International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 14s,2025
https://theaspd.com/index.php

# Prevalence And Clinical Impact Of Musculoskeletal Injuries Among Endoscopy Practitioners: A Cross-Sectional Analysis

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***Abstract:***

*Musculoskeletal injuries (MSIs) have emerged as a critical occupational health issue among endoscopy practitioners due to the physically demanding nature of their work. This cross-sectional study investigates the prevalence of MSIs and evaluates their impact on clinical practice. A structured questionnaire was distributed among gastroenterologists, colorectal surgeons, and other specialists involved in endoscopy to assess the frequency, location, severity, and clinical consequences of MSIs. Findings revealed a high prevalence of MSI, particularly affecting the neck, lower back, shoulders, and wrists. Many practitioners reported decreased work efficiency, procedural delays, and modified practices to accommodate symptoms. The study underscores the urgent need for ergonomic interventions and workload management to ensure practitioner well-being and sustained clinical performance.****Keywords:*** *Musculoskeletal injuries, Endoscopy, Occupational health, Clinical impact, Ergonomics.*

## INTRODUCTION

Due to advancements in endoscopy, endoscopists can now obtain in-depth imaging of anatomical structures and treat ailments with endoscopic treatments. Regardless of the specialty—whether gastrointestinal (GI) endoscopy (gastroscopy, duodenoscopy, or colonoscopy), bronchoscopy, rhinolaryngoscopy (ENT or nasal endoscopy), gynecologists (hysteroscopy, laparoscopy), or endourology (ureteroscopy, nephroscopy, or cystoscopy)—clinicians work within confined spaces, coordinating with medical teams and equipment, often adopting uncomfortable positions. Endoscopists carry out multiple procedures with minimal breaks, involving repetitive movements and significant physical exertion, comparable to that of athletes. Musculoskeletal diseases (MSDs) can be caused by frequent, repeated motions and awkward body positions [1]. Endoscopists face numerous health risks, including musculoskeletal injuries, ionizing radiation exposure, and infection-causing chemicals. Work-related MSDs have been recorded among ultrasonographers and surgeons, among other jobs [2, 3]. Several studies have found that the number of MSDs caused by endoscopies varies from 20 percent to 89 percent. Most pain and injuries happen in the neck, wrists, thumbs, and pain in the lower back [4, 5, and 6].Endoscopists must adhere to all of the safety precautions to safeguard themselves from potentially hazardous exposure. The Occupational Safety and Health Administration [7] makes it a requirement that personnel who perform endoscopies have the appropriate level of education and training to reduce the risk of being exposed to potentially harmful radiation, as well as the necessary shielding equipment to carry out the procedure. According to Matsuzaki (2021), the primary cause of MSDs, which most commonly appear in pain in the neck, low back, and shoulders, is the extended procedural timings of endoscopists [8]. It is essential that the incidence, types, and techniques for reducing endoscopy-related

musculoskeletal injuries be followed to meet society's growing demands. Risk factors for occupational pain and injury include the age of the endoscopists, how long the procedure takes, how long the endoscopists has been practicing, and how many procedures they do. Endoscopists have a high risk of musculoskeletal injuries because of their work and the pressures they put on their bodies [9]. Musculoskeletal injuries (MSI) in the workplace are associated with more procedures, longer endoscopy sessions per week, and a longer overall period of endoscopic sessions. Various types of treatment, such as rest, physiotherapy, steroid injections, splinting, as well as surgery, were to be done [10].

In the United States, MSDs are the cause of more than 70 million doctor's office visits and about 130 million total healthcare contacts, including outpatient, emergency room, and inpatient visits. The Institute of Medicine stated that work-related MSDs cost the economy between $45 billion and $54 billion each year. This is based on compensation costs, missed pay, as well as low productivity [11]. People who suffer from these ailments suffer financially and have a lower

Quality of life. Nursing & healthcare workers are particularly vulnerable to musculoskeletal problems [11]. Endoscopists had an increased chance of work-related MSDs than internists as well as other non-procedure-oriented experts, with 37 percent to 89 percent of endoscopists experiencing work-related MSI [12,13]. Despite the important observations, little is known about the prevalence of MSI among gastroenterology fellows. Since MSI can have long-term effects and could cause permanent disability, we wanted to find out how often fellows got hurt so we could use that knowledge to help future studies into ergonomic education.

