



Female author representation differs between journals from the United States of America, Europe, and Asia: a 10-year comparison of five medical disciplines

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Abstract

To provide information for targeted support of female scientists, the objective of this study was to evaluate how female authors are represented in journals of five medical disciplines with varying rates of female physicians from the United States of America (USA), Europe, and Asia. For this retrospective bibliometric study 15 representative gynecologic, pediatric, radiologic, urologic, and surgical journals from the USA, Europe, and Asia were selected from the Web of Science database. From these, all $n=24182$ publications of the years 2007/2008 and 2017/2018 were included. Gender and affiliations were assigned to first and senior authors using a software (Gender API, Passau, Germany), native speakers, and a web-based search. For statistics mixed logistic and multinomial logistic regression were applied. In pediatrics, radiology, and urology, highest female first and senior author shares were consistently found in journals from the USA. In European journals proportions across all disciplines tripled (odds ratio 2.96 [95% CI 2.60–3.37], $P<.0001$). Asian journals showed three-times fewer female authorships than journals from the USA or Europe and the smallest increase (1.36 [1.11–1.66], $P=.0026$). Compared to the proportion of female physicians within each specialty, female first authors remained underrepresented in Asian journals and female senior authors in journals of all regions. In journals from the USA most female authors originated from institutes within the USA (36.2%), in European journals from the USA (21.1%) or Europe (21.7%). Women from Asian institutes were worst represented in journals of all regions with lowest rates in Asian journals (9.4%). In conclusion female first authors remained underrepresented in Asian journals, female senior authors and women from Asian institutes in journals from all regions. Programs for gender equality in science are thus particularly necessary to support female senior authors, for Asian journals, and women from Asian institutes.

Keywords Female authors · Gender equality · Author origin · Asian journals · European journals · US journals

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Extended author information available on the last page of the article

Abbreviations

DE	Germany
FA	First author
JP	Japan
OR	Adjusted Odds Ratio
SA	Senior author
UK	United Kingdom
US	United States of America
95% CI	95% Confidence Interval

Introduction

Career perspectives in academic medicine are strongly dependent on an individual's scientific impact, the number of publications, and citations as indicated by the h-index (Saleem, 2011). Despite increasing proportions female authors are known to be underrepresented, even in specialties with high numbers of female physicians as gynecology and obstetrics or pediatrics (Hart & Perlis, 2019; Silver et al., 2018). Similarly, in disciplines with less female physicians like surgery, despite positive trends, persisting disparities in authorships, citation numbers, and funding between female and male authors have been described (Benjamins et al., 2020; Hart et al., 2022). This gender bias is likely to contribute to the fact that, even if more than half of the medical students are female in European countries like Germany since 1999 (StBA, 2020) and more than 45% of students from the United States (US) are female since 2004 (AAMC, 2005), women remain underrepresented in leading positions in academic medicine (Ärztinnenbund, 2019; Bickel et al., 2002; Penny et al., 2014).

Providing data on female author representation is thus important for the ongoing debate on gender equality in science. While female author representation has been examined for high-ranked journals of different medical specialties (Campbell et al., 2019; Silver et al., 2018), between journals of varying ranking within one specialty (Molwitz et al., 2021), or for separate nations (Pyatigorskaya & Di Marco, 2017; Sidhu et al., 2009; Zhang et al., 2017), the existing literature is mostly about US American journals. Analyses for European journals are less common and Asian journals have rarely been investigated at all. No study has evaluated whether female author proportions vary and develop differently between journals from different continents. Also, analyses of female author origin are rare and have been performed for only one journal (Wininger et al., 2017) or discipline (Bucknor et al., 2019).

If publication rates of female authors vary between journals from different continents and female authors are differently represented depending on their institute of origin, the need to support and encourage female scientists would however be heterogenous. Knowledge about such regional differences is thus vital to adequately plan the necessary means to improve gender equality in science, e.g., by raising awareness, mentoring, or grants which are adapted to a certain region.

Therefore, the purpose of this study was to evaluate differences between journals from the US, Europe, and Asia concerning female first and senior author proportions, trends, and institute origin in five medical specialties with high, medium, and low rates of female physicians.

Materials and methods

For this retrospective bibliometric study an ethics exemption was obtained from the local ethics committee (Ärztchamber Hamburg, Germany).

Selection of medical specialties and journals

Included specialties with high shares (> 50%) of female physicians were gynecology and pediatrics. Radiology was included as a specialty with medium shares of female physicians. Surgery and urology were chosen as disciplines with low female physician proportions (< 25%). Female physician rates were determined by a search of public databases and enquiries at national medical associations. As statistics on female physicians are documented on a national level, for Europe female physician rates of the UK and Germany, and for Asia Japanese statistics were surveyed for 2017/18 (Table 1).

