Does mental workload can lead to musculoskeletal disorders in healthcare office workers? Suggest and investigate a path

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Abstract: Considering the increased mental workload in office jobs, this research aimed to evaluate the association between mental workload and musculoskeletal disorders (MSDs) by assessing the mediating role of fatigue and sleep quality in office personnel. In this cross-sectional study we applied the structural equation modeling. The research population included office personnel of a healthcare in Borujerd, Iran, 243 of whom were selected via simple random sampling. Research tools included CMDQ, SOFI, PSQI, and SWAT. In addition, data analysis was performed in SPSS version 18 and AMOS version 18. Our findings showed a significant correlation between mental workload and sleep quality and fatigue with MSDs (P ≤ 0.05). The model proposed in this study had a proper goodness of fit, which demonstrated the mediating role of variables of fatigue and sleep quality in the relationship between mental workload and MSDs. According to the results of the study, the incidence of MSDs could be reduced by decreasing mental workload, fatigue and sleep quality.

Subjects: Environmental Psychology; Health Psychology; Work & Organizational Psychology; Introductory Work/Organizational Psychology

Keywords: fatigue; sleep quality; mental workload; musculoskeletal disorders

1. Introduction
In addition to physical needs, today's work environments have high mental requirements. In other words, mental workload and volume have soared in various occupations (Cinaz, La Marca, Arnnich, & Tröster, 2010). Mental workload is one of the common concepts in ergonomics and human factors, representing a topic of increasing importance (Sveinsdottir, Biering, & Ramel, 2006). The mental workload is an effort made by the mind during performing a task. This mental workload can lead to musculoskeletal disorders. In this research, we investigate the details of this path. 243 office staff were investigated. We found that mental workload directly lead to musculoskeletal disorders. In addition, mental workload increases fatigue and diminish sleep quality and these two variable lead to musculoskeletal disorders. So if you can't reduce your workload, try to reduce fatigue and improve the quality of your sleep!
workforce is an effort made by the mind during performing a task and is defined as “a level of intellectual and cognitive need or an analytical effort required by the worker or the staff to fulfill the physical, time and environmental needs of a given task” (Cao, Chintamani, Pandya, & Ellis, 2009). In fact, mental workload affects health, safety, and personal comfort (Haghshenas et al., 2018).

Musculoskeletal disorders (MSDs) occur due to the impact of mental workload on physical and mental factors (Cho, Hwang, & Cherng, 2012). A high incidence rate has been reported for MSDs in healthcare centers caused by various occupational stresses (e.g. high mental workload) (Habibi, Taheri, & Hasanzadeh, 2015). Work-related MSDs are one of the most important factors for the loss of working time, the loss of specialized workforce, and increased compensation, accounting for 48% of all occupational patients (Rahimi Fard, Hashemi Nejad, Choobine, Heidari, & Tabatabaee, 2011).

In a research, Khandan et al. showed a significant relationship between MSDs in different body parts and mental workload (Khandan, Mirshekari, Koorsani, Mosaferchi, & Koohpaei, 2018). Another study demonstrated a positive relationship between MSDs and mental workload (Darvishi, Maleki, Giahi, & Akbarzadeh, 2016). Moreover, a significant relationship was reported between MSDs and various aspects of mental workload in another research (Mohammadzadeh, Habibi, & Hasan-zadeh, 2015).

In addition to variable job requirements (e.g. perceptual and cognitive needs), health centers have physical needs (Kiekkas et al., 2008). Employees deal with various occupational stresses, work shift, and social-psychosocial factors that increase the possibility of sleep disturbance and fatigue in these individuals (Åkerstedt, Fredlund, Gillberg, & Jansson, 2002). In a research, Mirzaee et al. found a significant correlation between mental workload and fatigue in the healthcare personnel (Mirzaee, Zamanian, & Hasan Zade, 2015). The significant association between the aspects of mental workload and fatigue at the workplace was reported in another study (Hernandez, Alberto, & Nieves, 2015). In addition to MSDs, healthcare personnel is at a high risk of acute and chronic fatigue (Choobineh, Rajaeeefard, & Neghab, 2006; Menzel, 2007).

Work fatigue is defined as a change in the control mechanism of work-related behavior regulator (psychophysiological), which impairs the mental and physical activities of the individual and his ability to meet the work requirements (Van Veldhoven & Broersen, 2003). Feelings such as imposed overload, becoming more sensitive, tendency to be isolated from the society, reduced performance level, and lack of energy for work could be observed when there is a sense of fatigue and a need for rest. In addition, this issue leads to mental fatigue and decreased motivation (Mohren, Jansen, & Kant, 2010). In a research, Belghabadi et al. found a significant relationship between fatigue and MSDs, such as neck, back, waist and leg pain (Belghabadi, Dehghan, & Mahdipor, 2014).

