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Original Research

International Survey Assessing Gender Disparities in Advanced Therapeutic Endoscopy

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ABSTRACT

BACKGROUND AND AIMS: Underrepresentation of women in advanced therapeutic endoscopy is a multifactorial issue. We aim to evaluate the concerns about fluoroscopy use across genders and assess its impact on the representation of women in advanced therapeutic endoscopy.

METHODS: An international survey was distributed in August of 2023 to endoscopic retrograde cholangiopancreatography (ERCP)–performing physicians. The primary outcome was the frequency of concerns related to fluoroscopy exposure. Secondary outcomes included the reasons or implication of these concerns. Subgroup analyses were performed across gender.

RESULTS: ERCP-performing physicians revealed a gender disparity in therapeutic endoscopy, with 72.8% male respondents and 27.2% female respondents. Most participants were staff (67.6%), predominantly men (70.6%). The average age was 38.2 years, with a median institutional ERCP volume of 550 cases. Awareness of fluoroscopy safety standards was 56.1%, but only 51.6% received formal training. Concerns about radiation included cancer risk (73.4%) and fertility (43.9%). Usage of protective equipment was inadequate: thyroid dosimeters (21.9% always used), pelvic dosimeters (13.1%), and leaded goggles (8.4%). Female respondents specifically noted delayed family planning (27.6%) and fear of working while pregnant (40.4%), whereas male respondents focused on general health risks. Additionally, 68.4% of institutions recorded fluoroscopy time, but only 56.1% reported dosimeter use.

CONCLUSION: Gender disparities in fluoroscopy exposure concerns warrant the need for improved training and safety standards to foster equity in therapeutic endoscopy. Addressing these issues through targeted education and policy changes will not only enhance awareness of radiation risks but also promote a more inclusive environment for both male and female practitioners.

Keywords: Fluoroscopy; Endoscopic retrograde cholangiopancreatography; Radiation; Gastrointestinal endoscopy.

Abbreviations used in this paper: AEF, advanced endoscopy fellowship; ATE, advanced therapeutic endoscopy; ERCP, endoscopic retrograde cholangiopancreatography.

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What You Need to Know

Background

Gender disparities exist in therapeutic endoscopy, affecting training opportunities and safety practices. Understanding these differences is essential for improving workplace equity and addressing unique concerns.

Findings

In a survey of 173 endoscopy practitioners, 73.4% expressed concerns about cancer risk, whereas 43.9% were worried about fertility. Adherence to protective equipment use was insufficient across genders.

Implications for Patient Care

Enhancing training and awareness of radiation safety standards can improve clinician well being and support diverse practitioners, ultimately leading to better patient outcomes in fluoroscopy-guided procedures.

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) fluoroscopy use is influenced by several factors, including room setup, equipment, patient characteristics, and physician attributes. One physician attribute that has not been explored is the endoscopist's gender. In the field of advanced therapeutic endoscopy (ATE), there is significant underrepresentation of women, comprising only 12.8% to 14% of female fellows in the North America. Contributing elements to this disparity may include the lack of women in key leadership roles in which the absence of female role models may discourage aspiring endoscopists, as well as gender discrimination and subconscious biases, which act as a deterrent in medicine as a whole.[1,2] An overlooked contributor to female underrepresentation in ATE, however, may be the use of fluoroscopy. A standard therapeutic ERCP procedure has been estimated to produce an average of 12.4 mSv of radiation exposure.[3] Asradiation exposure during ERCP is proportional to fluoroscopy time, the threshold for occupational radiation exposure of 20 mSv/year that is set by the International Commission on Radiological Protection could be exceeded in a complex ERCP, which may require 10 minutes or more of fluoroscopy time.[4,5] An audit of radiation exposure during ERCP has even revealed that patients and health care staff are exposed to radiation equivalent to an additional lifetime fatal cancer risk ranging from 2.7% to 12.4%.[4] Concerns about radiation exposure during ERCP may exacerbate the existing gender disparity present in ATE due to anxiety surrounding radiation exposure especially at childbearing ages.[6] Closing the gender disparity in ATE requires a greater understanding of the unique concerns surrounding fluoroscopy exposure for women. Because of the disparity present in endoscopy, dedicated initiatives that prioritize underrepresented female perspectives are essential. We aim to gauge concerns surrounding fluoroscopy usage across genders to evaluate the impact of fluoroscopy usage on the representation of women in ATE.

