Gender gap in authorship within published orthodontic research. An observational study on evidence and time-trends over a decade

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Gender Gap in authorship within published Orthodontic Research. An observational study on evidence and time- trends over a decade.

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Short title: Gender Gap in Orthodontic research

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Abstract

Aim: To assess the representation of female authors in senior and leading positions in orthodontic research publications, as well as the fraction of women participating in the publication reports, for over a decade. In addition, association of women representation in orthodontic research and characteristics such as journal of publication, year, study design/ topic, and others, were sought.

Materials and Methods: Electronic search was performed within 3 major orthodontic journals, namely the European Journal of Orthodontics (EJO), the American Journal of Orthodontics and Dentofacial Orthopedics (AJODO), and the Angle Orthodontist (ANGLE) to identify all types of research articles published within 2 distinct year cohorts, the 2008- 2010 and the 2018- 2020. The outcomes of interest pertained to proportion of women in senior (last) and leading (first) position, and fraction of overall participation in the authorlist.

Results: A total of 2539 articles were eligible for inclusion, with an overall number of contributing authors being 11608, of which 34.4% were female. For seniority in authorship, 30.1% (312/ 1038) of the publications within 2018- 2020 were attributed to female authors, while 25.8% (388/ 1501) was identified in 2008- 2010. Publication timeline, geographic region and thematic topic of publication were determined as significant predictors. For leading (first) authorship, the respective percentages were 44.7% (464/ 1038) within 2018- 2020, and 34.7% (521/ 1501) in 2008- 2010. Dissemination timeline, geographic region and journal of publication were identified by the multivariable analysis, as revealing evidence of association with female leading publication authorship. Overall, the median proportion of female authors within the authorlist was 33.0%.

Conclusions: A gender gap related to Orthodontic research publications is persistent, with participation of women either as senior, or as leading authors, being suboptimal. Consistent efforts

should be set in place, to facilitate more equal representation of women in research publishing, being supported by academia.

Keywords: gender gap, gender bias, academic publishing, research, gender equity, authorship, publication

Introduction

Gender inequalities and disparities have been convulsing research societies and academia for decades (1). The apparent challenges female scientists may face across their career, have been framed most conceivably under the following broad domains: lack of female role models and appropriate guidance or mentorship to pursue career advancements, lack of efficient networking and socialization of women, and last, implicit bias and negative stereotypes (2). The latter, being translated to gender leadership bias, is one that most severely impacts women's advancement to high- end and leadership roles, while concerted organizational and institutional policies are currently deemed crucial in supporting the move against gender disparity (3).

The effect of gender stereotypes has been profoundly present in academic environments, including medicine and dentistry. Academic promotion and research output of female scientists have been considered suboptimal, with publication pipeline being mostly represented by men (4, 5). This might be regarded in part as a paradox or mismatch for biomedical sciences, since the number of female students and graduates from medical/ dental schools has not been considered reflective of the identified condition with regard to acquisition of leadership roles or high academic ranks from women (2, 6). According to a recent report of 2019, 60 percent of post-graduate orthodontists in Switzerland were female, and similar figures are also documented across medicine and dentistry students of the same region (7).

Not- surprisingly, the disseminated published research in dentistry and beyond is being conducted primarily in University structures and units, and is closely linked to academic career paths. As academic publishing is a prime factor for being hired as faculty member or being promoted within the academic ranks, the considerably lower female publication rate evidently affects their

representation in academia (8), with further implications for their role in educational and organizational decision making (9).

The sole currently existing study in orthodontic research, considering authorship determinants related to gender dates back to 2012. In essence, the percentage of female first authors in orthodontic literature increased significantly from 1986 to 2008, from a nearly undetectable representation to 18 percent (10). However, only articles involving United States affiliated primary authors were considered, while it was also concluded that participation of women in leadership and high- end roles was also limited (10). A similar bleak picture has also been noted for prosthodontic research, with regard to both authorship and leadership (11).

Therefore, the aim of the present empirical report was to estimate the representation and prevalence of female authors in senior positions in orthodontic research publications up- to- date and over a decade. On a secondary basis, we examined the proportion of women included as first authors, and the fraction of female authors in the author- list. Additionally, we aimed at identifying associations with a number of publication report characteristics including journal of publication, year, study design/ topic, and others.

Materials and Methods

The electronic contents of the 3- major orthodontic journal with the highest impact factors (IFs) in 2019 based on Journal Citation Report (Clarivate Analytics) were searched within two distinct 3-year timespans, namely 2008 to 2010 [January 1st to December 31st] and 2018- 2020 [January 1st to December 31st], in order to identify and include all types of research articles in the broad as well as specific orthodontic field covered by the journals. The journals were: the European Journal of Orthodontics (EJO)- IF 2.202, the American Journal of Orthodontics and Dentofacial Orthopedics

(AJODO)- IF 1.960, and the Angle Orthodontist (ANGLE)- IF 1.549. All types of articles other than editorials, forum reports, commentaries, letters to the editor, were included as eligible.

