ISSN 2310-4090

International Journal of Scientific Footprints

Open Access

Study the Relation between Fatigue, Sleepiness and Accidents among the workers of Indian Weaving Industries

Ajeet Jaiswal [1]

[1] Assistant Professor, Department of Anthropology, Pondicherry University, Puducherry, India

Keywords:
Weaving workers; Weaving Industry; Shift work; Sleepiness; Exhaustion or Fatigue; Accidents.

Correspondence:
Ajeet Jaiswal. Assistant Professor, Department of Anthropology, Pondicherry University, Puducherry, India.
E-mail: rpgajeet@gmail.com

Funding Information:
No funding information provided.

Received:
April 2014; Accepted: April 2014

International Journal of Scientific Footprints 2014; 2(2):1 8 –30

Abstract

It has been found that shift work can disrupt human circadian rhythms which are normally acclimated to daytime wakefulness and nighttime rest. At physiological level, medical investigations have demonstrated that circadian de-synchronization can lead to changes in hormonal levels, increase risk of cardiovascular disease, produce sleep-cycle disturbances and result in significant fatigue. Shift work is growing in modern society as an important tool for flexibility of work organization. The aim of this study was to examine the rate of exhaustion and sleepiness around the shift and non-shift workers and its relation to occupational accidents.
This was a cross-sectional study on the workers of Indian weaving textile industrial Group. Study included 150 shift workers as the case and 141 non-shift workers as the control. A multi-part questionnaire including demographic characteristics, Piper Fatigue Scale (PFS) and Epworth Sleepiness Scale (ESS) were applied. The X2 test and t-test were used to measure differences between variables. The mean of PFS scores in the two groups was significantly different ($p=0.045$), but the difference in the mean of ESS scores was not significant. Shift workers with the reported accident had a higher score on fatigue than shift workers with no accident ($p<0.001$) whereas the difference in the number of accidents in the two groups was not related significantly to the rate of sleepiness. The rate of fatigue or exhaustion and the number of the work accidents was more in the shift workers. Also, fatigue or exhaustion had a stronger relationship with the occupational accidents as compared to sleepiness. It seems that evaluation of exhaustion as compared to sleepiness is a more accurate factor for preventing work accidents.

Introduction

Shift work is highly prevalent in industrialized societies (>20%) but, when it includes night work, it has pronounced negative effects on sleep, subjective and physiological sleepiness, performance, accident risk, as well as on health outcomes such as cardiovascular disease and certain forms of cancer (Knutsson, 2003). The reason is the conflict between the day oriented circadian physiology and the requirement for work and sleep at the "wrong" biological time of day. Other factors that negatively impact work shift sleepiness and accident risk include long duration shifts greater than 12 hours and individual

vulnerability for phase intolerance that may lead to a diagnosis of shift work disorder; i.e., those shift workers with the greatest sleepiness and performance impairment during the biological night and insomnia during the biological day (Knauth, 1996). Whereas some countermeasures may be used to ameliorate the negative impact of shift work on nighttime sleepiness and daytime insomnia (combined countermeasures may be the best available), there seems at present to be no way to eliminate most of the negative effects of shift work on human physiology and cognition.

Shift work is growing in modern society as an important tool for flexibility of work organization. It is one of the characteristic features of work that millions of workers have experienced all over the world (Folkard and Monk, 1985; Scott, 1990). On shift work, workers are forced to change their typical sleep wake cycle according to the changed activity and rest periods. This intervenes with the normal cycles of physical functions (circadian rhythms) (Costa, 2003). It has been found that shift work can disrupt human circadian rhythms which are normally acclimated to daytime wakefulness and nightime rest (Patkai et.al, 1977; Rutenfranz et.al, 1977) . At the physiological level, medical investigations have demonstrated that circadian de-synchronization can lead to changes in hormonal levels, increase the risk of cardiovascular disease, produce sleep-cycle disturbances and result in significant fatigue (Knutsson, 2003; Midwinter and Arendt, 1991)

