Extended Work Shifts Increase Subjective Pain Complaints Among Cabin Crewmembers, but Not Among Airline Pilots or Healthcare Workers

A Repeated-Measures Study

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Objective: To determine whether four consecutive extended work shifts are associated with an increased risk of subjective pain complaints, sleep duration, and sleep disturbances. **Methods:** Forty-three healthcare workers, 41 cabin crewmembers, and 18 airline pilots working 4 consecutive extended workdays reported subjective pain complaints and sleep after the 1st and 4th workday. **Results:** The risk of headache (odds ratio [OR] 21.4, 95% confidence interval [CI] 1.85 to 246.5) and pain in the hands, arms, or wrists (OR 3.78, 95% CI 1.84 to 7.76) increased after workday 4 versus workday 1 in cabin crewmembers. Sleep duration was longer (0.6 to 1.1 hours), and sleep disturbances fewer, the night before the fourth extended workday, compared with before the first workday, in all occupations. **Conclusions:** We found no general support for an association between extended work shifts and subjective pain, whereas sleep duration was improved, and sleep disturbances reduced after 4 consecutive extended workdays.

Keywords: complaints, headache, musculoskeletal, shift work, work schedule

Musculoskeletal disorders (MSDs) and headache are among the most significant contributors to disability according to the Global Burden of Disease Study.[1,2] This underscores the unfavorable consequences of these ailments both for individuals and for the society. Factors contributing to musculoskeletal pain or headache need to be identified, to find optimal preventive measures.

Extended working hours is associated with increased sleepiness at work[3] and with shortened sleep.[4] In the European Union, 68% of the workers reported working more than 10 hours/d at least once per month.[5] Combining extended daily working hours followed by several days off, so-called compressed working weeks, has traditionally been practised in the Norwegian offshore sector and within the aviation sector.[6,7] Also in other sectors, such as the healthcare sector, construction sector, and service sector, the use of similar work schedules has increased in recent years, due to production benefits.[7]

Sleep disturbances represent one potential risk factor for both MSD and headache.[8,9] Sleep disturbances and shortened sleep are also risk factors for elevated pain sensitivity.[10,11] Several mechanisms have been suggested linking the bidirectional relationship between sleep and pain.[12] Other risk factors for MSD and headache include psychosocial and mechanical work exposures.[13,14]

Although extended working hours reduce the opportunity for sleep and restitution, there is a lack of knowledge of the association between long working hours and pain, and the published results are ambiguous.[15] Lack of knowledge also exist on the interaction between work content and extended working hours.

The present study aimed to determine whether extended work shifts were associated with an increased risk of subjective pain complaints, in three different occupational groups with different work content. The primary hypothesis was that subjective pain complaints increase from workday 1 to workday 4. A secondary hypothesis was that sleep duration becomes shorter, and/or more disturbed, before workday 4 compared with before workday 1.

METHODS

Study Population

Workers from three occupational groups participated: healthcare workers, airline pilots, and cabin crewmembers.

From the time a new nursing home opened on the west coast of Norway in 2012, a new temporary shift scheme was introduced. The new 3 weeks work schedule consisted of 4 consecutive day shifts (D) followed by 7 days off (F), 3-day shifts, and finally another 7 days off (DDDD FFFFFFF DDD FFFFFFF). The duration of the day shifts was 14 hours. Information about the study, and an invitation to participate were presented at staff meetings. To reduce recruitment bias, all 51 healthcare workers involved in the new shift scheme were invited to participate in the study, and 43 consented. Commuting time from home to the nursing home was on average around 15 minutes. Details on the inclusion of the healthcare workers are published elsewhere.[16] Data were collected in fall/winter 2014/2015.

Pilots and cabin crewmembers in a commercial airline based in Norway were recruited through e-mails sent by the management of flight and cabin operations at a national level, in coordination with pilot and cabin crew union representatives. In addition, handouts were distributed at the crew base. Representatives from the study's project group were present at the crew base at Oslo airport on several occasions to recruit crewmembers, hence seeking to reduce recruitment bias. Initially 160 crewmembers agreed to participate. The main criteria for selection of the final sample were characteristics of the planned flight duty period of the enrolled crewmembers. Work periods consisting of 4 consecutive working days were most common at the time of recruitment and was chosen, leaving a final sample of 59 airline crewmembers. In addition, we chose flights within the same time zone or with a maximum of 1 hour time difference, to avoid jet lag. Of the final sample, 18 were pilots and 41 were cabin crewmembers, see Table 1. Data were collected between April 2015 and September 2017. Commuting time from home to airport was on average more than 1 hour for these groups. More details on the inclusion of the crewmembers are published elsewhere.[17]

