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Gastrointestinal endoscopy and work-related injuries: an international survey

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ABSTRACT

Background and study aims Recently, the awareness of work-related musculoskeletal injuries (MSIs) among gastrointestinal endoscopists has increased because of their effect on the private and work life of clinicians as well as on the health care system. The high injury incidence (reported to range from 37 % to 89 %) has been correlated with the intensive muscular demand required during a procedure.

Patients and methods An online survey with 32 questions was conducted globally. Clinically active endoscopists (doctors and nurses) participated anonymously and voluntarily. The questionnaire included questions about endoscopist anthropometrics, experience of MSI, treatment, and preventive measures such as ergonomic training. Descriptive statistics were used to analyse the data.

Results Of 204 clinicians (78 % males; 81 % >35 years of age), 107 (53 %) stated to have experienced a work-related MSI. The most frequent locations were in the neck (n = 49), shoulder and thumb (n = 39, both). Female clinicians resulted to be significantly more prone to develop MSI. In addition, endoscopists who performed more than 15 hours of endoscopy or more than 15 procedures per week reported a significantly higher rate of MSI.

Conclusions The high frequency of MSIs among gastrointestinal endoscopists highlights the importance of implementing ergonomic training. Including simple precautions before and during endoscopy may reduce the risk of developing an injury.

Introduction

Gastrointestinal endoscopic procedures (gastroscopy, colonoscopy, endoscopic retrograde cholangiopancreatography [ERCP], and endoscopic ultrasonography [EUS]) are characterized by a demanding physical interaction between the clinician and the endoscope, resembling an endurance sport [1]. To perform a procedure, in fact, the endoscopist needs to press valves and switches, rotate the wheels, hold the endoscope, and apply forces/torques on the insertion tube. Moreover, the clinician is usually standing and continuously interacting with other people (nurses, patient) as well as with other equipment (monitor, pedals, bed, etc.) present in the operating room (OR). As a matter of fact, the OR set up, the handing of the endoscope, and the tip control are ergonomically correlated one another [1, 2]. Therefore, performing a gastrointestinal endoscopy is a complex activity and its ergonomic optimization is beneficial for the health of the clinician and the success of the intervention.

The shape and size of modern gastrointestinal endoscopes do not differ significantly from those designed decades ago [3, 4]. Despite the technological evolution of medical devices and the increased awareness on safety in the working place, endoscopes are still designed to be "one-size-fits-all" and based on anthropometrical data covering only a part of the user population, i. e., excluding most female users [5]. As a result, the clinicians work with a tool that may not allow them to perform to the best of their capabilities, needing to adapt the position/movements to each endoscope [6], which on the long term may result in work-related musculoskeletal injuries (MSIs). This in turn might lead to modification of their practice. MSIs frequently result in the inability to work, influencing the work and private life of the clinician but also the productivity of the health care system [3, 7]. Besides the handle design, other causes of MSI in gastrointestinal endoscopy include the high applied forces, the position of the equipment in the OR, the repetitive movements, and the prolonged standing time [3, 8–16].

MSIs are frequent in gastrointestinal endoscopy: Previous studies show that MSIs range from 37 % to 89 % among gastrointestinal endoscopists [8–12, 14, 15, 17–20], and are experienced in many joints, from the lumbar area to neck and upper limbs' joints [8, 9, 12, 14, 17, 18]. The most reported MSIs are hand numbness, DeQuervain's tenosynovitis, and carpal tunnel syndrome [9, 13, 15, 21, 22].

Despite the increased awareness of the influence of gastrointestinal endoscopy on MSIs, further research is necessary to better understand how to reduce the risk of MSIs. To the best of our knowledge, an investigation about the correlation between the anthropometrical characteristics and the occurrence and location of MSIs is missing. Therefore, a survey was conducted among gastrointestinal endoscopists with the purpose of investigating if certain anthropometrical characteristics correlate to MSIs. The study also aimed at investigating if female endoscopists are more affected by MSIs, if endoscopists with small hands are more affected by MSIs, and if tall endoscopists are more prone to develop back pain.

