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Original article

Ergonomics in digestive endoscopy: Prevalence, types of musculoskeletal disorders, and risk factors in endoscopists in Colombia

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Abstract

Introduction: The practice of digestive endoscopy is a physically demanding activity, with musculoskeletal disorders present in 39 % to 89 % of endoscopists, associated with "excessive use" maneuvers. Due to a lack of knowledge of this problem in endoscopists in Colombia, the main objective is to determine the prevalence, types, and risk factors of musculoskeletal disorders in specialists and graduate students. The secondary objective is to identify the occupational impact, treatments used, and importance of prevention and education in ergonomics. **Materials and methods:** Analytical cross-sectional observational study. Electronic survey methodology, open from June 1 to 30, 2021. Purposive sampling of 450 endoscopists from four scientific associations and eleven graduate programs, including 50 questions in six groups according to the objectives. We validated 203 responses, with 131 confirmations of musculoskeletal disorders, the group on which the analysis was performed. **Results:** Global prevalence of musculoskeletal disorders of 64.5 % and prevalence in graduate students of 58.6 %. There was more significant involvement of the upper limbs (right shoulder, left thumb, right elbow), followed by lower back, neck, knees, and hips. Graduate students reported pain in the right hand/fingers (right thumb) and the lower back. There was no significant difference due to work factors, but there was a tendency for more reports when increasing the volume of procedures and years of professional practice. The labor impact showed 78 % absenteeism. The most used treatments were medication, physiotherapy, and rest; 93.8 % had not received ergonomic education. However, there is a positive perception (74.1 % to 90.9 %) of receiving formal training. **Discussion:** The prevalence reflected the health and safety problem for the endoscopist. Demographic risk factors plus those of the endoscopic practice give rise to an individualized risk framework that enables endoscopists to understand learning and training as a way to prevent musculoskeletal disorders in themselves and their work team.

Keywords

Ergonomics, endoscopy, injuries, musculoskeletal, occupational health.

INTRODUCTION

An upper GI endoscopy is a physically demanding activity[1]. The high prevalence of pain and musculoskeletal disorders (MSDs) associated with its practice (between 39% and 89% in practicing endoscopists)[2] has been linked to "overuse" injury[3] involving procedures where up to 40% of working time is spent[4].

In turn, ergonomics, a discipline responsible for the design of workplaces and the analysis and adaptation of tools and tasks following the physiological, anatomical, and psychological characteristics of workers, studies 4 aspects of endoscopists' interactions: Workspace, redesigns necessary to minimize risks, optimization of well-being beyond the physical well-being, and maximization of the overall performance of the service system[1].

Musculoskeletal disorders result from frequent and repetitive maneuvers, uncomfortable postures, prolonged times[5,6], and lack of breaks[7]. These situations are common to other professionals such as sonographers and laparoscopic surgeons[8,9].

The anatomical sites most commonly affected by MSDs include the thumbs, wrists[10-13], neck, lumbar region, shoulders[6], and hands[14]. In graduate students of gastroenterology, pain in the thumbs (more often in the left one), hands[3], right wrist, back, and neck[15].

Risk factors for MSDs include gender, length of time in practice, improper positions, the volume of procedures[4,7,11,12], and the performance of new procedures (endoscopic submucosal dissection [ESD], enteroscopy, endoscopic ultrasound [EUS], endoscopic retrograde cholangiopancreatography [ERCP], and cholangioscopy) due to their longer duration and technical demands[6,16,17].

Musculoskeletal disorders translate into duplication of occupational injury risk, affecting professional performance, usual work routine, and meeting work goals[18].

The primary objective of this study was to determine the prevalence, location, types of MSDs, and risk factors in endoscopists (including graduate students) in Colombia. The secondary objectives included identifying the occupational impact of MSDs and the treatments used. Additionally, determining the importance attributed by respondents to educational processes in ergonomics.

MATERIALS AND METHODS

Analytical cross-sectional observational study. Self-administered electronic survey methodology developed in Google Qualtrics including 50 questions on general demographics (age, gender, professional certification level, weight, height, dominance, glove size); Musculoskeletal disorders presence, types, and location (according to the Nordic musculoskeletal standardized questionnaire of pain, numbness, and discomfort in body areas); related risk factors (years of practice, number and type of procedures accumulated in the last 2 years and 2 months, general and specific working hours in the endoscopy room); occupational impact and types of treatment used; preventive ergonomic activities and education, and awareness of the importance of specific ergonomic training in endoscopy. According to the observations, the survey was adjusted on 2 occasions by 8 endoscopists, 2 graduate gastroenterology students, a physiotherapist, 2 nurses, and a medical equipment engineer for content and appearance validity verification.

The survey was conducted among a purposive sample of endoscopists from the following associations: Asociaciones Colombianas de Endoscopia Digestiva, Colombian Associations of Digestive Endoscopy (ACED, by its abbreviation in Spanish); Gastroenterología, Colombian Gastroenterology Association (ACG, by its abbreviation in Spanish); Coloproctología, Colombian Association of Coloproctology (ACCP, by its abbreviation in Spanish), and Cirugía, Colombian Association of Surgery (ACC, by its abbreviation in Spanish), sent to their electronic media and social networks to 240 members of the ACED, 420 of the ACG, 60 of the ACCP and 50 of the ACC. Also, the survey was sent to students from the 11 gastroenterology programs with an estimated number of 45.