Informed consent was obtained from all individuals. The project was in accordance with the tenets of the Helsinki

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TABLE 1. Characteristics of the Study Population, by Occupation

	Healthcare Workers (n = 56/43)	Cabin Crew Members (n = 41/38)	Airline Pilots (n = 18/18)
Mean age (SD)	40.3 (8.0)	43.5 (8.9)	**51.8 (5.3)**
Proportion women (%)	86.9	87.3	**11.1**
Chronotype (%)			
Early bird	25.5	34.2	11.8
Night owl	33.0	21.5	29.4
Neither	41.5	44.3	58.8
Pain last month (%)			
Neck, shoulder, upper back	34.0	36.7	29.4
Low-back pain	22.8	20.3	**41.2**
Arms, wrists, hands	17.0	17.7	17.7
Headache or migraine	28.7	22.8	11.8
Pain last year (%)			
Neck, shoulder, upper back	47.9	**63.3**	47.1
Low-back pain	40.4	38.0	58.8
Arms, wrists, hands	33.0	41.8	29.4
Headache or migraine	33.7	38.0	**11.8**
Insomnia disorder (%)			
Fulfilling criteria	47.5	58.2	44.4

n, number of participants on workday 1/workday 4. Statistically significant group differences in bold.

Declaration (as amended in 2013) and was approved by the Regional Committee for Medical Research Ethics (2014/1508/REK sør-øst B).

Study Design

The study design was a repeated-measures study (cross-shift/cross-week), in which the participants served as their own controls, and were followed across 4 consecutive workdays.

Data Collection

At inclusion, each participant completed a paper-based questionnaire including questions on individual characteristics, such as marital status, number of children living at home, age, weight, smoking habits, physical activity, duration of current position, habitual sleep pattern, and self-reported health problems during the previous 4 weeks and the previous year. Questions were based on validated questionnaires on the psychosocial working environment, [18] and insomnia.[19] In addition, we included questions developed specifically for this study.

Outcomes were subjective pain complaints during the previous 24 hours, collected by paper diaries, using a Likert-type scale with response categories 0 (not troubled), 1 (somewhat troubled), 2 (quite troubled), or 3 (very troubled). Complaints were rated for four body areas: head (headache/migraine), neck/shoulder/upper back, arms/wrists/hands, and low-back. Secondary outcomes were sleep duration and sleep complaints, adapted from the Bergen Insomnia Scale,[19] as responses to the following questions: "How many hours did you sleep the previous night?" and (with yes/no alternatives): "Did you spend more than 30 min to fall asleep after trying to fall asleep?" "Have you been awake more than 30 min after falling asleep?" "Did you wake up more than 30 min earlier than planned?" Outcomes were reported at the end of the 1st and 4th workday. Sleep questions referenced to the night before the 1st and 4th workday.

The exposure was 4 consecutive workdays lasting 10 to 14 hours.

Statistical Analyses

We compared characteristics between occupations by chi-square tests (count variables) and by analysis of variance (age). If the main effect was significant at $P < 0.05$, paired comparisons were made between occupations. To test the primary hypothesis, pain complaints were treated as ordinal variables.[20,21] The proportional odds assumption was tested and met for all dependent variables (Brant test). The effect of time was analyzed using Stata's meologitfunction (mixed effects ordered logistic regression), for each occupation. If the model did not converge, pain complaint ratings were dichotomized into "no pain" (category 0) and "pain" (categories 1, 2, and 3) and analyzed by Stata's generalized estimating equationsfunction xtgee. To test the second hypothesis, the 2 workdays were compared by linear mixed models (sleep duration) or by xtgee (count variables), for each occupation. Age-adjusted models were also tested, treating age as a continuous variable. Statistical analyses were performed in Stata v. 16.1 (StataCorp LLC, TX, www.stata.com).