Materials and methods

A world-wide online survey was conducted between March and June, 2021. Clinically active endoscopists (doctors and nurses) participated anonymously, voluntarily and without monetary compensation. The responders were identified in the authors' network and asked to forward the questionnaire to other colleagues. The questionnaire was composed of 32 questions including endoscopist characteristics (as age, height, weight), experience of MSI, treatment, and preventive measures such as ergonomic training. Participants could select different MSIs and locations. The questions were based partially on previous publications [19, 20] and were reviewed in a final stage by one advanced gastrointestinal endoscopist and one gastrointestinal nurse.

Descriptive statistics were used to analyse the data. The chi-squared test was used using IBM SPSS Statistics (IBM Corp., Armonk, New York, United States) with a significance level of $P < 0.05$.

Results

A total of 204 endoscopists responded to the survey (89 % doctors, 11 % nurses of whom 59 % were actively using the endoscope for more than 10 hours/week) (▶ **Table 1**). Of the respondents, 78 % were males and 81 % older than 35 years. The ethnic distribution was 41 % Asian, 55 % White, and the rest distributed between Hispanic, mixed and Afro-American. Nine endoscopists worked in the United States, 117 in Europe (Italy, Germany, Spain, Portugal, France, Belgium, Norway, Sweden, Denmark, Finland, UK); 64 in Asia (Singapore, Malaysia, Japan, India, China, South Korea, Indonesia), and 13 in Oceania (Australia, New Zealand) – one did not answer. Of the respondents, 88 % weighed at least 60 kg, and 92 % were taller than 160 cm (▶ **Table 1**). A total of 92 % were right-handed and 88 % had a surgical glove size between 6.5 and 8.0 (▶ **Table 1**). More than half of the interviewees (53 %) reported a previous or present MSI related to gastrointestinal endoscopy. Gender revealed to be a risk factor, with female clinicians more prone to develop an MSI than the male counterparts ($\chi^2 = 11.437$, $P = 0.001$) (▶ **Table 1**).

More than 85 % of the responders had at least five years of experience, and 73 % had experience in ERCP (▶ **Table 2**). A total of 40 % reported having less than a 10-minute break between two procedures and the duration did not influence the probability of developing an MSI. Of the respondents, 47 % performed more than 25 procedures/week, and 55 % reported actively using the endoscope for more than 15 hours/week (▶ **Table 2**). Using the endoscope for more than 15 hours/week ($\chi^2 = 4.178$, $P = 0.041$) or performing more than 15 procedures/week ($\chi^2 = 5.416$, $P = 0.020$) were related to MSI.

Among the responders, 7 % stated to perform a muscular warm up before starting a procedure. 74 % adjusted the monitor position, 9 % the height of the patient bed, and 83 % the pedals' position. Only 19 % reported to use a floor mat. 18 % reported having participated in ergonomic training, while 49 % would be interested in participating in one (▶ **Table 3**). The willingness to participate in ergonomic training was significantly higher among those who have had MSI ($\chi^2 = 8.234$, $P = 0.016$) (▶ **Table 3**). Of the respondents, 18 % did not perform any physical activity during the week, while 33 % stated doing a leisure activity that involves the use of the fingers (▶ **Table 3**). Among the physical activities, jogging/running was the most common (n = 77), followed by walking (n = 67), cycling (n = 65), strength training (n = 47), yoga/pilates (n = 24), swimming (n = 20), hiking (n = 15), skiing (n = 3), martial arts (n = 2), and other activities (n = 13) (▶ **Table 3**).

Of the respondents, 53 % reported having or having had an work-related MSI (75 % within the female clinician group), located mainly in the neck (n = 49), shoulder and thumb (n = 39, both), and wrist (n = 34) (▶ **Fig. 1**). When in a limb, MSIs were located in 51 cases on the right side and in 48 on the left. Over 30% of the clinicians faced an MSI that limited him/her from going to work (days without working due to an injury: 1–2 days (16% of the responders); 3–7 (6 %); 7–15 (4 %); 15–30 (1%); over 30 (5 %)). Muscle/tendon strain was the most common MSI (n = 38), followed by tension neck syndrome (n = 21) and tendinitis (n = 20) (▶ **Fig. 2**). In most cases (n = 51), the clinicians did not intervene to heal it. Analgesics (n = 29) and anti-inflammatory medication (n = 28) were the most frequently used intervention, followed by exercise (n = 20), rest (n = 16), and physiotherapy (n = 15) (▶ **Fig. 3**).

