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Maria Tran  
*Kansas City University*

Michael W. Kortz  
*Kansas City University*

Britt Johnson  
*Kansas City University*

Jeffrey E. Janis  
*The Ohio State University*

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# Operation-related Musculoskeletal Injuries among United States Surgeons: A Gender-stratified National Survey

Maria Tran, DO\*  
 Michael W. Kortz, MBA\*  
 Britt Johnson, JD, PhD\*  
 Jeffrey E. Janis, MD, FACS†

**Background:** Operation-related musculoskeletal injury (ORMI) among surgeons is a well-described phenomenon. Our study aimed to determine the prevalence of self-reported ORMI among surgeons of various subspecialties and preliminarily investigate the role of gender.

**Methods:** An anonymous survey, querying information pertinent to ORMIs, was distributed online through the American College of Surgeons community membership forum. Nonparametric univariate analysis and a multivariate regression model were conducted. A *P* value of 0.05 determined significance.

**Results:** A total of 624 male and female surgeons responded to the survey, with 50.8% reporting having an injury related to operating. Among the entire cohort, the prevalence of ORMI was significantly higher among female surgeons than male surgeons (*P* = 0.01), although there was no significant difference among the genders in ORMI prevalence when stratifying by age group (all *P* > 0.05).

**Conclusion:** Female surgeons are more likely to report an ORMI, although the impact of confounding variables such as age, operative case volume, and surgical subspecialty remain to be fully elucidated. (*Plast Reconstr Surg Glob Open* 2022;10:e4142; doi: 10.1097/GOX.0000000000004142; Published online 18 February 2022.)

## INTRODUCTION

A growing awareness is emerging of the high-risk postures maintained while surgeons spend long strenuous hours operating and the risk of subsequent musculoskeletal injury.<sup>1</sup> There is an unsatisfied demand for education on optimal ergonomics during operations to help mitigate against these types of injuries.<sup>2</sup> This lack of awareness and education has resulted in a high prevalence of musculoskeletal pain and injury that can affect the head, neck, shoulder, wrist, hand, and back.<sup>3</sup> Work-related injuries are more prevalent in procedural specialties and have yet to be addressed. With the proper intervention, these issues and injuries can be minimized, and could contribute to increased surgeon productivity, career longevity, and improvement in quality of life.<sup>4</sup>

Even with the growing awareness of musculoskeletal injuries in surgeons, little research has been done to specifically

explore both male and female surgeon operation-related musculoskeletal injuries (ORMIs).<sup>5</sup> This is necessary, as the ratio of male to female physicians is equalizing over time.<sup>6</sup> The percentage of women enrolling in medical schools in the United States exceeded men in 2019, at 50.5 percent.<sup>7</sup> As female physicians increase, it is expected that more women will enter surgical specialties, which are still currently male-dominated.<sup>8</sup> The current literature suggests that even though women are the minority in various surgical specialties, they report more pain and occupational injuries than their male counterparts. Studies performed in subspecialties like plastic surgery have confirmed that female surgeons report more injury after operating, but currently, the definitive reason behind this is unknown.<sup>9</sup> Another question is whether male surgeons are under-reporting early symptoms of pain, leading to subsequently worse work-related injuries.<sup>10</sup>

We designed this study to focus on prevalence of ORMIs in male and female surgeons to help elucidate underlying causes if they exist. Based upon prior data and studies, we speculate that female surgeons are more likely to experience these injuries.<sup>9</sup>

## METHODS

### Survey

An anonymous Qualtrics survey was distributed through the American College of Surgeons (ACS) community

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From the \*Kansas City University of Medicine and Biosciences, Kansas City, Mo.; and †Department of Plastic and Reconstructive Surgery, The Ohio State University Wexner Medical Center, Columbus, Ohio.

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membership forum between July and November 2020 (Table 1). The survey was an adaptation of a prior survey about musculoskeletal injuries in plastic surgeons.<sup>9</sup> However, we included additional questions to increase the surgical specialties represented and to focus on gender. The survey was posted to the community forums based upon specialty group (general surgery, minimally invasive surgery, breast surgery, resident and associate society, colorectal, rural surgery, endocrine, surgical oncology, bariatric, hepato-pancreato-biliary, women's surgeons, GI surgery, trauma, senior surgeons, plastic surgery, otolaryngology, vascular surgery, urological surgery, and pediatric surgery). These specialty groups contain members who may participate in multiple forums based upon interest. Participating members are certified surgeons verified by the ACS website. The ACS members/surgeons voluntarily participated in this anonymous survey by clicking on the link in the forum post. The survey collected information pertaining to demographic characteristics and history of musculoskeletal injuries. Questions were formatted as binary yes/no, multiple choice, or free text. The protocol for this research was approved by the Kansas City University School of Medicine and Biosciences Institutional Review Board.