In addition to fatigue, sleep is one of the factors influencing general human health. Generally, sleep is a physiological mechanism that leads to the regain of lost energy and elimination of fatigue caused by daily activity. Sleep disturbance leads to decreased performance during waking hours, sleepiness, and sudden loss of consciousness. Various studies have been performed on the association between sleep disorders and MSDs. For example, the positive and significant correlation between pain score in different body parts and sleep disturbance was reported in a research performed in this area (Tekeoglu et al., 2013). In another study, researchers reported a relationship between pain in the back, shoulder and toe joints and the number of painful joints with poor sleep quality. In addition, the number of painful joints had a significant correlation with the total score of sleep quality (Li et al., 2016).

Research in this area has confirmed the relationship among mental workload, fatigue and sleep disorders and the association of these variables with MSDs. However, little research has been performed on the mediating role of problems caused by mental workload (fatigue and sleep quality) in the occurrence of MSDs. With this background in mind, this study aimed to evaluate the mediating role of fatigue and sleep quality in the relationship between mental workload and MSDs in healthcare personnel.
2. Methods
This cross-sectional study was performed on the personnel of health centers of Borujerdt, Iran in 2017. Subjects were selected from the staff who worked eight-hour shifts (day shift). The inclusion criterion was having the experience defined, and the research population was selected using simple or census (convenience) sampling. In total, 243 participants entered the study. Prior to the completion of questionnaires, research objectives were explained to the participants and written informed consent was obtained from the subjects.

2.1. Data collection tools
In this research, three questionnaires were applied, as follows:

A) The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ): this questionnaire was developed by Hedge et al. in 1999, and can be applied in cross-sectional studies to evaluate the frequency and severity of discomfort and its impact on work capacity. In addition, the questionnaire assessed 12 body parts. Afifazadeh et al. confirmed the reliability of the questionnaire at the Cronbach's alpha of 0.986 (Afifazadeh-kashani et al., 2009).

B) Swedish Occupational Fatigue Inventory (SOFI): this is a multidimensional tool applied to measure the quality and severity of perceived acute fatigue. In addition, it is able to evaluate the mental and physical aspects. This 20-item questionnaire contains five dimensions of lack of energy, physical exertion, physical discomfort, lack of motivation and sleepiness. In this questionnaire, the score range of 0–33 is indicative of low fatigue, whereas the score ranges of 34–66 and >67 show moderate and high fatigue, respectively. In a study by Javadpor, Keshavarzi, Chobineh, and Aghabigi (2015), the reliability of SOFI was confirmed at the Cronbach's alpha of 0.69–0.899 (Javadpor et al., 2015).

C) Pittsburgh Sleep Quality Questionnaire (PSQI): this 18-item self-rated questionnaire contains seven components, including sleep quality, sleep duration, sleep latency, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction (Lima, Medeiros, & Araujo, 2002). (Moghaddam, Nakhaee, Sheibani, Garrusi, & Amirkafi, 2012) confirmed the reliability of the questionnaire at the Cronbach's Alphas of 0.83 and 0.77, respectively.

D) Subjective Workload Assessment Technique (SWAT): this questionnaire is designed based on a multi-dimensional mental workload model. The dimensions of the questionnaire are time load, mental effort load, and psychological stress load. Each dimension is characterized by a three-point scale (low, medium, and high). After scoring each item, a figure in the range of one-three is obtained. In total, a three-digit number is achieved that is turned into a percentage by comparing the three-digit number with the mean scoring of the method (2727 score modes of 1–27). While the scores up to 33 are indicative of low mental workload, scores within the ranges of 34–66 and >67 show moderate and high mental workload, respectively (Díaz, Jesús, & José, 2004). It is notable that the reliability of the Farsi version of this questionnaire was confirmed at the Cronbach's alpha of 0.84.

2.2. Statistical analysis
Structural Equation Method (SEM) was used in AMOS version 23 in order to determine how mental workload could lead to MSDs. The raw data were entered into the AMOS software using SPSS version 23. In use of the structural equation model, an important component is how to fit the hypothesis model with data. Normally, the goodness of fit index (GFI) is applied by scholars to evaluate this fitness. In this regard, Chi-square and the ratio of this statistic to the degree of freedom of X²/df are among the most common indexes. The ratio of one-two in the measurement of X²/df is indicative of a good fit between the hypothesized model and the sample data. However, an estimate of above two shows an acceptable fit. In addition, another important indicator in determining the GFI of this model is the RMSEA index. In this regard, the lower the index, the higher the fit of the model.
### 3. Results

Sample members were 243 people whose demographic characteristics are listed in Table 1.

Mean and standard deviation and simple correlation between variables are shown in Table 2. Result showed that there is positive and significant correlation between mental workload with sleep quality and MSDs score.

Fitness indices between the data and suggested model was calculated. These results are displayed in Table 3. An overall satisfactory model fit was achieved. The standardized estimates of the model are shown in Figure 1.

