

# Relationship between mental workload and musculoskeletal disorders among Alzahra Hospital nurses

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## ABSTRACT

**Background:** Musculoskeletal disorders (MSDs) are a serious problem among the nursing staff. Mental workload is the major cause of MSDs among nursing staff. The aim of this study was to investigate the mental workload dimensions and their association with MSDs among nurses of Alzahra Hospital, affiliated to Isfahan University of Medical Sciences.

**Materials and Methods:** This descriptive cross-sectional study was conducted on 247 randomly selected nurses who worked in the Alzahra Hospital in Isfahan, Iran in the summer of 2013. The Persian version of National Aeronautics and Space Administration Task Load Index (NASA-TLX) (measuring mental load) specialized questionnaire and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) was used for data collection. Data were collected and analyzed by Pearson correlation coefficient and Spearman correlation coefficient tests in SPSS 20.

**Results:** Pearson and Spearman correlation tests showed a significant association between the nurses' MSDs and the dimensions of workload frustration, total workload, temporal demand, effort, and physical demand ( $r = 0.304, 0.277, 0.277, 0.216,$  and  $0.211$ , respectively). However, there was no significant association between the nurses' MSDs and the dimensions of workload performance and mental demand ( $P > 0.05$ ).

**Conclusions:** The nurses' frustration had a direct correlation with MSDs. This shows that stress is an inseparable component in hospital workplace. Thus, reduction of stress in nursing workplace should be one of the main priorities of hospital managers.

**Key words:** Iran, musculoskeletal disorders, National Aeronautics and Space Administration Task Load Index, nurses

## INTRODUCTION

Nowadays, various musculoskeletal disorders (MSDs) occur among the people of different occupations and populations. Among the different occupational groups, nurses experience higher occupational stress,<sup>[1]</sup> as MSDs are more prevalent in the staff in hospital environments.<sup>[2]</sup> Due to the nature of their work, nurses are exposed to a higher risk of fatigue and diseases, especially MSDs.<sup>[3,4]</sup> Although these disorders occur in various parts of the body such as neck, arm, wrist, and waist, low back pain is more prevalent.<sup>[5]</sup> Research shows

that many nurses permanently or temporarily leave their work on having such disorders.<sup>[6]</sup> On the other hand, it was reported that physical and psychosocial needs can be a reason for a job change among those working in the field of health.<sup>[7]</sup> One of the major problems in prevention of work-related MSDs is their multifactorial nature including physical, organizational, psychosocial, personal, and cultural factors.

Meanwhile, hospital staff, in addition to the physical needs associated with patients' transfer, are often exposed to other related factors including psychological needs, official disputes, pressure of time, lack of social support, conflicting needs, loss of work speed control, etc.<sup>[8-10]</sup> These factors are usually referred to as psycho-social or psychological factors which lead to staff's cognitive disorders through their effect on their mental resources.<sup>[11,12]</sup> Epidemiological studies have detected these factors, in combination with physical activities, as the risk factors for neck pain.<sup>[13,14]</sup>

On the other hand, working conditions in health care environments necessitate exposure to a combination of physical and psychological needs.<sup>[15]</sup> Cognitive disorders, which result in psychological stress, increase the biomechanical

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response of musculoskeletal system to physical factors, which may enhance the risk of such MSDs among nurses.<sup>[12,16]</sup> In addition, work overload was detected as an important issue among health care and treatment staff, especially in intensive care units. Work overload is counted as one of the most important occupational stressors, as reported by nurses.<sup>[5]</sup> It can indirectly affect patients' safety due to causing a reduction in job satisfaction and motivation and an increase in staff's burnout, as well as having negative effects on communication.<sup>[17]</sup> Despite the importance of the issue, few studies have been conducted to investigate in depth the psycho-social risk factors associated with the MSDs in nurses. Therefore, the association between MSDs and the existing risk factors among nurses should be studied more deeply.<sup>[3]</sup>

This study aimed to investigate and define the relationship between mental workload and MSDs among the nurses working in Alzahra Hospital. It is hoped that the obtained results can form the required background to evaluate various dimensions of psychological workload among nursing staff and lead to a macro-ergonomic intervention to redesign the nursing work environment to increase the efficiency and efficacy of nurses' activities in hospitals. They can also help the managers and health care decision makers to reduce staff's psychological workload, control the psycho-social factors and their outcomes in nursing profession, prevent and reduce prevalence of MSDs, increase patients' safety level and satisfaction from nursing services, and ultimately increase efficiency among the nurses and hospitals.

