

Periodic self-rostering in shift work: correspondence between objective work hours, work hour preferences (personal fit), and work schedule satisfaction

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Objectives The main objective of the present study was to investigate relative personal fit as the association between rated needs and preferences for work hours, on the one hand, and actual work hours, on the other hand, in three groups (hospital, call-center, and police) working with periodic self-rostering. We also examined the association between personal fit and satisfaction with the work schedule and preference for a fixed and regular shift schedule, respectively.

Methods We collected questionnaire data and objective work hour data over 6–12 months from the computerized self-rostering system. The response rate of the questionnaire was 69% at the hospital and call-center and 98% among the police. In total, 29 433 shifts for 285 shift workers were included in the study. Data was analyzed by means of mixed ANOVA, Kendal tau correlations and ordinal (proportional odds) logistic regression.

Results The results show that evening types worked relatively more hours during the evening and night hours compared to morning types as an indication of relative personal fit. Relative personal fit was also found for long shift, short rest, and morning-, evening- and night-shift frequency, but only personal fit related to morning, evening and night-shift was associated with satisfaction with work hours. Reported conflicts at the workplace about work hours and problems with lack of predictability of time for family/leisure activities, was associated with poor satisfaction and a preference for a fixed shift schedule.

Conclusions The present study shows that periodic self-rostering is associated with relative personal fit, in particular with respect to night, evening, and morning work. Personal fit seems to be associated with satisfaction with work hours and may be a moderator of tolerance to shift work exposure.

Key terms diurnal type; flexibility; flexible work hour; individual difference; self-scheduling; worktime control.

Periodic self-rostering can be defined as a working time arrangement where individual work hours are periodically (re-) negotiated for a certain time period to fit production needs, often with the help of computerized IT software. The exact implementation may vary but it usually involves the employer entering staffing requirements (minimum/maximum allowed) for all hours during the next period (usually 6–8 weeks), followed by the employees entering their requested work hours at their own discretion. The request is, presumably, based on the individual's needs, preferences, and/or perception of the probability of getting their request fulfilled. After these two steps, there is a negotiation in which differences in staffing needs and requested work

hours are resolved to produce the final schedule for each individual in the group. This process is usually repeated 6–10 times per year.

On the surface, it may look like the perfect system that provides individual workers perfect control over their working hours, while meeting the needs of the employer. However, in reality, influence over work hours may be limited since it is only possible to work a specific shift if the employer has a staffing need at that particular time and if other co-workers do not fill the need. This may cause problems for individuals when differences between requested work hours and staffing needs are resolved since some of the shifts may have to be moved to less than optimal positions in the roster,

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causing social problems or making the schedule less ergonomically sound.

There are anecdotal reports that self-rostering has existed in the healthcare sector since the 1960s (1), although scientific papers seem to be rare. It is therefore not surprising that a recent Cochrane systematic review on flexible working conditions only identified four studies (all with an intervention design) on self-rostering that fulfilled their quality requirements (2). It should be pointed out that Joyce et al (2) in their definition of self-rostering also included “flexible shift scheduling”, which means that the workers could participate in the design of the rosters/schedule that remained fixed over a longer period of time (3). Thus, in three of the studies (4–6), flexibility meant that the workers had to follow a pre-defined schedule, with limited possibilities to create individual schedules. The intervention in the fourth study (7) involved more individual autonomy over working times and the workers could more freely create individualized schedules. The results were positive and the introduction of self-rostering was associated with improved work–life balance, social support, and increased job satisfaction.

A related concept to self-rostering is employee worktime control (WTC), which has been defined as: “an employee’s possibilities to control the duration, position, and distribution of his or her work time, that is, autonomy with regard to worktime” (8, p503). In empirical studies, WTC has been operationalized as an index of seven items, of which one is related to influence over scheduling and the other six items cover aspects of flexi-time, breaks, short time leave, and vacation (9). Most of the studies indicate that high WTC is beneficial for self-rated health, buffers against stress, and reduces psychological distress, work–family conflicts, rates of sickness absence, and early retirement due to disability pension (9–15).

One important difference between shift work and normal daytime work is that shift workers are often replacing a co-worker when their shift starts. Compared to flexible day work where the exact day or time of day the actual work is done may be flexible, shift workers are often needed to fill a specific time spot in a schedule and have small means to adapt timing of a scheduled shift, ie, postponed, advanced, delayed, shortened or extended, to fit their personal need on a day-to-day basis. Thus, shift workers, in particular if they have night work, have been found to have lower levels of WTC than daytime workers (9).