▶ **Table 1** Responders' anthropometric and descriptive data vs. development of work-related injuries (n [%]). Statistical differences were calculated within the groups and when found ($p < 0.05$), data were reported in bold.

		Injury experienced			
		Yes (n = 107)[1]	**No (n = 97)[2]**	**Total (n = 204)[3]**	
Age (years)	<25	0 [0.0 %]	0 [0.0 %]	0 [0.0 %]	$\chi^2 = 4.264$ $P = 0.371$
	25–34	7 [36.8 %]	12 [63.2 %]	19 [9.3 %]	
	35–44	35 [50.7 %]	34 [49.3 %]	69 [33.8 %]	
	45–54	43 [57.3 %]	32 [42.7 %]	75 [36.8 %]	
	55–64	18 [50.0 %]	18 [50.0 %]	36 [17.6 %]	
	>65	4 [80.0 %]	1 [20.0 %]	5 [2.5 %]	
Gender	Female	33 [75.0 %]	11 [25.0 %]	44 [21.6 %]	$\chi^2 = 11.437$ $P = 0.001$
	Male	74 [46.3 %]	86 [53.7 %]	160 [78.4 %]	
Weight (kg)	<50	3 [60.0 %]	2 [40.0 %]	5 [2.5 %]	$\chi^2 = 6.136$ $P = 0.408$
	50–59	12 [63.2 %]	7 [36.8 %]	19 [9.3 %]	
	60–69	26 [53.1 %]	23 [46.9 %]	49 [24.0 %]	
	70–79	34 [54.8 %]	28 [45.2 %]	62 [30.4 %]	
	80–89	17 [38.6 %]	27 [61.4 %]	44 [21.6 %]	
	90–99	9 [52.9 %]	8 [47.1 %]	17 [8.3 %]	
	>100	6 [75.0 %]	2 [25.0 %]	8 [3.9 %]	
Height (cm)	<150	0 [0.0 %]	0 [0.0 %]	0 [0.0 %]	$\chi^2 = 1.618$ $P = 0.806$
	150–159	9 [56.3 %]	7 [43.7 %]	16 [7.8 %]	
	160–169	25 [59.5 %]	17 [41.5 %]	42 [20.6 %]	
	170–179	46 [51.1 %]	44 [48.9 %]	90 [44.1 %]	
	180–189	20 [46.5 %]	23 [53.5 %]	43 [21.1 %]	
	190–199	7 [53.8 %]	6 [46.2 %]	13 [6.4 %]	
	>200	0 [0.0 %]	0 [0.0 %]	0 [0.0 %]	
Right-handed	Yes	101 [53.7 %]	87 [46.3 %]	188 [92.2 %]	$\chi^2 = 2.373$ $P = 0.123$
	No	6 [37.5 %]	10 [62.5 %]	16 [7.8 %]	
Surgical glove size	5.5	2 [100.0 %]	0 [0.0 %]	2 [1.0 %]	$\chi^2 = 10.030$ $P = 0.187$
	6.0	4 [50.0 %]	4 [50.0 %]	8 [3.9 %]	
	6.5	22 [52.4 %]	20 [47.6 %]	42 [20.6 %]	
	7.0	25 [69.4 %]	11 [30.6 %]	36 [17.6 %]	
	7.5	26 [40.6 %]	38 [59.4 %]	64 [31.4 %]	
	8.0	19 [54.1 %]	18 [45.9 %]	37 [18.1 %]	
	8.5	4 [50.0 %]	4 [50.0 %]	8 [3.9 %]	
	9.0	4 [57.1 %]	3 [42.9 %]	7 [3.4 %]	
Profession	Doctor	95 [52.2 %]	87 [47.8 %]	182 [89.2 %]	$\chi^2 = 0.043$ $P = 0.835$
	Nurse	12 [54.5 %]	10 [45.5 %]	22 [10.8 %]	
Use bifocal or progressive lenses	Yes	40 [48.8 %]	42 [51.2 %]	82 [40.2 %]	$\chi^2 = -0.741$ $P = 0.389$
	No	67 [54.9 %]	57 [45.1 %]	122 [59.8 %]	

[1] The percentage is relative to the number of people in the relative group.
[2] The percentage is relative to the overall number of responders.
[3] Three clinicians did not reply to the question.

