FATIGUE AS A CONSEQUENCE OF SHIFT WORK AND EXHAUSTION

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Abstract

Shift work with rotating night shifts negatively impacts human rhythms and might increase probability of developing multiple diseases. This form of working schedule can contribute to obesity, diabetes, and development of cardiovascular diseases, sleep deprivation and insomnia. Common secondary effect is fatigue and its various forms. This article offers a quantitative study comparing the level of fatigue among shift and fixed schedule working conditions. The degree of fatigue is classified in the scope of chosen characteristics: frequency, intensity, symptoms and it's daily occurrence. The sample is composed of 57 workers participating in shift work and 57 having a fixed working schedule. Subjective interpretation was applied on analysing the questionnaires for identification of the degree of fatigue coefficient. The research findings are in accordance with previous studies and confirm shift work as a risk factor for physiological wellbeing of employees.

Key words

Shift work, fatigue, degree of fatigue, fatigue symptoms, the development of a fatigue /risk index for shift workers

JEL Classification: I15, M54, M55

Introduction

In modern society, shift work has become a very common phenomenon. A recent European Union (Eurofound, 2012) Survey on Working Conditions conducted in 2000 estimated that only 24% of the working populations of the 15 EU countries were engaged in 'normal or standard' day work, defined as work between 07:30–8:00 and 17:00–18:00 hours from Monday to Friday. The majority of workers were thus engaged in 'non-standard' work, including shift work and night work, part time work and weekend work. They work in a wide variety of industries including the emergency services, healthcare, the utilities, transport, manufacturing (including oil, gas & chemical industries), entertainment and retail. Poorly designed shift-working arrangements and long working hours that do not balance the demands of work with time for rest and recovery can result in fatigue, accidents, injuries and ill health. Fatigue refers to the issues that arise from excessive working time or poorly designed shift patterns. It is generally considered to be a decline in mental and/or physical performance that results from prolonged exertion, sleep loss and/or disruption of the internal clock. It is also related to workload, in that workers are more easily fatigued if their work is machine-paced, complex or monotonous. Fatigue results in slower reactions, reduced ability to process information, memory lapses, absent-mindedness, decreased awareness, lack of attention, underestimation of risk, reduced coordination etc. Fatigue can lead to errors and accidents, ill-health and injury, and reduced productivity. It is often a root cause of major accidents e.g. Herald of Free Enterprise, Chernobyl, Texas City, Clapham Junction, Challenger and Exxon Valdez.

1. Fatigue and shift work

Chronology is the science of arranging events in their order of occurrence in time, the use of a timeline or sequence of events. It is also "the determination of the actual temporal sequence of past events. With the development of chronology, occurrences and methodology of behaviours and feelings of a human time perspective is analysed (Bělina, 2012).

Fatigue can be defined as psychophysiological state of a body, derived the reparative attempt to retrieve the psychosomatic functionality of the body that fails. Due to intensity or constant pressure the body is brought to the state of exhaustion. (Ďurič, Bratská, a kol., 1997)

Fatigue is a common complaint among those working abnormal hours. It is particularly noticeable after the night shift, less so on the morning shift, and least on the afternoon shift. Fatigue, however, is a complaint that is exceedingly difficult to measure. Some published evidence exists to suggest that there is a reduction in complaints of fatigue after objective improvement in physical fitness. Nevertheless, it remains an important, if vague, symptom which is often cited as a major reason for intolerance to shift work.

Fatigue is one of the main limiting factors of human performance, and it is in the interest of individuals and companies to apply forms and methods of work that respect the patterns of its origin and course, but also those that regulate it in the optimal direction. According to Szarková (2007, s. 206), "fatigue in general is a state of the body caused by exertion, particularly increased activity, resulting in a relative weakening, a negative instinct that functions as a protection mechanism of the body against its damage".

It is important to distinguish between sleepiness and fatigue because ethology and treatment may differ. Hossain *et al.,* (2003)- although fatigue and sleepiness are distinct symptoms, they share many characteristics with each other. Such similarity has contributed to both the difficulty of defining fatigue and the failure of healthcare workers to treat fatigue as an independent phenomenon worthy of assessment and treatment. Both fatigue and sleepiness are prevalent in the general population, especially in primary care settings, however they are frequently equated, and when fatigue alone is reported many healthcare professionals do not consider the complaint serious enough to warrant further assessment or treatment (Pigeon *et al.,* 2003). Due to the use of common terminology to describe fatigue and sleepiness, such as tired, exhausted and worn-out, it has been difficult for patients and healthcare workers alike to differentiate between these two symptoms (Pigeon *et al.,* 2003). In an attempt to aid the discrimination of sleepiness and fatigue, Pigeon *et al.* (2003) have proposed the operationalization of sleepiness as drowsiness, sleep propensity and decreased alertness, and fatigue as weariness, weakness and depleted energy.

