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Musculoskeletal Symptoms Among Surgeons at a Tertiary Care Center: a Survey Based Study

Majed N. Alnefaie¹, Abdullah A. Alamri¹, Abdulaziz F. Hariri¹, Mohammed S. Alsaad¹, Abdulbari MA. Alsulami¹, Anas MN. Abbas¹, Adel A. Alfozan¹, Murad M. Aljiffry², Hatim Al-Abbadi²

¹Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

²Department of Surgery, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

Corresponding author: Hatim Al-Abbadi, MD. Department of Surgery, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia. E-mail: hatimalabbadi@yahoo.com. ORCID ID: <http://www.orcid.org: 0000-0002-2147-6513>.

ABSTRACT

Introduction: Musculoskeletal (MSK) manifestations represent a common work-related physical complication that affect surgeons and impacts their life and the healthcare service negatively. **Aim:** The aim of this study was to determine the prevalence of work related MSK manifestations among surgeons in a tertiary care hospital and to identify the possible associated risk factors. **Methods:** A Web-based self-administered cross-sectional survey was conducted. This study targeted all surgeons regardless of their nationalities, ages, genders, and marital statuses. The questionnaire assessed the participants' demographic data as well as musculoskeletal manifestations. **Results:** Most respondents (80%) suffered from MSK manifestations that were related to performing surgeries. Back and neck areas represented the most affected body parts (71.1% and 59.8%, respectively). A significantly higher percentage of those with musculoskeletal manifestations practiced for 5-10 years (28.9%) ($p = 0.006$). **Conclusion:** MSK pain is common among Saudi surgeons in different specialties. More attention should be directed to improving the physical environments in which the surgeons are operating. Moreover, surgeons should be educated about the recommended ergonomic positions that can prevent or decrease their work related MSK manifestations.

Keywords: surgeon, musculoskeletal symptoms, discomfort, pain, survey.

1. INTRODUCTION

One of the common work-related physical complications that face surgeons is musculoskeletal (MSK) manifestations, which can negatively affect their life in particular and the healthcare system in general by accelerating surgeons' retirement. These manifestations will affect different anatomical components including muscles, nerves, and tendons. From a physiological point of view local hypoperfusion and increased intramuscular pressure resulting from excessive stationary contractions may appear as MSK fatigue and pain. Regarding workplace-related morbidities in the United Kingdom, the Health and Safety Executive report (2011) showed a cost of 13.8 billion Euros among ratepayers, with MSK complications being the most frequent. Several studies were conducted on different professions such as bus drivers, cleaners, office workers, and healthcare providers especially surgeons due to the nature of their jobs that require intensive focusing, error-free manoeuvres, and accurate decision makings (1-5).

Although the incidence of MSK complications among general surgeons is high, it is much higher in orthopedic surgeons, predominantly affecting the upper extremity, neck, and back regions, probably to the struggle and duration spent on keeping suitable ergonomic poses (6).

The National Institute for Occupational Safety and Health suggests evading static loads, minimizing stationary working pose, and maintaining frontal neck position less than 15°. Despite these suggestions, poses that have been reported are mainly influenced by surgeons' training and one's own desire not to follow these suggestions (7).

Although MSK discomfort represents a common work-related physical complication that affects surgeons and impacts their life negatively, few studies have been carried out in Saudi Arabia to investigate this phenomenon, mainly among dentists (8-10) Saudi Arabia, using random cluster sampling. 224 surveys were distributed among dentists with a 91.1% response rate (101 women and 103 men; while the studies that ex-

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plored MSK pain among surgical team members focused principally on nurses and technicians, rather than the surgeons (11-14) characteristics, and risk factors of low back pain among Operating room (OR).

2. AIM

The aim of the current study was to determine the prevalence of work-related musculoskeletal symptoms in surgeons working at a tertiary care center in Jeddah, Saudi Arabia, and to identify the possible risk factors.