It was not a requirement to answer every question in the survey to participate in the study. All responses were considered and recorded for analysis except for responses that left the entirety of the survey questions blank.

### Statistical Analysis

The data obtained from the survey were downloaded into a numerical Microsoft Excel (version 14.2.3) spreadsheet, which was then analyzed using SPSS software (version 27.0). Descriptive data are reported as means, simple proportions, or percentages. Non parametric chi-square analysis or Fisher exact test for counts less than five, unpaired *t* test, and ANOVA analyses were used to evaluate the association of ORMI as a binary dependent variable (yes/no) with independent variables of interest (gender, glove size, age, and injury in various areas in the body). Analysis of gender was stratified by men and women, while age was queried as both a continuous variable and categorical variable (five groups; 20–39, 40–49, 50–59, 60–69, and 70+). A two-variable logistic regression (categorical age and gender) was also conducted. Respondents who reported they were retired were included in the analysis, given that ORMI was queried based on its occurrence at any point during the respondents' careers. Statistical significance for all analyses was set at a *P* value less than 0.05.

## RESULTS

Our survey had 683 responses from surgeons who participated from the ACS community board. Of these, 652 were valid and completed the end of the survey. Of these, 238 (36.5%) were women, 386 (59.2%) were men, and 28 (4.3%) preferred to self-describe or did not respond to the question. A total of 624 male and female surgeons were then coded for analysis. Most responses came from the general surgery community forum (40%). The majority were hospital-employed surgeons (33.3%) and academic

### Takeaways

**Question:** What is the prevalence of self-reported operation-related musculoskeletal injuries (ORMIs) among surgeons between genders?

**Findings:** Female surgeons are more likely to report an ORMI, although the impact of confounding variables such as age, operative case volume, and surgical subspecialty remain to be fully elucidated.

**Meaning:** Female surgeons may report more injury, so more research should be done on the prevalence and prevention of ORMIs in female and male surgeons.

**Table 1. The Survey Structure**

1	What is your age?
a.	(Open field for comment)
2	What is your gender?
a.	Man
b.	Woman
c.	Nonbinary/third gender
d.	Prefer to self-describe (open field for comment)
3	What is your practice type?
a.	Solo private practice
b.	Group private practice
c.	Hospital-employed
d.	Academic
4	What is your area of specialization (categorized by the American College of Surgeons)
a.	Cardiothoracic surgery
b.	Colon and rectal surgery
c.	General surgery
d.	Neurosurgery
e.	Obstetrics and gynecological surgery
f.	Gynecologic oncological surgery
g.	Ophthalmic surgery
h.	Oral and maxillofacial surgery
i.	Otolaryngology (ENT)
j.	Pediatric surgery
k.	Plastic surgery
l.	Urology
m.	Orthopedic surgery
n.	Vascular surgery
o.	Minimally invasive (endoscopic/laparoscopic/ robotic) surgery
5	What is your dominant hand?
a.	Right
b.	Left
c.	Both
6	What is your glove size?
a.	5.5
b.	6
c.	6.5
d.	7
e.	7.5
f.	8
g.	8.5
h.	9
7	Approximately, how many surgical cases do you perform every year?
a.	(Open field for comment)
8	Have you ever sustained a musculoskeletal injury directly related to your job as a surgeon?
a.	Yes
b.	No
9	If you answered yes to question 8, please briefly describe the injury and the circumstances under which it may have occurred.
a.	(open field for comment)
10	If you answered yes to question 8, has this injury caused you to decrease your surgical workload?
a.	Yes (if so, by how much in percent)
i.	(Open field)
b.	No

(Continued)

Table 1. (Continued)