Periodic self-rostering may offer shift workers a personal fit to more stable aspects of work hours that are not part of day-to-day WTC. Personal fit may come from the possibility to periodically create short-time schedules that correspond to individual’s stable or varying social and biological needs. For example, an evening-type person

who has a late circadian phase, which promotes high wakefulness in the evening and sleep in the late morning (16), should avoid early morning shifts and instead seek evening and late day shifts when he/she plans the work schedule. Other individuals may have personal needs, for example, related to need for recovery that have an impact on the personal fit regarding long/short shifts or rest periods. A match between individual needs and work hours may be beneficial for well-being, health and safety and increase the tolerance to shift work (17, 18, 19). We hypothesize that periodic self-rostering would allow individuals to (at least partially) match their working hours to personal preferences providing personal fit.

Previous studies on self-rostering have not been able to show any direct effects on health (19, 20), although, one study observed that a majority of the workers (63%) were positive to self-rostering (20), and self rated lack of fit was related to an intention to leave work (18). The reason for lack of effects on health might be related to various confounders associated with shift work such as socioeconomic status, selection mechanisms, and/or small effects sizes due to limited time of exposure. Outcomes that are more closely related to work hours, such as satisfaction with work hours and preference for self-rostering/fixed schedules, are likely to be less confounded and have a larger effect size yielding a better statistical power to test our hypotheses. Satisfaction with work hours seems to be a good global indicator of problems in shift work, with confirmed associations to sleepiness, sleep, and biological markers of stress and recovery (21, 22). The main objective of the present study was to investigate personal fit as the association between rated needs and preferences for work hours on the one hand and actual work hours on the other. This way of defining personal fit is *relative* rather than *absolute* and represents a realistic situation where a distribution of work hours, mostly reflecting production needs and organizational factors, is matched to a distribution of preferences in a population of employees. To permit a wide selection of rostering patterns, three groups working with periodic self-rostering (hospital, call-center, and police) were selected. Our primary hypotheses were: (i) evening-type persons will have relatively more work at night compared to morning-type persons as an indication of relative personal fit; (ii) there is a correlation present between actual work hours and rated preferences for long shifts, short rests, and morning, day, evening and night work as an indication of relative personal fit; (iii) personal fit is expected to be associated with satisfaction with work hours and a preference for self-rostering.

In addition to our main hypotheses we also had an explorative objective to look at characteristics of the work schedule that cannot easily be observed in objective records of work hours, such as regularity and

predictability of working times and possibility to plan family/leisure activities for days off. We also wanted to look at aspects of organizing and implementing periodic self-rostering. This includes managers' attitude to these arrangements, conflicts between employees (23) related to the mismatch between requested work hours and production needs as well as staffing levels (20) and whether compulsory shifts are imposed onto the employees to secure staffing on certain shifts. These factors may represent outcomes of various implementation choices in these systems and can point to areas of improvement. Our explorative hypothesis can be stated as: Indicators of a good implementation/organization (positive manager, less conflicts, good staffing) as well as a fit to personal need for planning family/leisure activities and less "compulsory shifts" are associated with better satisfaction with work hours and a preference for self-rostering.

Methods

The overall design was a cross-sectional study of three occupational groups (hospital, call-center and police) applying different IT software-based periodic self-rostering systems to determine their work hours. The exact implementation was not the same in all groups but they were all periodic self-rostering systems as defined in the introduction of this paper.

We collected objective work hour data over 6–12 months from the computerized self-rostering system. At the end of the period, a questionnaire was distributed to the respondents. The response rate of the questionnaire was 69% at the hospital and call-center and 98% at the police. In total 285 shift workers participated in the study.

See table 1 for a complete record of descriptive data from the questionnaire and table 2 for descriptive data on objective work hours.

Objective work hour data

We collected records of work hours from the computerized periodic self-rostering systems applied in the different groups and coded them into a common format in text files for further analyses. These records were submitted to a specially developed software (MI) to classify shifts into morning (starting before 07:30 hours), evening (ending after 20:00 hours), night (≥ 3 -hour work within 24:00–05:00 hours) and dayshifts (all other shifts), as well as calculating the frequencies of all shifts and possible shift sequences, distribution of work hours across time of day and various other summary statistics. As a general rule, calendar day was used as the reference unit of measurements, meaning that the estimates of,

for example, evening–morning shifts sequences (EM) described the proportion of calendar days in the schedule that contained an evening shift followed by a morning shift the next day.

We set a criterion of ≥ 50 shifts during the study time period to be included in the analyses in order to get reliable estimates of individuals work hours. A total of 20 subjects did not meet the criteria leaving 29 433 shifts for 285 individuals [mean 103, standard deviation (SD) 26, range 51–167 number of shifts per individual] for further analyses. The study time period per individual ranged from 73–362 calendar days with a mean period of 207 (SD 57) days and included some short leaves and vacation time, which needs to be taken into account when interpreting, for example, the average weekly work hours. Overtime work and business trips (eg, related to education) are normally not included in the objective working hour data. However, official statistics of overtime work among the police officers showed that the amount was low (median: 20 hours across 9 months, minimum 0 hours – maximum 129.5 hours).