Several studies have revealed that endoscopists and ancillary workers suffer from a high rate of MSI. Studies based on surveys show that between 29 percent and 89 percent of endoscopists have musculoskeletal discomfort [14], which makes them less productive. Since they have to go through a lot of training and because endoscopies are becoming more popular, gastroenterologists are valuable in the workplace, particularly in developing countries. A work-related injury can hurt the quality and longevity of a endoscopists career, making the lack of professionals even worst [15]. By making the workplace more ergonomic, this limited HR (human resource) will be used to its fullest potential. MSIs are common, and they have a strong link to a high number of procedures and long procedure times [16]. Endoscopists can get overuse syndromes and injuries like carpal tunnel syndrome (CTS), De Quervain's tenosynovitis, and lateral epicondylitis because they pinch and grip the endoscope, press, pull, and twist the insertion tube, and sometimes stand in uncomfortable position [14,17]. However, there are few structural improvements focused at minimizing MSI, which may contribute to a lack of understanding [14].

As a result of the essential characteristics of routine practice, the vast majority of medical professionals believe that work-related injuries to the MSI are the most prevalent issue when it comes to occupational health (OH). Furthermore, endoscopists frequently report musculoskeletal injury [5, 6, 12, 18, and 19]. It has been demonstrated that a physician's health and well-being along with work routine are affected by the constant stress and dangers of his or her job. Ergonomic ailments during operations have been linked to muscle contractions, doing the same thing over and over, and incorrect body posture [20, 21]. Constant repetitive tasks, not taking breaks, and endoscopists' own habits and routines all risk of occupational injury [22].

There is a high rate of ergonomic injuries reported by medical assistants, especially endoscopists, who suffer from chronic muscle and joint pain in their thumb and hand [6, 12]. Previous studies show that between 29 and 89 percent of endoscopists get these kinds of injuries during procedures [14]. Endoscopy is now the most significant and frequently performed technique in gastroenterology [23]. There is therefore a higher chance of injury for doctors and surgeons who undertake endoscopic procedures.There has also been an increase in disease in recent times, which has put endoscopists under additional stress and resulted in an increase in the rate of work - related injuries [10].

The health sector is currently concerned about work-related musculoskeletal illnesses and the accompanying ergonomic factors. The disease is dangerous for both health care workers and patients since it impairs their ability to do their jobs [24]. Endoscopists' typical job routine is known to be disrupted by musculoskeletal issues. In a prior study, 84.6 percent of endoscopists reported musculoskeletal pain, which significantly impacted their work routine [25].

Due to an absence of collected data, especially among the eastern populace, and a lack of knowledge, significant change has not occurred. In addition, there is no exhaustive examination of the risk variables for endoscopy-related injury. Endoscopic ergonomics can also prevent future injuries by raising awareness of their importance. Endoscopists often acquire their skills from their mentors throughout their fellowship training; therefore, the class possesses a wide variety of skills and knowledge. While ergonomics is not given much attention in the classroom, this variability can lead to MSI. Endoscopy is connected with a high risk of MSI, which can be reduced by adhering to standard ergonomic practices, organized training of trainees in ergonomic methods while performing endoscopy, and research into the development of more ergonomic endoscopes and process areas [12].

Endoscopic procedures are projected to become more popular [10, 11]. As a result, it's important to investigate and improve the ergonomics of endoscopy. Although the results of a series of global studies have been surprising, not much is known about the health complications most endoscopists face around the world. The main goal of the study was to find out how often ergonomic injuries & musculoskeletal pain happen to endoscopists and what affects these problems have on medical practice. We wanted to find out if everyday habits and risk factors have anything to do with how these injuries happen. This research also looks at the components of heavy workload which can lead to MSD and how they are related. This study aims to fill this gap by identifying the frequency of MSI in endoscopy professionals and analyzing its impact on clinical duties, thereby informing targeted prevention and intervention strategies.