## MATERIALS AND METHODS

### Ethical considerations

This study with No. 391,365 was approved at Isfahan University of Medical Sciences.

This is a descriptive cross-sectional study conducted in Alzahra university hospital in Isfahan, Iran in 2013. This hospital was selected due to its high number of personnel as well as having various wards and treatment activities. Firstly, 247 subjects were randomly selected through a systematic random sampling from the list of all nurses working in Alzahra Hospital. After selection of the subjects, necessary coordination was made with the hospital manager. Before completion of an anonymous questionnaire, subjects gave their consent to participate in the research.

If any of the selected nurses was excluded due to any reason (absence, loss of interest to attend the study, etc.), she/he was replaced by the next staff in the list. All volunteers were examined by a specialist of physical medicine before being selected as a subject and attending the research, and those with vertebral fractures, kyphosis, lordosis, scoliosis, intervertebral disk rupture, and hernia and other

diagnosed acute MSDs were excluded from the study. Inclusion criteria were work experience of more than 1 year and staff's permanent, contract, and casual employment status. In the present study, both goals of the study (mental workload and prevalence of MSDs) were investigated using the National Aeronautics and Space Administration Task Load Index (NASA-TLX) and the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). NASA-TLX is a tool used to investigate the mental workload and was designed by the human factors engineers in NASA.<sup>[18]</sup> This tool was suggested after 3 years of extensive research on the physical and mental activities in various occupations in over 40 simulation laboratories. This index is a multidimensional process with various evaluation degrees, which provides a self-evaluation model to estimate mental workload through use of six scales. The TLX model includes three dimensions of imposed demands to an operator during working (physical, mental, and temporal loads) and three factors associated with the outcome of the work (person's performance, level of effort, and level of frustration).<sup>[19]</sup> The process of mental workload evaluation through NASA-TLX involves three stages. At the first stage, weight in each of the six scales is determined to reveal the priority of the six scales of TLX. At this stage, all scales are self-evaluated and selected by the staff in a paired form and in 15 different positions, and then, each workload dimension is scored 0-1. At the second stage, to allocate the rating of workload, each of the six scales is rated with the goal of determination of each scale's effect on the mental workload. At this stage, the respondent or participant scores each of these six dimensions from 0 to 100 based on his/her own working condition. At the third and the last stage, after determination of weight and rating in previous stages, total workload is calculated in the range 0-100 through the following formula: Total workload = rating × weight/15.

Numerous methods were used to evaluate the validity and reliability of this tool.<sup>[20]</sup> Its reliability was 0.77. The research conducted on nurses showed that NASA-TLX had a high correlation with other methods of mental workload evaluation.<sup>[21]</sup> In a study conducted for the evaluation of nurses' mental workload in the intensive care unit (ICU) in Isfahan, its reliability was confirmed (Cronbach alpha = 0.83).<sup>[22]</sup>

CMDQ was used to investigate the prevalence of MSDs. This questionnaire is a data collecting tool for musculoskeletal discomfort data, which was designed by professor Alen Hedge *et al.* in 1999. This questionnaire has been designed in three stages of discomfort frequency, discomfort severity, and the effect on capacity for work in the latest working week. It has the map of body and 12 parts, which totally analyzes 20 sections of the body. Mean discomfort frequency for 12 body parts is calculated as the score of

MSDs [Figure 1]. This questionnaire is used in the USA and other countries as a valuable tool to investigate the level of musculoskeletal discomfort. Its validity and reliability were estimated by Cronbach alpha = 0.986.<sup>[23]</sup> To investigate some of the demographic characteristics of the subjects, age, sex, height, weight, work experience, related ward, working shift, and body mass index (BMI) were added to this tool. The collected data were analyzed by SPSS 20. To calculate and define the condition of investigated indexes, descriptive statistical tests and tables were used. To investigate the association between mental workload and musculoskeletal discomfort severity, Pearson, Spearman, and musculoskeletal linear regression tests were used.

