Phys Med Rehab & Electrodiagnosis 2019; 1(3): 97-104
DOI: https://doi.org/10.22122/pmre.v1i3.42 **Published by** *Vesnu Publications*

Original Article

Prevalence of Musculoskeletal Disorders and Postural Assessment during Endoscopy and Colonoscopy among Gastroenterologists in Isfahan City, Iran

Received: 17 Apr. 2019
Accepted: 10 July 2019
Published: 05 Sep. 2019

Babak Vahdatpour[1], Mostafa Sayed-Mirramazani[2]

[1] Associate Professor, Department of Physical Medicine and Rehabilitation, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran
[2] General Practitioner, Isfahan University of Medical Sciences, Isfahan, Iran

Keywords
Posture; Gastroenterologist; Musculoskeletal disorders

Abstract

Background: Gastroenterologists may be susceptible to various musculoskeletal disorders (MSDs) in the absence of correct posture because of working in various positions in offices and hospitals. The aim of this study was to assess the relationship between posture and MSDs among gastroenterologists in Isfahan city, Iran.

Methods: Three methods of posture evaluation are self-report, observational method, and direct measurement. Based on previous studies, the validity and reliability of the observational method is higher than others. In this study, gastroenterologists' postures during endoscopy and colonoscopy were analyzed using the two observational methods of Rapid Upper Limb Assessment (RULA) and Ovako Working Posture Assessment System (OWAS). They also completed the Nordic Musculoskeletal Questionnaire (NMQ).

Results: Based on OWAS, the posture risk was 1 in 22.2% and 2 in 77.8% of gastroenterologists, while based on RULA, this risk was 4 in 38.9%, 5 in 38.9%, and 6 in 22.2% of the subjects. The incidence of MSDs had a direct relationship with the level of risk based on RULA, but had no significant association with the level of risk based on OWAS. The level of risk based on RULA had a direct relationship with the number of procedures per day. In addition, the prevalence of MSDs had a direct relationship with the number of procedures per day and body mass index (BMI). The level of risk based on RULA had a direct relationship with incidence of MSDs in the neck, upper back, and knees.

Conclusion: musculoskeletal disorders are highly prevalent among gastroenterologists in Isfahan. Postural analysis results showed that the risk of incidence of these disorders is very high. High BMI was one of the factors contributing to the occurrence of MSDs. Since about half of the target group subjects were overweight, losing weight can help to reduce the incidence of MSDs. In addition, the high number of procedures per day increases the risk of posture and musculoskeletal problems simultaneously. Thus, reducing the number of procedures or increasing the rest time between appointments, performing endoscopy and colonoscopy as uncontinuous procedures, increasing precision and accuracy of positioning, and using tele-robotic techniques instead of manual ones could be effective in gastroenterologists who have a high workload.

How to cite this article: Vahdatpour B, Sayed-Mirramazani M. **Prevalence of Musculoskeletal Disorders and Postural Assessment during Endoscopy and Colonoscopy among Gastroenterologists in Isfahan City, Iran.** Phys Med Rehab & Electrodiagnosis 2019; 1(3): 97-104.

Notice: The Persian version of this article has been published before in Journal of Isfahan Medical School.

Corresponding Author: Mostafa Sayed-Mirramazani
Email: msmirramazani@gmail.com
Email: farapuboffice@gmail.com

Introduction

Work-related musculoskeletal disorders (WMSDs) are a group of prevalent health problems and the cause of many disabilities. Several factors such as work, demographic and psychosocial factors are associated with the prevalence of these disorders. Work factors include specific working position, the force exerted by the worker, movement frequency, duration of work, and exposure to vibration. Demographic factors include age, gender, muscle strength, and physical ability. Some examples of psychosocial factors are stress, lack of social support, and low satisfaction. Various studies have been performed with the aim to evaluate exposure to these risk factors and ergonomic changes in order to reduce their incidence. Most of these studies have focused on the back, shoulders, upper limbs, and neck because of the higher incidence of WMSDs in these parts.[1-5]

Three methods of evaluating posture are self-report, observational method, and direct measurement.[6]

Self-report is used to gather information on environmental, physical, and psychosocial factors through the use of daily notes, interviews, and questionnaires.

