Original Article

Mental workload and its association with fatigue in operating room personnel of Hamadan hospitals, Iran, 2016

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Abstract

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Background: Fatigue in the workers reduces the individual's resistance and eventually leads to the lower performance, increased errors and accidents. This study assessed the fatigue, mental workload and the correlation between them, in operating room personnel of Hamadan hospitals, Iran.

Materials and Methods: In a descriptive study, the mental workload and its association with fatigue in operating room personnel were investigated. Total of 188 cases including surgeons, nurses, operating room and anesthesia technicians participated in the study. Data were collected using demographic, fatigue and mental workload questionnaires, and were analyzed using SPSS software.

Results: The mean of overall mental workload was 74.3 ± 10.8. The results also showed that overall fatigue and its domains, including subjective fatigue, concentration, motivation and physical activity were 48.73%, 54.31%, 51.65%, 38.96% and 42.06%, respectively. Among different domains of mental workload, performance ($r = -0.380$, $P < 0.001$) and frustration ($r = 0.222$, $P = 0.014$) were significantly associated with overall fatigue. Between overall mental workload and overall fatigue, there was not a significant correlation ($r = 0.029$, $P = 0.749$). Among different dimensions of fatigue, only subjective fatigue was correlated with mental workload ($r = 0.255$, $P = 0. 005$).

Conclusions: Regarding the association of performance and the frustration with overall fatigue and the association of overall mental workload with subjective fatigue, it can be concluded that mental workload and fatigue may be correlated with each other. Therefore, any reduction in mental workload domains may lead to fatigue reduction in the operating room personnel.

Keywords: Workload, Fatigue, Operating Room, Personnel, Questionnaire

Introduction

Fatigue is defined as a temporary loss of energy and strength, resulting from hard or long time physical or mental work and usually results in performance decrement. This occurs when the body cannot provide enough energy to perform a task. The depletion of energy increases muscle fatigue to the point whereby physical or mental activity cannot be performed (1-3). Eventually, tired people may do their normal work procedures with error. Generally, fatigue may cause a feeling of contusion, decreased physical function, autonomic nervous system imbalance, and reduced work efficiency. Tired people are

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also more likely to choose risky behaviors such as taking shortcut routes to carry out their tasks (4-6).

Job dissatisfaction, mild mental disorders, lack of sleep and workload are mentioned in literature as fatigue risk factors in the job (7, 8). Higher workload, the existence of fatigue and inappropriate working time schedule, lead to lower efficiency and loss of memory, impaired thinking processes, irritability and reduced learning (9). For example, high levels of the workload in the laparoscopic task as a medical job have resulted in decreased performance (10).

There are several ways to measure workload. A simple method to measure the workload is a subjective method. According to this method, if a person feels heavy workload so the workload is categorized as high (11). Although physiological measurements are more accurate, subjective methods are more practical (12). Multidimensional methods are the most common and accepted subjective methods to measure mental workload. National Aeronautics and Space Administration-Task Load Index (NASA-TLX) is a good multi-dimensional scale for measuring mental workload, very sensitive to changes in workload and also has a high level of diagnosticity (13-15). There is not a direct way to measure fatigue. However, fatigue can be measured from its consequences and symptoms or from the physiological or psychological indications associated with the symptoms of fatigue (16).

Healthcare professions are of high sensitivity in nature due to concerns around patient's safety in the hospitals, increasing probability of human errors in tired personnel as well as and weak psychomotor and cognitive performance. (17, 18). Moreover, the increased workload can increase job pressures and cause difficulties in the decision making process in the healthcare personnel. Among the healthcare personnel, operating room personnel are subjected to high levels of mental workload, because they are always taking important decisions that are related to patient life and safety (19, 20).

