<https://helda.helsinki.fi>

The effects of using participatory working time scheduling software on working hour characteristics and wellbeing : A quasi-experimental study of irregular shift work

Karhula, Kati

2020-12

Karhula , K , Turunen , J , Hakola , T , Ojajärvi , A , Puttonen , S , Ropponen , A , Kivimäki , M & Härmä , M 2020 , ' The effects of using participatory working time scheduling software on working hour characteristics and wellbeing : A quasi-experimental study of irregular shift work ' , International Journal of Nursing Studies , vol. 112 , 103696 . <https://doi.org/10.1016/j.ijnurstu.2020.103696>

<http://hdl.handle.net/10138/336526>

<https://doi.org/10.1016/j.ijnurstu.2020.103696>

cc_by_nc_nd

acceptedVersion

Downloaded from Helda, University of Helsinki institutional repository.

This is an electronic reprint of the original article.

This reprint may differ from the original in pagination and typographic detail.

Please cite the original version.

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/ijns

The effects of using participatory working time scheduling software on working hour characteristics and wellbeing: A quasi-experimental study of irregular shift work☆☆☆

Kati Karhula^{a,*}, Jarno Turunen^{a,b}, Tarja Hakola^a, Anneli Ojajärvi^a, Sampsa Puttonen^a, Annina Ropponen^a, Mika Kivimäki^{a,c,d}, Mikko Härmä^a

^aFinnish Institute of Occupational Health (Työterveyslaitos), P.O. Box 40, FI-00032 Helsinki, Finland

^bJyväskylä University School of Business and Economics, Jyväskylä, Finland

^cClinicum, Faculty of Medicine, University of Helsinki, Helsinki, Finland

^dDepartment of Epidemiology and Public Health, University College London, London, United Kingdom

ARTICLE INFO

Article history:

Received 14 February 2020

Received in revised form 17 June 2020

Accepted 17 June 2020

Available online xxx

Keywords:

Shift work

Work time control

Working time autonomy

Self-rostering

Hospital employees, health care

Nursing

ABSTRACT

Background: Studies in the health care sector indicate that good work time control is associated with better perceived wellbeing but also with non-ergonomic work schedules, such as compressed work schedules. Participatory working time scheduling is a collaborative approach to scheduling shift work. Currently, there is a lack of information on whether working hour characteristics and employees' wellbeing in irregular shift work change after implementing participatory working time scheduling.

Objective: To investigate the effects of using digital participatory working time scheduling software on working hour characteristics and well-being among Finnish hospital employees.

Participants and methods: We compared changes in objective working hour characteristics and wellbeing between 2015 and 2017 among employees ($n=677$, mainly nurses and practical nurses) when using participatory working time scheduling software (participatory scheduling, $n=283$) and traditional shift scheduling (traditional scheduling, $n=394$). The statistical analyses were conducted using the repeated measures general linear model and the generalized logit model for binomial and multinomial variables adjusted for age, sex, education, shift work experience, control over scheduling of shifts at baseline (where applicable) and hospital district.

Results: The proportion of long work shifts (≥ 12 h) increased to a greater extent ($F=4.642$, $p=0.032$) with the participatory scheduling than with the traditional scheduling. In comparison to traditional scheduling, the perceived control over scheduling of shifts increased (OR 3.24, 95% CI 1.73–6.06) and excessive sleepiness in connection with evening shifts decreased (OR 0.40, 95% CI 0.16–0.99) significantly with participatory scheduling. None of the other wellbeing variables showed statistically significant changes in the adjusted models.

Conclusions: The proportion of long work shifts and perceived control over scheduling of shifts increased more among employees using participatory working time scheduling than among those using traditional scheduling. Otherwise, using participatory working time scheduling software had little effect on both objectively measured working hour characteristics and perceived wellbeing in comparison to traditional scheduling. The results merit confirmation in a larger sample with a longer follow-up.

Tweetable abstract

Participatory working time scheduling combines individual flexibility and staffing requirements in shift work.

© 2020 Elsevier Ltd. All rights reserved.

☆ This manuscript is submitted for 'Shift work in nursing' special Issue of International Journal of Nursing Studies.

☆☆ This study was registered to ClinicalTrials.gov (NCT02775331) before starting the intervention phase.

* Corresponding author.

E-mail address: kati.karhula@ttl.fi (K. Karhula).

<https://doi.org/10.1016/j.ijnurstu.2020.103696>

0020-7489/© 2020 Elsevier Ltd. All rights reserved.

What is already known about the topic?

- Previous research shows that good work time control associates positively with wellbeing at work, but may result in poorer ergonomics, for example compressed work schedules.
- Among nursing staff, good work time control can increase staff retention.

- As a new, collaborative form of working time arrangement, participatory working time scheduling can combine individual flexibility and staffing requirements in shift work.

What this paper adds

- Data on objective working hour characteristics show that working hour characteristics change only slightly after the implementation of participatory working time scheduling.
- Long work shifts increased among employees who used participatory working time scheduling software compared to employees who continued in traditional scheduling.
- Using participatory working time scheduling software had a positive effect on employees' perceived control over scheduling of shifts compared to traditional scheduling.

1. Introduction

Shift workers comprise more than one fifth of the workforce (Eurofound 2016). In many countries, health care workers have the largest proportion of shift workers, e.g., 60% of nurses work shifts in the National Health Service in the UK (Ball et al., 2015). Shift work has many negative impacts on employees' health and well-being, including insufficient sleep (Kecklund and Axelsson 2016), increased risk of occupational injuries (Nielsen et al., 2018), type 2 diabetes (Gao et al., 2020), breast cancer (Pahwa et al., 2018), and coronary heart disease (Torquati et al., 2018). Actions that promote shift workers' health, recovery, and wellbeing at work are thus needed.

Earlier research on work time control in shift work has mainly used the concepts self-rostering or self-scheduling, referring to a method that allows employees a certain amount of flexibility in choosing their shift patterns, which management can augment in terms of coping with operational requirements (Bailyn et al., 2007). Whereas self-rostering can be understood as individual entitlement (Barrett and Holme 2018), participatory working time scheduling is a collaborative approach in which working time legislation, operation of the ward, and employees' equality and fairness are all taken into account (Hakola et al., 2007) in cycles of negotiations and adjustments of schedules. Participatory working time scheduling is both an opportunity and an obligation for the employee to participate in their own scheduling and their ward's scheduling, which in turn affects the consistency of scheduling at the ward level.