In the study done in 15 European countries in 2000, it was shown that only 24% of the workers did not have to do shift work (Schutte and Maldonado, 2003). It can be said that, shift work can generate constant and severe sleep disorders, chronic fatigue and chronic anxiety or depression (Costa, 2001). Tempas and Mahan declared that many common work schedules interact violently with sleep, particularly those shifts that include some degree of night-time work (Akerstedt, 1994). Recently, growing interest has been around investigating sleep related problems, mostly due to the fact that sleepiness and fatigue are efficient in human errors and consequential many accidents in developed civilizations (Costa, 2003). It is obvious that sleepiness and reduced alertness are important risk factors for accident preparedness at work (Tempas and Mahan, 1989). Leger determined that as many as 53% of all occupational crashes in 1988 in the USA were potentially related to sleepiness (Leger, 1995). Fatigue is a feature varying from weakening function on alertness tasks (inattention) to complete falling asleep.

Fatigue is defined as "a state of declining alertness which eventually ends in sleep" (Costa, 2003). Various accidents, which could be attributed to the loss of control due to the fatigue and sleepiness of workers, have been reported at mines. In a study conducted in Australia, the occurrence of accidents for operators of heavy machinery in open-cut coalmines were determined 93% of the incidents in the occupations were possibly fatigue related.

The total expense of the Australian coal mining industry for injuries and the lost time due to possible fatigue-related accidents for the period in question was $ 3,345,000 (Mabbott et.al, 1999). According to the U.S National Transportation Safety Board Report, 57% of the accidents were due to fatigue (Summala, 1994). In another study carried out by Shen shift workers encountered more fatigue than non-shift workers, but there was no much difference between the severities of sleepiness for the two groups (Shen et.al, 2006). Knowledge about the influence of shift works on fatigue and sleep disturbances are still limited. Also their relations to the incidence of occupational accidents are not known. Therefore, it was decided to study fatigue and sleepiness in a group of shift and non-shift workers with similar demographic characteristics. Also the incidence of accidents was studied in relation to fatigue and sleepiness so as to help plan better preventable measures. To Bertolt Brecht---

Material and Methods

The cross-sectional survey studied two groups: employees who were on shift-work and employees not on shift-work. The study was carried out on workers of weaving textile Industries of Uttar Pradesh, India in 2006–2008. By random sampling, 920 men of the age group 20–65, a total of 165 men were selected as the case group and 155 non-shift workers as the control group. All around were similar in respect to age and work experience. The 11 subjects who had not answered the question were thereby excluded from the investigation (response rate 96.6%). After completion of the questionnaire, 5.6% of the workers of the two groups with positive history of alcohol and sedative drugs consumption, neurological, psychological and cardio-vascular problems groups were excluded from the study. This was due to the fact that all of these factors can affect the probability of accidents. In the present study, shift work was defined as work outside the routine time for work (8am–8 pm) (Akerstedt et.al, 2002). Ultimately, 150 shift workers and 141 non-shift workers were selected as the population under study.

Data collection was fulfilled through a questionnaire comprising several sections including demographic characteristics, Piper Fatigue Scale (PFS) and Epworth Sleepiness Scale (ESS) questionnaire. The variables in the demographic section included: health condition, history of cigarette smoking, alcohol consumption and sedative drugs. Piper Fatigue Scale questionnaire (PFS) (Piper et.al, 1998) was used to measure fatigue. The PFS currently is composed of 22 items numerically scaled from “0” to “10”, measuring four dimensions of subjective fatigue including: behavioral (6 items; 2–7), emotional (5 items; 8–12), sensory (5 items; 13–17), and cognitive/mood (6 items; 18–23). These 22 items are used to calculate the four sub-scale/dimensional scores and the total fatigue scores.

Five additional items (1 and 24-27) are not used to calculate subscale or total fatigue scores but are recommended to be kept on the scale as these items furnish rich, qualitative data. Item 1, in particular gives a categorical way in which to assess the duration of the respondent's fatigue. To score the PFS, add the items contained on each specific subscale together and divide by the number of items on that subscale. This will give you a subscale score that remains on the same "0" to "10" numeric scale. Should you have missing item data, and the respondent has answered at least 75%-80% of the remaining items on that particular subscale, calculate the subscale mean score based on the number of items answered, and substitute that mean value for the missing item score (mean-item substitution). Recalculate the subscale score.