### RESULTS

The study was conducted on 247 nurses working in the hospital in the summer of 2013. The obtained results on the demographic characteristics showed that there were 22 (9%) male and 225 (91%) female subjects of whom 71% were married and 29% were single. Nurses' mean age

was 34.8 (6.7) years, ranging 23-67 years. Nurses' mean BMI, weight, and height were 24.24, 64.5 kg, and 163 cm, respectively [Table 1].

As observed in Table 2, the results of mental workload questionnaire showed that the two dimensions of effort and performance had the highest values. The dimension of mental demand of work had the highest value and the dimension of frustration had the lowest value [Table 2]. Frequency distribution of musculoskeletal discomfort showed that low back pain (76.1%) was the most frequent complaint (total discomfort frequency in a part of body) among the nurses. Pain in neck and knee was the most frequently (68% and 61.9%, respectively) reported discomfort after low back pain. The lowest pain complaints were for back, elbow, arm, and thigh, which were 22.7%, 23.9%, 28.7%, and 31.2%, respectively [Table 3].

Pearson correlation coefficient showed no significant association between the levels of musculoskeletal discomfort among nurses, and workload scale of

The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.

	During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
	Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shoulder (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shoulder (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upper Back	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upper Arm (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upper Arm (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower Back	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forearm (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forearm (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wrist (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wrist (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hip/Buttocks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Thigh (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Thigh (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knee (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knee (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower Leg (Right)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower Leg (Left)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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Figure 1: Cornell musculoskeletal discomfort questionnaire

performance and mental demand ( $P > 0.05$ ), but other dimensions of workload, especially the dimension of frustration, had a significant direct association with the level of musculoskeletal discomfort among nurses ( $P < 0.05$ ) [Table 4]. As presented in Table 4, there was no significant association between the level of low back pain among nurses and the workload scale of performance and mental demand ( $P > 0.05$ ), but it had a significant association with other workload dimensions, especially the dimension of frustration ( $P < 0.05$ ). There was no significant association between the prevalence of MSDs and demographic characteristics ( $P > 0.05$ ). Workload score in the dimensions of physical, temporal demand, level of frustration, and level of effort showed an association with

MSDs. Musculoskeletal linear regression test was adopted to detect the effect of each mental workload dimension score on MSDs. The results showed that each workload dimension including the level of frustration, temporal demand, total mental workload, physical demand, and level of effort had the a significant effect on MSDs. Their standardized values were 0.17, 0.127, 0.1, 0.09, and 0.03, respectively.

## DISCUSSION

Prevalence of MSDs has notably increased among nurses working in hospitals in recent years.<sup>[24,25]</sup> Our obtained results also showed that MSDs have a high prevalence among nurses and the disorders in waist, neck, and knee are more frequent, which is consistent with the findings of a study conducted in Estonia.<sup>[26]</sup> In the present study, low back pain was the most reported complaint (76.1%) by nurses, which is consistent with a study conducted in Japan. It reported that the highest MSDs among nurses were low back pain (59%), shoulder pain (46.6%), neck pain (27.5%), knee pain (16.4%), and pain in upper part of the leg (11.8%).<sup>[27]</sup> In a study conducted by Choobineh *et al.* on 346 nurses in Iran, it was found that low back pain was the most common MSD among nurses (61.8%).<sup>[9]</sup> This finding is consistent with the findings of other researchers.<sup>[3,7,28]</sup> This shows that nurses are more predisposed to the risk factor of low back pain in their profession. The present study showed that mental workload is very high among the hospital nurses (77.7%). It was such that among the six subscales of NASA workload, the scales of effort and performance and mental demands were the highest respectively. One of the reasons for this finding could be the role of nurses in their working environment, as nursing errors can result

**Table 1: Subjects' mean age, weight, height, and BMI**

Variable	Mean	SD
Age, years	34.8	6.7
Weight, kg	64.5	10.9
Height, cm	16.3	6.9
BMI	24.24	3.4

BMI: Body mass index, SD: Standard deviation

**Table 2: Statistical indexes of each workload dimension among nurses (out of 100)**

Workload dimensions	Mean	SD	Min.	Max.
Mental demand	80.2	19.9	10	100
Physical demand	63.5	27.2	5	100
Temporal demand	74	22.5	5	100
Performance	81	16.8	5	100
Frustration	60	28.1	0	100
Effort	83.8	16.5	5	100
Total workload	77.7	12.6	38	100

