

*Original Article****A study on musculoskeletal disorders and personal and occupational risk factors among surgeons****** Aram Tirgar.¹ Sharnaz Khallaghi.² Mohammad Taghipour.³**

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Background and purpose: Surgery is a high risk profession owing to musculoskeletal disorders (MSDs). Fine and precise operations cause surgeons to adopt prolonged fixed posture. As there is limited information in this region, the purpose of this study was to determine the frequency of MSDs and personal and occupational risk factors among surgeons in Babol (a northern city in Iran).

Materials and methods: This cross-sectional study was conducted on 45 surgeons during 2011 using a questionnaire in three parts including: Demographic and occupational data, Nordic standardized musculoskeletal disorders questionnaire (NMQ), and Body Discomfort Assessment technique. The working posture during operation was assessed by Rapid Entire Body Assessment (REBA). The data were analyzed using descriptive statistical indexes and chi-square test, and a $p < 0.05$ was considered as significant.

Results: According to the data, the mean of work experience was 19.9 ± 6 years, and the mean of work hours was 54.2 ± 14 (ranged 20-80 hours per week). Ninety five percent of surgeons reported experiencing one or more MSDs symptoms during the previous year. Neck pain (66.7%) and low back pain (LBP) (51%) was the more frequent reported complaint. The results showed a significant statistical difference between LBP with weekly regular exercise and work experience.

Conclusion: The results indicate that MSDs are the common problems among the surgeons and they are at risk because of their personal and occupational conditions. So, ergonomics interventions in order to prevent MSDs are recommended.

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1. Introduction

The term work-related musculoskeletal disorders (WMSDs) encompass a broad range of signs and symptoms which may involve a definite clinical diagnosis, such as carpal tunnel syndrome, or defy clinical classification. These disorders affect nerves, tendons, and muscles (1). For instance, WMSDs account for one third of disorders and injuries reported to the U.S. Department of Labor. Moreover, The U.S. Bureau of Labor Statistics indicates that employers spend 15 million dollars every year on these disorders. Taking into account the other costs related to these disorders, such as training new personnel, will raise the figure to 45 billion dollars per year. Nevertheless, it must be noted that there is no accurate estimate of the rate and prevalence of work-related musculoskeletal disorders, as current data is very limited and a considerable proportion of cases are not reported (2). Previous studies indicate that these disorders are the result of accumulation of repeated injuries, especially those related to occupational risk factors (1). Some risk factors which have been demonstrated to be related to these disorders include working postures, repetitive motions and jobs, and psychosocial factors, including heavy workload, long working time, insufficient rest, and poor mental support in workplace (3). In addition, personal characteristics, such as weight and body mass index (BMI), constitute important predictors for these disorders (4).

Musculoskeletal complaints are quite serious and common among healthcare personnel, including nurses and dentists, and numerous studies have been conducted so far on these occupational groups (5,6). Surgeons are other healthcare personnel who face numerous occupational and psychosocial risk factors, and consequently musculoskeletal disorders (7). Although relatively extensive studies have been conducted on WMSDs in many occupational groups (5,6,8), few studies have dealt with the occupational hazards of surgeons, especially musculoskeletal disorders.

Therefore, further research is required to expand our knowledge of risk factors and preventive measures pertaining to these disorders in surgeons, and convince managers and authorities to provide a safer working environment and ergonomically improved tools for surgeons (9). For this purpose, we conducted the current study to investigate the frequency of musculoskeletal disorders and personal and occupational risk factors among surgeons of Babol. In addition, we attempted to raise the attention of surgeons regarding musculoskeletal disorders and the necessity of prevention, provide a picture of the current situation for authorities, including managers of healthcare centers, and advocate the science of ergonomics and use of preventive measures.