To calculate the total fatigue score, add the 22- item scores together and divide by 22 in order to keep the score on the same numeric "0" to "10" scale. The categories were as follows: 0 = no fatigue, 1–3 = mild fatigue, 4–6 = moderate fatigue and 7–10 = severe fatigue.

To ensure the clarity of questionnaires, pilot testing of the questionnaire was also performed using the coherence and consistency upon 25 workers who were not included in the survey. Then, the questionnaire was modified on the basis of the subjects’ feedback. To determine the internal reliability, a Cronbach’s alpha for total fatigue was calculated 0.97. Data were collected from the actual worksite of the workers. The finding of PFS revision showed that it is more appreciate to be used in an occupational setting.

Table 1 Question and their Score of the Piper Fatigue Scale (PFS)

S.No.	**Question/ Items**	**Score**
1	How long have you been feeling fatigue? (Check one response only).	1. not feeling fatigue, 2. Minutes, 3. Hours, 4. Days, 5.weeks, 6. Months, 7. other (Please describe)
2	To what degree is the fatigue you are feeling now causing you distress?	No Distress (1), 2, 3,4,5,6,7,8,9.A Great Deal (10)
3	To what degree is the fatigue you are feeling now interfering with your ability to complete your work or school activities?	None (1), 2, 3,4,5,6,7,8,9.A Great Deal (10)
4	To what degree is the fatigue you are feeling now interfering with your ability to socialize with your friends?	None (1), 2, 3,4,5,6,7,8,9.A Great Deal (10)
5	To what degree is the fatigue you are feeling now interfering with your ability to engage in sexual activity?	None (1), 2, 3,4,5,6,7,8,9.A Great Deal (10)
6	Overall, how much is the fatigue which you are now experiencing interfering with your ability to engage in the kind of activities you enjoy doing?	None (1), 2, 3,4,5,6,7,8,9.A Great Deal (10)
7	How would you describe the degree of intensity or severity of the fatigue which you are experiencing now?	Mild (1), 2, 3,4,5,6,7,8,9.Severe (10)
8	To what degree would you describe the fatigue which you are experiencing now as being?	Pleasant (1), 2, 3,4,5,6,7,8,9.Unpleasant (10)
9	To what degree would you describe the fatigue which you are experiencing now as being?	Agreeable(1),2,3,4,5,6,7,8,9.Disagreeable(10)
10	To what degree would you describe the fatigue which you are experiencing now as being?	Protective(1), 2, 3,4,5,6,7,8,9.Destructive(10)
11	To what degree would you describe the fatigue which you are experiencing now as being?	Positive(1), 2, 3,4,5,6,7,8,9. Negative (10)
12	To what degree would you describe the fatigue which you are experiencing now as being?	Normal(1), 2, 3,4,5,6,7,8,9. Abnormal(10)
13	To what degree are you now feeling	Strong(1), 2, 3,4,5,6,7,8,9.Weak (10)
14	To what degree are you now feeling	Awake(1), 2, 3,4,5,6,7,8,9.Sleepy (10)
15	To what degree are you now feeling	Lively(1), 2, 3,4,5,6,7,8,9.Listless(10)
16	To what degree are you now feeling	Refreshed(1), 2, 3,4,5,6,7,8,9.Tired(10)
17	To what degree are you now feeling	Energetic(1), 2, 3,4,5,6,7,8,9.Unenergetic(10)
18	To what degree are you now feeling	Patient (1), 2, 3,4,5,6,7,8,9.Unpatient(10)
19	To what degree are you now feeling	Relaxed(1), 2, 3,4,5,6,7,8,9.A Great Deal (10)
20	To what degree are you now feeling	Exhilarated(1), 2, 3,4,5,6,7,8,9.Depressed(10)
21	To what degree are you now feeling	Able to concentrate(1),2, 3,4,5,6,7,8,9.Unable to concentrate (10)
22	To what degree are you now feeling	Able to remember(1), 2, 3,4,5,6,7,8,9.Unable to remember(10)
23	To what degree are you now feeling	Able to think learly(1),2,3,4,5,6,7,8,9.Unable to think clearly(10)
24	Overall, what do you believe is most directly contributing to or causing your fatigue?	
25	Overall, the best thing you have found to relieve your fatigue is:	
26	Is there anything else you would like to add that would describe your fatigue better to us?	
27	Are you experiencing any other symptoms right now?	

