)	1.01	1.00, 1.02	-	-
Shift length (h)	0.97	0.94, 1.01	1.09	1.04, 1.15
Number of normal (≤12 h) shifts	1.06	1.04, 1.08	-	-
Number of long (>12 h) shifts				
0	1		1	
1–2	1.09	0.83, 1.44	1.26	1.00, 1.57
3–4	1.21	0.90, 1.63	1.78	1.47, 2.15
≥5	1.12	0.71, 1.77	2.54	1.68, 3.84
Number of very long (>24 hours) shifts				
0	1		1	
1–2	1.05	0.96, 1.15	1.14	1.03, 1.26
3–4	1.23	1.04, 1.46	1.51	1.30, 1.75
≥5	1.70	1.13, 2.56	2.62	1.61, 4.27
Length of duty period (h)	0.97	0.93, 1.00	1.18	1.09, 1.27
Shift intensity				
Number of consecutive working days				
3–5	1		1	
2 or 6	0.97	0.84, 1.11	1.09	0.92, 1.30
7	0.62	0.37, 1.02	0.64	0.39, 1.03
1 or ≥8	0.66	0.54, 0.81	0.93	0.71, 1.21
Number of work shifts in a day				
1	1		1	
2	1.09	0.92, 1.29	1.25	1.08, 1.45
3	1.52	1.10, 2.10	1.72	1.17, 2.53
Number of on-call shifts				
0	1		1	
1–2	1.12	1.05, 1.20	1.23	1.15, 1.32
3–4	1.36	1.04, 1.79	1.74	1.35, 2.24
≥5	1.22	0.89, 1.65	2.15	1.44, 3.21
Number of short (<11 h) shift intervals				
0–1	1		1	
2–4	2.47	1.94, 3.16	2.88	2.25, 3.69
≥5	10.75	0.59, 12.05	12.61	8.88, 17.90

*Adjusted for the weekly working hours and the number of normal (≤12 h) length shifts. Statistically significant OR and 95% CI indicated with boldface.

very long (>24 h) shifts, length of the duty period, number of on-call shifts, and number of short (<11 h) shift intervals were associated with increased odds of short sickness absence in dose-response manner among all physicians and also when assessing those with on-call work and those physicians without on-call work separately.

Our findings add to the existing literature with only few studies utilizing register data of physicians' working hours (Harbeck et al. 2015; Petrie et al. 2020; Rebnord et al. 2020) and sickness absence (Kivimaki 2001; Kristensen et al. 2010; Ro et al. 2008; Rosta et al. 2014; Rosvold and Bjertness 2001). Our findings are in line with these earlier studies indicating associations between on-call work or long work shifts and sickness absence (Kivimaki 2001; Lindfors et al. 2006).

Table 4. Conditional logistic regression (odds ratio, OR, with 95% confidence intervals, CI) for the associations between working hour characteristics in the 28 days case and control windows and first incident short (1–3 days) sickness absence of physicians with or without on-call shifts.

	On-call work (n = 1842)		No on-call work (n = 1003)	
	OR*	95%CI	OR*	95%CI
Length of working hours				
Shift length (h)	1.06	0.98, 1.15	1.75	1.17, 2.63
Number of long (>12 h) shifts				
0	1		1	
1–2	1.09	0.73, 1.65	2.82	1.87, 4.27
3–4	1.43	0.96, 2.13	37.72	5.27, 269.68
≥5	1.78	1.12, 2.81	na	-
Number of very long (>24 hours) shifts				
0	1		1	
1–2	1.18	1.01, 1.38	3.81	2.06, 7.05
3–4	1.51	1.34, 1.71	42.87	2.59, 697.54
≥5	2.50	1.21, 5.16	na	-
Length of duty period (h)	1.17	0.98, 1.40	2.95	1.94, 4.50
Shift intensity				
Number of consecutive working days				
3–5	1		1	
2 or 6	0.99	0.83, 1.18	0.93	0.69, 1.24
7	0.49	0.21, 1.13	0.92	0.33, 2.60
1 or ≥8	0.95	0.70, 1.28	0.90	0.59, 1.37
Number of work shifts in a day				
1	1		1	
2	1.22	0.89, 1.66	3.08	2.43, 3.91
3	1.69	1.08, 2.64	na	-
Number of short (<11 h) shift intervals				
0–1	1		1	
2–4	2.76	1.98, 3.85	2.43	0.93, 6.30
≥5	9.09	6.00, 13.76	17.04	5.58, 51.99