11	If you answered yes to question 8, have you ever had to take time off work because of this injury?
a.	Yes (if so, how long?)
i.	(Open field)
b.	No
12	If you answered yes to question 8, have you ever had to have surgery for this injury?
a.	Yes (if so what kind of surgery?)
i.	(Open field)
13	Have the injuries that you have incurred from prior performed surgeries affected the quality and the duration of future surgeries?
a.	Yes (if so, please elaborate)
b.	No
14	Have you incurred injuries outside of surgery that attribute to your ability to perform surgery?
a.	Yes (if so, please elaborate)
b.	No
15	Have you ever had any physical discomfort or symptoms you would attribute to your job as a surgeon?
a.	Yes
b.	No
16	If you answered yes to question 15, which of the following apply? (Check all that apply)
a.	Numbness
b.	Stiffness
c.	Fatigue
d.	Pain
e.	Other (Open field for comment)
17	If you answered yes to question 13, which body parts are most commonly affected? (Check all that apply)
a.	Head
b.	Neck
c.	Shoulders
d.	Upper back
e.	Mid back
f.	Lower back
g.	Arms
h.	Hands
i.	Legs
j.	Feet
k.	Other (open field for comment)
18	If you answered yes to question 15, when do these symptoms or discomfort you?
a.	During surgery
b.	Immediately after surgery
c.	Later after surgery (starts hours or days later)
d.	Persistently
e.	Other (insert open field for comment)
19	What is the severity of the pain? (0 being no pain at all and 10 being the worst pain you've ever had)
a.	0
b.	1
c.	2
d.	3
e.	4
f.	5
g.	6
h.	7
i.	8
j.	9
k.	10
l.	Other (open field for comment)
20	If you answered yes to question 15, performing what surgical procedure (s) is most likely to cause your symptoms
a.	(Open field for comment)
21	If you answered yes to question 15, what measures have you taken to minimize these problems or conditions (check all that apply)
a.	None
b.	Avoidance of exacerbating activity (please describe how) (open field for comment)
c.	Modification of work environment (please describe how) (open field for comment)
d.	Physiotherapy
e.	Exercise (please describe) (open field for comment)

(Continued)

Table 1. (Continued)

f.	Other (open field for comment)
22	If you answered yes to question 15, do you think the inappropriate sizing of instruments attribute to your symptoms or discomfort?
a.	Yes
b.	No
23	If you answered yes to question 15, do you think your gender affects your ability to report the pain?
a.	Yes (if so, in what way?) (Open field for comment)
b.	No
24	If you answered yes to question 15, what do you believe is the primary cause behind your musculoskeletal pain?
a.	(Open field for comment)
25	Have you ever been given recommendations to improve surgical ergonomics?
a.	Yes
b.	No
26	If you answered yes to question 25, where did you receive this information?
a.	(Open field for comment)
27	If you answered yes to question 25, have you been able to implement these recommendations to your surgical practice?
a.	Yes
b.	No
28	Are you a retired surgeon?
a.	Yes
b.	No
29	Would you like to receive results of this study? If so, please provide an email address to allow us to send you the results.
a.	Yes (open field for comment)
b.	No

surgeons (29%). Both female and male surgeons practiced more at hospitals and academic settings versus a solo or group private practice.

Of the 624 surgeons coded for analysis, there were 386 (61.9%) men and 238 (38.1%) women, with 317 (50.8%) respondents having sustained an ORMI. There was a significant difference between the average age of female surgeons (51) and male surgeons (59) ( $P < 0.01$ ). However, there was not a significant association between increasing age and acquiring musculoskeletal injury ( $P = 0.32$ ). There was a significant difference between the average annual caseloads for female surgeons (318) and male surgeons (389) ( $P < 0.01$ ). Despite varying participation between surgical specialties, there was not a significant difference between caseloads and musculoskeletal injury with ANOVA analysis ( $P = 0.09$ ). On univariate analysis, female surgeons were significantly more likely than male surgeons to have an ORMI ( $P = 0.01$ ) (Table 2). Regarding age as a categorical variable, 43.5% of women and 25.0% of men aged 20–39 years reported injury ( $P = 0.43$ ), 46.8% of women and 42.0% of men aged 40–49 years reported injury ( $P = 0.70$ ), 51.7% of women and 52.4% of men aged 50–59 years reported injury ( $P = 0.98$ ), 69.4% of women and 60.9% of men aged 60–69 years reported injury ( $P = 0.36$ ), and 86.7% of women and 94.7% of men aged 70+ years reported injury ( $P = 0.64$ ) (Fig. 1). On multiple logistic regression, older age cohorts were significantly more likely have an ORMI compared with the 20–39 age group (40–49:  $P = 0.04$ ; 50–59:  $P < 0.01$ ; 60–69:  $P < 0.001$ ; 70+:  $P < 0.001$ ). ORMI risk was not significantly related to gender when adjusting for categorical age group ( $P = 0.59$ ).