Observation is divided into two main groups. One group consists of the ways in which the observer is present in the workplace, assesses workers on the basis of pre-designed forms, and fills the forms. The other group uses photography, video, and analyzing software.

In direct measurement, sensors are connected to certain parts of the body and variables are measured. Electromyography (EMG) can also be used in this method.

Previous studies have emphasized that from among the above methods, the observational method is the best and most effective way to assess the health of workers at work in terms of the cost, capacity, more comprehensive outlook, accuracy, validity, and sensitivity.[7] Unfortunately, most studies in this field are based on self-report and questionnaires that are filled by workers; thus, further studies using observational methods are required.

In addition to visiting and examining patients, gastroenterologists perform endoscopy and colonoscopy as required. The physicians are likely to maintain an awkward posture due to the length and specific position of these interventions, and this may be one of the causes of MSDs in these individuals. Since these people are the professional workforce of society, their disorders can impose a heavy load on the government. Therefore, investigating and preventing the causes can be effective and helpful.

The present study was conducted with the aim to determine the frequency distribution of risk of posture during endoscopy and colonoscopy and the frequency distribution of MSDs in the target group and the relationship between these two. Moreover, the validity and reliability of Rapid Upper Limb Assessment (RULA) and Ovako Working Posture Assessment System (OWAS) were compared in evaluating posture in the target group during endoscopy and colonoscopy.

Methods

This cross-sectional study was performed on 18 of the 24 gastroenterologists of Isfahan, Iran, from April to December 2014. The exclusion criteria consisted of the presence of disability, injury, and anatomical problems. The physicians who did not want to cooperate were also excluded (n = 6).

Considering the number of gastroenterologists of Isfahan (n = 24), all of them were considered as the target group and no specific sampling was done. Therefore, the list of gastroenterologists of Isfahan was prepared through the Medical Council and the researchers visited their workplace (office or hospital).

The Nordic Musculoskeletal Questionnaire (NMQ) was used to investigate MSDs in different areas of the body during the last 12 months.[8] The reliability of the NMQ has been validated.[9-13] It should be noted that MSDs in this study

consisted of discomfort, pain, fatigue, swelling, stiffness, sensory problems, limited range of motion, and decreased motor control in various parts of the body. Questionnaires were completed by physicians at their workplace.

The postures of physicians during work were analyzed by direct observation using RULA after determining specific locations and measuring the angles in different parts of body.[14] The OWAS was also used to compare the validity of these instruments in predicting MSDs in gastroenterologists.[15,16]

Action level is determined based on the final score. Action levels are classified into the following four levels:

Level 1: Final score 1 or 2 shows that it is acceptable if you do not maintain a fixed posture for too long or perform a highly repetitive task.

Level 2: Final score 3 or 4 shows that further evaluation is needed in this area and ergonomic intervention may be necessary.

Level 3: Final score 5 or 6 shows that further evaluation, changes, and ergonomic intervention are necessary in the near future.

Level 4: Final score 7 or more shows that further evaluation, changes, and ergonomic intervention are needed immediately.

Considerations regarding the use of RULA and OWAS in this study include:

- Direct observation was performed during the specified time concerning the physician.
- Observation time was the entire period of an endoscopy or colonoscopy.
- Identifying and understanding the process of endoscopy and colonoscopy was performed before starting the study to obtain the most accurate information.

After data collection, statistical analysis was performed using SPSS software (version 18.0, SPSS Inc., Chicago, IL, USA). The Spearman's rho was used to determine the relationship between posture and MSDs in the target group.

Results

Based on data obtained from the NMQ, 17 subjects (94.4%) were male and 1 (5.6%) was female. The average age and work experience of the subjects were, respectively, 46.9 ± 7.4 years and 14.1 ± 8.9 years. Moreover, the average number of procedures performed per day by them was 5.3 ± 2.3 (Table 1).

Table 1. Frequency distribution of demographic information of the target group

Variable	Minimum	Maximum	Mean	SD
Age (year)	35	67	46.9	7.4
Working experience (year)	2	40	14.1	8.9
Procedures per day	2	10	5.3	2.3

SD: Standard deviation

BMI information obtained through the questionnaire is given in table 2.

