

Employee control over scheduling of shifts and objectively measured working hour characteristics: a cross-sectional analysis of linked register and survey data

Kati KARHULA¹, Paula SALO^{1,2}, Aki KOSKINEN¹, Anneli OJAJÄRVI¹, Tuula OKSANEN¹, Sampsa PUTTONEN¹, Mika KIVIMÄKI^{1,3,4}, Mikko HÄRMÄ¹

¹ Finnish Institute of Occupational Health, Helsinki, Finland

² Department of Psychology, University of Turku, Turku, Finland

³ Clinicum, Faculty of Medicine, University of Helsinki, Helsinki, Finland

⁴ Department of Epidemiology and Public Health, University College London, London, United Kingdom

Corresponding author: Kati KARHULA, PhD, researcher, Finnish Institute of Occupational Health, Topeliuksenkatu 41B, 00250 Helsinki, Finland, tel. +358 43 824 2267, kati.karhula@ttl.fi

Total word count: 6 302

Word count excluding title page and references: 3 854

Number of figures: 1

Number of tables: 3

Number of references: 39

ABSTRACT

We aimed to study the association of perceived control over scheduling of shifts with objectively measured working hour characteristics in shift workers. The participants were 5128 hospital employees (91% women, 78% nursing personnel, average age 43 years) in period-based work (114:45h/3 weeks) from the 2015 Finnish Public Sector study. Survey responses to a measure of control over scheduling of shifts were linked to payroll data on working hour characteristics during 91 days preceding the survey. We used multinomial logistic regression to assess differences in dichotomized working hour characteristics (being full-time worker, number of work shifts, long work weeks (>40h and >48h/week), long work shifts (>12-h), evening and night shifts, quick returns (<11h shift interval), single days off, weekend work, >4 consecutive work shifts and variability of shift length with cut points at 10% or 25%) between employees with high, intermediate or low control over scheduling of shifts. Analyses were adjusted for age, sex, education, full-/part-time work (where applicable), duration of shift work experience, perceived work ability, children <18 years in the household and overall stressfulness of the life situation. Differences between age groups, men and women and levels of work ability were examined using interaction terms. In adjusted analyses, the proportion of full-time workers was lower among employees with intermediate control over scheduling of shifts compared to those with high control (OR 0.78, 95% CI 0.61–0.98). High proportion (>25%) of weekend work was lower among employees with low compared to high control over scheduling of shifts (OR 0.75, 95% CI 0.61–0.93). High proportion (>25%) of having >4 consecutive work shifts was associated with lower control over scheduling of shifts (OR 1.35, 95% CI 1.13–1.62). Variability of shift length was lower among employees with intermediate and low control over scheduling of shifts compared to those with high control (OR 0.78, 95% CI 0.66–0.93; OR 0.62, 95% CI 0.51–0.75,

respectively). No association was observed between the level of control over scheduling of shifts and high proportion of long work weeks (>25% of >40h weeks and >10% of >48h weeks), long work shifts (>25%), quick returns (>25%), single days off (>25%), and evening or night shifts (>10%) in the whole sample. In subgroup analyses, women with low control over scheduling shifts had lower odds ratio (OR 0.58, 95% CI 0.37–0.91) and men had higher odds ratio (OR 2.97, 95% CI 1.26–6.98) for large proportion of >12-h shifts. In conclusion, the employees with high control over scheduling of shifts had slightly more often unsocial working hour characteristics than those with intermediate or low control over scheduling of shifts. The findings, however, suggest that good work time control in shift work may be possible without compromising shift ergonomics.

Keywords: work time control, work time autonomy, shift work, pay roll data, health care professional

INTRODUCTION

Work time control (WTC) is defined as “employees’ possibilities to control over the duration, position and distribution of his/her work time” (Knauth 1998). A high level of control over working times provides possibilities to adjust job demands with employees’ prevailing resources (Ala-Mursula *et al.* 2002). Recently, workplaces have increasingly offered flexible work time arrangements, either employee-oriented or company-based flexibility or combination of both (Beckers *et al.* 2012). In the European Union, 44% of employees have at least some control for their working hours (Eurofound, 2016). WTC is most prominent in North-European countries (Plantenga and Remery 2010), and prior to 2010, 60%–80% of companies in Finland, Sweden, Denmark, Germany and the UK utilize flextime (Kerkhofs *et al.* 2010). Flextime refers principally to control over starting and end times of work. Previous studies suggest that flextime improves work-life balance (Nijp *et al.* 2012, Peters *et al.* 2009).

Low individual WTC and high variability of working hours due to company’s interests are associated with poor health and well-being (Costa *et al.* 2004, Kubo *et al.* 2013). Also, low WTC is associated with psychological distress (Ala-Mursula *et al.*, 2002, Kandolin *et al.* 2001, Vahtera *et al.* 2010), poor perceived health (Ala-Mursula *et al.* 2002, Vahtera *et al.* 2010), increased risk of sleep disturbances (Salo *et al.* 2014), increased sickness absence (Ala-Mursula *et al.* 2002, Ala-Mursula *et al.* 2005), and increased accident risk (Tucker *et al.* 2016). Low WTC is further related to work-home interference (Nijp *et al.* 2012). Instead, influence on own working times helps to plan time off from work (Leineweber *et al.* 2016). Indeed, higher WTC is related to less conflict in combining work and family (Fenwick and Tausig 2001, Kandolin *et al.* 2001) and greater satisfaction with working hours (Ingre *et al.*

2012). Importantly, high WTC is one of the key factors in extending employment into older age (Virtanen *et al.* 2014).