2. Materials and Methods

This is a cross-sectional study conducted in spring and summer of 2011. The study population consisted of 52 surgeons employed in teaching hospitals of Babol University of Medical Sciences and other healthcare centers of the city (recruited through survey). Among these, 5 were disinclined to participate in the study, and 2 were excluded due to the fact that they have recently begun their surgical career. We used 3 data sheets to collect the data. The first sheet addressed the personal and occupational information of the surgeon, using specifically designed questions. Here, we dealt with age, height, weight, work experience, average working hours per week, average sleeping time per day, status of a regular exercise program (exercise for more than an hour at least twice a week). We also calculated the body mass index (BMI) for each surgeon using his height and weight (10). Some questions were inspired by the questionnaire used by Szeto et al. to investigate surgeons' work style (11).

The second section inquired about the prevalence of musculoskeletal symptoms in surgeons. For this purpose, we used the questionnaire developed in 1987 by Kornika et al. at the Scandinavian Institute of Professional Health, currently known as the Nordic questionnaire (12). This questionnaire has been used in many occupational groups and with many languages (13,14). Using this questionnaire, we inquired about musculoskeletal symptoms in different body parts during the last 12 months, any pain or discomfort hindering work during this period, as well as any pain or discomfort during the last week.

In the third section, we evaluated pain intensity using the Body Discomfort Assessment (BDA). This questionnaire has been used in many studies (15,16). The intensity of pain is reported by the person himself using a body map and a scale of 1 to 5, in which 1 represents the lowest degree and 5 represents maximal pain or discomfort.

Another parameter that we studied was the surgeon's body position during surgery and the predominant position (one which prevails most of the working time). For this purpose, we attended the operating unit during one or more major operations, and assessed the surgeon's body position through observation of the body and limbs using rapid entire body assessment (REBA) (17).

REBA was developed by McAtamney and Hignett. It provides an ergonomic assessment of the entire body and is used for rapid assessment of an individual's exposure to occupational risk factors (Figure1). The individual's status is classified in 5 levels and 15 points; the score assigned to each body level will determine its risk status and thus prioritize corrective measures. A higher score indicates greater risk. It is noteworthy, however, that lower scores do not necessarily indicate the absence of ergonomic risks in the work environment (17). Once collected, data were analyzed on SPSS software. We used chi-square test to investigate the relationship or differences between variables. $P < 0.05$ was considered as significant.

3. Results

We studied 45 surgeons. Table 1 presents some of their personal characteristics. The group consisted of 37 men and 8 women. None of the surgeons had a lower than normal BMI; 28.8% had normal BMI, 68.8% were overweight, and only one case was obese. The surgeons' mean age and work experience was 49.4 ± 7.1 and 19.9 ± 6 years, respectively, and 51.1% had over 20 years of work experience. 57.8% of the participants stated that they were involved with a regular exercise program at least twice a week.

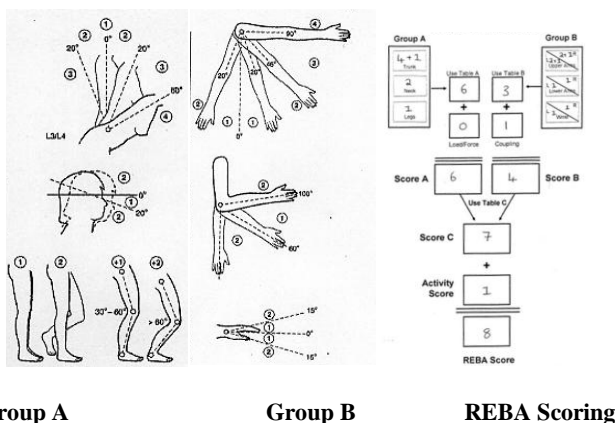


Figure1. Groups A and B and scoring sheet according to REBA

Table 1: General characteristics of participants

Variable	Mean	Standard Deviation	Range
Age (years)	49.4	7.1	32-65
Height (cm)	172.4	6.2	158-185
Weight (Kg)	77.8	9.5	60-98
Body mass index	26.2	2.3	22-31
Work experience	19.9	6	4-32
Mean working hours per week	54.2	14	20-80
Mean sleeping hours per day	6.6	0.9	5-9

Figure 2 compares the distribution of frequency of musculoskeletal symptoms in different body parts for the last 7 days and 12 months. As is observed, the most common complaint pertains to the cervical regions, with 11.1% and 66.7% of surgeons reporting neck discomfort during the last 7 days and 12 months, respectively. None of the surgeons reported any discomfort in the thigh region.

