

No Difference in Self Reported Health among Coalminers in Two Different Shift Schedules at Spitsbergen, Norway, a Two Years Follow-up

Rolf HANOA¹, Valborg BASTE², Arne KOOIJ¹,
Linda SOMMERVOLD¹ and Bente Elisabeth MOEN^{3*}

¹Occupational Health Services of Svalbard, Norway

²Uni Research, Bergen, Norway

³Department of Public Health and Primary Health Care, University of Bergen and Haukeland University Hospital, Kalfarveien 31, N 5018 Bergen, Norway

Received January 5, 2011 and accepted March 24, 2011

Published online in J-STAGE August 1, 2011

Abstract: This study was performed among coal miners in the remote location Svea, Spitsbergen. The shift schedule used to be 7 d on and 7 d off. The aim of this study was to investigate possible changes in health after a voluntary implementation of a new shift schedule, with periods of 14 d on and 14 d off, for 74 percent of the workers in 2007. A questionnaire was distributed to all employees before and two times after the new shift schedule, comprising questions on type of work, shift schedule, pain, sleep, stress and coping. Ninety nine percent of the employees responded; 274 in 2006, 307 in 2007 and 312 in 2008. Work neither in the 14/14 shift nor 7/7 shift was related to any change in the health after these two years. The coping index for workers in the 14/14 shift improved.

Key words: Arctic medicine, Coalminer, Health, Shift work, Work hours

Work schedules with long shift periods and extended work hours are common in geographically remote sites. Many employees prefer fewer and longer periods at work and off work. The state owned Norwegian coal company at Spitsbergen, Norway, operates a smaller underground mine in Longyearbyen, the capital of the Svalbard islands at 78° Northern latitude. The major underground operation is located in Svea, 45 km straight line to the south through snow covered mountains and glaciers¹). The location is reached by plane. The only purpose of staying in Svea is the job. The mine has a continuous production. Nobody is regularly spending the off-period in Svea. The employees are living permanently either in Longyearbyen which is located about 30 min flight time from Svea, or at the Norwegian mainland with much longer flight time home.

Before 2007 the regular shift period was a seven days

off - seven days on (7/7) schedule. The short off-periods caused frequent flights, hours and sometimes days of waiting at airports, high travel costs and little time at home. Most of the employees come from small coastal communities on the Norwegian mainland. Family and home tie them to the small community, which represents a limited labor market. Long distance commuting employees enjoyed the same Svalbard income low tax regime as those who lived in Longyearbyen and practiced short distance commuting to Svea.

In 2006 the miners' union, on behalf of the workers, demanded a change of the shift schedule in Svea so that the individual employee could choose for himself whether to work a period of seven days followed by seven days off (7/7) or a fourteen days period at work and fourteen days off period (14/14). The management endorsed the proposition which was accepted by the authorities on a probational basis. In their application to the authorities the management undertook in 2006 the obligation to carry out an investigation on the pos-

*To whom correspondence should be addressed.
E-mail: bente.moen@isf.uib.no

sible adverse health effects of the fourteen days period, starting before the implementation of a new schedule, with a follow up afterwards. The occupational health services of Svalbard were assigned the task. The management implemented a new schedule on January 15th 2007.

Both shift work and extended work hours may influence biological and social rhythms and cause negative health effects^{2, 3}). Shift work, especially when including night work, might be associated with coronary heart disease, mental health problems, sleep disturbances, gastrointestinal disorders and social problems²). However, a consistent health difference between shift workers and day workers is not always found. Further, the effect of extended work hours on health and performance is not clear. Continuous work for long hours has been associated with various health problems, sickness absence and fatigue⁴). However, current scientific evidence is inadequate to give any firm recommendations about long work hours and health⁵).