For each corresponding category (“Obstetrics and Gynecology”, “Pediatrics”, “Surgery”, “Urology and Nephrology”, “Radiology, Nuclear Medicine, and Medical Imaging”) of the Clarivate Analytics Web of Science’s Journal Citation Report for 2018 European, US, and Asian journals were selected. Inclusion criteria were high-ranking (upper third of the Journal Citation Report) if available and general representation of the corresponding medical discipline. Thus, journals of subspecialties, e.g., oncologic gynecology or interventional radiology, which in contrast to general gynecological or radiological journals are known to display different numbers of female authors (Bernard et al., 2020; Metheny et al., 2018; Salinaro et al., 2018), were not included. The geographical assignment of the journals was based on their affiliation to professional societies, if existent, e.g., of “European Radiology” to the “European Society of Radiology” or “Radiology” to the “Radiological Society of North America”, by their name such as the “British Journal of Surgery” to Europe, and by the regional assignment provided by the Web of Science database. In total 15 journals (three per specialty) were included. All included journals are listed in Table 2.

Author analyses

Of each included journal all publications of 2007, 2008, 2017, and 2018 were listed and classified as original research articles, reviews (literature reviews, meta-analyses), and others (e.g., editorials, pictorial essays, letters to the editor). The full names of the first author (FA) and senior author (SA) were obtained for reviews and original research articles, manually reviewed and assigned to their supposed gender. Asian names were re-evaluated by native speakers (Chinese, Japanese, Vietnamese, Korean). To obtain highest feasible assignment rates for unisex names or names provided as initials, other publications of the same research group, the authors’ institutes’ webpages, ResearchGate, and Google were searched. Finally, a publicly available software to determine a first name’s gender (Gender API, Passau, Germany) was consulted, as well. Names which could still not be assigned to one gender were coded as undefined. First authors’ and senior authors’ institutes were noted, and the institute’s continent of origin verified by a web search.

Table 1 Female physicians (%) in the United States of America (US), United Kingdom (UK), Germany (DE), and Japan (JP) and proportions of female first (FA) and senior authors (SA) in US journals, European journals, and Asian journals for each medical specialty in 2017/18

Speciality	US		
	Female Physicians [%] US	Female FA [%] US journals	Female SA [%] US journals
Pediatrics	64	66.1	43.0
Gynecology	57	64.0	40.8
Radiology	23	33.5	16.3
Urology	9	23.9	10.9
Surgery	13	23.2	10.5
	EUROPE		
	Female Physicians [%] UK, DE	Female FA [%] European journals	Female SA [%] European journals
Pediatrics	64, 59	61.9	36.2
Gynecology	67, 68	69.5	44.4
Radiology	38, 26	32.9	14.6
Urology	23, 17	14.8	5.8
Surgery	25, 21	27.6	11.8
	ASIA		
	Female physicians [%] JP	Female FA [%] Asian journals	Female SA [%] Asian journals
Pediatrics	36	17.3	10.6
Gynecology	37	26.0	16.6
Radiology	24	10.0	6.0
Urology	7	4.8	2.8
Surgery	9	2.6	1.5

Sources for female physician rates: UK ("Analysis of the representation of women across the hospital and community health services workforce," 2018), DE ("Ärztstatistik, 2018," 2018), US ("Physician Speciality Data Report 2008, 2012, 2014, 2016, 2018,"), JP ("Personal enquiry at the Japan Society of Obstetrics and Gynecology, Japan Pediatric Society, Japan Radiological Society, Japan Surgical Society, and the Japanese Urological Association," 2019)

Statistical analyses

Absolute and relative (i.e., percentages) numbers are given for categorical data. Logistic mixed regression models were used to analyze differences in the percentages of female first and female senior authorships between years, journal origin, author origin, and research field. The outcome variable was indicating whether a FA or SA was female. Since for each publication two observations were given (i.e., one information for FA and one for SA), a random effect was included in the model indicating the publication identification. Thus, a publication could also be included if only one of the authorships could be defined as female or male.