Jansen et al (2003) - The prevalence of *fatigue* was 18.1% in day workers, 28.6% in three-shift, 23.7% in five-shift, and 19.1% in irregular shift workers. For three-shift and five-shift workers substantial higher fatigue levels were observed compared to day workers at baseline measurement. In the course of fatigue over the 32 months of follow up there were only small and insignificant differences between employees in different work schedules. However, among employees fatigued at baseline, fatigue levels decreased faster over time among five-shift workers compared to fatigued day workers. Shift workers changing to day work reported substantially higher fatigue levels prior to change, compared to those remaining in shift work.

The field study was performed based on a questionnaire about sleep characteristics, environmental work-place exposure and fatigue level. Objective noise exposure was also measured. The samples were composed of 201 shift workers of a chemical industry in France. They were divided into two age groups (<40 and >40 years). Results: No significant effect of temperature, vibration, chemical agents, ergonomics and psychosocial factors was found on fatigue. However, noise exposure resulted in an increase in subjective fatigue ($P<0.0001$). Older shift workers reported more fatigue than the younger ones ($P<0.01$). Concerning sleep characteristics, sleep duration progressively decreased from evening to morning shifts, night shift being intermediate ($P<0.01$). Older shift workers reported more sleep fragmentation ($P<0.01$), longer sleep duration in the morning shifts ($P<0.05$) and lesser in the night shifts ($P<0.001$). Combined effects of noise exposure and age were observed on sleep quality of night workers ($P<0.01$). Conclusions: Older workers are less able to adjust to night work especially if they work in the noisy environments. (Saremi et al.,2008).

The aim of this study was to examine the rate of fatigue 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 Iranian Industrial Mining Group. They included 137 shift workers as the case and 130 non-shift workers as the control. A multi-part questionnaire including demographic characteristics, Piper Fatigue Scale and Epworth Sleepiness Scale were applied. The $\chi;^2$ 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 and the number of the work accidents was more in the shift workers. Also, fatigue had a stronger relationship with the occupational accidents as compared to sleepiness. It seems that evaluation of fatigue as compared to sleepiness is a more accurate factor for preventing work accidents. (Halvani et al., 2009).

Shift workers are particularly vulnerable to increased sleepiness, chronic fatigue, and decreased performance, which can adversely impact productivity and safety in military flight operations. Tvaryanas, Thompson (2006) This study examined the association of specific risk factors including work context and shift system details (squadron: remotely piloted aircraft [RPA] vs. manned aircraft [MA]), work/rest guidelines (career field: crewmember vs. maintainer), and participation in deployed operations (environment: home base vs. deployed) on subjective fatigue using standardized and validated fatigue questionnaires. A cross-sectional survey of 172 U.S. Air Force (USAF) personnel was conducted from

October 2004 to May 2005. The study sample was recruited from four different USAF occupational groups involved in some form of shift work to include irregular, rotational, or fixed shifts. Participants reported a mean (SD) of 6.6 (1.8) hours of sleep per day with no differences by squadron, career field, or environment. Mean daily sleep did not correlate with scores on the fatigue questionnaires. Mean scores on the fatigue questionnaires were associated with squadron (mean fatigue score: RPA > MA), but not with career field or environment. There were no significant interaction effects, nor were there significant effects based on the covariates age, gender, and rank. *Conclusion:* Work context, shift system details, or both appeared to best explain the observed differences in fatigue between USAF shift worker populations. Crewmember work/rest guidelines did not appear to be useful for mitigating fatigue associated with shift work. Shift work is intrinsically fatiguing, regardless of whether the shift worker is at home base or deployed.

2. Methodology

The study aims to compare degree of fatigue and rest in relation to diverse work regimes of the employees. The aim can be defined in the following sub. points:

1. If the employees feel different degree of tiredness depending on day vs. night shift
2. Evaluation of the degree of fatigues dependent of the different work regimes
3. Identify fatigue symptoms in different working regimes,
4. Identify fatigue peaks during a 24-hour cycle of employees in different working modes.

Survey respondents were employees of a chosen company active in the labour market in the area of social services. The survey sample consisted of 114 respondents who were selected on the basis of the criterion – shift work. The gender split was the following, 82 respondents from the total number were women (71%) and 32 men (29%). The sample was divided two groups according to the respondent work regime for the purposes of subsequent comparison.

A questionnaire was created by the method of quantitative study. It contained scaled answers with rating options: always -5 points, often -4 points, sometimes -3 points, rarely -2 points, never -1 points. For comparisons, selected items were processed in absolute and relative numbers. Scaled responses were applied to calculate average scores in individual pointers. The results were presented within a risk index. The risk index demonstrates the ratio of people with measured difficulties to the total number of people at risk. The risk index in our case is expressed by the formula.

R1 = number of people indicating frequency always and often / total number of respondents.

3. Findings

In the first part the focus was on identifying the frequency of fatigue of respondents after night shift and day shift. Respondents expressed the frequency of fatigue on a scale from 5 (always) to 1 (never).

