



The prevalence of musculoskeletal injuries in bariatric surgeons

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Received: 12 January 2018 / Accepted: 18 September 2018 / Published online: 24 September 2018
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Abstract

Objective To investigate the prevalence of musculoskeletal (MSK) injuries in bariatric surgeons around the world.

Background As the popularity of bariatric surgery increases, efforts into improving its patient safety and decreasing its invasiveness have also been on the rise. However, with this shift towards minimal invasiveness, surgeon ergonomic constraints have been imposed, with a recent report showing a 73–88% prevalence of physical complaints in surgeons performing laparoscopic surgeries.

Methods A web-based survey was designed and sent out to bariatric surgeons around the world. Participants were queried about professional background, primary practice setting, and various issues related to bariatric surgeries and MSK injuries.

Results There were 113 responses returned from surgeons from 34 countries around the world. 68.5% of the surgeons have had more than 10 years of experience in laparoscopic surgery, 65.8% in open, and 0.9% in robotic surgery. 66% of participants reported that they have experienced some level of discomfort/pain attributed to surgical reasons, causing the case load to decrease in 27.2% of the surgeons. It was seen that the back was the most affected area in those performing open surgery, while shoulders and back were equally as affected in those performing laparoscopic, and the neck for those performing robotic, with 29.4% of the surgeons reporting that this pain has affected their task accuracy/surgical performance. A higher percentage of females than males reported pain in the neck, back, and shoulder area when performing laparoscopic procedures. Supine positioning of patients evoked more discomfort in the wrists, while the French position caused more discomfort in the back region. A higher percentage of surgeons who did not exercise experienced more issues in the neck and back region, while those that exercised more than 3 h a week experienced issues in their shoulders and wrists in both open and laparoscopic approaches. Only 57.7% sought medical treatment for their MSK problem, of which 6.35% had to undergo surgery for their issue, of which 55.6% of those felt that the treatment resolved their problem.

Conclusion MSK injuries and pain are a common occurrence among the population of bariatric surgeons (66%), and has the ability to hinder performance at work. Therefore, it is of importance to investigate ways in which to improve ergonomics for these surgeons as to improve quality of life.

Keywords Bariatrics · Ergonomics · Laparoscopic surgery · Survey

Surgeons are known to be a unique group of healthcare professionals that are at a higher risk for the development of a range of work related musculoskeletal (MSK) pains and injuries. MSK disorders are typically defined as musculoskeletal complaints, symptoms, or pain that reflect a number

of conditions, such as neck pain, back pain, shoulder pain, pain of limbs, carpal tunnel syndrome, myofascial dysfunction syndrome, atypical facial pain, and so forth [1]. These could range from mild, infrequent symptoms, to severe and debilitating ones [2], interfering with surgeons daily activities.

As the popularity of bariatric surgery increases [3], efforts into improving its patient safety and decreasing its invasiveness have also been on the rise. However, with this shift towards minimal invasiveness, surgeon ergonomic constraints have been imposed, with recent reports showing a 73–88% prevalence of physical complaints in surgeons performing laparoscopic surgeries [4–6]. And

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while newer techniques in minimally invasive surgeries, such as natural orifice transluminal endoscopic surgery (NOTES) and single-incision laparoscopic surgery (SILS) have greater benefits for the patient [7, 8], they have been shown to increase the physical workload for the surgeon [9–11]. On the other hand, the recent emergence of robotic

surgery may provide the surgeon with ergonomic benefits; allowing the surgeon to operate from a seated position, with more degrees of freedom for instrumental movement and 3 dimensional vision [12, 13].

The physical posture, therefore, of a bariatric surgeon while providing care to their patient should ideally be that

Demographics

1. Age:

2. Gender: M F Other

3. Height (cm):

4. Height (in):

5. Specialty:

6. Years Practicing (total):

7. Percentage of practice in bariatric surgery: 0% 1-25% 26-50% 51-75% 76-100%

8. State:

9. Page of Practice (choose all that apply): inpatient office both other

10. State Size:

11. Page of Practice (choose all that apply): inpatient office both other

Physician Visits

12. General well being: Excellent Good Fair Poor

13. Number of doctor visits per year for general health: 0 1-2 3-4 5-6 7-8

14. Number of doctor visits per year for musculoskeletal problems: 0 1-2 3-4 5-6 7-8

15. Number of times per year blood test is performed: 0 1-2 3-4 5-6 7-8

Background Data

16. Years of experience in open surgery: 0 1-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45 46-50

17. Years of experience in laparoscopic surgery: 0 1-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45 46-50

18. Years of experience in robotic surgery: 0 1-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45 46-50

Bariatric Procedures

19. Please select all types of bariatric procedures you perform from the list below: Endoscopic Sleeve Gastrectomy Sleeve Bypass Gastric Bypass Sleeve Bariatric Mini Bariatric Other (please specify):