Sleepiness was measured by the Epworth Sleepiness Scale (ESS) (Johns, 1991). ESS is a validated questionnaire including eight items on expectation of dozing in eight hypothetical situations. Dozing probability rating ranges from zero (no probability) to three (high probability). ESS score of 10 or more indicates excessive daytime somnolence (Bastos et.al, 2007).

Table 2 Question and their Rating of the Piper Fatigue Scale (PFS)

	Situation	**Chance of Dozing (0–3)**
1	Sitting and reading	
2	Watching television	
3	Sitting inactive in a public place (e.g. a theater or meeting)	
4	As a passenger in a car for an hour without a break	
5	Lying down to rest in the afternoon when circumstances permit	
6	Sitting and talking to someone	
7	Sitting quietly after a lunch without alcohol	
8	In a car, while stopped for a few minutes in the traffic	
	Total Score	

Data on occupational accidents from February 2001 to March, 2005 were obtained from the ESIC Employees' State Insurance Corporation of the Indian Industrials Group, provides curative health care to around 8 million employees. The corporation has set up five zonal Occupational Diseases Centers with a view to providing facilities for early detection and diagnosis of occupational diseases among ESI beneficiaries. Both oral and written consent was obtained from each subject before staring the collections of data, In addition, the contributors were assured that their responses were confidential.

The computations were performed using SPSS 16 software program. The 2 test was used to test the differences between proportions and the t-test was used when the comparison involved continuous variables.

Results

Table 3 Distribution and Different characteristic of Shift workers and Non-shift workers

Characteristics of the subjects		Shift Workers	Non-shift Workers	χ^2 or *t*-value
Number (%)		150(51.55)	141(48.45)	
Mean age (± SD) (yrs)		31.58 ± 6.6	32.23 ± 8.4	χ^2 = *0.2* NS
Mean duration of employment (yrs)		9.3 ± 6.7	9.6 ± 4.6	χ^2 =*0.2* NS
Mean number of occupational accidents during the 5-yr period (Number (%))	Yes	41(27.33)	25(17.73)	χ^2 = 0.03 *S*
	No	109(72.76)	116(82.27)	
				t-value
ESS Mean Score (± SD)		6.98 ± 3.61	6.43 ± 3.37	*t*-value = 0.153
PFS Mean Score (± SD)		3.06 ± 1.54	2.64 ± 1.38	*t*-value = 0.045 S
Score<10 of ESS (Number (%))		124(82.67)	130(92.20)	χ^2 = 0.07 NS
Score>10 of ESS (Number (%))		26(17.33)	11(7.80)	
Relation between PFS mean score and accidents in shift & non shift workers Mean (± SD)	Yes	4.1 ± 1.83	3.11 ± 1.77	
	No	2.69 ± 1.22	2.58 ± 1.29	
	p-value	0.001 S	0.112 NS	
Relation between ESS mean score and accidents in shift & non shift workers Mean (± SD)	Yes	7.78 ± 3.3	6.71 ± 2.81	
	No	6.7 ± 3.7	6.37 ± 3.47	
	p-value	0.126 NS	0.672 NS	

Demographic characteristics of the subjects showed that the mean age of shift and non-shift workers was 31.58 ± 6.6 years and 32.23 ± 8.4, years respectively. There was no significant difference between the mean age of the two groups (p=0.2). The mean of duration of employment in the case and control group was 9.3 ± 6.7 and 9.6 ± 4.6 years which were not statistically significant and the work environment was similar in the both groups. The mean score of ESS for the two groups is 6.98 ± 3.61 and 6.43 ± 3.37 respectively and with a t-value of 0.153, the difference was no significant. Also according to the mean PFS (± SD) questionnaire score, 3.06 ± 1.54 for case group and 2.64 ± 1.38 for control group, significant difference (0.045) were found between the mean ESS score of two groups.