Adjusted for the weekly working hours and the number of normal (≤12 h) length shifts. Statistically significant OR and 95% CI indicated with boldface.

na = not assessed due to a low number of observations in the category

Irregular working hours of physicians, which may or may not include on-call work, are known to hamper sleep and recovery and disrupt circadian rhythms due to night work (Balch et al. 2010; Kancherla et al. 2020; Nicol and Botterill 2004; Rothenberger 2017; Wada et al. 2010). Of all the physicians in our sample, 65% did at least one on-call shift, which is in line with earlier estimates in Finland (Parvanne et al. 2016), although the number of on-call shifts had large variation (Table 2). Also, both the numbers of long (>12 h) and very long (>24 h) shifts varied greatly, and albeit there were some physicians with more than 6 long or very long shifts, this gives an expression of irregularity of working hours even in these limited time windows. For clarity, we collapsed the categories of work shifts in a day, on-call shifts, and short shift intervals from 0 to ≥5 for statistical analyses to capture the dose-response effects with reasonable sample sizes in the categories

investigated. The results are indicative of dose-response effects of the number of long or very long shifts, the number of shifts in a day or on-call shifts, but also for short shift intervals, they highlight the importance of considering these working hour characteristics while planning the working hours of physicians. Hence, our results suggest that perhaps avoiding workload peaks (in terms of the working hour characteristics) or cumulation of them should be emphasized in scheduling physicians work to affect the risk of short sickness absences. Furthermore, we detected associations between the number of consecutive working days and short sickness absence in various age groups. We assumed that very few (1 or 2) or very many (6, 7, 8 or more) consecutive working days would be more strenuous or perceived as more stressful than 3–5 days, since 3–5 consecutive working days resembles regular working hours in day work. However, the findings in this regard were inconsistent and further research is warranted further to examine this assumption in large samples. Our study allowed the investigation of various working hour characteristics both among physicians with and without on-call work based on objective data.

Investigation of objective working hour data within the comparable 28 day case and control windows applied rigor since each physician with short sickness absence served as his/her own control. The case-crossover design is analogous to a matched case-control design, and self-matching equalizes time-invariant factors. Since we did not use a separate comparison group, we avoided the control person selection bias although control time selection bias remained a challenge. Another strength of this study was the relatively large sample size with almost 3000 physicians in six hospital districts representing an extensive number of specialties. Such large-scale studies with objective working hour data are rare if not non-existing for physicians (Barger et al. 2019; Petrie et al. 2020; Su and Ding 2021; Weigl et al. 2020). We relied on sickness absences identified from the objective working hour data as before (Ropponen et al. 2019, 2020). Assessment of short (1–3 days) sickness absences that are not only certified by a doctor or a nurse but also self-certified enabled us to assess health-related absences and absences due to a need for recovery following insufficient sleep, need for a detachment from work (Boschman et al. 2017; Marmot et al. 1995), or motivational issues (Suadicani et al. 2014) (i.e. short sickness absences may provide a way for increasing control over working times) (Ala-Mursula et al. 2002). Our results of dose-response effects of many working hour characteristics on the risk of sickness absence may also be associated with longer sickness absences, since short ones are known to predict them and sickness absences also

have role as a proxy for health status and/or a work ability indicator (Laaksonen et al. 2013). As regards sickness absence, sickness presenteeism that is working while having symptoms or being sick should also be acknowledged (Helgesson et al. 2021). In this study, we cannot rule out sickness presenteeism, which can be considered as an alternative or complementary option to sickness absence.

Limitations of this study include that our objective working hour data did not include information on on-call work at home, stratification according to medical specialty or possible working hours outside the studied hospital districts. These should be addressed in further studies, although our case-crossover design captured at least the direction and magnitude of the associations. Sickness absences can be recurrent and of various lengths, which were not assessed in our study with the first incident short sickness absence. By restricting the data to the first incident sickness absence, we applied the assumption of “healthy at baseline” as defined by no sickness absence for the time windows and even the time before them. This somewhat decreased the possibility of reversed causation arising from changes in the working hours due to absence and potential recurrence of sickness absences. Although our data was from six Finnish hospital districts, that was widely distributed across Finland covering large regions and would be directly applicable especially to other Nordic countries with similar welfare systems, and results may not be fully applicable to other parts of world.