3. METHODS

This is cross-sectional study. Our target population was all practicing surgeons at King Abdulaziz University Hospital in Jeddah, regardless of their nationalities, ages, genders, or marital status. The sub specialties that were included are general surgery, orthopedic, urology, cardiac, head and neck, neurosurgery, plastic, pediatrics, vascular, ophthalmic, and obstetrics and gynecology. Participants with incomplete data were excluded from the study. The total sample size was 196 participants, with a response rate of 61.73%.

Data collection was done during period from June to July, 2018. A questionnaire formed by 17 questions was mailed to 14 pediatric surgeons, seven with a large experience in laparoscopy and seven in SILS. All surgeons completed the survey. The questionnaires were focused on the type of laparoscopic or SILS activity, location and type of pain, need for drugs and its physical consequences. Results were analyzed using Chi2 test. We used a web-based, self-administered, cross-sectional survey that was developed by authors of the current study. The survey was first tested in paper form on a pilot small sample of surgeons (who were not included later in study sample) to ensure its clarity and validity. Then, the survey was modified in response to the feedback given by the pilot sample. The final survey included two sections; a) demographic data of the participants and b) information regarding musculoskeletal manifestations and the possible subjective postoperative related symptoms. The questionnaires were filled subjectively by the participants via Google Docs that was sent to the participants' emails, with a reminding email sent one week later to increase the response rate.

Statistical analysis

An excel spreadsheet was established for the entry of data. Data analysis was carried out using SPSS version 22. All numerical variables were checked for normality by Shapiro Wilk test. Categorical variables were summarized as frequencies and percentages and association between variables was tested using Pearson's Chi square or Fisher-Freeman-Halton Exact Tests as appropriate. A p-value of < 0.05 was considered statistically significant.

Ethical Approval was obtained from Unit of Biomedical Ethics of King Abdulaziz University prior to the commencement of the study. Confidentiality of the collected data and participant's privacy were assured and the data were used only for research purpose. The act of completing and submitting the survey by any participant implied his consent.

4. RESULTS

Surgeons who responded to the questionnaire were 121. The majority of the respondents (80%) suffered from musculoskeletal manifestations that were related to surgery. Table 1 summarizes the demographic data of the respondents. Most the respondents aged 24-30 years (52.1%), were men (61.2%), did not smoke (75.2%), and had no chronic diseases (83.5%). There was no statistically significant association between the presence of musculoskeletal manifestations and any of the aforementioned demographic data.

The occupational data of the respondents as shown in Table 2. More than half the respondents were residents (57%) who practiced surgery for less than 5 years (52.1%). The highest percentage of the surgeons were in the specialties of general surgery (27.3%) and obstetrics and gynecology (24%); and has not yet completed their fellowship program (67.8%). A significantly higher percentage of those with musculoskeletal manifestations practiced

		Discomfort or physical symptoms as direct consequence of surgical practice						p
		Total (n = 121)		Yes (n = 97)		No (n = 24)		
		n	%	n	%	n	%	
1- Age (Years)	24-30	63	52.1%	47	48.5%	16	66.7%	0.419
	31-35	17	14.0%	16	16.5%	1	4.2%	
	36-40	11	9.1%	10	10.3%	1	4.2%	
	41-50	17	14.0%	14	14.4%	3	12.5%	
	>50	13	10.7%	10	10.3%	3	12.5%	
2- Gender	Male	74	61.2%	56	57.7%	18	75.0%	0.120
	Female	47	38.8%	41	42.3%	6	25.0%	
3- Weight (Kg)	<60	19	15.7%	18	18.6%	1	4.2%	0.326
	60-70	32	26.4%	24	24.7%	8	33.3%	
	71-80	24	19.8%	20	20.6%	4	16.7%	
	81-90	24	19.8%	17	17.5%	7	29.2%	
	>90	22	18.2%	18	18.6%	4	16.7%	
4- Height (Cm)	<160	29	24.0%	24	24.7%	5	20.8%	0.500
	160-170	42	34.7%	36	37.1%	6	25.0%	
	171-180	36	29.8%	27	27.8%	9	37.5%	
5- Practice Exercise	>180	14	11.6%	10	10.3%	4	16.7%	0.133
	Yes	59	48.8%	44	45.4%	15	62.5%	
	No	62	51.2%	53	54.6%	9	37.5%	
5- Exercise per week	1-3	44	36.4%	33	34.0%	11	45.8%	0.068
	4-5	13	10.7%	11	11.3%	2	8.3%	
	7	2	1.7%	0	0.0%	2	8.3%	
6- Sleep per day (hours)	<7	68	56.2%	54	55.7%	14	58.3%	0.689
	7-8	47	38.8%	37	38.1%	10	41.7%	
	>8	6	5.0%	6	6.2%	0	0.0%	
7- Smoke	Yes	30	24.8%	25	25.8%	5	20.8%	0.616
8- Chronic disease	Yes	20	16.5%	14	14.4%	6	25.0%	0.227
	Hypertension	7	5.8%	5	5.2%	2	8.3%	
	Diabetes Mellitus	6	5.0%	5	5.2%	1	4.2%	
	Arthritis	3	2.5%	2	2.1%	1	4.2%	
	Hyperlipidemia	6	5.0%	4	4.1%	2	8.3%	
	Other	2	1.6%	2	2.0%	0	0.0%	