Miners may experience combinations of shift work and extended work hours⁶). Relatively few studies on health effects from this type of work have been performed among miners, and the results are not consistent⁶⁻⁸). Some studies describe adverse health effects like increased fatigue after 12 h shifts for ten consecutive days⁶), which again may cause an increased risk of accidents. Results from other studies indicate no adverse effects of similar types of work⁷), or even development of improved sleep and performance after this kind of work schedules⁸). The lack of consistent findings makes further studies necessary, as one may ask if this kind of work will have any adverse health effect at all. From a circadian point of view, a 14/14 schedule would be an advantage compared to other shift schedules⁹), as this type of work will give a complete adaptation to the night shift. This might balance out the disadvantages related to the schedule, and the workers may end up reporting no adverse health problems related to such working periods. Our hypothesis was phrased like this: Change of shift schedule from 7/7 to 14/14 will not influence the employees self reported health and coping.

A prospective cohort study was performed, with three periods of data collection: October–December 2006 - before the new shift schedule; June–August 2007 - half a year after the new shift schedule was implemented; October 2008–January 2009 - two years after the new shift schedule was implemented. The time period in which the employees were present in Svea with no days off was either 14 d, 7 d, or 5 d (daytime, weekend off). Every calendar day was divided into a day shift and a night shift. In the groups of 7/7 and 14/14 each

individual did either night shift or day shift. After two work periods of seven days or one period of fourteen days the shift was changed from night to day or vice versa. Day shift started at 7 AM and night shift started at 7 PM, both lasting 12 h. The employees comprised three groups (7/7, 14/14 and 5/2 - daytime), based on the chosen shift schedule. The study was performed among workers in a coal mine with a number of departments or operations, categorized in the two groups underground and surface operations, as the underground work was considered to be more straining than surface work physically and psychologically. All the workers were sleeping above ground, in houses made for this purpose, with adequate heating, sanitarian equipment and a canteen. There were dark shades on the windows in the sleeping room, and normally no other noise than the one coming from neighbor sleeping rooms.

Employment in the coal company depends on passing an initial medical examination. All the employees are medically screened on a regular basis. Chronic disorders causing reduced performance or behavioral difficulties do not comply with work in the Norwegian mines of Svalbard, and employees therefore represent a generally healthy and robust population.

A questionnaire was distributed to all coal company employees in Svea (miners, foremen, supervisors, maintenance and staff personnel). In 2006 and 2008 the investigation period was during winter (the dark period), in 2007 during summer (midnight sun). The present analysis focuses on the self-reported health data from 2006 and 2008. New employees after 2006 were included in our study but excluded from the present analysis. Female employees were also excluded due to low numbers.

During the process of preparation for the study, the union representatives and the management were consulted. Data collection had to be performed at the work site, in the dining rooms underground and on the surface or in the assembly room after ended shift, with no medical facilities available. To minimize the non-response, the time needed to participate in the study was suggested to be not more than 15 min. A questionnaire study was chosen, as this seemed to be the most acceptable and applicable method in this setting, and a questionnaire on one sheet of paper was designed. The questionnaire comprised background variables on name, age, travel time from residence to Svea, department in the mine, shift schedule, day or night shift when completing the questionnaire. Four questions on pain (from head, neck/shoulder, low back, legs) and five questions on sleep (sleep disorder in Svea, insomnia, disturbed by noise, refreshed after sleep, lying awake), with response alternatives on frequency graded from 1 to 4 were asked