As previous studies have mainly investigated good work time control in shift work either using surveys on work time control or studied the effects of self-rostering instead of participatory working time scheduling, we cite these studies here. Good opportunities to influence working hours have many positive effects on day and shift workers' wellbeing, including improved sleep quality (Takahashi et al., 2011; Tucker et al., 2015), work-life balance (Keeton et al., 2007; Nijp et al., 2012), job/career satisfaction (Lowden and Åkerstedt 2000; Pryce et al., 2006; Clem et al., 2008), as well as decreased depressive symptoms (Takahashi et al., 2011), sickness absence (Nätti et al., 2015) and burnout (Keeton et al., 2007). In one cohort study, good work time control was even related to later retirement beyond the pensionable age (Virtanen et al., 2014). Among nursing staff, providing good opportunities to influence working hours seems to be a promising measure for increasing staff retention (Leineweber et al., 2016). Cohort studies have linked low control over working hours with psychological distress (Ala-Mursula et al., 2002; Vahtera et al., 2010), an increased risk of sleep disturbances (Salo et al., 2014), and poor perceived health (Ala-Mursula et al., 2002; Vahtera et al., 2010). Thus, employee-oriented flexibility is beneficial for employees and indeed, workplaces have increasingly implemented flexible work time arrangements (Beckers et al., 2012).

However, in shift work, the introduction of self-rostering may result in poorer ergonomic work schedules. Research shows that employees may prioritize longer continuous free time at the cost of sufficient sleep and recovery (Kecklund et al., 2008; Beckers et al., 2012) as well as at the cost of the functionality of the operations of the unit or workplace (Barrett and Holme 2018). The few previous intervention studies on this area show none or minor negative changes in working hour ergonomics after the implementation of self-rostering. In a Danish study, self-rostering increased both short and long shift durations, but did not compromise most recommendations for ergonomic shift work schedules (Garde et al., 2012) that restrict circadian disruption and promote sufficient sleep and recovery. On the other hand, self-rostering among nursing staff has been reported to result in significantly improved work-life balance (Wortley and Grierson-Hill 2003), which may, in turn, lead to increased staff retention (Barrett and Holme 2018).

As most of the earlier studies on work-time control are not experimental, we lack information on how working hour characteristics change after increasing employees' control over working hours. Our previous cross-sectional study (Karhula et al., 2019) utilized objective working hour data and showed that high perceived control over scheduling of shifts was associated with slightly more weekend work and more variability in shift length. Nevertheless, no association was found between most of the working hour characteristics studied, including short shift intervals and number of consecutive night shifts, and level of control over scheduling of shifts. Importantly, there is a further lack of studies on participatory working time scheduling and the implementation of participatory working time scheduling at workplaces.

In this study, we were able to observe the implementation of participatory working time scheduling software and utilize extensive objective working hour data to study the changes in the exact proportions of different working hour characteristics. The aim of the study was to investigate the effects of the implementation of software for participatory working time scheduling on realized working hour characteristics and changes in several wellbeing outcomes. These outcomes included self-reported sleep length, shift-specific insomnia and excessive sleepiness, work-life conflict, control over scheduling of shifts, and perceived health. We expected that the implementation of participatory working time scheduling software would decrease work-life conflict and increase perceived control over the scheduling of shifts, but also result in more irregularity in shift schedules, which might weaken shift ergonomics within the boundaries set in the studied shift scheduling software.

2. Methods

2.1. Study sample and participants

The study participants were hospital employees from three hospital districts that participated in the Finnish Public Sector (FPS) study survey in 2015 ($n = 11\,274$, response rate 69%) and 2017 ($n = 9\,030$, response rate 74%) and who had objective working hour data from Titania® (CGI Finland Ltd, Helsinki, Finland) shift scheduling software for 91 days preceding both survey waves. To be included in the quasi-experimental intervention, all the three hospital districts needed to have wards that were included in the intervention as well as wards that acted as controls. The employees had to be shift workers (with a minimum of three evening and three night shifts during the past 91 days) and to have had at least 31 work shifts during the past 91 days. All the employees worked on a period-based work contract (114:45 h/3 weeks) and had a

Fig. 1. Flow chart of study's inclusion criteria.

monthly salary. Day workers were excluded due to the lack of most of the studied working hour characteristics, and physicians were excluded due to on-call work not being registered in the database. The employees worked in wards that either started to use the new participatory working time scheduling software (from here on participatory scheduling) or remained in traditional shift scheduling (from here on traditional scheduling) (Fig. 1.).

2.2. Objective working hour data

The objective working hour data were retrieved from the shift scheduling program Titania®. Based these data we formed the following working hour characteristics: long (> 40 h) and very long (> 48 h) weekly working hours, long (≥ 12 h) work shifts, quick returns (< 11 h shift interval), single days off, evening shifts (starts after 12:00 and is not categorized as night shift) and night shifts (≥ 3 h between 23:00 and 06:00 according to the Finnish Working Time Act) and weekend work. The methodology of retrieving and analysing the daily payroll working hour data has been described earlier (Härmä et al., 2015).

2.3. Survey variables

We used the survey variables of age, sex, level of education, shift work experience and perceived control over scheduling of shifts at baseline (where applicable) as covariates in the statistical models, which are described later. Education was categorized into three levels: basic, vocational and applied university- or university-

level education. Duration of shift work experience was elicited by asking 'How long have you worked shifts altogether?' The response was the total number of years in shift work.