Data extraction was performed in bespoke piloted standardized forms and calibration procedure was conducted between the two assessors (CS, DK) in 30 papers, after initial piloting in 20, with regard to the variables under study, as described below. Any preliminary disagreement at piloting stage and before calibration, was settled through discussion and achievement of consensus between the two investigators. The range of publication characteristics assessed are as follows: journal, year of publication, geographic region of authorship (as determined by the affiliation details of the first author: 1/ Europe; 2/ America (North and South); 3/ Asia- other), number of authors, number of centers involved (single- or multi-, based on authors' affiliation details and further information within the Materials and Methods section of each report), study topic (for this variable we used a 4-level categorization of articles, to facilitate grouping and presentation of results: 1/ biomaterials- biomechanics; 2/ diagnosis- treatment- esthetics; 3/ craniofacial growth- morphology- genetics, and 4/ behavior- psychology- treatment need- satisfaction- quality of life), and study design (1/ observational; 2/ interventional; 3/ systematic review- meta-analysis; 4/ in-vitro; 5/ animal; 6/ case report- case series- pilot- technique description; 7/ meta-epidemiologic).

Outcomes of interest pertained to: a. whether a female author possessed a senior (last- author) place in the authorlist, b. whether a female author was first listed in the publication, and c. the proportion of female investigators among the authors of a publication report.

A python script was developed to automate the procedure of gender classification. The script has as an input the relevant author's list and performed the classification task based on [a] *gender_guesser* python library (https://pypi.org/project/gender-guesser/), [b] local collection of predefined list, and finally [c] a largely used online service of gender categorization based on first

name (https://gender-api.com/). The local gender dictionary was manually filled with name and gender that didn't reside in any existing database. Ultimately, unclassified names were manually searched in an extensive manner within the web, with specific focus within Institutions, Universities and Department webpages, following affiliation details. Aforementioned script's internal procedure is shown in Figure 1.

Statistical analysis

Descriptive statistics and cross- tabulations were initially conducted to analyze characteristics of the sample of studies examined with regard to the aforementioned variables. Univariable and multivariable logistic regression was performed to examine the effect of publication characteristics including journal, year of publication, geographic region of authorship, number of authors, number of centers, topic and study design on the inclusion of female as senior or first author. Potential predictors were examined sequentially one at a time in the crude model and were all retained in the final multivariable model, as decided ad- hoc. Presence of Interaction between journal and year- span was checked through likelihood ratio test. The Hosmer-Lemeshow test was used to check model fit.

For the continuous outcome related to proportion of female authors in the authorlist, data distribution was checked for normality of residuals, visually through qqplot and statistically through Shapiro- Wilk test. As normality could not be confirmed, non- parametric descriptive statistics were used. The Wilcoxon rank sum (Mann-Whitney) test was used to test for differences in proportion of female authors between the two time periods assessed.

The unweighted kappa statistic was used to assess inter-rater agreement on the pre- determined predictor variables. An almost perfect agreement was deemed across the variables ranging from

kappa= 0.86 (95% Confidence Interval, CI: 0.76, 0.95) to kappa= 1.00; specifically due to the "hard" nature of the examined set. The predefined level of significance was set at $p<0.05$ (two- sided). All analyses were conducted with Stata version 15.1 (Stata Corporation, College Station, Texas, USA).

Results

A total number of 2558 articles from two time- periods [2008- 2010 and 2018- 2020] were screened and included, after a priori exclusion of editorials, letters to the editor, commentaries. The overall number of authors contributing to these publications was 11608, the number of female authors being 3872 (33.4%), and the number of male being 7689 (66.2%). There were 47 (0.4%) names of authors that remained unclassified according to gender. Of the 2558 articles, 19 were excluded from the last and first- author analysis, since these involved unclassified names in these positions, and an ultimate 2539 publications were subsequently analyzed.

Descriptively, articles published a decade ago (2008- 2010) (1501/ 2539; 59.1%), outnumbered the most recent ones (2018- 2020). The majority of articles were published in the AJODO (1204/ 2539; 47.4%), while most originated from Europe (983/ 2539; 38.7%). The most prevalent pattern of number of authors involved was 4-5 (1096/ 2539; 43.2%), and the studies were conducted and reported following collaborations across more than one center (1366/ 2539; 53.8%). Diagnosis/ treatment/ and esthetics related articles formed the bulk of our sample (1275/ 2539; 50.2%) and were followed by biomaterials/ biomechanics related papers (504/2539; 19.9%). Observational study designs framed the majority of research endeavors (1195/ 2539; 47.1%), while in- vitro studies accounted for the second most prevalent type (368/ 2539; 14.5%) and interventional designs followed (324/ 2539; 12.8%).

