



Female authorship trends in the field of colorectal surgery: A retrospective bibliometric study

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ABSTRACT

Background: Gender disparity and hidden discrimination remained in the surgical subspecialties. This study aimed to explore the authorship gender composition in four high-impact colorectal surgery journals over the past two decades.

Method: This cross-sectional study queried the Web of Science Core Collection database and PubMed (MEDLINE) for articles published in four high-impact colorectal surgery specialty journals between 2000 and 2021 (Database accessed at July 2022). Extracted data included authors' full names, institutions, year of publication and total citation numbers. Authors' genders were assigned via gendrize.io, a third-party name predictor tool.

Results: 100,325 authorship records were included in the final analysis. 21.8% of writers were identified as female, an increase from 11.4% (95% CI, 9.4%–13.3%) in 2000 to 26.5% (95% CI, 25.6%–27.4%) in 2021. Female authorship has risen in all authorship types, but women physicians were less likely to be the last authors than the first (OR, 0.63; 95%CI, 0.6–0.67) or middle authors (OR, 0.57; 95%CI, 0.55–0.60). Female authorship has also increased substantially in different document types, but female authorships were less likely in editorials than original articles (OR, 0.76; 95%CI, 0.7–0.83) and reviews (OR, 0.83; 95%CI, 0.74–0.94). Compared with male physicians, females were more likely to author in publications with reportable funding, either as first authors (OR, 1.46; 95%CI, 1.12–1.78) or last authors (OR, 1.51; 95%CI, 1.22–1.89). Authorship varied geographically, and countries with the highest female authorship percentage were mainly in Europe and North America.

Conclusion: Female authorship has grown substantially in colorectal surgery literature. However, female physicians were still underrepresented and less likely to assume senior or leading authorship roles.

1. Introduction

Elizabeth Blackwell was reported to be the first female to attend medical school in the United States in 1847, while in the past few years, roughly half of medical school enrollments were women [1]. The so-called “feminization of medicine” led to a major shift in the gender composition of the physician workforce worldwide [2]. However, parity has not yet extended into surgical subspecialties and the gender gap widened with increasing academic ranking [3]. It was estimated that it would take another 50 years for half of the assistant and associate professors to be women, while women full professors will not achieve gender parity until 2096 [4].

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Publications in peer-reviewed journals were one of the most objective measurements and of paramount importance in career advancement. Studies showed that the amount and caliber of publications were often critical to the academic promotion and tenure process [5,6]. Even during residency or fellowship applications, more than half of the programs would consider “involvement in research” a factor for inviting candidates for interviews [7]. Female authorships have demonstrated an upward trend within surgical fields but varied greatly between different disciplines and authorship positions [8,9,10].

In the field of colorectal surgery, there are increasing numbers of female physicians worldwide engaged as leaders and making outstanding contributions [11]. However, gender disparity remains [12,13]. Frequently encountered barriers, such as societal norms/discrimination, work-life balance, lack of mentorship, payment gap and promotion inequity, have all been described as contributing factors [14,15]. To our knowledge, the publication gap in colorectal surgery literature has not been examined. Therefore, we conducted this study to explore the female authorship pattern in the field of colorectal surgery over the past two decades.

2. Methods

2.1. Data collection

Web of Science Core Collection database and PubMed (MEDLINE) were queried for articles published in four high-impact colorectal surgery specialty journals (*Diseases of the Colon & Rectum*, *Colorectal Disease*, *International Journal of Colorectal Disease*, and *Techniques in Coloproctology*) between 2000 and 2021 (Database accessed at July 2022). High-impact journals were defined as the four colorectal surgery journals with highest impact factor based on 2021 Web of Science Journal Citation Report. All document types were included. Extracted data included authors' full names, position in the authors' list, countries, affiliations, total citation numbers, year of publication, number of references, number of pages and funding agents. The information above was publicly available, and institutional review board approval was not required.

