The Functional Movement Screening Test Score Correlates with Age, Sex and Musculoskeletal Symptoms: A Study on Health Care Personnel

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Received: 25 January 2023
Revised: 24 February 2023
Accepted: 22 March 2023

Abstract

Background: Physical fitness and optimum functional movement are essential for efficient performance of job tasks without fatigue and injury. This study aimed to investigate the relationship between Functional Movement Screening (FMS) test score and prevalence of Musculoskeletal symptoms (MSSs) in emergency nurses and Emergency Medical Services (EMS) staff. The present study also sought to determine optimum cut-off point of FMS test score in health personnel.

Methods: This cross-sectional study was conducted on 134 male and female emergency nurses and EMS technicians. After watching a video tutorial and undergoing practical training of how to do the FMS test, the participants carried out the test while wearing comfortable clothes. In addition to the demographic data questionnaire, Nordic musculoskeletal questionnaire was also completed for each participant. The data were analyzed using the SPSS software, version 18 at the significance level of 0.05.

Results: Totally, 49.3% (n=66) of the participants were female. The subjects' mean age and work experience were 35.3±8.7 and 11.4±7.7 years, respectively. Cut-off point of 17 was determined with the highest sensitivity (0.71) and specificity (0.71) based on ROC curve. The highest prevalence of MSSs was observed in the knees (n=44, 32.8%) and lower back (n=31, 23.1%). Multiple linear regression modeling also showed that age, sex, and the prevalence of MSSs were significantly associated with the FMS test score.

Conclusion: FMS test seems to be an appropriate screening tool in pre-employment and periodic medical tests for jobs requiring physical fitness and optimum functional movements.

Please cite this article as: Jafari Roodbandi AS, Choobineh AR, Feyzi V, Foroozanfar Z, Hosseini N. The Functional Movement Screening Test Score Correlates with Age, Sex and Musculoskeletal Symptoms: A Study on Health Care Personnel. J Health Sci Surveillance Sys. 2023;11(2):317-324.

Keywords: Musculoskeletal system, Health personnel, Diagnosis

Introduction

Movement and physical fitness in individuals require a healthy musculoskeletal system. In fact, disorder or damage to the system leads to disability.[1] Research has shown that job is an effective factor in the creation of Musculoskeletal Symptoms (MSSs).[2] In some occupations, the rate of MSSs is higher because of the nature of the job.[3] For instance, the prevalence of MSSs is high among healthcare staff.[4] Nurses and Emergency Medical Services (EMS) staff are required to perform high physical activities, patient transfer, Cardiopulmonary Resuscitation (CPR), and similar actions that may lead to MSSs.[1, 5]

In Work-Related Musculoskeletal Disorders (WMSDs), the muscles, tendons, and nerves are damaged, and symptoms appear in the form of pain, discomfort, numbness, and tingling in the limbs.[6] These disorders are the main problems in the workplace caused by activities such as heavy load lifting,[7] repetitive tasks,[8] awkward working,[9] seated static postures,[10] and individual characteristics.[11] In addition to pain and discomfort, poor quality of work and work-related absences are major problems resulting from WMSDs in the workplace.[12]

MSSs have a negative effect on individuals' readiness to do the tasks. In a study conducted on army officer cadets in Greece, it was reported that musculoskeletal injuries caused individuals to be absent from work and military exercises during training 5 to 22 days more than common illnesses in the community.[13] Also, it was shown that MSDs are the main health problem and the major factor of disability in hospital nurses.[14]

In addition to MSSs, there are other factors that affect motion functions and muscle strength in the performance of tasks. These factors include age, sex, height, race, individual's physical condition, anthropometric measurements, load weight, load distance from body center of gravity, and disruption of respiratory patterns.[15]

The correct selection of the workforce for jobs leads to proper movement functions and required physical fitness to do things, which allows individuals to adapt to the assigned tasks without suffering from fatigue or injury.[16] Screening by Functional Movement Screen (FMS) test is an appropriate way to detect individuals with good functional ability and appropriate level of physical fitness.[17] FMS test includes seven motion tests, and the score is proportional to how the test can be performed. These tests are used to identify the limited mobility of the limbs and changes in normal motion patterns.[18] Previous studies have shown that this test could be used as a tool for identification of movement interactions and sustainability to perform basic and practical motion patterns.[17]