Shift workers have typically lower levels of WTC than day workers (Nätti *et al.* 2014, Vahtera *et al.* 2010). It also seems that shift workers are more vulnerable to the negative effects, e.g. stress and mental health symptoms, of moderate or low WTC than day workers (Nabe-Nielsen *et al.* 2011), as shift work affects employees' social life, health and well-being (Nabe-Nielsen *et al.* 2011, Nätti *et al.* 2014, Puttonen *et al.* 2010).

There is a lack of studies investigating how employees' high control over scheduling of shifts is associated with different working hour characteristics. High control could be associated with both beneficial and adverse working hour characteristics in shift work. For example, high WTC could risk sufficient recovery if employees choose to work shifts based on social commitments instead of recommended shift ergonomics that are based on health-related criteria. In a self-rostering study (Garde *et al.* 2012), employees changed shift length and timing but did not compromise most recommendations for acceptable shift work schedules. Employees with high WTC may also choose many quick returns (i.e. ≤ 11 hours rest between shifts), to obtain longer continuous free time periods. This could imply adverse health effects since a systematic review of quick returns found that they are associated with sleepiness and fatigue (Vedaa *et al.* 2016), and sickness absence in short term (Vedaa *et al.* 2017). However, very little evidence exists on how control over scheduling of shifts is associated with objectively measured working hour characteristics.

This study used survey data on control over scheduling of shifts combined with objective data on working hour characteristics to investigate association between control over working times with actual working hours. We hypothesized that in irregular shift work, employees with high control over scheduling of shifts would try to prioritize free time

arrangements instead of planning principally ergonomic work schedules. As shift work tolerance is generally better among younger employees and men (Saksvik *et al.*, 2011), we hypothesized that in sub-group analysis, men would have larger proportions of irregular working hour characteristics than women. We also hypothesized that older workers and workers with lower work ability would prefer shift characteristics that support health and recovery more than younger workers and workers with good work ability.

METHODS

Study sample and participants

This study was part of the Finnish Public Sector (FPS) study of the employees of 11 towns and six hospital districts in Finland. We included hospital employees who responded to the FPS survey in 2015 (response rate 69%) and whose work shifts were scheduled using Titania® shift scheduling software. The individual survey responses were linked to payroll data of working hours covering 91 days prior to the survey response.

We only included the employees who worked on period-based work contract (114:45h/3 weeks) with monthly salary and had at least 31 work shifts during the previous 91 days. For more details, see (Härmä *et al.* 2017, Karhula *et al.* 2017). Day workers with fixed daily working time were excluded due to the lack of studied shift work characteristics and physicians due to on-call work. (Figure 1.) The participants in the final sample were 78% (n= 3 980) nursing personnel. The largest occupational group was nursing personnel (85%, n= 4 188) including most common job titles nurse (51%, n= 2 637), practical nurse (13%, n= 654), and midwife (4%, n= 218). Hospital cleaners comprised the second largest occupational group (8%, n= 383). (Table 1.)

[Insert Figure 1. here]

[Insert Table 1. here]

Payroll data

The payroll-based daily working hour data were retrieved from the shift scheduling program (Titania®, CGI Finland Ltd, Helsinki, Finland). Validated sampling software was used to retrieve the data regarding realized rosters (Härmä *et al.* 2015).

The payroll-based working hour variables used in this study were full-time or part-time work, and the following dichotomized working hour characteristics: % of long weekly

working hours (cut point 25% of >40h work weeks and 10% of >48h work weeks; cut points applied to each for each employee individually) of all the work weeks, % of >12-hour shifts (cut point >25%) of all the work shifts, % of evening and night shifts of all the work shifts (cut point >10%), % of quick returns (<11h shift interval) of all shift intervals (cut point >25%), % of weekend work of all the weekends (cut point >25%), % of single days off of all the days off (cut point >25%), % of >4 consecutive work shifts of all the consecutive work shifts, and variability of shift length (cut point at 0.55h based on distribution of the variable). The formulation of the working hour characteristics is described in more detail in Härmä et al. (2015). Most of the cut points were based on the FIOH (Finnish Institute of Occupational Health) recommendations for working times in the public sector (Härmä et al., 2015), with the assumption that unsocial working hour characteristics are partly inevitable in 24/7 hospital care (25% criteria), but few of the characteristics can partly be avoided to a great extent (10% criteria). The cut point for variability of shift length was based on the 50th percentile distribution.

Survey variables

Control over scheduling of shifts was measured with a 7-item scale (Ala-Mursula *et al.* 2002). In this study, the item “How much control do you have over scheduling of work shifts?” was chosen to describe the respondents’ possibility to influence their shifts. The answer “very much” and “much” were classified as good control, “some” to intermediate control, and “little” and “very little” to low control.