Table 2 Included US, European, and Asian journals with impact and ranking position per category according to the Clarivate Analytics Web of Science’s Journal Citation Report Categories were “Radiology, Nuclear Medicine and Medical Imaging”, “Obstetrics and Gynecology”, “Pediatrics”, “Surgery”, and “Urology and Nephrology”

	Impact factor 2018	Ranking position
US Journals		
American Journal of obstetrics and Gynecology	6.120	2/83
Pediatrics	5.401	3/124
Radiology	7.608	4/129
Annals of Surgery	9.476	2/203
Nature Reviews Urology	19.684	1/80
European Journals		
European Radiology	3.962	20/129
BJOG International Journal of Obstetrics and Gynecology	5.193	6/83
European Journal of Pediatrics	2.188	45/124
British Journal of Surgery	5.572	8/203
European Urology	17.298	2/80
Asian Journals		
Journal of obstetrics and gynecology Research	0.588	78/83
Pediatrics International	0.939	107/124
Japanese Journal of Radiology	1.500	94/129
Surgery Today	2.077	87/203
International Journal of Urology	2.107	29/80

A multinomial logistic regression model was used to investigate collaborating authors by evaluating any differences between the percentages of the four possible FA and SA combinations (i.e. male-both, female-both, male FA-female SA, female FA-male SA) within year and journal or author origin. An observation was missing if either the FA’s, SA’s, or both authors’ gender were unknown.

Estimated proportions and adjusted odds ratio (OR) are reported along with 95% confidence intervals. All analyses and thus P-values are considered descriptive due to the explorative study design (i.e., no adjustment for multiple testing was conducted). For statistical analyses R, the free software environment for statistical computing by the R foundation was used (version 3.5.1, additional packages: lme4 (version 1.1–29) and nnet (version 7.3–16)). AO conducted the analyses.

Results

Overview

Of 24,182 registered original research articles and reviews and thus 48,364 observations concerning FA and SA, gender was assigned successfully for 27,595 observations (57.1%) and the continent of the author’s institute for 27,835 observations (57.6%). 7608 (27.6%) observations were from female leading authors (FA or SA). Independent of the authors’ gender, most publications were found in US journals ($n = 13,700$, 49.6%), followed by

European journals ($n=8751$, 31.7%). Asian journals ($n=5144$, 18.6%) showed the lowest overall number of publications.

Separated by medical discipline most publications were from radiological journals ($n=7648$, 27.7%), followed by pediatric journals ($n=6746$, 24.4%), and gynecological and obstetrical ones ($n=5816$, 21.1%). Lower numbers were found in surgical journals ($n=4529$, 16.4%) and lowest in urological journals ($n=2856$, 10.3%). The majority of authors with successfully assigned gender originated from US institutes ($n=9209$, 35.7%), followed by European ($n=9148$, 35.4%), and Asian institutes ($n=6609$, 25.6%). Authors working in Oceania ($n=538$, 2.1%), South America ($n=162$, 0.6%), or Africa ($n=141$, 0.5%) were a minority.

Female author shares stratified by journal origin

Over the course of ten years US journals showed the highest share of female leading authorships (female FA + female SA in 2007/8: 27.0%, in 2017/18: 35.1%), followed by European journals (12.7%, 30.1%). Proportions of female authors were consistently lowest in Asian journals (8.3%, 11.0%). Correspondingly, the separate proportions of both female first and female senior authors were highest in US journals and lowest in Asian journals at all time points (Table 3).

The strongest increase between both timepoints was observed for female leading author shares in European journals which nearly tripled (OR female FA + female SA 2.96 [95% CI 2.60–3.37], $P<0.0001$). In percentages, female first author proportions in European journals rose from 15.4 to 40.4% and female senior author shares from 9.0 to 19.2% (Table 3). In US journals which already showed highest proportions of female authors in 2007/8, the increase of female first authors (33.9 to 44.9%) and female senior authors (19.0 to 24.2%) was less pronounced (OR FA + SA 1.46 [95% CI 1.33–1.61], $P<0.0001$). Compared to European journals and US journals, Asian journals showed about three-times fewer female authors and the smallest increase for both female first authors (8.0 to 12.6%) and female senior authors (6.2 to 7.9%) (OR FA + SA 1.36 [95% CI 1.11–1.66], $P=0.0026$) (Table 3).

Female author proportions stratified by journal origin and discipline

Over the whole study period proportions of female first authors were consistently highest in US journals as far as the specialties pediatrics, urology, and radiology were concerned (Fig. 1). However, in radiology in 2017/18 the remaining difference of female first author rates between European (32.9%) and US journals (33.5%) was small (Fig. 1). In gynecological journals in 2007/08 most female first authors were found in the US journal with 46.8%, but the European journal surpassed the US journal in 2017/18 with 69.5%. This pattern was mirrored by surgery with 13.0% female first authors in the US journal in 2007/8 and 23.2% in 2017/18 vs. 11.8% and 27.6% in the European journal, respectively (Fig. 1).