This test was used as a predictor of severe injury in the UK professional football players and showed that those with a score less than 14 had more severe injuries.[19] Also, it was indicated that auto industry workers with lower FMS test scores had a higher risk of MSD occurrence.[20] In the same vein, a study on Iranian soldiers indicated the usefulness of the FMS test as a predictive tool for MSDs.[21]

EMS staff and nurses in emergency departments of hospitals are exposed to MSDs risk factors, such as carrying patients, frequent bending, urgent works, and using non-ergonomic equipment.[1, 22] Although the FMS test has been used in the screening of athletes and military personnel, it has been less used as a screening tool for on-the-job and periodic screening in healthcare occupations. In addition, such related factors as gender and job tenure have been less taken into consideration. Hence, the present study aimed to investigate the relationship between the FMS test score and the prevalence of MSSs and to determine the optimum cut-off point of FMS test score in Health Care Personnel with respect to their demographic characteristics.

Methods

In this cross-sectional study, the participants who were available at the hospital were included in the study by census method. After obtaining verbal informed consent, we enrolled 134 males and females from the emergency department and EMS staff of Shahid Chamran Hospital in the study.

The study data were collected using a demographic questionnaire, Nordic Questionnaire of Musculoskeletal Symptoms (NMQ), and practical FMS test. The NMQ, with validity and reliability of over 70%, contains questions about pain and discomfort related to MSSs in the past year, last week, and at the time of completing the questionnaire by body regions. NMQ is a widely used questionnaire with high efficiency due to repeatability capabilities and can be used with high confidence to investigate MSSs.[23]

To carry out the FMS test, we taught the participants through video tutorial. If necessary, supplementary explanations and practical tests were given by one of the researchers who were able to perform the test at the full function level. FMS test was recorded after assurance of the participants' understanding of how to do the test correctly. For preventing the impact of clothing on the joints' range of motion, the participants wore comfortable clothes during the FMS test. All participants were tested without shoes on the carpet.

The FMS test consists of seven subtests, including deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability pushup, and rotary stability[19] (Figure 1).

In each of the seven stages of the FMS test, the participants received a score of 3 in case they did the subtest properly without compensatory actions. They received a score of 2 in the case of doing the subtest properly but with compensatory actions. In the case of inability to perform the subtest without compensatory actions, they received a score of 1. The participants did not receive any scores if they felt pain while doing the test or performing a clearing test (shoulder impingement, spinal extension, and spinal flexion).[21] Finally, the scores of all seven subtests were summed up, which could range from 0 to 21. The final score could be used as the predictor of MSDs occurrence. Also, individuals with FMS scores of 14 or less were prone to suffer from MSDs.[24] In the present study, Receiver Operating Characteristic (ROC) curve was used to determine the cut-off point of the FMS test. The sensitivity and specificity of the FMS test were calculated, as well.