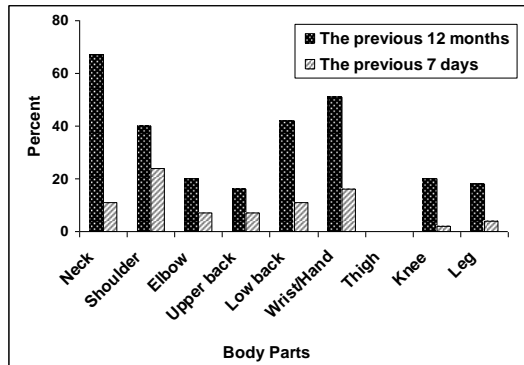


Figure 2. Relative frequency of musculoskeletal disorders in different body parts of surgeons of Babol in the last 7 days and 12 months in 2011

Inquiring about seeking medication, counseling or therapy for musculoskeletal symptoms over the last year revealed that 28.8% of participants sought counsel from a specialist, 35.5% used medication, 33.3% required physiotherapy, and 24.4% required medical imaging. As for limitation in daily activities, 17.8% of surgeons were forced to rest at home and stop operating during the last year due to musculoskeletal problems, and 17.8% of them were using medication for their musculoskeletal problems. Moreover, 33.3% of surgeons had to perform special exercises at home to prevent their musculoskeletal symptoms.

Table 2 presents the frequency of limitations in daily activities due to musculoskeletal problems, as well as the mean intensity of pain in each body part on a scale of 1-5 (1 lowest and 5 highest pain or discomfort) during the last 7 days.

Table 2. Frequency of limitations in daily activities due to musculoskeletal symptoms during the last 12 months alongside mean intensity of pain in each body part

Organ	Frequency of complaints during the last 12 months		Intensity of pain during the last 7 days		
	Number	Percent	Frequency	Mean	Standard deviation
Neck	8	17.8	29	2.1	1
Shoulder	4	8.9	19	2.1	0.6
Elbow	3	6.7	6	2	1.5
Wrist and hand	1	2.2	8	1.6	1.3
Back	5	11.1	19	1.8	0.9
Low back	5	11.1	23	1.8	0.8
Thigh	0	0	0	0	0
Knee	2	4.4	9	1.8	1.3
Foot	3	6.7	8	2	0.8

According to the data from questionnaires, the most common cause limiting activity during the last year as well as the highest pain intensity (on a scale of 1-5) pertained to the neck region, while the thighs had the least complaints. Table 3 presents the distribution of frequency of pain in neck and shoulders, as well as the trunk and back as body parts with the highest rate of complaint in surgeons.

Table 3. Distribution of frequency of pain complaint in neck and upper limbs for personal parameters

Variable	Frequency	Neck pain		Shoulder pain		Back pain		Low back pain		
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Age (years)	<45	16	13	81	7	44	7	44	8	50
	45-55	20	10	50	8	40	8	40	11	55
	55-65	9	7	78	3	33	4	44	4	44
	>65	5								
BMI*	20-24	13	9	69	5	38	5	38	7	54
	25-30	31	21	68	13	41	14	45	15	48
	>30									
Work experience (years)	<10	5	3	60	2	40	4	80	0	0
	10-20	17	9	53	9	53	5	29	8	47
	20-30	23	18	78	7	30	10	43	15	65
	>30									
Regular exercise	Yes	26	17	65	9	35	7	27	10	38
	No	19	13	68	9	47	12	63	13	68

* One surgeon was obese with a BMI value > 30.