Duration of shift work experience was surveyed with question “How long have you worked shifts altogether?”, to which the respondent gave the number of years in shift work. Educational level was categorized into basic, vocational and applied university or university level education. Current self-rated health was measured using a 5-point Likert-type scale

from good to poor (Blaxter 1987). Perceived work ability was assessed with a single item on a 10 point scale (0= not able to work at all, 10= my best work ability ever) (Tuomi *et al.* 2001). Number of children living in the household was also asked. Work-life conflict was surveyed with a question “*How often do you feel that your work takes too much time or energy from your family-life or life?*” with a 5-point Likert-type scale from never to very often adapted from (Mårdberg *et al.* 1991). The answers “often” and “very often” were dichotomized as having work-life conflict. The question for measuring the overall stressfulness of life situation was designed for the FPS study and used a 6-point Likert-type scale, where answers from easy to quite burdensome were classified as “not stressful life situation” and answers from burdensome to extremely burdensome as “stressful life situation”.

Statistical methods

The statistical analyses were conducted with SAS 9.4 (SAS Institute Inc., Cary, North Carolina, USA) and IBM SPSS Statistics 24 (IBM Corp., Armonk, NY, USA) softwares. One-way ANOVA and the Pearson Chi-square test were used to explore the group-level differences in the descriptive characteristics and average numbers or proportions of the studied working hour characteristics.

We used multinomial logistic regression to calculate odds ratios (OR) and their 95% confidence intervals (CI) for the associations of the work hour characteristics and level of control over scheduling of shifts in three steps: (1) unadjusted, (2) adjusted for age and sex, and (3) adjusted for age, sex, educational level, duration of shift work experience, full-time/part-time employment (where applicable), number of children in the household, perceived work ability, and overall stressfulness of the life situation. Based on significant interactions ($p < 0.10$) (Greenland and Rothman 1998) between age, sex or work ability and

working hour characteristics, a stratified analysis by age (≤ 39 , 40–49 and ≥ 50 years), sex, and work ability was also conducted.

RESULTS

The sample included 5 128 employees (91% women, 85% nursing personnel, average age 43 years, average shift work experience 14 years). Employees with high control over scheduling of shifts had higher education, better perceived health and work ability, and less work-life conflict than employees with intermediate or low control over scheduling of shifts. (Table 2.)

[Insert Table 2. here]

The average proportions of the studied working hour characteristics were rather similar in the three groups with different levels of perceived control over scheduling of shifts (high, intermediate, and low). The average proportion of >40-hour work weeks was 28–29%, and proportion of evening shifts 32–33% in all the groups. The average proportions of >48 hour work weeks of all work weeks (5–6%), >12-hour work shifts of all work shifts (4–6%), quick returns of all shift intervals under 48 hours (16–18%), single days off of all day-off periods (20–23%), night shifts of all shifts (13–17%), weekend work of all weekends (39–41%), variability of shift length (3–4%) and average number of spells of >4 consecutive work shifts (3.8–3.9), however, yielded statistical significance between the groups. (Table 3.) The proportion of realized shift wishes was close to 85% with no group difference ($p=0.417$).

[Insert Table 3. here]

The unadjusted analysis the probability of being a full-time worker was lower among employees with intermediate or low control over scheduling of shifts compared to the employees with high control (OR 0.84, 95% CI 0.71–0.99; OR 0.77, 95% CI 0.62–0.95, respectively). The probability for having a large proportion of single days off was higher among the employees with high than intermediate or low control over scheduling of shifts (OR 1.18, 95% CI 1.02–1.35; OR 1.40, 95% CI 1.19–1.65, respectively). Conversely, the

probability for having a large proportion of night shifts, weekend work and high variability of shift length work was lower among the employees with intermediate or low control over scheduling of shifts than among the employees with high control over scheduling of shifts (Table 4).

The model adjusted for age and sex showed lower probability of being a full-time worker among employees with low control over scheduling of shifts than among employees with high control over scheduling of shifts (OR 0.79, 95% CI 0.64–0.97). In a similar manner, the probability for having a large proportion of single days off was higher among the employees with high than low control over scheduling of shifts (OR 1.25, 95% CI 1.05–1.48) and the probability of having a large proportion of night shifts length work was lower among employees with low than employees with high control over scheduling of shifts. A large proportion of weekend work, and high variability of shift length was lower in intermediate and low control than high control over scheduling of shifts (Table 4).

In the fully adjusted models, the probability of being a full-time worker was lower among employees with intermediate control over scheduling of shifts compared to the employees with high control (OR 0.78, 95% CI 0.61–0.98). The probability for having a large proportion of weekend work was lower among the employees with low than high control over scheduling of shifts (OR 0.75, 95% CI 0.61–0.93). Conversely, the probability of having a large proportion of >4 consecutive work shifts was associated with low control over scheduling of shifts (OR 1.35, 95% CI 1.13–1.62). The probability of having a large variability in shift length was lower both among the employees with intermediate and low control over scheduling of shifts (OR 0.78, 95% CI 0.66–0.93; OR 0.62, 95% CI 0.51–0.75, respectively). The level of control over scheduling of shifts was not associated with proportion of long work weeks, quick returns, single days off and evening or night shifts. (Table 4.)

[Insert Table 4. here]

There were significant age interactions (Table 4.) with full-time work and over 48-hour work weeks. In the oldest age group (≥ 50 years) high control over scheduling of shifts was associated with having a full-time work (OR 1.85, 95% CI 1.04–3.29), but none of the three age groups were associated with over 48-hour work weeks.