**Literature Review**

Previous research has highlighted high rates of occupational MSI among medical professionals, particularly in surgery and imaging specialties. In the field of endoscopy, studies report prevalence rates ranging from 39% to 89%, with common injury sites including the back, neck, shoulder, and hand. Factors contributing to these injuries include poor posture, inadequate breaks, repetitive hand motions, and suboptimal equipment design.

Despite recognition of these issues, implementation of ergonomic training and preventive protocols remains inconsistent across institutions. There is a pressing need for standardized assessment tools and interventions tailored to endoscopy-related occupational hazards.

## METHODOLOGY:

The cross-sectional survey-based study was conducted between January and December 2024 across multispecialty hospitals of Delhi.

- **Participants:**
  A total of 250 endoscopy practitioners, including gastroenterologists, colorectal surgeons, and general surgeons, were approached. Inclusion criteria were: minimum of 6 months of endoscopy experience, performance of at least 5 procedures per week, and consent to participate. Practitioners with pre-existing chronic musculoskeletal conditions unrelated to work were excluded.
- **Questionnaire Design:**
  A validated, structured questionnaire was used, developed from prior occupational health surveys and modified to include endoscopy-specific ergonomic factors. The survey was divided into the following sections:
  1. Demographics and work history
  2. Frequency and type of endoscopic procedures performed
  3. Self-reported musculoskeletal symptoms (location, duration, severity)
  4. Contributing factors (work posture, duration, break frequency)
  5. Impact on clinical performance (missed workdays, reduced procedures, technique modifications)
- **Data Collection:**
  Data were collected in-person and through email. Respondents completed the questionnaire anonymously.
- **Data Analysis:**
  Data were analyzed using SPSS v25.0. Descriptive statistics were computed for prevalence and demographic variables. Chi-square and t-tests were used to assess associations between MSI occurrence and contributing factors.

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- **4. Results**

  Out of 250 surveys distributed, 214 completed responses were received (response rate: 85.6%).

  - **Demographics:**
    - Mean age: 41.2 ± 7.8 years
    - Gender: 68% male, 32% female
    - Mean years in practice: 11.4 ± 4.3 years
  - **Prevalence of MSI:**
    - 72% (n=154) reported experiencing MSI in the past 12 months.
    - Most common regions affected:
      - Neck: 51%
      - Lower back: 47%
      - Shoulders: 39%
      - Wrists/hands: 31%

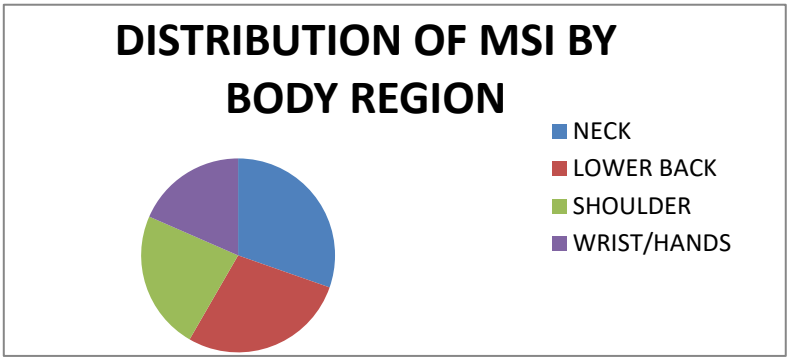


**Figure 1: Distribution of MSI by Body Region**

  - **Contributing Factors:**
    - Prolonged standing: 68%
    - Repetitive hand motion: 63%
    - Awkward neck/back posture: 59%
    - Lack of micro-breaks: 44%

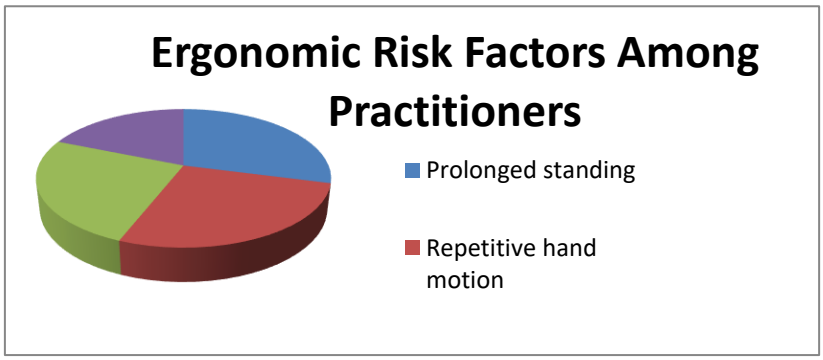


**Figure 2: Ergonomic Risk Factors among Practitioners**

  - **Clinical Impact:**
    - 36% reported reducing the number of weekly procedures
    - 27% required time off work due to MSI
    - 19% modified procedural technique to reduce pain
    - 12% considered early retirement due to chronic discomfort

