Payroll data based description of working hours in the Danish regions

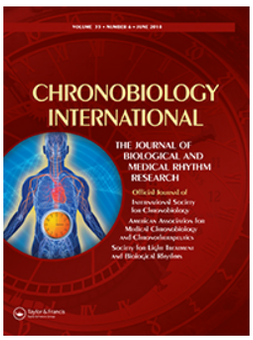
Garde, Anne Helene; Hansen, Johnni; Kolstad, Henrik A; Larsen, Ann Dyreborg; Pedersen, Jacob; Petersen, Jindong Ding; Hansen, Åse Marie

Published in:
Chronobiology International

DOI:
10.1080/07420528.2018.1466797

Publication date:
2018

Document version
Publisher's PDF, also known as Version of record



Taylor & Francis
Taylor & Francis Group

Chronobiology International

The Journal of Biological and Medical Rhythm Research

ISSN: 0742-0528 (Print) 1525-6073 (Online) Journal homepage: http://www.tandfonline.com/loi/icbi20

Payroll data based description of working hours in the Danish regions

Anne Helene Garde, Johnni Hansen, Henrik A. Kolstad, Ann Dyreborg Larsen, Jacob Pedersen, Jindong Ding Petersen & Åse Marie Hansen

To cite this article: Anne Helene Garde, Johnni Hansen, Henrik A. Kolstad, Ann Dyreborg Larsen, Jacob Pedersen, Jindong Ding Petersen & Åse Marie Hansen (2018) Payroll data based description of working hours in the Danish regions, Chronobiology International, 35:6, 795-800, DOI: 10.1080/07420528.2018.1466797

To link to this article: https://doi.org/10.1080/07420528.2018.1466797

Published online: 15 May 2018.

CHRONOBIOLOGY INTERNATIONAL
2018, VOL. 35, NO. 6, 795–800
https://doi.org/10.1080/07420528.2018.1466797

Payroll data based description of working hours in the Danish regions

Anne Helene Garde[a,b], Johnni Hansen[c], Henrik A. Kolstad[d], Ann Dyreborg Larsen[a], Jacob Pedersen[a], Jindong Ding Petersen[e], and Åse Marie Hansen[a,b]

[a]National Research Centre for the Working Environment, Copenhagen, Denmark; [b]Department of Public Health, University of Copenhagen, Copenhagen, Denmark; [c]The Danish Cancer Society Research Center, Copenhagen, Denmark; [d]Danish Ramazzini Centre, Department of Occupational Medicine, Aarhus University Hospital, Aarhus, Denmark; [e]Research Unit for General Practice, Department of Public Health, University of Southern Denmark, Odense, Denmark

ABSTRACT

The aim was to describe the organization of working hours in the Danish regions according to sex, age and calendar year. Based on the Danish Working Hour Database (DWHD), individuals were classified according to schedules: Permanent day (57.8%), evening (1.7%), or night (1.2%); day/evening (22.0%); day/night (6.6%); evening/night (0.6%); and day/evening/night (10.2%). More men (9.1%) than women (5.9%) worked day/night, whereas more women (10.9%) than men (7.4%) worked day/evening/night. More young than older employees worked day/evening/night, and fewer worked permanent day or night. From 2008 to 2015 we observed a trend towards more employees working permanent day and fewer employees working other schedules. Altogether DWHD provides a strong tool in research on working hours.

ARTICLE HISTORY
Received 25 September 2017
Revised 19 January 2018
Accepted 27 March 2018

KEYWORDS
DWHD; working hours; payroll data; shift work; register data

Introduction

It is well documented that shift work, in particular when including night work, is associated with less and disturbed sleep, fatigue, injuries, and work-life interference (Åkerstedt & Wright, 2009; Jansen et al., 2004). Many studies suggest that shift workers have increased risk of cardiovascular disease, breast cancer, diabetes, and gastrointestinal disorders (Hansen et al., 2016; Kivimaki et al., 2011; Knutsson & Bøggild, 2010; Stevens et al., 2014; Vyas et al., 2012), but a causal relationship remains to be settled.

In order to study associations between working hours and health outcomes and trends in working hours over the years, large epidemiological cohorts with accurate assessment of working hours and diseases are needed, e.g. time of day, working hour duration, intensity, and rest periods between work periods are suggested to be captured in future epidemiological studies (Härma et al., 2015; Stevens et al., 2011). Questionnaires are in general not optimal for obtaining all this information retrospectively because of possible recall bias. In addition, workers with irregular working hours may be particularly difficult to reach rendering studies vulnerable for selective participation. Furthermore, with point estimates of working time, e.g. from questionnaires, little is known about changes in exposure during the follow-up time, which may result in misclassification of the working hours.