Table 1. Demographic factors of the respondents (n = 121).

		18- Discomfort or physical symptoms as direct consequence of your surgical practice						P
		Total (n = 121)		Yes (n = 97)		No (n = 24)		
		n	%	n	%	n	%	
9- Position	Consultant	52	43.0%	45	46.4%	7	29.2%	0.127
	Resident	69	57.0%	52	53.6%	17	70.8%	
10- Speciality	General Surgery	33	27.3%	27	27.8%	6	25.0%	0.077
	Pediatric Surgery	2	1.7%	0	0.0%	2	8.3%	
	Neurosurgery	2	1.7%	1	1.0%	1	4.2%	
	Ophthalmology	3	2.5%	2	2.1%	1	4.2%	
	Plastic / micro-scospic surgery	3	2.5%	2	2.1%	1	4.2%	
	Orthopedics	14	11.6%	8	8.2%	6	25.0%	
	Obstetrics and Gynecology	29	24.0%	26	26.8%	3	12.5%	
	Urology	4	3.3%	4	4.1%	0	0.0%	
	ENT	5	4.1%	3	3.1%	2	8.3%	
	Other	26	21.5%	24	24.7%	2	8.3%	
11- Complete Fellowship program	Yes	39	32.2%	33	34.0%	6	25.0%	0.397
	No	82	67.8%	64	66.0%	18	75.0%	
15- Years of practicing	<5	63	52.1%	46	47.4%	17	70.8%	0.006*
	5-10	28	23.1%	28	28.9%	0	0.0%	
	11-20	10	8.3%	8	8.2%	2	8.3%	
	>20	20	16.5%	15	15.5%	5	20.8%	

Table 2. Occupational data of the respondents (n = 121).

for 5-10 years (28.9%), compared to those who had no symptoms (p = 0.006).

The characteristics of the procedures performed by the respondents as Table 3 reveals. The highest frequency of respondents with pain performed laparoscopic procedures (55.4%); spent an average duration of 1-3 hours per procedure (70.2%); worked for 8-10 hours per day (66.9%); and used to manually lift parts of the patients (75.3%). In 42.3% of cases, there was a shortage in the staff number in their workplace. None of the above mentioned characteristics was significantly associated with the musculoskeletal manifestations.

Demonstration the characteristics of the musculoskeletal pain suffered by the respondents as shown in Table 4. The most common manifestations were pain (82.5%) and fatigue (66%). Back and neck represented the most affected body parts (71.1% and 59.8%, respectively). In 83.5% of respondents the symptoms were localized; and in 93.8% the symptoms were linked to surgical activity. The symptoms affected the surgeons the most after work (63.9%). A significantly higher frequency of surgeons who performed laparoscopic procedures felt fatigue (78.2% versus 50%, p = 0.004) and linked their complaints to surgery (100% versus 85.7%, p = 0.005). Pain and shoulder symptoms were higher in laparoscopic surgeons, though the results were not statistically significant. Comparison between the surgeons who performed laparoscopic procedures and those who didn't revealed that a higher percentage of the formers discontinued during some procedures (7.3% versus 2.4%) and took a day off from work (20% versus 17.1%); however, no significant association was found.