RESULTS

Characteristics of the Study Population

Table 1 shows the characteristics of the study population, stratified by occupation. Among airline pilots, the proportion of men as higher among pilots than among healthcare workers ($P < 0.001$) and cabin crewmembers ($P = 0.0005$). While cabin crewmembers were somewhat older than healthcare workers ($P = 0.007$), airline pilots were older than both cabin crewmembers and healthcare workers ($P < 0.001$). Airline pilots were more likely to be early birds, although this was not statistically significant. Approximately one-third of the workers reported of having had pain in the neck, shoulder, and upper back region during the last month. The prevalence of other pain complaints during the last month was lower, except for among the airline pilots, where 41.2% reported lower back pain, more than both cabin crewmembers ($P = 0.021$) and healthcare workers ($P < 0.026$). Reported prevalence of pain during the last year was generally higher than reported prevalence during the last month. The highest prevalence of pain during the last year was reported by cabin crewmembers (63.3%), although not significantly higher than among healthcare workers or airline pilots. Airline pilots reported less headache or migraine than cabin crewmembers ($P = 0.005$), and healthcare workers ($P = 0.015$). In all groups, approximately half of the workers fulfilled the criteria for insomnia disorder, with the highest proportion among the cabin crewmembers.

Commute time differed considerably between occupational groups and was shortest for the healthcare workers (day 1: 12.2 [7.6] minutes; day 4: 11.5 (6.8) minutes; mean [standard deviation]), for the cabin crewmembers (day 1: 53.7 [20.9]; day 4: 50.8 [21.5]), and for the airline pilots (day 1: 42.8 [24.0]; day 4: 37.5 [34.9]). The difference between day 1 and 4 was not statistically significant for any of the occupational groups ($P > 0.079$).

Subjective Pain Complaint Prevalence

Most of the workers (between 60% and 85%) reported that they were "not troubled" by pain in the regions investigated (Fig. 1). The reported prevalence of pain in the neck, shoulders, or upper back was highest among healthcare workers and cabin crewmembers, between 40% and 45%. The prevalence of low-back pain was highest among healthcare workers, around 40%. The prevalence of pain in the hands, arms, or wrists was also highest among healthcare workers, where around 25% reported such complaints. Headache/migraine prevalence varied from less than 10% (airline pilots after workday 4) to around 40% (cabin crewmembers after workday 4).