Questionnaire items

We collected descriptive statistics of the groups with questionnaire items asking for age, sex, marriage status (married/cohabiting versus being single), and having children living at home (response scale: number of children divided into the age categories 0–1.5 years, 1.5–7 years and >7 years), night work experience (response scale: never worked at night versus I have worked at night during xx years), extra work (response scale: no versus yes, I work xx number of hours extra/month). We also asked about self-rated health (1=very poor to 5=very good).

We also reported group statistics of the WTC measure developed by Ala-Mursula et al (9). This instrument asks to what extent the respondent was able to influence the following seven aspects of his/her working times: (i) total length of working day; (ii), starting and finishing times of a working day; (iii) breaks during the working day; (iv) taking care of private matters during the working day; (v) scheduling of work shifts; (vi) scheduling of vacations and paid days off; and (vii) unpaid leave. The response scale ranges from 1=very little to 5=very much.

Items related to our primary hypothesizes (H1–H3) of relative personal fit, satisfaction with work hours and preference for self-rostering/fix schedules were: (i) satisfaction with work hours: What is your satisfaction with your working hours? (response scale: 1=very negative, 2=somewhat negative, 3=neither positive nor negative, 4=somewhat positive, 5=very positive) (21, 22); (ii) preference for self-rostering/fix schedules: I prefer a fixed shift schedule with a regular shift cycle to self-rostering that covers a period of one month

Table 1. Descriptive statistics of questionnaire data. [SD=standard deviation]

Variables	All N=285			Hospital N=134			Call-center N=98			Police N=53		
	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD	%
Age	43	11		43	11		44	10		42	13	
Females			73			93			70			26
Married/cohabiting			75			73			74			81
Parents with children living at home			51			52			49			51
Have extra work			9			8			11			8
Extra work hours/month	24	24		23	27		30	25		12	6	
Have night work experience			86			75			96			96
Night work years	13	11		9	8		15	10		17	13	
Self rated health (1–5 good)	3.8	0.9		3.7	0.9		3.9	0.9		3.8	0.9	
Worktime control (1–5 high)	2.3	0.5		2.3	0.5		2.2	0.5		2.7	0.6	
Evening types			52			44			56			64
Like night work (1–4 agree totally)	2.2	1.2		2.0	1.1		2.5	1.2		2.2	1.1	
Like early work (1–4 agree totally)	2.4	1.1		2.4	1.1		2.6	1.1		2.0	0.9	
Like day work (1–4 agree totally)	2.9	1.0		3.0	1.0		2.7	1.0		2.9	0.9	
Like long shifts (1–4 agree totally)	2.0	1.0		1.6	0.9		2.2	1.0		2.5	0.9	
Like short rests (1–4 agree totally)	2.1	1.0		2.0	0.9		2.0	0.9		2.6	1.0	
Satisfaction work hours (1–5 very satisfied)	3.8	0.8		3.8	0.9		3.8	0.9		3.8	0.6	
Prefer fixed and regular schedules over self rostering (1–4)	2.3	1.2		2.0	1.1		2.5	1.2		2.8	1.1	
Regular work hours are important for planning my life (1–4 agree totally)	2.6	1.1		2.5	1.1		2.6	1.1		3.0	1.0	
It is important to have at least two months of lead time in working hours (1–4 agree totally)	2.9	1.0		2.7	1.1		3.2	0.9		3.2	0.8	
I need long lead time to plan my leisure activities (1–4 agree totally)	2.5	0.8		2.4	0.8		2.7	0.8		2.5	0.8	
I like to meet new colleagues at work every day (1–4 agree totally)	3.4	0.7		3.3	0.7		3.3	0.8		3.5	0.5	
It is important to know my co-workers well (1–4 agree totally)	3.3	0.8		3.2	0.8		3.3	0.8		3.6	0.6	
There are conflicts at my workplace about work hours (1–4 often)	2.4	0.9		2.5	0.9		2.4	0.9		2.2	0.8	
There are compulsory shifts I cannot refuse (1–5 several times a week)	2.8	1.3		2.6	1.4		2.6	1.1		3.4	1.1	
My manager is positive towards self-rostering (1–5 very positive)	2.9	2.1		2.9	2.8		2.7	0.9		3.0	0.9	
Staffing (1=too few, 5= too many, 3=optimal)	2.2	0.8		2.0	0.8		2.5	0.7		2.3	0.6	

(1=disagree totally, 2=somewhat disagree, 3=somewhat agree, 4=agree totally); (iii) diurnal type: rate to what extent you are a morning- or evening-type person. (response scale: 1=extreme morning type, 2=somewhat morning type, 3=somewhat evening type, 4=extreme evening type) (16); (iv) statements about preferences for specific aspect of work hours (response scale: 1=disagree totally, 2=somewhat disagree, 3=somewhat agree, 4=agree totally). I like to work: early shifts (ca. 06:00–14:00 hours), day shifts (ca. 08:00–16:00 hours), evening shifts (ca. 14:00–22:00 hours), night shifts (ca. 22:00–06:00 hours), long shifts (>10 hours), short rest (<11 hours) between shifts.