		18- Discomfort or physical symptoms as direct consequence of your surgical practice						P
		Total (n = 121)		Yes (n = 97)		No (n = 24)		
		n	%	n	%	n	%	
12- Procedures per week	1-5	59	48.8%	44	45.4%	15	62.5%	0.213
	6-10	50	41.3%	43	44.3%	7	29.2%	
	11-15	10	8.3%	9	9.3%	1	4.2%	
	>15	2	1.7%	1	1.0%	1	4.2%	
13- Average duration per procedure	<1	10	8.3%	8	8.2%	2	8.3%	0.686
	1-3	85	70.2%	70	72.2%	15	62.5%	
	4-6	21	17.4%	15	15.5%	6	25.0%	
	7-10	5	4.1%	4	4.1%	1	4.2%	
14- Perform Laparoscopic procedures	Yes	67	55.4%	55	56.7%	12	50.0%	0.782
	No	34	28.1%	26	26.8%	8	33.3%	
	Not Applicable	20	16.5%	16	16.5%	4	16.7%	
16- Working hours per day	5-7	23	19.0%	18	18.6%	5	20.8%	0.177
	8-10	81	66.9%	68	70.1%	13	54.2%	
	>10	17	14.0%	11	11.3%	6	25.0%	
17- Dominant hand	Right	109	90.1%	89	91.8%	20	83.3%	0.287
	Left	7	5.8%	5	5.2%	2	8.3%	
	Ambidextrous	5	4.1%	3	3.1%	2	8.3%	
32- Manually lift parts of the patient's	Yes	91	75.2%	73	75.3%	18	75.0%	0.979
	No	30	24.8%	24	24.7%	6	25.0%	
33- Shortage in the staff number	Yes	53	43.8%	41	42.3%	12	50.0%	0.834
	No	44	36.4%	36	37.1%	8	33.3%	
	I don't know	24	19.8%	20	20.6%	4	16.7%	
34- Type of shoes wear during procedure	Walking shoe-hard sole	16	13.2%	11	11.3%	5	20.8%	0.316
	Walking shoe-soft sole (crocs)	28	23.1%	25	25.8%	3	12.5%	
	Sports/Men's Shoe	52	43.0%	39	40.2%	13	54.2%	
	Ladies dress shoe/ high sole	1	0.8%	1	1.0%	0	0.0%	
	Designed shoes/clogs	24	19.8%	21	21.6%	3	12.5%	

Table 3. Characteristics of the procedures performed by the respondents (n = 121).

The effects of musculoskeletal pain on the respondents and some of the probable risk factors are summed in Table 5. The majority of surgeons (94.8%) continued operating even when they felt the symptoms during the procedure; and did not take a day off from work (81.3%) or thought of early retirement (61.5%) as a result of the manifestations.

Regarding the methods used by the suffering surgeons to relieve the manifestations; among which medical (53.6%) and non-medical (58.8%) therapies were the most common. In 23.7% of respondents, no method was attempted. Massage was the most common used non-medical method (46.4%), followed by ointment/cream use (28.9%), then hot packs (20.6%).

5. DISCUSSION

In this study, 80% of the respondents suffered from MSK manifestations that were related to surgery. Surgeons are at higher risk for the development of musculoskeletal fatigue during both open and laparoscopic operations (15-17) the surgical team, and particularly the surgeon, have been further removed from direct interaction with the patient's tissues. A scientific and ergonom-

ic approach to the analysis of the operating room environment and the performance and workload characteristics of members of the modern surgical team can provide a rational basis for maximizing the efficiency and safety of our increasingly technology-dependent surgical procedures. This could be attributed to the working postures taken by surgeons while performing the procedures in the form of prolonged static head-bent and back-bent positions (18). In addition, surgeons are obliged to do frequent awkward repetitive movements of the upper extremities in the operating theatre (15). The rate of MSK symptoms in our study is comparable to rates reported by other previous studies. Park et al (19) we investigated the association of demographics, ergonomics, and environment and equipment with physical symptoms reported by laparoscopic surgeons.