One efficient way to improve assessment of working hours is to use daily payroll information on starting and ending times, which may be used to assess different types of shifts, e.g. day, evening, and night shifts, as well as other relevant characteristics related to the scheduling of shifts, e.g. number of consecutive nights and duration of shifts (Garde et al., 2016; Härma et al., 2017). So far, payroll data has been used in a few studies with relatively small study groups and over a limited length of time (Fekedulegn et al., 2013; Garde et al., 2012; Ingre et al., 2012; Nabe-Nielsen et al., 2010; Vedaa et al., 2016) although two larger cohorts have recently been established in Finland (Härma et al., 2015; Härma et al., 2017) and Denmark (Garde et al., 2016; Vistisen et al., 2017). The Danish Working Hour Database (DWHD) provides payroll data for a large number

CONTACT Anne Helene Garde ahg@nrcwe.dk National Research Centre for the Working Environment, Lersø Parkallé 105, Copenhagen DK-2100, Denmark

of employees in the Danish regions that has a major task to run the public hospitals.

The aim of the present study was to provide an overall description of the organization of working hours in the Danish regions according to sex, age, and calendar year by use of DWHD.

Methods

The study population in DWHD includes all employees in the Danish administrative regions from 2007 (four regions) to 2008 (all regions). So far, there are data from 265 898 unique employees included in the cohort from 2007 to 2015. The number of unique employees for each year is shown in Table 1. A total of 68 840 employees (57% of the 2007 population), who were in the cohort in 2007, were also employed in the regions in 2015.

Linear regression analyses were used for trend analysis by use of the mixed procedure in SAS 9.4.

The cohort was approved by The Danish Data Protection Agency (ref no: 2011–41-7046) and the study conforms to international ethical standards (Portaluppi et al., 2010).

Working hour information

Payroll data were obtained from two commercial providers of payroll systems: Silkeborg Data (SD; 4 regions; 2007–2013) and KMD (1 region; 2008–2013). This data comprised observations on an individual basis for all payment with description of type of payment. The initial data included 346 387 unique employees with 422 352 645 observations. All observations related to payments for clothing and diets only etc. were excluded leaving 345 260 unique employees. After excluding 79 362 employees without any observations of working hours the final cohort included 265 898 employees. The employees excluded in the last step were mainly clients, e.g. in handicap homes who received allowances, external teachers and invigilators at exams and were therefore not employees with regular working hours.

The DWHD includes information on regular working hours, overtime, and on-call work. Consecutive observations of working hours, e.g. a shift followed by overtime work at the same workplace were collapsed into one registration defined by the starting time and ending time if they were 60 minutes or less apart. Gaps of more than 60 minutes were considered time off and working hours prior and subsequent to the gap were recorded as two independent shifts. Thus there may be more than one shift per day. The DWHD also includes information on a daily basis about absence due to (a) sickness, (b) holidays, (c) maternity leave, (d) care days, and (e) work-related injury (not included in sickness absence). Care days are economically compensated days of leave due to taking care of a sick person often children's first and/or second day of sickness. Data has been cleansed so that there are no double registrations, e.g. there is no overlap between periods of absence and (on-call) work. For this purpose the following priority was applied: work > absence due to holiday > injury > parental leave > sickness in family > own sickness > sick child > on-call work. DWHD furthermore includes information on sex and date of birth from the Danish personal identification number, as well as information related to workplace, e.g. job type, hospital, department, and degree of employment. Comparison with information from 4-week shift plans in paper from 157 employees (4088 shifts) from hospitals (N = 67), psychiatric wards (N = 68), and a handicap home (N = 22) showed that 99.6% of all shifts and 100% of absences were matched by date and time.