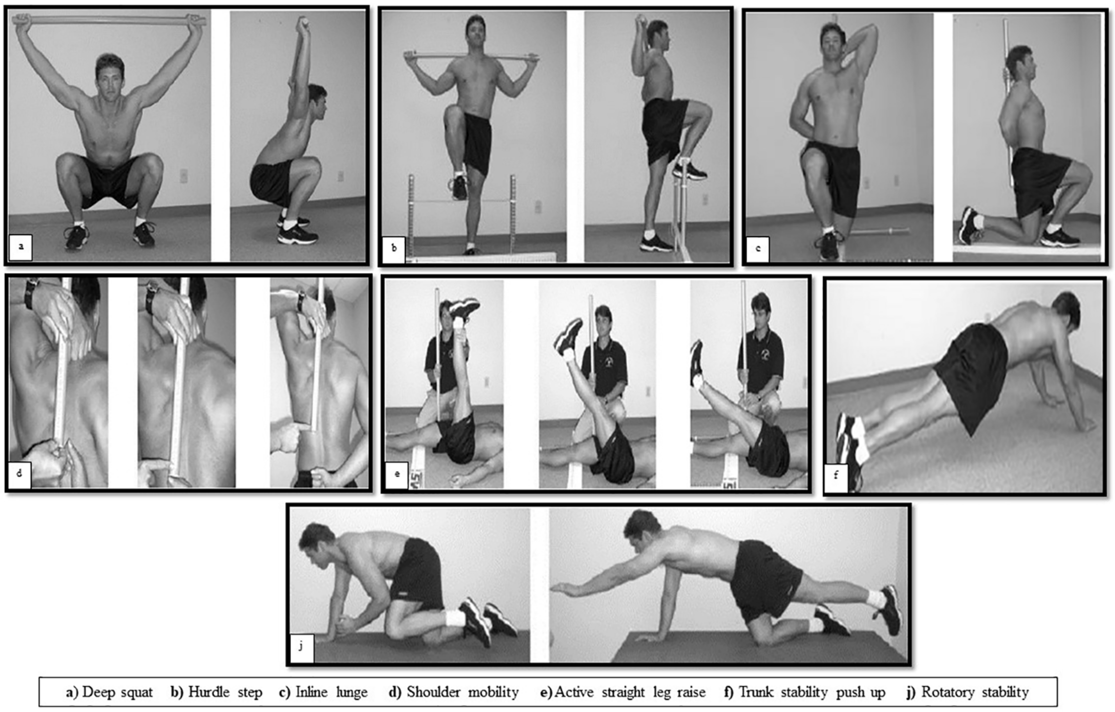

Figure 1: Subtests FMS (Functional Movement Screening) test performed in the study.

In order to determine the best cut-off point in the FMS test, a qualitative and standard test is needed. In this study, the NMQ questionnaire was used as a standard tool to investigate MSSs because this questionnaire divided the participants into two groups including with/without MSSs. The cut-off point was calculated with the most sensitivity and specificity in the FMS test.

The inclusion criteria of the study were job tenure of more than one year as an emergency hospital nurse and rescuer in EMS, and below 60 years of age. On the other hand, participants with a history of surgery, injury, and congenital defects in the musculoskeletal system and defects and diseases of the cardiovascular and respiratory system were excluded from the study.

Participants' personal data remained confidential. Due to the cultural sensitivity of women's clothing, FMS tests were conducted in the presence of the female researcher. No photo or video was taken during the experiment.

Qualitative variables were reported as frequency and percent and quantitative variables were reported as mean, standard deviation, and maximum and minimum. Pearson's correlation, Chi-square, simple and multiple linear regression models, and simple logistic regression models were also used. Moreover, we used simple logistic regression for finding the association between the score of seven of FMS subtest (0-3) and having/not having MSSs at the time of data collection. After all, the data were analyzed using the SPSS software, version 18 at the significance level of 0.05.

Results

This study was conducted on 134 emergency hospital nurses (n=99, 73.9%) and EMS staff (n=35, 26.1%). The participants' mean age and work experiences were 35.3±8.7 and 11.4±7.7 years, respectively. Other demographic characteristics are presented in Table 1.

Also, the prevalence of MSSs among the participants are presented in Table 2.

According to the ROC curve, test score of 17 was determined as the cut-off point with the highest sensitivity (0.71) and specificity (0.71). This finding resulted in a positive likelihood ratio (sensitivity/1-specificity) of 2.46 and a negative likelihood ratio (1-sensitivity/specificity) of 0.40 (Figure 2).

Based on the results, 68 participants (50.7%) obtained FMS test scores of 17 and less. Among these participants, 40 were female and 28 were male. However, 66 participants (49.3%) obtained FMS test scores above 17.

The results of univariate Pearson's correlation test revealed that height and work experiences from quantitative demographic variables were significantly associated with the total score of the FMS test (Table 3).

Chi-square test showed that shiftwork schedule had no significant relationship with FMS test score (P=0.738). The mean score of the FMS test was 15.9±3.13 in females and 17.6±2.82 in males, and the results of the Chi-square test showed that the difference was statistically significant (P=0.019). The mean score of the FMS test was 16.28±3.21 in hospital nurses and 18.22±3.4 in EMS staff.