SD: Standard deviation

**Table 3: Frequency distribution of musculoskeletal discomfort among nurses**

Musculoskeletal discomfort	No. (%)				
	Never	1-2 times a week	3-4 times a week	Once a day	Several times a day
Body part					
Neck	79 (32)	68 (27.5)	37 (15)	23 (9.3)	40 (16.2)
Shoulder	171 (69.2)	29 (17.7)	15 (6.1)	11 (4.5)	21 (8.5)
Back	124 (50.2)	48 (19.4)	27 (10.9)	18 (7.3)	30 (12.1)
Arm	176 (71.3)	38 (15.4)	14 (5.7)	4 (1.6)	15 (6.1)
Waist	59 (23.9)	48 (19.4)	33 (13.4)	28 (11.3)	79 (32)
Elbow	188 (76.1)	31 (12.6)	8 (3.2)	5 (2)	15 (6.1)
Wrist	154 (62.3)	31 (12.6)	20 (8.1)	15 (6.1)	27 (10.9)
Buttocks	191 (77.3)	20 (8.1)	10 (4)	8 (3.2)	18 (7.3)
Thigh	170 (68.8)	29 (11.7)	13 (5.3)	9 (6.3)	26 (10.2)
Knee	94 (38.1)	39 (15.8)	31 (12.6)	22 (8.9)	61 (24.7)
Leg	128 (51.8)	44 (17.8)	17 (6.9)	18 (7.3)	40 (16.2)
Sole	119 (48.2)	31 (12.6)	18 (7.3)	25 (10.1)	54 (21.5)

**Table 4: Spearman and Pearson correlation coefficients between MSDs and workload dimension**

Workload dimension	MSDS		Low back pain	
	Pearson correlation	Sig. (2-tailed)	Spearman correlation	Sig. (2-tailed)
Mental demand	0.07	0.309	0.045	0.484
Physical demand	0.211	0.001	0.140	0.028
Temporal demand	0.277	0.001	0.170	0.008
Performance	0.043	0.504	0.043	0.504
Frustration	0.304	0.001	0.304	0.001
Effort	0.216	0.001	0.216	0.001
Total workload	0.277	0.001	0.277	0.001

MSDS: Musculoskeletal disorders

in irreversible miserable outcomes in patients and directly affect patients' safety.<sup>[17]</sup> Based on a report by IOM, (Institute of medicine) about 44,000-98,000 persons die of medical errors due to mental and physical workload imposed to the staff working in various wards in the USA.<sup>[29]</sup> On the other hand, the association between total mental workload and each of the six scales with MSDs showed that frustration had the highest association with the prevalence of MSDs and low back pain among nurses, although it had the lowest value, which is consistent with the study of Habibi *et al.* They reported that occupational stress and high workload among nurses resulted in a physiological response in the form of muscular tension, and ultimately, low back pain, which can be due to getting less support from their superior management, other colleagues, and others, as well as increased misbehavior of clients (patients and their families) and exposure to critical patients.<sup>[30]</sup> In a systematic review on previous research entitled "Are depression, anxiety and poor mental health risk factors for knee pain?," the obtained results yielded absolute evidences and documents claiming the association between depression and knee pain.<sup>[31]</sup> As MSDs are one of the major reasons for work absenteeism and sick leave among nurses, these results are of great importance and can be used by hospital managers and nurses.<sup>[32]</sup> Therefore, it seems that more concrete results can be obtained through further and more comprehensive studies conducted by experts of mental workload in nursing profession.

## CONCLUSION

This study investigated the association between mental workload among hospital nursing staff and the prevalence of MSDs. Our obtained results showed a significant association between high mental workload among hospital nurses and the increase in their MSDs. Among the six mental workload scales, frustration had the lowest value but the highest association with MSDs, especially low back pain. This scale of workload should be specifically noticed by

hospital managers to modify nurses' mental workload to prevent the ascending trend of MSDs. This can be effective on staff's efficiency and efficacy and, consequently, can lead to an increase in efficiency of health and treatment services in Iran.

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