In the present study, 190 438 405 observations of working hours were included (4 097 926 on-call shifts were excluded). Shifts were classified as: *Day* (D; ≥3 hours between >06:00 and <21:00; *Evening* (E; ≥3 hours between ≥18:00 and <02:00); and *Night* (N; ≥3 hours between ≥23:00 and ≤06:00). The definitions were not mutually exclusive and shifts were following prioritised: night>evening>day. For each person and year, shifts were further classified into schedules based on the work by Härmä et al. (Härma et al., 2015; Härma et al., 2017): *Permanent day*: <6.7% evening shifts and <6.7% night shifts (corresponding to more than 130 day shifts and less than 10 evening and 10 night shifts for employees with 150 shifts/year); *permanent evening*: <6.7% D and <6.7% N; *permanent night*: <6.7% D and <6.7% E; *day/evening*: ≥6.7% D, ≥6.7% E, and <6.7% N; *day/night*: ≥6.7% D, <6.7% E, and ≥6.7% N; *evening/night*: <6.7% D, ≥6.7% E, and ≥6.7% N per year;

Table 1. Distribution of employees with permanent day (D), evening (E), or night (N) work and shift work (day/evening (D/E), evening/night (E/N), evening/night (E/N), and day/evening/night (D/E/N)) in the Danish regions by sex, age and job (2015) and calendar year (2007–2015).

		D		E		N		D/E		D/N		E/N		D/E/N		Total
		%	N	%	N	%	N	%	N	%	N	%	N	%	N	
Sex	**Men**	61.1	19 347	1.4	451	1.5	460	19.0	6 005	9.1	2 892	0.6	174	7.4	2 356	31 685
	Women	56.9	68 512	1.8	2 120	1.1	1 320	22.8	27 487	5.9	7 117	0.6	683	10.9	13 156	120 395
Age	**< 30 yrs**	48.3	12 479	1.4	359	0.7	183	25.2	6 519	5.7	1 484	0.7	179	18.0	4 648	25 851
	30-50 yrs	57.7	42 390	0.9	676	1.0	749	20.9	15 320	8.5	6 236	0.4	318	10.6	7 794	73 483
	> 50 yrs	62.6	32 990	2.9	1 536	1.6	848	22.1	11 653	4.3	2 289	0.7	360	5.8	3 070	52 746
Job	**Nursing personnel**	37.5	26 693	3.0	2 109	2.2	1 583	31.4	22 299	6.5	4 645	1.1	765	18.3	13 030	71 124
	Physicians	54.8	10 075	0.2	44	0.2	34	12.4	2 277	27.1	4 979	0.1	19	5.2	959	18 387
	Other	83.5	48 168	0.3	182	0.3	154	12.6	7 280	0.6	347	0.1	69	2.6	1 476	57 676
Year	**2007**	52.7	63 755	2.4	2 950	1.8	2124	22.9	27 687	7.1	8 561	0.7	799	12.6	15 204	121 080
	2008	53.0	75 126	2.3	3 303	1.7	2356	23.1	32 744	7.2	10 180	0.7	963	12.0	17 020	141 692
	2009	53.0	76 358	2.3	3 296	1.7	2417	23.2	33 386	7.1	10213	0.8	1 085	12.0	17249	144 004
	2010	53.3	75 345	2.3	3 245	1.8	2 518	22.8	32 290	7.1	10 103	0.8	1 066	12.0	16 905	141 472
	2011	53.6	74267	2.1	2 932	1.7	2 315	22.4	30 971	7.3	10 171	0.7	1015	12.1	16 807	138 478
	2012	56.2	81 620	1.8	2 655	1.5	2 184	21.0	30 474	7.0	10 198	0.6	911	11.8	17 171	145 213
	2013	57.0	85 644	1.7	2 531	1.4	2 158	20.7	31 145	6.8	10 271	0.6	935	11.7	17 504	150 188
	2014	57.9	88 165	1.7	2 528	1.1	1 736	21.8	33 118	6.6	10 008	0.6	850	10.4	15 750	152 155
	2015	57.8	87 859	1.7	2 571	1.2	1 780	22.0	33 492	6.6	10 009	0.6	857	10.2	15 512	152 080
	Estimate(sd)		2219(423)		-135.5(20.7)		-103.0(22.9)		-0.43(197)		-20.1(13.7)		-28.7(9.1)		-189(91.8)	
	p-value*		0.002		0.001		0.004		0.998		0.192		0.020		0.085	

and *day/evening/night*: ≥6.7% D, ≥6.7% E and ≥6.7% N.

Results

In 2015, 79% of the employees were women, 17% were aged <30 years, 48% were 30–50 years, and 35% were >50 years.