Table 1: Characteristics of the participants (n=134)

Quantitative variable	Mean±SD†	Min-Max
Weight (Kg)	68.74±13.53	47-100
Height (Cm)	169.42±8.27	152-90
BMI‡ (Kg/m^2)	23.83±3.68	15.2-31.4
Weekly working hours (hr)	51.07±13.42	35-96
Work experience (Year)	11.14±7.79	1-29
Qualitative variable	Frequency	Percent
Gender		
Male	68	50.7
Female	66	49.3
Occupation		
Nurse	99	73.9
EMS‡ staff	35	26.1
Shift work schedule		
24 Hours	26	19.4
12 Hours	26	19.4
8 Hours	81	60.4

†SD: Standard deviation; ‡BMI: Body Mass Index; ‡EMS: Emergency Medical Services

Table 2: The prevalence of MSSs* in the participants' different body regions in the last 12 months, last week, and at the time of completing the questionnaire (n=134)

Body regions	Period prevalence % (n)		Point prevalence % (n)
	Last year	Last week	While completing the questionnaire
Neck	29.1 (39)	21.6 (29)	20.1 (27)
Shoulders/Arm	23.9 (32)	20.1 (27)	20.1 (27)
Upper back	20.9 (28)	19.4 (26)	14.2 (19)
Lower Back	28.4 (38)	29.9 (40)	23.1 (31)
Elbows	9 (12)	9.7 (13)	7.5 (10)
Wrists and Hands	14.9 (20)	12.7 (17)	10.4 (14)
Thighs/Hip	25.4 (34)	14.2 (19)	13.4 (18)
Knees	38.8 (52)	36.6 (49)	32.8 (44)
Ankles/feet	18.7 (25)	22.4 (30)	19.4 (26)

*MSSs: Musculoskeletal Symptoms

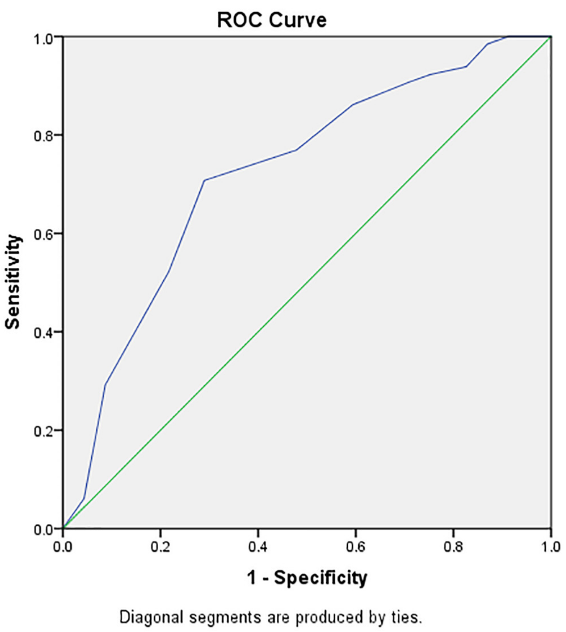

Figure 2: ROC* curve for the best cut-off point of FMS‡ test scores to detect the MSSs†. *ROC: Receiver operating characteristic; ‡FMS: Functional Movement Screening; †MSSs: Musculoskeletal Symptoms

The results of the Chi-square test also illustrated a non-significant difference between hospital nurses and EMS staff regarding the FMS test score (P=0.152) (Table 4).

The results of simple logistic regression test revealed that the FMS test score was significantly associated with MSSs (B=-0.21, P=0.023). Simple logistic regression test was also used to compare the obtained scores (0 to 3) in each of the seven subscales to the prevalence of MSSs in different body regions. Accordingly, a significant positive correlation was observed between the prevalence of MSSs in the Shoulders/Arms, Upper Back, Wrist/Hand, Elbows, Thighs/Hip, Knees, and Ankles /Feet with the total score of the FMS test (Table 5).

In order to assess the simultaneous consequence of the factors affecting the FMS test score, we entered the variables with P<0.25 in the univariate test into the linear regression model.[25] These variables included age, height, work experiences, working hours per day, sex, and occupation. The remaining factors in the model included sex, age, and having at least one MSS. An increase in age and the prevalence of MSSs

Table 3: The correlation between quantitative demographic variables and the total score of the FMS test; Pearson's correlation test

Variable	r†	P value
Age (Year)	-0.162	0.062
Height (Cm)	0.231	0.008*
Weight (Kg)	0.071	0.410
Weekly working hours	0.173	0.051
Work experiences	-0.22	0.010*