The wellbeing outcomes of interest included work-life conflict, perceived health, perceived control over scheduling of shifts, sleep duration, and shift-specific insomnia and excessive sleepiness symptoms. Work-life conflict was elicited by asking 'How often do you feel that your work takes too much time or energy from your family-life or life?' adapted from Mårdberg et al. (1991). The response options were on a five-point Likert-type scale from never to very often, and they were dichotomized: 'never' to 'sometimes' as not having work-life conflict, and 'often' and 'very often' as having work-life conflict. Perceived health was measured using a five-point Likert-type scale from good to poor (Blaxter 1987). When dichotomized, poor perceived health included the alternatives 'poor' and 'rather poor', and good perceived health the three alternatives 'intermediate', 'rather good' and 'good'. Perceived control over scheduling of shifts was elicited by asking 'How much control do you have over the scheduling of work shifts?' (Ala-Mursula et al., 2002). The responses 'very much' and 'much' were classified as good control, 'some' as intermediate control, and 'little' and 'very little' as low control. The baseline answers were used as covariates where applicable.

Average 24 h sleep duration was elicited with the question 'How many hours do you normally sleep during a 24-h period?' with options from five hours or less to ten hours or more in 30-min intervals (Vahtera et al., 2006). The responses were categorized into three classes; short sleep (≤ 6 h), normal sleep (6.5–8.5 h)

Table 1
Descriptive statistics of participants.

	All <i>n</i> = 677		Participatory scheduling <i>n</i> = 283		Traditional scheduling <i>n</i> = 394		Group difference
	Mean	SD	Mean	SD	Mean	SD	Sig. ¹
Age (years)	40.8	(10.95)	39.9	(11.71)	41.3	(10.39)	0.150
Shift work experience (years)	13.6	(9.64)	13.6	(10.57)	13.6	(8.99)	0.461
	%	(<i>n</i>)	%	(<i>n</i>)	%	(<i>n</i>)	Sig.
Sex							< 0.001 ²
Female	79.2	(536)	93.8	(166)	72.0	(193)	
Male	20.8	(141)	6.2	(11)	28.0	(75)	
Level of education							< 0.001 ³
Basic	5.2	(23)	0.6	(1)	8.3	(22)	
Vocational	43.1	(190)	41.5	(73)	44.2	(117)	
Bachelor or higher	51.7	(228)	58.0	(102)	47.5	(126)	
Full-time work							< 0.001 ²
Yes	87.0	(589)	74.9	(212)	95.7	(377)	
No	13.0	(88)	25.1	(71)	4.3	(17)	
Job title							0.268 ¹
Registered nurse	64.4	(436)	73.9	(209)	57.6	(227)	
Psychiatric nurse	7.4	(50)	2.8	(8)	10.7	(42)	
X-ray nurse	4.3	(29)	1.4	(4)	6.3	(25)	
Practical nurse	8.4	(57)	9.9	(28)	7.4	(29)	
Other ⁴	15.5	(105)	12.0	(34)	18.0	(71)	

¹ Mann-Whitney *U* test.² Fisher's exact test.³ Pearson Chi-Square test.⁴ Other health care professions, instrument attendants, hospital cleaners, and porters.

and long sleep (≥ 9 h). Insomnia and excessive sleepiness were elicited separately using shift-specific questions 'How often have you experienced insomnia/excessive sleepiness in connection with morning/evening/night shifts or on days off during the past three months?' The response options were on a six-point Likert-type scale from 'not at all' to 'every day' (Vanttola et al., 2020). The answers were classified as having sleep difficulties if the frequency was at least two times per week.

2.4. Quasi-experimental participatory working time scheduling intervention

In this quasi-experimental intervention, the researchers had no influence on the implementation process of the working time scheduling software in the hospital districts. The hospital districts followed internal processes to decide which units started to use the digital participatory working time scheduling software and when. The introduction period, training and negotiations regarding the rules that outlined the shift scheduling (for example, minimum number of night shifts or weekend shifts per employee in each three-week period) were also organized internally. Based on the ward-level rules, each employee recorded their schedules in three-week periods in the software in a view that showed current staffing requirements in the ward and the ergonomics of their planned schedule in traffic light colour coding (i.e. green = good, yellow = moderate, orange = should be avoided and red = forbidden). The employees were able to check the ergonomic criteria for each colour in a separate view. The shift ergonomics tool consisted of working time dimensions and characteristics that are described in detail in Härmä et al. (2015).

To ensure enough experience in using the participatory working time scheduling software, only the employees from the wards that had been using the Titania® software for at least the whole of 2017 (365 days) were included in the participatory scheduling group. The traditional scheduling group was selected from among the employees who worked in the wards that continued using traditionally scheduled rosters in the same hospital districts. In our

study, traditional scheduling meant that in these units, a head nurse or a shift planner made the plans for three-week periods at least two weeks before the start of a new period. The employees had the opportunity to express their wish for single shifts (i.e., due to personal needs or preferences). After the person responsible for planning agreed, the final version of the three-week roster was made available to the employees at least one week before the beginning of the three-week period. A head nurse or shift planner used the shift scheduling program and may have had access to the information in the shift ergonomics view, depending on the software version. Employees who had used the new working time scheduling software for only part of 2017 (*n* = 669) were excluded.

2.5. Ethical issues

All the hospital districts gave the Finnish Institute of Occupational Health their written permission to use the employers' working time registries for its research. All data were anonymized, and international ethical standards were conformed to. The coordinating ethics committee of the Hospital District of Helsinki and Uusimaa (HUS) approved this study as part of the Finnish Public Sector study ethical approval (HUS 1210/2016). As required by The International Committee of Medical Journal Editors (Zarin et al., 2011), the intervention was registered to ClinicalTrials.gov (NCT02775331) before the intervention phase began. The primary outcome of the intervention, sickness absence, is reported by Turunen et al. (2020).

2.6. Statistical methods

The statistical analyses were conducted using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA) and SAS 9.4 (SAS Institute Inc., Cary, North Carolina, USA) software. Changes in the continuous objective working hour characteristics between 2015 and 2017 were analysed using repeated measures GLM (general linear model). The within-subject GLM models were run to calculate

the F- and p-values for both the unadjusted and adjusted models. Mauchly's test of sphericity showed no violation of sphericity and therefore no corrections were used. The fully adjusted model included age, sex, level of education, shift work experience, perceived control over scheduling of shifts at baseline (where applicable) and finally, hospital district, to control for possible differences between the three hospital districts studied. Changes in the categorical wellbeing outcomes (work-life conflict, control over scheduling of shifts, perceived health and shift-specific insomnia and excessive sleepiness) between 2015 and 2017 were analysed using a generalized logit model for binomial and multinomial variables. The fully adjusted model included age, sex, level of education, shift work experience, perceived control over scheduling of shifts at baseline (where applicable) and hospital district.