There were 317 surgeons identified as involved in laparoscopic practices who completed the online survey. Data collected from this comprehensive 23-question survey were analyzed using chi-square. There were 272 laparoscopic surgeons (86.9%) found that 87% of surgeons who performed laparoscopic procedures complained of physical discomfort related to their practice. Moreover, 62%–72% of surveyed otolaryngologists reported had back or neck pain associated with their surgical practice (7,20) related to microscope work and prolonged sitting. The importance of these findings has demonstrated the lack of awareness and adequate training to prevent long-term disability in ENT surgeons.

This study determined which types of laparoscopic instruments are most often used in Europe, why they are

		Perform laparoscopic procedures						P
		Total (n = 97)		Yes (n = 55)		No (n = 42)		
		n	%	n	%	n	%	
19-Which of the following applies?	Numbness	17	17.5%	10	18.2%	7	16.7%	0.846
	Stiffness	28	28.9%	16	29.1%	12	28.6%	0.955
	Fatigue	64	66.0%	43	78.2%	21	50.0%	0.004*
	Pain	80	82.5%	47	85.5%	33	78.6%	0.377
20-Which body part?	Back	69	71.1%	41	74.5%	28	66.7%	0.487
	Neck	58	59.8%	33	60.0%	25	59.5%	1.000
	Shoulder	38	39.2%	24	43.6%	14	33.3%	0.344
	Arm	14	14.4%	9	16.4%	5	11.9%	0.757
	Hand	32	33.0%	20	36.4%	12	28.6%	0.578
	Leg	32	33.0%	21	38.2%	11	26.2%	0.277
21- Symptoms localized or radiating	Localized	81	83.5%	46	83.6%	35	83.3%	0.621
	Radiate	14	14.4%	7	12.7%	7	16.7%	
22- Symptoms are linked to surgical activity	Yes	91	93.8%	55	100.0%	36	85.7%	0.005*
	No	6	6.2%	0	0.0%	6	14.3%	
25-When do these symptoms or discomforts affect you the most?	In the morning	7	7.2%	5	9.1%	2	4.8%	0.695
	During procedure	37	38.1%	22	40.0%	15	35.7%	0.667
	After work	62	63.9%	34	61.8%	28	66.7%	0.622
	Before sleep	17	17.5%	10	18.2%	7	16.7%	0.846

Table 4. Characteristics of the musculoskeletal pain suffered by the respondents (n = 97). *Significant at p <0.05.

being used, and what problems exist while using the instruments. The handles were also evaluated according to ergonomic design criteria. A questionnaire was sent to 62 experienced surgeons in 19 countries. The laparoscopic instruments were divided into four groups: instruments with similar functionality and hand grip mod-

		Perform laparoscopic procedures						P
		Total (n = 97)		Yes (n = 55)		No (n = 42)		
		n	%	n	%	n	%	
23- Do you continue operating when you have symptoms during the procedure?	Yes	92	94.8%	51	92.7%	41	97.6%	0.385
	No	5	5.2%	4	7.3%	1	2.4%	
24- What do you do when you don't continue?	Swap with your assistant	1	20.0%	1	25.0%	0	0.0%	0.600
	To take a break	2	40.0%	2	50.0%	0	0.0%	
	Let assistant finish the procedure while watching & supervising	1	20.0%	1	25.0%	0	0.0%	
	Other	1	20.0%	0	0.0%	1	100.0%	
26- Resulted in taking a day off or absence from work	Yes	18	18.8%	11	20.0%	7	17.1%	0.716
	No	78	81.3%	44	80.0%	34	82.9%	
27- Resulted in thinking about early retirement	Yes	36	37.5%	19	34.5%	17	41.5%	0.811
	No	59	61.5%	35	63.6%	24	58.5%	
28- Methods used to relief your discomfort	Didn't use	22	22.7%	14	25.5%	8	19.0%	0.455
	Medical	52	53.6%	29	52.7%	23	54.8%	
	Non-Medical	57	58.8%	31	56.4%	26	61.9%	
	Surgical	2	2.1%	1	1.8%	1	2.4%	

Table 5. Effects of musculoskeletal pain on the respondents and some probable risk factors (n = 97).

el were grouped together. Eight questions were asked for every group about the type of instrument (disposable, reusable, or semi reusable; while in other studies a rate of 40% and 60% was found (23, 24) the Netherlands.