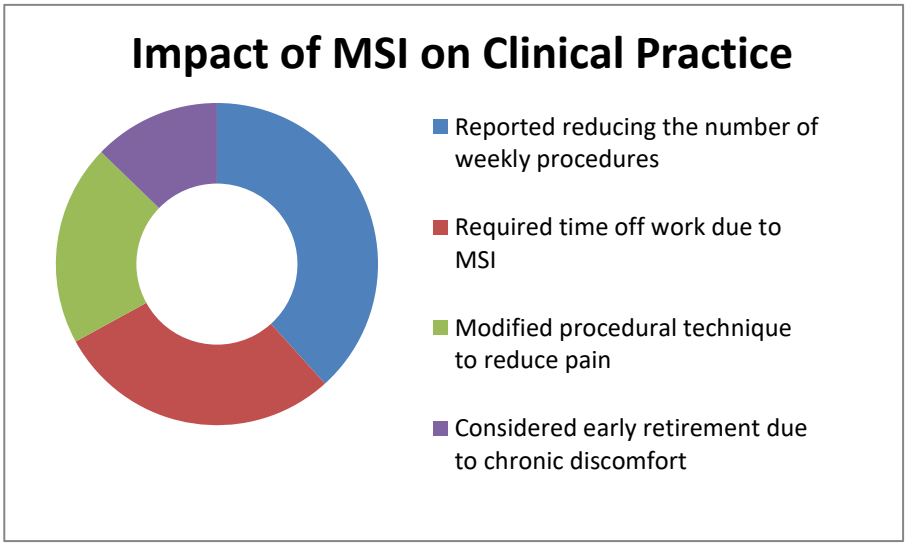


**Figure 3: Impact of MSI on Clinical Practice**

## DISCUSSION

This study demonstrates a high burden of MSI among endoscopy practitioners, with over two-thirds of participants affected. The neck and lower back were the most frequently reported sites of injury, consistent with prior literature attributing these to prolonged static postures and forward neck flexion. The upper limbs, particularly wrists and shoulders, also showed significant symptom prevalence, likely related to repetitive manipulation of endoscopic controls.

The findings highlight an alarming impact on clinical productivity. A third of participants modified their procedural workload, while a significant proportion took sick leave or altered technique to mitigate pain. This may lead to skill deterioration, reduced patient throughput, and heightened burnout.

The ergonomics of endoscopy suites, poor posture awareness, and workload intensification emerged as major contributors to MSI. It is imperative that healthcare systems integrate ergonomic risk assessments and redesign procedural environments. Educational workshops on posture correction, use of adjustable height equipment, and enforcing regular micro-breaks are strongly recommended.

Furthermore, the study emphasizes the lack of formal occupational health protocols for endoscopists. Institutions must implement standardized preventive strategies to mitigate risks and support the long-term career sustainability of practitioners.

## CONCLUSION

MSIs represent a prevalent and impactful occupational hazard among endoscopy practitioners. The current findings reinforce the need for comprehensive ergonomic interventions, awareness programs, and structured occupational health policies to ensure clinician well-being and uninterrupted high-quality care delivery.

### Recommendations

- Incorporate ergonomics into endoscopy training curricula.
- Modify equipment and workspaces to promote neutral posture.
- Conduct regular ergonomic audits in endoscopy units.
- Schedule mandatory short breaks after every 3-4 procedures.
- Encourage use of supportive aids (e.g., anti-fatigue mats, hand braces).