With regard to last (ie, senior) author analysis, female authors attained seniority in 30.1% (312/ 1038) of the publications within 2018- 2020, while this percentage was, to some degree lower, with regard to the 2008- 2010 timeline (388/ 1501; 25.8%) (Table 1; Figure 2). The EJO slightly outnumbered the other journals with regard to the fraction of published articles authored by women in senior positions (167/ 540; 30.9%). This was also the case for articles from European origin (338/ 983; 34.4%) (Table 1). Breakdown of articles by study design, published under female seniority is presented in Figure 3. According to the multivariable analysis, more recent publication of articles (2018- 2020), presented 1.22 times higher odds for inclusion of female authors as senior, compared to earlier (2008- 2010) (adjusted Odds Ratio, OR= 1.22; 95%CI: 1.02, 1.49; p= 0.03). No interaction was identified between journal and year of publication (likelihood ratio test, p= 0.65). Publications originating from America (adjusted OR= 0.58; 95%CI: 0.46, 0.73) and Asia/ other (adjusted OR= 0.57; 95%CI: 0.45, 0.72) were negatively associated with female authors included as senior, compared to European originating publications (Wald test, p<0.001). Article topic and thematology showed some evidence of association with female author seniority in research publications (Wald test, p= 0.03). Specifically, articles related to biologic entities (craniofacial growth- morphology and genetics), showed 68% higher odds of including women in such positions, compared to biomaterials/ biomechanics related papers (adjusted OR= 1.68; 95%CI: 1.17, 2.43) (Table 2).

With regard to first (ie, leading) author analysis, female authors appeared as first in orthodontic publications within 2018- 2020, in 44.7% (464/ 1038) of the sample. The respective figure for the early 2008- 2010 timeline was 34.7% (521/ 1501) (Table 3; Figure 2). EJO presented an almost even distribution of articles published with women as leading authors (258/540; 47.8%). Following, European country of origin accounted for the most prevalent detection of women as leading first

authors (456/983; 46.4%). Increased number of authors' participation were more likely to include a female first author (ie, 4-5: 436/ 1096, 39.4%; ≥ 6: 272/ 658; 41.3%). Articles related to a. craniofacial morphology and genetics (206/ 486; 42.4%) and b. psychology/ treatment need and quality of life (124/ 274; 45.3%), presented the highest proportions of female first- authored publications (Table 3). Breakdown of articles by study design, published under leading female authorship is presented in Figure 3, as well. The multivariable analysis, identified timeline of publication, journal and continent as significant predictors (Table 4). No interaction was recorded between journal and year of publication (likelihood ratio test, p= 0.07). Indeed, late publication timeline in 2018- 2020 induced 49% higher odds of being led by a female author compared to early (2008- 2010) (adjusted OR= 1.49; 95%CI: 1.25, 1.77; p<0.001). Published articles in the AJODO and the ANGLE presented 28% (adjusted OR= 0.72; 95%CI: 0.57, 0.90) and 17% (adjusted OR= 0.83; 95%CI: 0.65, 1.06) lower odds of having a female first author, compared to the EJO (Wald test, p= 0.01) (Figure 4). Similarly, publications originating from America (adjusted OR= 0.78; 95%CI: 0.64, 0.97) and Asia/ other (adjusted OR= 0.48; 95%CI: 0.39, 0.60) presented 22% and 52% lower odds, compared to European ones (Wald test, p<0.001) (Table 4).

Last, the median proportion of female authors within the authorlist overall was estimated to 33.0%. The difference in proportion between the two timelines was statistically significant, with a median female fraction of 25.0% within the early and 33.0% within the late year- group (rank- sum, p<0.001) (Figure 5). Only 320 out of 2539 articles were jointly co- authored by female first and last authors (12.6%), while the respective figure for similar joint male authorship was 1174/ 2539 (46.2%). A geographic variation was recorded for articles jointly co- authored by female scientists. European origin was denoted for the vast majority (185/ 320; 57.8%), followed by American (79/320; 24.7%).

Discussion

Findings in Context

The findings of the present study have elucidated the effect of gender and gender disparities in authorship in the disseminated research in Orthodontics. While some increments of improvement have been identified and have become more marked recently, for certain article authorship characteristics, the overall picture in the field is still bleak.

Only about a third of the aggregate authorship in an article that reaches publication is of female gender overall, while acquired position in the authorlist appears to play a significant role. This is additionally important with regard to seniority, where no considerable amounts of advancements have been detected over the years. Albeit some significant improvements recently, as well as some additional effects acting for specific journals [such as the EJO, which performed better overall] and geographic origin of the research work, the level of the recorded improvement remains lower than probably anticipated; what is more, within the era of technological reforms, with internationalization striving for elimination of gender disparities. The identified low prevalence of women as senior authors in publication reports in Orthodontics, within both timeline periods assessed is potentially indicative of the persistent occupation, in part of men, of leading positions in Institutions, Universities and Research Units, following relevant appointments; this might translate into more frequent up-taking of roles such as research coordinators and directors, thus, attainment of subsequent seniority to relevant publications, by men (12). The close relation between academics and research publishing is profound, while a report dating back in 2016 elucidates the role of gender in science academies, where it has been shown that more than 80% comprise of men (13).