Questionnaire items related to our explorative hypothesis were: (i) there are compulsory shifts I cannot refuse (1=never, 2=seldom: once or a few times a

year, 3=sometimes: once or twice a month, 4=often: approximately once a week, 5=several times/week); (ii) my manager is positive towards self-rostering (1=very negative, 2=somewhat negative, 3=neutral, 4=somewhat positive, 5=very positive); (iii) is staffing sufficient for the operations? (response scale: 1=too few staff, 2=somewhat too few staff, 3=optimal staffing, 4=somewhat too many staff, 5=too many staff); (iv) statements about social factors at work and importance of regularity/predictability of work hours (response scale: 1=disagree totally, 2=somewhat disagree, 3=somewhat agree, 4=agree totally): (a) regular work hours are important for planning my life; (b) it is important to have at least two months of leadtime in work scheduling; (c) I need long lead time to plan my leisure activities; (d) I like to meet new colleagues at work every day; (e) it is impor-

Table 2. Observed prevalence of shifts and shift sequences. [F=Free day; M=Morning shift (start 7:30 hours or earlier); E=Evening shift (ends 20:00 hour or later); N=Night shift (3 hours, 24:00–05:00 hours). Capital letter indicates first shift of the calendar day and lower case letters indicate the second shift the same day; SD=standard deviation for individuals with prevalence.]

Shift/ sequence	All			Hospital			Call-center			Police		
	% ^a	Mean ^b	SD	% ^a	Mean ^b	SD	% ^a	Mean ^b	SD	% ^a	Mean ^b	SD
F ^c	100	0.500	0.100	100	0.510	0.115	100	0.477	0.090	100	0.514	0.066
M	96	0.186	0.107	94	0.240	0.101	98	0.148	0.099	100	0.124	0.064
E	95	0.159	0.087	93	0.188	0.090	97	0.146	0.088	100	0.114	0.041
D	68	0.127	0.127	34	0.082	0.106	99	0.137	0.139	100	0.148	0.114
N	68	0.126	0.087	50	0.125	0.116	87	0.125	0.072	79	0.132	0.058
Long (>10 hour) shifts	63	0.080	0.095	60	0.085	0.117	48	0.072	0.101	100	0.080	0.034
Short (<11 hour) rests	91	0.084	0.056	86	0.104	0.064	94	0.064	0.049	100	0.075	0.028
EM	86	0.062	0.057	83	0.098	0.062	86	0.041	0.032	94	0.019	0.014
M	96	0.182	0.108	94	0.240	0.101	98	0.142	0.098	100	0.120	0.064
MN	38	0.014	0.008	4	0.006	0.000	64	0.013	0.008	75	0.015	0.009
Mn	17	0.018	0.018	0	.	.	23	0.028	0.020	47	0.008	0.007
Dn	7	0.008	0.005	0	.	.	15	0.009	0.006	9	0.007	0.002
NN	58	0.055	0.044	41	0.059	0.057	71	0.053	0.040	75	0.055	0.030
NNN	36	0.020	0.022	23	0.021	0.019	39	0.023	0.028	62	0.015	0.016
NNNN	9	0.013	0.016	3	0.015	0.016	14	0.016	0.020	17	0.007	0.004
NNNNN ^d	2	0.008	0.007	1	0.006	0.000	4	0.010	0.009	2	0.003	.

^a Indicates the percentage of shift workers with prevalence at least once.

^b Indicate proportion of calendar days preceded by a specific sequence or shift for those with actual prevalence. Groups differed in the median on all variables (Fisher's exact $P < 0.001$) except see following footnotes.

^c $P = 0.012$

^d $P = 0.421$

tant to know my co-workers well, (f) there are conflicts at my workplace about work hours.

Statistical analysis

Our first hypothesis (H1) was to test if evening types had relatively more work at night compared to morning types. We used questionnaire item 3 and created one factor variable (TYPE) that divided the group into morning types (rating: 1&2) and evening types (rating: 3&4). We created another factor (TOD) with 24 levels, one for each hour of time of day. Finally, we calculated the total number of actual work hours for each individual (wt) as well as the number of work hours that fell within each hour for each individual (wh) and used that to calculate the fraction of total work hours that fell at a certain hour across the 24-hour day (wh/wt). The fraction of total work hours was used as a dependent variable in a mixed ANOVA with factors TYPE (between groups) and TOD (within subject). The hypothesis was tested by means of a Wald-test examining the interaction TYPE×TOD.

The second hypothesis of relative personal fit (H2) was tested as a correlation between variable pairs describing exposure and preferences to work hours based on items 4 in the questionnaire and corresponding objective work hour data. Since data was not considered

linear and normally distributed, we used Kendal Tau rank order correlation coefficients.