Highest female first author rates of journals from all regions and disciplines were found in the pediatric US journal in 2007/8 with 49.1% and gynecological European journal in 2017/18 with 69.5%. Female first author proportions were lowest and hardly showed any increase in the surgical Asian journal with 2.5% in 2007/8 and 2.6% in 2017/18, respectively. Across all medical disciplines, Asian journals also showed consistently lowest female first author publication shares at all time points (Fig. 1).

The described patterns and the development over time were the same for female senior authors. Again, highest female senior author proportions were found in the pediatric

Table 3 Female first and senior authors in US, European, and Asian journals in 2007/8 and 2017/18

Author position	US Journals (USJ)			European journals (EJ)			Asian journals (AJ)			Comparison of journal region		
	Total OBS	Female total	Female % [95% CI]	Total OBS	Female total	Female % [95% CI]	Total OBS	Female total	Female % [95% CI]	Between	ADI, OR [95% CI]	P-value
2007/8												
FA	4044	1523	33.9 [32.0–35.8]	2222	463	15.4 [13.7–17.2]	965	128	8.0 [6.5–9.8]	EJ vs USJ	0.35 [0.30–0.43]	<.0001
										EJ vs AJ	2.09 [1.54–2.82]	<.0001
										USJ vs AJ	5.89 [4.43–7.82]	<.0001
SA	4096	1016	19.0 [17.6–20.6]	2251	306	9.0 [7.8–10.3]	967	107	6.2 [4.9–7.8]	EJ vs USJ	0.83 [0.70–0.99]	.0406
										EJ vs AJ	4.71 [3.74–5.94]	<.0001
										USJ vs AJ	5.67 [4.54–7.08]	<.0001
2017/18												
FA	2794	1295	44.9 [42.5–47.3]	2098	901	40.4 [37.7–43.1]	1607	295	12.6 [10.9–14.4]	EJ vs USJ	0.42 [0.34–0.51]	<.0001
										EJ vs AJ	1.49 [1.07–2.08]	.0119
										USJ vs AJ	3.55 [2.62–4.81]	<.0001

Table 3 (continued)

Author position	US Journals (USJ)		European journals (EJ)		Asian journals (AJ)		Comparison of journal region		
	Total OBS	Female total Female % [95% CI]	Total OBS	Female total Female % [95% CI]	Total OBS	Female total Female % [95% CI]	Between	Adj. OR [95% CI]	P-value
SA	2766	829 24.2 [22.3–26.2]	2180	547 19.2 [17.3–21.2]	1605	198 7.9 [6.7–9.3]	EJ vs USJ	0.74 [0.62–0.90]	.0008
							EJ vs AJ	2.78 [2.16–3.57]	<.0001
							USJ vs AJ	3.73 [2.93–4.75]	<.0001

FA first author, SA senior author, Total Obs. total observations, Female Total total number of female first and senior authors, Female % [95% CI] percentage of female authors with 95% confidence interval, Adj. OR adjusted odds ratio