2.2. Data categorization

Authors for each extracted article were further categorized into first, middle, last and corresponding authors. Traditionally, first author is responsible for writing the first draft of the manuscript, while the last/senior author is the primary investigator who initiates and oversees the project. The corresponding author ensures the descriptions are accurate and communicates with the journal during manuscript submission, peer review, and throughout the publication process. In our analysis, only the writer positioned first on the authorship list was counted as the first author. If the writer were the sole author of a publication, they would take credit for both the first and last author. Publications were further categorized by manuscript types (articles, reviews and editorial materials). The rest were grouped as other document types. If extracted authors' first names only had one initial character available, their first name initial and last name were cross-matched with those whose full names were available based on affiliation and country information. Unmatched authorship records were excluded. For each author's name, the sex and its probability were generated by the online

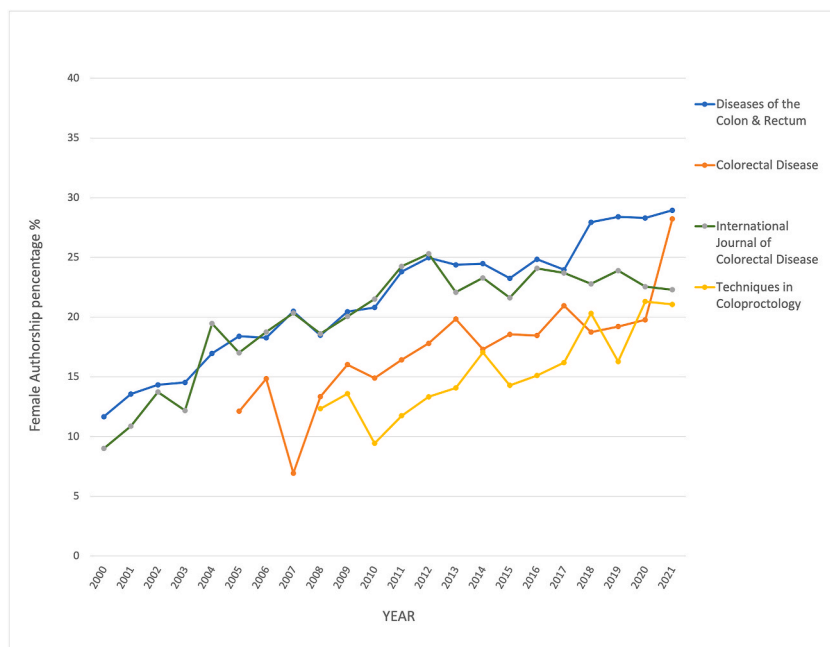


Fig. 1. Female author percentage stratified by different journals.

application gendrive.io., as described in other authorship studies [16]. If a first name only included initials, a name was not recognized, or the probability generated was <0.75 , then the related authorship records were excluded from the final cohort.

2.3. Statistical analysis

The data were coded and stored in the Microsoft Excel database (Microsoft, Redmond, WA, USA) and analyzed using SPSS version 26 (IBM, NY, USA). Characteristics were summarized using means for continuous variables and proportions for categorical variables. Independent t-tests were used to compare continuous variables with normal distribution, and Mann-Whitney U tests were used to compare continuous variables with skewed distribution data. Categorical variables were analyzed using χ^2 tests for trends. Statistical significance was set at $p < 0.05$ for all analyses.

3. Results

Of the authorship records, 117,491 met the inclusion criteria. Exclusion criteria included those writers who only had initials for their first name (3,944, 3.4%), names not recognized by the online application (4222, 3.6%), or a generated gender probability by the online application of less than 75% (9,000, 7.6%). Based on this, 100,325 authorships records (85.4%) were included in the final cohort. Among them, 21.8% (95% CI, 21.6%–22.1%) were identified as female, an increase from 11.4% (95% CI, 9.4%–13.3%) in 2000 to 26.5% (95% CI, 25.6%–27.4%) in 2021 ($p < 0.001$).