After explaining its relevance and ensuring the anonymity of the responses, the survey remained open from June 1 to June 30, 2021. Informed consent was stated as implicit in answering the survey. In addition, a participation incentive was granted through educational and financial support allocated among participants on July 5, 2021. The ACED ethics committee approved this study.

STATISTICAL ANALYSIS

Descriptive statistics were used for demographic characteristics, with means and standard deviation (SD) for continuous variables and proportion for discrete variables. In addition, the Chi-square test (χ^2) and the Fisher's exact test were used for risk factors identification associated with MSDs related to workloads, types of procedures performed, and gender based on the observed percentage and to compare the distributions of nominal data and the χ^2 trend for ordinal data. A $p < 0.05$ was considered to determine significance. All analyses were performed with the free statistic JAMOVI *software*.

RESULTS

Regardless of the endoscopists' training and work environments, a 64.5% MSDs prevalence (in 131 of 203 validated responses) was found, while 35.5% (72) did not report MSDs. Twenty-nine graduate students responded, and 58.6% (17) reported MSDs (**Figure 1**).

In the 131 positive univariate analysis, the groups with the highest frequency (with significant differences) were men vs. women ($p < 0.001$); specialists versus graduate students ($p < 0.001$); right vs. left hand dominance ($p < 0.001$); glove sizes M and L vs. S size ($p < 0.001$), and the

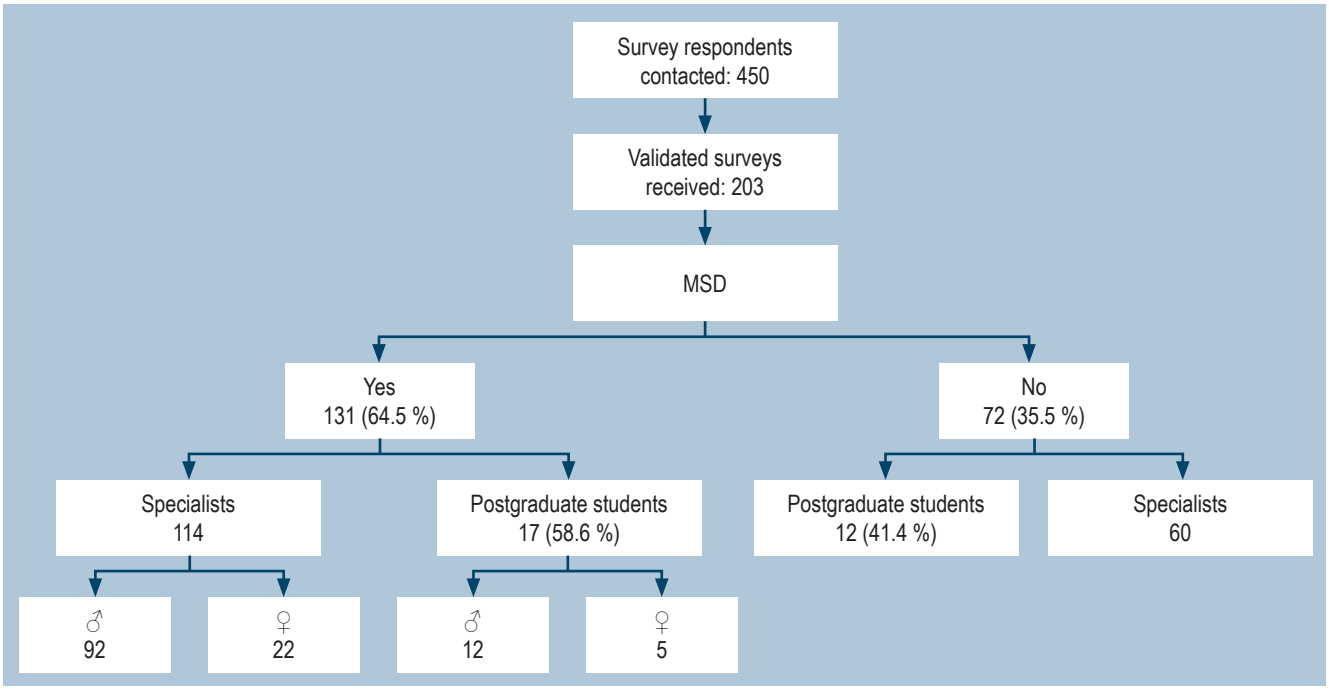

Figura 1. Respondent flow chart. Authors' elaboration.

use of Olympus technology vs. Fujifilm and Pentax (p < 0.001) (**Table 1**).

Since more than one MSD could occur per body segment, the 131 affected specialists reported 262 upper limbs injuries, over 85 reported neck-back injuries, and 41 reported lower limbs injuries. The most frequent complaints in the upper limb involved the right shoulder (n = 49, 48.7% of men, 60% of women), pain in the left thumb (n = 43, 60% of men, 50% of women). Although only 9 cases of carpal tunnel syndrome were recorded, it was the only type of MSD with a significant difference by gender (more frequent in men for both hands) (p < 0.011) (**Table 2**). In postgraduate students, there is a higher pain condition in the right hand-hand, especially the thumb.

Neck and back MSDs in specialists mainly involve the lower back (n = 21.95% of men) and neck (n = 19.79% of men, 21% of women). There were no significant differences by gender in both groups (p 0.058 in specialists and p 0.076 in graduate students) (p < 0.05) (**Table 3**). The most common involvement in postgraduate students was in the upper back (n = 7).