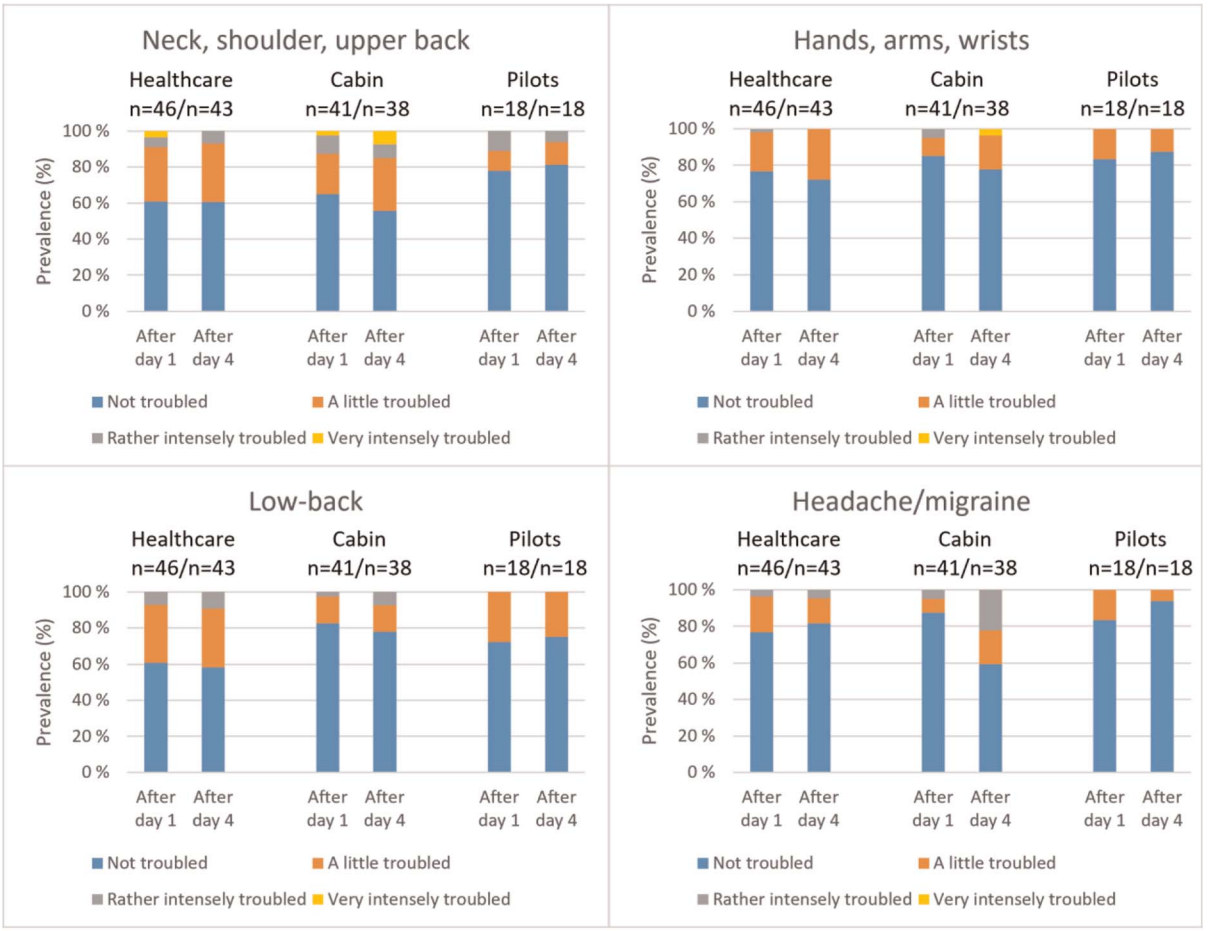

FIGURE 1. Pain complaint prevalence (in percent of group) after 1st and 4th workday, by pain region and occupation.

Effect of Extended Workdays on Pain Complaints

Working 4 consecutive extended workdays was associated with increased prevalence of pain complaints in hands, arms, or wrists (OR 3.78, 95% CI 1.84 to 7.76) and headache or migraine (OR 21.4, 95% CI 1.85 to 246.5) among cabin crewmembers, when compared with the first workday (Table 2). The analyses indicated no increase of pain complaints in any of the other body areas (neck, shoulders, upper back; low-back pain), in any of the occupational groups. Adjusting for age in the analyses did not change the results.

Effect of Extended Workdays on Sleep

Sleep duration was significantly longer the night before workday 4, compared with the night before workday 1 (Table 3). Healthcare workers slept 0.6 hours longer (95% CI: 0.3 to 1.0), cabin crewmembers slept 1.1 hours longer (95% CI: 0.5 to 1.7), and airline pilots slept 0.9 hours longer (95% CI: 0.2 to 1.5). Among cabin crewmembers, long sleep latency was significantly less frequent the night before workday 4, than workday 1. The same tendency, albeit not significant, was seen among the pilots. Among health care workers, lying more than 30 minutes awake during the night, and waking up more than 30 minutes earlier than planned, were significantly less frequent before workday 4, than before workday 1. Adjusting for age in the analyses did not change the results.

DISCUSSION

The results from the present study suggest that 4 extended workdays elevate the risk among cabin crewmembers of reporting headache or migraine, and of pain in the hands, arms, or wrists. Furthermore, the results do not indicate any increase of pain complaints for any of the other body areas investigated (neck, shoulders, upper back, or lower back), in any of the three occupational groups. Finally, the results indicate longer sleep duration among all occupations, and fewer sleep disturbances among healthcare workers and cabin crewmembers the night before the fourth versus the first workday.

The prevalence of subjective pain complaints assessed by diary was comparable to a previous study among nurses.[21] Whether extended workdays are associated with increased risk of subjective pain complaints, has received limited attention in the literature. The few studies that exist, support a positive association. A longitudinal study among nurses reported that working more than or equal to 13 hours per day increased the risk for work-related MSDs in the neck, shoulder, or back.[22] In another study among nurses, smaller and with cross-sectional design, the authors similarly report that workdays more than 12 hours were associated with increased risk of reporting musculoskeletal pain in the neck, shoulder, and back, however only in those working more than or equal to 40 hours per week.[23] In the present study, 4 extended workdays were only associated with higher prevalence of pain in hands, arms, or wrists in cabin crewmembers. Further cross-sectional data from a national health survey in the United States,

TABLE 2. Risk of Subjective Pain Complaints After Fourth Versus First Extended Workday, by Body Area and Occupational Group, OR and 95% CI

