

THE FATIGUE IN WORKERS OF IRAN CENTRAL IRON ORE COMPANY IN YAZD

GOLAM HOSSEIN HALVANI¹, MOHSEN ZARE¹, and HAMID HOBObATI²

¹ Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Department of Occupational Health, Faculty of Health

² Kerman University of Medical Sciences, Kerman, Iran

Department of Neurosurgery, Faculty of Medicine

Abstract

Aims: To evaluate fatigue, sub-dimensions, and job satisfaction among workers of Iran Central Iron Ore Co., and obtain the relationship between them. **Materials and Methods:** In a cross-sectional study, fatigue and the dimensionality were measured using Iranian version of Piper Fatigue Scale questionnaire (PFS). Job satisfaction was estimated with the job satisfaction scale (JSS) as well. **Results:** The score of severe fatigue in four sub-scale/dimensions and total fatigue scores were: 11.9, 15.2, 11.3, 10.8 and 10.6%, respectively. Furthermore, there was significant difference between total fatigue and all its sub-dimensions in relation to job satisfaction of workers. **Conclusions:** Fatigue has caused job dissatisfaction of participants in our study, therefore we should note that the nature of fatigue may affect the psychological aspects of industrial workforce and can be harmful for business activities.

Key words:

Workers, Piper Fatigue Scale, Mine

INTRODUCTION

Fatigue is a common statement of dissatisfaction in the working population [1]. And a complex as well as a subjective phenomenon with multifactorial origins [2]. In a cross-sectional survey in working community in 15 European countries, 5–56% of employees reported fatigue at work [3]. Other studies have stated prevalence rates of fatigue varying from 7% to 45%, depending on the instruments used and the utilized cut-off points [4]. Chronic fatigue is reported to be associated with disorders comparable to prolonged medical conditions, and may affect the individual's performance and functioning in the occupational as well as in the home setting [5]. Although fatigue is not always insignificant, little consideration has been given to its epidemiology, perhaps because it is difficult to define and measure, and rarely is directly fatal [5,6]. The difficulty of measuring fatigue is due to its subjectivity in meaning and experience, and its

multidimensional and heterogeneous nature [4,7]. Also, the lack of tools and treatment procedures available to evaluate and manage fatigue is another reason for this [8]. Fatigue was defined as "an alteration which occurs in the psychophysiological control mechanism that regulates task behaviour, as a result of previous mental and physical considerable efforts which have become onerous to such extent that the individual is no longer capable to effectively meet the necessities that the job requires of his or her mental functioning". This definition mainly implies that fatigue itself is not an adverse effect but rather a physiological adjustment or safety mechanism of the individual confronted with the risk of overstrain or exhaustion [9]. A distinction between aspects of fatigue is as follows: physiological fatigue (reduction of physical capacity), objective fatigue (reduction in work) and subjective fatigue (feelings of weariness). Following this classification, most of the operative definitions have been

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Address reprint requests to G.H. Halvani, Faculty of Health; Department of Occupational Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran (e-mail: halvani@yahoo.com).

grouped in bodily changes, changes in performance and perceptual changes [10]. Job satisfaction is also found to be associated with almost all mental or physical problems. The scientific evidence trends show that dissatisfaction can result in physiological and psychological alterations that may increase the likelihood of developing physical and mental problems. With regard to studies in the work environment, insufficient attention has been given to psychological factors, especially job dissatisfaction, and risk of fatigue [11]. Studies conducted in the various populations have shown that fatigue is one of the most disabling symptoms [12]. A study conducted among railroad workers recognized two dimensions of fatigue: enfeebled activation and enfeebled motivation. In contrast, an additional research realized three main dimensions of fatigue: boredom, visual fatigue, and muscular fatigue, whereas within another study in a sample of 9575 industrial workforces the following dimensions were obtained from a collection of 30 fatigue symptoms: drowsiness and dullness, mental symptoms, and projection of physical disintegration [10]. In working population, previous research of fatigue and psychological distress was carried out in a specific occupational setting which showed a correlation of 0.54 [1]. Previous cross-sectional studies have shown that fatigue, including chronic fatigue, is associated with age, gender, marital status, ethnic identification, socioeconomic status and work status [13,14]. Studies conducted recently verified that non-married status was more associated with fatigue [15]. It is also possible that cumulative fatigue leads to decreased productivity in the workplace and induces critical errors in the worst cases.