Table 2. Frequency distribution of body mass index (BMI) of the target group

BMI (kg/m^2)	Count	Percent
18.5-25 (normal)	10	55.6
25-30 (overweight)	8	44.4
Total	18	100

According to the NMQ, the neck and back, respectively, with 66.7% and 61.1% had the most MSDs. Then, the total score of MSDs was calculated based on the NMQ, with a minimum of 0 and a maximum of 15 from a total of 36 and an average of 6.2 ± 4.4 in the target group. The status of MSDs in other parts of the body in the target group are presented in table 3.

Table 3. Frequency distribution of musculoskeletal disorders in the target group

Musculoskeletal disorders	Count	Percent
Neck	12	66.7
Shoulders	10	55.6
Upper back	11	61.1
Elbows	2	11.1
Wrists/Hands	9	50
Lower back	11	61.1
Hips/Thighs	3	16.7
Knees	9	50
Ankles/Feet	2	11.1

Scores of MSDs in each area of the body were also determined based on the NMQ and the number of people with each score was obtained (Figure 1).

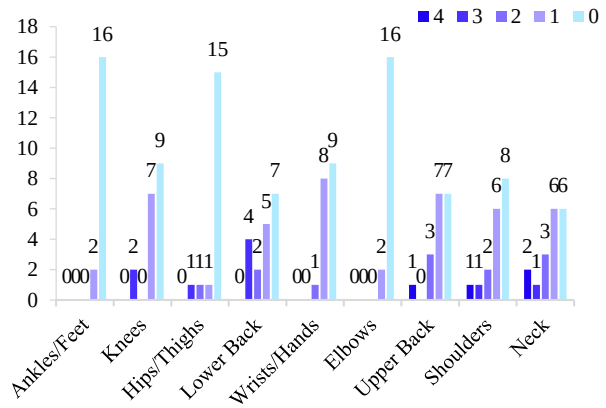

Figure 1. The number of people with each Nordic Musculoskeletal Questionnaire score in different areas of the body

Afterwards, the average score was calculated for each area in the target group (Figure 2). In explaining these two diagrams, we should say that a score of 0 means that the person has had no trouble in the last 12 months in the questioned area. A score of 1 means that the person has had trouble during the last 12 months. Another point is added to 1 if the person has been prevented from carrying out normal activities, has seen a physician for this condition during the last 12 months, or has had trouble during the last 7 days (1 point is added for each positive answer).

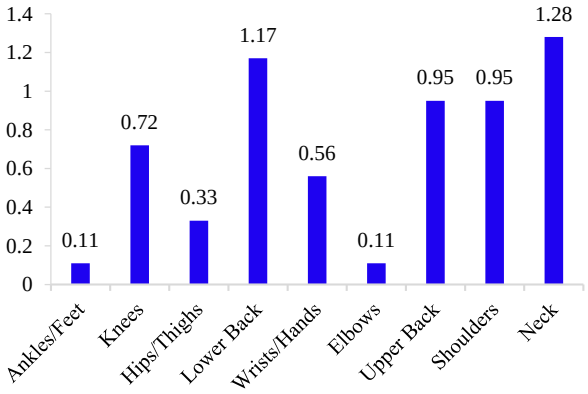

Figure 2. Average score of the Nordic Musculoskeletal Questionnaire in each area of the body in the target group

Therefore, the score of each area of the body can vary from 0 to 4. Higher scores illustrate more severe MSDs.

Moreover, 22.2% and 77.8% of the subjects obtained an OWAS score of 1 and 2, respectively (Table 4).

Table 4. Frequency distribution of the Ovako Working Posture Assessment System (OWAS) score in the target group

OWAS score	Count	Percent
1	4	22.2
2	14	77.8
Total	18	100

The RULA score was also obtained (Table 5) according to which 38.9% were in the second action level and 61.1% in the third action level (Figure 3).

Table 5. Frequency distribution of Rapid Upper Limb Assessment (RULA) score in the target group

RULA score	Count	Percent
4	7	38.9
5	7	38.9
6	4	22.2
Total	18	100

Spearman's rho was used to determine the relationship between NMQ, RULA, and OWAS scores. The NMQ score had a direct relationship with the RULA score ($P = 0.03$ and $r = 0.384$), but had no significant relationship with the OWAS score ($P = 0.40$ and $r = -0.060$).