3. Results

3.1. Characteristics of participants

The participants' ($n = 677$) mean age was 40.8 years, and 84% were females and 87% full-time workers. The participants' descriptive characteristics are shown in Table 1. At baseline, the proportion of participants with at least a bachelor's degree and part-time work as well as the proportion of females was larger in the participatory scheduling group than in the traditional scheduling group. There were no differences between the groups in terms of mean age, shift work experience and job title. The most common occupational titles were registered nurse, practical nurse, psychiatric nurse, and X-ray nurse.

3.2. Using the participatory working time scheduling software and changes in working hour characteristics

In the participatory scheduling group, the participatory working time scheduling software was used for an average of 193 min (range 64–735 min) per employee during 2017.

The working hour characteristics showed some parallel changes in both the participatory and the traditional scheduling (Table 2). In the crude GLM analysis, the proportion of long (> 40 h) and very long (> 48 h) work weeks as well as the proportion of long (≥ 12 h) work shifts and weekend work increased to a greater extent in the participatory than in the traditional scheduling group. In the adjusted models, only the effect on long work shifts remained ($F = 4.642$, $p = 0.032$). The changes in the proportions of short shift intervals, single days off and evening and night shifts did not statistically significantly differ in the participatory and traditional scheduling, neither in the crude nor adjusted models (F -values ≤ 3.361 and p -values ≥ 0.057).

3.3. Effects on wellbeing

In the baseline survey, the participatory and traditional scheduling differed only in terms of perceived control over the scheduling of shifts and often having insomnia in connection with evening shifts. Self-rated sleep length, work-life conflict, perceived health, as well as insomnia and excessive sleepiness in association with all the other shift types did not differ in the participatory scheduling compared to the traditional scheduling (Table 3).

Compared to the traditional scheduling group, perceived control over scheduling of shifts increased significantly in the participatory scheduling group (OR 3.24, 95% CI 1.73–6.06). Experiencing often excessive sleepiness in connection with evening shifts decreased in the participatory scheduling group compared to the traditional scheduling group (OR 0.40, 95% CI 0.16–0.99). The other wellbeing

Table 2
Changes in average proportions (%) of studied working hour characteristics between 2015 and 2017 using repeated measures general linear model (GLM).

Proportion of...	Participatory scheduling $n = 757$						Traditional scheduling $n = 394$						GLM	
	2015			2017			2015			2017			Unadjusted	
	Mean	SD		Mean	SD		Mean	SD		Mean	SD		F	p-value
Long (> 40 h) work weeks of all work weeks	31.97	(13.79)		35.66	(18.68)		34.10	(10.99)		34.35	(16.65)		7.130	0.008
Very long (> 48 h) work weeks of all work weeks	6.49	(8.25)		9.60	(12.12)		6.92	(8.59)		8.71	(12.04)		23.159	< 0.001
Long (≥ 12 h) work shifts of all shifts	6.83	(10.55)		8.32	(9.15)		4.67	(8.69)		4.78	(7.62)		13.607	< 0.001
Short (< 11 h) shift intervals of all shift intervals < 48 h	20.53	(11.18)		19.34	(11.43)		16.92	(10.35)		16.76	(10.62)		3.631	0.057
Single days off of all day off periods	19.32	(10.11)		18.72	(9.34)		19.10	(10.46)		19.80	(10.39)		0.683	0.409
Evening shifts of all shifts	34.22	(11.41)		33.55	(12.06)		35.67	(12.78)		35.71	(11.67)		0.510	0.475
Night shifts of all shifts	27.95	(15.58)		27.80	(15.86)		27.60	(15.49)		26.03	(13.51)		3.250	0.072
Weekend work of all weekends	46.64	(15.46)		52.47	(16.04)		46.47	(17.99)		51.34	(16.28)		68.368	< 0.001

¹ Adjusted for age, sex, level of education, shift work experience, perceived control over scheduling of shifts at baseline (where applicable) and hospital district.

Table 3
Wellbeing measures at baseline (2015).

			All		Participatory scheduling		Traditional scheduling		Group difference Sig.
			%	(n)	%	(n)	%	(n)	
Work-life conflict	Very often/often		42.3	(173)	43.2	(70)	41.7	(103)	0.420 ¹
	Sometimes/seldom/never		57.7	(231)	56.8	(92)	58.3	(144)	
Perceived health	Good/rather good		85.5	(377)	88.6	(155)	83.5	(222)	0.087 ¹
	Intermediate/rather poor/poor		14.5	(64)	11.4	(20)	16.5	(44)	
Perceived control over scheduling of shifts	Good		37.5	(165)	50.3	(88)	29.1	(77)	<0.001 ²
	Intermediate		43.9	(193)	37.7	(66)	47.9	(127)	
	Poor		18.6	(82)	12.0	(21)	23.0	(61)	
Sleep length	≤ 6h		13.0	(57)	10.9	(19)	14.3	(38)	0.563 ²
	> 6–≤ 8.5h		82.7	(364)	84.6	(148)	81.5	(216)	
	≥ 9h		4.3	(19)	4.6	(8)	4.2	(11)	
Insomnia	Morning shifts	≤ 1/week	75.1	(331)	78.9	(138)	72.5	(193)	0.083 ¹
		≥ 2/week	24.9	(110)	21.1	(37)	27.4	(73)	
	Evening shifts	≤ 1/week	90.5	(399)	93.7	(164)	88.3	(235)	0.041 ¹
		≥ 2/week	9.5	(42)	6.3	(11)	11.7	(31)	
	Night shifts	≤ 1/week	82.8	(365)	85.6	(149)	80.9	(216)	0.123 ¹
		≥ 2/week	17.2	(76)	14.4	(25)	19.1	(51)	
	Days off	≤ 1/week	95.7	(420)	96.0	(167)	95.5	(253)	0.500 ¹
		≥ 2/week	4.3	(19)	4.0	(7)	4.5	(12)	
Excessive sleepiness	Morning shifts	≤ 1/week	65.8	(288)	66.5	(115)	65.3	(173)	0.440 ¹
		≥ 2/week	34.2	(150)	33.5	(58)	34.7	(92)	
	Evening shifts	≤ 1/week	93.2	(411)	95.4	(167)	91.7	(244)	0.092 ¹
		≥ 2/week	6.8	(30)	4.6	(8)	8.3	(22)	
	Night shifts	≤ 1/week	70.1	(309)	67.8	(118)	71.5	(191)	0.233 ¹
		≥ 2/week	29.9	(132)	32.2	(56)	28.5	(76)	
	Days off	≤ 1/week	87.7	(384)	87.2	(150)	88.0	(234)	0.462 ¹
		≥ 2/week	12.3	(54)	12.8	(22)	12.0	(32)	

