ORIGINAL RESEARCH

# Pain and Discomfort Among Mohs Surgeons: An Ergonomic Model of Procedural Dermatologists

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## ABSTRACT

**Background:** Dermatologic surgeons are at risk for work-related injuries and chronic pain.
**Objectives:** To investigate the prevalence and characteristics of pain and discomfort among fellowship trained Mohs surgeons across the United States
**Methods:** A cross-sectional survey study was conducted of members of the American College of Mohs Surgery (ACMS). Participants reported the continuous variables of hours spent working, standing versus sitting while operating, typing to the electronic medical record, and exercising per week.
**Results:** 107 male and female respondents participated. 88.7% of respondents reported chronic pain; the most common anatomic locations for pain were the neck (54.2%), upper back (38.2%), and lower back (33.6%). At these anatomic locations, male respondents less frequently complained of upper back pain (odds ratio (OR) 0.349, 95% confidence interval (CI) 0.155 to 0.787; $P = 0.010$) but more frequently complained of lower back pain (OR 2.462, 95% CI 1.606 to 13.320; $P = 0.044$), than female respondents. Respondents were significantly more likely to report regular pain-relieving medication use when suffering from pain at the neck (OR 4.665, 95% CI 1.450 to 15.007; $P = 0.006$) or upper back (OR 3.366, 95% CI 1.251 to 9.054; $P = 0.013$). Respondents regularly using sit-stand stools were less likely to report neck pain (OR 0.326, 95% CI 0.105 to 1.015; $P = 0.046$).
**Conclusions:** Pain is prevalent among Mohs surgeons. Adopting and training in an ergonomically-friendly environment and incorporating an ergonomically aware mindset early in a surgeon's career may decrease one's risk for job-related injury and pain.

## INTRODUCTION

Proceduralists are susceptible to work-related musculoskeletal disorders and chronic pain. Among dermatologists, there is a concordant rise in the risk of musculoskeletal injuries and the numbers of procedures performed.[1] Therefore, operating without pain and discomfort is an important factor in the productivity and longevity of a procedure-performing dermatologist. Such dermatologists often practice in awkward postures given the need to operate on all parts of the body, perform repetitive movements and either sit or stand for long periods of time.[2,3,4] These various risk factors contribute to the high prevalence of musculoskeletal disorders among members of the American College of Mohs Surgery (ACMS).

Ergonomics is the science of fitting workplace conditions and job demands to the capability of the working population, and poor surgical ergonomics have likely contributed to pain, headaches and stiffness in the neck, lower back and shoulders.[5,6] Multiple previous publications report that poor posture is the most commonly identified ergonomic error. The resultant increase in intervertebral disc pressure, primarily of the cervical and lumbar spine, contributes to spinal hypermobility and fractures that accumulate as degenerative changes. Correcting a surgeon's setup, posture and initiating "postural resets" are necessary for a longer, healthier and pain-free surgical career. [7,8,9]

A previous survey conducted in 2010 from the ACMS assessed the prevalence, type and severity of work-related musculoskeletal injuries and addressed work style habits, attitudes and the role of ergonomics in dermatologic surgery.[1] We aim to investigate the current prevalence of pain and discomfort among ACMS members and provide further insight on what practices and characteristics are associated with a more comfortable, injury-free career for both Mohs surgeons and ancillary staff members.

## METHODS

A survey created through Google Forms (Google, Mountain View, CA) was distributed to members of the ACMS in March 2023. Data was collected for one month. This study was given exempt status from the Institutional Review Board (IRB) at the University of Alabama at Birmingham (UAB). Survey contents included baseline demographics, workstyle preferences, operating preferences, use of vision correction, hours spent operating per week and exercise habits. Demographics included age, sex, years in practice, height and weight. Pain assessment was also conducted with a focus on anatomic location of pain.

### Statistical Analysis

The presence or absence of pain in each respondent was indicated nominally (e.g., yes or no) for each anatomic location (eyes, neck, shoulders, elbows, wrists, fingers, upper back, lower back, hips, knees, legs, and feet) and, if present, quantified using an ordinal ten-point linear analog self-assessment (LASA) pain scale. Additionally, a summary pain score was calculated for each respondent as a mean of their individual, anatomically localized pain scores. Given the intrinsic subjectivity of pain, analysis was performed with non-parametric tests and ordinal regression.[10,11]