Above table also shows the Score > 10 and Score < 10 of ESS in shift and non-shift workers. 17.33% of shift workers had Score>10 of ESS whereas only 7.80% of non-shift workers gained this score. Also 82.67% of the subject in the case group had score<10 of ESS but this in the control group were 92.20%. $\chi 2$ test indicated that these differences were not statistically significant (p=0.07). Occupational accident of the

population, those who had or had not been involved in at least one occupational accident showed that a total of 66 workers had sustained accidents during the past 5 years. The history of accidents were measured by $\chi 2$ test in the two groups was statistically significant ($p=0.03$).

Shift workers with an accident precedent showed a higher score on fatigue than shift workers with no accident ($p<0.001$). As shown in the Table, PFS mean in both shift and non-shift workers were significantly related to accidents. In the case group, those with accidents precedent had a significantly higher fatigue score as compared to those with no accident ($p<0.001$), while in the control group, the fatigue score in those with a certain history of accidents was not statistically different from those with no accident ($p=0.112$). Although the ESS mean score of the shift workers who had accidents was more, the relation was not significant ($p=0.126$). It was the same for non-shift workers.

Discussion

This experimental analytical study was done to determine fatigue and sleepiness and their relation with the rate of accidents in shift and non-shift workers of Indian weaving textile industries. In the present study, the PFS mean score in shift workers was significantly higher than the other group. The result of the study by Shen was also similar, i.e. fatigue in shift workers was more than non-shift workers and there was a significant relationship between severity of fatigue and shift work (Shen et.al, 2006). The Jansen study showed that there is a strong relation between fatigue and different types of shift work and this was determined after controlling or deleting other interfering factors (Jansen et.al, 2003). In a study by Rosa, fatigue increased rapidly in night shifts as compared to day shifts (Rosa et.al, 1989). But in the study by De Fatima, there was no significant relationship between fatigue and shift work, while satisfaction of bank workers decreased their fatigue (De Fatima et.al, 2002). Jansen concluded that use of different fatigue questionnaires has a direct role on prevalence rates of fatigue in various investigations (Jansen et.al, 2003).

In the present study, the ESS mean score in shift workers and non-shift workers was statistically similar. In the study on South African industry, operators were required to complete an Epworth Sleepiness questionnaire, only one 1/4 of them diagnosed as being sleepy on the basis of scores (Costa, 2003). Garbanio's investigation of Italian officers showed that the relation between sleepiness and shift work was not significant

(Garbarino et.al, 2002). Similarly, in the study by Shen, the relation between sleepiness (calculated by ESS) and shift work was not significant. It seems that responsibility and probability of accidents prevents high sleepiness in workers, but it is worth mentioning that ESS ≥10 which depicts excessive daytime somnolence (Bastos et.al, 2007) was greater than shift workers though the difference was not significant (Shen et.al, 2006).

In this study, there was significant relationship between shift work and accidents. In the study by Fransen, there was strong relationship between work accidents and shift work, also this study showed that even though interfering factors like occupational risks, sleepiness and mode of living are excluded, there is a significant relationship between fatigue and shift work (Fransen et.al, 2006). Smith declared that there is a 30–50% increase in the risk of accidents during night shifts (Smith et.al, 1989). The studies by Mitler showed that the Chernobyl disaster occurred at night was due to human error and mismanagement of human resources (Mitler et.al, 1988). The relation between fatigue and accidents in shift workers was significant. But fatigue and accident did not show any relationship together in non-shift workers. In the study by Swaen, there was a significant association between increased fatigue and incidence of physical injury due to accidents (Swaen et.al, 2003). In a study conducted in Australian Department of Energy, more than 90% of the incidents in the occupations were possibly fatigue- related (Mabbott et.al, 1999). There was no significant statistical relationship between ESS results and accidents in both the case and control groups, but the ESS scores in the workers of both groups who had accidents was higher than the rest. Also, the ESS mean score of the shift workers who had at least one accident during 5 years was higher than shift workers with no accident. Gabarino showed that shift work can cause sleepiness leading to increase in occupational accidents, but shift work had no effect on the ESS score (Garbarino et.al, 2002). Shen confirmed that although there was a difference on fatigue for the two groups; sleepiness in the shift and non- shift workers was not different (Shen et.al, 2006). In the study by Hossain, it was determined that shift workers who had fatigue had higher sleepiness scores (Hossain et.al, 2003). It seems that the relationship between fatigue and sleepiness is not very strong and these two need to be studied and evaluated separately.