3.1. Journal types

The number and percentage of authorship records in four journals were 55184 (55%) in Diseases of The Colon & Rectum, 16813 (16.8%) in Colorectal Disease, 22702 (22.6%) in International Journal of Colorectal Disease, 5626 (5.6%) in Techniques in Coloproctology. The breakdown of female authorship percentage by year and different journals is shown in Fig. 1. All four journals had a significant growth in female authorship over the past two decades. Female authorship in Diseases of The Colon & Rectum has increased from 11.7% (95% CI, 9.6%–13.7%) in 2000 to 28.9% (95% CI, 27.4%–30.5%) in 2021 ($p < 0.001$). Female authorship in Colorectal Disease has increased from 12.1% (95% CI, 8.2%–16.1%) in 2005 to 28.2% (95% CI, 26.7%–29.7%) in 2021 ($p < 0.001$). Female authorship in International Journal of Colorectal Disease has increased from 9.0% (95% CI, 3.6%–14.4%) in 2000 to 22.3% (95% CI, 20.6%–24%) in 2021 ($p = 0.001$). Female authorship in Techniques in Coloproctology has increased from 12.3% (95% CI, 7.1%–17.6%) in 2008 to 21.1% (95% CI, 18.1%–24.0%) in 2021 ($p = 0.013$). There is statistically significant difference between the female author percentage in four journals in the last year of study period ($p < 0.001$).

3.2. Author types

Female writers' percentage has grown in all author types, as shown in Fig. 2. Between 2000 and 2021, the female first author percentage has risen from 7.7% (95% CI, 4.5%–10.9%) to 28.1% (95% CI, 25.8%–30.3%) ($p < 0.001$). Female last author percentage has risen from 10.4% (95% CI, 6.7%–14%) to 18.6% (95% CI, 16.8%–20.5%) ($p < 0.001$). Female middle author percentage has risen

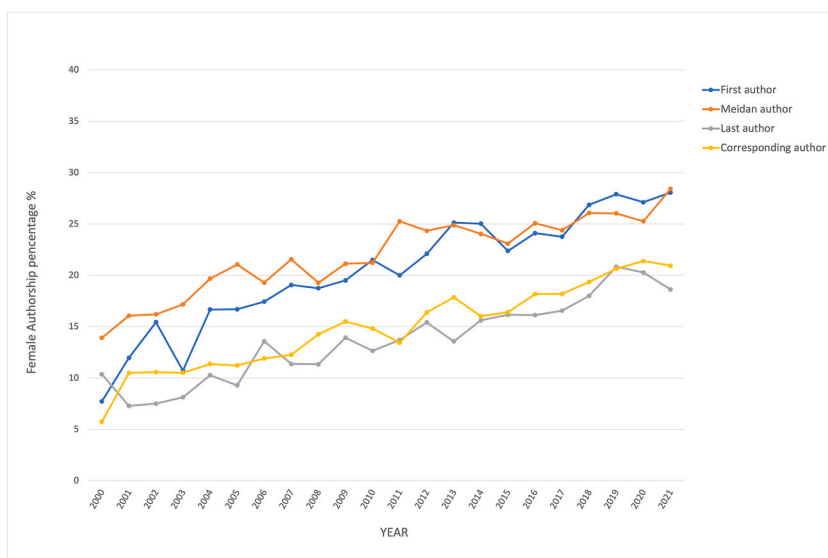


Fig. 2. Female authorship percentage stratified by authorship positions.

from 13.9% (95% CI, 10.9%–17.0%) to 28.4% (95% CI, 27.3%–29.5%) ($p < 0.001$). Female correspondence author percentage has risen from 5.7% (95% CI, 2.6%–8.9%) to 20.9% (95% CI, 18.7%–23.2%) ($p < 0.001$). However, female physicians were less likely to be the last authors (15.2%, 95%CI, 14.7%–15.7%) and corresponding authors (16.4%, 95%CI, 15.8%–17.1%) compared to the first authors (22.4%, 95% CI, 21.8%–23%) and middle authors (23.8%, 95%CI, 23.5%–24.1%) during the study period ($p < 0.001$). The odds ratio for female authorship as the last vs first author was 0.63 (95%CI, 0.6–0.67), while as the last vs middle author was 0.57 (95% CI, 0.55–0.60).