### Conclusion

The findings from this study emphasize that musculoskeletal injuries (MSIs) are a prevalent and impactful occupational health risk among endoscopy practitioners. A significant proportion (72%) of participants reported experiencing MSIs, particularly in the neck, lower back, shoulders, and wrists. The study also highlights that these injuries affect clinical performance, with many practitioners modifying their procedures, reducing the number of cases they perform, or taking time off due to pain. The analysis

further underscores the urgent need for ergonomic interventions, such as the integration of posture correction, better equipment design, and scheduled micro-breaks, to mitigate the risk of these injuries. Incorporating ergonomic training into endoscopy curricula and conducting regular ergonomic assessments could help in reducing the prevalence of MSIs, ensuring long-term practitioner well-being and maintaining high-quality care delivery. Moreover, the implementation of standardized occupational health protocols and strategies tailored to endoscopy practitioners is crucial for reducing work-related injuries and enhancing overall productivity in clinical settings.

## REFERENCES:

1. Hildebrandt VH, Bongers PM, Van Dijk FJ, Kemper HC, Dul J. Dutch Musculoskeletal Questionnaire: description and basic qualities. Ergonomics. 2001 Oct 1;44(12):1038-55.
2. Smith AC, Wolf JG, Xie GY, Smith MD. Musculoskeletal pain in cardiac ultrasonographers: results of a random survey. Journal of the American Society of Echocardiography. 1997 May 1;10(4):357-62.
3. Van Det MJ, Meijerink WJ, Hoff C, Totte ER, Pierie JP. Optimal ergonomics for laparoscopic surgery in minimally invasive surgery suites: a review and guidelines. Surgical endoscopy. 2009 Jun;23(6):1279-85.
4. Buschbacher R. Overuse syndromes among endoscopists. Endoscopy. 1994 Aug;26(06):539.
5. Liberman AS, Shrier I, Gordon PH. Injuries sustained by colorectal surgeons performing colonoscopy. Surgical Endoscopy and Other Interventional Techniques. 2005 Dec;19(12):1606-9.
6. Byun YH, Lee JH, Park MK, Song JH, Min BH, Chang DK, Kim YH, Son HJ, Rhee PL, Kim JJ, Rhee JC. Procedure-related musculoskeletal symptoms in gastrointestinal endoscopists in Korea. World Journal of Gastroenterology: WJG. 2008 Jul 7;14(27):4359.
7. Occupational Safety and Health Administration. Quick Reference Guide to the Bloodborne Pathogens Standard. https://www.osha. gov/SLTC/bloodbornepathogens/bloodborne_quickref.html [Accessed Apr 02, 2018].
8. Matsuzaki I, Ebara T, Tsunemi M, Hatta Y, Yamamoto K, Baba A, Hattori M, Nakamura M, Fujishiro M. Effects of endoscopy-related procedure time on musculoskeletal disorders in Japanese endoscopists: a cross-sectional study. Endoscopy International Open. 2021 May;9(05):E674-83.
9. Yung DE, Banfi T, Ciuti G, Arezzo A, Dario P, Koulaouzidis A. Musculoskeletal injuries in gastrointestinal endoscopists: a systematic review. Expert Review of Gastroenterology & Hepatology. 2017 Oct 3;11(10):939-47.