Lower limb musculoskeletal disorders in specialists occurred primarily in the hips (n = 15, 60% with bilateral involvement), knee pain (n = 15. 40% in the right, 26.7% bilateral). No significant difference was found by gender. In addition, no illness was reported in graduate students (**Figure 2**).

Absenteeism or work disability was reported in 89 specialists; 24.9% reduced the number of procedures and working hours. However, 14.6% (7 men and 6 women) had to discontinue specific endoscopic procedures associated with MSDs, which was significantly higher in female endoscopists (33.3% vs. 8.4%; p < 0.004). In addition, two male graduate students had to suspend specific procedures (**Figure 3**).

The most frequently used treatments for MSDs were medication (usually anti-inflammatory drugs), physiotherapy and rest, carpal tunnel splint to a lesser degree, steroid injections, and surgery. There were no significant differences by gender in any treatment. Fifteen specialists and 2 postgraduate students decided not to opt for any treatment (**Figure 4**).

In terms of risk factors, the most affected patients by MSDs (n = 54, including both genders) reported more than 20 years of professional practice (with a higher significant frequency in men from the 4-10 years of work practice group; p < 0.029) (**Table 4**). By age group, there was greater involvement of men between 51-60 years who fulfilled weekly working days between 24-48 hours and 49-60 hours. In addition, there was significant involvement in 34 endoscopists when working in the endoscopy room was less than 24 hours per week (**Tables 2** and **4**).

Injury reporting was higher when performing between 50 and 100 basic procedures, up to 50 advanced interven-

Table 1. General Characteristics of Respondents

Characteristics	n = 131 Fa (%)	χ^2 Test
Age by group (years)		
- 20-30	1 (0.76)	< 0.001
- 31-40	31 (23.6)	
- 41-50	32 (24.2)	
- 51-60	44 (33.6)	
- > 60	23 (17/5)	
Gender		
- Female	27 (20.6)	< 0.001
- Male	104 (79.4)	
Height		
- Mean (SD)	1.73 (0.09)	< 0.001***
- Median (IQR)	1.74 (1.68: 1.80)	
- Lower limit: Upper	1.50: 1.94	
Weight*		
- Mean (SD)	77.8 (13.0)	
- Median (IQR)	78 (68.5: 89)	0.039**
- Lower limit: Upper	50: 103	
Handedness		
- Right	122 (93.1)	< 0.001
- Left	9 (6.9)	
Glove size (n = 130)		
- Small	24 (18.5)	< 0.001
- Medium	62 (47.7)	
- Large	44 (33.8)	
Level of Education		
- Specialist	114 (87.0)	< 0.001
- Fellow r1	5 (3.8)	
- Fellow r2	9 (6.9)	
- Fellow r3	3 (2.3)	
Specialization		
- Gastrointestinal surgeon and endoscopist	31 (23.7) 6 (4.6)	< 0.001
- General surgeon	14 (10.7)	
- Proctologist	80 (61.1)	
- Gastroenterologist		
Video endoscopy system		
- Olympus	78 (59.5)	< 0.001
- Fujifilm	46 (35.1)	
- Pentax	7 (5.3)	

*No normal.
**Wilcoxon signed rank.
Test Student and test multinominal.
Fa: Absolute frequency; IQR: Interquartile range.

tional procedures, or up to 50 third-space interventional procedures in the last two months, and in the previous two years, more than 500 basic procedures, between 200 and 1000 advanced interventional procedures or between 200 and 1000 fluoroscopy-supported procedures (**Table 4**).

As for preventive measures, the study found that 96% of the specialists did not take intraprocedural breaks, while 62.9% paused between procedures. For training in ergonomics, 93.8% did not receive formal training, while 40% had self-taught training. Only 21% received didactic indications for ergonomic correction in the endoscopy room (**Table 5**).

Regarding awareness of ergonomics in endoscopy, 74% of the specialists would feel comfortable changing the way endoscopy is performed if this helped prevent injuries. While 93.75 % of the postgraduate students strongly agreed on the importance of ergonomic training, 81.25 % expressed their willingness to receive formal training on the subject (**Table 6**).

DISCUSSION

As a primary objective, an overall prevalence of 65.2% of MSDs was found in 203 specialists and postgraduate students in this representative sample of 45% from the estimated national population of 450 endoscopists as of June 2021, an intermediate figure compared to publications reporting 39% and 89%[2], similar to a study in Canada with a prevalence of 67% in ERCP endoscopists[19], and a European survey with a majority of 69.6 %[13].

The types of MSD reported included pain, musculocartilaginous, and joint discomfort in different segments of the upper limbs (less frequently in the neck, upper and lower back, and lower limbs), corresponding to areas that perform internal and external rotations (right shoulder, back, neck), flexion and extension (left thumb, neck, hips); torsion (wrists, elbows, hands, back); grasp (right thumb, right-hand fingers). Moreover, specific lesions of Quervain's tenosynovitis and carpal tunnel syndrome. This is consistent with reports in which its presence is associated with unsuitable endoscope design[10-13]. Other publications[2,13,14,16] confirm a greater involvement of the upper limbs, followed by neck-back and, in smaller numbers, lower limbs. In a survey on injuries during colonoscopies procedures, there was a higher frequency of injuries to the lumbar region (35.2%), neck (35.2%), and left thumb (33.9%)[20].

Postgraduate students reported increased involvement of the right hand and fingers (especially the right thumb). That report is inconsistent with a publication describing greater involvement of the left thumb[3]. In our students, it can be attributed to excessive gripping forces with biopsy forceps and other accessories at the beginning of their training.