Methods

Study Design

A previously validated 35-item survey with a modified, semistructured component was embedded into the SurveyMonkey platform (SVMK Inc). Prompts were tailored to fit the objectives of this study based on expert consultations (J.D.M., N.F., and N.C.C.) and existing literature.[6] Open-ended questions and rating scales were included to elicit detailed responses about participants' views and experiences. The survey is structured into the following domains:

1. Demographic characteristics, including age (years), biological sex, country of operation, and professional status.
2. Annual volume of physician, trainee, and institutional ERCP procedures.
3. Fluoroscopy knowledge and attitudes, including training, availability of protective equipment, and current practices.
4. Biological sex–specific prompts regarding perceptions and influence of fluoroscopy exposure on practice, fertility, and family planning.

In early August 2023, the survey was distributed internationally through e-mails to physicians, including consultants and trainees, who perform ERCP. These e-mails were sent via newsletters of reputable international gastroenterology and endoscopy organizations such as American Society for Gastrointestinal Endoscopy, European Society of Gastrointestinal Endoscopy, Gastroenterological Society of Australia, and Society of Gastrointestinal Endoscopy of India. The survey remained open for 10 months, from August 2023 to May 2024.

Outcomes

The primary outcome of this study is the frequency of concern associated responses with fluoroscopy exposure among physicians who perform ERCP. These concerns include fertility problems, cancer risk, cataracts, delayed family planning, level of doubt while selecting ATE, and other open-ended contributions. Secondary outcomes were related to the implications of these concerns, such as delayed family planning, level of fear, adherence to safety practices, and reduction in procedural volume. For each outcome, subgroup analyses were compared by gender to infer the degree to which fluoroscopy exposure is a barrier for women in endoscopy. The frequency of female endoscopists who cite fluoroscopy exposure as a significant concern of working while pregnant was assessed. Subsequently, changes in ERCP involvement while pregnant were also assessed through alterations in protective

equipment, number of procedures, and adjustments to fluoroscopy time.

Data Analysis

Basic descriptive statistics were used to summarize and report data on physician demographics, ERCP volumes, and confidence levels. Qualitative data were analyzed and interpreted through a combination of thematic and narrative analyses. Thematic analysis was used to classify recurring themes based on patterns observed within the responses. Narrative analysis was applied to open-ended and rating prompts in order to accurately capture physician experiences reported on the survey. Frequency counts of specific themes and codes were established to capture the prevalence of particular views or experiences. Subgroup analyses were also performed for gender, age (years), endoscopist experience (years), countries, and volumes of ERCP performed.

Results

Participant Characteristics

A total of 173 participants were included in the survey, with 126 (72.8%) male and 47 (27.2%) female respondents. The average age was 38.2 years (SD ± 8.4 years). Among the participants, 117 (67.6%) were staff, predominantly male (70.6%), and 56 (32.4%) were trainees, with a higher proportion of women in the trainee group (40.4%). Geographic distribution of the participants included Asia (25.4%), Australia (3.5%), Europe (31.8%), North America (35.3%), South America (0.6%), and Oceania (0.6%); the geographic distribution for 2.9% participants was unspecified. Staff members had varied experience in therapeutic endoscopy: 59.8% had 1 to 5 years, 12.8% had 6 to 10 years, and 27.4% had >10 years. For trainees, 58.2% were in ATE fellowships, 40.0% in gastroenterology residency programs, and 1.8% in other training programs. The median estimated total institutional ERCP volume was 550 cases (IQR, 300-1000 cases), with individual participant volumes being 175 cases (IQR, 60-300 cases). The median percentage of cases involving trainees was 50% (IQR, 10%-80% cases) (Table 1).