Store Norske Spitsbergen Grubekompani A/S Occupational health services Professor Rolf Hanoa	Health form autumn 2008 Occupational health services Confidential 2
<p>Questionnaire 08: SHIFT SCHEDULE, COMMUTING, HEALTH, COPING Confidential</p> <p>This form concerns all who work in Svea. Please, complete the form as correctly as you can according to your present work situation. The occupational health services collect the forms. Your contribution by completing the form is appreciated. Collecting boxes are installed at the mine office, at the dining rooms underground and in the mess.</p> <p>The completed forms are read by the occupational health services only. Nobody else will have access to the completed forms. The occupational health nurses direct line: 79 02 42 00/ 41 66 61 80.</p> <p>Date completed: _____ Surname, first name: _____ Age: _____</p> <p>Family: Married <input type="checkbox"/> Cohabitant <input type="checkbox"/> Other <input type="checkbox"/> (single, divorced)</p> <p>Residence during off periods (most frequent residence): Longyearb. <input type="checkbox"/> Troms/Finnmark <input type="checkbox"/> Nordland <input type="checkbox"/> Trøndelag counties <input type="checkbox"/> Western Norway <input type="checkbox"/> Eastern and Southern Norway <input type="checkbox"/> Other <input type="checkbox"/></p> <p>Travel time: (one way from Svea to your residence; Svea – Longyearbyen is an estimated one hour) _____ hours</p> <p>Present shift schedule: 7/7 <input type="checkbox"/> 14/14 <input type="checkbox"/> Daytime Monday - Friday <input type="checkbox"/> Other <input type="checkbox"/></p> <p>When completing the form: Day shift <input type="checkbox"/> Night shift <input type="checkbox"/></p> <p>Working place in Svea: Coalface <input type="checkbox"/> Tunnelling/building <input type="checkbox"/> Conveyor belt <input type="checkbox"/> Maintenance underground <input type="checkbox"/> Maintenance surface <input type="checkbox"/> Power station <input type="checkbox"/> Store <input type="checkbox"/> Health & safety/fire/rescue <input type="checkbox"/> Management/administration <input type="checkbox"/> Other <input type="checkbox"/></p> <p>Present job duties: _____</p> <p>Tiredness: How do you feel towards the end of the shift period (5, 7 or 14 days)? Chronically tired <input type="checkbox"/> Tired now and then <input type="checkbox"/> Rarely tired <input type="checkbox"/> Other answer <input type="checkbox"/> _____</p> <p>Irritability: Do you grow increasingly irritable towards the end of the shift period? Yes <input type="checkbox"/> No <input type="checkbox"/> Comments: _____</p> <p>Harder to concentrate: Do you find it harder to concentrate towards the end of the shift period?: Yes, usually <input type="checkbox"/> Yes, in some shift periods <input type="checkbox"/> Not often <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Do you have headache? Daily <input type="checkbox"/> More days a week <input type="checkbox"/> One day a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Do you have pain in the neck/shoulders? Daily <input type="checkbox"/> More days a week <input type="checkbox"/> One day a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Do you have low back pain? Daily <input type="checkbox"/> More days a week <input type="checkbox"/> One day a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/> Other <input type="checkbox"/> _____</p> <p>Do you have pain in your legs? Daily <input type="checkbox"/> More days a week <input type="checkbox"/> One day a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/> Other <input type="checkbox"/> _____</p>	<p>Sleep: Do you experience a sleep disorder while in Svea?: Daily sleep disorder <input type="checkbox"/> More days a week <input type="checkbox"/> One day a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Problem falling asleep: Daily <input type="checkbox"/> More times a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/> Other <input type="checkbox"/></p> <p>Disturbing noise in the barrack when going to sleep: Daily <input type="checkbox"/> More times a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Refreshed: Do you feel refreshed after sleep?: Always <input type="checkbox"/> Usually <input type="checkbox"/> Rarely <input type="checkbox"/> Never refreshed <input type="checkbox"/></p> <p>Lying awake: Do you lie awake during sleep time?: Daily <input type="checkbox"/> More times a week <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/> Other <input type="checkbox"/></p> <p>Depressed: Do you experience depression in the course of the shift period (5, 7 or 14 days)? Often <input type="checkbox"/> Some days/now and then <input type="checkbox"/> Never <input type="checkbox"/> Other <input type="checkbox"/> _____</p> <p>Indisposed: Are you indisposed during the first days after the shift period?: Usually <input type="checkbox"/> Now and then <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Family: Does your present shift schedule cause problems for your family? Yes <input type="checkbox"/> No <input type="checkbox"/> Have no family <input type="checkbox"/> Other <input type="checkbox"/> _____</p> <p>Work colleagues: Do your work colleagues appear increasingly irritable/indisposed towards the end of the shift period?: Usually <input type="checkbox"/> Now and then <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Length of service: For how long put together have you been working in Store Norske?: Less than 1 year <input type="checkbox"/> 1-3 years <input type="checkbox"/> 4-6 years <input type="checkbox"/> More than 6 years <input type="checkbox"/></p> <p>Job satisfaction: Do the work conditions make you enjoy work?: Usually <input type="checkbox"/> Some days <input type="checkbox"/> Rarely <input type="checkbox"/> Never <input type="checkbox"/></p> <p>Other paid job: Would you have energy to manage an additional paid job in your period off?: Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know <input type="checkbox"/> _____</p> <p>Plans for the future: How long do you intend to stay in your present job?: 1 year <input type="checkbox"/> 2-3 years <input type="checkbox"/> 4-6 years <input type="checkbox"/> More than 6 years <input type="checkbox"/> Do not know <input type="checkbox"/></p> <p>Termination of 14/14: If the 14/14 was terminated, what would that mean to you: Nothing <input type="checkbox"/> Would choose 7/7 <input type="checkbox"/> Quit my job <input type="checkbox"/> Other choices <input type="checkbox"/> Do not know <input type="checkbox"/></p> <p>Wellbeing: Which circumstances/conditions make you feel well in your job? 1. _____ 2. _____ 3. _____</p> <p>Improvements: What could management (colleagues) do to promote thriving? 1. _____ 2. _____ 3. _____</p> <p>Your challenges: What could you do to improve thriving? 1. _____ 2. _____ 3. _____</p>