▶ **Table 2** Responders' work descriptive data vs. development of work-related injuries (n [%]). Statistical differences were calculated within the groups and when found (*P* < 0.05), data were reported in bold.

		Injury experienced			
		Yes (n = 107)[1]	**No (n = 97)**[1]	**Total (n = 204)**[2]	
Years of practicing endoscopy	< 2[1]	3 [30.0 %]	7 [70.0 %]	10 [4.9 %]	χ^2 = 5.469 *P* = 0.361
	2–5	7 [36.8 %]	12 [63.2 %]	19 [9.3 %]	
	6–15	42 [58.3 %]	30 [41.7 %]	72 [35.3 %]	
	16–25	34 [50.7 %]	33 [49.3 %]	67 [32.8 %]	
	26–35	15 [57.7 %]	11 [42.3 %]	26 [12.7 %]	
	> 35	6 [60.0 %]	4 [40.0 %]	10 [4.9 %]	
Experience in ERCP	Yes	79 [53.4 %]	69 [46.6 %]	148 [72.5 %]	χ^2 = 0.186 *P* = 0.666
	No	28 [50.0 %]	28 [50.0 %]	56 [27.5 %]	
Average ERCP procedure duration (min)	< or = 10	0 [0.0 %]	1 [100.0 %]	1 [0.7 %]	χ^2 = 5.203 *P* = 0.635
	11–20	9 [60.0 %]	6 [40.0 %]	15 [10.1 %]	
	21–30	34 [54.0 %]	29 [46.0 %]	63 [42.6 %]	
	30–60	28 [50.0 %]	28 [50.0 %]	56 [37.8 %]	
	60–90	5 [71.4 %]	2 [28.6 %]	7 [4.7 %]	
	> 90	2 [100.0 %]	0 [0.0 %]	2 [1.4 %]	
	I am not sure	1 [25.0 %]	3 [75.0 %]	4 [2.7 %]	
Average gastroscopic procedure duration (min)	< or = 5	14 [45.2 %]	17 [54.8 %]	31 [15.2 %]	χ^2 = 4.701 *P* = 0.453
	6–10	62 [58.5 %]	44 [41.5 %]	106 [52.0 %]	
	11–15	21 [48.8 %]	22 [51.2 %]	43 [21.1 %]	
	16–30	5 [33.3 %]	10 [66.7 %]	15 [7.4 %]	
	> 30	1 [50.0 %]	1 [50.0 %]	2 [1.0 %]	
	I am not sure	4 [57.1 %]	3 [42.9 %]	7 [3.4 %]	
Average colonoscopic procedure duration (min)	< or = 5	2 [50.0 %]	2 [50.0 %]	4 [2.0 %]	χ^2 = 7.622 *P* = 0.178
	6–10	3 [23.1 %]	10 [76.9 %]	13 [6.4 %]	
	11–15	23 [48.9 %]	24 [51.1 %]	47 [23.0 %]	
	16–30	65 [59.1 %]	45 [40.9 %]	110 [53.9 %]	
	> 30	8 [53.3 %]	7 [46.7 %]	15 [7.4 %]	
	I am not sure	6 [40.0 %]	9 [60.0 %]	15 [7.4 %]	
Average break duration between two procedures (min)	< or = 10	42 [51.2 %]	40 [48.8 %]	82 [40.2 %]	χ^2 = 0.639 *P* = 0.887
	11–20	49 [54.4 %]	41 [45.6 %]	90 [44.1 %]	
	21–30	15 [51.7 %]	14 [48.3 %]	29 [14.2 %]	
	> 30	1 [33.3 %]	2 [67.7 %]	3 [1.5 %]	
Average number of procedures per week	< or = 5	4 [33.3 %]	8 [67.7 %]	12 [5.9 %]	χ^2 = 6.834 *P* = 0.233
	6–10	8 [33.3 %]	16 [67.7 %]	24 [11.8 %]	
	11–15	9 [50.0 %]	9 [50.0 %]	18 [8.8 %]	
	16–20	19 [57.6 %]	14 [42.4 %]	33 [16.2 %]	
	21–25	12 [54.5 %]	10 [45.5 %]	22 [10.8 %]	
	> 25	55 [57.9 %]	40 [42.1 %]	95 [46.6 %]	