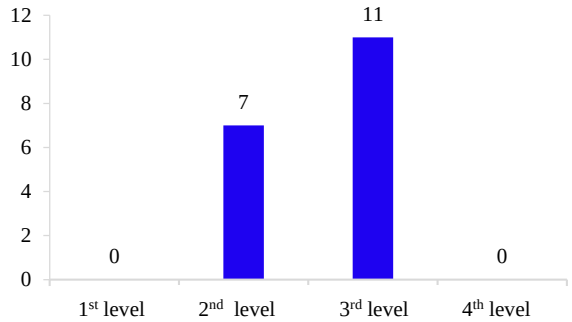

Figure 3. Frequency distribution of action levels in the target group

Furthermore, the RULA score had a direct relationship with number of procedures per day and the MNQ score had a direct relationship with number of procedures per day and BMI (Table 6).

Table 6. Spearman's rho of Rapid Upper Limb Assessment (RULA) and Nordic Musculoskeletal Questionnaire (NMQ) scores with age, body mass index (BMI), work experience, and number of procedures per day in the target group

Variable	RULA		NMQ	
	P	r	P	R
Age (year)	0.45	0.03	0.86	-0.04
BMI (kg/m^2)	0.2	0.21	0.048	0.314
Work experience (year)	0.98	0.006	0.56	-0.15
procedures per day	0.04	0.328	0.027	0.392

Spearman's rho showed that RULA score had a direct relationship with the NMQ score of the neck, upper back, and knees (Table 7).

Table 7. Spearman's rho between Rapid Upper Limb Assessment (RULA) and Nordic Musculoskeletal Questionnaire (NMQ) scores in each area in the target group

RULA	Variable	
	P	R
Neck	0.026	0.396
Shoulders	0.36	0.09
Upper back	0.048	0.31
Elbows	0.41	0.06
Wrists/Hands	0.36	0.09
Lower back	0.08	0.25
Hips/Thighs	0.38	-0.07
Knees	0.01	0.48
Ankles/Feet	0.28	-0.15

Discussion

The incidence of MSDs and risk of postural problems among the gastroenterologists of Isfahan during endoscopy and colonoscopy was investigated in this study.

Among the subjects, 8 (44.4%) were overweight (BMI: 25-30 kg/m^2). Based on a systemic review performed in 2014, the prevalence of overweightness and obesity in Iranian adults was 27-38.5% and 12.6-25.9%, respectively.[17] The BMI of none of the gastroenterologists in our study was higher than 30 and the prevalence of obesity was 0%, and obviously, less than the Iranian society. Nevertheless, the prevalence of overweightness was a little higher than the Iranian society and can be acceptable according to the prevalence of obesity among them. This can be due to their diet and sedentary lifestyle.

Moreover, 88.9% of the gastroenterologists had MSDs in at least one part of their body during the last 12 months. This is more than double the prevalence of MSDs in Iranian physicians regardless of their specialty that was obtained in 2012.[18]

This difference could be due to various postures of different medical activities. In another study, the prevalence of MSDs in among American endoscopists was only 53%, but they used a 25-question email instead of the standardised NMQ.[19] The prevalence of MSDs among Indian dentists, surgeons, and general practitioners was 61%, 37%, and 20%, respectively, which is less than that among the gastroenterologists of Isfahan.[20]

The highest prevalence of MSDs was observed in the neck (66.7%), back (61.1%), and shoulders (55.6%) among the gastroenterologists of Isfahan. This is in agreement with the results of studies on Iranian dentists, pathologists, and cardiologists.[21-24] However, the difference is that MSDs were obviously less prevalent among them, so that only 33.3% of pathologists and 20% of cardiologists had trouble in the neck. Perhaps the reason for this difference is that gastroenterologists have a standing position during endoscopy and colonoscopy, but the others mostly have a sitting position. In echocardiographers, surgeons, and dentists of other countries, most issues were also observed in the neck.[25-27] In a systemic review conducted in 2011 on studies published in 1990-2010, the highest prevalence of MSDs was in the back (33-68%), neck (9-28%), and shoulders (17%) among physicians.[28] Nevertheless, most issues were present in the knees (19.8%) in Iranian hospital physicians.[18] Perhaps this finding is due to excessive walking and using of stairs by physicians of Iranian hospitals.