10. Ridtitid W, Coté GA, Leung W, Buschbacher R, Lynch S, Fogel EL, Watkins JL, Lehman GA, Sherman S, McHenry L. Prevalence and risk factors for musculoskeletal injuries related to endoscopy. Gastrointestinal Endoscopy. 2015 Feb 1;81(2):294-302.
11. Centers for Disease Control and Prevention. Work-Related Musculoskeletal Disorders & Ergonomics. Available from: https:// www.cdc.gov/workplacehealthpromotion/health- strategies/musculoskeletal-disorders. 2016.
12. Hansel SL, Crowell MD, Pardi DS, Bouras EP, DiBaise JK. Prevalence and impact of musculoskeletal injury among endoscopists: a controlled pilot study. Journal of clinical gastroenterology. 2009 May 1;43(5):399-404.
13. Shergill AK, Asundi KR, Barr A, Shah JN, Ryan JC, McQuaid KR, Rempel D. Pinch force and forearm-muscle load during routine colonoscopy: a pilot study. Gastrointestinal Endoscopy. 2009 Jan 1;69(1):142-6.
14. Harvin G. Review of musculoskeletal injuries and prevention in the endoscopy practitioner. Journal of clinical gastroenterology. 2014 Aug; 48(7): 590.
15. Morais CL, Lima KM, Singh M, Martin FL. Tutorial: multivariate classification for vibrational spectroscopy in biological samples. Nature Protocols. 2020 Jul; 15(7):2143-62.
16. González Villa I, González Dávila EF, Afonso IJ, Blanco LI, Ferrer JF, Galván JJ. An effective algorithm to detect the possibility of being MSI phenotype in endometrial cancer given the BMI status and histological subtype: a statistical study. Clinical and Translational Oncology. 2022 May 5:1-9.
17. Ofori E, Ramai D, John F, Reddy M, Ghevariya V. Occupation-associated health hazards for the gastroenterologist/endoscopist. Annals of Gastroenterology. 2018 Jul; 31(4):448.
18. O'Sullivan S, Bridge G, Ponich T. Musculoskeletal injuries among ERCP endoscopists in Canada. Canadian journal of gastroenterology. 2002 Jun 1; 16(6):369-74.
19. Kuwabara T, Urabe Y, Hiyama T, Tanaka S, Shimomura T, Oko S, Yoshihara M, Chayama
K. Prevalence and impact of musculoskeletal pain in Japanese gastrointestinal endoscopists: a controlled study. World journal of gastroenterology: WJG. 2011 Mar 21; 17(11):1488.
20. Geraghty J, George R, Babbs C. A questionnaire study assessing overuse injuries in United Kingdom endoscopists and any effect from the introduction of the National Bowel Cancer Screening Program on these injuries. Gastrointestinal endoscopy. 2011 May 1; 73(5):1069- 70.
21. Harris-Adamson C, Eisen EA, Kapellusch J, Garg A, Hegmann KT, Thiese MS, Dale AM, Evanoff B, Burt S, Bao S, Silverstein B. Biomechanical risk factors for carpal tunnel syndrome: a pooled study of 2474 workers. Occupational and environmental medicine. 2015 Jan 1; 72(1):33-41.
22. Shergill AK, McQuaid KR. Ergonomic endoscopy: An oxymoron or realistic goal?. Gastrointestinal Endoscopy. 2019 Dec 1; 90(6):966-70.
23. Dolay K, Hasbahçeci M. The role of surgeons on the development and performance of endoscopy. Turkish Journal of Surgery. 2017; 33(1):1.