To our knowledge, there was not any published study about the association between mental workload and fatigue in operating room personnel of hospitals. Therefore, we decided to study fatigue and mental workload prevalence in the operating room personnel and the association between mental workload and fatigue. We hope to provide a scientific basis for management measures in order to reduce the mental workload and consequently the fatigue in the personnel and eventually increase the patient safety in the operating room.

Materials and Methods

In a descriptive study, mental workload and its association with fatigue in operating room personnel of Besat, Fatemieh, Tamin ejtemaei, Farshchian and Shahid Beheshti hospitals, Hamadan, Iran, were investigated in 2016.

Based on census method, 188 cases of operating room personnel including surgeons, nurses, operating room and anesthesia technicians who would like to participate in the research voluntarily were recruited. All of the participants were assured that their information will remain confidential to the researcher. Moreover, participants were not asked to enter their names in the demographic questionnaire. Demographic characteristics of the participants include age, gender, job, marriage status, work experience, educational degree, monthly work-hours, type of shift work (fixed night shift, fixed morning shift, fixed evening shift, and rotating shift work), working in multiple hospitals, expertise and type of employment were collected using a demographic characteristics questionnaire.

CIS20R questionnaire was used to assess fatigue (21). Reliability and validity of CIS20R questionnaire were evaluated by Habib and colleagues for emergency service personnel. They obtained reliability of 0.86 for this questionnaire (22). CIS20R contains 20

questions related to 4 dimensions of fatigue including subjective fatigue, concentration, motivation and physical activity levels. Each of these dimensions has a response boxes ranging from 1 to 6 and the sum of this 4 domain score indicates overall fatigue severity. In this questionnaire, the more overall fatigue score was interpreted as the more overall fatigue severity (23).

Mental workload was assessed using NASA-TLX (24). The validity of the Persian version of this scale has been confirmed by Mohammadi et al. (α = 0.847) (9). The NASA-TLX uses six dimensions to assess workload including mental demand, physical demand, temporal demand, performance, effort, and frustration. This multidimensional index estimates workload during work or immediately after work (25-27).

After giving a brief description to the main objectives of the study, questionnaires were completed by participants.

Statistical analysis was performed using SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA). To find the correlation between parameters, statistical tests of Pearson correlation, analysis of variance (ANOVA) and paired t-test were used. The significance level was set at 0.05.

Table 1: Ratings for overall mental workload and its subscales (domains) in operating room personnel

NASA-TLX Subscales	Mean	SD	MIN	MAX
Mental demand	76.4	19.5	20	100
Physical demand	77.1	19.0	10	100
Temporal demand	76.0	17.1	27	100
Effort	76.8	15.8	23	100
Performance	75.9	17.1	20	100
Frustration	63.8	22.3	10	100
Overall workload	74.3	10.8	41.2	100

NASA-TLX: National Aeronautics and Space Administration-Task Load Index; SD: Standard deviation;

Results

Participants were surgeons (15.6%), nurses (22.1%), operating room technicians (22.1%) and anesthesia technicians (40.2%). In this study, 102 were women and 86 were men. Among the participants, 67 were single and 121 were married. The mean age of subjects (± standard deviation) was 32.6 ± 7.5 years, minimum and maximum age of participants was 20 and 53 years, respectively. The mean work experience of subjects was 8.78 ± 6.61 years; the minimum and maximum were 1 and 32 years respectively. The mean monthly work hours of participants were 218 ± 81.7 hours, minimum and maximum monthly work hours of participants was 70 and 400, respectively. Participants' educational degrees were bachelor of science (BSc, 52.7%), master of science (MSc, 11.2%), specialist (11.2%), professor (6.9%), general practitioner (1.6%), associate degree (15.4%) and diploma (1%). The mean of the overall mental workload rating of participants was 74.3 ± 10.8. The average rating for the subscales of mental workload stated by participants is shown in table 1.

The mean rating for fatigue and its subscales stated by participants is listed in table 2.