Musculoskeletal disorders have been associated with risk factors for "overuse injury" (a term imported from sports) for repetitive movements and poor postures that generate repetitive stress; together with rotational and grasping forces, endos-

Table 2. Upper Limb MSDs in Specialists by Gender, Age Group, and Dominance

														N = 131
Types of MSD		**Specialist n = 114**												
		Male n = 92					**Total Fa (%)**	**Female n = 22**					**Total Fa (%)**	**P-value**
Upper limb		**20-30**	**31-40**	**41-50**	**51-60**	**> 60**		**20-30**	**31-40**	**41-50**	**51-60**	**> 60**		
Thumb involvement	Both				5	1	6 (17.1)		1	1			2 (25)	0.843
	Right		1	1	2	4	8 (22.9)			1		1	2 (25)	
	Left	1	2	5	10	3	21 (60)		1	1	2		4 (50)	
	Total	**1**	**3**	**6**	**17**	**8**		**0**	**2**	**3**	**2**	**1**		
Hand or finger pain	Both			1	7	2	10 (41.7)		2	2	1		5 (41.7)	0.424
	Right		1	3	3	1	8 (33.3)		1	3	2		6 (50.0)	
	Left			1	3	2	6 (25.0)				1		1 (8.3)	
	Total	**0**	**1**	**5**	**13**	**5**		**0**	**3**	**5**	**4**	**0**		
Hand-arm numbness	Both			2	4	3	9 (56.3)				1		1 (14.3)	0.095
	Right		1	1	1	1	4 (25)		1	3	1		5 (71.4)	
	Left				1	2	3 (18.8)			1	**2**		1 (14.3)	
	Total	**0**	**1**	**3**	**6**	**6**		**0**	**1**	**4**		**0**		
Carpal tunnel syndrome	Both			1	3	1	5 (71.4)						0	0.011
	Right						0		1		1		2 (100)	
	Left				2		2 (28.6)						0	
	Total	**0**	**0**	**1**	**5**	**1**		**0**	**1**	**0**	**1**	**0**		
De Quervain's tenosynovitis	Both				2		2 (20)		1	1			2 (40)	0.592
	Right				6	1	7 (70)				3		3 (60)	
	Left				1		1 (10)						0	
	Total	**0**	**0**	**0**	**9**	**1**		**0**	**1**	**1**	**3**	**0**		
Wrist pain	Both		1	3	3		7 (33.3)			1	2		3 (30)	0.576
	Right		2	3	3	1	9 (42.9)		3	2	1		6 (60)	
	Left	1	1		2	1	5 (23.8)			1			1 (10)	
	Total	**1**	**4**	**6**	**8**	**2**		**0**	**3**	**4**	**3**			
Elbow pain	Both			1	5	1	7 (22.6)		1		1		2 (28.6)	0.943
	Right		1	6	5	2	14 (45.2)			3			3 (42.9)	
	Left			5	3	2	10 (32.3)		1	1			2 (28.6)	
	Total	**0**	**1**	**12**	**13**	**5**		**0**	**2**	**4**	**1**	**0**		
Shoulder pain	Both			2	7	3	12 (30.8)			1			1 (10)	0.404
	Right		1	4	10	4	19 (48.7)			4	1	1	6 (60)	
	Left			2	2	4	8 (20.5)			2	1		3 (30)	
	Total	**0**	**1**	**8**	**19**	**11**		**0**	**0**	**7**	**2**	**1**		
Total		**2**	**11**	**41**	**90**	39		0	13	28	18	2		

copic support in uncomfortable positions, prolonged standing times, and the attempt to permanently relocate the visual field with the tip of the endoscope, they add to the cumulative trauma that worsens when associated with the large volume of procedures and number of years of practice[4,21].

The significant differences in risk factors included: Gender (greater involvement in males; $p < 0.001$), unlike an extensive series of 1698 participants, in which there was no difference by gender[22]. Also, a lower frequency of MSDs was associated with small glove size (compared to medium and large sizes; $p < 000.1$), contrasting publications linking most of the injuries to small hand size[22,23].

Other risk factors for women, including the combination of suboptimal endoscopic grip, lower muscle mass genera-

Table 3. Neck and Back MSDs in Specialists by Gender and Age Group

Types of MSD		N = 131 Specialist n = 114												P-value
		Male n = 92					Total Fa (%)	Female n = 22					Total Fa (%)	
Upper limb		20-30	31-40	41-50	51-60	> 60		20-30	31-40	41-50	51-60	> 60		
Neck and back														
- Neck pain	Yes		1	5	5	4	15 (20.8)		1	1	1	1	4 (25)	0.058
	No													
- Neck pain, upper back pain	Yes			1	1	4	6 (8.3)		1	3	2		6 (37.5)	
	No													
- Neck pain, upper back pain, lower back pain	Yes			1	5	4	10 (13.9)		1				1 (6.3)	
	No													
- Neck pain, lower back pain	Yes		1	1	3	1	6 (8.3)		1				1 (6.3)	
	No													
- Upper back pain	Yes		1	4	3	1	9 (12.5)				1		1 (6.3)	
	No													
- Upper back pain, lower back pain	Yes			3	1	2	6 (8.3)			2			2 (12.5)	
	No													
- Lower back pain	Yes	1	4	7	4	4	20 (27.8)				1		1 (6.3)	
	No													
	Total	1	7	22	22	20		0	4	6	5	1		