The more optimistic picture framed for European originating articles, as well as publication within the official journal of the European Orthodontic Society might be indicative of some more efficient and productive work against gender disparities and towards promotion of gender equity and inclusion strategies; orchestrated actions by the European commission, through channels, initiatives and charters have been set in place with a major aim to facilitate equal representation of women in decision- making positions (14). Universities and institutions accounting for research dissemination have been identified as being key determinants in this respect.

A more neuralgic role of women in certain fields of research was confirmed, with those being in senior positions in publications related to craniofacial growth/ morphology and genetics, potentially denoting underlying biology- related and laboratory work, while also reflecting preferences and education related to specific research questions. However, any further conclusion with regard to interpretation of research findings and preferential reporting of outcomes or investigation of certain types of outcome- related predictor factors, might only be speculative and beyond the scope of the present study.

Prior Research

Earlier empirical reports across aspects of scientific writing and gender inequalities are not abundant within the oral health field, while only one study with regard to orthodontic research exists, however, comprising diverse inclusion criteria and assessing a considerably earlier publication timescale (10); thus, albeit apparent mismatches in straightforward comparisons across the scientific literature, it might be speculated that the overall picture has been slowly and gradually improving during the last 40 years.

In essence, lately, focus has been placed on gender disparities in education, academic career advancements and research (15). A very recent report from Ioannidou et al, 2019, elucidates the

initiatives of the International Association of Dental Research (IADR) to promote gender equity, under 5 basic pillars (16). Among others, scholarly productivity is one of the most recognized domains, which should be constantly embraced by the scientific community and the society as a unity, in order to safeguard against persisting inequalities.

Evidence from research output within oral and maxillofacial surgery specialty, for 4 decades until 2010, suggests that there is significant under-representation of women in authorship, related to leading positions, albeit documentation of improvement increments over time. Indeed, publication by male authors in such positions exceeded those of women approximately by 4- times (17). Research output has been evidently related to academia and academic productivity (2). In this respect, data from Dental Schools based in North America and having received funding from the National Institute of Dental and Craniofacial Research, has revealed a significantly higher number of publications being authored by male in senior positions, along with the achievement of higher H-indices. In the same line, only a third of dental faculty is female, while the respective percentage of female in the highest academic rank is even lower, approximating 25% (18). A further assessment of the percentage of female staff across a range of Orthodontic Departments, coupled with the assessment of co- authored publications in leading/ senior positions, following a relevant time-span, would potentially translate to a more straightforward evaluation of how published and disseminated research work might be associated with academic ranking and promotion.

Moreover, representation of women in the advisory and editorial boards of scientific journals is limited and does not come without barriers (19). The corresponding figures ranged from 7.5% to 41.1% across different dental specialty domains. In orthodontics, based on the Thomson Reuters Web of Knowledge Journal Citation Reports list of 2012, the respective figure for the journals was 11.5% (19). It might be possible that such findings corroborate with their career path in academia.

Not surprisingly, scholarly recognition and research productivity is interconnected with academic promotion, award receiving and thus invitations to join panel groups and editorial boards (20).

Women in science and gender parity has been examined with exceptional interest in the broad biomedical literature as well, and across different levels of dissemination of scholarly work and scientific output (21). A very recent systematic review has examined disparity between male and female physicians in United States Institutions (22). As for career advancement and promotion to the highest academic rank, it has been suggested from evidence over the last 2 decades, that gender equality shall be achieved in no least than 120 years. In the same line, men appear to publish more articles and this happens earlier than women in their career (22). Furthermore, findings from orthopedics literature suggest that although the gender gap is closing in terms of representation of women in leading positions in authorship for published research, there is still considerable potential for improvement. Women as first or corresponding authors in this domain have been found to represent nearly 20 percent of the published work, albeit the documentation of a linear trend for improvement across the years (23).

Gender inequalities have also been identified very recently in grant applications undergoing external review. A large cross- section of submitted proposals approximating 13,000, being assessed by nearly 40 thousand reviewers, in the Swiss National Science Foundation (SNSF), has revealed that male applicants received systematically higher scores for their proposals, while effects were potentially more pronounced for certain domains and institutions (24). Results were analogous to earlier reports on grant applications from the National Institutes of Health R01 applications (25), or the European Research Council Starting Grants, Consolidator Grants or Advanced Grants (26). Latest evidence on research grant proposal writing and language use in applications submitted to the Southern Brazil Research Support Foundation (FAPERGS), did not

identify gender bias from use of language as a significant predictor for successful application; apparently, gender effect and bias may constitute a more generic parameter to be assessed than sole language pattern used, with further drivers being the general societal concepts related to promotion of women and/ or research output and scholarly productivity (27).

Initiatives and Future Perspectives

Albeit efforts to promote gender equality and attenuate disparity have been in place since several years, the "glass ceiling" effect is profoundly persistent in academia and research (20). This inclusive term describes the barriers that are inequitably set in career advancement and promotion to leadership positions and roles, while not being readily visible. Some of these barriers may be explained through societal preconceptions, cultural aspects, traditional gender- based evaluation of candidates for a position or an application, family related concepts and lack of supportive structures for maternity/ family career breaks (28).