Fig. 1. The questionnaire used among mine employees at Spitsbergen in 2006, 2007 and 2008; here translated from Norwegian to English.

(Fig. 1). In addition five questions on stress (tired, irritable, concentration difficulties, depression, indisposed after shift period) and five questions on coping were asked, graded from 1 to 3 (family problems, irritable colleagues, job satisfaction, energy for other paid jobs, plans for future). For each individual every year indices of pain, sleep, stress and coping were calculated. For the individual to be included in the calculation of the index in the respective year at least 75% of the questions related to the specific index had to be answered. The specific index was calculated as a mean value of the items it consisted of and used in the analyses as a continuous variable. The higher index figure, the better.

The employees were free to participate or not. They were instructed from their union and the occupational health personnel involved that any answer should be given of the individuals free will. All information given and collected was treated as strictly confidential by occupational health personnel only. Neither the management nor the union representatives had any access to the collected forms. The completed forms would not be filed together with the occupational health services usual reports, but treated separately and in the end destructed. The Spitsbergen islands are governed by Norway, but the mainland legislation on regional ethical committees on medical research is not implemented on Spitsbergen.

The Governor of Svalbard and the local community authorities have been presented with the project.

Descriptive statistics were given for demographic variables from the questionnaires and for the shift schedules in different years. In addition, distribution of answers within each index variable was given. Differences in indexes between shift schedules (7/7 and 14/14) at baseline (2006 questionnaire) were tested by independent two-sided *t*-tests. Difference in indexes between baseline and the follow up was calculated and applied in analyses of variance to test if there was a difference between shift schedules. Two analyses of variance were performed, one of the crude data, and one including adjustments for age and department in the mine. For the sleep index also day or night shift when the individual completed the questionnaire was adjusted for. We used SPSS 15.0 (SPSS Inc., Chicago, IL, USA), and significance level was set to $p < 0.05$.

The autumn 2006 the coal company registered 297 individuals as employees in Svea. Eight were on long-lasting sickness leave. Eleven terminated shortly their job in the company or had long-lasting professional leave. Of the remaining 278, 274 (262 males) completed the first questionnaire (99% participation). The participation rate was similar in 2007 and 2008. In 2007 the majority of those who were entitled to choose

had started on a 14/14 schedule (Table 1). Among the employees in 2007 a larger proportion, 133, chose 14/14, while 84 chose 7/7. The comparisons in 2008 were performed among 44 employees working 7/7 and 137 working 14/14, participating both in 2006 and 2008 (Table 1). These 14/14-employees were six years younger than the 7/7-employees (Table 1). The 14/14 employees had a mean transport time of 5.8 h from residence to Svea, while the similar transport time home for the 7/7 employees was 1.1 h.