20. Number performed per month:

Endoscopic:	<input type="text"/>
Sleeve Gastrectomy:	<input type="text"/>
Sleeve Bypass:	<input type="text"/>
Gastric Bypass:	<input type="text"/>
Sleeve Bariatric:	<input type="text"/>
Other:	<input type="text"/>

21. Position bariatric procedure is usually performed in: Prone position Supine position

Revisions Bariatric Procedures

22. Please select all types of bariatric procedures you perform from the list below: 0 1-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45 46-50

23. Number Performed per Year:

Bariatric to Sleeve	<input type="text"/>
Bariatric to Gastric Bypass	<input type="text"/>
Sleeve to Sleeve	<input type="text"/>
Sleeve to Bypass	<input type="text"/>
Sleeve to USG	<input type="text"/>
Sleeve to Duodenal Switch	<input type="text"/>
Bypass to Bariatric Bypass	<input type="text"/>

Discomfort and Procedure Duration

24. Average number of hours that surgical procedures last: <1 1-2 3-4 5-6 7-8

25. Have you ever experienced abnormal amounts of pain or discomfort in any of the following areas?

	Neck	Shoulders	Back	Wrists	Fingers
While performing open surgery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
While performing laparoscopic surgery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
While performing robotic surgery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

26. If pain/discomfort was experienced, what is the nature of it?

	Fatigue	Pain	Stiffness	Numbness	Not applicable
Open surgery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Laparoscopic surgery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Robotic surgery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

27. Did you feel as if it has affected your task accuracy/surgical performance? Yes No

28. Have you ever experienced any abnormal levels of discomfort/pain that you would attribute to surgical reasons? Yes No

29. If pain/discomfort was experienced (if not, skip to next section) Pain Scale: 0 1-2 3-4 5-6 7-8

30. Did you continue working despite the pain/discomfort? Yes No

31. Has this pain/discomfort caused you to decrease your case-load? Yes No

32. How long does each episode of pain/discomfort last? 1 hour 1 day 1 week 1 month 6 months

33. Do you take any pain medications on a regular basis? Yes No

34. How often do you exercise per week? 0 1-2 3-4 5-6

35. Have you had any previous non-work related musculoskeletal injury in the past? Yes No

36. If yes, Specify Region: Back Neck Arm Leg

37. Number of vacation days per year: 0 1-10 11-20 21-30 >30

38. Number of conferences attended per year: 0 1-2 3-4 5-6

39. Time spent per day on mobile/computer: 1 hour 1-2 hours 3-4 hours 4-5 hours

40. Number of hours of quality sleep per night: 2 3 4 5 6 7 8 9 10 11 12

41. Have you had any imaging done to diagnose this problem? Yes No

42. If yes, Choose all that was done: X-Ray CT Scan MRI Other (please specify):

43. Number of times each diagnostic imaging modality was done:

	0	1-2	3-4	5-6
X-Ray	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CT Scan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MRI	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

44. Did this help diagnose the problem? Yes No

45. Have you had any medical treatment for this problem? Yes No

46. If yes, what type of treatment? Pharmacological Physical therapy Surgical

47. If surgery was performed, what was the procedure done?

48. If you did, did the treatment resolve the problem? Yes No

Fig. 1 Sample of the survey

all muscles are in a relaxed, well-balanced, and neutral position. Postures outside of this neutral position for a prolonged period, such as those experienced during surgery, are likely what cause the musculoskeletal discomfort experienced by this population of physicians [14].

We, therefore, conducted a study to explore the prevalence of MSK pain and injuries in bariatric surgeons from around the world, investigating possible factors contributing to these injuries.

Methods

Survey

We developed an online, web-based survey adapted from the previously validated Nordic Musculoskeletal Questionnaire [15] using an online survey generator. We have attached a sample of the questionnaire in Fig. 1. The survey was then sent out to bariatric surgeons around the world through multiple social media platforms. Participants were queried about professional background and demographics, primary practice setting, and various issues related to bariatric surgeries and MSK injuries. Demographics collected included gender, age, height, weight, years practicing, average hours in the operating room per week, glove size, and most commonly employed operating position.