Conclusion

Fatigue has a stronger relationship with

accidents as compared to sleepiness thus evaluation of fatigue as compared to sleepiness is a more accurate factor for preventing work accidents. This is also true with operators in the Indian textile industry: fatigue and reduced levels of alertness during operations are realities with potential safety risks.

Recommendation

A variety of industries and professions have developed programs to reduce sleepiness-based errors under the aegis of "fatigue management." These programs usually include an educational component, and sometimes include schedule alterations. Employees are usually given information about circadian rhythms, sleep hygiene measures, shift work and its adverse effects, and a variety of strategies that can be used to reduce fatigue (e.g., judicious use of caffeine and napping during night shifts). Managers may be urged to consider altering the starting times of shifts whenever possible to make schedules more compatible with circadian rhythms; to avoid scheduling employees to work more than two or three consecutive night shifts; and to provide adequate recovery time between shifts, especially when an employee is rotating off night shift. Hours of service regulations, where applicable, are also considered in the development of a fatigue management program.

Acknowledgement

The author wish to acknowledge Prof A.K Kapoor and many helpful workers, medical professional and researcher, which have influenced my thinking on shift work and shift work disorder. Author also like a thank ESIC for providing the data and informational support for this research endeavor

References

[1] Akerstedt, T., P. Fredlund, M. Gillberg and B. Jansson. (2002). Work load and work hours in relation to disturbed sleep and fatigue in a large representative sample. Journal of Psychosomatic Research, Vol. 53: 585–8.

[2] Akerstedt, T. (1994). Accidents and sleepiness: a consensus statement from the International Conference on Work Hours, Sleepiness and Accidents, Stockholm, 8–10 September. Journal of Sleep Research 3, 195.

[3] Bastos, J. P. C., R. B. de Sousa, N. L. A. de Medeiros, O. A. Gutierrez-Adrianzen, P. F. C. de Bruin, M. L. L. de Barros, and V. M. S. de Bruin. (2007). Sleep disturbances in patients on maintenance hemodialysis: role of

dialysis shift. Rev Assoc Med Bras, Vol. 53:492–496.

[4] Costa, G. (2003). Shift work and occupational medicine: an overview. Occup Med, Vol. 53: 83–88.

[5] Costa, G. (2001). Shift work health consequences, International Encyclopedia of Ergonomics and Human Factors. In: Karwowski W (Ed.), 1357–61, Taylor & Francis, London.

[6] De Fatima, M., M. de Souza, K. Messing, P. R. Menezes and H. J. Cho. (2002). Chronic fatigue among bank workers in Brazil. Occup Med, Vol. 52: 187–194.

[7] Folkard, S. and T. H. Monk. (1985). Hour of work: temporal factors in work scheduling, Wiley, Chichester.

[8] Fransen, M., B. Wilsmore, J. Winstanley, M. Woodward, R. Grunstein, S. Ameratunga and R. Norton. (2006). Shift work and work injury in the New Zealand Blood Donors Health Study. Occup Environ Med, Vol. 63: 352–8.

[9] Garbarino, S., F. De Carli, L. Nobili, B. Mascialino, S. Squarcia, M. A. Penco, M. Beelke and F. Ferrill. (2002). Sleepiness and sleep disorders in shift workers: a study on a group of Italian police officers. Sleep, Vol. 25: 648–53.

[10] Hossain, J. L., L. W. Reinish, L. Kayumov, P. Bhuiya and C. M. Shapiro. (2003). Underlying sleep pathology may cause chronic high fatigue in shift-workers. J Sleep R, Vol. 12: 223–30.