To our knowledge, however, little is known about the causal relationship between job dissatisfaction and fatigue. In this study, we assessed fatigue and its aspects among workers of Iran Central Iron Ore Co., and evaluated the relationship between job satisfaction and some personal factors.

MATERIALS AND METHODS

Study population

In order to assess fatigue, we selected a work population from Iran Central Iron Ore Co. in Yazd, Iran (sample size = 395). Employees with different jobs and

characteristics from various parts of company were selected to participate in the study. All of the subjects were male, aged 17–57 years, with a minimum of 42 hours work a week. The mean of working hours per week was 43.2 hours and range of this was between 42–44 hours. There were no differences between duration of work among workers. Accurate data on health status of subjects was obtained from periodic medical examination files. Subjects were randomly chosen from the list of the healthy workers. Selected employees were divided into 6 groups based on their jobs. The first group of employees consisted of 90 healthy mining workers with high physical workload, mostly working at slope of mountain. The second group consisted of 98 mechanics responsible for repair and maintenance of equipment and installations. The third group consisted of 61 healthy drivers. The fourth group of employees consisted of white collar workers employed at office. The fifth group included supervisors. These employees performed mental work in Central Iron Ore Co. And the last group consisted of fire fighters, restaurant workers, and watchman workers.

Individual characteristics such as level of education, age, smoking, marital status, duration of employment, and shift work were collected with a standard demographic questionnaire. Shift work schedules of study population were classified as morning (from 8:00 to 16:00), night (from 22:00 to 6:00), morning and afternoon (from 6:00 to 14:00 and 14:00 to 22:00, weekly), and rotating shift in which employees' work schedule changes weekly (work must be done without halt).

Iran Ore Co. is situated at Torrid Zone and microclimate conditions are hot.

Questionnaire

All 395 employees received a self-administered questionnaire which contained questions about demographic factors, fatigue, and job satisfaction. We obtained informed consent from all participants and managers of workers. In addition, the contributors were assured that their responses were confidential. Iranian version of Piper Fatigue Scale questionnaire (PFS) [16] was used to measure fatigue. The PFS currently is composed of 22 items numerically scaled "0" to "10" that measure 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). Five additional points (1 and 24–27) were not applied to calculate subscale or total fatigue scores but these items furnished rich, qualitative data. Item 1, for example gives a categorical way to assess the duration of the respondent's fatigue. To score the PFS, we added the entries of each specific subscale together and divided them by the number of items on the subscale. This will give a subscale score that remains on the same "0" to "10" numeric scale. To calculate the total fatigue score, we added the 22 item scores together and divided them by 22 in order to keep the score on the same numeric "0" to "10" scale. The severity code of fatigue is none = 0, mild = 1–3, moderate = 4–6 and severe = 7–10.

To ensure the clarity of questionnaires, pilot testing of the questionnaire was also performed using the coherence and consistency upon 30 workers who were not included in the survey. After that, the questionnaire was modified on the basis of their feedback. Content validity was established by 5 experts who were academic staff and industrial psychologists. To determine the internal reliability, a Cronbach's alpha for total fatigue was calculated, which was 0.97. Cronbach's alpha for behavioral, emotional, sensory and cognitive/mood was 0.92, 0.94, 0.91, and 0.97, respectively. Data was collected in the actual work situation of all workers.

Job agreement was measured with the job satisfaction scale (JSS) [11]. The 12-item JSS was originally developed to measure an individual's perception of job satisfaction at work. These items can be classified as factors related to organization, profession, job insecurity and income. This factor for the lowest dissatisfaction was 0 and the highest was 36. A group of psychologist experts verified the validity of the questionnaire. Cronbach's alpha for JSS was 0.90. The Code of job satisfaction was classified as dissatisfied (0–9), comparatively satisfied (10–18), satisfied (19–27), and very satisfied (28–36).

Analysis

All data analyses were done with SPSS (Ver. 11.5) (Statistical Package for Social Sciences). To gain insight into the discriminates validity, differences among the six groups

of employees for the four dimensions of the fatigue and total fatigue were calculated with univariate analysis of variance (ANOVA). Also, to evaluate the relationship between total fatigue and dimensions with job satisfaction we used ANOVA, in addition Bonferroni test was used to check if there was a significant differences between different groups of job satisfaction. We calculated the Pearson correlation coefficient between fatigue and sub-dimensions.