Initiatives to address issues of gender disparity in academia and research have been described more concertedly since 2005, where the Athena SWAN (Scientific Woman's Academic Network) charter was launched (29). The role of Athena SWAN framework has been to encourage universities and institutions to recognize inequalities and promote career advancement of women in science. Currently, further action plans and policies are being adopted by well- established institutions or granting networks. The Swiss National Science Foundation (SNSF) has lately introduced gender quotas in evaluation committees and advisory boards. Such quotas target at least 40 percent female representation in research councils and presiding boards, thus offering increased visibility (30).

In essence, concerted efforts should be placed and constantly updated in order to establish a viable level of representation of women in science and research in general, as well as within oral health

and orthodontics. Men and women already possessing high- rank posts should be aware, alert and additionally educated, so as to create equal opportunities for female peers. Promotion and support of female scientists to actively integrate to groups should be prioritized. This applies for scientific societies, research councils, funding agents, academia and beyond, as a unity (31). Strategic priorities to increase equity, diversity and inclusion (EDI) have been identified as potential action plans for the future. Such priorities should focus on organizational and institutional levels and be closely monitored, to achieve targets and measurable goals (32).

Strengths and Limitations

The present study, to our knowledge, constitutes the first empirical report on gender disparities in scientific publications in orthodontics, with no geographic limitation determinants (10), and one of the very few that exist in dental research. We included a wide cross- section of all published studies in the three prestigious and historic journals in Orthodontics, and it is apparently likely that current and prior practices of these journals reflect a best- case scenario of the publication pool in the field. Two distinctive timelines were included, in an attempt to detect any relevant time trend, while also a wide interval was allowed for any potential practice or policy endorsement to have taken place and reveal its characteristics, if possible. In fact, we consider our approach a rather representative example on the assessment of time- trends for gender- gap in authorship, as well as documentation of the current situation and scope to compare and contrast between 3-year time spans, with an interval of 10 years. Indeed, significant differences were ultimately revealed for both first- and senior- author assessment with regard to gender inequalities and time- effect, conditional on a number of other predictors. Similar timescales have also been utilized as indicators of gender gaps in authorship of publications, within the biomedical literature (33, 34). Further, a python module was developed that could assume the authors' gender based on online libraries and local

dictionaries, thus, minimizing potential human error and automating the process of gender identification.

The study does not come without limitations. First, not all articles across the last decade were assessed, however, a large amount of data reflecting two distinct 3- year time- spans was evaluated, that may be considered of adequate representativeness; in essence, this plan would facilitate the maximum of improvement trends to be exposed. Second, only final publication reports were examined, with no further insights regarding submission rates to journals from female authors. As such, any speculations about gender disparities in orthodontic research writing may only be made based on the disseminated data, while it is currently not possible to estimate any effects or biases stemming from the submission stage and reflecting journals' and editors' preconceptions. Third, we assessed only publications related to orthodontic research, thus, rendering any considerations for other disciplines in dentistry practically impossible, at least within the frame of the present work. In addition, our evaluation was confined to orthodontic journals as this would allow for a representative assessment, across a wide spectrum of study designs. Apparently, one might presume that general dentistry journals of high impact might well be a pool of orthodontic studies; however, and given the preference of more general journals in specific, high end- of evidence research designs from specific specialties such as orthodontics, any attempt to include such data could potentially result in a significant inflation of our findings. Moreover, it is probably unlikely that a considerable number of orthodontic articles would be disseminated in more generic journals, while if this is the case, non- significant differences are anticipated, due to the low overall prevalence of this practice. To this end, the present empirical report constitutes a comprehensive evaluation of the state of the art research output regarding gender inequalities, in published research in Orthodontics.

Conclusions

Despite advancements in female representation in orthodontic research publications, a gender disparity remains. Less than one third of females obtained seniority in authorship and a third were recognized on an author list. Concerted efforts need to be directed through academia first, to promote gender equity in orthodontic research publication.

Conflict of Interest

Nothing to declare.

Ethical Approval

Not required. This is a meta-epidemiologic study without patients or records involvement.

Data Availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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Captions

Table 1. Frequency distribution for the presence female researchers as senior (ie, last) authors (n=2539).

Table 2. Univariable and multivariable logistic regression with Odds Ratios (OR) and associated 95% CIs for the effect of a range of article characteristics on inclusion of female authors as senior (ie, last), within the authorlist (n=2539).

Table 3. Frequency distribution for the presence female researchers as first authors (n=2539).

Table 4. Univariable and multivariable logistic regression with Odds Ratios (OR) and associated 95% CIs for the effect of a range of article characteristics on inclusion of female authors as first, within the authorlist (n=2539).

Figure 1. Python script's internal procedure for gender classification.

Figure 2. Odds (with 95% Confidence Intervals) for inclusion of female as last or first author, across the two time cohorts.

Figure 3. Frequency distribution for inclusion of female/ male as last or first authors, across study design

Figure 4. Predictive margins with 95% Confidence Intervals for the probability of female inclusion as first author, across journal of publication, by timeline.

Figure 5. Frequency distribution of the percentage of female authors within the authorlist, by publication timeline.