There was no statistically significant association between the presence of MSK symptoms and any of the demographic or lifestyle variables of our respondents. On the contrary, many studies have reported a higher prevalence of MSK disorders among women (21, 25, 26) indirect ophthalmoscopy. They explained this sex difference by the lower pain threshold in women (26-28); and also by the tendency of women to seek medical attention for pain than men (29) gender differences in work-related health conditions have received little research attention. This appears to be the first study to examine why employed women are much more likely than men to experience upper body musculoskeletal disorders. A mailed self-report survey gathered data from 737 Australian Public Service employees (73% women). This discrepancy between our results and the other studies might be explained by the higher number of female surgeons in our study who specialized in obstetrics and gynaecology, while more male surgeons specialized in general surgery and orthopedics. There may be differences in the working postures and the duration of procedures among these specialties that confounded the effect of gender.

We found that a significantly higher percentage of those with MSK manifestations have practiced for 5-10 years (28.9%), compared to those who had no symptoms. Older surgeons are usually expected to have a higher risk of developing MSK complaints. However, studies have revealed that younger workers had higher rates of MSK disorders due to their limited experience and job skills that resulted in inefficient practice (30-32). Older surgeons may be able to apply coping strategies with the work related physical stresses and their movements are less awkward due to their experience.

The most common manifestations - as reported by our respondents - were pain (82.5%) and fatigue (66%). Back and neck represented the most affected body parts (71.1% and 59.8%, respectively). On comparison between surgeons who performed open and laparoscopic procedures, we found that fatigue was the only symptom that was reported by a significantly higher frequency of laparoscopic surgeons and it was linked to surgery. Pain and shoulder symptoms were slightly higher in laparoscopic surgeons, though the results were not statistically significant. Moreover, a higher percentage of the laparoscopic surgeons discontinued during some procedures (7.3% versus 2.4%) and took a day off from work (20% versus 17.1%); however, no significant association was found. All these findings indicate a tendency towards a higher physical stress that affects surgeons negatively during laparoscopy. Many factors interact to cause musculoskeletal stress on the shoulder region during laparoscopy; including the height of operating table and the design of instruments. Our findings are consistent with many studies have reported that a higher number of surgeons complained of neck, back and shoulders stiffness after laparoscopic than after open surgery (17, 20, 33-36)

trunk, shoulder, elbow, and wrist movements during the first hour of surgery. We also compared post procedural complaints of pain, stiffness, or numbness between the two groups.

6. CONCLUSION

Musculoskeletal pain is common among Saudi surgeons as eighty percent suffered from musculoskeletal manifestations that were related to surgery in different specialties, probable risk factors were long operating duration, lifting body parts manually and shortage of staff. More attention should be directed to improving the physical environments in which the surgeons are operating. Moreover, surgeons should be educated about the recommended ergonomic positions that can prevent or decrease their work related MSK manifestations.

- **Author's contribution:** M.N., A.A., A.F., M.S., A.MA., A.MN., A.A., H.A., M.M. gave substantial contribution to the conception or design of the work and in the acquisition, analysis and interpretation of data for the work. Each author had role in drafting the work and revising it critically for important intellectual content. Each author gave final approval of the version to be published and they agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
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REFERENCES