RESULTS

The study population included a total of 395 participants who responded to the survey. We analyzed data for the 388 who filled the questionnaire correctly, all of them were male. In this survey, mean age was 32.08 (range: 17–57) years. Subject characteristics are shown in Table 1. The proportion of participants' jobs was 23.2% miners, 25.3% mechanics, 15.7% truck drivers, 24.2% white collar workers, 8.8% supervisors, and 2.8% others. Table 2 indicates characteristics of different job groups separately. Also the prevalence of fatigue and its sub-dimensions were measured among different occupations. Figure 1 indicates the prevalence of fatigue and sub dimension across different occupations, the highest prevalence of total fatigue was found among "miners" (3.29%), while the lowest prevalence was found among "supervisors" (2.77%), and "others" (1.8%). The differences between these groups were not statistically significant.

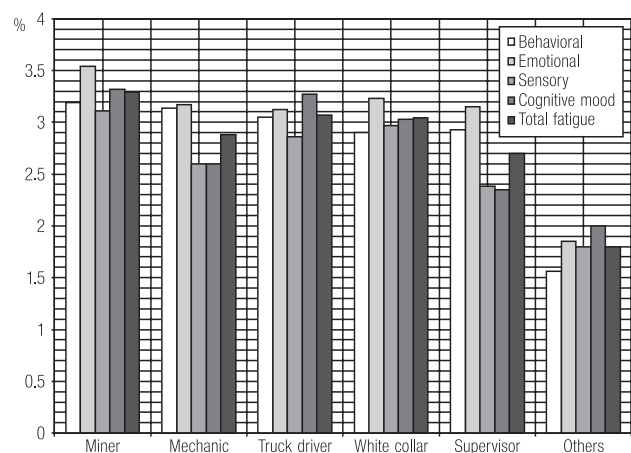


Fig. 1. The prevalence of fatigue and sub-dimension across different occupations.

Table 1. Participants' characteristics

Characteristics	% (n)
Age	
17–29 years	42.0 (163.0)
30–39 years	43.0 (167.0)
40–57 years	14.9 (58.0)
Job type	
Miner	23.2 (90.0)
Mechanic	25.3 (98.0)
Truck driver	15.7 (61.0)
White collar	24.2 (94.0)
Supervisor	8.8 (34.0)
Others	2.8 (11.0)
Duration of employment	
< 6 years	28.1 (109.0)
6–14 years	41.2 (160.0)
> 14 years	30.7 (119.0)
Educational attainment	
Elementary	39.4 (153.0)
High school	43.0 (167.0)
College or higher	17.5 (68.0)
Marital status	
Single	10.6 (41.0)
Married	89.4 (347.0)
Smoking	
Smoker	22.9 (89.0)
Non smoker	77.1 (299.0)
Shift work	
Morning	30.4 (118.0)
Afternoon	0.1 (3.0)
Night	1.3 (5.0)
Shift rotating	65.2 (253.0)
Morning & Afternoon	2.3 (9.0)

Table 3 shows the prevalence of fatigue and its sub-dimensions in the study population. The score of severe fatigue in four sub-scale/dimensions and total fatigue was 11.9, 15.2, 11.3, 10.8 and 10.6%, respectively. Table 4 shows the education level of the employees in relation to fatigue and its sub-dimensions. Results show that fatigue and its sub-dimensions are not significantly different in workers with various levels of education. The results

Table 2. Population characteristics and mean fatigue scores across different job groups