	Healthcare Workers			Cabin Crewmembers			Airline Pilots		
	OR	95% CI		OR	95 % CI		OR	95% CI	
Neck, shoulders, upper back	1.07	0.33	3.50	1.89	0.47	7.55	0.82	0.07	9.08
Low-back pain	1.38	0.42	4.54	1.44	0.37	5.65	1.30	0.54	3.15
Hands, arms, wrists	*1.13*	*0.76*	*1.68*	***3.78***	***1.84***	***7.76***	0.57	0.05	6.40
Headache/migraine	1.14	0.26	5.04	**21.4**	**1.85**	**247**	0.33	0.03	3.58

OR, odds ratio, with first workday as reference (OR = 1). Significant findings are in bold. Stata's meologit function were used in all analyses. If the model did not converge, the outcome measure was dichotomized, and Stata's xtgee-function was used instead (results shown in italic).

found that those working 46 hours or more per week were more likely to report neck pain, compared with working 40 hours per week.[24,25] Extremely long working hours (on average 85.6 hours per week) among medical residents in a cross-sectional study in South Korea did also show an association with upper limb and low back pain.[26] Unfortunately, none of the mentioned studies of long working hours and pain measured sleep or insomnia symptoms. This would have improved comparison to previous studies. Also diverging findings between long working hours and pain exist. A cross-sectional study among a representative sample from the Norwegian general working population, did not find an association between working more than or equal to 12 hours per day hours and musculoskeletal disorders.[27] However, workers reporting long working hours in that study, also reported being a shift worker, which may have confounded the results. It is not evident why an association between long working hours and MSD was not found occur in the present population of healthcare workers, as this has previously been shown in nurses.

However, it should be mentioned that at the nursing home from which the participants were drawn, several preventive measures were taken minimizing mechanical exposures, extra breaks, and more, limiting the cumulative load on shoulders, arms, and neck. Furthermore, the present population of healthcare workers included also other occupational groups than registered nurses, such as nurses' aides and one social worker. Group characteristics may have contributed to the results. The fact that only the cabin crewmembers experienced higher prevalence of pain in the hands, arms, and wrists, may be due to a higher cumulative mechanical exposure associated with their job, compared with the jobs of healthcare workers and airline pilots. The airline pilots were mainly men and have a more sedentary work situation than the two other groups. These factors may independently contribute to group differences both at baseline and following the extended workdays.

Hence, it seems that work content, not only work duration, plays a significant role when it comes to pain complaints.

In the cabin crewmembers, the odds ratio of reporting an increased intensity headache or migraine after the fourth, versus after the first, workday was 21.4 (95% CI: 1.85 to 247). The wide confidence interval indicates low number of subjects; hence this result should be interpreted with care. The number of crewmembers responding after workday 4 were halved when compared with after workday 1 (from $n = 35$ to $n = 16$). It may be speculated whether non-responding crewmembers did not experience headache, rendering the percentage reporting a headache respectively lower. Anyway, an association between extended working hours and increased risk of headache do corroborate findings from previous studies. In healthy white-collar men, long working hours (>50 hours per week) induced headache longitudinally after 1 year.[28] In a cross-sectional study among the general working population, long working hours were associated with the prevalence of headaches, although the association may depend on a lack of physical activity.[29] A cross-sectional study among medical residents in Brazil, indicated that long duty-hours were related to headache.[30] Long working hours were, however, not predictors of headache in two cohorts randomly drawn from the Norwegian[31] or Swedish[32] working populations. Hence, diverging findings exist, which also was observed in the present study, as neither the healthcare workers, nor the airline pilots, showed any indication of higher prevalence of headache after the 4 extended working days, but rather the contrary (Table 2).

The prevalence of insomnia disorder in the present study was between 44% and 58%, depending on occupation. This is in the range of insomnia disorder prevalence among nurses with different work schedules (daytime, rotating shift work, night work) (47% to 66%) using the same insomnia scale (Bergen Insomnia Scale).[33] The prevalence is somewhat higher than in a Norwegian study among the general population (HUNT4), which compared questionnaire-based insomnia disorder based on the DSM-5 criteria[34] with a face-to-face interview, reporting a 33% prevalence.[35] The relatively high prevalence of insomnia may relate to different diagnostic criteria,[36] but is in any

TABLE 3. Sleep Parameters Before Workday 1 and 4, Including Results From Paired Comparisons