There was a significant sex interaction in the $>25\%$ proportion of >12 -hour work shifts. Women with low control over scheduling of shifts had lower odds for >12 -hour shifts (OR 0.58, 95% CI 0.37–0.91), whereas men with low control over scheduling of shifts had higher odds for >12 -hour shifts (OR 2.97, 95% CI 1.26–6.98). There also was a significant work ability interaction with >4 consecutive work shifts. Among employees with good work ability, low control over scheduling of shifts was associated with having more often >4 consecutive shifts (OR 1.27, 95% CI 1.08–1.49).

DISCUSSION

This study aimed to investigate the association of perceived control over scheduling of shifts with objectively measured working hour characteristics. Our first hypothesis was that employees with high control over scheduling of shifts would try to prioritize free time arrangements instead of planning principally ergonomic work schedules. In the fully adjusted model, we did not find support for this, as employees with high control over scheduling of shifts had actually slightly more often weekend work than employees with less control. Variability of shift length was lower among employees with intermediate and low control over scheduling of shifts than among employees with high control over scheduling of shifts and employees with high control over scheduling of shifts had less often long spells of consecutive shifts than employees with low control over scheduling of shifts. No association was observed in the fully adjusted model between the level of control over scheduling of shifts and high proportion of long work weeks, long work shifts, quick returns, single days off and evening or night shifts, although there were several associations in the unadjusted model and model adjusted for age and sex only.

For the sub-group analysis, we hypothesized that men would have larger proportions of irregular working hour characteristics than women. However, we found only one sex interaction, as men with low control over scheduling of shifts had higher and women with low control lower odds for having a large proportion of >12-hour shifts. Secondly, we hypothesized that older workers and workers with lower work ability would prefer shift characteristics that support health and recovery more than younger workers and workers with good work ability. The only age interaction we found showed that among the employees aged ≥ 50 years, high control over scheduling of shifts was associated with having a full-time work. This could indicate that high control over scheduling of shifts supports

recovery from full-time work. On the other hand, the findings from the whole sample also showed that the employees with high control over scheduling of shifts were more often full-time workers than the employees with intermediate control over scheduling of shifts. Similarly, we found no direct support for association between lower work ability and shift characteristics that relate to shorter working hours and more continuous free time.

Based on earlier results (reviewed by Saksvik *et al.* 2011), we hypothesized that younger employees and men would optimize their free time on the cost of choosing unsocial working hours, as, in general, young employees and males have better shift work tolerance than older employees and females. In the current study, employees with high control were on average younger and had more often high education and good perceived health than the employees in the groups of intermediate or low control. The survey responses indicated that the older employees and those with poorer work ability more often cannot influence their working times substantially. These employees could possibly benefit from having high control over scheduling of shifts to maintain their health and work ability.

High control over scheduling of shifts was not significantly associated with poorer shift ergonomics. Previous study found that self-rostering did not compromise most recommendations for acceptable shift work schedules, and instead, number of single days off decreased after implementation of self-rostering (Garde *et al.* 2012). In this study, there were no major differences in average proportions of unsocial working hour characteristics, but the employees with high control over scheduling of shifts had slightly more quick returns, night shifts, weekend work and variability in working times than the groups with intermediate or low control over scheduling of shifts. This indicates that in hospital work, all

employees irrespective of the level of control over scheduling of shifts face a need to compromise between sufficient recovery and socially optimal free time arrangements.

It is noteworthy, that even though the employees with high control over scheduling of shifts had slightly more irregular shift characteristics than the employees having intermediate or low control, they also reported less often work-life conflict than the employees having intermediate or low control. Previous results also show that high WTC is associated with less work-life conflict both among shift workers (Tausig and Fenwick 2001) and white-collar workers (Moen *et al.* 2008).

In this data set, the proportion of realized shift wishes was very high in all the three groups, as was in a self-rostering study (Garde *et al.* 2012). Many employees appeared to be able to influence their working hours by making wishes for the most important days. It can be argued that making a few wishes is a rather small way to have control over working hours but, on the other hand, also when self-rostering is in use, the influence over working hours may be limited, as employer sets the staffing requirements and co-workers have their own priorities in their scheduling (Ingre *et al.* 2012).

Strengths and limitations

The main strength of this study was the use of the objective working hour data which allowed us to calculate the exact proportions of the working hour characteristics. The methodology to retrieve the working hour data has previously been validated (Härmä *et al.* 2015). In survey research, subjective estimations of different types of shifts and especially more complex shift characteristics, e.g., proportion of long work shifts or variability of shift length, are prone to recall bias.

Another strength was that the large sample with high participation rate included a variety of hospital occupations. The large data also enabled us to conduct subgroup analyses

based on age, sex and work ability. We were also able to use a comprehensive epidemiologic survey data which enabled us to adjust for multiple confounders.

There are limitations as well. The main limitation was the cross-sectional study design, which did not allow us to make conclusions about causality. Period-based work contract (114:45h/3 weeks) with monthly salary is a national working time arrangement, where actual working hours are principally evened out within each period. This may limit the generalizability of the results to other working time arrangements.

Using a single item to capture control over shift scheduling can also be regarded as a limitation. We did not use the entire Ala-Mursula scale (Ala-Mursula *et al.* 2002), since we aimed to focus on control for the shift rotas of the shift workers. Three of the six items in Ala-Mursula scale measure control over free time (Albrecht *et al.* 2016), and two of the remaining three items measure control over the length of the working day and control over starting and ending times of the work day, which is more common among white-collar workers than among shift workers.