Conclusions

Strong epidemiological associations suggest that higher numbers of long (>12 h) and very long (>24 h) shifts, short (<11 h) shift intervals and accumulation of work shifts on a single day merit attention as potential risk factors for short sickness absences among physicians working in hospitals. Workload due to these adverse working hour characteristics, which may also disrupt biological rhythms, should be considered in efforts to improve physicians' well-being at work.








Disclosure statement

The authors declare no competing interests.

Funding

This study was financially supported by the Finnish Work Environment Fund [no. 180022] and the Academy of Finland, DIGIHUM-programme [grants 329200, 329202]; Työsuojelurahasto.

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References

- Åkerstedt T, Hallvig D, Kecklund G. 2017. Normative data on the diurnal pattern of the Karolinska Sleepiness Scale ratings and its relation to age, sex, work, stress, sleep quality and sickness absence/illness in a large sample of daytime workers. *J Sleep Res.* 26:559–566. doi:10.1111/jsr.12528
- Ala-Mursula L, Vahtera J, Kivimäki M, Kevin MV, Pentti J. 2002. Employee control over working times: Associations with subjective health and sickness absences. *J Epidemiol Community Health.* 56:272–278. doi:10.1136/jech.56.4.272
- Balch CM, Shanafelt TD, Dyrbye L, Sloan JA, Russell TR, Bechamps GJ, Freischlag JA. 2010. Surgeon distress as calibrated by hours worked and nights on call. *J Am Coll Surg.* 211:609–619. doi:10.1016/j.jamcollsurg.2010.06.393
- Barger LK, Sullivan JP, Blackwell T, O'Brien CS, St Hilaire MA, Rahman SA, Phillips AJK, Qadri S, Wright KP, Segar JL, et al. 2019. Effects on resident work hours, sleep duration, and work experience in a randomized order safety trial evaluating resident-physician schedules (ROSTERS). *Sleep.* 42:zsz110. doi:10.1093/sleep/zsz110
- Boschman JS, Noor A, Sluiter JK, Hagberg M. 2017. The mediating role of recovery opportunities on future sickness absence from a gender- and age-sensitive perspective. *PLoS One.* 12:e0179657. doi:10.1371/journal.pone.0179657
- Cotter L, Roberts T, Graham B, Horner D, Stevens KN, Enki D, Lyttle MD, Latour J; Trainee Emergency Research N, Paediatric Emergency Research in the UK, Ireland. 2020. Need for recovery amongst emergency physicians in the UK and Ireland: A cross-sectional survey. *BMJ Open.* 10:e041485. doi:10.1136/bmjopen-2020-041485
- Dall'Ora C, Ball J, Redfern O, Recio-Saucedo A, Maruotti A, Meredith P, Griffiths P. 2019. Are long nursing shifts on hospital wards associated with sickness absence? A longitudinal retrospective observational study. *J Nurs Manag.* 27:19–26. doi:10.1111/jonm.12643
- Daniel DA, Poynter SE, Landrigan CP, Czeisler CA, Burns JP, Wolbrink TA. 2020. Pediatric resident engagement with an online critical care curriculum during the intensive care rotation. *Pediatr Crit Care Med.* 21:986–991. doi:10.1097/PCC.0000000000002477
- Eurofound. 2012. Sustainable work and the ageing workforce. A report based on the fifth European Working Conditions Survey. Luxembourg: Publications Office of the European Union. ef1266en.pdf (europa.eu).