Table 1. Frequency distribution for the presence female researchers as senior (ie, last) authors (n=2539).

	Female as senior author		
	No N (%)	**Yes N (%)**	**Total N (100.0%)**
Year of publication			
2008- 2010	1113 (74.2)	388 (25.8)	1501
2018- 2020	726 (69.9)	312 (30.1)	1038
Journal			
EJO	373 (69.1)	167 (30.9)	540
AJODO	880 (73.1)	324 (26.0)	1204
ANGLE	586 (73.7)	209 (26.3)	795
Continent			
Europe	645 (65.6)	338 (34.4)	983
America	596 (76.7)	181 (23.3)	777
Asia/other	598 (76.8)	181 (23.2)	779
No. authors			
1-3	551 (70.2)	234 (29.8)	785
4-5	808 (73.7)	288 (26.3)	1096
≥ 6	480 (73.0)	178 (27.0)	658
Center			
Single	841 (71.7)	332 (28.3)	1173
Multi	998 (73.1)	368 (26.9)	1366
Topic			
biomaterials- biomechanics	407 (80.7)	97 (19.3)	504
diagnosis- treatment-esthetics	916 (71.8)	359 (28.2)	1275
craniofacial growth-morphology- genetics	320 (65.8)	166 (34.2)	486
behavior- psychology-treatment need-satisfaction- quality of life	196 (71.5)	78 (28.5)	274
Type of Study Design			
Observational	819 (68.5)	376 (31.5)	1195
Interventional	219 (67.6)	105 (32.4)	324
SR/ meta-analyses	111 (75.0)	37 (25.0)	148
In- vitro	299 (81.3)	69 (18.7)	368
Animal	178 (80.5)	43 (19.5)	221
Case reports/ technique	200 (74.6)	68 (25.4)	268
Meta- Research	13 (86.7)	2 (13.3)	15

Total	1839 (72.4)	700 (27.6)	2539

Table 2. Univariable and multivariable logistic regression with Odds Ratios (OR) and associated 95% CIs for the effect of a range of article characteristics on inclusion of female authors as senior (ie, last), within the authorlist (n=2539).

Category	Univariable			Multivariable		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Year of publication			0.02			0.03
2008- 2010	Reference			Reference		
2018- 2020	1.23	1.03, 1.47		1.22	1.02, 1.49	
Journal			0.14*			0.91*
EJO	Reference			Reference		
AJODO	0.82	0.66, 1.03		1.06	0.82, 1.35	
ANGLE	0.80	0.63, 1.01		1.03	0.80, 1.34	
Continent			<0.001*			<0.001*
Europe	Reference			Reference		
America	0.58	0.47, 0.72		0.58	0.46, 0.73	
Asia/other	0.58	0.47, 0.71		0.57	0.45, 0.72	
No. authors			0.23*			0.56*
1-3	Reference			Reference		
4-5	0.84	0.68, 1.03		0.89	0.72, 1.10	
≥ 6	0.87	0.69, 1.10		0.92	0.72, 1.19	
Center			0.44			0.24
Single	Reference			Reference		
Multi	0.93	0.78, 1.11		0.89	0.74, 1.08	
Topic			<0.001*			0.03*
biomaterials- biomechanics	Reference			Reference		
diagnosis- treatment- esthetics	1.64	1.28, 2.12		1.27	0.92, 1.74	
craniofacial growth- morphology- genetics	2.18	1.63, 2.91		1.68	1.17, 2.43	
behavior- psychology- treatment need- satisfaction- quality of life	1.67	1.18, 2.35		1.27	0.84, 1.92	
Type of Study Design			<0.001*			0.05*
Observational	Reference			Reference		

Interventional	1.04	0.80, 1.36		1.11	0.84, 1.47	
SR/ meta-analyses	0.73	0.49, 1.07		0.74	0.49, 1.10	
In- vitro	0.50	0.38, 0.67		0.67	0.47, 0.97	
Animal	0.53	0.37, 0.75		0.70	0.48, 1.05	
Case reports/ technique	0.74	0.55, 1.00		0.85	0.61, 1.17	
Meta- Research	0.34	0.08, 1.49		0.30	0.07, 1.39	

*wald test for overall association

Table 3. Frequency distribution for the presence female researchers as first authors (n=2539).