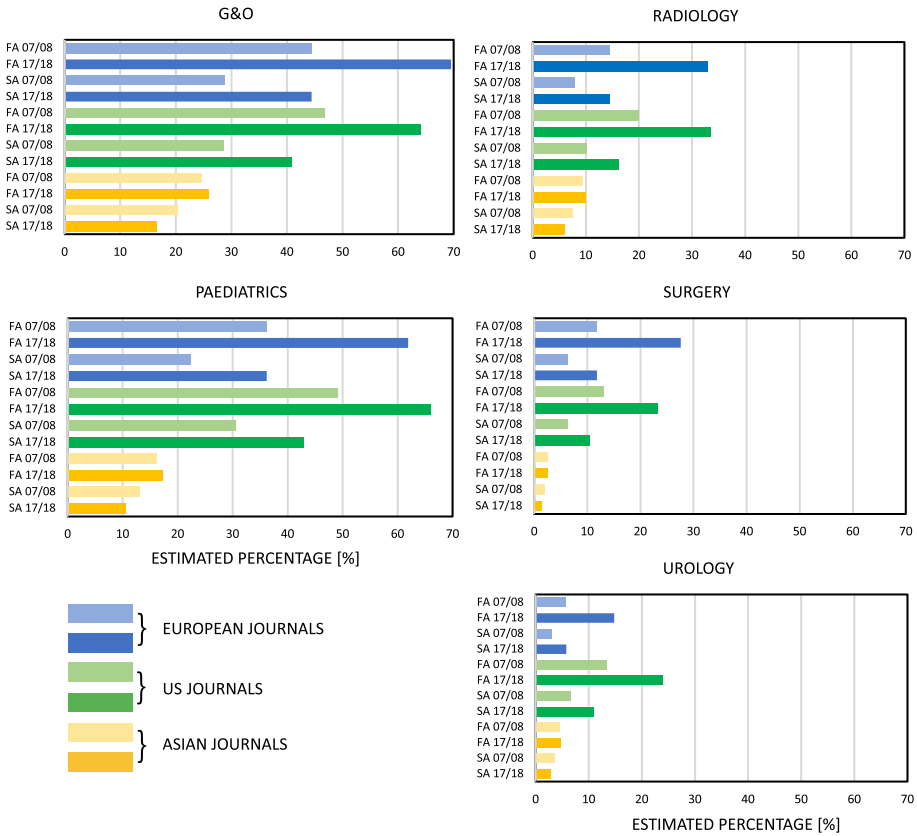


Fig. 1 Development of publication numbers from 2007/08 to 2017/18 stratified for journal origin and medical discipline

US journal in 2007/08 with 30.5% and the gynecological European journal in 2017/18 with 44.4%. As for female first authors, lowest female senior author shares were observed for the surgical Asian journal with 1.5% in 2017/18. Across all medical disciplines, in Asian journals female senior author rates even decreased between 2007/08 and 2017/18 (Fig. 1).

Compared to the rate of female physicians in the US in 2018, female first authors of the corresponding specialties in US journals were about equal or higher (Table 1). However, apart from urology, female senior author shares in US journals were lower than the rate of US female physicians in the corresponding disciplines (Table 1). For Europe, the proportions of female physicians in the UK and Germany in 2018 (there are no statistics for the whole continent) were in the range of female first authors in European journals (Table 1). Like for the US journals, female senior authors in European journals were underrepresented compared to the number of female physicians of the corresponding disciplines in the UK and Germany. In Asian journals for each specialty, female first and female senior authors were markedly lower than the rate of Japanese female physicians within the discipline (Table 1).

For the comparison of first and senior author proportions between US journals, European journals, and Asian journals of each medical discipline in 2017/18 please see Supplement, Table 1.

Female author origin in US American, European, and Asian journals

With 36.2% [95% CI 34.8–37.6] women from US institutes were the largest group among female authors in US journals. Female authors who worked at European institutes made up for 26.0% [95% CI 24.0–28.0] of female authors in US journals. Of female authors in US journals 16.8% [95% CI 14.3–19.7] originated from Asian institutes (Fig. 2). In contrast, female authors in European journals were about equally affiliated to European institutes (21.7% [95% CI 20.3–23.1]) and US institutes (21.1% [95% CI 18.0–24.5]). Like in the US journals, with 16.7% [95% CI 14.7–18.8] women from Asian institutes were the smallest group among female authors in European journals.

In Asian journals 9.4% [95% CI 8.4–10.5] of all female authors were working at Asian institutes, which were less than the proportion of female authors from European (14.3% [95% CI 11.4–17.7]) or US institutes (11.2% [95% CI 8.3–14.8]) (Fig. 2).

Publication shares of same- and mixed-sex authorships stratified by journal region

Even though decreasing over the course of 10 years, male same-sex author collaborations remained more common than other author combinations in all surveyed European, US, and Asian journals (Fig. 3). In journals of each region, male senior mixed-sex author combinations with female first authors were observed more frequently than female senior mixed-sex

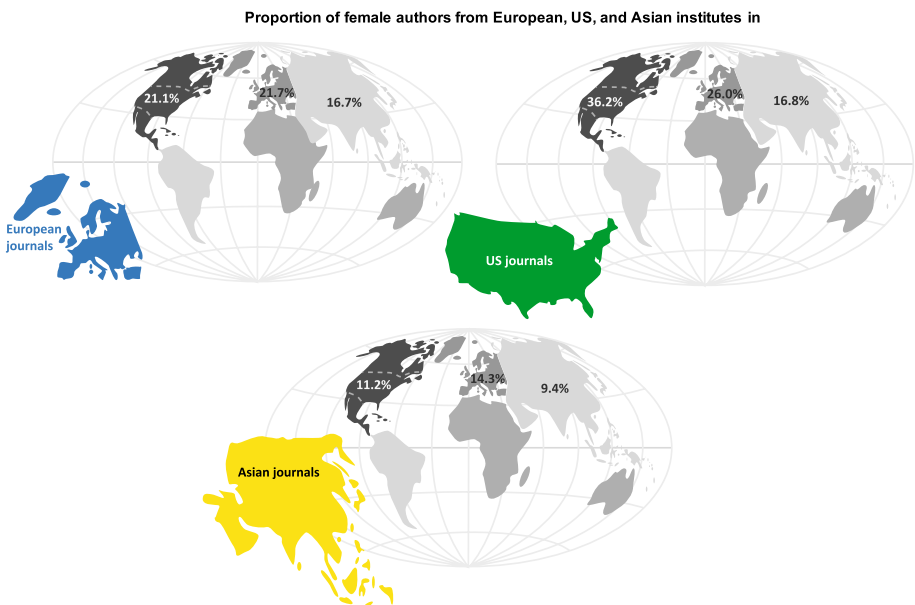


Fig. 2 Proportions of female first and senior authors from European, US, and Asian institutes in European journals (a), US journals (b), and Asian journals (c)