In the present study, the most severe MSDs were also reported in the neck, back,

and shoulders. Thus, neck pain was the most severe and most prevalent MSD and the most common cause of abandoning normal activities and seeing a physician. The severity of MSDs has not been estimated in similar previous studies.

In the present study, MSDs were significantly more prevalent in gastroenterologists with higher BMI and number of procedures per day. This is in agreement with the result of a study on Brazilian citizens, which confirmed that higher BMI causes more MSDs.[29] In another study, the number of procedures per day, hours of endoscopy per week, and work experience were the main causative factors of MSDs in endoscopists.[19] Prolonged sitting and standing, neck flexion, work experience, and working hours per shift were the main causative factors of MSDs in Iranian physicians.[18] According to a study performed in 2010, the male gender was an augmenting factor of MSDs among the radiologists of Isfahan.[30] In a prospective study on dentists, laboratory technicians, nurses, physicians, and hospital physiotherapists of India in 2013, working in a fixed position for a long duration of time, working in awkward and restricted positions, and handling too many patients or samples per day were the main causative factors.[31] A study performed in 2000 on 3798 citizens showed that fixed posture, repetitive pulling, pushing, and lifting, and frequent bending of the neck are the main biomechanical factors affecting musculoskeletal status of the American society.[32]

MSDs had a direct relationship with RULA score, but no significant relationship with OWAS score in this study. Therefore, OWAS does not have sufficient value for the assessment of gastroenterologists' posture during endoscopy and colonoscopy despite the simplicity and speed of its use. Thus, it can be replaced with RULA that is a newer, more accurate, quick, and easy method. In a study, RULA and OWAS were compared in students of dentistry in 2013.[33] The risk of posture based on OWAS was medium and based on RULA was extremely high in their target group. Although there was no significant relationship between OWAS and RULA in their study, the relationship between MSDs and RULA and OWAS scores was not noted.[33]

Postural assessment by RULA method in our study showed that the gastroenterologists' postures during endoscopy and colonoscopy are in the second (38.9%) and third (61.1%) action level. This means that physicians' working postures require corrections, changes, and ergonomic interventions in the near future.

There was a direct relationship between risk of posture based on RULA and number of procedures per day. This means that, with increase in the number of procedures, physicians pay less attention to their posture. This could be due to their haste to visit patients or exhaustion due to their workload. Although age affected body posture in cardiologists and shoulder posture in pathologists, and gender, working hours, and age affected body posture in radiologists of Isfahan have been reported as risk of posture factors, the instrument used in these studies was the Quick Exposure Check (QEC) and not RULA (23-24 and 30). Hence, we can say that so far, in similar studies, the factors that increase the risk of posture in physicians have been less investigated separately.

Risk of posture based on RULA had a direct relationship with MSDs in the neck, upper back, and knees. This means that RULA has a high value for the prediction of the incidence of MSDs in these body parts among gastroenterologists during endoscopy and colonoscopy.

The findings of this study should be interpreted with caution given the cross-sectional nature of the study and self-report method of data collection in the NMQ. Self-report methods have weak points such as difficulty in remembering complications. However, we tried to reduce the impact of this problem by limiting the period of recollection of complications to 12 months in this study.

The total population of gastroenterologists of Isfahan was 24 individuals and 6 of them were unwilling to cooperate despite all our

efforts. More trusted and comprehensive results can be achieved by investigating more gastroenterologists in different cities in the future.

It is recommended that we compare the reliability and validity of the modified RULA (mRULA), Rapid Entire Body Assessment (REBA), and QEC with RULA in future studies to specify the best available tool for assessing the posture of gastroenterologists during endoscopy and colonoscopy.[34,35]

Conclusion

MSDs are highly prevalent among the gastroenterologists of Isfahan. Postural analysis results showed that the risk of incidence of these disorders is very high (action level 2 and 3). High BMI was one of the factors contributing to the occurrence of MSDs. Since about half of the target group were overweight, losing weight can help reduce the incidence of MSDs. Furthermore, the high number of procedures per day increases the risk of posture and prevalence of MSDs simultaneously. Therefore, reducing the number of procedures or increasing the rest time between appointments, performing endoscopy and colonoscopy as discontinuous procedures, increasing precision and accuracy of positioning (including placing the monitor in the front and with appropriate height and distance to reduce flexion, extension, and rotation of the neck, adjusting the height of the bed to reduce flexion, extension, and rotation of the back, using a brace to reduce the pressure on the neck and back, dividing weight on both legs, etc.), and using tele-robotic techniques instead of manual ones[36] could be effective interventions in gastroenterologists who have high workload.