*Significant at 0.05 level; †r: Correlation Coefficient

Table 4: The relationship between FMS (Functional Movement Screening) test scores above and below 17 and qualitative variables; Chi-square test

Variable	Sub-variable	Scores 17 and below	Scores above 17	P value*
		Frequency (percent)	Frequency (percent)	
Gender	Female (n=66)	40 (60.6)	26 (39.4)	0.019*
	Male (n=68)	28 (41.2)	40 (58.8)	
Occupation	Nurse, practical nurse (n=99)	55 (55.6)	44 (44.4)	0.152
	EMS† staff (n=35)	13 (37.1)	22 (62.9)	
Shift work schedule	Hours 24 (n=26)	12 (17.76)	14 (21.2)	0.738
	Hours 12 (n=26)	12 (17.76)	14 (21.2)	
	Hours 8 (n=81)	43 (63.2)	38 (57.6)	

*Significant at 0.05 level; †Emergency Medical Services

Table 5: The relationship between MSSs (Musculoskeletal Symptoms) in different body regions and the seven FMS (Functional Movement Screening) subtests (n=134); simple logistic regression model

Body region	Correlation significantly	7 Sub-test of FMS test							
		Deep squat	Hurdle step	Inline lunge	Shoulder mobility	Active straight leg raise	Trunk stability push up	Rotatory stability	Total score
Neck	B†	0.47	-0.055	0.148	0.124	-0.122	0.24	-0.108	0.084
	P value	0.94	0.86	0.547	0.6	0.709	0.173	0.69	0.210
Shoulders/arms	B†	0.485	0.785	0.479	0. 44	0.58	0.47	0.612	0.289
	P value	0.085	0.006*	0.034*	0.046*	0.039*	0.007*	0.015*	0.001*
Upper Back	B†	0.87	0.96	0.42	0.05	-0.17	0.53	0.17	0.218
	P value	0.005*	0.001*	0.082	0.85	0.66	0.008*	0.553	0.004*
Lower Back	B†	0.19	0.11	-0.06	0.07	-0.003	0.12	0.49	0.074
	P value	0.493	0.697	0.810	0.743	0.991	0.485	0.039	0.246
Elbows	B†	0.59	0.85	0.528	0.58	-0.55	0.35	0.56	0.237
	P value	0.123	0.011*	0.068	0.041*	0.38	0.171	0.110	0.013*
Wrists and hands	B†	0.64	0.36	0.162	0.27	-0.36	0.37	0.42	0.156
	P value	0.056	0.284	0.600	0.348	0.465	0.099	0.183	0.060
Thighs/Hip	B†	0.60	0.83	0.63	-0.08	0.67	0.178	0.247	0.205
	P value	0.056	0.005*	0.008*	0.781	0.029*	0.390	0.396	0.007*
Knees	B†	1.88	0.90	0.89	0.076	0.83	0.46	0.50	0.341
	P value	0.001*	0.003*	0.001*	0.72	0.004*	0.004*	0.026*	0.001*
Ankles/feet	B†	0.73	0.82	0.50	0.270	0.39	-0.03	0.42	0.183
	P value	0.012*	0.004*	0.027*	0.244	0.172	0.85	0.092	0.007*

*Significant at 0.05 level, Association between the score of the seven of FMS subtest (0-3) and having / not having MSSs (Musculoskeletal Symptoms). †B: Beta Value

Table 6: The factors associated with the score of the FMS (Functional Movement Screening) test; multiple linear regression model

Variables	B†	SE‡	P value
Constant	17.70	1.15	0.001*
Age	-.086	.031	0.005*
Sex	2.216	.508	0.001*
Having at least one MSSs	-1.530	.626	0.016*

*Significant at 0.05 level R=0.428, R square: 0.183, Adjusted R square: 0.164, †B: Beta Value; ‡SE: Standard error

resulted in a decrease in the FMS test score (Beta=-0.086 and -1.530, respectively), and male gender had a protective effect (Beta=2.216) (Table 6).