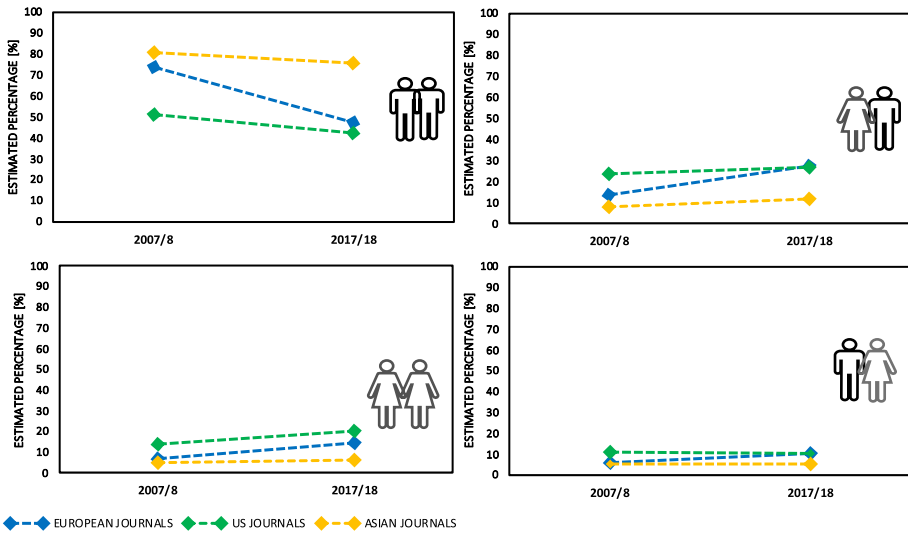


Fig. 3 Development of same-sex and mixed-sex first and senior author combinations in European, US, and Asian journals between 2007/8 and 2017/18

authorships with male first authors (Table 4). Over the course of 10 years in journals of all regions, male senior mixed-sex author collaborations increased more than female senior mixed-sex combinations (Fig. 3). In all surveyed journal regions female same-sex authorships were more common than female senior mixed-sex authorships (Table 4).

The highest proportions of female senior author combinations were found in US journals in 2017/18 (same-sex 20.1%, mixed-sex 10.2%). In European journals, starting with only few female same-sex authorships in 2007/08 (6.8%) numbers more than doubled over the course of 10 years (to 14.9%) (Fig. 3). On the contrary the number of male same-sex author collaborations in European journals was cut into half (73.7% to 47.2%) but remained higher than in US journals (42.5% in 2017/18). Also, the share of female senior mixed-sex authorships in European journals increased over the course of 10 years (6.0% to 10.2%), which then equaled numbers in US journals in 2017/18 (10.2%) and was about the double of proportions in Asian journals (5.7%). The lowest shares of both female same-sex and female senior mixed-sex authorships were found in Asian journals (6.5%; 5.7%). In Asian journals male same-sex combinations correspondingly stayed high (81.0% in 2007/8; 76.1% in 2017/18).

Discussion

In this study for the first-time female first and senior author rates were evaluated and compared between journals from the US, Europe, and Asia. It was demonstrated that female first and senior author proportions and trends vary between US, European, and Asian journals: in all disciplines taken together female first and senior author rates were consistently highest in US journals, followed by European journals. Over the course of 10 years the largest increase of female first and senior author numbers was found in European journals. Asian journals displayed low numbers of female leading authors with a small increase

Table 4 Same-sex and mixed-sex combinations of first and senior authors in US, European, and Asian journals for 2017 and 2018