24. Centers for Disease Control and Prevention. Work-related musculoskeletal disorders & ergonomics. Centers for Disease Control and Prevention, Atlanta. 2020.
25. Lotters F, Burdorf A. Prognostic factors for duration of sickness absence due to musculoskeletal disorders. The Clinical journal of pain. 2006 Feb 1; 22(2):212-21.
26. Smith CD, Stival A, Howell DL, Swafford V. Endoscopic therapy for achalasia before Heller myotomy results in worse outcomes than Heller myotomy alone. Annals of surgery. 2006 May;243(5):579.
27. Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. Bulletin of the world health organization. 2003 Sep;81(9):646-56.
28. Coggon D, Ntani G, Palmer KT, et al. Disabling musculoskeletal pain in working populations: is it the job, the person, or the culture? Pain. 2013;154:856–863.
29. Richardson AB. Overuse syndromes in baseball, tennis, gymnastics, and swimming.Clin Sports Med. 1983;2:379–390.
30. Silverstein BA, Fine LJ, Armstrong TJ.Hand wrist cumulative trauma disorders in industry.Br J Ind Med. 1986;43:779–784.
31. Fish DR, Morris-Allen DM. Musculoskeletal disorders in dentists. New York State Dental Journal. 1998 Apr 1;64(4):44.
32. Salik Y, Ozcan A.Work-related musculoskeletal disorders: a survey of physical therapists in Izmir-Turkey. BMC Musculoskelet Disord. 2004;5:27.
33. Sakai N, Liu MC, Su FC, et al. Hand span and digital motion on the keyboard: concerns of overuse syndrome in musicians.J Hand Surg [Am]. 2006;31:830–835.
34. Reyes DA, Tang B, Cuschieri A. Minimal access surgery (MAS)-related surgeon morbidity syndromes. SurgEndosc. 2006;20:1–13.
35. Szeto GP, Ho P, Ting AC, et al. Work-related musculoskeletal symptoms in surgeons. J Occup Rehabil. 2009;19:175–184.
36. Keate R, Dryden GW, Wang K, et al. ASGE Web Editorial Board. Occupational injuries to endoscopists: report from the ASGE web survey. Gastrointest Endosc. 200663.
37. Pawa S, Banerjee P, Kothari S, D'Souza SL, Martindale SL, Gaidos JK, Oxentenko AS, Burke CA. Are all endoscopy-related musculoskeletal injuries created equal? Results of a national gender-based survey. Official journal of the American College of Gastroenterology| ACG. 2021 Mar 1;116(3):530-8.
38. Austin K, Schoenberger H, Sesto M, Gaumnitz E, Teo Broman A, Saha S. Musculoskeletal injuries are commonly reported among gastroenterology trainees: results of a national survey. Digestive Diseases and Sciences. 2019 Jun;64(6):1439-47.
39. Khan R, Scaffidi MA, Satchwell J, Gimpaya N, Lee W, Genis S, Tham D, Saperia J, Al- Mazroui A, Walsh CM, Grover SC. Impact of a simulation-based ergonomics training curriculum on work-related musculoskeletal injury risk in colonoscopy. Gastrointestinal endoscopy. 2020 Nov 1;92(5):1070-80.
40. Shergill AK, Lightdale JR, Bruining DH, Acosta RD, Chandrasekhara V, Chathadi KV, Decker GA, Early DS, Evans JA, Fanelli RD, Fisher DA. The role of endoscopy in inflammatory bowel disease. Gastrointestinal endoscopy. 2015 May 1;81(5):1101-21.
41. Barnard E, Sheaffer K, Hampton S, Measel ML, Farag A, Shaw C. Ergonomics and Work- Related Musculoskeletal Disorders: Characteristics Among Female Interventionists. Cureus. 2021 Sep 23;13(9).
42. Cappell MS. Colonoscopist's thumb: DeQuervains's syndrome (tenosynovitis of the left thumb) associated with overuse during endoscopy. Gastrointestinal endoscopy. 2006 Nov 1;64(5):841-3.
43. Siegel JH, Kasmin FE, Cohen SA. Health hazards and endoscopy: the known and newly experienced-a personal report. Endoscopy. 1994 Aug;26(06):545-8.
44. Appleyard MN, Mosse CA, Mills TN, Bell GD, Castillo FD, Swain CP. The measurement of forces exerted during colonoscopy. Gastrointestinal endoscopy. 2000 Aug 1;52(2):237-40.
45. Ali KM, Sathiyasekaran BW. Computer professionals and carpal tunnel syndrome (CTS). International Journal of Occupational Safety and Ergonomics. 2006 Jan 1;12(3):319-25.
46. Arvidsson I, Arvidsson M, Axmon A, Hansson GÅ, Johansson CR, Skerfving S. Musculoskeletal disorders among female and male air traffic controllers performing identical and demanding computer work. Ergonomics. 2006 Sep 15;49(11):1052-67.
47. Berguer R, Hreljac A. The relationship between hand size and difficulty using surgical instruments: a survey of 726 laparoscopic surgeons. Surgical Endoscopy and Other Interventional Techniques. 2004 Mar;18(3):508-12.
48. Cohen DL, Naik JR, Tamariz LJ, Madanick RD. The perception of gastroenterology fellows towards the relationship between hand size and endoscopic training. Digestive diseases and sciences. 2008 Jul;53(7):1902-9.
49. Emmanuel J, Torres A. The impact of automated electronic surveillance of electronic medical records on pediatric inpatient care. Cureus. 2018 Oct 1;10(10).
50. Shergill AK, McQuaid KR, Rempel D. Ergonomics and GI endoscopy. Gastrointestinal endoscopy. 2009 Jul 1;70(1):145-53.Cristiana and Eunice (2012)
51. Adhikari CL, Dhakal GP, Suwisith N, Dargay S, Sharma KP. Characteristics of helicobacter pylori infection in a national referral hospital in Bhutan. Bhutan Health Journal. 2020 May 15;6(1):6-10.