Discussion

In the present study, the personnel suffered from MSSs in various body regions, and the highest point prevalence (the prevalence of MSSs while the participant completing the questionnaire) frequencies belonged to the knees, lower back, neck, shoulders/arms (Table 2). Along the same line, a study was conducted on emergency nurses in Qom hospitals and reported the highest prevalence of MSSs in the back, neck, thighs, and shoulders.[26] In another study of musculoskeletal disorders among nurses in Saudi Arabia, it was shown that back pain, shoulder pain, and upper back pain were more common.[27]

The current study findings showed a significant relationship between the FMS test score and the participants' age and sex. Increase in age leads to a decrease in physical capability and movement functions for doing things, thereby increasing the prevalence of MSSs and reducing the FMS score.[28] Accordingly, with an increase in the participants' age, a lower score was obtained from the FMS test. Indeed, this decrease was more pronounced in the female group in comparison with the males. This can be justified by the fact that the increase in age is accompanied with slowed movements, bone mass loss, decrease in tendon and muscle stimulation, accumulation of traumas, and occurrence of abnormalities, which ultimately make people less flexible in movements.[29] Additionally, obtaining lower scores by the female group might be due to the weaker physiological and anatomical status, repetitive tasks, and increased level of job stress.[30] Also, another study showed the index of the work ability in relation to age and sex.[31]

The results of the present study revealed a significant difference between nurses and EMS staff regarding the FMS test score. This could be due to the fact that most personnel in the emergency department were female, while males comprised the majority of the medical emergency technicians. Thus, the relationship between the FMS test scores and the prevalence of MSSs was not unexpected considering the gender distribution in the two groups.

The present study findings indicated a relationship between the prevalence of MSSs in different body regions and the FMS test scores (Table 5). Thus, it can be argued that the FMS test provides accurate information on the stability and mobility of organs, which ultimately results in the formation of precise movements in individuals.[32] FMS test includes some steps to assess the rate of power, flexibility, durability, strength, mobility, and freedom of joints used for transporting patients, which is directly associated with the prevalence of MSSs.[33]

Although other studies have reported different cut-off points for the FMS test, the current study findings revealed a cut-off point of 17 for determining the degree of risk with the highest sensitivity and specificity (0.71). Similar results were also obtained in another study.[34] Given the FMS test for assessing the quality of motion patterns and identifying defects and asymmetry as well as a predictor of MSSs, the score 17 was considered as the cut-off point. The results of the present study indicated that the participants with FMS scores less than 17 had a significantly high prevalence of MSSs (P=0.0001). In a study conducted on football players to investigate the relationship between the FMS test score and the possible occurrence of severe injuries, the results indicated that the participants who scored less than 14 were more likely to suffer from injuries.[19] Also, it was shown in another study that obtaining lower scores in the FMS test was related to damage and disturbance of rugby players.[35]

This was the first study conducted on healthcare personnel in Iran that could serve as the basis for other groups and businesses requiring high physical activities and temporal stress. Yet, future studies are suggested to consider more comprehensive information, including individuals' anthropometric characteristics in different ages, genders, and occupational groups.

Limitations

This study had some limitations. The collected data on MSSs were mainly self-reported and not medical diagnosis. Selection bias may exist due to enrolling voluntary participants in this study. Also, recall bias in having MSSs in the past year is another limitation of the study.

Future Studies

Although the FMS test score had a significant relationship with the prevalence of MSSs, the participants' neck, lower back, and upper arm had no significant relationship with FMS subtests and were not screened by these subtests. Therefore, it seems that specialized tests for screening for MSSs in these regions need to be developed. Hence, screening tests are recommended to be developed based on occupational requirements and the ability to identify MSSs in all body regions.

Conclusion

The study results indicated that the prevalence of MSSs was significantly associated with the FMS test score. Therefore, the FMS test can be done concurrently with pre-employment and periodic medical tests as an appropriate screening method to determine the individuals' level of performance and prevent injuries and abnormalities during work. Further occupational studies related to physical screening tests require the attention of researchers.

Acknowledgment

The authors would like to thank all EMS staff and nurses who participated in the study as well as the management of Shahid Chamran Hospital, Shiraz, Iran. Thanks also go to Ms. Keivanshekouh at the Research Improvement Center of Shiraz University of Medical Sciences for improving the use of English in the manuscript.

The research proposal for this study was approved by Bam University of Medical Sciences with the code of IR.MUBAM.REC.1399.022 from the ethics committee of Bam University of Medical Sciences. Data were collected after receiving official approval from Shiraz University of Medical Sciences.