Fluoroscopy Training and Usage

Awareness of fluoroscopy safety standards was reported by 56.1%, formal training by 51.6%, and formal evaluation by 46.9%. Fluoroscopy sources included built-in or fixed C-arm in the endoscopy suite (31.2%), portable C-arm in the endoscopy suite (46.8%), built-in or fixed C-arm in the radiology department (6.4%), and portable C-arm in the radiology department (5.2%). The availability of C-arm with undercouch protection was reported by 56.8%. Fluoroscopy was controlled by physicians (31.0%), technicians (39.4%), or both, depending on the situation (29.7%). Guide wire control was managed by endoscopists (24.5%), assistants (43.2%), or both, depending on the situation (32.2%). Fluoroscopy time was recorded in 68.4% of institutions, and dosimeter use was reported by 56.1%. Formal training in cholangiogram evaluation was reported by 49.7%, with confidence in evaluating (mean, 77.5% ± 17.0%) and reporting (mean, 77.3% ± 18.2%) cholangiograms (Table 1).

Adherence to Protective Equipment

The use of thyroid dosimeters among participants was never (46.5%), partially (31.6%), and always (21.9%). Pelvic dosimeter usage was never (64.7%), partially (22.2%), and always (13.1%). Protective leaded goggles were used never (62.6%), partially (29.0%), and always (8.4%). Additionally, 30.6% of participants reported always using a personal lead apron (Table 2).

Fluoroscopy-Associated Concerns

Concerns about fertility were reported by 43.9% of participants, cancer risk by 73.4%, and cataract risk by 59.0%. The decision to enter ATE was doubted by 8.7%, and family planning was delayed by 8.7% (Table 3). Among female endoscopists, concerns included delayed family planning (27.6%), fewer children than planned (2.1%), fear of working while pregnant (40.4%), and decision to interrupt work during pregnancy (42.6%). Modifications during pregnancy included increased awareness of fluoroscopy exposure (66.7%), consistent dosimeter use (44.4%), reduced procedure numbers (44.4%), and access to radiation safety support (22.2%). The median duration of working while pregnant was 8 months (IQR, 1.5 months). Prenatal care provider concerns were discussed by 52.9%, not discussed by 23.5%, and not addressed by 23.5% (Table 4).

Biological Sex–Specific Perspectives on Fluoroscopy Exposure

In exploratory, open-ended questions, men primarily expressed concerns about decreased bone density, fatigue, cancer risk, and ergonomic issues due to the weight of lead aprons. They also highlighted the lack of education regarding the potential health effects of fluoroscopy exposure. Conversely, women raised concerns about gender disparities in training opportunities, with concerns that trainees may be less inclined to train women because of worries about their fluoroscopy exposure and subsequent absence from work during pregnancy. They also noted a perceived lack of interest among male colleagues in addressing specific female issues related to fluoroscopy exposure. Moreover, women were concerned about fertility effects, pregnancy-related absence from work, and the impact of fluoroscopy exposure on reproductive health. They expressed perceived lack of awareness among male attendings regarding the specific risks faced by female practitioners. Additionally, women emphasized the importance of considering ergonomic factors, particularly the weight of lead aprons, and questioned whether lighter alternatives provide sufficient protection. Moreover, respondents from Europe noted