- Finnish Institute of Occupational Health. 2021. Työaikaisten kuormittavuuden arviointi jaksotyössä (in English: Evaluation of working hour loading in irregular shift work). Helsinki.
- Griffiths P, Dall'Ora C, Sinden N, Jones J. 2019. Association between 12-hr shifts and nursing resource use in an acute hospital: Longitudinal study. *J Nurs Manag.* 27:502–508. doi:10.1111/jonm.12704
- Harbeck B, Siefert S, Haas CS, Lehnert H, Kropp P, Moenig H. 2015. No stress after 24-hour on-call shifts? *J Occup Health.* 57:438–447. doi:10.1539/joh.14-0276-OA
- Harma M, Karhula K, Puttonen S, Ropponen A, Koskinen A, Ojajarvi A, Kivimäki M. 2019. Shift work with and without night work as a risk factor for fatigue and changes in sleep length: A cohort study with linkage to records on daily working hours. *J Sleep Res.* 28:e12658. doi:10.1111/jsr.12658
- Harma M, Karhula K, Ropponen A, Puttonen S, Koskinen A, Ojajarvi A, Hakola T, Pentti J, Oksanen T, Vahtera J, 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.* 44:394–402. doi:10.5271/sjweh.3730
- Harma M, Koskinen A, Sallinen M, Kubo T, Ropponen A, Lombardi DA. 2020. Characteristics of working hours and the risk of occupational injuries among hospital employees: A case-crossover study. *Scand J Work Environ Health.* 46:570–578. doi:10.5271/sjweh.3905
- Harrison EM, Walbeek TJ, Maggio DG, Herring AA, Gorman MR. 2019. Circadian profile of an emergency medicine department: Scheduling practices and their effects on sleep and performance. *J Emerg Med.* S0736-4679(19)30839-X. doi:10.1016/j.jemermed.2019.10.007
- Helgesson M, Gustafsson K, Marklund S, Aronsson G, Leineweber C. 2021. Sickness absence and sickness presence among health and care employees in Sweden—health complaints, health behavior, and future long-term sickness absence. *J Occup Environ Med.* 63:514–520. doi:10.1097/JOM.0000000000002181
- Heponiemi T, Puttonen S, Elovainio M. 2014. On-call work and physicians' well-being: Testing the potential mediators. *Occup Med (Lond).* 64:352–357. doi:10.1093/occmed/kqu036
- Kancherla BS, Upender R, Collen JF, Rishi MA, Sullivan SS, Ahmed O, Berneking M, Flynn-Evans EE, Peters BR, Gurubhagavatula I. 2020. What is the role of sleep in physician burnout? *J Clin Sleep Med.* 16:807–810. doi:10.5664/jcsm.8412
- Kivimäki M. 2001. Sickness absence in hospital physicians: 2 year follow up study on determinants. *Occup Environ Med.* 58:361–366. doi:10.1136/oem.58.6.361
- Kristensen TR, Jensen SM, Kreiner S, Mikkelsen S. 2010. Socioeconomic status and duration and pattern of sickness absence. A 1-year follow-up study of 2331 hospital employees. *BMC Public Health.* 10:643. doi:10.1186/1471-2458-10-643
- Laaksonen M, He L, Pitkaniemi J. 2013. The durations of past sickness absences predict future absence episodes. *J Occup Environ Med.* 55:87–92. doi:10.1097/JOM.0b013e318270d724
- Leinonen T, Viikari-Juntura E, Husgafvel-Pursiainen K, Virta LJ, Laaksonen M, Autti-Ramo I, Solovieva S. 2018. Labour market segregation and gender differences in sickness absence: Trends in 2005–2013 in Finland. *Ann Work Expo Health.* 62:438–449. doi:10.1093/annweh/wxx107