▶ **Table 2** (Continuation)

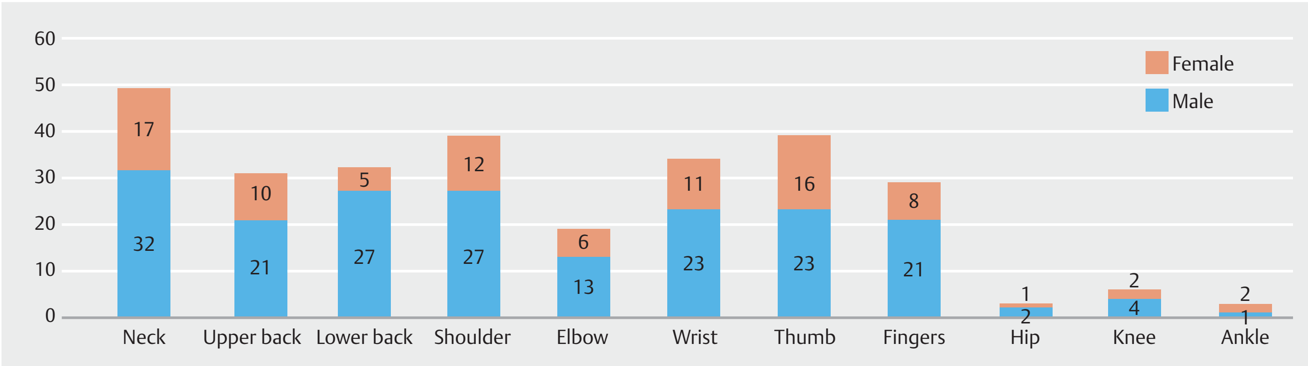
		Injury experienced			
		Yes (n = 107)[1]	No (n = 97)[1]	Total (n = 204)[2]	
Hours per week of active endoscopic procedures (active means actively using the endoscope)	< or = 5	6 [33.3 %]	12 [67.7 %]	18 [8.8 %]	$\chi^2 = 10.510$ $P = 0.062$
	6–10	15 [45.5 %]	18 [54.5 %]	33 [16.2 %]	
	11–15	20 [48.8 %]	21 [51.2 %]	41 [20.1 %]	
	16–20	28 [68.3 %]	13 [31.7 %]	41 [20.1 %]	
	21–25	8 [38.1 %]	13 [61.9 %]	21 [10.3 %]	
	> 25	30 [60.0 %]	20 [40.0 %]	50 [24.5 %]	

ERCP, endoscopic retrograde cholangiopancreatography.
[1] The percentage is relative to the number of people in the relative group.
[2] The percentage is relative to the overall number of responders.

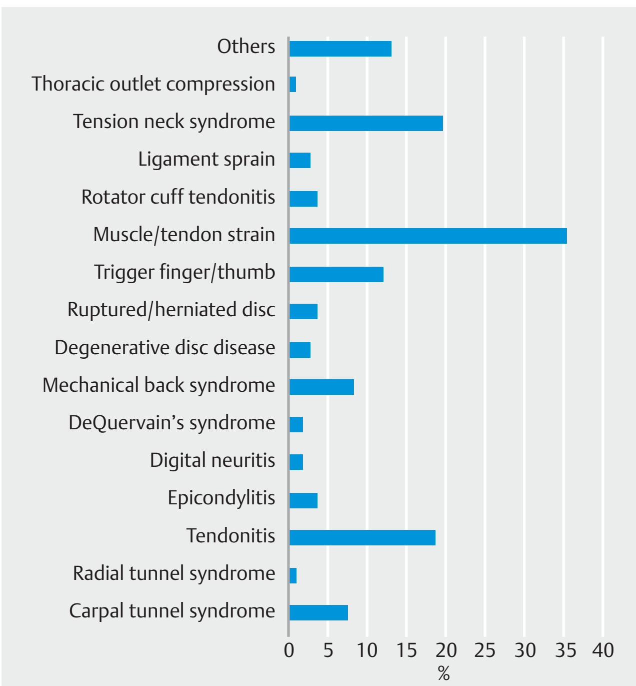
▶ **Table 3** Responders' ergonomic data and work-related injuries (n [%]). Statistical differences were calculated within the groups and when found ($P < 0.05$), data were reported in bold.