The third (H3) hypothesis aimed to test if relative personal fit was associated with satisfaction with work hours (item 1) and preference for fixed schedules versus self-rostering (item 2) and was modeled by means of ordinal (proportional odds) logistic regression. Independent variables were variable pairs tested in H2, but here they were added as independent variables describing main effects (preference and prevalence) in addition to the interaction between the two (preference×prevalence) that tested the hypothesis of personal fit. We report odds ratios adjusted for occupational group, sex, and age.

Our explorative analyses (E4) aimed to estimate associations with satisfaction with work hours (item 1) and preference for fixed schedules versus self-rostering (item 2) from aspects related to the organization, implementation and personal fit of planning family/leisure activities described in questionnaire item 8 and was modeled as an ordinal (proportional odds) logistic regression. We report odds ratios separately for each of the items, adjusted for occupational group, sex, and age.

In all statistical tests we used a type 1-error rate of ($\alpha = 0.05$). All analyses were performed with Stata 12 for the Macintosh (24). Mixed ANOVA was estimated using the procedure *xmixed*, tau correlations with *ktau* and ordinal logistic regression with *ologit*.

Results

Figure 1 shows descriptive data related to our first hypothesis of personal fit (H1). The interaction between time of day and diurnal type was significant ($\chi^2=266$, $df=23$, $P<0.001$) suggesting that work hours were distributed differently in the two diurnal type groups. The figure shows that evening types had relatively more hours during the evening and night hours compared to morning types in all three occupational groups.

Personal fit was also tested as a correlation between rated preference for various aspects of work hours and the corresponding prevalence in the objective records of work hours (H2). The results presented in table 3 show that there was a significant correlation for all aspects of work hours except for day shifts. When the results were broken down for the three occupational groups, the sample size and statistical power was reduced and there is great variation and not all correlations remain significant though the overall general pattern persisted. The most consistent result was observed for night shifts which showed strongest correlation in all groups combined ($r=0.45$) but also in each of the occupational groups ($r=0.38-0.54$).

Our third hypothesis (H3) was to test if relative personal fit was associated with satisfaction with work hours and preference for fixed and regular schedules versus self-rostering by means of an interaction between rated preference and observed work hours. The results presented in table 4 suggest that personal fit related to morning, evening and night work was associated with satisfaction with work hours, but not preference for fixed schedules/self-rostering (ie, with a lower risk of poor satisfaction with work hours). Personal fit related to day work, long shifts, and short rest was not associated with either of the two outcomes.

Explorative analysis

We estimated that 40% of all individuals, 28% (hospital), 46% (call-center), 57% (police), had a preference towards fixed regular schedules instead of self-rostering by scoring 3 or 4 on item 2 in the questionnaire. Our explorative analyses (E4) examined if other aspects of work hours and organization, that were not observable in the objective records of work hours, were associated with satisfaction with work hours or preference for self-rostering/ fixed and regular schedules. Table 5 indicates that increased need for regularity and predictability, poorer staffing, more frequent compulsory shifts and more conflicts about work hours was associated with poor satisfaction and a preference for fixed and regular schedules. The need to know one's co-workers was only significant for preference for fixed and regular schedules. Preference for meeting new

colleagues and the manager's attitude were not associated with either outcome.

Discussion

The present study tested three primary hypotheses of relative personal fit and one explorative hypothesis. Data corroborated the hypothesis that evening-type persons worked more during the night hours (H1) and that rated preferences correlated with most aspects of work hours (morning, evening, and night shifts, long shifts, and short rests) as an indication of relative personal fit (H2). The association between personal fit and satisfaction with work hours (H3) was, however, only partially supported by data. Specific personal fit related to night, evening and morning work was associated with satisfaction with work hours but not preference for self-rostering. Results from explorative analyses suggest that several aspects related to the organization of self-rostering, social aspects and predictability were related to satisfaction with work hours and preference for fixed and regular schedules/self-rostering (E4).

We used a relative definition of personal fit rather than an absolute one because it represents a realistic situation where production need had to be met with the available work force. Absolute fit however, may be more important for individual subjects but also represents methodological challenges of reliably assessing the absolute level of individual preferences from imperfect data (in this case a single questionnaire item) and an unknown relation between a rating and the "true" absolute value of the latent score. Future studies would benefit from trying to address these challenges and look at absolute fit in periodic self-rostering and shift work in general.

An obvious limitation of the present study is its cross-sectional and observational design. This means we have no information of work hours or personal fit before the introduction of self-rostering, and it is impossible to establish causal effects. The observational nature of the study also means that we were only studying naturally occurring variation in exposure to work hours and this variation is heavily influenced by quantitative production needs, organization, legislation, tradition, and collective work agreements. We have no empirical knowledge outside of these naturally occurring constraints. The present study also lacks a representative sample and is focused on only three specific occupational groups and worksites.