Table 1 shows that the cohort includes 140 000 or more employees/year from 2008 onwards. In 2015, 87 859 worked permanent day (57.8%), and <2% worked permanent evening (1.7%) or night (1.2%). Approx. 30 000 worked day/evening (22.0%) and 15 000 had a 3-shift schedule (10.2%). More men (9.1%) than women (5.9%) worked day/night, whereas more women (10.9%) than men (7.4%) worked day/evening/night in 2015. Employees <30 years of age were more likely to work day/evening/night, and less likely to work permanent day or night than older employees. There is a small but significant trend towards more employees working permanent day and fewer employees working other schedules from 2008 to 2015.

Discussion

We found that almost half of the employees in the Danish regions work in non-standard schedules (not permanent day) with a small decrease in non-standard and an increase in daytime workers over the past 8 years. In the same period there has been a large focus on reducing health care expenses, e.g. by reducing time in hospital. As an example the number of days in hospital for women giving birth has been reduced from 5–10 days to 1–3 days for primiparae and 3–6 hours for multipara, and the number of beds in public hospitals has decreased from 18 141 in 2007 to 15 849 in 2013 corresponding to a reduction of 12.6%. Correspondingly, the number of in-patients has decreased from 4.9 to 4.1 million/year and the number of out-patients has increased from 6.0 to 7.9 million/year, which may at least partially explain the changes in number of employees with evening and night work.

The accurate daily information on working hours is a major strength of the study. In addition to estimation of schedules as in this study, the DWHD provides the possibility to derive specific working hour arrangements, e.g. number of consecutive nights and duration of different shifts and prospectively link them to the studied outcomes in future studies. Another strength is the inclusion of a large number of employees, and that the cohort includes all employees in the regions with compulsory registration in the database. Further, all subjects can be individually linked with information from other Danish databases on health, early retirement and disability pension

The validity regarding timing of working hours is expected to be high, since it is closely related to payment. In contrast, the validity of length of shifts and weekly working hours is expected to be somewhat under-estimated among, e.g. physicians and other academic personnel where unpaid extra working hours are more common. The database covers only employees in the regions, and there is no information on working hours for periods, where employees have left employment in the regions and worked elsewhere.

In the future, the DWHD may be used to improve the quality of research on health consequences of shift work by overcoming some of the limitations in previous studies. For outcomes which have short latency and are independent of previous working hours exposures, e.g. short term sickness absence and accidents, the DWHD offers the opportunity to use fixed effects models by comparing periods with e.g. night work to periods without night work within the same individual and thereby reducing potential bias due to individual factors. For long-term effects, e.g. cancer, the lack of information on working hour arrangement before 2007 is a limitation of DWHD. The day-to-day information collected over many years offers the opportunity to use advanced study designs have a wash-out period from previous night work by exclusion of employees with night work for a period before allocating into exposed and reference groups, thus using observational data to mimic trials (Hernan et al., 2008).

The detailed information on starting and ending time of working hours in the DWHD has been used to examine how different definitions affect the proportion of shifts classified as night shifts (Garde et al., 2016). It was concluded that the

proportion of classified night shifts differs very little when using definitions including a period of time during the night, e.g. at least 3 hours between 00:00 and 05:00 in this cohort (Garde et al., 2016). Risk of breast cancer with recent night work has been studied by linking the DWHD to seven Danish registries on an individual basis. No increased risk of all breast cancer was found among women who had night work during the past five years compared to women who did not (Vistisen et al., 2017). Current studies use DWHD to study cardiovascular disease, mental disorders, long and short term sickness absence, pregnancy related outcomes, and injuries in relation to specific work schedules, e.g. evening or night work, consecutive night shifts, quick returns (<11 hours between shifts), and permanent night work. Altogether DWHD provides a new strong tool in the research on how to arrange working hours in order to provide recommendations on the best way to organize working hours to employees, employers, work environmental professionals, and regulators.

Acknowledgements

The DWHD is established in collaboration between National Research Centre for the Working Environment, The Danish Cancer Society, Danish Ramazzini Centre, Department of Occupational Medicine, Aarhus University Hospital, and Department of Public Health, University of Copenhagen.

The Danish regions are acknowledged for their participation and willingness to provide data to the DWHD. Jens Worm Begtrup, Lisbeth Nielsen and Anders Ørberg are thanked for valuable work with data management.

Declaration of Interest

The authors declare no conflicts of interest.

Funding

The establishment of the DWHD has been financed by research grants from the Danish Working Environment Research Fund [23-2012-09], NordForsk, Nordic Program on Health and Welfare [74809], and the National Research Centre for the Working Environment. The regions have partially financed the transfer of data to the cohort.