Table 1. Participant and Institutional Characteristics

Characteristic	All participants	Men	Women
Demographic information			
Total population	173 (100.0)	126 (72.8)	47 (27.2)
Age mean (SD), y	38.2 (8.4)	39.0 (8.9)	36.2 (6.4)
Staff	117 (67.6)	89 (70.6)	28 (59.6)
Trainee	56 (32.4)	37 (29.4)	19 (40.4)
Region of practice			
Asia	44	36	8
Australia	6	6	0
Europe	55	40	15
North America	61	38	23
South America	1	1	0
Oceania	1	1	0
Unspecified	5	4	1
Staff characteristics			
1-5 y of experience	70 (59.8)	52 (58.4)	18 (64.3)
6-10 y of experience	15 (12.8)	12 (13.5)	3 (10.7)
>10 y of experience	32 (27.4)	25 (28.1)	7 (25.0)
Trainee characteristics			
Advanced therapeutic endoscopy fellowship	32 (58.2)	20 (54.1)	12 (66.7)
Gastroenterology residency training program	22 (40.0)	16 (43.2)	6 (33.3)
Other	1 (1.8)	1 (2.7)	0 (0.0)
ERCP volume			
Estimated total institutional cases, median (IQR)	550 (300-1000)	500 (250-1000)	700 (400-2000)
Estimated participant cases, median (IQR)	175 (60-300)	170 (77.5-300)	200 (50-400)
Estimated % of cases with trainees, median (IQR)	50 (10-80)	50 (10-80)	50 (20-87.5)
Level of fluoroscopy training			
Awareness of fluoroscopy safety standards	87 (56.1)	62 (53.9)	25 (62.5)
Formal training in fluoroscopy	80 (51.6)	61 (53.0)	19 (47.5)
Formal evaluation on fluoroscopy training	46 (46.9)	35 (46.1)	11 (50.0)
Fluoroscopy source			
Built-in/fixed C-arm in your endoscopy suite	54 (31.2)	32 (25.4)	22 (46.8)
Portable C-arm in your endoscopy suite	81 (46.8)	65 (51.6)	16 (34.0)
Built-in/fixed C-arm in the radiology department	11 (6.4)	10 (7.9)	1 (2.1)
Portable C-arm in the radiology department	9 (5.2)	8 (6.3)	1 (2.1)
Availability of C-arm with under couch protection	88 (56.8)	66 (57.4)	22 (55.0)
Fluoroscopy control			
Physician	48 (31.0)	30 (26.1)	18 (45.0)
Technician	61 (39.4)	48 (41.7)	13 (32.5)
Both/it depends	46 (29.7)	37 (32.2)	9 (22.5)
Guide wire control			
Endoscopist	38 (24.5)	27 (23.5)	11 (27.5)
Assistant	67 (43.2)	49 (42.6)	18 (45.0)
Both/it depends	50 (32.2)	39 (33.9)	11 (27.5)
Fluoroscopy time recorded at institution	106 (68.4)	77 (67.0)	29 (72.5)
Use of dosimeter instruction	87 (56.1)	69 (60.0)	18 (45.0)
Cholangiograms			
Formal training on cholangiogram evaluation	77 (49.7)	63 (54.8)	14 (35.0)
Level of confidence evaluating a cholangiogram, mean (SD)	77.5 (17.0)	78.3 (17.3)	75.1 (15.9)
Level of confidence reporting a cholangiogram, mean (SD)	77.3 (18.2)	78.3 (18.1)	74.5 (18.5)

Data are presented as n (%) unless specified.

Table 2. Physicians' Level of Adherence to the Use of Protective Equipment

Characteristic	All participants	Men	Women
Frequency of thyroid dosimeter use			
Never	72 (46.5)	50 (43.5)	22 (55.0)
Rarely	26 (16.8)	20 (17.4)	6 (15.0)
Often	12 (7.7)	9 (7.8)	3 (7.5)
Sometimes	11 (7.1)	9 (7.8)	2 (5.0)
Always	34 (21.9)	27 (23.5)	7 (17.5)
Frequency of pelvic dosimeter use			
Never	99 (64.7)	74 (64.4)	25 (65.8)
Rarely	19 (12.4)	14 (12.2)	5 (13.2)
Often	6 (3.9)	4 (3.5)	2 (5.3)
Sometimes	9 (5.9)	8 (7.0)	1 (2.6)
Always	20 (13.1)	15 (13.0)	5 (13.2)
Frequency of protective (leaded) goggles use			
Never	97 (62.6)	68 (59.1)	29 (72.5)
Rarely	24 (15.5)	20 (17.4)	4 (10.0)
Often	9 (5.8)	5 (4.4)	4 (10.0)
Sometimes	12 (7.7)	11 (9.6)	1 (2.5)
Always	13 (8.4)	11 (9.6)	2 (5.0)
Use of personal lead apron	53 (30.6)	37 (29.4)	16 (34.0)

Data are presented as n (%).

strict regulations prohibiting fluoroscopy exposure during pregnancy or lactation.