3.3. Manuscript types

Female authorship has grown substantially in all manuscript types (Fig. 3). Due to limited female contributed editorials, reviews and other manuscript types at the beginning of the study period, comparisons were conducted between the first three years (2000–2002) and the last three years (2019–2021). Female authorship in articles has increased from 13.2% (95%CI, 12%–14.4%) to 25.9% (95%CI, 25.1%–26.7%) ($p < 0.001$). Female authorship in review articles has increased from 6.6% (95%CI, 2%–12.9%) to 22.3% (95%CI, 20.3%–24.2%) ($p = 0.003$). Female authorship in editorials has increased from 15.1% (95%CI, 11.1%–19.1%) to 21.4% (95%CI, 19.0%–23.7%) ($p = 0.013$). Female authorship in other manuscript types has increased from 10.1% (95%CI, 5.6%–14.5%) to 26.2% (95%CI, 25.3%–27%) ($p < 0.001$). In total, female authorship was less likely in editorial materials (17.3%, 95%CI, 16%–18.5%) compared with articles (21.5%, 95%CI, 21.2%–21.8%; OR: 0.76, 95%CI, 0.7–0.83), reviews (20.0%, 95%CI, 18.8%–21.3%; OR: 0.83, 95%CI, 0.74–0.94) and other document types (22.9%, 95%CI, 22.5%–23.4%; OR: 0.7, 95%CI, 0.64–0.77).

3.4. Publication characteristics

Table 1 shows the publication characteristics stratified by authorship position and gender. The three-year span at the beginning and the end of the study period was used to decrease the year-to-year variability. Between 2000 and 2002, no difference was observed in the total citation, yearly adjusted citation, number of pages or references, or grant funding between male and female colorectal physicians. While between 2019 and 2021, publications with female first or last authors had more pages than their male counterparts (8 vs 7.5, $p = 0.019$; 8 vs 7.5, $p = 0.097$). Female first authors tended to quote more references (28.7 vs 26, $p = 0.028$) than males, but such phenomena were not observed in female last authors. Female authors were more likely to receive reportable funding/grant compared to male counterparts, both as first author (32.3% vs 24.7%, OR, 1.46; 95%CI, 1.12–1.78, $p < 0.001$) and last author (34% vs 25.4%, OR, 1.51; 95%CI, 1.22–1.89, $p < 0.001$).

3.5. Geographic locations

Fig. 4 shows the percentage of female authors by country. Countries with more than five authorship records were included. The five countries with the highest female authorship percentage during the study period were all located in Europe (Bulgaria 48.6%, Hungary

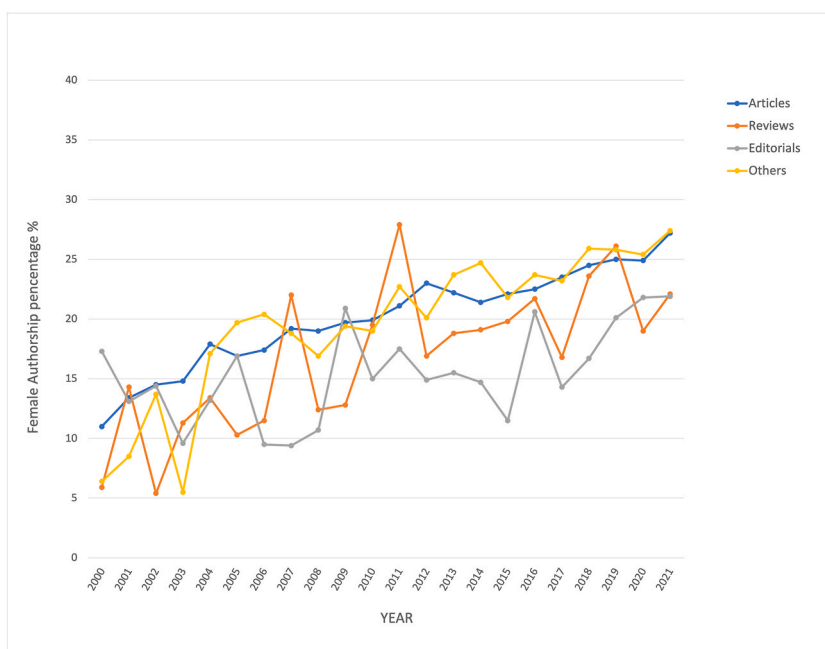


Fig. 3. Female authorship percentage stratified by document types.