The sections of the survey included: demographics, physician visits, bariatric surgery background data, bariatric procedures, revisional bariatric procedures, and discomfort and procedure duration. The symptom portion of the questionnaire inquired about the nine different anatomic regions used in the NMQ: neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, knees, and ankles/feet. The survey skipped to the next section if a respondent indicated no pain experienced in any body region. If they answered positively, however, further questions followed. These included questions about interference with work, difficulties, and characterization of the difficulty (pain, stiffness, weakness, paresthesia, or other), severity (scale of 0–10), whether the symptoms stopped the surgeon from operating, and whether the surgeon attributed their symptoms to their work.

Statistical analysis

The study was conducted anonymously between May 2017 and August 2017, receiving responses from 113 bariatric

surgeons from around the world. Descriptive statistics were analyzed using SPSS software version 22. The significance of the difference between the two values was analyzed using a two-tailed unpaired Student's *t* test. Significant levels were assessed at *p*-value < 0.05. %.

Results

A total of 113 bariatric surgeons from 34 countries around the world completed the survey during the period of data collection, with the majority (15.9%) being from Kuwait. Of the respondents, 94.7% were men, with an average age of 45.2 years. The rest of the demographics are summarized in Table 1. Details on respondents' health status are reported in Table 2.

Table 3 summarizes the experiences of the surgeons in open versus laparoscopic versus robotic surgery. It was seen that 98.2% of surgeons reported performing sleeve gastrectomy, and 88% reported performing gastric bypasses, with 65.7% performing the surgery in the French position (Tables 4, 5).

66% of participants reported that they have experienced some level of discomfort/pain attributed to surgical reasons, causing the case load to decrease in 27.2% of the surgeons (Table 6). It was seen that the back was the most affected area in those performing open surgery, while shoulders and back were equally as affected in those

Table 1 Demographics

Variables	
Age	45.2 (± 7.8)
Gender (%)	
Male	94.7
Female	5.3
Height	175.3 (± 7.4)
Weight	83.1 (± 12.9)
BMI	27.0 (± 3.5)
Years practicing medicine	19.4 (± 7.5)
Glove size	7.4 (± 0.5)
% Practice in bariatrics	
< 10%	7.1
10–30%	16.8
30–60%	20.4
> 60%	54.0
Not eligible	1.8
Place of practice (%)	
Academic centre	29.2
Private hospital	63.7
Governmental hospital	51.3

Table 2 Physician visits

	Percentage (%)
General well being	
Well	83.8
Averagea	16.2
Low	0.0
Number of vacation days per year	
0	5.4
1–10	16.2
11–20	24.3
21–30	29.7
> 30	24.3
Number of conferences attended per year	
0	0.9
1–3	54.1
4–6	24.3
> 6	20.7
Number of doctor visits per year for general health	
0	48.7
1–2	44.1
3–4	5.4
> 5	1.8
Number of doctor visits per year for musculoskeletal problems	
0	57.7
1–2	33.3
3–4	5.4
> 5	3.6
Number of times per year blood test is performed	
0	31.5
1–2	63.1
3–4	4.5
> 50	0.9
Pain medications taken on a regular basis	
Yes	20.7
No	79.3
Exercise per week	
0	25.2
1–3	49.6
> 3	25.2
Previous non-work related musculoskeletal injury in the past	
Yes (region)	52.3
Back	23.3
Neck	15.0
Arms	20.0
Legs	41.7
No	47.7
Time spent per day on mobile/computer	
1 h	8.1
1–3 h	51.4
3–5 h	26.1
> 5 h	14.4

Bold indicates the overall percentage of participants that answered Yes/No

Table 3 Background data

	Percentage (%)
Years of experience in open surgery	
0	0.9
<3	2.7
3–5	4.5
5–10	26.1
>10	65.8
Years of experience in laparoscopic surgery	
0	0.0
<3	0.9
3–5	6.3
5–10	24.3
>10	68.5
Years of experience in robotic surgery	
0	76.6
<3	15.3
3–5	3.6
5–10	3.6
>10	0.9