Job type	Age mean (SD)	Education % (n)		Duration of employment		Marital status % (n)		Smoking % (n)		Shift work % (n)		Behavioral mean (SD)	Emotional mean (SD)	Sensory mean (SD)	Cognitive mood mean (SD)	Total fatigue mean (SD)		
		elementary school or higher	high school or higher	single	married	no	yes	morning	night	rotating	morning						afternoon	
Miner	31.6 (5.5)	48.9 (44.0)	38.9 (35.0)	12.2 (11.0)	10.2 (5.5)	5.6 (5.0)	94.4 (85.0)	74.4 (67.0)	25.6 (23.0)	12.2 (11.0)	2.2 (2.0)	78.9 (71.0)	6.7 (6.0)	3.2 (2.7)	3.5 (2.9)	3.1 (2.6)	3.3 (2.7)	3.3 (2.5)
Mechanic	30.7 (7.2)	45.9 (45.0)	45.9 (45.0)	8.2 (8.0)	9.5 (6.8)	14.3 (14.0)	85.7 (84.0)	81.6 (80.0)	18.4 (18.0)	41.8 (41.0)	0.0	56.1 (55.0)	2.0 (2.0)	3.1 (2.5)	3.2 (2.7)	2.6 (2.3)	2.6 (2.2)	2.8 (2.2)
Truck driver	32.4 (6.5)	60.0 (37.0)	36.1 (22.0)	3.3 (2.0)	10.4 (6.9)	8.2 (5.0)	91.8 (56.0)	63.9 (39.0)	36.1 (22.0)	6.5 (4.0)	0.0	91.8 (56.0)	1.6 (1.0)	3.1 (2.4)	3.1 (2.5)	2.8 (2.4)	3.3 (2.5)	3.1 (2.3)
White collar	33.1 (6.5)	21.3 (20.0)	43.0 (45.7)	33.0 (31.0)	10.4 (6.5)	7.4 (7.0)	92.6 (87.0)	79.8 (75.0)	20.2 (19.0)	54.3 (51.0)	1.1 (1.0)	44.7 (42.0)	0.0	2.9 (2.4)	3.2 (2.8)	2.9 (2.6)	3.0 (2.5)	3.1 (2.3)
Supervisor	34.5 (8.4)	20.6 (7.0)	41.2 (14.0)	38.2 (13.0)	11.4 (8.3)	20.6 (7.0)	79.4 (27.0)	82.4 (28.0)	17.6 (6.0)	26.5 (9.0)	5.9 (2.0)	67.6 (23.0)	0.0	2.9 (2.2)	3.1 (2.4)	2.4 (1.9)	2.3 (1.9)	2.7 (1.9)
Others	29.4 (6.5)	0.0	72.7 (8.0)	27.3 (3.0)	9.2 (6.9)	27.3 (3.0)	72.7 (8.0)	90.9 (10.0)	9.1 (1.0)	45.5 (5.0)	0.0	54.5 (6.0)	0.0	1.6 (2.2)	1.8 (2.3)	1.8 (2.4)	2.0 (2.0)	1.8 (2.2)
P	-	-	-	-	-	-	-	-	-	-	-	0.5	0.2	0.6	0.8	0.5	0.8	0.5

Table 3. Distribution of fatigue and sub-dimensions among workers

Fatigue & Sub-dimension	None % (n)	Low % (n)	Moderate % (n)	Severe % (n)
Behavioral	21.1 (82.0)	43.0 (167.0)	24.0 (93.0)	11.9 (46.0)
Emotional	19.8 (77.0)	38.7 (150.0)	26.3 (102.0)	15.2 (59.0)
Sensory	18.0 (70.0)	51.5 (200.0)	19.1 (74.0)	11.3 (44.0)
Cognitive mood	13.9 (54.0)	54.9 (213.0)	20.4 (79.0)	10.8 (42.0)
Total fatigue	11.6 (45.0)	54.9 (213.0)	22.9 (89.0)	10.6 (41.0)

Table 4. Fatigue and sub-dimensions related to individual factors

Fatigue & Sub-dimension	Education			P	Marital status			P	Duration of employment			P
	Elementary mean (SD)	High school mean (SD)	College or higher mean (SD)		Non-married (41) mean (SD)	Married (347) mean (SD)	< 6 years mean (SD)		6-14 years mean (SD)	> 14 years mean (SD)		
Behavioral	3.1 (2.5)	3.1 (2.5)	2.7 (2.5)	0.8	3.3 (2.6)	2.9 (2.5)	0.2	3.3 (2.5)	3.1 (2.7)	2.6 (2.2)	0.4	
Emotional	3.2 (2.7)	3.3 (2.7)	2.9 (2.8)	0.1	3.5 (3.2)	3.2 (2.6)	0.04	3.4 (2.8)	3.3 (2.8)	2.9 (2.4)	0.4	
Sensory	2.8 (2.4)	2.8 (2.5)	2.8 (2.5)	0.5	2.9 (2.6)	2.8 (2.4)	0.3	2.7 (2.3)	3.1 (2.7)	2.5 (2.2)	0.3	
Cognitive mood	3.1 (2.4)	2.9 (2.4)	2.8 (2.5)	0.5	2.9 (2.5)	2.9 (2.4)	0.6	2.7 (2.2)	3.3 (2.2)	2.8 (2.1)	0.3	
Total fatigue	3.1 (2.2)	3.0 (2.3)	2.8 (2.4)	0.6	3.2 (2.5)	2.9 (2.3)	0.2	3 (2.2)	3.2 (2.5)	2.7 (2.4)	0.4	