First, pain was statistically described by frequency, and when present, its scores were described by median severity with interquartile ranges. Summary and anatomically localized pain scores were compared with the Kruskal-Wallis one way-analysis of variance. The significance of relationships between the reporting of pain and categorical variables (i.e., sex, preferred operating height, regular pain relief use, primary form of exercise and anti-fatigue equipment used) was determined by the chi-squared test, when ≤20% of expected cell counts were <5, or Fisher's exact test, when >20% of expected cell counts were <5. The significance of relationships between ordinal pain scores and categorical variables was determined by the Mann-Whitney test for independent samples. Lastly, the statistical relationships between ordinal pain scores and quantitative variables (i.e., age, years in practice, height, weight, body mass index (BMI), time working per week, time on break per day, time sitting versus standing while operating, time typing into the electronic medical record (EMR) per day, nurses/medical assistants per physician, and time exercising per week) were determined by ordinal regression. A minimum sample size of twenty-five respondents was implemented per regression. Calculations were performed with IBM SPSS Statistics version 29.0.0.0 (International Business Machines Corporation, Armonk, NY) and visualization was designed with Prism 9 version 9.5.1 (GraphPad Software, Boston, MA).

## RESULTS

### Respondent Demographics and Lifestyle Habits

107 total responses were collected. The demographics of the respondents are similar to those of the survey published in 2012 by Liang et al. (**Table 1**).[1] The mean age across respondents was 46.1 years with a standard deviation (SD) of 10.6 years. 61.7% of respondents identified themselves as male and 38.3% of respondents identified themselves as female. On average, respondents were 68.4 ± 4.2 inches tall and weighed 161.0 ± 33.9 pounds (mean ± SD); the mean respondent body mass index (BMI) was 23.9 kg/m$^2$ ± 3.1 kg/m$^2$ (mean ± SD).

Regular exercise was frequently reported (90.7%) and time spent exercising was well-distributed (mean ± SD, 161 ± 127 minutes/week). 9.3% of respondents engaged in no exercise, 65.4% primarily performed cardiovascular training, 20.6% primarily performed strength training, and 4.7% primarily performed flexibility training.

### Workstyle Habits

On average, respondents worked 39.8 ± 9.2 (mean ± SD) hours per week, had 28.5 ± 22.5 minutes of break per day, and spent 43.6 ± 41.4 minutes per day typing into the electronic medical record (EMR). In terms of operating position, respondents spent 75.7 ± 29.0 (mean ± SD) % of their time sitting versus standing.

Regarding corrective eyewear, 48.6% reported loupes, 42.1% used glasses, 25.2% used contacts and 20.6% did not use corrective eyewear. 80.4% of participants did not use pain relieving medications regularly for musculoskeletal pain.

Of the 100% of respondents who endorsed performing Mohs surgery, 89.7% also performed excisions, 20.6% utilized lasers or other energy-based devices, 25.2% used injectables, and 0.9% performed liposuction. 52.3% of respondents preferred to operate at elbow level, 41.1% preferred chest level, 2.8% below elbow level, 2.8% shoulder level, and 0.9% eye level. A wide variety of equipment was employed by respondents to reduce work-related discomfort and fatigue (**Table 1**).

### Pain

88.7% of all respondents reported pain at least once. Pain was most frequently reported in the neck (54.2%), followed by the upper back (38.2%), lower back (33.6%) and shoulders (30.8%) (**Figure 1**). There was no statistical difference in pain severity by anatomic location ($P$ = 0.679). The median pain score (range: 0-10) reported was 3/10 and pain onset most frequently occurred within the first five years of practice or after ten years of practice.