Table 4 Bariatric procedures

	Percentage (%)
Type of bariatric surgeries performed	
Endo-luminal	19.4
Sleeve gastrectomy	98.2
Gastric bypass	88.0
Gastric bands	41.7
Not eligible	0.9
Avg number performed per month	
Endo-luminal	6
Sleeve gastrectomy	23
Gastric bypass	8
Gastric bands	3
Not eligible	41
Position bariatric procedure is usually performed in	
French position	65.7
Supine position	34.3

performing laparoscopic, and the neck for those performing robotic (Fig. 2), with 29.4% of the surgeons reporting that this pain has affected their task accuracy/surgical performance. As demonstrated by Fig. 3, the nature of the discomfort experienced was shown to be mostly pain for open and laparoscopic surgery, but of the fatigue nature for robotic surgery (Fig. 4). Figure 5 illustrates the difference between genders when it came to assessing the location of pain according to the type of surgery. A higher percentage of females than males reported pain in the

Table 5 Revisional bariatric procedures

Type of bariatric surgeries performed	
Band to sleeve	62.86%
Band to gastric bypass	64.76%
Sleeve to resleeve	50.48%
Sleeve to bypass	66.67%
Sleeve to MGB	58.10%
Sleeve to duodenal switch	17.14%
Bypass to redo bypass	43.81%
None	16.19%
Avg number performed per year	
Band to sleeve	15
Band to gastric bypass	14
Sleeve to re-sleeve	5
Sleeve to bypass	10
Sleeve to MGB	12
Sleeve to duodenal switch	3
Bypass to redo bypass	5

neck, back and shoulder area when performing laparoscopic procedures. Supine positioning of patients evoked more discomfort in the wrists, while the French position caused more discomfort in the back region. An interesting observation was seen when correlating amount of physical exercise per week with pain/discomfort during surgery. It was seen that a higher percentage of surgeons that did not exercise experienced more issues in the neck and back region, while those that exercised more than 3 h a week experienced issues in their shoulders and wrists in both open and laparoscopic approaches.

Only 36.9% of the respondents who had experienced pain/discomfort due to surgical reasons had some form of imaging done to diagnose the problem (Table 6) and 57.7% sought medical treatment for their MSK problem, of which 6.35% had to undergo surgery for their issue, and 55.6% of those felt that the treatment resolved their problem.

Discussion

Work-related MSK injuries are one of the most important occupational health issues among health care workers, and with the high physical demands of surgeons' daily activities, high rates of MSK injuries have been reported, specifically between the orthopedic surgery group [16–18]. This has been hypothesized to be due to the fact that a static posture needs to be maintained for long periods of time while using precision hand and wrist movements during surgical procedures [14]; in a systemic review conducted, Alleblas et al. [19] was able to show that the prevalence of MSK complaints was 74% among surgeons. This number

Table 6 MSK injuries attributed to bariatric surgical procedures

	Percentage (%)
Average number of hours that surgical procedures lasts	
< 1	20.4
1–3	73.8
3–5	4.9
> 5	0.9
Have you ever experienced any abnormal levels of discomfort/pain that you would attribute to surgical reasons?	
Yes (pain scale)	66.0
0	7.8
1–3	64.1
4–6	26.2
7–10	1.9
No	34.0
Continue working despite the pain/discomfort	
Yes	100
No	0
Pain/discomfort caused a decrease in case-load	
Yes	27.2
No	72.8
Length that each pain/discomfort episode last	
1 h	33.0
1 day	40.8
1 week	17.5
1 month	5.8
6 months	2.9
Imaging done to diagnose problem	
Yes (what was done)	36.9
X-ray	37.8
CT-scan	10.8
MRI	86.5
No	63.1
Did imaging help diagnose the problem	
Yes	66.7
No	33.3
Medical treatment for this problem	
Yes (type)	57.7
Pharmaceutical	54.0
Physical therapy	39.7
Surgical	6.4
No	42.3
Did treatment resolve problem	
Yes	55.6
No	44.4

Bold indicates the overall percentage of participants that answered Yes/No

is comparable to our percentage of bariatric surgeons that had reported the existence of some form of MSK problem that they would attribute to their work. However, there are

currently no studies that look specifically into the prevalence and cause of MSK injuries and pain the bariatric surgery group.