References

Åkerstedt T, Wright KP. 2009. Sleep loss and fatigue in shift work and shift work disorder. Sleep Medicine Clinics. 4 (2):257–71.

Fekedulegn D, Burchfiel CM, Hartley TA, Andrew ME, Charles LE, Tinney-Zara CA, Violanti JM. 2013. Shiftwork and sickness absence among police officers: The BCOPS study. Chronobiol Int. 30(7):930–41.

Garde AH, Albertsen K, Nabe-Nielsen K, Carneiro IG, Skotte J, Hansen SM, Lund H, Hvid H, Hansen AM. 2012. Implementation of self-rostering (the PRIO-project): Effects on working hours, recovery, and health. Scand J Work Environ Health. 38(4):314–26.

Garde AH, Hansen J, Kolstad HA, Larsen AD, Hansen AM. 2016. How do different definitions of night shift affect the exposure assessment of night work? Chronobiol Int. 33 (6):295–98.

Hansen AB, Stayner L, Hansen J, Andersen ZJ. 2016. Night shift work and incidence of diabetes in the Danish Nurse Cohort. Occup Environ Med. 73(4):262–68.

Härma M, Koskinen A, Ropponen A, Puttonen S, Karhula K, Vahtera J, Kivimaki M. 2017. Validity of self-reported exposure to shift work. Occup Environ Med. 74(3):228–30.

Härma M, Ropponen A, Hakola T, Koskinen A, Vanttola P, Puttonen S, Sallinen M, Salo P, Oksanen T, Pentti J; et al. 2015. Developing register-based measures for assessment of working time patterns for epidemiologic studies. Scand J Work Environ Health. 41(3):268–79.

Hernan MA, Alonso A, Logan R, Grodstein F, Michels KB, Willett WC, Manson JE, Robins JM. 2008. Observational studies analyzed like randomized experiments: An application to postmenopausal hormone therapy and coronary heart disease. Epidemiology. 19 (6):766–79.

Ingre M, Akerstedt T, Ekstedt M, Kecklund G. 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(4):327–36.

Jansen NW, Kant I, Nijhuis FJ, Swaen GM, Kristensen TS. 2004. Impact of worktime arrangements on work-home interference among Dutch employees. Scand J Work Environ Health. 30(2):139–48.

Kivimaki M, Batty GD, Hublin C. 2011. Shift work as a risk factor for future type 2 diabetes: Evidence, mechanisms, implications, and future research directions. PLoS Med. 8 (12):e1001138.

Knutsson A, Bøggild H. 2010. Gastrointestinal disorders among shift workers. Scand J Work Environ Health. 36 (2):85–95.

Nabe-Nielsen K, Kecklund G, Ingre M, Skotte J, Diderichsen F, Garde AH. 2010. The importance of individual preferences when evaluating the associations between working hours and indicators of health and well-being. Appl Ergon. 41(6):779–86.

Portaluppi F, Smolensky MH, Touitou Y. 2010. Ethics and methods for biological rhythm research on animals and human beings. Chronobiol Int. 27(9–10):1911–29.

Stevens RG, Brainard GC, Blask DE, Lockley SW, Motta ME. 2014. Breast cancer and circadian disruption from electric lighting in the modern world. CA Cancer J Clin. 64 (3):207–18.

Stevens RG, Hansen J, Costa G, Haus E, Kauppinen T, Aronson KJ, Castaño-Vinyals G, Davis S, Frings-Dresen MHW, Fritschi L; et al. 2011. Considerations of circadian impact for defining 'shift work' in cancer studies: IARC Working Group Report. Occup Environ Med. 68(2):154–62.

Vedaa O, Pallesen S, Waage S, Bjorvatn B, Sivertsen B, Erevik E, Svensen E, Harris A. 2016. Short rest between shift intervals increases the risk of sick leave: A prospective registry study. Occup Environ Med. 74(7):496–501.

Vistisen HT, Garde AH, Frydenberg M, Christiansen P, Hansen AM, Andersen J, Bonde JP, Kolstad HA. 2017. Short-term effects of night shift work on breast cancer risk: A cohort study of payroll data. Scand J Work Environ Health. 43(1):59–67.

Vyas MV, Garg AX, Iansavichus AV, Costella J, Donner A, Laugsand LE, Janszky I, Mrkobrada M, Parraga G, Hackam DG. 2012. Shift work and vascular events: Systematic review and meta-analysis. Bmj. 345:e4800.