**Table 1.** Respondent Demographics and Workstyle Habits

| Characteristic | Respondents (n=107) | Liang et al. 2011 (n=354) |
|---|---|---|
| **Age, years, mean ± SD** | 46.1 ± 10.6 | 44.5 ± 9.0 |
| **Sex, No. (%)** | | |
| Male | 66 (61.7) | 251 (71) |
| Female | 41 (38.3) | 103 (29) |
| Height, inches, mean ± SD | 68.4 ± 4.2 | 68.7 ± 3.9 |
| Weight, pounds, mean ± SD | 161.0 ± 33.9 | 164.0 ± 32.5 |
| BMI, kg/m$^2$, mean ± SD | 23.9 ± 3.1 | 24.2 |
| Time spent exercising per week, minutes, mean ± SD | 161 ± 127 | NA |
| **Primary form of exercise, No. (%)** | | |
| None | 10 (9.3) | NA |
| Strength training | 22 (20.6) | NA |
| Cardiovascular training | 70 (65.4) | NA |
| Flexibility training | 5 (4.7) | NA |
| Hours worked per week, mean ± SD | 39.8 ± 9.2 | 42.2 ± 9.0 |
| Minutes of break per day, mean ± SD | 28.5 ± 22.5 | 24.6 ± 20.4 |
| Time per day spent typing in EMR, minutes, mean ± SD | 43.6 ± 41.4 | NA |
| Time spent sitting versus standing while operating, %, mean ± SD | 75.7 ± 29.0 | NA |
| **Preferred operating height, No. (%)** | | |
| Eye-level | 1 (0.9) | NA |
| Shoulder level | 3 (2.8) | NA |
| Chest level | 44 (41.1) | NA |
| Elbow level | 56 (52.3) | NA |
| Below elbow level | 3 (2.8) | NA |
| **Procedures performed on a regular basis, No. (%)** | | |
| Mohs surgery | 107 (100) | 354 (100) |
| Excision | 96 (89.7) | 339 (95.7) |
| Laser/energy-based devices | 22 (20.6) | 169 (47.7) |
| Injectables | 27 (25.2) | 155 (43.8) |
| Liposuction | 1 (0.9) | 27.3 (7.7) |
| **Anti-fatigue equipment used, No. (%)** | | |
| None | 6 (5.6) | NA |
| Compression stockings | 62 (57.9) | 122 (34.5) |
| Ergonomic eyewear | 52 (48.6) | 116 (32.8) |
| Orthopedic shoes | 38 (35.5) | NA |
| Ergonomic microscope | 33 (30.8) | 104 (29.5) |
| Sit-stand stool | 16 (15.0) | 57 (16.3) |
| Anti-fatigue mat | 9 (8.4) | 58 (16.5) |
| Orthotic shoe inserts | 10 (0.9) | NA |
| Massage Ball | 10 (0.9) | NA |

Male participants were significantly less likely than female participants to report chronic pain affecting their wrists (OR 0.347, 95% CI 0.265 to 0.453; $P$ = 0.002) and upper backs (OR 0.349, 95% CI 0.155 to 0.787; $P$ = 0.010) (**Table 2**). Alternatively, male participants were more likely to report lower back pain (OR 2.462, 95% CI 1.013 to 5.979, $P$ = 0.044). Even though no male participants reported wrist pain (0/66, 0%), there were no statistical differences in pain severity by sex for any anatomic location or summary pain score. There were also no statistical differences in either the frequency or severity of pain based on operating height. Respondents regularly taking pain-relieving medications were significantly more likely to report finger (OR 4.625, 95% CI 1.606 to 13.320; $P$ = 0.006), neck (OR 4.665, 95% CI 1.450 to 15.007; $P$ = 0.006), eye (OR 3.456, 95% CI 1.197 to 9.975; $P$ = 0.029), upper back (OR 3.366, 95% CI 1.251 to 9.054; $P$ = 0.013) and leg pain (OR 5.063, 95% CI 1.312 to 19.540; $P$ = 0.024) than those not (**Table 2**). Only pain in the upper back ($P$ < 0.001, $Z$ = -3.672), neck ($P$ = 0.002, $Z$ = -3.142), leg ($P$ = 0.007, $Z$ = -2.703) and shoulder ($P$ = 0.022, $Z$ = -2.290) were statistically more severe among respondents regularly taking pain-relieving medications (**Table 2**).