Perceived health and perceived work ability were also measured with single items. These items, however, have been validated and used widely in earlier studies (Ahlstrom *et al.* 2010, Roelen *et al.* 2014). To avoid over-adjusting, we did not include both perceived health and perceived work ability to the adjusted model 2. We conducted analyses also with alternative adjusted model including perceived health and excluding perceived work ability and they produced the same results than the model included in the article.

CONCLUSION

High control over scheduling of shifts was associated with having slightly more often unsocial working hour characteristics than intermediate or low control. Among the older

employees high control over scheduling of shifts may promote continuing in full-time work. The findings suggest that good work time control in shift work can be possible without compromising shift ergonomics. Longitudinal studies are warranted to confirm the results of this study.

ACKNOWLEDGEMENTS

This study was funded by the Finnish Work Environment Fund (114 317) and NordForsk, the Nordic Program on Health and Welfare (74809). Mika Kivimäki is supported by a professorial fellowship from the Economic and Social Research Council, UK and NordForsk (75021). FPS is supported by the Finnish Work Environment Fund (117 094).

REFERENCES

- Ahlstrom, L., Grimby-Ekman, A., Hagberg, M. et al. 2010. The work ability index and single-item question: Associations with sick leave, symptoms, and health--a prospective study of women on long-term sick leave. *Scand J Work Environ Health*. 36:404-12.
- Ala-Mursula, L., Vahtera, J., Kivimäki, M. et al. 2002. Employee control over working times: Associations with subjective health and sickness absences. *J Epidemiol Community Health*. 56:272-8.
- Ala-Mursula, L., Vahtera, J., Linna, A. et al. 2005. Employee worktime control moderates the effects of job strain and effort-reward imbalance on sickness absence: The 10-town study. *J Epidemiol Community Health*. 59:851-7.
- Albrecht, S.C., Kecklund, G., Tucker, P. et al. 2016. Investigating the factorial structure and availability of work time control in a representative sample of the Swedish working population. *Scand J Public Health*. 44:320-8.
- Beckers, D.G., Kompier, M.A., Kecklund, G. et al. 2012. Worktime control: Theoretical conceptualization, current empirical knowledge, and research agenda. *Scand J Work Environ Health*. 38:291-7.
- Blaxter, M., 1987. Evidence on inequality in health from a national survey. *Lancet* 4:30-3.
- Costa, G., Akerstedt, T., Nachreiner, F. et al. 2004. Flexible working hours, health, and well-being in Europe: Some considerations from a saltsa project. *Chronobiol Int*. 21:831-44.
- Eurofound, 2016. *6th European working conditions survey - overview report* [online]. Publications Office of the European Union. Available from: http://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf [Accessed 16.05.2018].
- Fenwick, R. & Tausig, M., 2001. Scheduling stress: Family and health outcomes of shift work and schedule control. *Am Behav Sci*. 44:1179-1198.
- Garde, A.H., Albertsen, K., Nabe-Nielsen, K. et al. 2012. Implementation of self-rostering (the prio-project): Effects on working hours, recovery, and health. *Scand J Work Environ Health*. 38:314-26.
- Greenland, S. & Rothman, K.J., 1998. Concepts of interaction. *Modern epidemiology*. USA, New York: Lippincott-Raven, 329-342.
- Härmä, M., Koskinen, A., Ropponen, A. et al. 2017. Validity of self-reported exposure to shift work. *Occup Environ Med*. 74:228-230.
- Härmä, M., Ropponen, A., Hakola, T. et al. 2015. Developing register-based measures for assessment of working time patterns for epidemiologic studies. *Scand J Work Environ Health*. 41:268-79.
- Ingre, M., Akerstedt, T., Ekstedt, M. et al. 2012. Periodic self-rostering in shift work: Correspondence between objective work hours, work hour preferences (personal fit), and work schedule satisfaction. *Scand J Work Environ Health*. 38:327-36.
- Kandolin, I., Härmä, M. & Toivanen, M., 2001. Flexible working hours and well-being in Finland. *J Hum Ergol (Tokyo)*. 30:35-40.
- Karhula, K., Puttonen, S., Ropponen, A. et al. 2017. Objective working hour characteristics and work-life conflict among hospital employees in the Finnish public sector study. *Chronobiol Int*. 34:876-885.