The main strength of the present study is the detailed analysis of objective exposure data (work hours) in a flexible periodic self-rostering system together with individual ratings of preferences for shift work that makes it possible to look at personal fit. To the best of

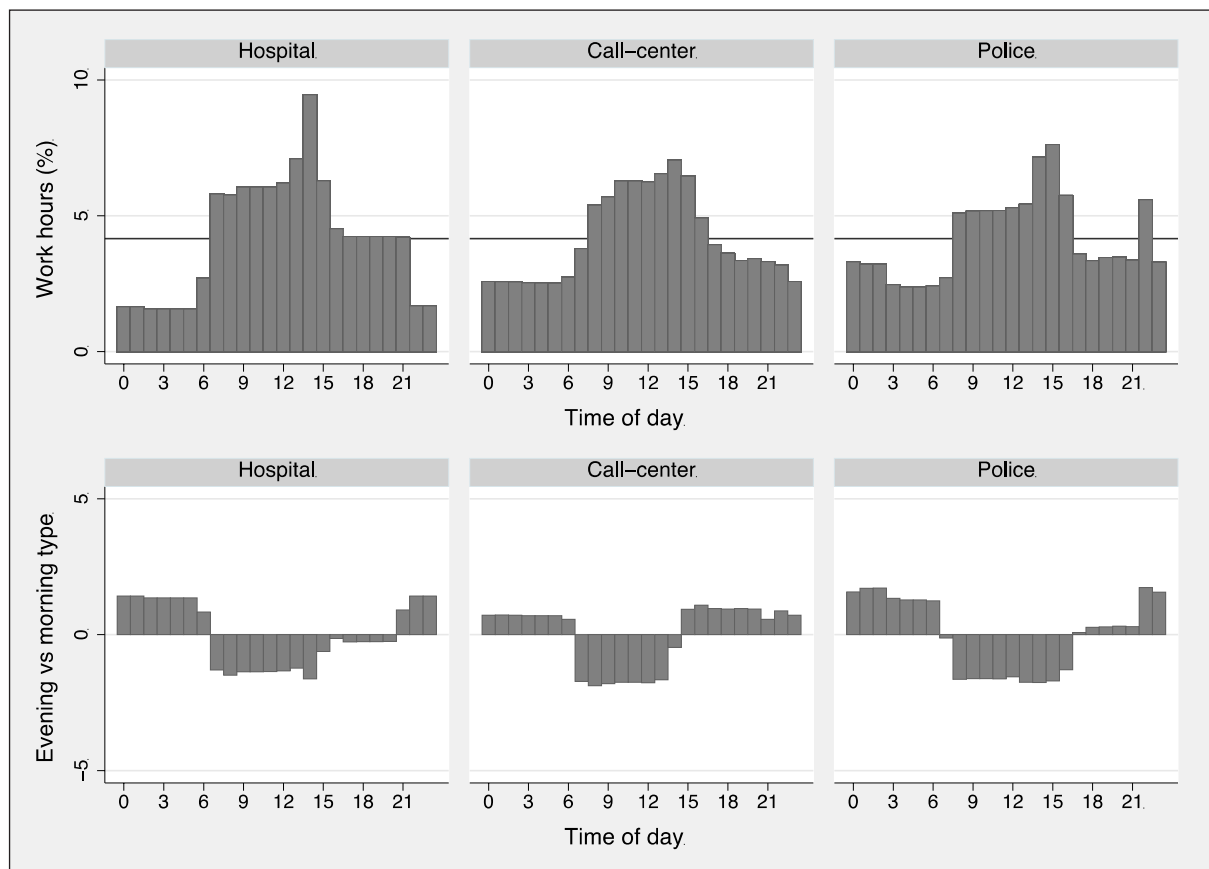


Figure 1. Distribution of work hours in percent of total work hours with respect to time of day (top) and differences in percentage between evening and morning types (bottom, positive values=higher percentage for evening types). The horizontal line in the top panel indicates the level (4.2%) corresponding to a uniform distribution of work hours across the day.

Table 3. Kendall Tau correlations between rated preferences and observed prevalence in objective work hours as an indication of personal fit

Correlation	All (N=276)		Hospital (N=130)		Call-center (N=93)		Police (N=52)	
	τ	P-value	τ	P-value	τ	P-value	τ	P-value
Type of shift								
Morning	0.25	0.001	0.16	0.01	0.36	0.001	0.21	0.05
Day	-0.03		-0.01		0.14	0.05	0.18	0.05
Evening	0.16	0.001	0.22	0.001	0.25	0.001	0.09	
Night	0.45	0.001	0.38	0.001	0.41	0.001	0.54	0.001
Long	0.17	0.001	0.18	0.001	0.07		0.01	
Short rests	0.12	0.01	0.02		0.30	0.001	0.16	

our knowledge, such data has not been published before and our data support the hypothesis that relative personal fit is present in self-rostering (9, 19). The association between diurnal type and actual working hours suggest that the shift workers to some extent could plan their schedules according to their preferred sleep/wake behavior. Such personal fit may be very beneficial for recovery

and might increase tolerance to shift work, since evening types have been associated with longer sleep, lower sleepiness, and less sleep complaints during night work, whereas the opposite is found during morning work (16, 25). In addition, one of the more established aspects of work hours in relation to health and well-being is night work (26) and this was where we found the strongest correlation suggesting that on this important aspect we have the best evidence for relative personal fit in data.