¹ Fisher's exact test.² Pearson Chi-Square test.**Table 4**
Changes in wellbeing outcomes between 2015 and 2017 in participatory scheduling group (traditional scheduling as reference). Results from generalized logit model to binomial and multinomial variables presented as odds ratios (OR) and their 95% confidence intervals (CI).

		Unadjusted		Adjusted ¹	
		Participatory scheduling		Participatory scheduling	
		OR	(95% CI)	OR	(95% CI)
Sleep length (hours)	≤ 6 h vs. 6–8.5h	0.86	(0.63–1.19)	0.93	(0.58–1.49)
	≥ 9 h vs. 6–8.5h	1.01	(0.46–2.20)	1.43	(0.51–4.02)
Work-life conflict	Often vs. seldom/never	1.27	(0.95–1.70)	1.03	(0.67–1.59)
Control over scheduling of shifts	High vs. intermediate	2.30	(1.52–3.48)	3.24	(1.73–6.06)
	Low vs. intermediate	0.27	(0.09–0.81)	0.41	(0.09–1.84)
Perceived health	Poor vs. good	0.56	(0.14–2.15)	1.17	(0.15–9.32)
Insomnia in connection with...					
Morning shifts	≥ 2/week vs. ≤ 1/week	0.92	(0.65–1.30)	1.29	(0.79–2.08)
Evening shifts	≥ 2/week vs. ≤ 1/week	0.88	(0.67–1.16)	0.84	(0.56–1.26)
Night shifts	≥ 2/week vs. ≤ 1/week	1.09	(0.79–1.51)	1.29	(0.81–2.06)
Days off	≥ 2/week vs. ≤ 1/week	1.11	(0.85–1.46)	1.09	(0.74–1.61)
Excessive sleepiness ² in...					
Morning shifts	≥ 2/week vs. ≤ 1/week	0.96	(0.69–1.32)	1.08	(0.70–1.66)
Evening shifts	≥ 2/week vs. ≤ 1/week	0.73	(0.41–1.28)	0.40	(0.16–0.99)
Night shifts	≥ 2/week vs. ≤ 1/week	1.43	(1.03–1.98)	1.00	(0.64–1.58)
Days off	≥ 2/week vs. ≤ 1/week	1.10	(0.71–1.71)	1.08	(0.60–1.94)

¹ Adjusted for age, sex, level of education, shift work experience, perceived control over scheduling of shifts at baseline (where applicable), and hospital district.² During past 3 months.

at work variables showed no statistically significant changes in the adjusted models (Table 4).

4. Discussion

The aim of this study was to investigate the effects of the implementation of participatory working time scheduling software on realized working hour characteristics and perceived wellbeing. The study was conducted among hospital employees from wards that used the participatory working time scheduling software through-

out 2017 and employees from wards that continued with traditional shift scheduling.

Working hour characteristics showed parallel changes in both participatory and traditional scheduling during the follow-up, demonstrating a small increase in the proportion of long and very long work weeks, long work shifts and weekend work, and a decrease in the proportion of short shift intervals in both groups. However, only the increase in the proportion of long work shifts was greater in the participatory scheduling than in the controls. Therefore, the expected increase in irregularity of shift schedules

in the participatory scheduling was not confirmed. Perceived control over scheduling of shifts increased and excessive sleepiness in connection with evening shifts decreased significantly with participatory scheduling. The other wellbeing outcomes did not show statistically significant differences between the participatory scheduling and traditional scheduling.

To the best of our knowledge, no previous studies have investigated the effect of participatory working time scheduling on objective working hour characteristics. Moreover, only a few studies that have used the partly overlapping concept of self-rostering and objective working hour data exist. In Denmark, self-rostering decreased the proportion of single days off (Garde et al., 2012). In this study, the non-significant results showed a tendency for the proportion of single days off to decrease with participatory scheduling and increase with traditional scheduling. However, in this study, the only statistically significant difference in working hour characteristics between the participatory scheduling and the traditional scheduling after adjustment was the increase in the proportion of long work shifts, which was higher in the participatory scheduling. This is also in line with results from a Danish self-rostering study (Garde et al., 2012). Among nurses, working long shifts has been associated with negative outcomes, such as fatigue (Dall'Ora et al. 2016) and higher error rates (Clendon and Gibbons 2015). However, in this study, the proportion of long work shifts of all shifts was low (< 10% of all shifts in the participatory scheduling) and the results showed no other differences in excessive sleepiness except for evening shifts according to whether the scheduling was participatory or traditional. The overall minor effects on working hour characteristics can be partly due to the shift ergonomics information in traffic light colour coding that was a part of the most recent versions of the scheduling software.