Conflict of Interest: None declared

References

1 Derakhshanrad S, Alamdarifar S, ZEYNALZADEH GB. Examining the Prevalence of Musculoskeletal Impairments and Its Association with Upper Extremity Functional Disability of Nurses. JPSR 2017; 6 (2):7-14. doi: 10.22038/JPSR.2017.13909.1291.

2 Heydari P, Varmazyar S, Hakimi C. Investigation of Individual and Occupational Risk Factors on the Prevalence and Consequence of Musculoskeletal Disorders among the Rescue Department Employees in Qazvin in Year 2016. j.health. 2019; 10 (1):73-82.

3 Saraji G, Ebrahimy L, Fouladi B. A survey on ergonomic stress factors of musculoskeletal system in Iranian carpet restoration workers. Tehran Univ Med J. 2008; 65 (13):25-32.

4 Abedini R, Choobineh A, Hasanzadeh J. Patient manual handling risk assessment among hospital nurses. Work. 2015;50 (4):669-75. doi: 10.3233/WOR-141826.

5 Zamanian Z, Norouzi F, Esfandiari Z, Rahgosai M, Hasan F, Kohnavard B. Assessment of the prevalence of musculoskeletal disorders in nurses. Armaghanj. 2017; 21 (10):976-86.

6 Mokhtarinia H, Shafiee A, Pashmdarfard M. Translation and localization of the Extended Nordic Musculoskeletal Questionnaire and the evaluation of the face validity and test-retest reliability of its Persian version. Iran J Ergon. 2015; 3 (3):21-9.

7 Khan MR, Singh NK. Prevalence of musculoskeletal disorders among Indian railway sahayaks. Int J of Occup Environ Health. 2018; 24 (1-2):27-37. doi: 10.1080/10773525.2018.1507187.

8 Nur NM, Dawal S, Dahari M, editors. The prevalence of work related musculoskeletal disorders among workers performing industrial repetitive tasks in the automotive manufacturing companies. Proceedings of the 2014 International conference on industrial engineering and operations management, Bali, Indonesia; 2014.

9 Wang M-H, Chen Y-L, Chiou W-K. Using the OVAKO working posture analysis system in cleaning occupations. Work. 2019; 63 (4): 613-621. doi: 10.3233/WOR-193022. PMID: 31658093.

10 Anghel M, Argeanu V, Talpo C, Lungeanu D. Músculoskeletal disorders (MSDS) consequences of prolonged static postures. J Exper Med Surg Res. 2007; 4:167-72.

11 Ziaei M, Choobineh A, Abdoli-Eramaki M, Ghaem H. Individual, physical, and organizational risk factors for musculoskeletal disorders among municipality solid waste collectors in Shiraz, Iran. Industrial health. 2018; 56 (4):308-319. doi: 10.2486/indhealth.2018-0011.b PMID: 29503392. PMCID: PMC6066438.

12 Motamedzade M, Saedpanah K, Salimi K, Eskandari T. Risk assessment of musculoskeletal disorders by Muscle Fatigue Assessment method and implementation of an ergonomic intervention in Assembly industry. johe. 2016;3 (1):33-40.

13 Havenetidis K, Paxinos T. Risk factors for musculoskeletal injuries among Greek Army officer cadets undergoing Basic Combat Training. Military medicine. 2011; 176 (10):1111-6. doi: 10.7205/milmed-d-10-00448. PMID: 22128644.

14 Habibi E, Farrokhi E, Mansourian M. The Effectiveness of DINO Method in Estimating Musculoskeletal Disorders Risk Related to Patient Transfer. Iran J Ergon. 2016;4 (1):56-63.

15 Bradley H, Esformes JD. Breathing pattern disorders and functional movement. Int J Sports Phys Ther. 2014;9 (1):28-39. PMID: 24567853. PMCID: PMC3924606.

16 Elahi T, Ashtiani A, Bigdeli E. The relationship between physical fitness and mental health of the employees of a medical sciences university. J Mil Med 2012; 14 (3):197-205.

17 Cook G, Burton L, Hoogenboom B. Pre-participation screening: the use of fundamental movements as an assessment of function-part 1. N Am J sports phys ther: 2006;1 (2):62-72.