**Table 2. Demographic Details Asked on the Survey**

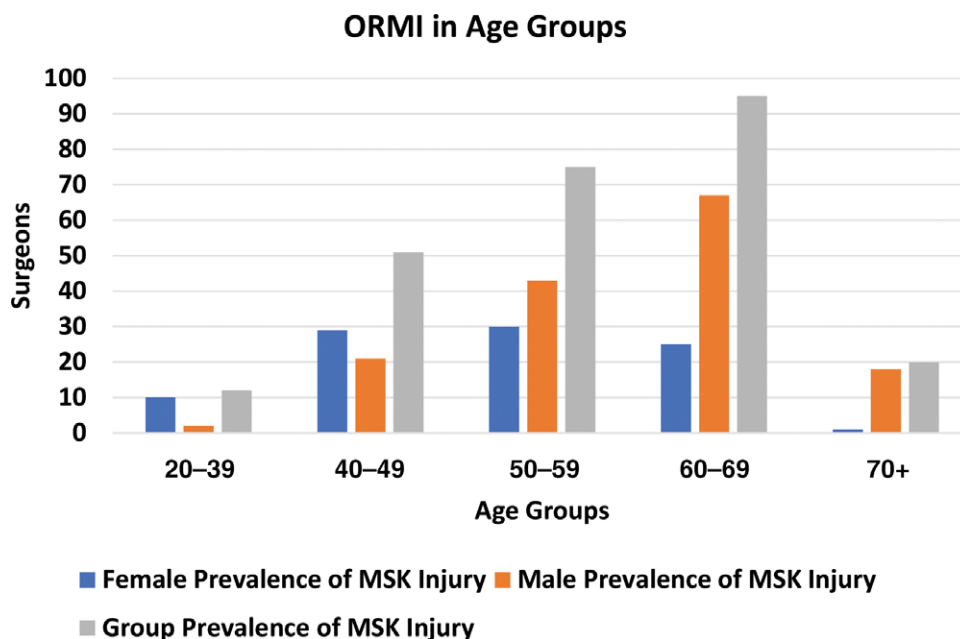
	Women	Men	P
N (%)	238 (36.5)	386 (59.5)	—
MSK injury (%)*	124 (52)	193 (50)	0.01
Average age (y)	51	59	—
Average glove size	6.5	7.5	—
Average annual no. cases performed*	318	389	<0.01
Right handedness(%)	212 (88.3)	336 (87.7)	—
Solo private practice (%)	81 (20.9)	81 (20.9)	—
Group private practice (%)	80 (20.7)	80 (20.73)	—
Hospital employed (%)	12 (31.6)	122 (31.6)	—
Academic (%)	10 (26.7)	103 (26.7)	—
Retired (%)	9 (5.4)	34 (14.5)	—
Do you think gender affects your ability to report pain?*(%)	55 (23.1)	21 (6.7)	<0.01
Do you think inappropriate sizing attributes to symptoms of discomfort?*	100 (50.6)	51 (16.4)	<0.01

\*Significant difference exists,  $P < 0.05$ .

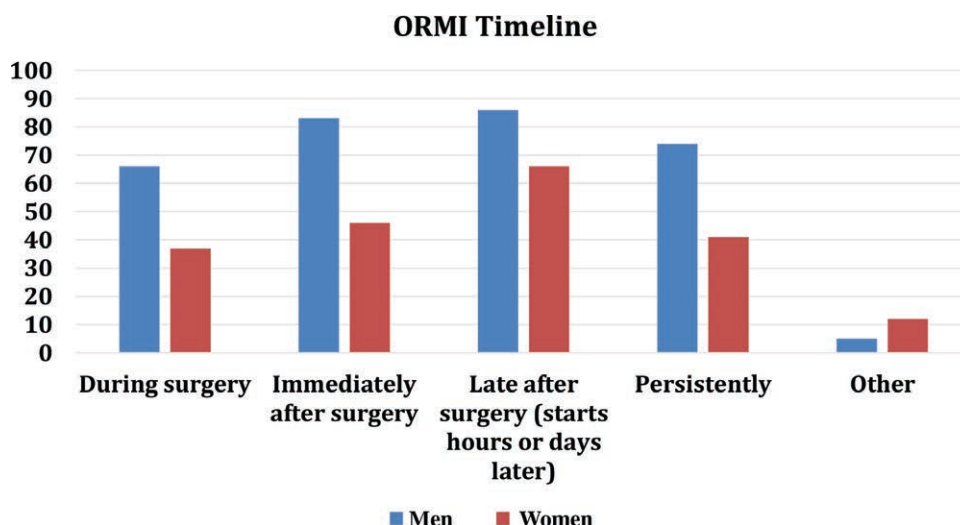
A significant difference between musculoskeletal injury is seen between male and female surgeons, and average number of cases between female and male surgeons, with gender affecting ability to report pain, and inappropriate sizing attributing to discomfort using chi-square analysis with  $P < 0.05$ .