1. Esposito C, Najmaldin A, Schier F, Yamataka A, Ferro M, Riccipitoni G, Czauderna P, Ponsky T, Till H, Escolino M, Iaquinto M. Work-related upper limb musculoskeletal disorders in pediatric minimally invasive surgery: a multicentric survey comparing laparoscopic and sils ergonomics. *Pediatric surgery international*. 2014 Apr 1;30(4):395-9.
2. Liang CA, Levine VJ, Dusza SW, Hale EK, Nehal KS. Musculoskeletal Disorders and Ergonomics in Dermatologic Surgery: A Survey of Mohs Surgeons in 2010. *Dermatologic Surgery*. 2012 Feb;38(2):240-8.
3. Szeto GP, Ho P, Ting AC, Poon JT, Cheng SW, Tsang RC. Work-related musculoskeletal symptoms in surgeons. *Journal of occupational rehabilitation*. 2009 Jun 1; 19(2): 175-84.
4. Vijendren A, Yung M, Sanchez J, Duffield K. Occupational musculoskeletal pain amongst ENT surgeons-are we looking at the tip of an iceberg?. *The Journal of Laryngology & Otolaryngology*. 2016 May; 130(5):490-6.
5. Vijendren A, Yung M, Sanchez J, Duffield K. Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?. *The Journal of Laryngology & Otolaryngology*. 2016 May; 130(5): 490-496.
6. Knudsen ML, Ludewig PM, Braman JP. Musculoskeletal pain in resident orthopaedic surgeons: results of a novel survey. *The Iowa orthopaedic journal*. 2014;34:190.
7. Cavanagh J, Brake M, Kearns D, Hong P. Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members. *American journal of otolaryngology*. 2012 Jul 1;33(4):441-6.
8. Al-Mohrej OA, AlShaalan NS, Al-Bani WM, Masuadi EM, Almodaimegh HS. Prevalence of musculoskeletal pain of the