We chose to compare data from 2006 and 2008 (not 2007) in the further analyses, as the data in 2006 and 2008 were obtained at the same time of the year, in the winter season.

As much as 36.2–48.1 percent of the employees in 2006 did indicate “never” on the four symptoms of pain. Only one percent reported pain daily for headache, four percent pain daily for neck/shoulder, three percent for low back pain and five percent pain in the legs. Similar low percentages had problems with their

sleep, 32.6–40.3 percent of the employees reported “never” on symptoms of sleep problems, and 72.5 percent reported to feel refreshed after sleep.

In 2006, those who later chose 14/14 reported significant less pain than those who remained in 7/7 (Table 2). In 2008 the 14/14 reported relatively more pain than the 7/7, but not when adjusting for department and age. There were neither differences between the later 14/14 and 7/7 in sleep index in 2006 nor between 2006 and 2008 (Table 2). Adjustments for day or night shift when completing the questionnaire did not change the results.

Stress symptoms did not occur or occurred “rarely” for 38.1–85.5 percent of the employees. Eighty-five percent had no/rarely problems with the job-family relationship, and 69.1 percent reported that they usually enjoyed their work. The stress index in 2006 was significantly better for those who chose 14/14 compared to those who remained in 7/7 (Table 2). Stress index change 2006–2008 did not demonstrate difference

Table 1. Male responders with employment continued from 2006, by shift schedule in 2006, 2007 and 2008. Nobody had the 14/14 schedule in the beginning of 2006, but 133 started this schedule this year. Department and age distribution are given for those who stayed on 7/7 or had changed to 14/14 in 2008 (n=181)

Shift schedule	2006	2007	2008		
	n	n	n	Department	Age
				Underground %	Mean (SD)
7/7	226	84	50 ^a	86.4	42.3 (9.4)
14/14	0	133	140 ^b	87.6	35.8 (9.8)
Day time	36	33	21 ^c		
Total	262	250	211		

^a6 persons had day time schedule in 2006 and was excluded in the analyses.

^b3 persons had day time schedule in 2006 and was excluded in the analyses.

^cMonday–Friday only, not included in further analyses.

Table 2. Health indices in 2006 and differences in indices between 2008 and 2006 by shift schedule, those who chose 14/14 compared to those who stayed with 7/7. The Svea mine male employees, n=181

Index	Shift schedule	2006				Difference (2008–2006)			
		Mean	SE	Crude <i>p</i>	Adjusted ^a <i>p</i>	Mean	SE	Crude <i>p</i>	Adjusted ^a <i>p</i>
Pain	7–7	3.09	(0.07)			0.06	(0.06)		
	14–14	3.32	(0.04)	0.005	0.029	–0.10	(0.04)	0.037	0.156
Sleep	7–7	3.05	(0.08)			–0.03	(0.08)		
	14–14	3.15	(0.04)	0.230	0.437 ^b	–0.05	(0.05)	0.785	0.992 ^c
Stress	7–7	2.48	(0.06)			0.02	(0.05)		
	14–14	2.64	(0.03)	0.011	0.006	–0.02	(0.03)	0.544	0.910
Coping	7–7	2.57	(0.05)			–0.12	(0.06)		
	14–14	2.56	(0.03)	0.875	0.777	0.09	(0.03)	<0.001	<0.001

^aAdjusted for department in 2008 and age.

^bIn addition adjusted for day or night shift in 2006.

^cIn addition adjusted for day or night shift in 2006 and in 2008.

between 14/14 and 7/7.

Regarding coping, fifteen percent reported family problems related to the work schedule and five percent reported that the colleagues were irritable at the end of the shift period. Seventy percent reported that they enjoyed their work and thirty-one percent intended to stay in this job more than six years.

The employees working 14/14 and 7/7 did not differ in 2006 in coping index (Table 2). Through 2006–2008 those who stayed in 7/7 reported deteriorated coping while 14/14 reported improving. Looking at specific items of coping, testing differences between 2006 and 2008, it was revealed significant more problems related to the job-family relationship in the 7/7 group (data not presented).