		Injury experienced			
		Yes (n = 107)[1]	No (n = 97)[1]	Total (n = 204)[2]	
Warm up before the procedure (stretching, mobility exercises, etc.)	Yes	5 [33.3 %]	10 [67.7 %]	15 [7.4 %]	$\chi^2 = 2.373$ $P = 0.123$
	No	102 [54.0 %]	87 [46.0 %]	189 [92.6 %]	
Adaptation of the position of the monitor to the height	Yes	75 [50.0 %]	75 [50.0 %]	150 [73.5 %]	$\chi^2 = 1.365$ $P = 0.243$
	No	32 [59.3 %]	22 [40.7 %]	54 [26.5 %]	
Adaptation of the position of the bed of the patient to the height	Yes	7 [36.8 %]	12 [63.2 %]	19 [9.3 %]	$\chi^2 = 2.955$ $P = 0.086$
	No	100 [54.1 %]	85 [45.9 %]	185 [90.7 %]	
Use of floor mat	Yes	19 [50.0 %]	19 [50.0 %]	38 [18.6 %]	$\chi^2 = 0.112$ $P = 0.737$
	No	88 [53.0 %]	78 [47.0 %]	166 [81.4 %]	
Adaptation of the position of the foot pedals	Yes	88 [51.8 %]	82 [48.2 %]	170 [83.3 %]	$\chi^2 = 0.193$ $P = 0.661$
	No	19 [55.9 %]	15 [44.1 %]	34 [16.7 %]	
Ergonomic training	Yes	16 [44.4 %]	20 [55.6 %]	36 [17.6 %]	$\chi^2 = 1.124$ $P = 0.289$
	No	91 [33.3 %]	77 [66.7 %]	168 [82.4 %]	
Will to participate in an ergonomic training	Yes	60 [60.6 %]	39 [39.4 %]	99 [48.5 %]	$\chi^2 = 8.234$ $P = 0.016$
	No	11 [32.4 %]	23 [67.6 %]	34 [16.7 %]	
	Maybe	36 [50.7 %]	35 [49.3 %]	71 [34.8 %]	
Hours of physical activity per week	0	19 [52.8 %]	17 [47.2 %]	36 [17.6 %]	$\chi^2 = 0.170$ $P = 0.997$
	1–2	29 [52.7 %]	26 [47.3 %]	55 [27.0 %]	
	3–5	35 [53.8 %]	30 [46.2 %]	65 [31.9 %]	
	6–9	16 [48.5 %]	17 [51.5 %]	33 [16.2 %]	
	> 10	8 [53.3 %]	7 [46.7 %]	15 [7.4 %]	
Leisure activity involving the use of fingers (i. e. videogames, playing a musical instrument)	Yes	31 [45.6 %]	37 [54.4 %]	68 [33.3 %]	$\chi^2 = 1.926$ $P = 0.165$
	No	76 [55.9 %]	60 [44.1 %]	136 [66.7 %]	

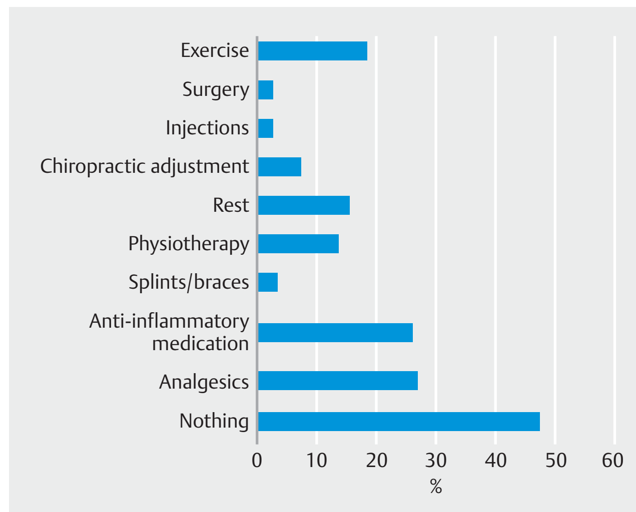
[1] The percentage is relative to the number of people in the relative group.
[2] The percentage is relative to the overall number of responders.