- Kerkhofs, M., Román, A. & Ester, P., 2010. *European company survey 2009: Flexibility profiles of european companies. European foundation for the improvement of living and working conditions*. Publication Office of the European Union.
- Knauth, P., 1998. Innovative worktime arrangements. *Scand J Work Environ Health*, 24:13-7.
- Kubo, T., Takahashi, M., Togo, F. et al. 2013. Effects on employees of controlling working hours and working schedules. *Occup Med (Lond)*. 63: 148-51.
- Leineweber, C., Kecklund, G., Lindfors, P. et al. 2016. Change in work-time control and work-home interference among Swedish working men and women: Findings from the slosh cohort study. *Int J Behav Med*. 23:670-678.
- Moen, P., Kelly, E. & Huang, Q., 2008. Work, family and life-course fit: Does control over work time matter? *J Vocat Behav*. 73:414-425.
- 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*. 32:233-9.
- Nabe-Nielsen, K., Garde, A.H., Albertsen, K. et al. 2011. The moderating effect of work-time influence on the effect of shift work: A prospective cohort study. *Int Arch Occup Environ Health*. 84:551-9.
- Nijp, H.H., Beckers, D.G., Geurts, S.A. et al. 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*. 38:299-313.
- Nätti J., Oinas T., Härmä M. et al. 2014. Combined effects of shiftwork and individual working time control on long-term sickness absence: a prospective study of Finnish employees. *J Occup Environ Med*. 56:732-8.
- Peters, P., Den Dulk, L. & Van Der Lippe, T., 2009. The effects of time-spatial flexibility and new working conditions on employees' work-life balance: The dutch case. *Community Work Fam*. 12:279-297.
- Plantenga, J. & Remery, C., 2010. *Flexible working time arrangements and gender equality. A comparative review of 30 European countries* Luxembourg: Publications Office of the European Union, pp. 21-27.
- Puttonen, S., Härmä, M. & Hublin, C. 2010. Shift work and cardiovascular disease - pathways from circadian stress to morbidity. *Scand J Work Environ Health*. 36:96-108.
- Roelen, C.A., Van Rhenen, W., Groothoff, J.W. et al. 2014. Work ability as prognostic risk marker of disability pension: Single-item work ability score versus multi-item work ability index. *Scand J Work Environ Health*. 40:428-31.
- Saksvik, I.B., Bjorvatn, B., Hetland, H. et al. 2011. Individual differences in tolerance to shift work--a systematic review. *Sleep Med Rev*. 15:221-35.
- Salo, P., Ala-Mursula, L., Rod, N.H. et al. 2014. Work time control and sleep disturbances: Prospective cohort study of Finnish public sector employees. *Sleep*. 37:1217-25.
- Tausig, M. & Fenwick, R., 2001. Unbinding time: Alternate work schedules and work-life balance. *J Fam Econ Issues*. 22:101-119.
- Tucker, P., Albrecht, S., Kecklund, G. et al. 2016. Work time control, sleep & accident risk: A prospective cohort study. *Chronobiol Int*. 33:619-29.
- Tuomi, K., Huuhtanen, P., Nykyri, E. et al. 2001. Promotion of work ability, the quality of work and retirement. *Occup Med (Lond)*. 51:318-24.

- Vahtera, J., Laine, S., Virtanen, M. et al. 2010. Employee control over working times and risk of cause-specific disability pension: The Finnish public sector study. *Occup Environ Med.* 67:479-485.
- Vedaa, O., Harris, A., Bjorvatn, B. et al. 2016. Systematic review of the relationship between quick returns in rotating shift work and health-related outcomes. *Ergonomics.* 59:1-14.
- Vedaa, O., Pallesen, S., Waage, S. et al. 2017. Short rest between shift intervals increases the risk of sick leave: A prospective registry study. *Occup Environ Med.* 74:496-501.
- Virtanen, M., Oksanen, T., Batty, G.D. et al. 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.
- Virtanen, M., Oksanen, T., Pentti, J. et al. 2017. Occupational class and working beyond the retirement age: A cohort study. *Scand J Work Environ Health.* 43:426-435.

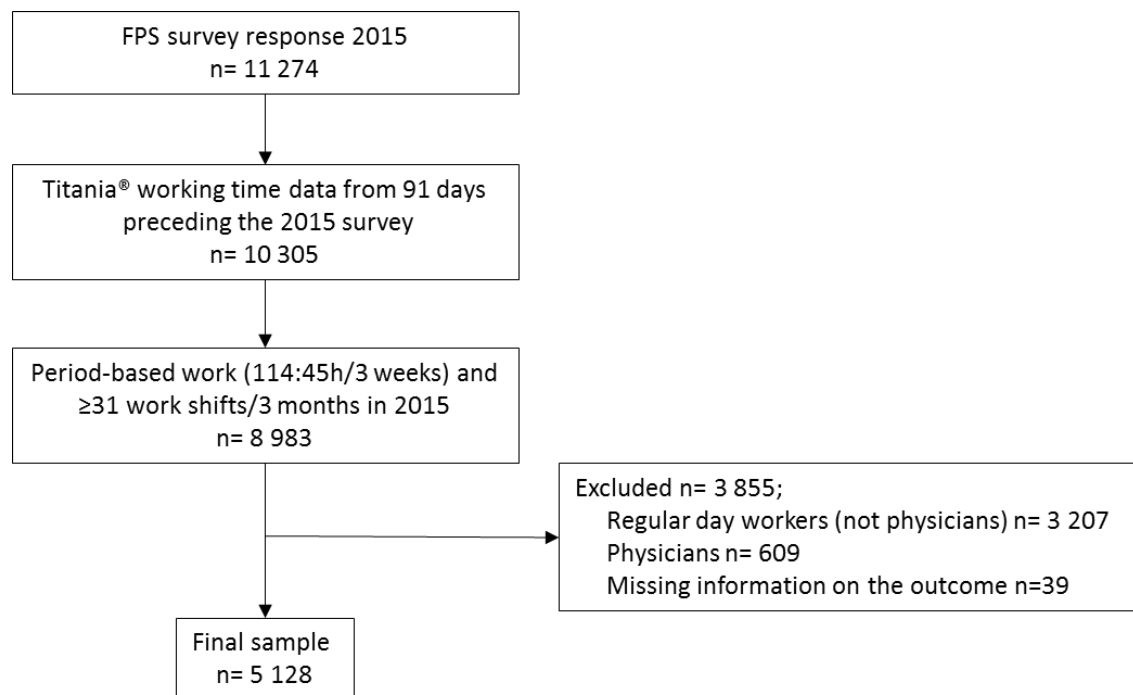


Figure 1. The flow chart of the study participants.