There was no difference in self reported health among mine workers working 7/7 and 14/14 shift schedule after two years follow-up. On the contrary, the employees choosing the 14/14 schedule improved their score on an item concerning coping. This is in accordance with findings in a study of tunnel workers employed by a contractor at the same location in 2003¹⁰. In this study tunnel workers had a shift schedule of 10 h work, 14 h off; 21 days shift period, 21 d at home on the Norwegian mainland, and the follow-up time was approximately one year. The prevalence of subjective health complaints in this group of workers did not change during the observation period, similar to our present results. Also, sleep did not deteriorate among these tunnel workers, just like in our study, and this was found both by subjective and objective measures¹¹. However, in the present study, we had no objective measures, and there might have been changes in the variables that were not detected in the study.

A Canadian study of workers in underground mines has shown no adverse effects of a change from a 8-h shift to a 10-h shift schedule. Actually, the workers reported more refreshing sleep, and fewer performance impairments were registered with the 10-h shift schedule⁸. However, the number of shifts was only three or four in a row among these workers. Also, an Australian study of 51 miners showed that the number of consecutive shifts had no impact upon sleep duration, and in this study a schedule of as much as 14 consecutive shifts was included⁷. On the other hand, a study of fatigue among miners in a fly-in-fly-out operation has suggested adverse implications for safety, as fatigue was increased at the end of some shifts in a 28 d roster. However, the schedule was totally different from the one in Svea, with 10 d shifts, 5 d rest, 8 night shifts and 5 d rest⁶.

The prevalence of substantial self reported pain and sleep problems were low in the present study. For

instance, in a Norwegian study in 1999 with a population of industrial workers in the aluminium industry low back pain occurred “often” among 22 percent¹², whereas similar figures in our population of miners was only three percent. This may indicate the presence of a healthy worker effect among our miners, as there are specific demands of good health to be allowed to enter and stay in this kind of work. There was a weakness of the study that we had no information on smoking and previous disorder among the workers. However, there was no reason to believe that these factors differed to a large extent among the workers in the two shift schedules. This is supported by the fact that their self-reported health was the same both before and after the comparison period started, both within the groups and when comparing the groups.

The questionnaire was not validated before distribution, but had questions that were comparable with those found in other, more extensive instruments^{12, 13}. However, the employees were familiar with all the topics in the form and the type of language used. The compact and simplified nature of the form made it practically applicable and culturally acceptable, which the minimal non-response (99% responded) and high degree of completing all the questions indicated. The occupational health personnel explained with emphasis that there were no “correct” or favorable answers. The authorities had not exposed any idea of what kind of shift schedule would be considered favorable. No likely result would simply lead to the termination or continuation of any of the schedules. What a majority of the hard working employees preferred would overshadow many other considerations in a picture of increasing productivity and coal prices. A possible bias arises from the fact that those employees who advocated the 14/14, would appreciate that alternative to turn out without too strong adverse effects. However, the defenders of 7/7 could be expected to prefer results in favor of 7/7 as well. Our results do not indicate any strong subgroup trends which could be explained in this context.

The choice of 14/14 may relate to family life in Longyearbyen or at the mainland, or leisure time activities. The 14/14 gave a better off-period and a tougher on-period, and it is interesting that the employees actually reported improvement of their coping with family life. It is also interesting that most of the employees choosing 14/14 had a very long travel time from Svea to their own residence. The lack of detrimental health effects and improved coping related to shift work has been reported in previous studies among shift workers, for instance when the long working hours are associated with proper timing and reduced commuting time¹⁴. The long period of consecutive shifts is also an advan-

tage from a circadian point of view, and might be the explanation of the lack of sleep problems related to this type of work in the present study⁹).

Extended shift periods and periods off have been the standard in Norwegian offshore oil industry for more than forty years. Similar schedules have been increasingly practiced on large construction and production sites onshore. The agreement of April 2010 between Norway and Russia on the delimitation line in the Barents Sea and the Arctic Ocean will actualize a wider application of such schedules in arctic areas. That gives our findings a momentum.