Acknowledgments

The authors would like to thank Mohammadreza Taheri, health professional expert, for collaborating on this project and all the physicians participating in this study. This article was derived from the doctoral thesis of Mostafa Sayed-Mirramazani and was financed by Isfahan University of Medical Sciences.

The Persian version of this article has been published before in Journal of Isfahan Medical School "Vahdatpour B, Sayed-Mirramazani M. Prevalence of Musculoskeletal Disorders and Postural Assessment during Endoscopy and Colonoscopy among Gastroenterologists in Isfahan City, Iran. J Isfahan Med Sch 2017; 34(413): 1573-81".

Conflict of Interest

Authors have no conflict of interest.

References

1. Jose JA. Outcome measures and prognosis of WRMSD. Work 2012; 41(Suppl 1): 4848-9.
2. Scopel J, Oliveira PA, Wehrmeister FC. RSI/WRMSD in the third decade after restructuring of banking: new associated factors?. Rev Saude Publica 2012; 46(5): 875-85. [In Portuguese].
3. Coutu MF, Baril R, Durand MJ, Cote D, Cadieux G. Health and illness representations of workers with a musculoskeletal disorder-related work disability during work rehabilitation: a qualitative study. J Occup Rehabil 2011; 21(4): 591-600.
4. Gillen M, Cisternas MG, Yen IH, Swig L, Rugulies R, Frank J, et al. Functional recovery following musculoskeletal injury in hospital workers. Occup Med (Lond) 2010; 60(7): 532-9.
5. Morse TF, Dillon C, Warren N, Levenstein C, Warren A. The economic and social consequences of work-related musculoskeletal disorders: the Connecticut Upper-Extremity Surveillance Project (CUSP). Int J Occup Environ Health 1998; 4(4): 209-16.
6. David GC. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. Occup Med (Lond) 2005; 55(3): 190-9.
7. David G, Woods V, Li G, Buckle P. The development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. Appl Ergon 2008; 39(1): 57-69.
8. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987; 18(3): 233-7.
9. Dockrell S, O'Grady E, Bennett K, Mullarkey C, Mc CR, Ruddy R, et al. An investigation of the reliability of Rapid Upper Limb Assessment