In this quasi-experimental study, we found an increase in the perceived control over the scheduling of shifts after using participatory working time scheduling software. Previous intervention studies have shown somewhat conflicting results regarding the effects of the implementation of self-rostering on different aspects of wellbeing. A previous Finnish study reported positive effects on health care workers' sleep, social life and leisure time (Hakola et al., 2007). However, several other studies (Lowden and Åkerstedt 2000; Garde et al., 2011; Nabe-Nielsen et al., 2011), like ours, have found no or very little effect on sleep quality. A plausible explanation for no effects on sleep in this and previous studies (Garde et al., 2011; Nabe-Nielsen et al., 2011) is that even when self-rostering or participatory working time scheduling is in use, shift start and end times in the health care sector are rather fixed, including, for example, the start of morning shifts and the end of evening shifts, which play a role in having the opportunity for sufficient sleep. Moreover, even though interventions aiming to increase control over working hours seem to increase employees' satisfaction with working hours (Lowden and Åkerstedt 2000), employees may have unrealistic expectations of how much their control over working hours increases, whereas in reality shift start and end times and staffing requirements, for example, still set boundaries for individual schedules. In addition, when working time control increases, some employees also experience strong injustice regarding the way in which the new scheduling methods are used (Hansen et al., 2015), which in turn may influence their estimations of the effects on wellbeing.

To the best of our knowledge, this is among the largest studies on self-rostering or participatory working time scheduling and one of the first to utilize objective working hour data. The use of objective working hour data is the main strength of this study, as it allowed us to calculate very detailed and accurate exposure to the working hour characteristics. In previous research, working hour data has mostly been self-reported, which is prone to recall bias (Härmä et al., 2017), especially when studying more complex

or irregular working hour characteristics such as long work shifts or short shift intervals. The objective working hour characteristics used in this study have been validated previously (Härmä et al., 2015). The effects of the implementation of the participatory working time scheduling were studied before the intervention and after one year of continuous use of the new software to minimize possible resistance to change, or alternatively, a 'honeymoon period', i.e., stronger adherence in the beginning. The used time period also covered summer vacations and public holidays, which may set challenges for fair shift scheduling. Another strength of this study was that its large sample included a variety of hospital occupations and that the combination of register and survey data enabled multiple adjustments in the statistical models.

Some limitations need to be addressed. The study design and data did not allow us to follow the actual implementation processes in each hospital district. It is likely that the wards that volunteered to start using the new software may have had more flexible scheduling practises before the participatory working time scheduling intervention, as the participants in the participatory scheduling group had higher estimations of work time control at baseline. The proportion of participants in the participatory scheduling group varied between the three hospital districts (11.3%, 33.2% and 55.5%), and it is possible that other staffing policy changes took place in parallel. However, we used hospital district as a covariate in the analysis to control the potential effect on the estimates. It is also possible that successful utilization of participatory working time scheduling requires, for example, more training and staff meetings to set up the policies and rules for each ward.

Secondly, the categorical variables for the wellbeing outcomes set limits for the statistical analysis, and the binomial/multinomial analysis used may have lacked the sensitivity to distinguish small changes in the outcomes. Even though participatory working time scheduling seems a recommendable practice, the generalizability of the results to other working time arrangements may be limited, as shift schedules in hospitals are quite irregular and the Finnish practice is to avoid overtime, when possible (Ropponen et al., 2017).

Despite the analyses being conducted among employees who had used the participatory working time scheduling software for at least a year, the results would merit confirmation by longer follow-up. Previously, good work time control has been associated with strong outcomes, for example, postponed retirement beyond the pensionable age (Virtanen et al., 2014). Further studies should investigate whether successful implementation of participatory working time scheduling would have similar beneficial short- and long-term effects to good work time control. Further research could also more specifically analyse whether the effects of participatory working time scheduling differ between different occupational sectors and which organizational factors, for example, the size and type of the unit, play a role in how fluently working times can be participatorily scheduled.

5. Conclusion

Implementing participatory working time scheduling had no major effect on shift ergonomics. The employees with participatory working time scheduling had long work shifts more often than the employees who continued with traditional scheduling. Using participatory working time scheduling software increased perceived control over scheduling of shifts and decreased excessive sleepiness in connection with evening shifts in comparison to traditional scheduling.

Contributorship statement

All authors (KK, JT, TH, AO, SP, AR, MK, MH) were responsible for the conception and design of the study. KK, JT and MH were responsible for the registration of the intervention, KK, JT and data manager Aki Koskinen for the acquisition of the data, and KK and AO for the data analysis. All the authors took part in interpreting the results. KK wrote the draft of the article and all the authors took part in revising the article. All the authors approved the final version.

Conflict of Interest

The authors report no conflict of interest. The authors are solely responsible for the content and writing of the article.

Funding

This study was funded by the [Finnish Work Environment Fund \(114 317\)](#), by [NordForsk](#), the Nordic Program on Health and Welfare ([74809](#)) and by the European Union's Horizon 2020 research and innovation programme (grant agreement No [826 266](#)). Mika Kivimäki is supported by a professorial fellowship from the Economic and Social Research Council, UK and [NordForsk \(75021\)](#).

Ethical approval

The coordinating ethics committee of the Hospital District of Helsinki and Uusimaa (HUS) approved this study as part of the Finnish Public Sector study ethical approval (HUS 1210/2016).