Table 2: Mean rating for fatigue and its subscales in operating room personnel

Fatigue domains	Rating range	Mean	SD	Min	Max
Subjective fatigue	8-48	26.10	7.02	9	48
Concentration	5-30	15.30	3.78	5	25
Motivation	4-24	9.43	2.63	4	18
Physical activity levels	3-18	7.53	2.51	3	16
Overall fatigue	20-120	58.40	11.90	28	97

SD: Standard deviation

Relationships between studied demographic variables and mental workload and overall fatigue were analyzed with Pearson correlation, analysis of variance (ANOVA) and paired t-test (Tables 3 and 4).

Table 3: Correlation of demographic variables with the mental workload and overall fatigue

Demographic Characteristic	Mental workload		Overall fatigue	
	P	R^2	P	R^2
Age	0.254	0.007	0.731	0.001
Work experience	0.080	0.016	0.525	0.002
Monthly work-hours	0.210	0.008	0.022	0.028

The work shift had a significant effect on overall fatigue. Since only one person was in the night shift work, there was not the feasibility of LST-test. So, pairwise comparisons were not conducted. The educational degree was significantly related to mental workload. Pairwise comparisons showed that mental workload in associate degree group was more than BSc and professor groups (P = 0.032 and P = 0.019, respectively), in BSc group was lower than MSc and specialist groups (P = 0.039 and P = 0.020, respectively), and in MSc and specialist groups was more than professor group (P = 0.019 and P = 0.012, respectively).

Pearson correlation test showed that among the different domains of mental workload, only performance and frustration had a significant correlation with overall fatigue (Table 5). Between other domains of mental workload and overall fatigue, as well as between mental workload and overall fatigue there was not any significant correlation (Table 5).

Table 4: Association of demographic variables with the mental workload and overall fatigue

Demographic Characteristic	Mental workload		Overall fatigue	
	P	t or F	P	t or F
Gender	0.897	1.225	0.646	-2.111
Marital status	0.931	-1.426	0.459	-1.481
Working in multiple hospitals	0.833	-1.936	0.203	0.417
Job	0.891	0.207†	0.613	0.604†
Work shift	0.458	0.785†	0.018	4.131†
Educational degree	0.021	2.551†	0.417	1.015†
Type of employment	0.117	1.991†	0.912	0.176†

t-value in t-test

†F- value in analysis of variance (ANOVA)

Table 5: Statistical test results for correlation between mental workload and fatigue in the operating room personnel

Mental workload domains		Fatigue domains				
		Subjective fatigue	Concentration	Motivation	Physical activity levels	Overall fatigue
Mental demand	r	0.087	-0.020	-0.093	-0.163	-0.010
	P	0.233	0.783	0.206	0.025	0.893
Physical demand	r	0.223	-0.097	-0.021	-0.256	0.042
	P	0.002	0.183	0.775	< 0.001	0.569
Temporal demand	r	0.241	-0.015	-0.044	0.048	0.118
	P	0.001	0.833	0.550	0.509	0.107
Effort	r	0.094	-0.028	-0.122	-0.180	-0.019
	P	0.201	0.701	0.096	0.013	0.799
Performance	r	-0.183	-0.342	-0.330	-0.311	-0.357
	P	0.012	< 0.001	< 0.001	< 0.001	< 0.001
Frustration	r	0.205	0.046	0.117	0.183	0.202
	P	0.005	0.531	0.108	0.012	0.006
Overall workload	r	0.200	-0.119	-0.121	-0.199	0.011
	P	0.006	0.103	0.098	0.006	0.880

Discussion

This study showed that the mean rating of mental workload in operating room personnel was 74.3 (SD = 10.8). The maximum and minimum ratings were belonged to physical demand (mean = 77.1 ± 19.0) and frustration (63.8 ± 22.3), respectively.