Table 1. Frequency of fatigue

	After night shift		After day shift	
	Sum	**%**	**Sum**	**%**
5 Always	20	35	0	0
4 Often	17	30	13	23
3 Sometimes	13	23	27	47
2 Rarely	6	10	14	25
1 Never	1	2	3	5
Total	57	100	57	100

As can be seen in Table 1, 35% feels always tired and 30% often feels tired post night shift. After a shift in the day 0% feel always tired and 23% of respondents stated that they feel often feel tired post day shift.

The arithmetic average of the fatigue frequency after night shift is 3.8 and after daily change of 2.8. Scattered on the scale, after a night shift, we are approaching the frequency often and for the post day shift the frequency sometimes. The risk index for the night shift is 0.64 (37/57 = 0.64) and 0.22 a day. (13/57 = 0.22).

In the next part, the degree of fatigue the respondents reported after day and night shift was analyzes. Fatigue levels responded by the appropriate scale from 1- don't feel tired, 2 feel little tired, 3 feel somewhat tired, 4 I feel tired, 5 I feel very tired.

Table 2. Fatigue degree/ rate

Fatigue degree/ rate	After day shift		After night shift	
	Sum	%	Sum	%
1 don't feel tired	9	16	1	2
2 feel little tired	15	26	5	9
3 feel somewhat tired	18	32	9	15
4 feel tired	8	14	21	36
5 feel very tired	7	12	22	38
Total	57	100	57	100

As we can see in Table 2. after daily shift, average fatigue is felt by 32% of respondents and 26% of respondents feel little tired. For respondents after night shift, 38% of respondents feel very tired, and 36% of respondents report they felt tired.

The arithmetic mean for the post night shift is 4.0 and after day shift is 2.28. The risk index is in measuring fatigue by expressing the ratio of respondents with high and increased fatigue to the total number of respondents. After night shift, RI = 0.75 (43/57 = 0.75), after daily shift RI = 0.26 (15/57 = 0.26).

The symptoms of fatigue were also researched among employees working, who were classified into two groups based on the production's working times. The respondents working in productions with fixed times versus continuous operations running 24/7 were looked upon . Following symptoms of fatigue: nervousness, attention deficit, irritability, error rate and others were preselected.

Table 3. Fatigue Symptoms

	Fixed production times		Continuous production	
	Sum	%	Sum	%
1 - nervousness	12	21	13	23
2 – attention deficit	9	16	8	14
3 -irritability	30	53	18	32
4 - error rate	5	9	12	21
5 - others	1	1	6	10
Total	57	100	57	100

Workers with fixed working hours – fixed production are most often experiencing fatigue with irritability - situational emotional disorders (53%), nervousness (21%) and attention deficit disorder (16%). In the group of workers on a continuous production times , irritability appeared highest (32%), nervousness continued (23%) and error rate of (21%) are most common symptoms.

The time of the day and it's influence on the employee tiredness were equally research in contexts of respondents experiencing different working regimes experience a peak of fatigue. We were also interested in whether the peak of fatigue interfered with employees' working time.

Table 4 Fatigue over a 24-hour cycle

	Fixed production times		Continuous production	
	Sum	%	Sum	%
8:00 - 12:00	1	1	4	7
12:00 - 16:00	25	44	17	30
16:00 - 20:00	10	18	11	19
20:00 - 24:00	15	27	11	19
after 24:00	6	10	14	25
Spolu	57	100	57	100

As the table n.4 suggest, for workers with fixed production time, the highest levelss of tiredness felt between 12.00 and 16.00 (25%) and then from 20.00 to 24.00. Also, in the case of workers employed in non-stop productions, the peak of fatigue is between 12.00 and 16.00 (30%) and 24.00 (25%).

Conclusion

Our findings revealed differences in the risk index. The risk index for the night shift is RI = 0.64 and after day shift RI = 0.22. This implies that employees experience differences in frequency and rate of fatigue arising after day shift and fatigue arising after night shift. The arithmetic average of the fatigue frequency after night shift is 3.8 and after day shift of 2.8. Scattered on the scale, after a night shift, we are approaching the frequency often and after a day shift the frequency sometimes is reached.

Secondly the variation between night shift and day shift regimes were continuously assessed through the questionnaire. The arithmetic average of fatigue after night shift is 4.0 and after day shift of 2.28.When asked how tired workers felt, further degree of variation was identified between the two regimes. Post night shift largest proportion felt very tired, whereas post day shift largest proportion felt somewhat tired.

Similarly the difference was also found in the risk index, where night shift followed a higher trend as the day shot. Post night shift risk index (RI) was defined as 0.75, and post day risk index was of 0.26.

Our findings further indicate that respondents report the difference in fatigue symptoms in different working modes. We found the difference in the symptom of discontent/irritability amongst the employees of fixed operation and the error rate in the respondents of continuous operation.

The peak of fatigue during the 24-hour cycle of workers in different working modes was recorded as follows: For workers of fixed production times the greatest fatigue is felt between 12.00 and 16.00 (25%) and then from 20.00 to 24.00 (15%). In the case of non-stop workers, peak fatigue also occurs between 12.00 and 16.00 (30%) and 24.00 (25%).

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