Table 1. Control over scheduling of shifts in different occupational groups.

	Control over scheduling of shifts							
	High		Intermediate		Low		Total	
	n = 1 953		n = 1 951		n = 1 044		n = 4 928	
	%	(n)	%	(n)	%	(n)	%	(n)
Nursing personnel ¹	42.9	(1 797)	39.2	(1 643)	17.9	(748)	100	(4 188)
Other health care staff ²	30.6	(19)	41.9	(26)	27.4	(17)	100	(62)
Departmental secretary	41.7	(45)	38.0	(41)	20.4	(22)	100	(108)
Hospital cleaner	17.0	(65)	35.0	(135)	48.0	(184)	100	(383)
Other ³	14.4	(27)	46.5	(87)	39.0	(73)	100	(187)

¹ E.g. nurse, midwife, laboratory nurse, nursing assistant

² E.g. pharmacist, physiotherapist

³ E.g. administrative or maintenance professions

Table 2. Descriptive characteristics of the study participants according to the level of control over scheduling of shifts.

	Control over scheduling of shifts								Sig. ¹
	All n= 5 128		High n= 2 020		Intermediate n= 2 020		Low n= 1 088		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age (years)	42.8	(11.7)	40.5	(11.5)	43.6	(11.3)	45.7	(11.6)	<0.001
Shift work experience (years)	13.8	(10.3)	13.3	(10.1)	14.1	(10.5)	14.5	(10.1)	0.004
	%	(n)	%	(n)	%	(n)	%	(n)	Sig. ²
Sex									0.069
Woman	90.9	(4 659)	91.5	(1 849)	89.7	(1 812)	91.7	(998)	
Man	9.1	(469)	8.5	(171)	10.3	(208)	8.3	(90)	
Education									<0.001
Basic	7.6	(385)	3.7	(74)	7.3	(148)	15.2	(163)	
Vocational	49.4	(2 521)	44.8	(901)	52.7	(1059)	52.0	(561)	
Bachelor or higher	43.1	(2 156)	51.6	(1040)	39.8	(801)	32.9	(355)	
Full-time work									0.024
Yes	84.4	(4 346)	83.1	(1 679)	85.4	(1 726)	86.5	(941)	
No	15.2	(782)	16.9	(341)	14.6	(294)	13.5	(147)	
Perceived health									<0.001
Good	82.5	(4 222)	87.4	(1 761)	79.9	(1 608)	78.4	(853)	
Poor	17.5	(894)	12.6	(254)	20.1	(405)	21.6	(235)	
Perceived work ability									<0.001
Good	91.2	(4 656)	94.3	(1 898)	89.8	(1 808)	87.9	(950)	
Poor	8.8	(450)	5.7	(114)	10.2	(205)	12.1	(131)	
Children <18 years ³									0.570
Yes	44.9	(2 021)	45.1	(815)	45.5	(804)	43.3	(402)	
No	55.1	(2 478)	54.9	(991)	54.5	(963)	56.6	(524)	
Work-life conflict									<0.001
Often/very often	41.0	(1 950)	35.6	(670)	42.4	(799)	48.3	(481)	

Never/seldom/sometimes	59.0	(2 810)	64.4	(1 210)	57.6	(1 086)	51.7	(514)	0.435
Stressful life-situation ⁴									
Yes	10.4	(531)	10.0	(202)	10.2	(205)	11.4	(124)	
No	89.6	(4 581)	90.0	(1 814)	89.8	(1 807)	88.6	(960)	

¹ One-way ANOVA

² Pearson Chi-Square test

³ Living in the same household

⁴ During the past 12 months

Table 3. The mean frequency or proportion (%) of working hour characteristics during past 91 days according to the level of control over scheduling of shifts.

	Control over scheduling of shifts								Sig. ¹
	All		High		Intermediate		Low		
	n= 5 128		n = 2 020		n = 2 020		n = 1 088		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Number of...									
Work shifts in 91 days	43.44	(7.54)	43.10	(7.45)	43.62	(7.59)	43.72	(7.58)	0.031
Spells of >4 consecutive work shifts	3.83	(0.69)	3.80	(0.69)	3.83	(0.69)	3.90	(0.71)	<0.001
Proportion of...									
>40-hour work weeks of all work weeks	28.36	(16.07)	28.74	(15.80)	28.34	(16.00)	27.68	(16.70)	0.210
>48-hour work weeks of all work weeks	5.12	(8.38)	5.59	(8.55)	4.92	(8.22)	4.61	(8.32)	0.003
>12-hour shifts	5.01	(12.27)	5.64	(12.02)	4.84	(12.21)	4.19	(12.75)	0.005
Quick returns (<11h) of all shift intervals <48h	17.58	(12.43)	18.00	(12.14)	17.79	(12.31)	16.42	(13.12)	0.002
Single days off of all day off-periods	20.93	(11.55)	20.01	(11.49)	21.03	(11.47)	22.56	(11.66)	<0.001
Evening shifts of all shifts	32.66	(14.44)	32.27	(14.47)	32.78	(14.17)	33.19	(14.89)	0.213
Night shifts of all shifts	15.65	(18.80)	17.49	(19.46)	15.10	(17.77)	13.29	(19.13)	<0.001
Weekend work of all weekends	41.05	(18.89)	41.74	(18.03)	41.40	(19.28)	39.10	(19.61)	0.001
Variability of shift length	3.42	(1.42)	3.53	(1.44)	3.44	(1.38)	3.17	(1.41)	<0.001

¹ One-way ANOVA

Table 4. Multinomial logistic regression analysis for working hour characteristics during the past 91 days. Odds ratios for intermediate and low control over scheduling of shifts calculated with high control over scheduling of shifts as reference category.