A concern with respect to personal fit for night shifts is that preferences might be based on economic factors (higher salary for night work) rather than health or safety and might produce less ergonomically sound schedules. Our descriptive data (table 2), however, show that extreme work hours (such as many night shifts in a row – which would be a strategy to increase one's salary) are not very common. Data suggest that 9% of individuals experienced a workday preceded by ≥ 4 night shifts in a row at least once with an average occurrence of 1.3% of calendar days in their schedule (about once every three months). More common than many nightshifts in a row was a morning shift followed by a night shift (Mn) the

Table 4. Work hour preferences, prevalence, and personal fit and the association with poor satisfaction with work hours and preference for fixed schedules over periodic self-rostering models were fitted separately for each aspect of work hours (morning-, day-, evening- and night-shifts, short rests, and long shifts) by means of ordinal (proportional odds) logistic regression. Each model estimated two main effects (prevalence and preference) in addition to the interaction (preference×prevalence) describing personal fit and was adjusted for occupational group, age, and sex. Work hour prevalence represent units of 10% calendar days. Work hour preferences were rated on a scale 1–4. [OR=odds ratio; 95% CI=95% confidence interval.]

Questionnaire items	Poor satisfaction			Prefer fixed schedule		
	OR	95% CI	P-value	OR	95% CI	P-value
Morning shift						
Prevalence	3.59	2.10–6.14	0.000	1.50	0.93–2.44	0.098
Preference	1.93	1.24–3.03	0.004	0.96	0.65–1.41	0.825
Personal fit (preference×prevalence)	0.69	0.57–0.85	0.000	0.97	0.81–1.15	0.705
Day shift						
Prevalence	1.01	0.46–2.22	0.978	0.95	0.44–2.06	0.892
Preference	1.86	1.38–2.51	0.000	1.30	0.98–1.71	0.065
Personal fit (preference×prevalence)	0.89	0.70–1.13	0.329	0.97	0.76–1.23	0.800
Evening shift						
Prevalence	13.35	5.16–34.54	0.000	1.27	0.56–2.87	0.572
Preference	1.09	0.69–1.73	0.699	1.01	0.66–1.55	0.967
Personal fit (preference×prevalence)	0.55	0.42–0.73	0.000	0.92	0.72–1.19	0.535
Night shift						
Prevalence	2.77	1.14–6.69	0.024	1.47	0.62–3.49	0.385
Preference	0.74	0.53–1.05	0.088	0.78	0.57–1.07	0.122
Personal fit (preference×prevalence)	0.75	0.57–0.98	0.035	0.94	0.73–1.21	0.642
Short rest						
Prevalence	1.00	0.92–1.10	0.928	1.06	0.97–1.17	0.211
Preference	0.91	0.60–1.37	0.640	0.75	0.48–1.17	0.205
Personal fit (preference×prevalence)	1.01	0.97–1.05	0.609	1.01	0.96–1.05	0.786
Long shift						
Prevalence	0.99	0.93–1.07	0.864	0.98	0.91–1.07	0.707
Preference	0.92	0.70–1.23	0.588	0.80	0.58–1.08	0.148
Personal fit (preference×prevalence)	1.00	0.98–1.03	0.904	1.00	0.97–1.02	0.801

same day observed among 47% of police, 23% of call-center, and 0% of hospital staff ($P < 0.001$) but with a low frequency (1.4% of calendar days). Such shift combination is far from optimal with respect to recovery between shifts but seems to be isolated to certain groups. Future studies should look into whether these exposures are more or less common in periodic self-rostering and/or are isolated to certain groups or workplaces.

Relative personal fit, as we have defined it in the present study, seems to be present in periodic self-rostering. We cannot rule out the possibility that relative personal fit is also present in traditional fixed scheduling due to, for example, selection mechanisms. However, when defined as an association between individual preferences and work hour characteristics, there has to be heterogeneity in work hours and individual preferences similar to what we have observed in the present study. If everybody worked exactly the same schedule, relative personal fit, estimated as an association between individual preferences and work hours, cannot be present since there would be no variance.