Total OBS	Both female ♀♀		Both male ♂♂		Female-male ♀♂		Both male ♂♂		Comparison of author combinations	
	FEM. OBS	% [95%-CI]	FEM. OBS	% [95%-CI]	FEM. OBS	% [95%-CI]	FEM. OBS	% [95%-CI]	ADI. OR [95%-CI]	P-value
European journals										
3800	306	14.9 [13.2–16.5]	210	10.2 [8.8–11.6]	572	27.8 [25.7–29.8]	973	47.2 [44.9–49.5]	♂♀ vs. ♀♀ ♀♂ vs. ♀♀ ♀♂ vs. ♂♂ ♂♂ vs. ♀♀ ♂♂ vs. ♂♂ ♂♂ vs. ♀♂	.0025 <.0001 <.0001 <.0001 <.0001 <.0001
US journals										
4938	542	20.1 [18.5–21.7]	275	10.2 [9.0–11.4]	731	27.1 [25.3–28.9]	1146	42.5 [40.5–44.5]	♂♀ vs. ♀♀ ♀♂ vs. ♀♀ ♀♂ vs. ♂♂ ♂♂ vs. ♀♀ ♂♂ vs. ♂♂ ♂♂ vs. ♀♂	<.0001 .0002 <.0001 <.0001 <.0001 <.0001
Asian journals										
2475	104	6.5 [5.2–7.8]	91	5.7 [4.5–6.9]	186	11.7 [10.0–13.3]	1216	76.1 [73.9–78.4]	♂♀ vs. ♀♀ ♀♂ vs. ♀♀ ♀♂ vs. ♂♂ ♂♂ vs. ♀♀ ♂♂ vs. ♂♂ ♂♂ vs. ♀♂	.7887 .0007 <.0001 <.0001 <.0001 <.0001

Total Obs. total observations, Female Obs. female observations, % [95%-CI] estimated percentage of female authors with 95% confidence interval, Adj. OR adjusted odds ratio

of female first authors and a decrease of female senior authors. Compared to the rate of female physicians, female first authors were well represented in US journals, and European journals, but underrepresented in Asian journals. Female senior authors remained underrepresented in journals from all regions.

Concerning female author origin, US journals mainly published articles of female authors from the US, while in European journals female authors of European and US institutes were equally represented. Women from Asian institutes were worst represented among the female authors not only in US and European journals, but in Asian journals, as well. In journals from all continents, male-same sex authorships decreased but remained most common and female same-sex authorships were more common than mixed-sex authorships with female senior authors.

As there are no previous studies which compared female publication rates between journals from different continents, comparison of this study's results is only feasible with studies, which focused on one country/continent or separate medical disciplines.

Concerning US journals, the findings for pediatrics of 66.1% female first and 43.0% female senior authors indicate a continuous increase of female authorships compared to the results of Fishman et al. from 2016 (female FA 57.7%, female SA 38.1%) (Fishman et al., 2017) or Hart et al. from 2017 (female FA 58.6%, female SA 42.6%) (Hart & Perlis, 2019). For gynecology the female first and senior author proportions of 64.0% and 40.8% in this study were in the range of 5% compared to the results of Hart et al. (female FA 59.2%, female SA 44.4%). Similarly, the results for radiology with 33.5% female first authors were in the same range as those of Hart et al. (36.8%) (Hart & Perlis, 2019). The results for radiological female senior authors in 2017/18 with 16.3%, however were lower than those of Hart et al. (25.3%) (Hart & Perlis, 2019). This is likely because in contrast to this study, Hart et al. also included journals from subspecialties as neuroradiology, cardiovascular radiology, and journals from Nuclear Medicine, and female author rates are known to differ between subspecialties (Bernard et al., 2020). The results for urology with 23.9% female first authors in 2017/18 indicate an increase not only to the results of this study from 2007/08 (13.5%) but also compared to the work of Weiss et al. from 2009 (16.7%) (Weiss et al., 2012). On the contrary, representation of urological female senior authors did not change much over the course of 10 years with 6.6% in this study in 2007/08 and 9.8% described by Weiss et al. in 2009 (Weiss et al., 2012), and 10.9% in the present work in 2017/18. For the same surgical US journal as included in this study *The Annals of Surgery* a proportion of 23.0% female first authors has been described for 2003 (Kurichi et al., 2005), while 16.7% female first and 6.7% female senior authors were documented by another study in 2004 (Jagsi et al., 2006). The observed changes compared to this study's results (23.2% female FA, 10.5% female SA in 2017/18) have thus at best been small.

Comparison of the study results for European and Asian journals is difficult as literature is scarce. One work which analyzed publication numbers of *European Radiology* for 2016 described slightly higher results (35.0% female FA, 18.0% female SA) (Bernard et al., 2020) than were found for the same journal in this study (2017/18: 32.9% female FA, 14.6% female SA). The authors, however, do not mention whether they included all published articles, review articles or only original research articles, which makes direct comparison difficult. One study which investigated Japanese urological journals found 0.4% female first authors for the years 2010–2014 (Niwa et al., 2016), a number even lower than determined for the urological Asian journal in this study with 4.8% in 2017/18.