- neck, upper extremities and lower back among dental practitioners working in Riyadh, Saudi Arabia: a cross-sectional study. *BMJ open*. 2016 Jun 1;6(6):e011100.
9. Al Wassan KA, Almas K, Al Shethri SE, Al Qahtani M. Back & neck problems among dentists and dental auxiliaries. *J Contemp Dent Pract*. 2001;2(3): 17-30.
 10. Alghadir A, Zafar H, Iqbal ZA. Work-related musculoskeletal disorders among dental professionals in Saudi Arabia. *Journal of physical therapy science*. 2015;27(4):1107-12.
 11. Homaïd MB, Abdelmoety D, Alshareef W, Alghamdi A, Alhozali F, Alfahmi N, Hafiz W, Alzahrani A, Elmorsy S. Prevalence and risk factors of low back pain among operation room staff at a Tertiary Care Center, Makkah, Saudi Arabia: a cross-sectional study. *Annals of occupational and environmental medicine*. 2016 Dec;28(1): 1.
 12. Al Dajah S, Al Daghdhi A. Prevalence and risk factors of low back pain among nurses in Sudayr region. *European Scientific Journal, ESJ*. 2013 Nov 30;9(33).
 13. Attar SM. Frequency and risk factors of musculoskeletal pain in nurses at a tertiary centre in Jeddah, Saudi Arabia: a cross sectional study. *BMC research notes*. 2014 Dec;7(1):61.
 14. Keriri H. Prevalence and risk factors of low back pain among nurses in operating rooms, Taif, Saudi Arabia. *Am J Res Commun*. 2013;1(11):25.
 15. Berguer R. Surgery and ergonomics. *Archives of surgery*. 1999 Sep 1; 134(9): 1011-6.
 16. Berguer R, Rab GT, Abu-Ghaida H, Alarcon A, Chung J. A comparison of surgeons' posture during laparoscopic and open surgical procedures. *Surgical endoscopy*. 1997 Feb 1; 11(2): 139-42.
 17. Nguyen NT, Ho HS, Smith WD, Philipps C, Lewis C, De Vera RM, Berguer R. An ergonomic evaluation of surgeons' axial skeletal and upper extremity movements during laparoscopic and open surgery. *The American journal of surgery*. 2001 Dec 1;182(6):720-4.
 18. Kant IJ, de Jong LC, van Rijssen-Moll M, Borm PJ. A survey of static and dynamic work postures of operating room staff. *International archives of occupational and environmental health*. 1992 Feb 1;63(6):423-8.
 19. Park A, Lee G, Seagull FJ, Meenaghan N, Dexter D. Patients benefit while surgeons suffer: an impending epidemic. *Journal of the American College of Surgeons*. 2010 Mar 1;210(3):306-13.
 20. Babar-Craig H, Banfield G, Knight J. Prevalence of back and neck pain amongst ENT consultants: national survey. *The Journal of Laryngology & Otology*. 2003 Dec;117(12):979-82.
 21. Chams H, Mohammadi SF, Moayyeri A. Frequency and assortment of self-reported occupational complaints among Iranian ophthalmologists: a preliminary survey. *Medscape General Medicine*. 2004;6(4).
 22. Van Veelen MA, Meijer DW. Ergonomics and design of laparoscopic instruments: results of a survey among laparoscopic surgeons. *Journal of Laparoendoscopic & Advanced Surgical Techniques*. 1999 Dec;9(6):481-9.
 23. Van Veelen MA, Nederlof EA, Goossens RH, Schot CJ, Jakimowicz JJ. Ergonomic problems encountered by the medical team related to products used for minimally invasive surgery. *Surgical Endoscopy and Other Interventional Techniques*. 2003 Jul 1;17(7):1077-81.
 24. Reyes DA, Tang B, Cuschieri A. Minimal access surgery (MAS)-related surgeon morbidity syndromes. *Surgical Endoscopy and Other Interventional Techniques*. 2006 Jan 1;20(1):1.
 25. Hoofman WE, van der Beek AJ, Bongers PM, van Mechelen W. Gender differences in self-reported physical and psychosocial exposures in jobs with both female and male workers. *Journal of occupational and environmental medicine*. 2005 Mar 1;47(3):244-52.
 26. Punnett L, Herbert R. Work-related musculoskeletal disorders: Is there a gender differential, and if so, what does it mean?. In *Women and health 2000* (pp. 474-492).
 27. Bellman S, Forster N, Still L, Cooper CL. Gender differences in the use of social support as a moderator of occupational stress. *Stress and Health: Journal of the International Society for the investigation of Stress*. 2003 Feb; 19(1):45-58.
 28. Fillingim RB, Ness TJ. Sex-related hormonal influences on pain and analgesic responses. *Neuroscience & Biobehavioral Reviews*. 2000 Jun 1;24(4):485-501.
 29. Strazdins L, Bammer G. Women, work and musculoskeletal health. *Social science & medicine*. 2004 Mar 1;58(6):997- 1005.
 30. Szeto GP, Lam P. Work-related musculoskeletal disorders in urban bus drivers of Hong Kong. *Journal of occupational rehabilitation*. 2007 Jun 1;17(2):181-98.
 31. Frymoyer JW, Pope MH, Clements JH, Wilder DG, MacPherson B, Ashikaga T. Risk factors in low-back pain. An epidemiological survey. *JBJS*. 1983 Feb 1;65(2):213-8.
 32. Anderson R. The back pain of bus drivers. Prevalence in an urban area of California. *Spine*. 1992 Dec;17(12):1481-8.
 33. Knudsen ML, Ludewig PM, Braman JP. Musculoskeletal pain in resident orthopaedic surgeons: results of a novel survey. *The Iowa orthopaedic journal*. 2014;34:190.
 34. Auerbach JD, Weidner ZD, Milby AH, Diab M, Lonner BS. Musculoskeletal disorders among spine surgeons: results of a survey of the Scoliosis Research Society membership. *Spine*. 2011 Dec 15;36(26):E1715-21.
 35. Sivak-Callcott JA, Diaz SR, Ducatman AM, Rosen CL, Nimbarte AD, Sedgeman JA. A survey study of occupational pain and injury in ophthalmic plastic surgeons. *Ophthalmic Plastic & Reconstructive Surgery*. 2011 Jan 1;27(1):28-32.
 36. Esser AC, Koshy JG, Randle HW. Ergonomics in office-based surgery: a survey-guided observational study. *Dermatologic Surgery*. 2007 Nov;33(11):1304-14.
 37. Van Veelen MA, Jakimowicz JJ, Kazemier G. Improved physical ergonomics of laparoscopic surgery. *Minimally Invasive Therapy & Allied Technologies*. 2004 Jan 1;13(3): 161-6.
 38. Hallbeck MS, Konecny S, Buchel D, Matern U. Ergonomic usability testing of operating room devices. *Studies in health technology and informatics*. 2008; 132:147-52.