References

- Ala-Mursula, L., Vahtera, J., Kivimäki, M., Kevin, M.V., Pentti, J., 2002. Employee control over working times: associations with subjective health and sickness absences. *J. Epidemiol. Community Health* 56 (4), 272–278. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&opt=Citation&list_uids=11896134.
- Bailyn, L., Collins, R., Song, Y., 2007. Self-scheduling for hospital nurses: an attempt and its difficulties. *J. Nurs. Manag.* 15 (1), 72–77. doi:[10.1111/j.1365-2934.2006.00633.x](#).
- Ball, J., Maben, J., Murrells, T., Day, T., Griffiths, P., 2015. 12-Hour Shifts: Prevalence, Views and Impact Report National Lead 'Compassion in Practice: Action Area 5' Retrieved from <https://www.england.nhs.uk/6cs/wp-content/uploads/sites/25/2015/06/12-hour-shifts-report.pdf>.
- Barrett, R., Holme, A., 2018. Self-rostering can improve work-life balance and staff retention in the NHS. *Br. J. Nurs.* 27 (5), 264–265. doi:[10.12968/bjon.2018.27.5.264](#).
- Beckers, D.G., Kompier, M.A., Kecklund, G., Härmä, M., 2012. Worktime control: theoretical conceptualization, current empirical knowledge, and research agenda. *Scand. J. Work. Environ. Health* 38 (4), 291–297. doi:[10.5271/sjweh.3308](#).
- Blaxter, M., 1987. Evidence on inequality in health from a national survey. *Lancet* 4 (2), 30–33. doi:[10.1016/s0140-6736\(87\)93062-5](#).
- Clem, K.J., Promes, S.B., Glickman, S.W., Shah, A., Finkel, M.A., Pietrobon, R., Cairns, C.B., 2008. Factors enhancing career satisfaction among female emergency physicians. *Ann. Emerg. Med.* 51 (6), 723–728.e8. doi:[10.1016/j.annemergmed.2008.01.011](#).
- Clendon, J., Gibbons, V., 2015. 12h shifts and rates of error among nurses: a systematic review. *Int. J. Nurs. Stud.* 52 (7), 1231–1242. doi:[10.1016/j.ijnurstu.2015.03.011](#).
- Dall'ora, C., Ball, J., Recio-Saucedo, A., Griffiths, P., 2016. Characteristics of shift work and their impact on employee performance and wellbeing: a literature review. *Int. J. Nurs. Stud.* 57, 12–27. doi:[10.1016/j.ijnurstu.2016.01.007](#).
- Eurofound, 2016. 6th European Working Conditions Survey - Overview Report. Publications Office of the European Union [online]. Available from: http://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf.
- Gao, Y., Gan, T., Jiang, L., Yu, L., Tang, D., Wang, Y., Li, X., Ding, G., 2020. Association between shift work and risk of type 2 diabetes mellitus: a systematic review and dose-response meta-analysis of observational studies. *Chronobiol. Int.* 37 (1), 29–46. doi:[10.1080/07420528.2019.1683570](#).
- Garde, A.H., Albertsen, K., Nabe-Nielsen, K., Carneiro, I.G., Skotte, J., Hansen, S.M., Lund, H., Hvid, H., Hansen, Å.M., 2012. Implementation of self-rostering (the PRIO-project): effects on working hours, recovery, and health. *Scand. J. Work. Environ. Health* 38 (4), 314–326. doi:[10.5271/sjweh.3306](#).
- Garde, A.H., Nabe-Nielsen, K., Aust, B., 2011. Influence on working hours among shift workers and effects on sleep quality - an intervention study. *Appl. Ergon.* 42 (2), 238–243. doi:[10.1016/j.apergo.2010.06.011](#).
- Hakola, T., Koivumäki, M., Sinivaara, M., Kasanen, R., 2007. Working time autonomy and age in health care. *Ergon. IJ&HF* 29 (3–4), 241–245.
- Hansen, Å.M., Nabe-Nielsen, K., Albertsen, K., Høgh, A., Lund, H., Hvid, H., Garde, A.H., 2015. Self-rostering and psychosocial work factors - a mixed methods intervention study. *Appl. Ergon.* 47, 203–210. doi:[10.1016/j.apergo.2014.10.006](#).
- Härmä, M., Koskinen, A., Ropponen, A., Puttonen, S., Karhula, K., Vahtera, J., Kivimäki, M., 2017. Validity of self-reported exposure to shift work. *Occup. Environ. Med.* 74 (3), 228–230. doi:[10.1136/oemed-2016-103902](#).
- Härmä, M., Ropponen, A., Hakola, T., Koskinen, A., Vanttola, P., Puttonen, S., Sallinen, M., Salo, P., Oksanen, T., Pentti, J., Vahtera, J., Kivimäki, M., 2015. Developing register-based measures for assessment of working time patterns for epidemiologic studies. *Scand. J. Work. Environ. Health* 41 (3), 268–279. doi:[10.5271/sjweh.3492](#).
- Karhula, K., Salo, P., Koskinen, A., Ojajarvi, A., Oksanen, T., Puttonen, S., Kivimäki, M., Härmä, M., 2019. Employee control over scheduling of shifts and objectively measured working hour characteristics: a cross-sectional analysis of linked register and survey data. *Chronobiol. Int.* 36 (1), 85–95. doi:[10.1080/07420528.2018.1520240](#).
- Kecklund, G., Axelsson, J., 2016. Health consequences of shift work and insufficient sleep. *BMJ* 355, i5210. doi:[10.1136/bmj.i5210](#).
- Kecklund, G., Eriksen, C.A., Åkerstedt, T., 2008. Police officers attitude to different shift systems: association with age, present shift schedule, health and sleep/wake complaints. *Appl. Ergon.* 39 (5), 565–571. doi:[10.1016/j.apergo.2008.01.002](#).
- Keeton, K., Fenner, D.E., Johnson, T.R., Hayward, R.A., 2007. Predictors of physician career satisfaction, work-life balance, and burnout. *Obstet. Gynecol.* 109 (4), 949–955. doi:[10.1097/01.AOG.0000258299.45979.37](#).
- Leineweber, C., Chungkham, H.S., Lindqvist, R., Westerlund, H., Runesdotter, S., Smeds Alenius, L., Tishelman, C.RN4CAST consortium, 2016. Nurses' practice environment and satisfaction with schedule flexibility is related to intention to leave due to dissatisfaction: a multi-country, multilevel study. *Int. J. Nurs. Stud.* 58, 47–58. doi:[10.1016/j.ijnurstu.2016.02.003](#).
- Lowden, A., Åkerstedt, T., 2000. Introduction of self-selected working hours in retail work - effects on work satisfaction, health and social life. [Einführung selbst gewählter Arbeitszeiten im Einzelhandel - Auswirkungen auf Arbeitszufriedenheit, Gesundheit und Sozialleben]. *Z. Arb. Wiss* 54 (4), 300–305.
- Mårdberg, B., Lundberg, U., Frankenhauser, M., 1991. The total workload of parents employed in white-collar jobs: construction of a questionnaire and a scoring system. *Scand. J. Psychol.* 32 (3), 233–239. doi:[10.1111/j.1467-9450.1991.tb00873.x](#).
- Nabe-Nielsen, K., Garde, A.H., Albertsen, K., Diderichsen, F., 2011. The moderating effect of work-time influence on the effect of shift work: a prospective cohort study. *Int. Arch. Occup. Environ. Health* 84 (5), 551–559. doi:[10.1007/s00420-010-0592-5](#).
- Nätti, J., Oinas, T., Anttila, T., 2015. Time pressure, working time control and long-term sickness absence. *Occup. Environ. Med.* 72 (4), 265–270. doi:[10.1136/oemed-2014-102435](#).
- Nielsen, H.B., Larsen, A.D., Dyreborg, J., Hansen, Å.M., Pompeii, L.A., Conway, S.H., Hansen, J., Kolstad, H.A., Nabe-Nielsen, K., Garde, A.H., 2018. Risk of injury after evening and night work - findings from the Danish working hour database. *Scand. J. Work. Environ. Health* 44 (4), 385–393. doi:[10.5271/sjweh.3737](#).
- Nijp, H.H., Beckers, D.G., Geurts, S.A., Tucker, P., Kompier, M.A., 2012. Systematic review on the association between employee worktime control and work-non-work balance, health and well-being, and job-related outcomes. *Scand. J. Work. Environ. Health* 38 (4), 299–313. doi:[10.5271/sjweh.3307](#).
- Pahwa, M., Labreche, F., Demers, P.A., 2018. Night shift work and breast cancer risk: what do the meta-analyses tell us? *Scand. J. Work. Environ. Health* 44 (4), 432–435. doi:[10.5271/sjweh.3738](#).
- Pryce, J., Albertsen, K., Nielsen, K., 2006. Evaluation of an open-rota system in a Danish psychiatric hospital: a mechanism for improving job satisfaction and work-life balance. *J. Nurs. Manag.* 14 (4), 282–288. doi:[10.1111/j.1365-2934.2006.00617.x](#).