Female surgeons reported experiencing symptoms hours or days later, whereas male surgeons reported feeling symptoms more immediately after surgery ( $P < 0.01$ ) (Fig. 2). Both female and male surgeons reported pain as the most experienced symptom (Fig. 2). There was no significant difference between rating the severity of the pain on a scale of 0 to 10 between genders, with the average rating 5 out of 10. Four hundred twenty three free text responses were given, and some form of laparoscopic procedure was most frequently reported (29%), followed by subjectively long (2 to >6 hours) procedures (24%) then open surgeries (13%). In total, 26.7% of surgeons state that they have incurred injuries outside of surgery that attribute to their ability to perform surgery. Neither male nor female surgeons had a significant difference of incurring injury outside of performing surgery.

Most of the male participants specialized in general surgery (32%), followed by cardiothoracic surgery (10%) and then vascular surgery (10%) (Fig. 3). Of the 124 male general surgeons, 45.9% reported having a musculoskeletal injury. Of the 39 male cardiothoracic surgeons, 53% reported having a musculoskeletal injury. Of the 38 male vascular surgeons, 50% reported having a musculoskeletal injury. Of the 37 male pediatric surgeons, 32% reported injury. Of the 32 male ENT surgeons, 47% reported injury. Of the 31 male plastic surgeons, 68% reported injury. Of the 22 male colon and rectal surgeons, 36% reported injury. Of the 22 male minimally invasive surgeons, 55% reported injury. Of the 18 male urology surgeons, 67% reported injury. Of the nine male orthopedical surgeons, 78% reported injury. Of the 6 male neurosurgical surgeons, 50% reported injury. Of the six male oral and maxillofacial surgeons, 83% reported injury. The single male



**Fig. 1.** Prevalence of ORMI in five different age groups. The blue bar represents female surgeons, the orange bar represents male surgeons, and the gray bar represents the total number of surgeons in the age group. The 50–69 age group is an inflection point in total prevalence of ORMI. No significant differences in ORMI between men and women were seen by age group with  $P$  value of less than 0.05.



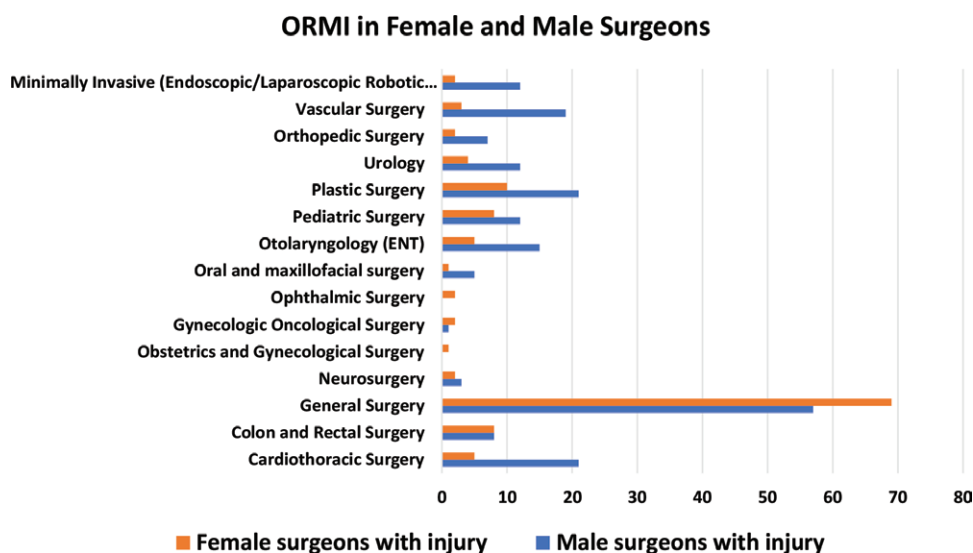
**Fig. 2.** The timeline of male vs female surgeons experiencing pain during or after operating. Men were found to significantly experience more pain and injury after surgery in comparison with women in chi-square analysis.

gynecologic and oncological surgeon reported injury. The single obstetrics and gynecological male surgeon did not report injury. No male ophthalmic surgeons participated.