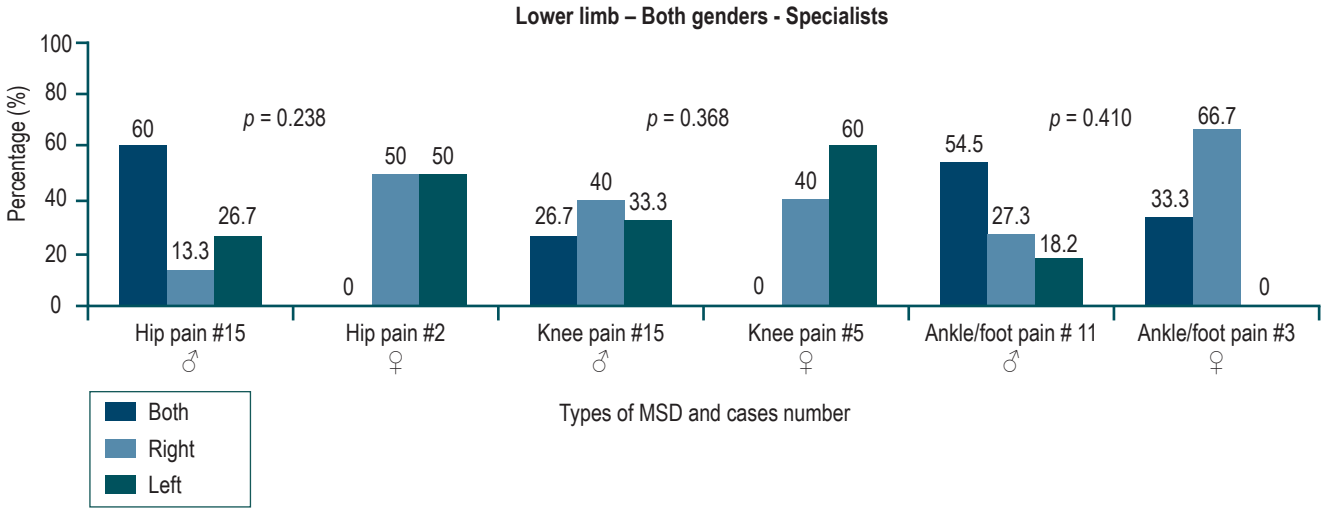

Figure 2. Musculoskeletal disorders in lower limbs in specialists by gender. Authors' elaboration.

ting prehensile strength in fingers[3,13,22,23], and endoscope inadequate ergonomic designs or procedure rooms[24], were not the subjects of this study. Although, they should be considered for future research.

Working conditions were evaluated as risk factors as follows: workload in years (accumulated and recent), number and type of procedures performed, and working hours dedicated to endoscopy. This research only found a significant difference ($p < 0.029$) for the group of 4-10 years of practice, resulting in more frequent MSDs in men than in women. When compared by gender, the remaining workload factors did not show significant differences.

Table 4. Characteristics of Cumulative and Recent Endoscopic Exercise in Male and Female Specialists and Postgraduate Students with MSDs

Characteristics of the endoscopic practice		Specialists			Postgraduate students		
Years of practice		Male n = 92 Total Fa (%)	Female n = 22 Total Fa (%)	Valor p	Male n = 12 Total Fa (%)	Female n = 5 Total Fa (%)	P-value
Accumulated years of endoscopic practice	< 3 < 4 4-10 10-20 > 20	1 (1.1) 5 (5.4) 13 (14.1) 24 (26.1) 49 (53.3)	0 2 (9.1) 8 (36.4) 8 (36.4) 4 (18.2)	0.029	11 (91.7) 0 0 0 1 (8.3)	5 (100) 0 0 0 0	0.50611
Two-year cumulative procedures							
- No. endoscopic procedures accumulated in the last 2 years (gastroscopy, colonoscopy, and basic interventional procedures)	< 200 201-500 501-1000 > 1000	4 (4.4) 6 (6.7) 42 (47.7) 38 (42.2)	2 (9.5) 3 (14.3) 7 (33.3) 9 (42.9)	0.437	2 (16.7) 3 (25) 6 (50) 1 (8.3)	1 (20) 3 (60) 1 (20) 0	0.487
- No. endoscopic procedures accumulated in the last 2 years (advanced interventionism (ERCP, EUS-FNA, enteroscopy, stent])	< 200 201-500 501-1000 > 1000	31 (54.4) 11 (19.3) 12 (21.1) 3 (5.3)	9 (75) 2 (16.7) 1 (8.3) 0	0.523			Un-known
- No. endoscopic procedures accumulated in the last 2 years (third space [DES, POEM, G-POEM, Z-POEM, D- POEM])	< 200 201-500	26 (92.9) 2 (7.1)	5 (100) 0	0.538			Un-known
- No. endoscopic procedures accumulated in the last 2 years (under radiology)	< 200 201-500 501-1000 > 1000	24 (51.1) 10 (21.3) 10 (21.3) 3 (6.4)	6 (60) 3 (30) 1 (10) 0	0.664	4 (57.1) 3 (42.9) 0 0	2 (66.7) 1 (33.3) 0 0	0.778
Cumulative procedures per week (averaged over 2 months)							
- No. endoscopic procedures per week (averaged over the last 2 months [gastroscopy, colonoscopy, and basic interventional procedures])	< 50 50 51-100 101-150 > 150	4 (4.5) 25 (28.1) 37 (41.6) 16 (18) 7 (7.9)	2 (9.5) 6 (28.6) 11 (52.4) 1 (4.8) 1 (4.8)	0.495	4 (36.4) 3 (27.3) 1 (9.10) 3 (27.3) 0	0 1 (20) 1 (20) 3 (60) 0	0.362
- No. endoscopic procedures per week (averaged over the last 2 months [advanced interventionism])	< 50 50 51-100 101-150 > 150	4 (9.3) 29 (67.4) 4 (9.3) 5 (11.60) 1 (2.3)	0 8 (100) 0 0	0.464	3 (42.9) 1 (14.3) 3 (42.0) 0	0 1 (100) 0 0	0.180
- No. endoscopic procedures per week (averaged over the last 2 months [third space interventionism])	< 50 50 51-100	2 (10) 17 (85) 1 (5)	0 2 (100) 0	0.841	5 (83.3) 1 (16.7) 0	0 0 0	Un-known
Hours worked per week (2 months)							
- General work	< 24 24-48 49-60 > 60	6 (7.2) 36 (43.4) 25 (30.1) 16 (19.3)	1 (4.8) 11 (52.4) 5 (23.8) 4 (19)	0.877	0 3 (25) 3 (25) 6 (50)	0 0 1 (20) 4 (80)	0.401
- Work in the endoscopy room	< 24 24-48 49-60 > 60	25 (29.1) 42 (48.8) 11 (12.8) 8 (9.3)	9 (40.9) 10 (45.5) 3 (13.6) 0	0.411	1 (10) 4 (40) 3 (30) 2 (20)	0 1 (20) 0 4 (80)	0.145