	Healthcare Workers		Cabin Crewmembers		Airline Pilots	
	Before Day 1	Before Day 4	Before Day 1	Before Day 4	Before Day 1	Before Day 4
Sleep duration, mean hours (SD)	5.98 (1.18)	6.50 (1.06)	5.48 (1.51)	6.48 (1.26)	6.18 (0.94)	6.98 (1.37)
	$P < 0.001$		**$P < 0.001$**		**$P = 0.009$**	
>30 min sleep latency (% yes)	38.2	34.9	39.0	15.4	27.8	6.3
	$P = 0.224$		**$P = 0.019$**		$P = 0.062$	
>30 min awake (% yes)	29.1	14.0	31.7	26.9	16.7	18.8
	$P = 0.021$		$P = 0.679$		$P = 0.924$	
Woke up >30 min early (% yes)	32.1	14.0	39.0	53.9	27.8	25.0
	$P < 0.014$		$P = 0.219$		$P = 0.786$	

respect significant. Preventive measures should be taken with the aim to reduce insomnia prevalence in these groups.

The sleep data have been reported before,[16,17,37] but is also reported here since the three occupational groups are combined in the present manuscript. On average, subjects in the three occupational groups extended their sleep duration with 36 to 66 minutes, from the night before the first workday to the night before the fourth workday. The increase was highly significant among all occupations. Improved sleep duration over consecutive long workdays apparently stands in contrast to previous studies. Long working hours (more than 50 hours per week) were inversely associated with sleep duration in a 1-year follow-up study among healthy white-collar men.[28] In another prospective study, repeated exposure to long working hours for several years was associated with elevated odds ratio for shortened sleep.[4] In a cross-sectional study, an association between working more than 8 hours per day and sleeping less than 6 hours per night was found among male employees in small and medium size businesses in Japan.[38] In a systematic review, long working hours were associated with longer sleep latency, longer awakenings during nocturnal sleep, and earlier awakenings.[39] Several factors may have led to the improved sleep over the 4 consecutive days observed in the present study. The airline pilots spent the fourth night at a hotel, relieving them from obligations at home and reducing their commuting time from before their fourth workday. The cabin crewmembers' fourth workday started on average one and a half hour later than their first workday, also leaving increased sleep opportunity. As for the healthcare workers, the first workday started half an hour earlier than the other days due to reading reports from the personnel leaving their 4-day work period, hence potentially shortening the sleep for the before the first workday. This, together with the fact that the administration of the patients' medications during the early morning hours of the first workday may have potentially contributed to an anticipation of higher work demands and to the observed higher cardiovascular strain before the first compared with the fourth workday.[16] A ° kerstedt[40] claims that anticipation of high demands or efforts the next day seems to be an important determinator of impaired sleep. However, the data collection methodology may also have had an impact on the diverging findings. Whereas the previous studies investigated the association over the time course of one to several years, the present study assessed the association in a daily perspective. Hence, differences in study design may have contributed to the apparently diverging findings between the mentioned studies and the present study.

The data supported reduced insomnia symptoms over the workdays in healthcare workers and cabin crewmembers. In the present study, both health care workers and cabin crewmembers experienced fewer sleep disturbances the fourth night, compared with the first night. Hence, with the present day-to-day collection of sleep complaints, 4 consecutive 10 to 14-hour workdays were associated with fewer crewmembers reporting more than 30 minutes sleep latency, as well as fewer healthcare workers reporting more than 30 minutes time awake at night and more than 30 minutes early awakenings. When this does not seem to occur among the airline pilots, it indicates that a positive association between long working hours and fewer sleep disturbances is not a general phenomenon. It is tempting to speculate that the level of physical activity could play a role. Could more physically demanding work among healthcare workers and cabin crewmembers (vs airline pilots) lead to exhaustion and to the observed reduction in sleep latency and awakenings? A cross-sectional study with objective physical activity measurements, however contradicts this speculation, indicating that occupational physical activity was positively associated with insomnia symptoms.[41]

A strength of the present study is its diary study design, presumably reducing recall bias since subjects are asked to record health complaints and sleep during the respective days. Another strength is the use of a case-crossover design, as a mean to control for unmeasured confounding. External validity was presumably high, given the real-life data collection situation, with detailed exposure information. A limitation is the relatively small number of subjects in all occupational groups, as well as the unequal gender distribution. Another limitation is that generalization to other healthcare institutions may be hampered by the optimally designed ergonomic work environment of the present institution.

As conclusion, the present study does not generally support the hypothesis that extended work shifts per se is a risk factor for subjective pain complaints, but increased risk of headache/migraine or pain complaints in hands, arms, or wrists were found among cabin crewmembers. Sleep duration was improved across occupations, and sleep disturbances reduced in two occupational groups, after 4 extended workdays.

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