Discussion

Diversity in medicine indisputably augments research, education, teamwork, and patient-centered communication, simultaneously providing equal access to high-level health care.[7] Nevertheless, gender discrepancy among gastroenterology professionals continues, remaining even more explicit in therapeutic endoscopy. The most recent study overviewing advanced endoscopy fellowship (AEF) programs in North America confirmed female underrepresentation among trainees and lack of female role models in the interventional field,[8] especially in fluoroscopy-guided procedures.[9] Moreover, analogous tendency was observed in other interventional subspecialties including interventional radiology and interventional cardiology. One of the obstacles to pursuing AEF was concern for radiation exposure during childbearing age, which was mainly reported by female trainees.[8] A similar issue has been raised by women deciding on other interventional subspecialties with high-volume load of fluoroscopy-guided procedures.[10,11] Interestingly, male students who were considering interventional radiology also reported concerns regarding radiation exposure.[12]

Table 4. Fluoroscopy-Associated Concerns for Female Endoscopists

Fluoroscopy-associated concerns for female endoscopists	Total (n = 47)	Percentage
Concerns		
Delayed family planning	13	27.6
I had fewer children than originally planned	1	2.1
Makes me afraid of working while pregnant	19	40.4
Will/did make me decide to interrupt working while pregnant	20	42.6
Alterations to ERCP involvement while pregnant (n = 9)		
I was more aware of fluoroscopy exposure	6	66.7
I had access to pregnancy-customized lead aprons	0	0.0
I used the dosimeters more consistently compared with that before pregnancy	4	44.4
I had dosimeter readings reported back to me	3	33.3
I had access to a radiation safety officer (or equivalent) in my institution for support/guidance	2	22.2
I reduced the no. of procedures	4	44.4
I reduced the complexity of the cases to be exposed to less fluoroscopy	0	0.0
I did not modify any aspects of fluoroscopy exposure during pregnancy	2	22.2
Working while pregnant, median (IQR), mo	8 (1.5)	
Prenatal care provider concerns (n = 17)		
Yes	9	52.9
No	4	23.5
Did not discuss	4	23.5

Table 3. Frequency of Fluoroscopy-Associated Concerns Stratified by Gender

Characteristic	Total (N = 173)	Men (n = 126)	Women (n = 47)
Creates concerns about fertility problems	76 (43.9)	52 (41.3)	24 (51.1)
Creates concerns about cancer risk	127 (73.4)	109 (86.5)	28 (59.6)
Creates concerns about cataract	102 (59.0)	80 (63.5)	23 (48.9)
Made me doubt going into the subspecialty advanced therapeutic endoscopy	15 (8.7)	10 (7.9)	6 (12.8)
Made me delay family planning	15 (8.7)	3 (2.4)	13 (27.7)

Data are presented as n (%).

This international survey study summarizes the different perceptions, concerns, and attitudes regarding fluoroscopy use with a focus on biological sex, which has not been addressed in depth before (Figure). The main finding is the clear underrepresentation of women in the role of staff physician in therapeutic endoscopy (29.4%). However, this percentage is higher among trainees, which is a positive trend suggesting change. Previous studies have highlighted general concerns among trainees like radiation exposure during childbearing age.[8,13] This study showed that concerns about fertility issues was reported by almost 44% of respondents and 8.7% doubted entering AEF or delayed family planning due to these concerns. More specifically, female trainees expressed various concerns like fear of working during pregnancy or need for work interruption due to pregnancy. Also, only half of trainees had opportunity to formally discuss prenatal care provider concerns, despite that median duration of working while pregnant was 8 months. On the other hand, female respondents claimed that these obstacles could be mitigated along with proper training in fluoroscopy, consciousness sobbing in available options for limiting radiation exposure, and access to adequate safety support, as well as providing proper workload for pregnant or family planning trainees.