Table 5. MSD Prevention Behaviors and Ergonomics Training in Male and Female Specialists and Postgraduate Students

		Specialists			Postgraduate Students		
		Male n = 92 Total Fa (%)	Female n = 22 Total Fa (%)	Valor p	Male n = 12 Total Fa (%)	Female n = 5 Total Fa (%)	P-value
Regular breaks							
- Endoscopic intraprocedures	Yes No	2 (3.8) 50 (96.2)	0 12 (100)	0.490	0 7 (100)	1 (33.3) 2 (66.7)	0.107
- Between endoscopic procedures	Yes No	45 (60.8) 29 (39.2)	13 (65) 7 (35)	0.732	5 (55.6) 4 (44.4)	2 (66.7) 1 (33.3)	0.735
Training in ergonomics							
- Formal didactics of a program	Yes No	4 (4.9) 78 (95.1)	2 (12.5) 14 (87.5)	0.245	1 (10) 9 (90)	0 5 (100)	0.464
- Informal/self-taught didactics	Yes No	31 (36.5) 54 (63.5)	11 (55) 9 (45)	0.128	4 (40) 6 (60)	1 (20) 4 (80)	0.439
- Didactics within the procedure room	Yes No	17 (20.2) 67 (979.8)	2 (12.5) 14 (87.5)	0.470	3 (25) 9 (75)	0 5 (100)	0.218