A possible angle to consider is that, while the prevalence of bariatric surgery is on the rise [3], the shift towards the laparoscopic approach has become more prominent, with 68.5% of our study population having over 10 years of experience in laparoscopic bariatric surgery as of 2017. This has been hypothesized to be due to the fact that laparoscopic bariatric surgeries are the preferred approach from the patients' perspective, as well as the most recommended approach by guidelines, given the lower complication rates and improved aesthetics over the open approach [20–22]. However, this comes with its own consequences given a different form of physical demand and physical workload for the surgeon, taking little consideration of ergonomics. As shown by our study, 58.4% of bariatric surgeons complained of pain in their shoulders, as well as in the back region and 40.59% reported having pain in their wrists and fingers while performing laparoscopic bariatric surgeries. These numbers were shown to be notably higher than those for the open approach, with 15.2 and 20.7% reporting pain in their wrists and fingers, respectively. This observation is understandable given the equipment and surgical techniques employed in laparoscopic bariatric surgeries.

One reported benefit from the introduction of robotic surgery in bariatrics is the superior ergonomics that it is known to offer. However, from our study population, it was shown that 69.2% of the surgeons complained of having had some form of pain or discomfort in the neck that they attributed to performing bariatric surgery using the robotic approach. This can be explained given the position in which robotic surgery is performed. This has also been shown to be the case in several previous studies conducted [4, 23–25], but at a much lower average prevalence of 35% than in our study population.

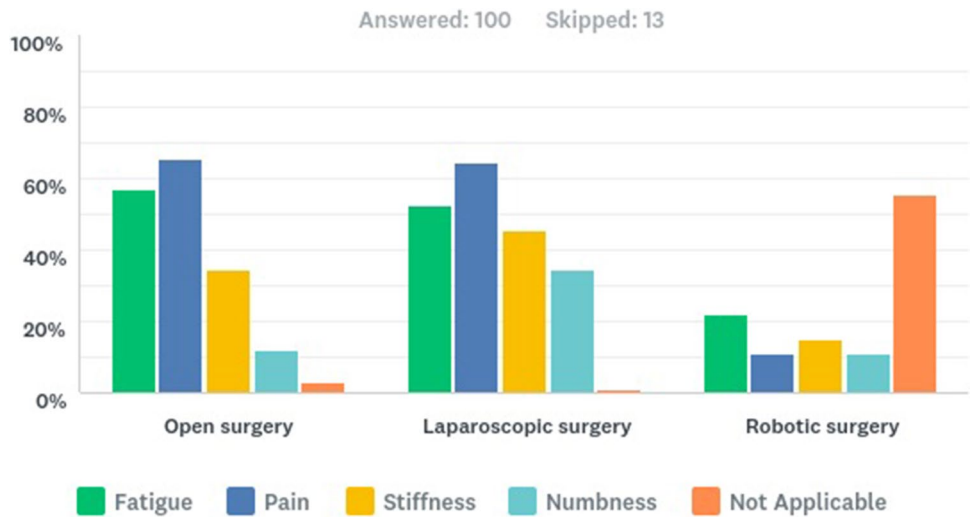
An interesting observation noted was the difference in results when comparing genders. On average, female surgeons are known to have smaller hands and glove sizes, and therefore, the “one size fits all” of the laparoscopic equipment handles may be a cause of discomfort [4, 9]. However, according to our results, male participants tended to exhibit more pain during laparoscopic bariatric procedures in their wrists and fingers compared to the female ones (17.6% and 18.0% vs. 11.8% and 5.9% respectively), but vice versa when it came to neck and shoulder complaints (15.8% and 23.9% vs. 23.5% and 35.3%). This finding could be influenced by the anatomical muscular differences between the sexes, as well as the differences between working life and private circumstances [26].

Physical complains may be thought of as “part of the job”, however, when such complaints appear to influence the quality of surgical care, it becomes a matter of concern.

Fig. 2 Percentage of surgeons that had experienced abnormal amounts of pain or discomfort by area



Fig. 3 Nature of the pain/discomfort experienced by surgical approach



As was shown by our study, 27.2% of the surgeons felt like the pain they had experienced had caused them to decrease their caseload, with 29.4% of the surgeons reporting that this pain has affected their task accuracy/surgical performance. Multiple previous studies illustrated the same finding, with surgeons believing that their surgical performance was negatively affected by their own injury or pain [27–29]. This observation is of concern and raises the question as to what should be done to decrease these modifiable factors.