Despite the factors identified as potentially facilitating women to pursue training in fluoroscopy-guided procedures were investigated, the results of this study revealed that local endoscopy environments and AEF programs still omit this decision-making factor for pursuing career in the field of therapeutic endoscopy. Similarly, leading international endoscopy societies' guidelines consider mainly patients and staff safety, based on quality indicators for ERCP, but do not allude to concerns on performing fluoroscopy cases for endoscopists or health care personnel of childbearing age, release guidance on training in proper fluoroscopy use, and pursue to promote awareness and training on fluoroscopy exposure safety.[14,15] In contrast to female respondents, male respondents did not report significant fertility issues or concerns, and concerns were mainly focused on fluoroscopy-use consequences including decreased bone density. Among general aspects of radiation consequences, participants were most concerned about the risks of cancer (73.4%) and cataract (43.9%).

There are no previous data on the complications of fluoroscopy use in ERCP. However, the risks can be extrapolated from other medical specialties in which physicians are close to the patient and radiation source. A study determined that the risk of cataract for interventional cardiologist was 3 times higher than that of the general population.[16] Although the exact use of protective devices, such as lead glasses, was not reported in this study, respondents claimed that it was infrequent; this mirrors the outcomes of our study, in which protective leaded goggles were not used by the majority of the participants (62.6%) and worn partially by only one-third of them.

Another study assessed lifetime cancer risks from occupational radiation exposure among workers in interventional radiology. Interestingly, the risk was lower than that in previously published studies.[17-19] This reflects shifting paradigm in timing and dose of fluoroscopy use during procedures, declining occupational radiation dose through rigorous radiation protection regulations in some countries, and potentially changing risk of cancer

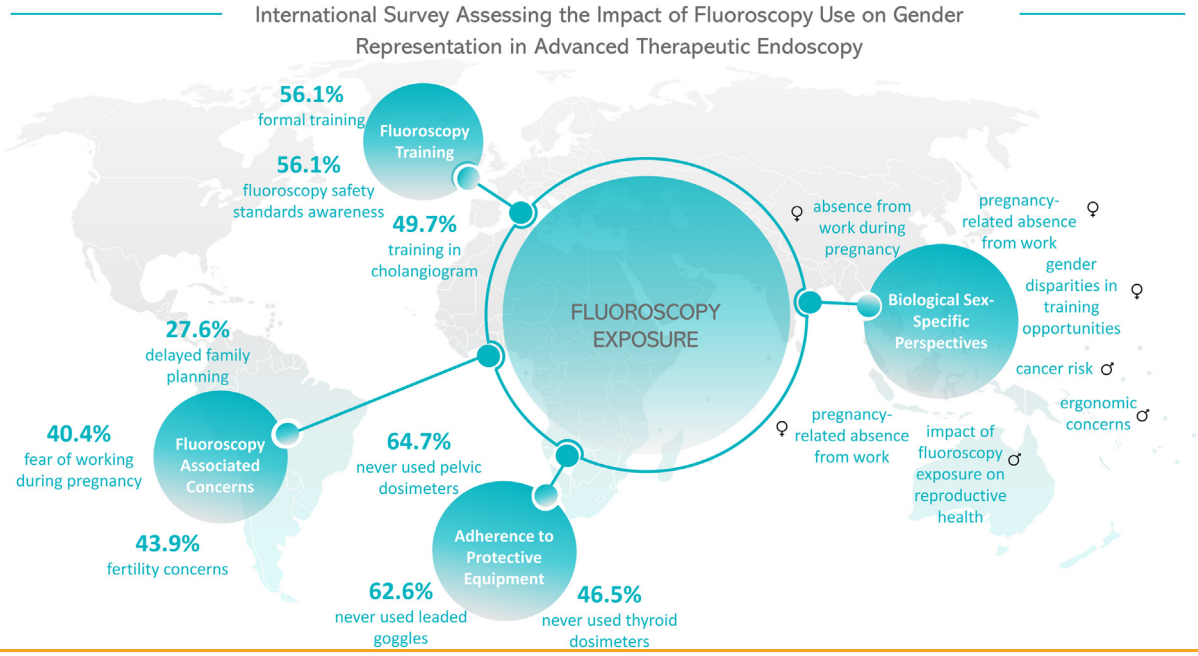

Figure. Key findings from an international survey on fluoroscopy use in advanced therapeutic endoscopy, highlighting fluoroscopy-related training, protective equipment use, and gender-specific concerns. It also underscores low adherence to protective measures, raising occupational health concerns.