In a study conducted to evaluate the mental workload and its affecting factors among the nurses of Kashan, Iran (Sarsangi et al.), it has been reported that the maximum rating belongs to effort and minimum rating belongs to frustration. We found that the minimum rating belongs to frustration in both studies. The mean rating of 69.5 ± 15.7 for mental workload has been reported by Sarsangi et al. that is lower than the mean of workload rating in our study. This comparison shows the importance of mental workload in operating room personnel (27).

Although the overall mental workload was significantly correlated only with work experience, certain demographic characteristics were associated with some of the mental workload subscales. Demographic characteristics, such as age, were statistically correlated with mental demand (P = 0.005), work experience with performance (P = 0.045) and monthly work-hours with effort (P = 0.004). These findings mean that when age, working history or monthly work-hours increase, the mental workload experienced by personnel also increases. Although we did not find a significant association between gender and mental workload (P = 0.883), physical demand and frustration domains of mental workload were statistically correlated with gender. So, we find that women feel greater physical workload than men. As well as gender, we did not find a significant association between marital status and mental workload (P = 0.883), but mental demand and frustration domains of mental workload were statistically correlated with marital status, so the ratings for both of these domains were higher in married than singles. Although the job (surgeons, nurses, operating room and anesthesia technicians) was not significantly correlated with mental workload and its domains (P > 0.050), the mental work in surgeons was higher than other jobs.

The mean rating of overall mental workload in this study (74.3) was less than the mean rating obtained in the study of mental workload among the nurses of intensive care unit (82.3) and was higher than the mean rating obtained among the nurses of the orthopedic unit (63.5) in Malekpour study (28). The findings of Malekpour study show that mental workload is different in nurses of different units, but this difference was not found in different jobs in our study. The overall mental workload in this study was also more than that of has been reported in intensive care unit (ICU) nurses (71.4) (29). This finding shows the importance of mental workload in operating room personnel.

We did not find a significant association between shift work and mental workload (P = 0.783), which can be due to a mismatch between the number of samples in two working groups of day shift (n = 18) and night shift (n = 104) workers. Unlike this study, Sarsangi et al. has found a significant association between mental workload and age and type of work shift. Here, we can say again that this can be due to the mismatch between the number of samples in groups and Small sample size. But our study is consistent with Sarangis' report, showing that the mental workload has a significant correlation with work experience (27).

Another study by Habibie et al. has found that overall fatigue, subjective fatigue, concentration, motivation, and physical activity levels in emergency service personnel were 44.44%, 49.40%, 45.40%, 38.75%, and 37.22%, respectively (22). Compared to Habibie's results (22), we can say that overall fatigue and its domains are more severe in operating room personnel than emergency service personnel. Moreover, the severity of fatigue domains in our study were higher than that of has been reported in workers exposed to jute dust, wood dust, chemicals and office workers (30). These results show the importance of fatigue in operating room personnel.

In this study, gender was not significantly correlated with overall fatigue but Raftopoulos et al. reported that fatigue prevalence in female nurses (93%) is more than males (87.5%) (31). This inconsistency in results may be due to different sample sizes in two studies.

Statistical test results showed that only performance and frustration have a significant inverse correlation with overall fatigue. This means that feeling lower fatigue rate is inversely proportional to a better performance. A similar correlation was also found between performance and concentration, and motivation and physical activity levels. These results of our study are consistent with barker et al. findings that have assessed fatigue in nurses (32). Small sample size especially the low number of surgeons was one of the drawbacks of our study. We suggest that other studies with a larger sample size should address the mental workload and fatigue as well as human errors resulting from higher mental workload and fatigue. Such studies will be useful to policy-makers of healthcare system to improve the work time scheduling, work shifts and the maximum number of surgeries that personnel can take part in.

Conclusion

In general, the results of this study showed that the mental workload in the operating room personnel is high. These personnel also feel fatigue to some degrees. By examining the different domains of fatigue it was observed that the mental workload is significantly correlated with mental fatigue. It can be concluded that mental workload may be correlated with fatigue and reducing the mental workload in operating room personnel may reduce fatigue.

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