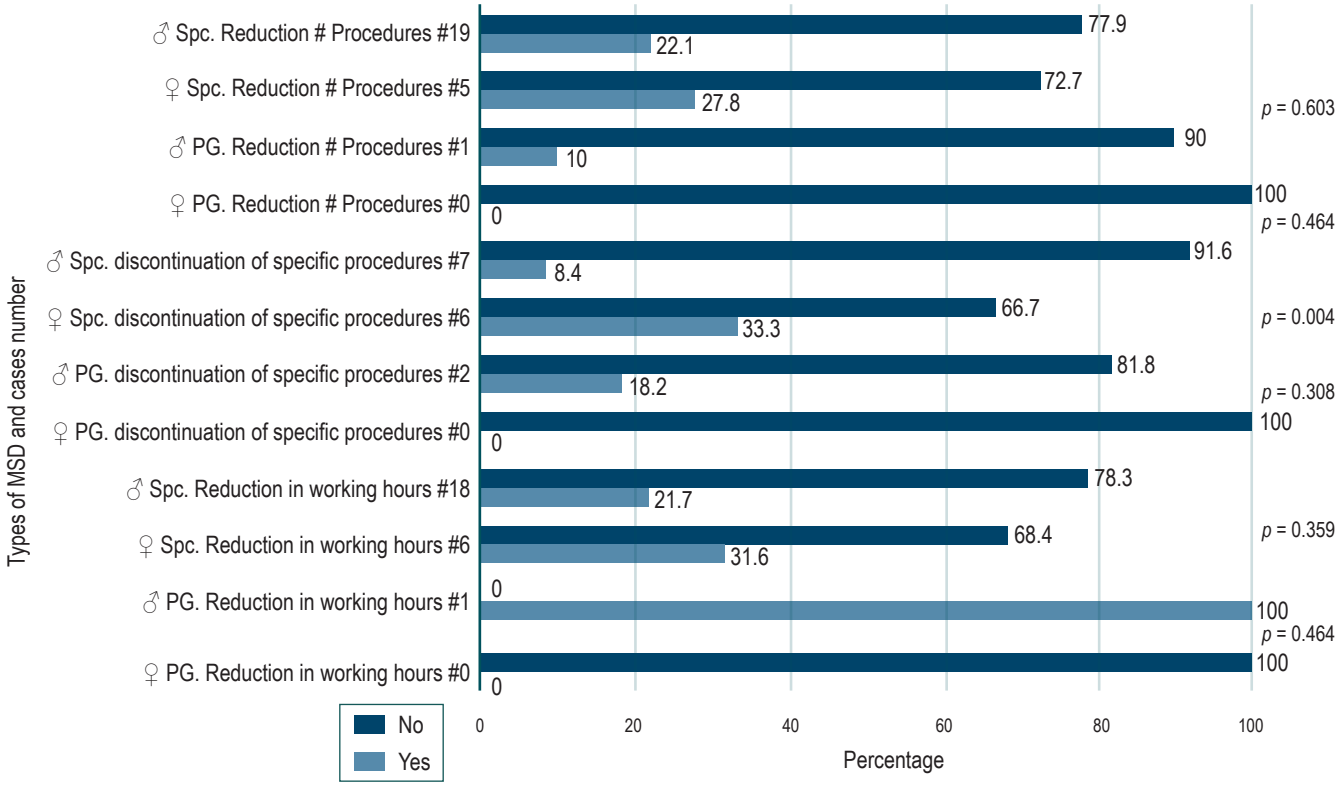

Figure 3. Occupational impact of MSDs in specialists and graduate students according to gender. Esp.: Specialists; PG: Graduate students; ♂: Male; ♀: Female. Authors' elaboration.

Table 6. Awareness of Ergonomics Endoscopy Training in Male and Female Specialists and Postgraduate Students

		Specialists		
		Male n = 92 Total Fa (%)	Female n = 22 Total Fa (%)	P-value
For practicing specialists				
- I am willing to change how I perform endoscopy if it helps me prevent endoscopy-related injuries.	Strongly agree Neither Agree nor Disagree Strongly disagree	62 (72.9) 8 (9.4) 15 (17.6)	12 (63.2) 1 (5.3) 6 (31.6)	0.366
- I am willing to receive and provide training to the endoscopy room care team on the prevention of overuse-related injuries in endoscopy	Strongly agree Neither Agree nor Disagree Strongly disagree	63 (74.10) 9 (10.6) 13 (15.3)	12 (66.7) 0 6 (33.3)	0.098

		Postgraduate Students		
		Male n = 12 Total Fa (%)	Female n = 5 Total Fa (%)	P-value
For postgraduate students-fellows				
- Ergonomic training during specialization is important	Strongly agree Neither Agree nor Disagree Strongly disagree	10 (90.9) 0 1 (9.1)	5 (100) 0 0	0.486
- I am willing to educate myself on what can help me prevent an injury related to performing endoscopies	Strongly agree Neither Agree nor Disagree Strongly disagree	9 (81.8) 0 2 (18.2)	4 (80) 0 0	0.211
- I would like to receive formal didactic training on how to prevent overuse injuries in endoscopy	Strongly agree Neither Agree nor Disagree Strongly disagree	10 (90.9) 1 (9.1) 0	4 (80) 1 (20) 0	0.541
- I receive training in the procedure room on how to prevent endoscopy-related injuries	Strongly agree Neither Agree nor Disagree Strongly disagree	3 (27.3) 5 (45.5) 3 (27.3)	2 (40) 2 (40) 1 (20)	0.872

Reports showed a tendency towards increased reporting in males (groups 51-60 years and 41-50 years), practicing for more than 20 years, working 24-48 and 49-60 hours per week; in addition to a higher number of basic endoscopic procedures, advanced interventional procedures or under fluoroscopy, both accumulated and recent. In the procedure room, the number of reported MSDs increased when the working day was less than 24 hours per week. This suggests that detraining caused by less practice may represent a risk factor.

Therefore, these results could not validate Pawa *et al.*[22], who reported higher odds of MSDs according to age (51.9 ± 12.3 years; $p < 0.001$), general gastrointestinal practice ($p < 0.001$), years of endoscopy practice (21.1 ± 12.0 years; $p < 0.001$), and the number of colonoscopies per week (between 11 and 30; $p < 0.001$) in univariate analysis, and, years of endoscopies practice and the number of hours performing endoscopies/week in a multivariate analysis.

The Japanese prevalence of 69% MSDs could not be confirmed in third space endoscopy (TSE) with MSDs (71% from the beginning of TSE and 48.8% with previous symptomatic worsening while performing echoendoscopes and ERCP)[17,25], probably due to the small amount of TSE in the current sample. However, the higher demands of time and technique could show an increase in this group in the future since these diagnostic and therapeutic modalities are rapidly expanding.

The occupational impact of MSDs was significant: Seventy-eight percent of specialists reported absenteeism and work disability. Absenteeism was much higher than in