development. However, similar to lens protective devices use, personal lead aprons were used always by only one-third of participants. Moreover, thyroid and pelvic dosimeters were never or partially used by around 80% of respondents. Hence, we may assume that concerns regarding cataract formation, cancer risk, fertility, and bone density issues arise from insufficient awareness because of lack of training regarding exposure limitation and strict institutional requirements on radiation-limiting devices use. More importantly, lack of training might enhance harmful effects in accumulation of large doses of radiation.[20]

In this study, the issue of ergonomic injuries due to weight of lead aprons was reported by both genders. The musculoskeletal problems and fatigue among interventionists resulting from long-term use of traditional lead aprons are well-known and confirmed by studies.[21] Nowadays, the whole spectrum of solutions exists, including aprons composed of lead composite or lead-free material, providing similar protection at approximately one-third of the weight.[15] Furthermore, ergonomic exploitation could be regulated by fluoroscopy-cases distribution among staff and trainees.

Finally, open-ended questions referring to different issues remained deeply worrying. For example, some respondents stated lack of awareness among male attendings in terms of the specific risk to women. Moreover, women felt that there was no general interest in female-specific issues related to fluoroscopy exposure. Regarding training in therapeutic procedures, female respondents highlighted gender disparities in training opportunities, with concerns that trainees may be less inclined to train women due to worries about their fluoroscopy exposure. Finally, some pointed out national regulations forbidding participation in fluoroscopy-guided procedures during pregnancy or breastfeeding. On the contrary, women reported that they are not aware of fertility risk for men.

There are several limitations to this study. The number of participants from different countries was unequal, which might potentially lead to the sampling bias. Moreover, selection bias could exist when taken into consideration various exposure to radiation (experience) and ERCP cases load. Second, sample size was relatively small. Third, we did not reach directly program directors, and the assessment on fluoroscopy training relies on individual opinions and endoscopy society available position statements (guidelines or recommendations). Finally, there was a significant female-to-male respondent ratio, but this mirrored existing gender gap in therapeutic endoscopy.

Conclusion

This study depicts gender discrepancies in perspectives on fluoroscopy exposure. Moreover, it reveals existing omissions in providing fluoroscopy-use standards across continents. The formalization of training focusing on radiation exposure safety and proper fluoroscopy use is necessary to increase awareness and gender equality among health care professionals performing ERCP and other fluoroscopy-guided procedures.

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Conflicts of Interest
These authors disclose the following: J.D.M. is a speaker for Boston Scientific, Pendopharm, Vantage, and Medtronic and is in the medical advisory boards of Pendopharm, Boston Scientific, Janssen, Pentax, and Fuji. The remaining authors disclose no conflicts.

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Author Contributions
K.M.P. distributed the survey, drafted the manuscript, and provided critical intellectual input. K.K. collected the data, drafted the manuscript, provided critical intellectual input, and coordinated the study. A. H.M., C.N., M.M., B.A. conducted data analysis, interpreted results, and drafted and contributed to manuscript revisions. E.B., A.V., T.V., S.B.M., A.K., J.v.H., U.S., R.M., J.D.M., J.T., and N.F. were responsible for survey distribution. J.D.M. and N.F. provided critical intellectual input. N.C.C. conceptualized the study, drafted the manuscript, and supervised the study. All authors reviewed and approved the final version of the manuscript.

Ethical Statement
Institutional review board approval was not required for this study, identifiable personal data, or interventional procedures. A formal ethics review was waived per institutional policies.

Reporting Guidelines
None.