Table 1

Publication characteristics were stratified based on authorship position and gender. Only articles, reviews and editorial were included here as they are the most valued scientific publications.

	First author						Last author					
	2000–2002			2019–2021			2000–2002			2019–2021		
	Female	Male	P	Female	Male	P	Female	Male	P	Female	Male	P
Total Citation, mean (95%CI)	47.6 (37.4–58.9)	44.4 (40–49.3)	0.575	4.4 (3.9–4.9)	4.5 (4.2–4.9)	0.728	41.5 (22.6–72.4)	44.6 (40.7–48.7)	0.698	4.7 (4.1–5.3)	4.5 (4.2–4.9)	0.635
Yearly adjusted citation, mean (95%CI)	2.3 (1.8–2.8)	2.1 (1.9–2.4)	0.507	2.2 (2.0–2.4)	2.3 (2.1–2.4)	0.66	2.0 (1.1–3.3)	2.1 (1.9–2.4)	0.647	2.3 (2–2.6)	2.3 (2.1–2.4)	0.922
Number of Pages, mean (95% CI)	5.7 (5.2–6.2)	5.5 (5.3–5.7)	0.484	8.0 (7.6–8.3)	7.5 (7.3–7.7)	0.019	5.1 (4.3–5.9)	5.6 (5.4–5.8)	0.194	8 (7.5–8.5)	7.5 (7.4–7.7)	0.097
Number of References, mean (95%CI)	22.8 (18.9–27.3)	22.7 (21.2–24.4)	0.978	28.7 (27–30.8)	26 (24.7–27.5)	0.028	17.6 (14–21)	23 (21.4–24.5)	0.055	28.9 (25.9–33.3)	26.7 (25.6–27.8)	0.139
Grant/funding, n (%)	0 (0%)	6 (0.9%)	1	214 (32.3%)	396 (24.7%)	<0.001	0 (0%)	7 (1%)	1	154 (34%)	493 (25.4%)	<0.001

47.7%, Serbia 47.4%, Portugal 44.8%, Finland 40.7%), while the five countries with the least authorship gender diversity were Egypt 5.2%, Japan 5.8%, Argentina 9.6%, India 9.9%, Switzerland 12.4%. Countries were then grouped by continents. The relative contributions (continent, number of authorships, percentage) were Asia, 15772, 19.6%; Africa, 299, 0.4%; Europe, 33151, 41.2%; North America, 26714, 33.2%; South America, 1757, 2.2%, Oceania, 2824, 3.5%. Female Authorship records were then grouped within the first three and last three years for further comparison (Table 2). There was a statistically significant difference in female authorship percentage at all four authorship positions in Europe and North America. While in other continents, such differences were only found in first authors in Oceania (4.3% vs 25.2%, $p = 0.026$), last authors in Asia (2.2% vs 8.8%, $p = 0.007$), first and corresponding authors in South America (0% vs 21.1%, $p < 0.001$; 0% vs 17.6%, $p = 0.012$).

4. Discussion

Our results show that female authorship in the field of colorectal surgery have grown substantially regardless of journal types, authorship order or manuscript types. The growth pattern mirrored the patterns noted in female authorship studies among other surgical subspecialties [9,10] and probably reflected the rising percentage of female surgeons worldwide. These findings were encouraging, and the success will not be achieved without multiple professional organizations' deliberate effort and commitment worldwide [17,18,19].