### Table 1. Demographic characteristics

| Variable        | n/mean | %/SD |
|-----------------|--------|------|
| Age             | 37.37  | 8.43 |
| Work experience | 12.48  | 8.05 |
| Gender          |        |      |
| Male            | 111    | 45.7 |
| Female          | 132    | 54.3 |
| Marital status  |        |      |
| Single          | 55     | 22.6 |
| Married         | 188    | 77.4 |
| Education level |        |      |
| Associate degree| 74     | 30.4 |
| BSc             | 136    | 56   |
| MSc             | 26     | 10.7 |
| Doctoral        | 7      | 2.9  |
| Type of work contract | |     |
| Permanent       | 167    | 68.7 |
| Non-permanent   | 76     | 31.3 |

### Table 2. Mean, Standard deviation and simple correlation

|                | M (SD) | Mental workload | fatigue | Sleep quality | MSDs |
|----------------|--------|-----------------|---------|---------------|------|
| Mental workload| 52.87  | 28.18           | -       |               |      |
| Fatigue        | 71.90  | 36.27           | 0.49    | 0.396**       | -    |
| Sleep quality  | 4.47   | 2.88            | 0.158*  | 0.219**       | 0.250** |
| MSDs           | 27     | 12.19           | 0.219** | 0.214**       | 0.250** |

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

### Table 3. Model fit summary

| RMSEA | TLI | IFI | CFI | NFI | AGFI | GFI | X^2/df | df | sig | *X^2 |
|-------|-----|-----|-----|-----|------|-----|--------|----|-----|------|
| 0.08  | 0.91| 0.95| 0.95| 0.92| 0.88 | 0.94| 2.53   | 25 | 0.00| 63.27|

### 4. Discussion

The present research aimed to assess the mediating role of fatigue and sleep quality in the relationship between mental workload and MSDs. According to the results, there was a significant association
between MSDs of the personnel and their mental workload, meaning that MSDs increased by the elevation in the mental workload of the staff. In this regard, our findings are in line with the results obtained by Seadatfar and Torkaman (2016), Giahi, Darvishi, Akbarzadeh, and ahsavari (2013), Mohammadzadeh et al. (2015), Bolghanabadi, Nayerabadi, and Taheri Nameghi (2017), and Costa, Monteiro, Ilmarinen, and Rodrigues (2009). Our findings also indicated a direct relationship between fatigue and MSDs. Other studies also reported a direct association between fatigue and MSDs (Daneshmandi, Choobineh, Ghaem, Alhamd, & Fakherpour, 2017; Gallagher, 2015). In a study by Carvalho et al., the occurrence of MSDs had a significant correlation with fatigue, which is in congruence with our findings (Carvalho et al., 2016). In addition, Balghinabadi et al. evaluated the relationship between MSDs, occupational stress, and fatigue in the staff of a food industry in 2014. At the end, they found a significant association between fatigue and low back pain and leg pain, which is consistent with our findings (Belghabadi et al., 2014).

Since fatigue is divided into two types of central and peripheral (neuromuscular), one of the factors influencing the control of lower limb joints and the risk of injury is neuromuscular fatigue (Cairns, Knicker, & Thompson, 2005). Moreover, fatigue reduces contraction speed and range of muscle relaxation (Bigland-Ritchie, Johansson, & Lippold, 1983). Therefore, the risk of developing MSDs will increase as a result of increased fatigue. According to the results of the present research, there was a significant relationship between sleep quality and MSDs, which could be due to insomnia and undesirable sleep quality resulting in lack of elimination of fatigue and emergence of MSDs. In this regard, Juha et al. evaluated the insufficient quality and quantity of sleep in the incidence of MSDs in 2009 and denoted a direct association between sleep quality and pain in the neck and shoulders, which is in accordance with our findings (Juha, Tuija, & Paavo, 2009). Furthermore, a significant correlation existed between sleep quality and shoulder pain, reported by Ediz et al., which is in line with our results (Ediz, Toprak, Yazmalar, & Karaaslan, 2013).

In the current research, the model proposed was able to evaluate the mediating role of fatigue and sleep quality in the relationship between mental load and MSDs. In the end, the suggested model was accepted. In this respect, the underlying hypothesis was that mental workload could cause fatigue and reduce the sleep quality in personnel, thereby playing a role in the emergence of MSDs. Previous studies on the mediating role of mental workload in fatigue have also shown the possible role of this...
factor in the emergence of fatigue and muscle endurance (Mehta & Agnew, 2012). Therefore, it seems that mental workload plays a role in the formation of MSDs. Regarding sleep, former studies have shown the role of excessive workload in sleep problems and low sleep quality (Kanazawa, Suzuki, Onoda, & Yokozawa, 2006), which could be caused by fatigue, lack of recovery, reduced muscle tolerance (Åkerstedt et al., 2004; Darrian, Baulk, & Dawson, 2011) and MSDs.

One of the major drawbacks of the present study was self-report nature of the tools. In this regard, it is recommended that more objective tools, such as polysomnography and electromyography, be applied to more accurately evaluate sleep quality and fatigue, respectively.

5. Conclusion

According to the results of the study, mental workload could be involved in the incidence of MSDs through fatigue and low sleep quality. Therefore, considering the lack of ability to reduce mental workload at many organizational levels, it is suggested that proper education be provided to improve sleep quality and reduce fatigue in personnel, so that the possibility of MSDs could be reduced.

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