Most of the female participants also specialized in general surgery (57%), followed by plastic surgery (7%), and then ENT surgery (7%) (Fig. 3). Of the 136 female general surgeons, 50.7% reported having a musculoskeletal injury. Of the 17 female plastic surgeons, 58.8% of them reported musculoskeletal injury. Of the 16 female ENT surgeons, 31.6% of them reported musculoskeletal injury. Of the 15 female plastic surgeons, 53% reported injury. Of the 14 female colon and rectal surgeons, 57% reported injury. Of the eight female urology surgeons, 50% reported injury. Of the seven female cardiothoracic surgeons, 71% reported injury. Of the seven female vascular surgeons,

42% reported injury. Of the four female minimally invasive surgeons, 50% reported injury. Of the three female orthopedic surgeons, 66% reported injury. Of the three female oral and maxillofacial surgeons, 33% reported injury. Of the two female gynecologic oncological surgeons, 100% reported injury. Of the two female obstetrics and gynecological surgeons, 50% reported injury. Of the two female neurosurgical surgeons, 100% reported injury.

The most common glove size was 6.5 for female surgeons and 7.5 for male surgeons. An estimated 35% of female surgeons wore a glove size of six or smaller, with 60.7% of these reporting a musculoskeletal injury. In total, 24.9% of male surgeons wore a glove size smaller than seven, with 51% of them reporting musculoskeletal injury. Of all surgeons with a glove size of 7.5 or greater, 49.2%



**Fig. 3.** Prevalence of operation-related musculoskeletal injury among female and male surgeons that participated in this survey based upon specialty. Female surgeons are represented by the orange bar, and male surgeons are represented by the blue bar.

reported having an injury. More female surgeons reported that inappropriate instrument size attributed to their discomfort ( $P < 0.01$ ).

The neck was the most reported area of musculoskeletal pain in all surgeons, irrespective of gender (20%) (Fig. 4). Female surgeons reported feeling the most musculoskeletal discomfort in their neck (19%) and shoulders (18%), whereas male surgeons reported having the most pain in their neck (21%) and lower back (17%). The majority of both male and female surgeons in this survey have used exercise as a measure to alleviate injury and physical discomfort.

Of all participants, 23.3% reported having to decrease their surgical workload due to their musculoskeletal injuries. In total, 39% stated that they had to take time off work, ranging from as little as 5% workload decrease to 100% from early retirement due to severity of symptoms. 26% of surgeons stated that they had to have surgery for the injury that they obtained from operating. Twenty four percent of surgeons stated that their injury continued to affect their quality and duration of future surgeries. Overall, 35% of male surgeons reported having to take time away from work due to their injuries versus 29.8% of female surgeons.

There were 43 retired surgeons that participated in the study (79% men; 21% women), with a greater proportion of men reporting injury during their careers (55.9% versus 44%).

Those that reported injury had the option of entering open-ended text responses to describe type and severity of their symptoms. The responses included answers about a variety of neck pain, back pain, carpal tunnel syndrome, and tendonitis in the arms. The responses also included causes of their musculoskeletal injuries. Over 100 participants, men and women, responded with answers including the terms “poor ergonomics” or “positioning.” In total, 194 participants reported receiving information on how to improve the ergonomics and 168 participants

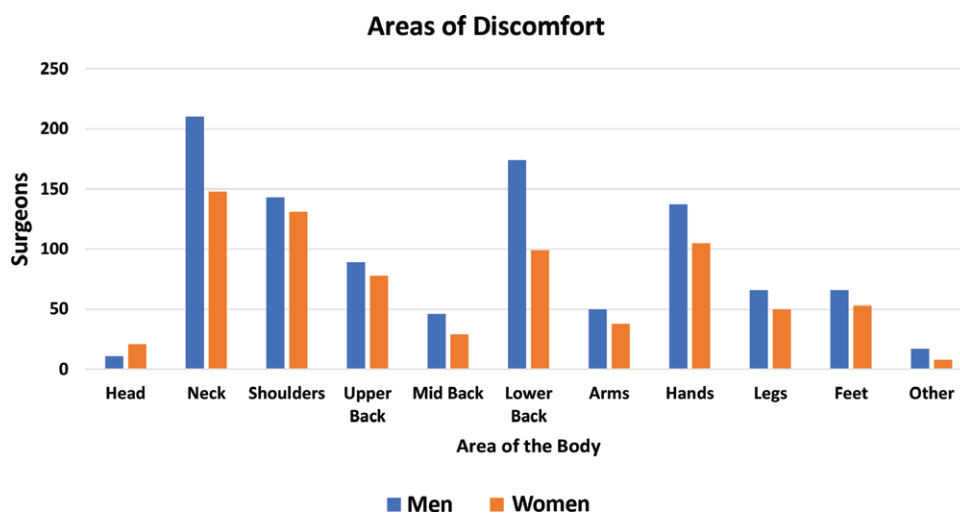
reported being able to implement it into their practice. The most common types of procedures that caused injury mentioned in the responses are shown in Figure 4. No difference was seen between types of procedures and musculoskeletal injury between male and female surgeons.