The scarce literature on European and Asian journals, as well as the missing intercontinental comparisons highlight the importance of this study. The results of this study demonstrate that female author proportions and trends in leading female authorships vary between

journals from different continents, especially between US and European journals opposed to Asian journals.

To estimate whether women are adequately represented as authors, female publication rates were put into context with the proportions of female physicians within a medical specialty and region. Again, this revealed clear differences between the journals from the different continents. It was surprising to note, that women from Asian institutes were the smallest group among female authors not only in US and European journals but in Asian journals as well. They were underrepresented compared to the Japanese female physicians' rates and would be if considering other Asian countries (e.g., 25.4% female physicians in Korea in 2017), as well. Concerning the overall low female author rate in Asian journals, a preference of female authors to submit to the higher impact European and US journals can be discussed, as Asian journals in the Journal Citation Report for 2018, and thus the included journals as well, were of lower ranking and thus less attractive to submit to. However, this should have affected male and female authors equally. Beside the submission rates, acceptance rates of female authored articles in Asian journals might also have differed due to a (subconscious) gender bias of editorial boards and reviewers. This is supported by the finding, that both, male and female editors, have a same-sex preference for reviewer assignment (Helmer et al., 2017) and that of the top 10 international journals of 41 categories only 21% have female editors-in-chief (Pinho-Gomes et al., 2021). Furthermore, after single-blinded review, acceptance rates are higher for established—and thus more likely male—authors (Helmer et al., 2017; Okike et al., 2016).

The results of this study can thus serve to raise awareness among editors for the underrepresentation of female authors in Asian journals and of women from Asian institutes worldwide and motivate journals, which still use single-blinded review (e.g., > 50% of all radiological journals in 2020 (Kwee et al., 2020)), to switch to a double- or triple-blinded review process. Also, this study provides further insights into remaining gender disparities within the included specialties. It can thus serve to illustrate the need for network structures, a safe learning environment, improved research and funding options, as well as professional support for the advancement of women, which organization such as “Women in Surgery”, “Women in Transplantation”, “Women in Pediatrics”, or the “Society of Women in Urology” strive for.

Concerning author collaborations, the fact that female same-sex authorships were more common than female senior mixed-sex authorships with male first authors, could indicate a preference for same-sex mentor–mentee relationships as described in previous studies (Bernard et al., 2020). The remaining high number of male same-sex authorships is likely also influenced by the high number of male senior faculty members (Penny et al., 2014), who are commonly in the position of last author. Similarly, due to the majority of male senior faculty members, male senior mixed-sex author combinations were observed more frequently than female senior mixed-sex authorships. The increase of women in junior faculty ranks is mirrored by the increase of male senior mixed-sex author collaborations. Also, the continent specific representation of female authors is mirrored by the author collaborations: in US journals which mainly showed highest rates of female first and female senior authors, same-sex female author combinations were more common than in European or Asian journals. In Asian journals, where female leading authors were generally rare, male-same sex combinations remained particularly frequent (76.1% in 2017/18).

One limitation of this study is the number of author names, which were not assigned to one gender. This is likely because in contrast to other studies, which a priori excluded Asian journals, or Asian names as those are often unisex, this study specifically investigated Asian names, as well. To reduce missing assignments software-based and manual

analyses of Chinese, Japanese, Vietnamese, and Korean native speakers were performed. Odds are, that for not assigned names the relation between male and female authors is equivalent to that of the successfully assigned names. Another limitation is the varying ranking of the included journals, which was inevitable as there are rarely any high-ranked journals from Asia. Finally, due to inclusion of one journal per specialty and continent, results between individual journals are less reliable, than the overall pattern, which became evident between all journals from the US, Europe, and Asia across the medical disciplines: a good representation of female first authors in US and European journals, a remaining underrepresentation of female first authors in Asian journals and of female senior authors and women from Asian institutes in journals from all regions.

Conclusion

In conclusion this study demonstrates that despite overall increasing female author rates differences in author proportions and trends exist between journals from the US, Europe, and Asia: while female senior authors remain underrepresented in US journals, European journals, and Asian journals, female first authors are mainly underrepresented in Asian journals. Women from Asian institutes are the smallest group among all female authors in US, European, and even Asian journals. Support of female scientists is thus especially needed to encourage transition of female scientists from the position of first to last author, to increase female leading authorships in Asian journals, and for female scientists of Asian institutes.

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Data availability All data are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethical standard For this retrospective bibliometric study an ethics exemption was obtained from the local ethics committee (Ärzttekammer Hamburg, Germany).

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