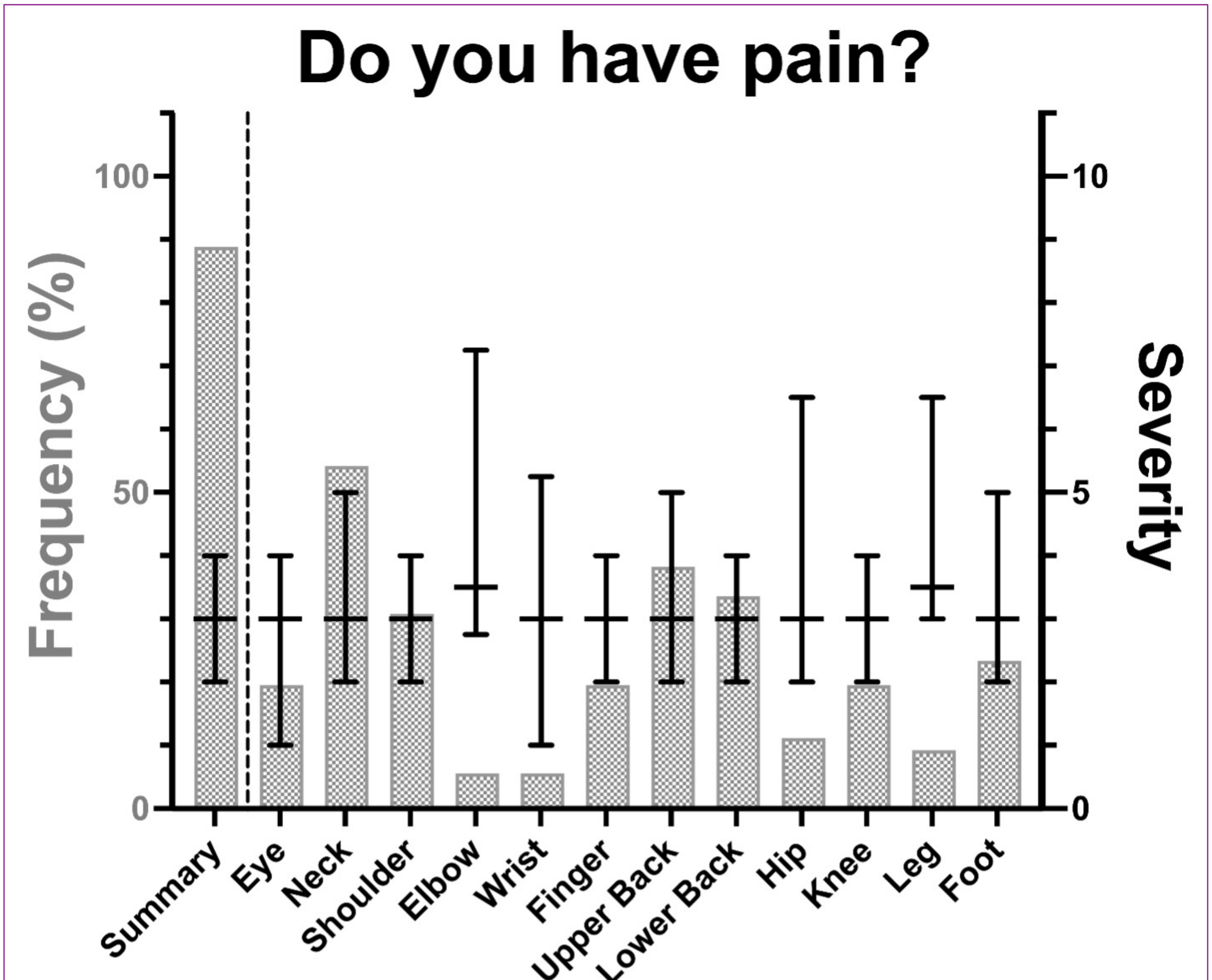


**Figure 1.** Anatomically localized and summary pain scores by frequency of reporting (left axis) and severity (right axis). Per Kruskal-Wallis test, differences in severity between groups are nonsignificant ($P$ = 0.679).

In terms of anti-fatigue equipment use, sit-stand stools were associated with differences in pain frequency; surgeons less frequently reported neck pain when utilizing sit-stand stools (OR 0.326, 95% CI 0.105 to 1.015; *P* = 0.046) (**Table 2**). Ergonomic eyewear, orthopedic shoes, and ergonomic microscopes were not significantly correlated with differences in pain frequency and the remaining pieces of anti-fatigue equipment were utilized too infrequently for analysis. No piece of anti-fatigue equipment was associated with significantly different pain severities.

Five anatomic locations (neck, shoulder, upper back, lower back, and foot) met the minimum sample size requirement of reported pain scores for ordinal regression. No continuous respondent demographics (e.g., height) were found to significantly correlate with either summary pain scores or scores for those five anatomic locations. However, ordinal regression estimates that an increase of 200 minutes of weekly exercise is correlated with a one-point decrease on the LASA for upper back pain (estimate = -0.005, 95% CI -0.011 to 0.000; *P* = 0.057) and an extra 58.8 minutes spent typing into the EMR each day is correlated with a one-point increase on the LASA for lower back pain (estimate = 0.017, 95% CI 0.000 to 0.034; *P* = 0.046) (**Table 2**). Alternatively, an increase of 29.6% of time spent sitting while operating is correlated with a one-point decrease on the LASA for foot pain (estimate = -0.338, 95% CI -0.640 to -0.036; *P* = 0.028).