A total of 15% of all surgeons participating in this survey believed that their gender affects their ability to report the pain. There were a significant number of female surgeons believing that gender affects their ability to report their pain in comparison with their male peers ( $P < 0.01$ ). There were multiple reasons reported in the open-ended text responses, but a prominent reason was that surgeons are discouraged from complaining. Female surgeons reported not wanting to appear “weaker” than their male counterparts. Male surgeons felt pressure to “be tougher” and feeling as if they are not allowed to complain. There were also complaints of poor operation ergonomics due to instrument size and table height.

## DISCUSSION

Musculoskeletal symptoms were surveyed amongst female and male surgeons across different surgical specialties to investigate potential gender differences and to expand on prior research reporting female surgeons experiencing more musculoskeletal injury than male surgeons to help better elucidate the causes.<sup>10–12</sup> In our study surveying 624 male and female participants, we have found that there were significantly more women reporting injury than men, despite the lower participation of 36.5% of female surgeons compared with the 59.2% of male surgeons. These findings are comparable to previous studies that found female surgeons in other specialties tend to experience more symptoms due to occupational injury.<sup>9,11,13,14</sup> This is problematic because as the gender gap in surgery lessens, there will be more of a need to address the causes of these injuries.

In our study, the average glove size was 7.5 for men and 6.5 for women. Even though our study did not reveal



**Fig. 4.** Areas of discomfort. Neck and lower back were most frequently the area of discomfort among male surgeons. Neck and shoulders were most frequently the area of discomfort among female surgeons.

significance in smaller glove size leading to injury, a significant number of surgeons self-reported that hand size could be the cause behind physical discomfort in their hands. Women have a smaller glove size, on average, and prior studies have shown that ill-fitting instruments are associated with greater difficulty and injury.<sup>11</sup> The correct sizing could improve excess ulnar and radial deviation, ring handle pressure on fingers, and pressure on the thenar eminence that leads to better operation ergonomics.<sup>15</sup> The prevention of injury in surgeons may also be addressed by implementing micro breaks.<sup>4</sup>

Male and female surgeons that experienced injury had the option to state which procedures caused them symptoms. The most frequent answers included laparoscopic procedures, long procedures (procedures that lasted over an hour), and open surgeries. The association of pain with laparoscopic procedures causing pain has been documented previously, and this study confirms those findings, with no difference reported between genders.<sup>1,5,16</sup> Furthermore, longer open surgeries tend to promote poorer ergonomics for longer periods of time, leading to more injury, which is also consistent with previous literature.<sup>1-5,9-21</sup>

With regard to age, the female surgeons that participated in our study were, on average, 8 years younger than male respondents (51 versus 59). On multiple logistic regression, older age cohorts were significantly more likely to have an ORMI compared with the 20–39 age group (40–49:  $P = 0.04$ ; 50–59:  $P < 0.01$ ; 60–69:  $P < 0.001$ ; 70+:  $P < 0.001$ ). This has been shown in prior studies and may be due to ORMI accumulating over years of practice.<sup>10,20</sup> However ORMI risk was not significantly related to gender when adjusting for categorical age group ( $P = 0.59$ ). The statistical claims between male and female surgeons cannot be made due to much lower older female surgeon participation. This will require further investigation, as more women enter the field of surgery and the average age of female surgeons become closer to the average age of their male peers.

One of the focuses of our survey was to address the fact that little is known about retired surgeons and the role that ORMIs may have played in their careers, and even decisions on retirement. A total of 7% of participants identified as retired surgeons and their participation did not bias the data, as no change in significance is seen when this group is excluded. Retired male surgeons more frequently reported injuries than their retired female counterparts. Reported injuries amongst older male surgeons were typically chronic. One 60-year-old male surgeon reported partial cord transverse myelitis, which ended his surgical career and forced him into retirement. This may indicate that men tend to report less ORMI, but the lack of reporting may lead to more chronic severe injury in the long term as has been suggested in prior research.<sup>10</sup> As more women are joining surgical specialties, more research will be necessary to discover if there will be a significant difference in ORMIs between retired male and female surgeons.