	Female as first author		
	No N (%)	**Yes N (%)**	**Total N (100.0%)**
Year of publication			
2008- 2010	980 (65.3)	521 (34.7)	1501
2018- 2020	574 (55.3)	464 (44.7)	1038
Journal			
EJO	282 (52.2)	258 (47.8)	540
AJODO	777 (64.5)	427 (35.5)	1204
ANGLE	495 (62.3)	300 (37.7)	795
Continent			
Europe	527 (53.6)	456 (46.4)	983
America	473 (60.9)	304 (39.1)	777
Asia/other	554 (71.1)	225 (28.9)	779
No. authors			
1-3	508 (64.7)	277 (35.3)	785
4-5	660 (60.2)	436 (39.8)	1096
≥ 6	386 (58.7)	272 (41.3)	658
Center			
Single	737 (62.8)	436 (37.2)	1173
Multi	817 (59.8)	549 (40.2)	1366
Topic			
biomaterials- biomechanics	337 (66.9)	167 (33.1)	504
diagnosis- treatment-esthetics	787 (61.7)	488 (38.3)	1275
craniofacial growth-morphology- genetics	280 (57.6)	206 (42.4)	486
behavior- psychology-treatment need-satisfaction- quality of life	150 (54.7)	124 (45.3)	274
Type of Study Design			
Observational	685 (57.3)	510 (42.7)	1195
Interventional	188 (58.0)	136 (42.0)	324
SR/ meta-analyses	87 (58.8)	61 (41.2)	148
In- vitro	261 (70.9)	107 (29.1)	368
Animal	143 (64.7)	78 (35.3)	221
Case reports/ technique	180 (67.2)	88 (32.8)	268
Meta- Research	10 (66.7)	5 (33.3)	15

Total	1554 (61.2)	985 (38.8)	2539

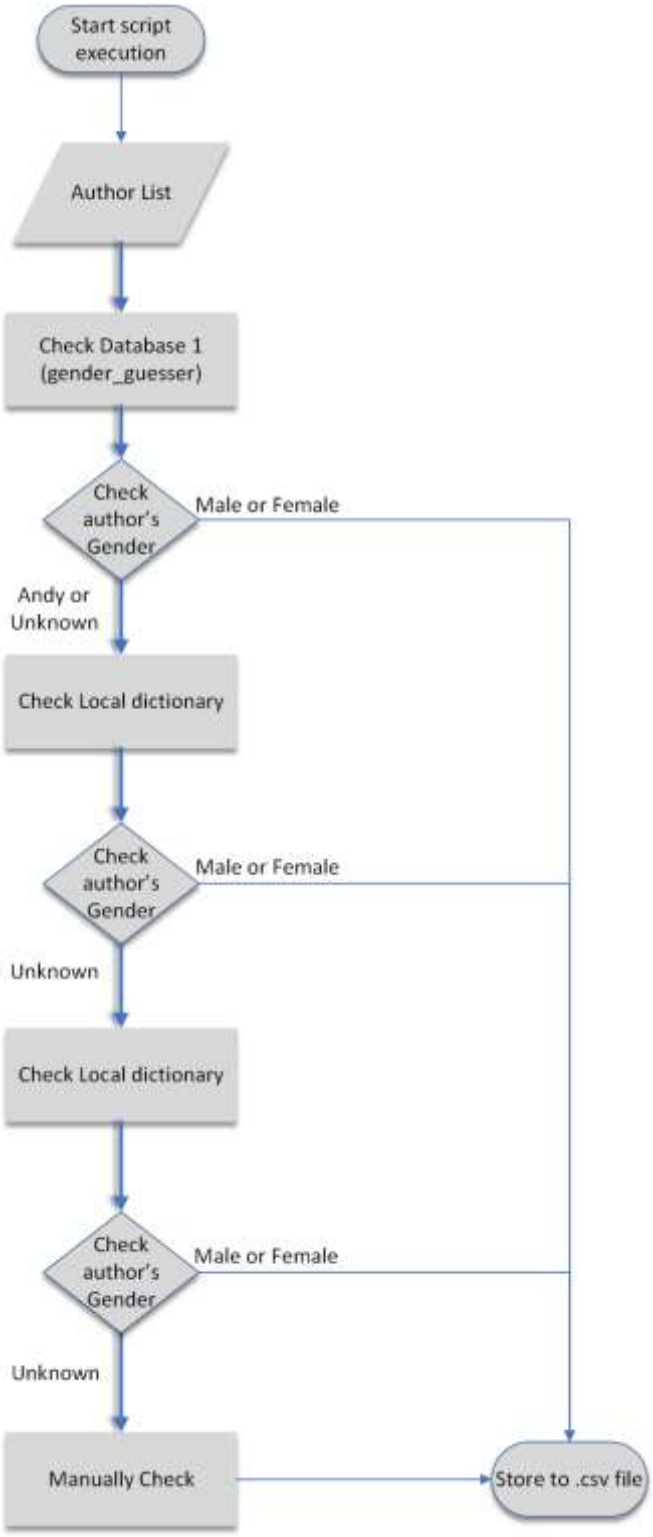
Table 4. Univariable and multivariable logistic regression with Odds Ratios (OR) and associated 95% CIs for the effect of a range of article characteristics on inclusion of female authors as first, within the authorlist (n=2539).