However, our study demonstrated that women were less likely to assume senior authorship roles in editorial materials or as the last or corresponding authors. Editorials are mainly solicited by the editors and required experience and expertise in a specific field to share insights and provide an authoritative opinion. The authors were usually considered sentinel sources or subject matter experts. It is important to note that the disparity was unlikely secondary to research productivity. Geltzeiler et al. found that gender did not affect publication productivity among colorectal surgeons, despite unequal representation [20]. Thomas et al. reported odds of authoring in the invited commentary were 21% lower for women compared with men after adjusting for the scientific field, seniority and publication records [16]. Such phenomena could be explained by the delaying effect of the expanding colorectal surgeon cohort. However, imbalanced female representation in those prestigious authorship positions has been reported among specialties with higher female faculty percentages, like pediatrics, dermatology and ophthalmology [21,22,23]. On the other hand, lacking authorship as the last or corresponding authors suggested that females hold fewer supervisory roles in research, which implied a lack of same-sex mentorship and role model for female trainees. Gender-concordant mentorship has been shown to inspire women or other minorities, possibly by modelling their own careers with real-life experience [24]. Lacking female role models are often recognized as a barrier for women physicians to pursue the same career as mentors [11,25].

Another finding was that female physicians were more likely to author publications with reportable funding. Previous studies suggested that women academics had lower access to resources [26]. Lin et al. reported that males received 77.3% of National Institute of Health (NIH) funding in general surgery between 2015 and 2020 [27]. Saif et al. reported that females represent 40% of the colorectal surgeon scientist cohort funded by NIH but had a substantially lower proportion of funding (female vs male, \$2 M vs \$4.2 M) [28]. The gender disparity in grants/funding has been reported in other parts of the world [29,30,31]. Those studies may not contradict ours as funding sources reported in our cohort varied, and the funding/grant could be held solely by the male authors in the same article. Instead, our result may imply that females were more likely to collaborate with already funded colleagues or that a higher proportion of female had accessible resources even before they became academically productive. However, this could be a multifactorial process and may warrant further research.

It is worth noting that female authorship varied significantly between different geographic locations. It is critical to compare workforce status while conducting gender-authorship studies. Unfortunately, most current literature focused on female physician workforce status in developed countries. In contrast, data and research from low and middle-income countries, where major gaps existed, were either unavailable or not easily accessible due to language barriers [32]. Colorectal surgeons often shared some practice

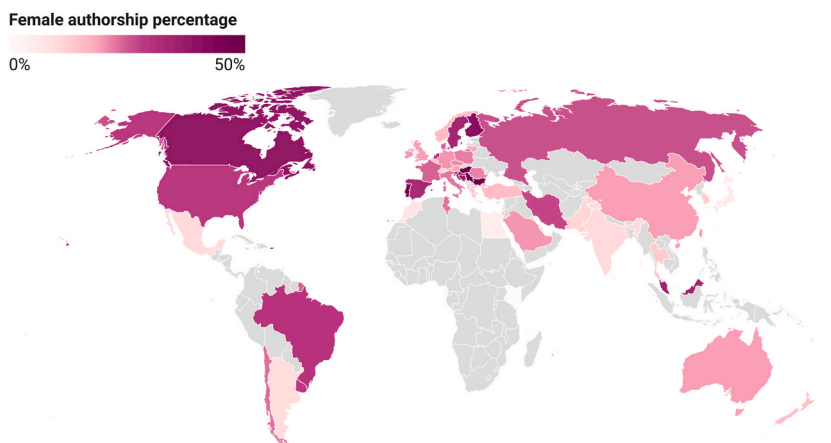


Fig. 4. World map colored upon female authorship percentage.

Table 2Female authorship percentage stratified by geographic location and author position, percentage (95%CI). **t*-test was not performed because 2000–2002 group was empty.