Our conclusion is that long shift periods and off periods (14/14) did not turn out to be less favorable than shorter shift and off periods (7/7), related to self reported health, sleep and stress for a period of two years. Employees who chose 14/14 reported improved coping with family life. These conclusions relate to a situation where the employees were enabled to choose.

Acknowledgements

Store Norske Kull Kompani AS (The Great Norwegian Coal Company Ltd.) has financed the study. The authors would like to thank the coal company's former CEO Robert Hermansen who initiated the study, the communications director Terje Carlsen and the health and safety managers Oyvind Aasgaard and Einar Fjerdingsoy for practical assistance and support. Dr. Hanoa has been engaged by Store Norske Kull Kompani AS as a medical advisor through the period of this study. Mr. Kooij and Mrs. Sommervold are authorized nurses employed in The Occupational Health Services of Svalbard, which serve the coal company on a contractual basis. The other authors have indicated no conflicts of interest.

References

- 1) Hisdahl V (1998) Svalbard - nature and history. 1–123, Norwegian Polar Institute, Oslo.
- 2) Smith CS, Robie C, Folkard S, Barton J, Macdonald I, Smith L, Spelten E, Totterdell P, Costa G (1999) A process model of shiftwork and health. *J Occup Health Psych* **4**, 207–18.
- 3) Costa G (2003) Shift work and occupational medicine: an overview. *Occup Med* **52**, 83–8.
- 4) Knutsson A, Åkerstedt T (1992) The healthy-worker effect - self-selection among Swedish shift workers. *Work Stress* **6**, 163–7.
- 5) Bendak S (2003) 12-h workdays: current knowledge and future directions. *Work Stress* **17**, 321–36.
- 6) Muller R, Carter A, Williamson A (2008) Epidemiological diagnosis of occupational fatigue in a fly-in-fly-out operation of the mineral industry. *Ann Occup Hyg* **52**, 63–72.
- 7) Paech GM, Jay SM, Lamond N, Roach GD, Ferguson SA (2010) The effects of different roster schedules on sleep in miners. *Appl Ergon* **41**, 600–6.
- 8) Hossain JL, Reinish LW, Heslegrave RJ, Hall GW, Kayumov L, Chung SA, Bhuiya P, Jovanovic D, Huterer N, Volkov J, Shapiro CM (2004) Subjective and objective evaluation of sleep and performance in daytime versus nighttime sleep in extended hours shift-workers at an underground mine. *J Occ Environ Med* **46**, 212–26.
- 9) Midwinter M, Arendt J (1991) Adaptation of the melatonin rhythm in human subjects following night-shift work in Antarctica. *Neurosci Lett* **122**, 195–8.
- 10) Waage S, Odeen M, Bjorvatn B, Eriksen H, Ursin H, Hollund BE, Moen BE (2010) Still healthy after extended work hours? Ten hours shift, twenty-one days working period for tunnel workers. *Ind Health* **48**, 804–10.
- 11) Forberg K, Waage S, Moen BE, Bjorvatn B (2010) Subjective and objective sleep and sleepiness among tunnel workers in an extreme and isolated environment: 10-h shifts, 21-day working period, at 78 degrees north. *Sleep Med* **11**, 185–90.
- 12) Morken T, Moen B, Riise T, Bergum O, Bua L, Hauge SH, Holien S, Langedrag A, Olson H-O, Pedersen S, Saue LL, Seljeboe GM, Thoppil V (2000) Prevalence of musculoskeletal symptoms among aluminium workers. *Occup Med* **50**, 414–21.
- 13) Ihlebaek C, Eriksen HR, Ursin H (2002) Prevalence of subjective health complaints (SHC) in Norway. *Scand J Publ Health* **30**, 20–9.
- 14) Costa G (2003) Factors influencing health of workers and tolerance to shift work. *Theor Issues Ergon Sci* **4**, 263–88.