▶ **Fig. 1** Location of the musculoskeletal injury and distribution among female and male endoscopists (n = 107).



▶ **Fig. 2** Kind of musculoskeletal injury reported by the respondents (n = 107).



▶ **Fig. 3** Kind of treatment for the injury reported by the respondents (n = 107).

Regarding the correlation between MSI location and anthropometric and descriptive data, clinicians who reported an MSI located in the hip, knee and ankle had a statistically significant higher body weight (all $P < 0.05$). Taller physicians reported a higher incidence of MSIs in the knee and ankle (both $P < 0.05$). Physicians performing a leisure activity involving the use of the fingers (e. g. videogames, playing a musical instrument) reported more MSIs located in the thumb ($P = 0.052$). Having smaller hands (surgical glove size ≤ 6.5) did not relate to have experienced an MSI located in the thumb or fingers.

Discussion

Recently, awareness of MSIs among gastrointestinal endoscopists has increased in response to their impact on clinicians and subsequent effects on resources, cost, and quality of the health care system [5, 7, 9]. In this study, 53 % of the interviewed endoscopists had experienced at least one work-related MSI, in line with previous publications reporting an occurrence between 37 % and 89 % [8–12, 14, 15, 17–20]. More than 30 % of those experiencing MSIs had such severe problems that they were not be able to work.

In the present study, the only anthropometric or descriptive variable that statistically led to MSI was gender: Female endoscopists were more prone to MSIs than males. An explanation might be the biological lower force-generation of women compared to men [23], also in gastrointestinal endoscopy [13]. Having a small surgical glove size and thus a smaller hand was not found to be a risk factor for developing MSIs in the thumb or fingers, but despite that, users with smaller hands need to adapt their position and movements to the endoscope [6, 9]. In this regard, it is important to consider the role of movement adaptation to external constraints, in this case to the handle design and size. Being the interaction user-endoscope a repetitive movement, each clinician strategically applies a different movement pattern to perform the task. Therefore, there is not a single optimal solution to a specific task, but several [24]. As a result, only considering hand size as an injury risk factor is not sufficient, since due to the movement adaptation, each user is overloading a particular joint differently from other endoscopists [6].

Gastrointestinal endoscopy can be considered an extremely high-intensity endurance activity [1], with long standing periods and a continuous application of forces and torques [9, 12, 17, 18, 25], especially in colonoscopy and ERCP. Performing a warmup (stretching or mobility exercise) before a procedure has been demonstrated to be beneficial for gastrointestinal endoscopists, as it is for athletes [1]. However, few responders (7 %) reported performing a warmup, and whether or not warm-up was done did not correlate to MSIs. In line with previous publications [9, 15, 16], also the current survey found that the probability of experiencing an MSI is related to the number of procedures or of hours of active use of the endoscope per week. Prolonged standing periods in the workplace are generally considered a risk factor for back pain and discomfort [26]. For this reason, taking breaks between procedures is beneficial, permitting a proper recovery [4, 9]. The importance of this practice seems to still be underestimated, as reported in the current and previous studies [4]. 37 % of those younger than 35 years had experienced an MSI, showing that any endoscopists exempt from MSIs and highlighting the importance of injury prevention and ergonomic training even among younger fellows [1]. The ratio of doctors and nurses who experienced an MSI was comparable (52 % and 55 %, respectively), demonstrating that MSIs are not only frequent among doctors, but also among the gastrointestinal nurses who assist and sometimes perform the procedures as well [27].