	Level of control	Unadjusted model		Adjusted model 1 ¹		Adjusted model 2 ²		Interactions ³		
		N	OR (95% CI)	N	OR (95% CI)	N	OR (95% CI)	Age	Sex	Work ability
>25% of >40-hour work weeks of all work weeks	High	2 020	1	2 020	1	1 751	1	0.616	0.741	0.766
	Intermediate	2 020	0.93 (0.83–1.06)	2 020	0.94 (0.83–1.06)	1 686	0.96 (0.83–1.11)			
	Low	1 088	0.97 (0.84–1.13)	1 088	0.99 (0.89–1.15)	864	1.04 (0.87–1.24)			
>10% of >48-hour work weeks of all work weeks	High	2 020	1	2 020	1	1 751	1	0.031	0.153	0.174
	Intermediate	2 020	0.88 (0.76–1.02)	2 020	0.86 (0.74–1.01)	1 686	0.90 (0.76–1.06)			
	Low	1 088	0.83 (0.69–1.00)	1 088	0.83 (0.69–0.99)	864	0.97 (0.79–1.19)			
>25% of >12-hour shifts of all shifts	High	2 020	1	2 020	1	1 751	1	0.374	0.020	0.243
	Intermediate	2 020	1.00 (0.73–1.35)	2 020	1.08 (0.80–1.45)	1 686	1.06 (0.77–1.45)			
	Low	1 088	0.81 (0.55–1.18)	1 088	0.96 (0.65–1.41)	864	1.14 (0.76–1.71)			
>25% of quick returns (<11h) of all shift intervals <48h	High	2 020	1	2 020	1	1 751	1	0.871	0.478	0.305
	Intermediate	2 020	0.97 (0.85–1.11)	2 020	0.95 (0.83–1.10)	1 686	0.95 (0.81–1.10)			
	Low	1 088	0.95 (0.80–1.12)	1 088	0.91 (0.77–1.08)	864	0.93 (0.77–1.13)			
>25% of single days off of all day off-periods	High	1 867	1	1 867	1	1 625	1	0.515	0.409	0.726
	Intermediate	1 830	1.18 (1.02–1.35)	1 830	1.10 (0.95–1.27)	1 543	1.02 (0.87–1.19)			
	Low	956	1.40 (1.19–1.65)	956	1.25 (1.05–1.48)	764	1.03 (0.85–1.25)			
>10% of evening shifts of all shifts	High	2 020	1	2 020	1	1 751	1	0.268	0.107	0.779
	Intermediate	2 020	1.14 (0.89–1.46)	1 088	1.18 (0.92–1.52)	1 686	1.26 (0.95–1.66)			
	Low	1 088	1.01 (0.76–1.36)	2 020	1.06 (0.79–1.43)	864	1.06 (0.76–1.48)			
>10% of night shifts of all shifts	High	2 020	1	2 020	1	1 751	1	0.713	0.526	0.206
	Intermediate	2 020	0.80 (0.70–0.90)	2 020	0.89 (0.78–1.01)	1 686	0.96 (0.83–1.11)			
	Low	1 088	0.57 (0.49–0.67)	1 088	0.69 (0.59–0.81)	864	0.85 (0.71–1.02)			

>25% of weekend work of all weekends	High	2 020	1	2 020	1	1 751	1	0.958	0.177	0.122
	Intermediate	2 020	0.84 (0.72–0.98)	2 020	0.87 (0.75–1.02)	1 686	0.91 (0.76–1.08)			
	Low	1 088	0.68 (0.57–0.81)	1 088	0.71 (0.59–0.85)	864	0.75 (0.61–0.93)			
>25% of >4 consecutive work shifts	High	2 020	1	2 020	1	1 751	1	0.869	0.256	0.051
	Intermediate	2 020	1.07 (0.94–1.22)	2 020	1.06 (0.93–1.21)	1 686	1.09 (0.94–1.26)			
	Low	1 088	1.24 (1.07–1.45)	1 088	1.25 (1.07–1.46)	864	1.35 (1.13–1.62)			
Variability of shift length >0.55h	High		1	2 020	1	1 751	1	0.141	0.399	0.871
	Intermediate		0.69 (0.59–0.79)	2 020	0.76 (0.65–0.88)	1 686	0.78 (0.66–0.93)			
	Low		0.46 (0.39–0.55)	1 088	0.55 (0.47–0.65)	864	0.62 (0.51–0.75)			

¹ Adjusted with age and sex

² Adjusted with age, sex, level of education, full-time / part-time work shift work experience, perceived work ability, children under 18 years living in the same household, and overall stressfulness of the life-situation

³ Separate analysis of interaction between age or sex or work ability and the working hour characteristics