- Ropponen, A., Vanttola, P., Koskinen, A., Hakola, T., Puttonen, S., Härmä, M., 2017. Effects of modifications to the health and social sector's collective agreement on the objective characteristics of working hours. *Ind. Health* 55 (4), 354–361. doi:[10.2486/indhealth.2016-0166](https://doi.org/10.2486/indhealth.2016-0166).
- Salo, P., Ala-Mursula, L., Rod, N.H., Tucker, P., Pentti, J., Kivimäki, M., Vahtera, J., 2014. Work time control and sleep disturbances: prospective cohort study of Finnish public sector employees. *Sleep* 37 (7), 1217–1225. doi:[10.5665/sleep.3842](https://doi.org/10.5665/sleep.3842).
- Takahashi, M., Iwasaki, K., Sasaki, T., Kubo, T., Mori, I., Otsuka, Y., 2011. Worktime control-dependent reductions in fatigue, sleep problems, and depression. *Appl. Ergon.* 42 (2), 244–250. doi:[10.1016/j.apergo.2010.06.006](https://doi.org/10.1016/j.apergo.2010.06.006).
- Torquati, L., Mielke, G.I., Brown, W.J., Kolbe-Alexander, T., 2018. Shift work and the risk of cardiovascular disease. A systematic review and meta-analysis including dose-response relationship. *Scand. J. Work. Environ. Health* 44 (3), 229–238. doi:[10.5271/sjweh.3700](https://doi.org/10.5271/sjweh.3700).
- Tucker, P., Bejerot, E., Kecklund, G., Aronsson, G., Akerstedt, T., 2015. The impact of work time control on physicians' sleep and well-being. *Appl. Ergon.* 47, 109–116. doi:[10.1016/j.apergo.2014.09.001](https://doi.org/10.1016/j.apergo.2014.09.001).
- Turunen, J., Karhula, K., Ropponen, A., Koskinen, A., Hakola, T., Puttonen, S., Hämäläinen, K., Pehkonen, J., Härmä, M., 2020. The effects of using participatory working time scheduling software on sickness absence: A difference-in-differences study. *Int. J. Nurs. Stud.* 103716. doi:[10.1016/j.ijnurstu.2020.103716](https://doi.org/10.1016/j.ijnurstu.2020.103716), Online ahead of print.
- Vahtera, J., Laine, S., Virtanen, M., Oksanen, T., Koskinen, A., Pentti, J., Kivimäki, M., 2010. Employee control over working times and risk of cause-specific disability pension: the Finnish public sector study. *Occup. Environ. Med.* 67 (7), 479–485. doi:[10.1136/oem.2008.045096](https://doi.org/10.1136/oem.2008.045096).
- Vahtera, J., Pentti, J., Helenius, H., Kivimäki, M., 2006. Sleep disturbances as a predictor of long-term increase in sickness absence among employees after family death or illness. *Sleep* 29 (5), 673–682. doi:[10.1093/sleep/29.5.673](https://doi.org/10.1093/sleep/29.5.673).
- Vanttola, P., Puttonen, S., Karhula, K., Oksanen, T., Härmä, M., 2020. Employees with shift work disorder experience excessive sleepiness also on non-work days: a cross-sectional survey linked to working hours register in Finnish hospitals. *Ind. Health* 58 (4), 366–374. doi:[10.2486/indhealth.2019-0179](https://doi.org/10.2486/indhealth.2019-0179).
- Virtanen, M., Oksanen, T., Batty, G.D., Ala-Mursula, L., Salo, P., Elovainio, M., Pentti, J., Lybäck, K., Vahtera, J., Kivimäki, M., 2014. Extending employment beyond the pensionable age: a cohort study of the influence of chronic diseases, health risk factors, and working conditions. *PLoS ONE* 9 (2), e88695. doi:[10.1371/journal.pone.0088695](https://doi.org/10.1371/journal.pone.0088695).
- Wortley, V., Grierson-Hill, L., 2003. Developing a successful self-rostering shift system. *Nurs. Stand.* 17 (42), 40–42. doi:[10.7748/ns2003.07.17.42.40.c3413](https://doi.org/10.7748/ns2003.07.17.42.40.c3413).
- Zarin, D.A., Tse, T., Williams, R.J., Califf, R.M., Ide, N.C., 2011. The clinicaltrials.gov results database - update and key issues. *N. Engl. J. Med.* 364, 852–860. doi:[10.1056/NEJMsa1012065](https://doi.org/10.1056/NEJMsa1012065).