[11] Jansen, N. W. H., L. Van Amelsvoort, T. S. Kristensen, P. A. Van den Brandt and I. J. Kant. (2003). Work schedules and fatigue: a prospective cohort study. Br Med J, Vol. 60: 147.

[12] Johns, M. W. (1991). A new method of measuring daytime sleepiness: the Epworth Sleepiness Scale. Sleep, Vol. 14: 540–545.

[13] Knauth, P. (1996). Categories and parameters of shiftwork systems. In: Colquhoun, WP.; Costa, G.; Folkard, S.; Knauth, P., editors. Shiftwork: Problems and solutions. Frankfurtam Main: Peter Lang GmbH; 17-28.

[14] Knutsson, A. (2003). Health disorders of shift workers. Occup Med (Lond), Vol. 53(2):103–108.

[15] Leger, D. (1995). The cost of sleepiness: a response to comments. Sleep, Vol. 18: 281–4.

[16] Mabbott, N. A., M. Lydon, L. R. Hartley and P. K. Arnold. (1999). Procedures and devices to monitor operator alertness whilst operating machinery in open cut coalmines. Rep No: RC7433 ARRB, Transport Research Ltd. Perth, Western Australia.

[17] Midwinter, M. and J. Arendt. (1991). Adaptation of the melatonin rhythm in human subjects following night-shift work in Antarctica. Neurosci Lett, Vol. 122: 195–198.

[18] Mitler, M. M., M. A. Carskadon, C. A. Czeisler, W. C. Dement, D. F. Dinges and R. C. Graeber. (1988). Catastrophes, sleep, and public policy: consensus report. Sleep, Vol. 11: 100–9.

[19] Patkai, P., T. Akerstedt and K. Pettersson. (1977). Field studies of shift work: I. Temporal patterns in psychophysiological activation in permanent night workers. Ergonomics, Vol. 20: 611–619.

[20] Piper, B. F., S. L. Dibble, M. J. Dodd, M. S. Weiss, R. E. Slaughter and S. M. Paul. (1998). The revised piper fatigue scale: psychometric evaluation in women with breast cancer. Oncology Nursing Forum, Vol. 25: 677–84.

[21] Rosa, R. R., M J. Colligan and P. Lewis. (1989). Extended work-days: effects of 8-hour and 12-hour rotating shift schedules on performance, subjective alertness, sleep patterns, and psychosocial variables. Work & Stress, Vol. 3: 21–32.

[22] Rutenfranz, J., W. Colquhoun, P. Knauth and N. Ghata. (1977). Biomedical and psychosocial aspects of shift work. A review. Scand J Work Environ Health; Vol. 3: 165–182.

[23] Scott, A. J. (1990). State of the art review-shift work, Occupational medicine 5, Hanley and Bbelphus, Philadelphia.

[24] Schutte, P. C. and C. C. Maldonado. (2003). Factors affecting driver alertness during the operation of haul trucks in the South African mining industry. CSIR mining technology, Rep No: SIM 020502, 78, Safety in Mines Research Advisory Committee, South Africa.

[25] Shen, J., L. C. P. Botly, S. A. Chung, A. L. Gibbs, S. Sabanadzovic and C. M. Shapiro. (2006). Fatigue and shift work. J Sleep R, Vol,15: 1–5

[26] Smith, C. S., C. Reilly and K. Midkiff. (1989). Evaluation of three circadian rhythm questionnaires with

suggestions for an improved measure of morningness. J Appl Psychol, Vol. 74: 728–38.

[27] Summala, H. M. T. (1994). Fatal accidents among car and truck drivers; effects of fatigue, age and alcohol consumption. Human Factors, Vol. 36: 315–26.

[28] Swaen, G. M. H., L. van Amelsvoort, U. Bultmann and I. J. Kant. (2003) Fatigue as a risk factor for being injured in an occupational accident: results from the Maastricht Cohort Study. Br Med J, Vol. 60.

[29] Tempas, D. I. and R. P. Mahan. (1989). The many meanings of sleep. Work and Stress, Vol. 3: 93–102.