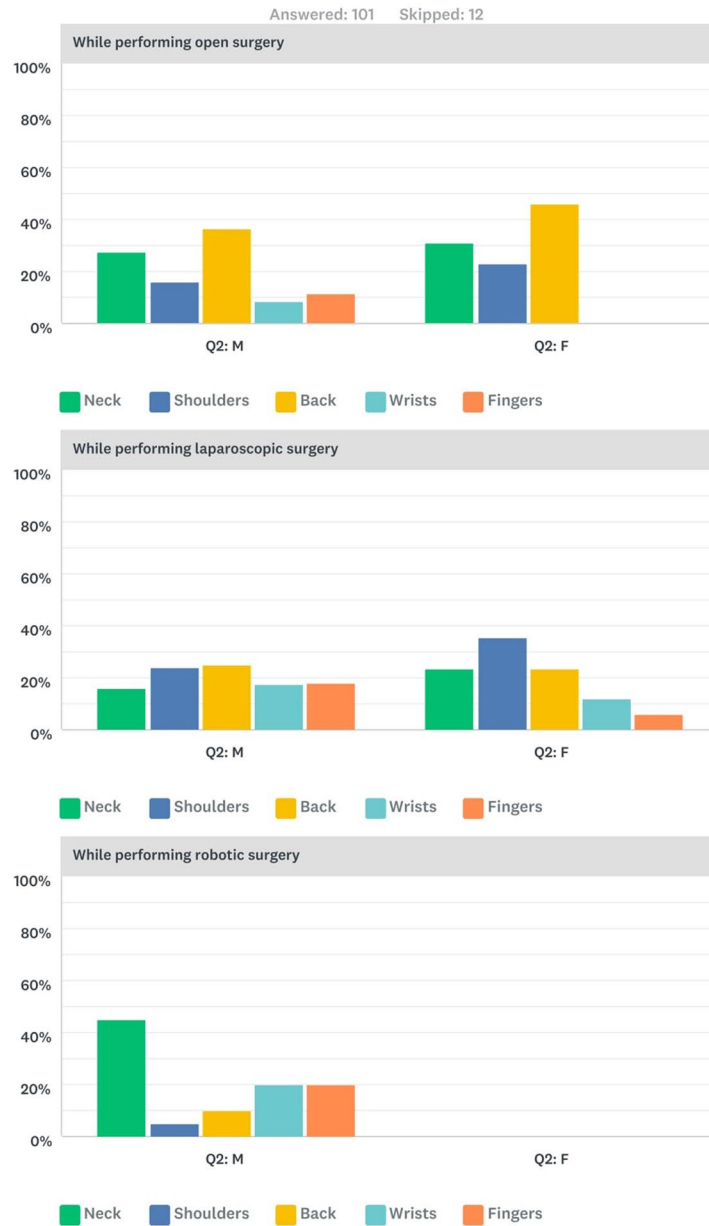
The limitations of our study include the use of self-reported measure to assess the degree of pain, as well as recall bias, as

the disorders were surgeon-reported injuries. However, while subjective reports are not alone diagnostic of musculoskeletal pathology, subjective complaints remain the most common manifestation of musculoskeletal occupational injury.

Conclusion

MSK injuries and pain are a common occurrence among the population of bariatric surgeons, and has the ability to hinder performance at work, decreasing case loads and

Fig. 4 Pain or discomfort experienced according to gender



MSK Injuries in Surgeons

SurveyMonkey

While performing open surgery						
	Neck	Shoulders	Back	Wrists	Fingers	Total
Q2: M	27.44% 45	15.85% 26	36.59% 60	8.54% 14	11.59% 19	162.38% 164
Q2: F	30.77% 4	23.08% 3	46.15% 6	0.00% 0	0.00% 0	12.87% 13
While performing laparoscopic surgery						
	Neck	Shoulders	Back	Wrists	Fingers	Total
Q2: M	15.77% 35	23.87% 53	24.77% 55	17.57% 39	18.02% 40	219.80% 222
Q2: F	23.53% 4	35.29% 6	23.53% 4	11.76% 2	5.88% 1	16.83% 17
While performing robotic surgery						
	Neck	Shoulders	Back	Wrists	Fingers	Total
Q2: M	45.00% 9	5.00% 1	10.00% 2	20.00% 4	20.00% 4	19.80% 20
Q2: F	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0



Fig. 5 Pain or discomfort experienced according to weekly hours of exercise

performance. Therefore, it is of importance to investigate ways in which to improve ergonomics for these surgeons as to improve quality of life. From our results, we could see that the French position was a cause of back pain, while lack of exercise was correlated to neck and back issues.

Compliance with ethical standards

Disclosures Dr. Salman AlSabah, Dr. Eliana Al Haddad and Dr. Haris Khwaja have nothing to declare.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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