## DISCUSSION

Overall, our survey yielded similar results to those of Liang et al. (**Table 1**) and shows that work-related pain and discomfort remain prevalent among Mohs surgeons (**Figure 1**). Previous studies have found the strongest predictor for job-related pain to be a high case volume, which is correlated with neck, hand and lower extremity symptoms.[1] However, these authors noted that back problems and eye fatigue were even reported with low case volumes.[12,13]

Neck pain continues to be the single most common (54.2%) complaint among Mohs surgeons (**Figure 1**).[1] Though its severity is not statistically worse than other anatomically localized pain, neck pain is associated with an increased regular use of pain-relieving medications (frequency, 81.0%) at worse pain severities (median, 5/10; **Table 2**). This suggests a degree of intolerability and an opportunity to increase a surgeon's productivity while decreasing pain. In terms of evaluating anti-fatigue equipment, employing sit-stand stools was found to be inversely related to reports of neck pain from survey participants (**Table 2**). Occupations that involve prolonged flexion of the neck have been identified as a major risk factor in the development of neck pain, but sit-stand stools offer surgeons a way to adjust their degrees of neck flexion without sacrificing support during a procedure.[14] Alternating between sitting and standing is likely viable and increasing the time spent sitting while operating was significantly associated with decreased foot pain (**Table 2**). However, this strategy is less adaptable to the height of the surgical field and the standing component does not allow any offloading of biomechanical stress. Incorporating regular repositioning into one's workflow may improve surgeon awareness of prolonged flexion, but further research is needed to evaluate efficacy and appropriate repositioning time intervals.

Both upper and lower back pain were frequently reported (38.3% and 33.6%, respectively) (**Figure 1**); however, only upper

**Table 2.** Statistically Significant Relationships of Pain Frequency and Severity by Sex and Pain-Relieving Medication Use

| Variable | Pain Descriptor | Anatomic Site (Test) | Results | Odds Ratio (95% CI) |
|---|---|---|---|---|
| **Sex** | Frequency, % Female (N=41) Male (N=66) | Upper back (chi-squared) | Female: 22/41, 53.7% Male: 19/66, 28.8% *P*=.010 | 0.349 (0.155 – 0.787) |
| | | Lower back (chi-squared) | Female: 9/41, 22.0% Male: 27/66, 40.9% *P*=0.044 | 2.462 (1.013 – 5.979) |
| | | Wrist (Fisher's exact) | Female: 6/41, 14.6% Male: 0/66, 0% *P* (two-sided)=0.002 | 0.347 (0.265 – 0.453) |
| **Regular pain-relieving medication use** | Frequency, % No (N=86) Yes (N=21) | Eye (Fisher's exact) | No: 13/86, 15.1% Yes: 8/21, 38.1% P (two-sided)=0.029 | 3.456 (1.197 – 9.975) |
| | | Neck (chi-squared) | No: 41/86, 47.7% Yes: 17/21, 81.0% P=0.006 | 4.665 (1.450 – 15.007) |
| | | Finger (Fisher's exact) | No: 12/86, 14.0% Yes: 9/21, 42.9% P (two-sided)=0.006 | 4.625 (1.606 – 13.320) |
| | | Upper back (chi-squared) | No: 28/86, 32.6% Yes: 13/21, 61.9% P=0.013 | 3.366 (1.251 – 9.054) |
| | | Leg (Fisher's exact) | No: 5/86, 5.81% Yes: 5/21, 23.8% P (two-sided)=0.024 | 5.063 (1.312 – 19.540) |
| | Severity score, median | Neck (Mann-Whitney) (N=58) | No (N=41): 3 Yes (N=17): 5 P=0.002 | NA |
| | | Shoulder (Mann-Whitney) (N=33) | No (N=24): 3 Yes (N=9): 6 P=0.022 | NA |
| | | Upper back (Mann-Whitney) (N=41) | No (N=28): 2 Yes (N=13): 5 P<0.001 | NA |
| | | Leg (Mann-Whitney) (N=10) | No (N=5): 3 Yes (N=5): 6 P=0.007 | NA |
| **Sit-stand stool use** | Frequency, % No (N=91) Yes (N=16) | Neck (chi-squared) | No: 53/91, 58.2% Yes: 5/16, 31.3% P=0.046 | 0.326 (0.105 – 1.015) |

| | | | | |
|---|---|---|---|---|
| **Time exercising (minutes/week)** | Severity | Upper back (ordinal regression, N=41) | Estimate (95% CI): -0.005 (-0.011 – 0.000) P=0.057 | NA |
| **Time typing into EMR (minute/day)** | Severity | Lower back (ordinal regression, N=36) | Estimate (95% CI): 0.017 (0.000 – 0.034) P=0.046 | NA |
| **Proportion of time spent sitting while operating** | Severity | Foot (ordinal regression, N=25) | Estimate (95% CI): -0.338 (-0.640 –0.036) P=0.028 | NA |