The study investigated any gender discrepancy of reporting these injuries qualitatively with the psychosocial

theme of women or men not wanting to appear “weaker” or “less tough” than their peers, regardless of gender. Male surgeon responses included feeling they must “suck it up,” that men are “expected to be tough,” and that men are expected not to complain or report. Female surgeons reported feeling like they already are “respected less” and do not want to complain in fear of appearing weaker than their male equivalents. There were a significant number of female surgeons believing that gender affects their ability to report their pain in comparison with their male peers ( $P < 0.01$ ). One female respondent reported “no one cares” because she is a female surgeon. These feelings are unfortunately not an uncommon theme seen in surgery for women, as prior narratives have disclosed surgery being unwelcoming to women that aspire to be surgeons.<sup>22-24</sup> Other psychosocial factors were not asked about or addressed in the questionnaire. A smaller study adjusting for age, practice-type, and subspecialty, comparing genders and with the help of psychology experts would be valuable to elucidate differences between male and female surgeons.

Even if one disregards the gender differences, it is clear many of the surgeons that participated in this survey reported obtaining ORMI due to poor ergonomics. Research has suggested that harmful injuries may be prevented by including neutral posture correction; adequate lighting; elbow angle between 90 and 120 degrees; adjusting table and seat heights, floor mats, and proper magnification loupe size; and allowing microbreaks at least every 15 minutes.<sup>4,15,25-28</sup> Surgeons routinely performing vaginal surgery emphasized table-mounted retractors and camera use as critical to improving ergonomics in the operating room.<sup>29</sup> Applying these methods of prevention to surgical practice should be made, and given that these injuries may start as early as residency, prevention should be emphasized to residents.<sup>30</sup>

There are several limitations to this study. Selection bias may be a factor as the individuals responding to this survey from the ACS forums believed injuries in surgeons to be important. The surgery specialties were limited to the available categories on the ACS website, and the survey was given to only surgeons that are active on the ACS community board. The members of ACS were allowed to be a part of several group forums, and it was not possible to account for duplicate members. Community membership during the duration of the survey being distributed may have increased or decreased in member size and therefore could not be accounted for. The activity of the accounts was also variable, and the ACS website administrators are not tracking membership activity. Therefore, the rate of musculoskeletal injuries reported by the participants may be higher than the general population of surgeons. Future smaller studies should focus on locoregional subpopulations, including coalescing subspecialties with similar operating characteristics (ie, surgical duration and ergonomics) as well as accounting for academic versus community practice and other factors (ie, the role of graduate medical education and the prevalence of ORMIs before a surgical career starts). There are also no data on the nonparticipants of the study, and partial responses

lead to differing participation numbers to each question. There is also the subjective nature of self-reported data. All participants were surgeons; however, there was no distinction between residents and attendings. Future studies would benefit from distinguishing between these distinct stages of practice. Due to the limitations of vast differences in ages and in performing a valid regression, optimal age groups could not be used to completely distinguish between experienced versus less-experienced surgeons. Regarding surgeons' duration of practice, it is noted that as surgeons age, strength and visual acuity diminishes. This can have impacts on operative performance.<sup>31,32</sup> This could synergistically compound with ORMIs. Other limitations include the fact that there was also a lower participation rate among female surgeons in comparison with male surgeons, although that may be inherent to the numbers in the field.

Despite these limitations, this research points out the prevalence of injuries across surgical subspecialties and between genders, which reinforces the importance of the need to improve operation ergonomics and add to the growing research addressing how "tough" surgery culture is leading to injuries and burnout. This culture is affecting female and male surgeons slightly differently, but it still greatly impacts both genders in the field of surgery.

## CONCLUSIONS

The research of improving the ergonomics of operating and musculoskeletal injury in surgeons has been gradually increasing and gaining more recognition. As women in surgery increase, so should the studies on the prevalence of ORMIs in female versus male surgeons. The long-term effects of these injuries can lead to decreased workload and performance, and even early retirement. It is crucial to point out the injuries surgeons face due to poor ergonomics. It is also important to reveal the underlying "tough it out" culture that might be allowing these injuries to persist and go underreported in both male and female surgeons.

**Jeffrey E. Janis, MD, FACS**

Department of Plastic and Reconstructive Surgery  
The Ohio State University Wexner Medical Center  
915 Olentangy River Rd  
Columbus, OH 43212  
E-mail: [jeffrey.janis@osumc.edu](mailto:jeffrey.janis@osumc.edu)  
Twitter: @jjanismd  
Instagram: [jeffreyjanismd](https://www.instagram.com/jeffreyjanismd)

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