18 Sorenson EA. Functional movement screen as a predictor of injury in high school basketball athletes: University of Oregon; 2009.

19 Kiesel K, Plisky PJ, Voight ML. Can serious injury in professional football be predicted by a preseason functional movement screen? N Am J sports phys ther. 2007; 2 (3):147- 58. PMID: 21522210. PMCID: PMC2953296.

20 Shin E, Kim Y. A Study on Functional Movement Screen and Automobile Worker. Journal of the Ergonomics Society of Korea. 2016; 35 (3):125-33. doi: 10.5143/JESK.2016.35.3.125.

21 Zarei M, Asady Samani Z, Reisi J. Can functional movement screening predict injuries in Iranian soldiers. J Mil Med. 2015; 17 (2):107-14.

22 Hosseini M, Varmazyar S, Safari A. A study of the physical status of emergency wards' personnel in hospitals affiliated to Qazvin University of Medical Sciences through REBA (Rapid Entire Body Assessment) method and its relation with muscular and skeletal disorders in Qazvin, Iran. Qom Univ Med Sci J. 2010; 3 (4):32-39.

23 Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987; 18 (3):233-7. doi: 10.1016/0003-6870 (87)90010-x. PMID: 15676628.

24 Chorba RS, Chorba DJ, Bouillon LE, Overmyer CA, Landis JA. Use of a functional movement screening tool to determine injury risk in female collegiate athletes. N Am J Sports Phys Ther. 2010; 5 (2):47- 54. PMID: 21589661. PMCID: PMC2953387.

25 Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research: principles and quantitative methods: John Wiley & Sons; 1982.

26 Farahabadi M, Aliakbarzade arani Z, Chavoshizadeh SA, Barati A. Investigation of factors affecting musculoskeletal disorders among hospital emergency nurses of Qom University of Medical Sciences, Iran. Qom Univ Med Sci J 2016; 10 (8):54-61.

27 Abu Tariah H, Nafaic S, Alajmia M, Almutairi F, Alanazi B. Work-related musculoskeletal disorders in nurses working in the Kingdom of Saudi Arabia. Work. 2020; 65 (2): 421-428. doi: 10.3233/WOR-203094. PMID: 32007985.

28 Kjellberg K, Lagerström M, Hagberg M. Work technique of nurses in patient transfer tasks and associations with personal factors. Scand J Work Environ Health. 2003; 29 (6):468-77. doi: 10.5271/sjweh.755. PMID: 14712855.

29 Halvani G, Fallah H, Hokmabadi R, Smaeili S, Dabiri R, Sanei B, et al. Ergonomic assessment of work related musculoskeletal disorders risk in furnace brickyard workers in Yazd. Journal of North Khorasan University of Medical Sciences. 2014; 6 (3):543-50.

30 Gorgi Z, Assadollahi Z, Ghaffarian A, Rezaeian M. The Prevalence of musculoskeletal disorders in the employees of office systems at Rafsanjan University of Medical Sciences in 2012. JRUMS. 2014; 12 (12):991-1002.

31 Mokarami H, Kalteh HO, Varmazyar S, Poursdaeghiyan M, Marioryad H. The effect of work-related and socio-demographic factors on Work Ability Index (WAI) among Iranian workers. Work 2019;65 (1): 137-143. doi: 10.3233/WOR-193066. PMID: 31868720.

32 Shojaedin Ss, Hadadnezhad M. Relationship between Functional Movement Screen (FMS) Score and the History of Injury and Identify the Predictive Value of the FMS. JRRS 2013; 9 (3):459-69. doi: 10.22122/JRRS.V9I3.967.

33 Waters TR. When is it safe to manually lift a patient? AJN 2007; 107 (8):53-8. doi: 10.1097/01.NAJ.0000282296.18688.b1. PMID: 17667392.

34 Letafatkar A, Hadadnezhad M, Shojaedin S, Mohamadi E. Relationship between functional movement screening score and history of injury. Int J sports phys ther. 2014;9 (1):21-7.

35 Tee JC, Klingbiel JF, Collins R, Lambert MI, Coopoo Y. Preseason Functional Movement Screen component tests predict severe contact injuries in professional rugby union players. J Strength Cond Res. 2016; 30 (11):3194-203. doi: 10.1519/JSC.0000000000001422. PMID: 26982969.