Year Continent	First author			Median author			Last author			Corresponding author		
	2000–2002	2019–2021	P	2000–2002	2019–2021	P	2000–2002	2019–2021	P	2000–2002	2019–2021	P
Africa	0	0	/*	0	11.5 (2.6–20.5)	/*	0	6.3 (0–19.6)	0.735	0	0	/*
Asia	13 (4.9–21.2)	13.5 (11.2–15.9)	0.907	10.5 (6–15)	11.5 (10.4–12.6)	0.674	2.2 (0–6.6)	8.8 (6.8–10.8)	0.007	13.6 (4.6–22.6)	8.8 (6.6–11.1)	0.312
Europe	6.4 (2.5–10.3)	28 (25.7–30.3)	<0.001	13.9 (9.7–18)	29.4 (28.3–30.6)	<0.001	3.5 (0.4–6.4)	15.5 (13.7–17.3)	<0.001	9.2 (4.2–14.2)	21.1 (19–23.2)	<0.001
Oceania	4.3 (0–13.4)	25.2 (18.1–32.3)	0.026	12.5 (0–26.8)	17.3 (14.1–20.5)	0.541	15 (0–32.1)	6.4 (2.7–10.1)	0.32	11.1 (0–27.2)	23.1 (15.7–30.4)	0.17
North America	20.3 (13.2–27.4)	37.8 (35.2–40.3)	<0.001	26.3 (20.4–32.2)	35.1 (33.8–36.4)	0.004	17.6 (10.8–24.4)	30 (27.9–32.1)	0.001	10.3 (4.1–16.5)	31.2 (27.9–34.6)	<0.001
South America	0	21.1 (10.1–32)	<0.001	20 (0–50)	29.8 (24–35.6)	0.507	33.3 (0–1)	10.4 (1.5–19.4)	0.24	0	17.6 (4.1–31.1)	0.012

with general surgeons, and data regarding colorectal surgeons specifically were even more scarce. In the United States, female colorectal surgeons represented over 40% of fellowship trainees, 22% of the faculties and 18% of the professors [20,33]. In England, women made up 64% of the medical students but only 13.2% of consultant surgeons [34]. In comparison, 26.2% of Dutch surgeons and 36% of the Spanish Society of Coloproctology were women [35]. In Asia, women accounted for 8.9% of surgical physicians in Korea and 6.2% in Japan [36,37]. A review from Australian and New Zealand Colorectal Surgical Society revealed that about 13% of the memberships were women [38]. Another survey from three African capital cities showed female surgeon percentage was only 4.5% (1/22) [39]. Female workforce status varied between continents and sometimes even within continents. Europe and North America were leading in closing the gender gap, while trends remained relatively stagnant in other parts of the world. Countries with persistently low proportions of the female workforce were usually affected by social norms or cultural altitude. The analysis of two international colorectal conferences may also shed some light on this topic. At the 2017 American Society of Colon and Rectal Surgeons Scientific and Tripartite Meeting, women comprised 32% of the 1,532 attendees, 28% of moderators and speakers, 24% of abstract reviewers and 27% executive council [40]. The percentage of international fellows was only 8%, but this may be biased by low attendance from colorectal surgeons outside of the U.S. While among 1686 attendees at the 2017 European Society of Coloproctology, fewer women attended the conference (25%), serving as speakers (21%), on committees (10%) or as session chairs (8%), compared with men [35].

5. Limitations

Our study had several limitations. We only included four high-impact colorectal surgery specialty journals, while publications in non-specialty and non-English journals were not captured. Literature has shown that women physicians tended to publish fewer articles and often in lower-impact journals [9]. Thus, we may underestimate the female authorship percentage here. Secondly, the author's gender was generated binarily by a third-party application. Inference accuracy may lead to systemic bias, and this dichotomized process would also raise ethical concerns, as gender exists on a spectrum. Additionally, authors from medicine and ancillary departments were not excluded from the final analysis. Our result may overinflate the female authorship percentage as the non-surgical department generally had a higher female faculty percentage.

6. Conclusion

Diversity can promote new insights, encourage engagement, and improve patient care. Identifying and breaking down the barriers to diversity and inclusion lead to equitable treatment of women and minorities in medicine. Our study offers a global perspective on the changing patterns of female authorship in colorectal surgery, which has grown substantially in the past two decades. However, female physicians were still underrepresented and less likely to assume senior or leading authorship roles. The gender gap is closing, but hidden barriers persist. Consistent efforts should be made to facilitate gender equity in research publications and develop strategies to improve this situation.

Production notes

Author contribution statement

Shengliang He: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Jianping Gong: Conceived and designed the experiments; Wrote the paper.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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