(RULA) as a method of assessment of children's computing posture. Appl Ergon 2012; 43(3): 632-6.
10. Dawson AP, Steele EJ, Hodges PW, Stewart S. Development and test-retest reliability of an extended version of the Nordic Musculoskeletal Questionnaire (NMQ-E): a screening instrument for musculoskeletal pain. J Pain 2009; 10(5): 517-26.
11. Choobineh A, Lahmi M, Shahnavaz H, Jazani RK, Hosseini M. Musculoskeletal symptoms as related to ergonomic factors in Iranian hand-woven carpet industry and general guidelines for workstation design. Int J Occup Saf Ergon 2004; 10(2): 157-68.
12. Pinheiro FA, Troccoli BT, Carvalho CV. Validity of the Nordic Musculoskeletal Questionnaire as morbidity measurement tool. Rev Saude Publica 2002; 36(3): 307-12. [In Portuguese].
13. Baron S, Hales T, Hurrell J. Evaluation of symptom surveys for occupational musculoskeletal disorders. Am J Ind Med 1996; 29(6): 609-17.
14. McAtamney L, Nigel CE. RULA: a survey method for the investigation of work-related upper limb disorders. Appl Ergon 1993; 24(2): 91-9.
15. Scott GB, Lambe NR. Working practices in a perchery system, using the OVAKO Working posture Analysing System (OWAS). Appl Ergon 1996; 27(4): 281-4.
16. Karhu O, Harkonen R, Sorvali P, Vepsalainen P. Observing working postures in industry: Examples of OWAS application. Appl Ergon 1981; 12(1): 13-7.
17. Jafari-Adli S, Jouyandeh Z, Qorbani M, Soroush A, Larijani B, Hasani-Ranjbar S. Prevalence of obesity and overweight in adults and children in Iran; a systematic review. J Diabetes Metab Disord 2014; 13(1): 121.
18. Mehrdad R, Dennerlein JT, Morshedizadeh M. Musculoskeletal disorders and ergonomic hazards among Iranian physicians. Arch Iran Med 2012; 15(6): 370-4.
19. Ridtitid W, Cote GA, Leung W, Buschbacher R, Lynch S, Fogel EL, et al. Prevalence and risk factors for musculoskeletal injuries related to endoscopy. Gastrointest Endosc 2015; 81(2): 294-302.
20. Rambabu T, Suneetha K. Prevalence of work related musculoskeletal disorders among physicians, surgeons and dentists: a comparative study. Ann Med Health Sci Res 2014; 4(4): 578-82.
21. Tirgar A, Javanshir K, Talebian A, Amini F, Parhiz A. Musculoskeletal disorders among a group of Iranian general dental practitioners. J Back Musculoskelet Rehabil 2015; 28(4): 755-9.
22. Rafeemanesh E, Jafari Z, Kashani FO, Rahimpour F. A study on job postures and musculoskeletal illnesses in dentists. Int J Occup Med Environ Health 2013; 26(4): 615-20.
23. Rahimi A, Vahdatpour B, Khosrawi S, Mogtaderi A, Sattari S, Dabiri F, et al. Work-related musculoskeletal disorders among pathologists in Isfahan: A cross-sectional study. Research Journal of Biological Sciences 2010; 5(12): 793-7.
24. Khosrawi S, Rahimi A, Vahdatpour B, Dabiri Skouie F, Mashrabi O. Work-related musculoskeletal disorders among cardiologists. Research Journal of Biological Sciences 2011; 6(4): 170-4.
25. Szeto GP, Ho P, Ting AC, Poon JT, Cheng SW, Tsang RC. Work-related musculoskeletal symptoms in surgeons. J Occup Rehabil 2009; 19(2): 175-84.
26. MacDonald K, King D. Work-related musculoskeletal disorders in veterinary echocardiographers: a cross-sectional study on prevalence and risk factors. J Vet Cardiol 2014; 16(1): 27-37.
27. Kumar VK, Kumar SP, Baliga MR. Prevalence of work-related musculoskeletal complaints among dentists in India: a national cross-sectional survey. Indian J Dent Res 2013; 24(4): 428-38.
28. Oude Hengel KM, Visser B, Sluiter JK. The prevalence and incidence of musculoskeletal symptoms among hospital physicians: a systematic review. Int Arch Occup Environ Health 2011; 84(2): 115-9.
29. Caberlon CF, Padoin AV, Mottin CC. Importance of musculoskeletal pain in work activities in obese individuals. Obes Surg 2013; 23(12): 2092-5.
30. Vahdatpour B, Khosravi S, Rahimi A, Sattari S, Mogtaderi A, Dabiri Scoie F, et al. Work-related musculoskeletal disorders among radiologists in Isfahan: A cross-sectional study. Research Journal of Biological Sciences 2010; 5(10): 664-9.
31. Yasobant S, Rajkumar P. Work-related musculoskeletal disorders among health care professionals: A cross-sectional assessment of risk factors in a tertiary hospital, India. Indian J Occup Environ Med 2014; 18(2): 75-81.
32. Warren N, Dillon C, Morse T, Hall C, Warren A. Biomechanical, psychosocial, and organizational risk factors for WRMSD: population-based estimates from the Connecticut upper-extremity surveillance project (CUSP). J Occup Health Psychol 2000; 5(1): 164-81.
33. Petromilli Nordi Sasso GP, Polli GS, Campos JA. Working postures of dental students: ergonomic analysis using the Ovako Working Analysis System and rapid upper limb assessment. Med Lav 2013; 104(6): 440-7.
34. Levanon Y, Lerman Y, Gefen A, Ratzon NZ. Validity of the modified RULA for computer workers and reliability of one observation compared to six. Ergonomics 2014; 57(12): 1856-63.
35. Hignett S, McAtamney L. Rapid entire body assessment (REBA). Appl Ergon 2000; 31(2): 201-5.
36. Lee EC, Rafiq A, Merrell R, Ackerman R, Dennerlein JT. Ergonomics and human factors in endoscopic surgery: a comparison of manual vs telerobotic simulation systems. Surg Endosc 2005; 19(8): 1064-70.