As the table depicts, the relative frequency of pain complaint rises for all body parts with increasing age and work experience. Table 4 lists the answers provided by surgeons to questions dealing with work style. One noteworthy issue is that 53% of surgeons often or always continued their work despite fatigue to maintain their quality. According to 45% of surgeons, they were unable to control their working hours, 27% of them often or almost always did not have enough time to rest due to their professional responsibilities, and 27% often or almost always felt intense physical exhaustion at the end of the day.

Table 4. Distribution of frequency of surgeons' reaction to variables related to work style (n=45)

Questions	Never	Rarely	Sometimes	Often	Almost always
I feel tired in my hands and arms during work.	9	9	22	4	1
In order to maintain quality, I continue my work despite tiredness.	5	4	12	5	19
I use medication to eliminate musculoskeletal symptoms and continue work.	23	7	13	2	0
It is impossible for me to control my working hours.	4	14	7	16	4
Appropriate completion of my tasks does not leave me enough time to rest.	5	10	18	11	1
I feel intense physical exhaustion at the end of the day.	7	6	20	8	4
I put a lot of pressure on myself to finish work appropriately.	9	15	14	4	3

The results of chi-square test indicate the considerable impact of reactions related to work style parameters in the development and progression of musculoskeletal disorders. Neck pain ($p=0.01$) and low back pain ($p=0.02$) are significantly more frequent in surgeons who often or almost always continue working despite tiredness. Surgeons who stated that they do not have enough time to rest due to their responsibilities experienced more neck pain ($p=0.03$) and knee pain ($p=0.02$). Surgeons who experienced intense physical exhaustion at the end

of the day reported significantly more neck pain ($p=0.03$) and low back pain ($p=0.01$). Finally, surgeons who said they put a lot of pressure on themselves to complete their works experienced more shoulder and knee (both $p=0.01$) pain.

We used direct observation and posture analysis (REBA) to analyze the surgeons' body positions during work. According to the observations and the surgeons' comments, 89% of them performed surgery mostly in standing and 11% mostly in sitting position. Almost all surgeons who operated standing had to maintain their neck at 30 degrees or more for a long time, whereas surgeons who operated sitting usually had small neck angle (less than 15° deviation from normal).

Long and persistent arm abduction and flexion (more than 4 minutes) was observed in most surgeons during surgery (93%). The abduction angle ranged from 20 to 45 degrees, and the flexion degree was at 20° or more. This was observed in both groups of surgeons who operated in standing or sitting positions. The trunk angle from neutral position ranged from 0 to 20 degrees in most surgeons, and the surgeon would have to maintain this position for a long time during surgery (84%). The wrist was often kept in flexion (78%) with an angle more than 15°. In all surgeons, the posture analysis score according to REBA was 4-7, which indicates a moderate level of risk, necessitating ergonomic interventions (17).

4. Discussion

The findings of the Nordic questionnaire indicated that musculoskeletal symptoms during the last 12 months are common in surgeons, interfering with work in many cases. In addition, the relative frequency of these symptoms was higher in neck, low back and back compared to other body parts, followed by shoulder. Our results indicate neck pain to be the most frequent complaint among musculoskeletal problems in surgeons, afflicting 67% of them. It also constitutes the most frequent work-preventing