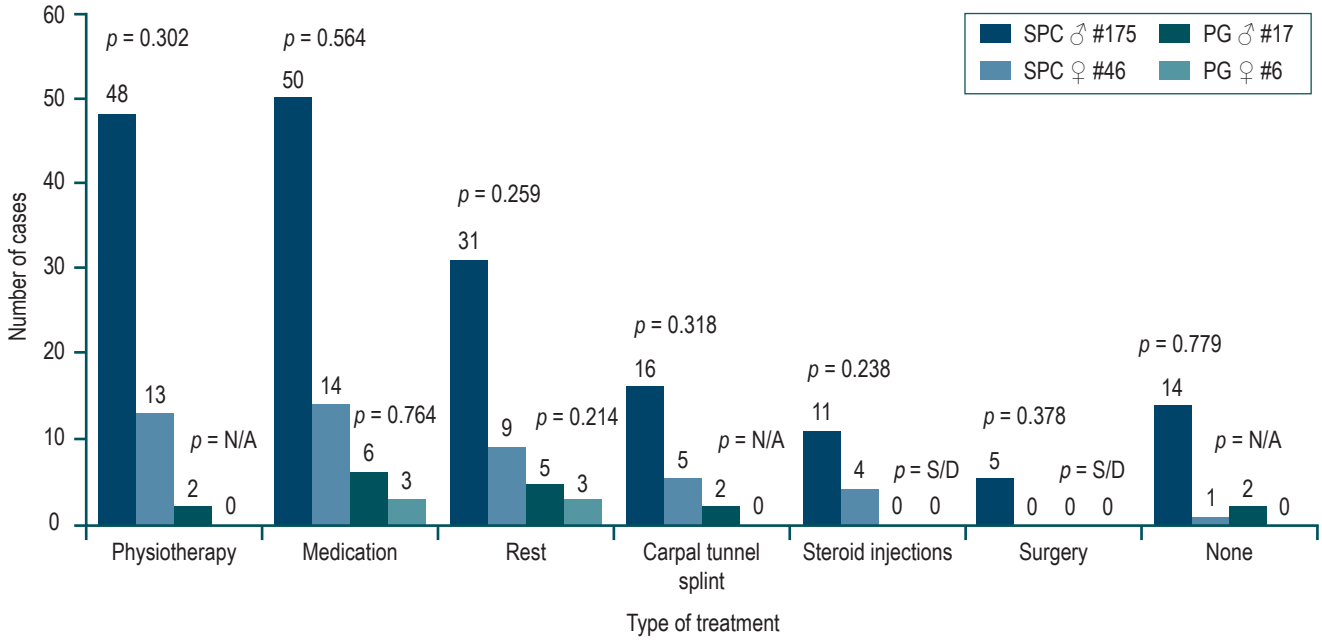

Figure 4. Treatment modalities for MSDs in specialists and graduate students according to gender. Esp.: Specialists; PG: Graduate students; ♂: Male; ♀: Female. Authors' elaboration.

other publications, with absence rates from work between 3% and 18.5%[4,13,15,26], 17.3% in endoscopists performing extended diagnostic and therapeutic procedures[6], and 9.7% in those performing colonoscopy procedures[20]. In terms of disability, this research found a significant difference with women discontinuing specific procedures more often (33.3% vs. 8.4%; $p < 0.004$). While disability accounted for only 2.2% of TSE research[17].

The most commonly used reported treatments included respectively: Medications, physiotherapy, rest, carpal tunnel splint or wrist splint treatment, steroid injection, no treatment, and finally, surgery. These behaviors coincide with therapeutic choices in TSE[17] and those performing colonoscopy[20]. In this study, many male endoscopists rejected any alternative, which may have influenced the high absenteeism rate.

Regarding the prevention of MSDs, 93.8% did not receive ergonomic training under formal didactics, a higher number than the 61.5% reported by Pawa *et al.*[22]. There was an intention of informal self-study training 40%, and 61.7% paused between procedures. These are inferior figures, possibly associated with the high prevalence found of MSDs. The positive perception of ergonomic training (74.1% in specialists, 90.9% in postgraduate students) enables a comprehensive preventive approach that must keep education and training as central elements[1,27,28].

Therefore, a proposal such as the Core Curriculum for Ergonomics in Endoscopy published by the American Society for Gastrointestinal Endoscopy (ASGE)[1] defines basic knowledge, technical skills, and non-technical skills by teaching the performance of endoscopy and the safety of the endoscopist with an ergonomic approach, including leadership and awareness of risk factors within the work team, supported by teachers who bring a level of understanding of competence the aspects mentioned above[29,30]. Prevention may include individualized studies and physiotherapy plans[24], ergonomic programs on colonoscopy simulators[31], and endoscope redesign tailored to gender needs. However, the advent of the customized endoscope is ideal, albeit inapplicable for the near future[32]. For some, the tremendous physical load demanded requires endoscopists to receive a training plan similar to that of an athlete, including 5 steps: Knowledge and appropriate use of equipment, preparation "for the game," teamwork, recovery, and reflection on the result, which keeps them physically "in the game"[28].

This study has limitations inherent to the application of surveys, such as response bias (likely reason for suffering from MSDs that overestimates the prevalence) and recalls bias. No detailed inquiry was made about other MSDs before endoscopic practice or potentially harmful habits such as excessive use of cell phones, nor was there any inquiry about healthy practices. Postgraduate students' participation was poor. Thus, their results are pretty limited, albeit interesting as a first approximation. Therefore, these results remained part of the report.

Study highlights: Despite the small sample size, it shows a response rate close to 50% of the estimated Colombian endoscopists population, constituting thus far the most extensive study of MSDs in endoscopy in the country. This study investigates various MSDs, professional practice characteristics, educational levels, and specific ergonomic training. Furthermore, it approaches impact according to gender.

CONCLUSIONS

The 65.2% MSDs prevalence rate evidences an occupational health problem for endoscopists. Consequently, further research and interventions in its prevention, diagnosis, and treatment should continue.

The type of MSD and the risk factors found are similar to those published (therefore, the pathophysiological mechanisms are shared). Hence, a common scenario can hasten the prevention and intervention measures already described.

Data from this study allows endoscopists' placement in the different groups surveyed to bring them closer to their risk factors and, consequently, to their prevention.

Numerous aspects require ergonomic improvements in endoscopy practice. If awareness, training, and prevention on the subject fail in this area, discussing the topic of "safe endoscopy practices" would remain a mere oxymoron[33].

Conflicts of Interest

The authors of this study declare that they have no conflicts of interest.

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