Suboptimal and poor positioning of the equipment in the OR has been demonstrated to be a risk factor for the health of endoscopists [4, 16, 18, 28, 29]. Adjusting the height and position of the screen and bed, for instance, can reduce neck, shoulder, spine, and arm pain. But in the present study, no significant correlation was found between adjusting the height of the screen or of the bed, the position of the pedals, or the use of a floor mat and reported MSIs. There was, however, a nonsignificant trend indicating that endoscopists adjusting the position of the equipment in the OR had fewer MSIs. Therefore, as previously recommended [5, 9, 19], an "ergonomic time-out" is suggested to prepare the OR and to ensure the correct equipment positioning. Surprisingly, despite such practice could be considered "common sense," only 74 % and 83 % of the clinicians reported adjusting the height of the monitor and the position of the pedals, respectively, 19 % use a floor mat, and 9 % adjusted the height of the bed/cart.

The importance of the ergonomic time-out could be highlighted during endoscopy-specific ergonomic training. Only a small portion of the endoscopists have received such training (18 %), despite its potential benefits in reducing MSIs [9, 30, 31]. In the study, no correlation between participating in an ergonomic training and occurrence of work-related MSIs was found, differently from what previously reported [19]. The importance of ergonomic training is nonetheless recognized by endoscopists who had experienced MSIs, and these reported to be willing to participate in such training ($P = 0.016$).

In the present study, no statistical correlation was found between performing physical activity for more than two hours/week and the occurrence of MSIs. Having an active lifestyle reduces the risk of MSIs among dentists [32], who, as gastrointestinal endoscopists stand for extended periods watching monitors and operating with instruments. This suggests that having an active lifestyle might reduce MSIs, also among endoscopists [1].

In line with previous studies [8–10, 14, 15, 18, 20, 33], neck, upper and lower back, shoulder, wrist, and thumb were the primary locations of MSIs. Women were more likely than men to have neck (52 % vs. 43 %) and thumb pain (49 % vs. 31 %), while male clinicians more frequently reported lower back pain (37 % vs. 15 %) [9]. When located in a limb, MSIs have been reported to be distributed relatively equally between the left and right side (n = 48; 51, respectively). MSIs located on the lower limb are rare and have been previously associated with frequent pressing of the electrocautery and rinsing foot pedals [20]. In the current investigation, weight and height of the endoscopists were associated with a higher risk of experiencing MSIs in the hip, knee, and ankle. Therefore, as proposed in studies on injury prevention in the workplace, a sitting position during procedures could be suggested to reduce the weight on the limbs [34], though this may be impractical when for instance torquing the colonoscope. The use of bifocal lenses was not a risk factor for developing neck pain, though previous studies have suggested it [35]. DeQuervain's syndrome was not as frequently reported as in other studies [18, 33], while the high frequency of muscle and tendon strain is related to the fact that this injury can be in several different joints. Regarding treatment of MSIs, besides not taking any remedy, most of the doctors utilized pain and anti-inflammatory medications, which is in line with previous findings [15, 20].

A limitation of the study is that the survey did not require the endoscopists to indicate specifically the side of the MSI. Previous publications have shown that, due to the use of the elevator in ERCP, the thumb is the most affected joint of the left side [33], while the wrist and shoulder are most affected on the right side due to the relatively high forces and torque movements [3, 12, 18, 19]. In addition, endoscopists were not asked whether they were using a lead apron. Therefore, its influence on the development of MSIs (especially located in the neck and back, due to its weight) could not be investigated directly. However, because the lead apron is mandatory protective equipment, especially in ERCP, it can be considered that at least 73 % of those interviewed use it while performing ERCP. In the current study, no statistical significance was found between practice of ERCP and development of MSIs, confirming findings from a previous study [19] but differing from another [17].

Conclusions

The high frequency of MSIs among gastrointestinal endoscopists supports the need to increase awareness about the importance that ergonomics plays in injury prevention. The present study shows that considerations about ergonomics should be implemented in different fields of gastrointestinal endoscopy. As a recommendation, the following aspects should be considered to reduce injury prevention:

- Promoting ergonomic training specific to gastrointestinal endoscopy
- Reconsidering the position of the doctor during procedures, suggesting the possibility of doctors sitting to reduce the load on joints if possible
- Providing only adjustable, movable beds and screens in the OR, and adjusting these during the ergonomics time-out.

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Competing interests

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