pain (18%) as well as having the highest degree of pain intensity compared to other body parts (2.1 ± 1 on a scale of 1-5). Auerbach JD et al. (18), Adam C Esser et al. (19) and Grace PY Szeto et al. (9) reported similar results in surgeons, finding neck pain to be the most common musculoskeletal complaint among surgeons. The close consistency of our findings and those of previous studies indicates neck to be a particularly important body part for surgeons and necessitates corrective interventions as soon as possible. Sixty percent of surgeons complaining of neck pain had work experience of more than 20 years, which might reflect the accumulative effect of work environment stress in this group. It must be noted that although neck pain appeared to be work-related experience, it was not significantly correlated with this factor and personal characteristics such as age, height, weight, BMI, working hours and resting hours. This may be accounted for by the small number of individuals participating in our study. The postural analysis of surgeons during operation revealed that most of them operated with flexed head and neck, which was usually forced by need for better view of the surgical field. A review of previous studies indicates that long term neck flexion more than 15° and long term arm abduction are related with disorders and symptoms in these body parts (20). Therefore, it is particularly important to establish an optimal positioning of the patient's body during operation. Low back pain and back pain had a frequency of 51% and 42%, respectively, among surgeons, thus, standing on the second and third ranks of complaints. In addition, low back pain and back pain constitute the most common work-preventing complaints after neck pain, and are therefore a serious challenge for these individuals. Our findings are in line with those of Afifehzadeh et al (21), Dolan and Martin et al. (22), and Grace PY Szeto et al. (9). In our study, increasing work experience was associated with increased frequency of low back pain, which is statistically significant ($p=0.03$), highlighting the importance of risk factors in work environment. Previous studies have mentioned the relationship between low back pain and work experience (23, 24).

The findings of our study indicate that back pain and low back pain are significantly more common in surgeons without a regular exercise program ($p=0.01$, $p=0.04$). Therefore, in line with findings of previous reports, a regular exercise program may be considered as a protective and relatively inexpensive strategy against musculoskeletal complaints (25, 26). It must be noted that back pain and low back pain were not significantly related to other personal characteristics.

In the present study, the frequency of shoulder pain was 40%, placing it on the fourth rank after neck, low back and back pain. Furthermore, shoulder pain and discomfort had the highest frequency among musculoskeletal complaints during the last week, indicating its persistence and continuous exposure to its risk factors. These results are consistent with those of Afifehzadeh et al. (21) and Grace PY Szeto et al. (9), which reported 51% and 58% of shoulder pain frequency in surgeons. In this study, increasing age was associated with decreasing rate of shoulder pain (Table 3). In other words, it appears that shoulder disorders are more common among younger surgeons, despite the expectation that increasing age and accumulation of work stresses should raise the rate of musculoskeletal complaints in older surgeons. As previous studies suggest, it is possible that younger workers face this challenge due to their less experience, lower professional skills, and less practice (27). Postural analysis of surgeons during surgery revealed that most of them kept their arms at 15-45 degrees of abduction and more than 20 degrees of flexion for long times. Arm abduction also decreases the cervical range of motion and elevates the risk of neck pain; 67% of surgeons who had shoulder pain also mentioned concurrent neck pain. The authors' experience indicates that in many cases, surgeons elevate the operating table in order to gain a better view of their field, which causes further abduction of shoulders and arms.

Studies indicate that exposure to inappropriate biomechanical conditions; work environment factors, occupational needs, and psychosocial factors all interact to affect the development and

progression of work-related musculoskeletal disorders (28, 29). The manner of completing a task is a factor which affects or aggravates musculoskeletal disorders alongside other ergonomic risk factors and psychosocial parameters, and actually reinforces the person's reaction or response to work load (30). As our results indicate (Table 4), we inquired about the surgeons' function and work habits using questions designed by Feuerstein and Nicholas (9). The results indicate that feeling of pain and complaining of pain in different body parts, especially neck and low back, are significantly related to factors such as continuing work despite tiredness, insufficient rest, and intense exhaustion at the end of the day ($p < 0.05$). Therefore, factors such as inappropriate body posture, lack of rest during work, having high expectations as surgeon, or ignoring the early symptoms of musculoskeletal disorders in order to continue work are all factors contributing to development and progression of musculoskeletal disorders in this occupational group (30). In general, the results indicated surgeons are susceptible to development and rapid progression of musculoskeletal disorders due to exposure to different occupational risk factors such as inappropriate posture, sedentary and long activities, insufficient rest, as well as exposure to certain stressful occupational factors such as heavy responsibilities or lack of control of one's time. Therefore, in line with the recommendations accompanying the respective REBA score, it is necessary to consider preventive and ergonomic modifications.

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