- Lindfors PM, Nurmi KE, Meretoja OA, Luukkonen RA, Viljanen AM, Leino TJ, Harma MI. 2006. On-call stress among Finnish anaesthetists. *Anaesthesia*. 61:856–866. doi:10.1111/j.1365-2044.2006.04749.x
- Maclure M, Mittleman MA. 2000. Should we use a case-crossover design? *Annu Rev Public Health*. 21:193–221. doi:10.1146/annurev.publhealth.21.1.193
- Mak NT, Li J, Wiseman SM. 2019. Resident physicians are at increased risk for dangerous driving after extended-duration work shifts: A systematic review. *Cureus*. 11:e4843. doi:10.7759/cureus.4843
- Marmot M, Feeney A, Shipley M, North F, Syme SL. 1995. Sickness absence as a measure of health status and functioning: From the UK Whitehall II study. *J Epidemiol Community Health*. 49:124–130. doi:10.1136/jech.49.2.124
- Nicol AM, Botterill JS. 2004. On-call work and health: A review. *Environ Health*. 3:15. doi:10.1186/1476-069X-3-15
- Parvanne P, Ruskoaho J, Vänskä J. 2016. Physicians in Finland. Statistics on physicians and the health care system 2016. Helsinki: Finnish Medical Association.
- Pekkala J, Blomgren J, Pietilainen O, Lahelma E, Rahkonen O. 2017. Occupational class differences in diagnostic-specific sickness absence: A register-based study in the Finnish population, 2005–2014. *BMC Public Health*. 17:670. doi:10.1186/s12889-017-4674-0
- Petrie K, Crawford J, LaMontagne AD, Milner A, Dean J, Veness BG, Christensen H, Harvey SB. 2020. Working hours, common mental disorder and suicidal ideation among junior doctors in Australia: A cross-sectional survey. *BMJ Open*. 10:e033525. doi:10.1136/bmjopen-2019-033525
- Rebnord IK, Morken T, Maartmann-Moe K, Hunskaar S. 2020. Out-of-hours workload among Norwegian general practitioners - an observational study. *BMC Health Serv Res*. 20:944. doi:10.1186/s12913-020-05773-7
- Ro KE, Gude T, Tyssen R, Aasland OG. 2008. Counselling for burnout in Norwegian doctors: One year cohort study. *BMJ*. 337:a2004. doi:10.1136/bmj.a2004
- Rodriguez-Jareno MC, Demou E, Vargas-Prada S, Sanati KA, Skerjanc A, Reis PG, Helimaki-Aro R, Macdonald EB, Serra C. 2014. European working time directive and doctors' health: A systematic review of the available epidemiological evidence. *BMJ Open*. 4:e004916. doi:10.1136/bmjopen-2014-004916
- 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. doi:10.1016/j.ijnurstu.2018.11.002
- Ropponen A, Koskinen A, Puttonen S, Harma M. 2020. A case-crossover study of age group differences in objective working-hour characteristics and short sickness absence. *J Nurs Manag*. 28:787–796. doi:10.1111/jonm.12992
- Rosta J, Gerber A. 2007. Excessive working hours and health complaints among hospital physicians: A study based on a national sample of hospital physicians in Germany. *Ger Med Sci*. 5:Doc09.
- Rosta J, Tellnes G, Aasland OG. 2014. Differences in sickness absence between self-employed and employed doctors: A cross-sectional study on national sample of Norwegian doctors in 2010. *BMC Health Serv Res*. 14:199. doi:10.1186/1472-6963-14-199
- Rosvold EO, Bjertness E. 2001. Physicians who do not take sick leave: Hazardous heroes? *Scand J Public Health*. 29:71–75. doi:10.1177/14034948010290010101
- Rothenberger DA. 2017. physician burnout and well-being: A systematic review and framework for action. *Dis Colon Rectum*. 60:567–576. doi:10.1097/DCR.0000000000000844
- Sallinen M, Kecklund G. 2010. Shift work, sleep, and sleepiness - differences between shift schedules and systems. *Scand J Work Environ Health*. 36:121–133. doi:10.5271/sjweh.2900
- Smiley RA, Lauer P, Bienemy C, Berg JG, Shireman E, Reneau KA, Alexander M. 2018. The 2017 national nursing workforce survey. *J Nurs Regul*. 9:S4–S88.
- Su IM, Ding DC. 2021. The workload of obstetric doctors working in different modes at a medical center. *Tzu Chi Med J*. 33:87–90. eCollection Jan-Mar 2021. doi:10.4103/tcmj.tcmj_41_20.
- Suadicani P, Olesen K, Bonde JP, Gyntelberg F. 2014. Psychosocial work conditions associated with sickness absence among hospital employees. *Occup Med (Lond)*. 64:503–508. doi:10.1093/occmed/kqu064
- Wada K, Yoshikawa T, Goto T, Hirai A, Matsushima E, Nakashima Y, Akaho R, Kido M, Hosaka T. 2010. National survey of the association of depressive symptoms with the number of off duty and on-call, and sleep hours among physicians working in Japanese hospitals: A cross sectional study. *BMC Public Health*. 10:127. doi:10.1186/1471-2458-10-127
- Weigl M, Catchpole K, Wehler M, Schneider A. 2020. Workflow disruptions and provider situation awareness in acute care: An observational study with emergency department physicians and nurses. *Appl Ergon*. 88:103155. doi:10.1016/j.apergo.2020.103155