Relative personal fit related to night, evening and morning work was associated with satisfaction with work hours but not preference for self-rostering. Satisfaction with work hours has been suggested to be an indicator of general vulnerability to shift work, with an association

with sleepiness, sleep as well as biological markers of stress and recovery (21, 22), however, the authors did not consider the possibility of personal fit. The present data suggest that personal fit may be a moderator in that association, with possible implications for shift work tolerance. We could not corroborate the relation between personal fit and short rests or long shifts. A possible explanation is small effect sizes, as indicated by relatively small correlations indicating relative personal fit, and less than perfect statistical power. More research is needed with larger samples to test if other aspects of personal fit are associated with satisfaction with work hours.

Personal fit was not confirmed to be associated with preference for self-rostering. This was unexpected and went against one of our primary hypotheses. The reason might be that individuals attribute most of their (lack of) personal fit to shift work, rather than self-rostering, making the association weaker and harder to detect because of reduced statistical power. Larger studies are needed to reliably detect smaller effects and to test such hypothesis.

Explorative findings

An unexpected finding in the present study was that 40% of the individuals would prefer a fixed and regular

Table 5. Explorative regression models and the association with poor satisfaction with work hours and preference for fixed schedules. Models were fitted separately for each independent variable and adjusted for occupational group, age and sex by means of ordinal (proportional odds) logistic regression. [OR=odds ratio]

Questionnaire items	Poor satisfaction			Prefer fixed schedule		
	OR	95% CI	P-value	OR	95% CI	P-value
Regularity and predictability						
Regular work hours are important for planning my life (1–4 agree totally)	2.02	1.58–2.57	0.000	5.96	4.36–8.15	0.000
It is important to have ≥2 months of lead time in working hours (1–4 agree totally)	1.84	1.42–2.39	0.000	3.43	2.59–4.54	0.000
I need long lead time to plan my leisure activities (1–4 agree totally)	1.87	1.40–2.50	0.000	2.20	1.65–2.93	0.000
Social aspects at work						
I like to meet new colleagues at work every day (1–4 agree totally)	0.74	0.53–1.03	0.072	1.09	0.79–1.50	0.594
It is important to know my co-workers well (1–4 agree totally)	1.29	0.94–1.77	0.119	1.44	1.07–1.94	0.016
There are conflicts at my workplace about work hours (1–4 often)	1.66	1.26–2.18	0.000	1.37	1.06–1.77	0.016
Organization						
There are compulsory shifts I cannot refuse (1–5 several times a week)	1.36	1.10–1.69	0.005	1.29	1.08–1.54	0.005
My manager is positive towards self-rostering (1–5 very positive)	0.85	0.70–1.04	0.106	0.94	0.78–1.14	0.555
Staffing (1=too few, 5= too many, 3=optimal)	0.54	0.39–0.75	0.000	0.67	0.50–0.90	0.008

schedule to periodic self-rostering. Exploratory regression analyses suggested that the need for regularity and predictability to plan one's life and the presence of compulsory shifts was associated with a preference for fixed schedules. These factors are difficult to measure in observed work hours but seem to be important to consider when constructing systems for periodic self-rostering. Limiting one's choices by introducing compulsory shifts in self-rostering is probably detrimental to the acceptance of such system and is likely to cause a misfit between desired and actual working hours.

Explorative analyses also suggest that social aspects were related to preference for fixed and regular schedules. Conflicts at the workplace about work hours and the perceived need to know one's co-workers well was associated with preference for a fixed schedule. These findings highlights some key differences between traditional fixed schedules and periodic self-rostering; when everybody works their own schedules, tight groups working together with colleagues they know well will be scarce and this might be a stressor or at least a source of insecurity among some individuals. This might be especially important in some organizations where teamwork is a central focus. Also, in these systems, work hours need to be periodically negotiated which is a potential source of conflicts. The way these conflicts are handled and solved is probably a key factor in determining the success of periodic self-rostering systems.

Concluding remarks

Relative personal fit, in particular with respect to morning, evening and night work frequency, was observed in the present study of self-rostering. However, the association between preferences and objective work hours estimated in the present study was not that large in magnitude for most

variables. Personal fit also seems to be unable to capture the essence of problems with periodic self-rostering. Social factors and the organization of how to prevent and solve potential conflicts may be key to a successful implementation of self-rostering. There also seems to be a challenge in giving individuals flexibility and predictability/regularity for planning of future family/leisure activities because work hours are periodically re-negotiated for short periods (6–8 weeks) of time, compared to traditional fixed schedules that may not change for years.

In conclusion, the present study shows that periodic self-rostering is associated with relative personal fit, in particular with respect to night, evening, and morning work. Personal fit may be a moderator of tolerance to shift work exposure, although this needs to be confirmed in future studies with a prospective or experimental design. Some individuals seem to experience conflicts at the workplace about work hours and have problems with lack of predictability of time for family/leisure activities and, as a result, prefer a fixed and regular shift schedule to self-rostering.

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