show that the score of total fatigue and its sub-dimensions in non-married workers is higher than in married workers, but this difference is not statistically significant (Table 4). There was no significant difference between total fatigue and its sub-dimensions in relation to duration of employment (Table 4).

As Table 5 shows, there was a statistically significant relationship between the prevalence of total fatigue and its sub-dimensions and job satisfaction ($p < 0.001$). Also in accordance with Bonferroni multiple comparison test, we observed that there was a significant relationship between total fatigue and its sub-dimensions with different classifications of job satisfaction; this implies that the mean score of total fatigue was higher in workers who were dissatisfied than in workers stating they were comparatively satisfied and satisfied, and the difference was statistically significant. But there was no relationship between the satisfied and the very satisfied workers. Similarly, all of sub-dimensions of fatigue were the same. We also found a correlation between total fatigue and the entire sub-dimension to each other with $p < 0.01$ (Table 6).

DISCUSSION

The purpose of this study was to assess fatigue and its sub-dimensions among workers of Iran Central Iron Ore Co., and evaluate the relationship between job satisfaction and some personal factors. Fatigue is categorized to four sub-dimensions including emotional, sensory, behavioral, and finally cognitive components. Smets and colleagues [7] and Gawron and coworkers, [17] have stated that nowadays there is general agreement to measure fatigue as a multidimensional concept.

In this study about 11% of workers had severe fatigue, and severe fatigue was observed in "emotional" sub-dimension more than others (15.2%). We found some degrees of chronic fatigue in nearly all of the working population (88.4%). This finding is coherent with other studies performed among different populations [1,18–20]. It should be noted that previous studies reported prevalence rates of fatigue varying from 22% (11% for 6 months or longer) in the general population [20] and 25% (at least 2 weeks duration) in an Australian primary care study [21] to 38% (18% for 6 months or longer) in a UK community survey

Table 5. Fatigue and sub dimension in relation to job satisfaction

Fatigue & Sub-dimension	Dissatisfied mean (SD)	Comparatively satisfied mean (SD)	Satisfied mean (SD)	Very satisfied mean (SD)	P Anova	Bonferroni Post Hoc
Behavioral	5 (2.6)	3.4 (2.4)	2.6 (2.3)	1.9 (2.3)	0.001	Dissatisfied vs. Comparatively satisfied (p = 0.003) Dissatisfied vs. satisfied (p = 0.0001) Dissatisfied vs. very satisfied (p = 0.0001) Comparatively satisfied vs. satisfied (p = 0.025) Comparatively satisfied vs. very satisfied (p = 0.0001) Satisfied vs. very satisfied (p = 0.232)
Emotional	5.4 (2.7)	3.8 (2.6)	2.7 (2.5)	2.1 (2.6)	0.001	Dissatisfied vs. Comparatively satisfied (p = 0.005) Dissatisfied vs. satisfied (p = 0.0001) Dissatisfied vs. very satisfied (p = 0.0001) Comparatively satisfied vs. satisfied (p = 0.002) Comparatively satisfied vs. very satisfied (p = 0.0001) Satisfied vs. very satisfied (p = 0.627)
Sensory	4.7 (2.8)	3.3 (2.5)	2.4 (2.2)	1.7 (1.9)	0.001	Dissatisfied vs. Comparatively satisfied (p = 0.01) Dissatisfied vs. satisfied (p = 0.0001) Dissatisfied vs. very satisfied (p = 0.0001) Comparatively satisfied vs. satisfied (p = 0.009) Comparatively satisfied vs. very satisfied (p = 0.0001) Satisfied vs. very satisfied (p = 0.288)
Cognitive mood	4.7 (2.7)	3.4 (2.4)	2.6 (2.3)	1.9 (2.1)	0.001	Dissatisfied vs. Comparatively satisfied (p = 0.018) Dissatisfied vs. satisfied (p = 0.0001) Dissatisfied vs. very satisfied (p = 0.0001) Comparatively satisfied vs. satisfied (p = 0.016) Comparatively satisfied vs. very satisfied (p = 0.001) Satisfied vs. very satisfied (p = 0.534)
Total fatigue	4.9 (2.3)	3.5 (2.2)	2.6 (2.1)	1.9 (2.0)	0.001	Dissatisfied vs. Comparatively satisfied (p = 0.002) Dissatisfied vs. satisfied (p = 0.0001) Dissatisfied vs. very satisfied (p = 0.0001) Comparatively satisfied vs. satisfied (p = 0.003) Comparatively satisfied vs. very satisfied (p = 0.0001) Satisfied vs. very satisfied (p = 0.250)