Abbreviations: CI, confidence interval; EMR, electronic medical record

back pain was associated with an increased regular use of pain-relieving medications (frequency, 61.9%) at worse severities (median, 5/10; **Table 2**). The severity of these two complaints were also associated with continuous variables; time exercising was negatively associated with upper back pain and time typing into the EMR was positively associated with lower back pain (**Table 2**). The relationship between time spent using a computer and lower back pain is well-documented; it is theorized that prolonged back flexion weakens paraspinal muscles and predisposes the vertebra to injury.[15] The relationship between exercise and the reduction of upper back pain, however, is less understood. Sustained trapezius muscle activity has been associated with neck pain, so one hypothesis is that strong trapezius muscles may have a positive effect on the thoracic spine.[16] Therefore, strength training, as well as regular repositioning, may be recommended exercise regimens pending further research.

Leg pain, although infrequently reported (9.35%) (**Figure 1**), was associated with an increased regular use (frequency, 23.8%) of pain-relieving medications at worse pain severities (median, 6/10; **Table 2**). The use of compressive stockings, however, was associated with a decreased prevalence of leg pain (**Table 2**). Though traditionally employed in patients facing venous insufficiency, compressive stockings have shown utility in healthy individuals at attenuating leg edema and discomfort. Given the unique postural limitations faced by Mohs surgeons, specific research is needed to evaluate optimal stocking length, but even low pressure (i.e., 10, 15 mmHg) compression stockings have shown efficacy in healthy subjects.[17]

Though some of our results reflect prior research, we did not observe any differences on pain frequency or severity based on preference of operative height. However, research has begun to highlight the influence of posture and operative height awareness on the prevention of unnecessary biomechanical stress on the cervical spine. Numerous studies have demonstrated that a higher level of surgeon awareness regarding ergonomic guidelines and the incorporation of an ergonomic mindset in office-based surgery is important to the health and wellness of a surgeon.[18,19,20] For example, Rosenblatt et al. found that dentists who are able to recognize and either avoid or neutralize poor ergonomic habits were associated with reporting less musculoskeletal pain and discomfort.[9] Furthermore, a survey of plastic surgeons found musculoskeletal symptoms were most closely related to prolonged surgery, tissue retraction and prolonged neck flexion.[20] Core strengthening exercises and repositioning during surgery have been proposed to prevent work-related injury. In the case of our survey, exercise, irrespective of its degree or impact, appeared protective against upper back pain.

Although the results of this survey may indicate that the use of anti-fatigue equipment during surgery may provide some benefit, their possible risks should be considered as well. We did not find any correlation between the use of loupes, headlamps and microscopes with pain, but a survey conducted among orthopedic hand surgeons found that the frequent use of loupes and microscopes appear detrimental to a surgeon's health and career longevity.[21] It has been hypothesized that the use of loupes or headlamps increases the biomechanical load on the cervical spine.[18,22] Furthermore, a study by gynecologic surgeons found that body discomfort was not different with respect to chair type, although chair discomfort scores were higher for round stools and saddle chairs than round stools with backrests and the Capisco chair.[23]

This study was constrained by a limited number of participants. Furthermore, data gathering was restricted to responses to pre-defined survey questions and such data may be impacted by selection bias. Steps taken to account for the subjectivity of pain (e.g., interpreting ordinal data non-parametrically) magnified the constraints of a small size and limited the drawing of conclusions. Future research could aim to collect paired data (e.g., pain before and after using anti-fatigue equipment) to account for the effect of non-interval subjective data on statistical comparisons.

The experience and prevention of work-related musculoskeletal disorders is interdisciplinary. Not only are Mohs surgeons at risk for musculoskeletal injury, but Mohs histology technicians and other ancillary staff also remain vulnerable.[24,25] In the case of surgeons, we suspect that a lack of ergonomic awareness and education during formative training can have a significant effect on the wellbeing and career of a young dermatologic surgeon.[26,27] Future collaboration with current educators, occupational health professionals, and physical and occupational therapists may provide insight on future ergonomic education and modifications.

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