[19]. Different definitions of fatigue, different settings, different response rates, and the use of different fatigue questionnaires have a direct role on measuring prevalence rates of fatigue in various investigations.

This study revealed that the prevalence of fatigue in different sectors and jobs was different, and miners showed the highest rate among other occupations, but this was not statistically significant. The Maastricht Cohort Study has shown the role of several work characteristics in the onset of fatigue. The considerable differences in the prevalence of prolonged fatigue among different sectors and trades, companies, and departments may be due to the work environment that affects the etiology and natural course

of fatigue [13]. However, these differences may be due to dissimilarities in the study population, the response rate, and the predefined cut-off points of questionnaire.

The results of this study showed that the duration of employment did not affect the fatigue. The fatigue and all its dimensions were similar in workers with different duration of employment. Total fatigue in workers with 14 years of employment was lower than the others. We didn't find any study that comprises these variables, but the results of Chad showed that fatigue in younger workers was more severe than in older workers [22]. This finding is consistent with our results, because in our study the workers with longer duration of employment were older than others. This

Table 6. Pearson's correlation between total fatigue and fatigue's sub-dimensions

Variables	Fatigue	Behavioral	Emotional	Sensory
Behavioral	0.9	–	–	–
Emotional	0.9	0.8	–	–
Sensory	0.9	0.7	0.7	–
Cognitive mood	0.9	0.7	0.7	0.9

$P < 0.01$.

may be due to increase in adaptation with workplace and decrease in additional non-beneficial activities because of growing expertise at their jobs.

Our results showed that fatigue among workers with different levels of education was similar but slightly decreased with growing educational levels. Beurskens showed that the education level of the employees with fatigue was not significantly different and only slightly changed the scores of questionnaires [23]. Bultmann [1] found a slight linear trend towards lower fatigue scores with increasing educational level, which agreed with data of Loge et al [20]. The results of our investigation indicated more fatigue among employees who reported living alone. This association is consistent with the finding of more fatigue among single individuals in a study between employees of the UK National Health Service [24]; although some previous researches showed no or minor effects of marital status on fatigue [18,20]. This may be due to cultural and other social and psychological variability among populations studied [25]. Our results show that there is significant difference between total fatigue and all its sub-dimensions in relation to job satisfaction. This is same as the results of de Fatima et al. in Brazil [26]. They concluded that satisfaction of bank workers decreased their fatigue. Another study by de Croon also explained a significant amount of variance in fatigue (3%) and job dissatisfaction (7%) in relation to job control and quantitative workload [27]. This may be due to the psychosocial work environment being able to affect wellbeing [28]. The correlation found between fatigue and its sub-dimensions in this study was significant and was consistent with other studies [29–32]. In this cross-sectional study, all variables were gathered by a self-reported questionnaire, which may cause an error in estimation of the associations.

CONCLUSION

Our work demonstrated the prevalence of fatigue in various mining workforces. In general, fatigue has affected job dissatisfaction of participants in our study, therefore we should note that cumulative nature of fatigue may play a complex role in decrement of productivity and can be harmful for industrial activities. There were few associations between demographic variables (i.e. gender, age, marital status, and level of education) and the scores of the fatigue questionnaires.

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