Category	Univariable			Multivariable		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Year of publication			<0.001			<0.001
2008- 2010	Reference			Reference		
2018- 2020	1.52	1.29, 1.79		1.49	1.25, 1.77	
Journal			<0.001*			0.01*
EJO	Reference			Reference		
AJODO	0.60	0.49, 0.74		0.72	0.57, 0.90	
ANGLE	0.66	0.53, 0.83		0.83	0.65, 1.06	
Continent			<0.001*			<0.001*
Europe	Reference			Reference		
America	0.74	0.61, 0.90		0.78	0.64, 0.97	
Asia/other	0.47	0.38, 0.57		0.48	0.39, 0.60	
No. authors						
1-3	Reference		0.04*	Reference		0.19*
4-5	1.21	1.00, 1.46		1.18	0.97, 1.45	
≥ 6	1.29	1.04, 1.60		1.21	0.95, 1.53	
Center			0.12			0.79
Single	Reference			Reference		
Multi	1.14	0.98, 1.33		1.02	0.86, 1.22	
Topic			0.003*			0.49*
biomaterials- biomechanics	Reference			Reference		
diagnosis- treatment- esthetics	1.25	1,01, 1.55		0.97	0.73, 1.29	
craniofacial growth- morphology- genetics	1.48	1.15, 1.92		1.13	0.81, 1.57	
behavior- psychology- treatment need- satisfaction- quality of life	1.67	1.23, 2.26		1.15	0.79, 1.67	
Type of Study Design			<0.001*			0.08*
Observational	Reference			Reference		

Interventional	0.97	0.76, 1.25		0.94	0.72, 1.23	
SR/ meta-analyses	0.94	0.67, 1.33		0.84	0.58, 1.20	
In- vitro	0.55	0.43, 0.71		0.62	0.44, 0.85	
Animal	0.73	0.54, 0.99		0.92	0.65, 1.29	
Case reports/ technique	0.66	0.50, 0.87		0.83	0.62, 1.13	
Meta- Research	0.67	0.23, 1.98		0.51	0.17, 1.58	

*wald test for overall association

Figure 1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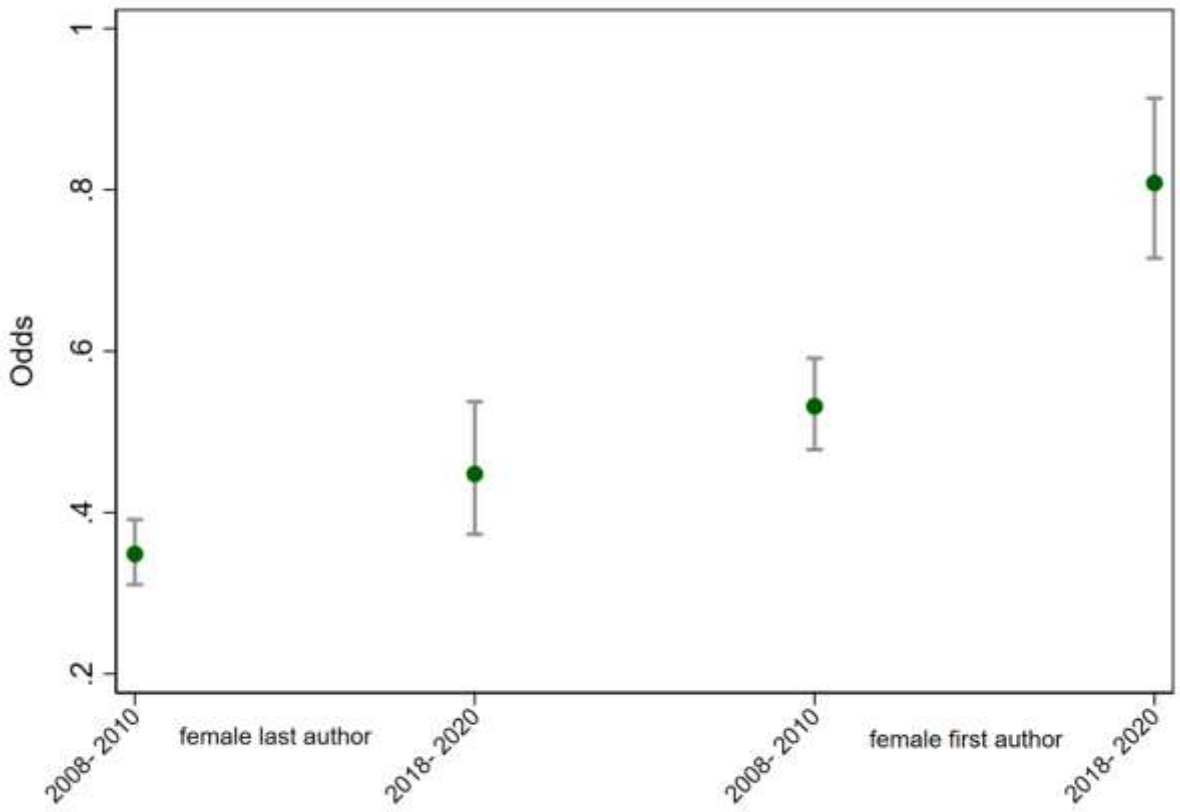
Author List
Check Database 1 (gender_guesser)
Check author's Gender
Male or Female
Andy or Unknown
Check Local dictionary
Check author's Gender
Male or Female
Unknown
Check Local dictionary
Check author's Gender
Male or Female
Unknown
Manually Check
Store to .csv file

Figure 2


Odds
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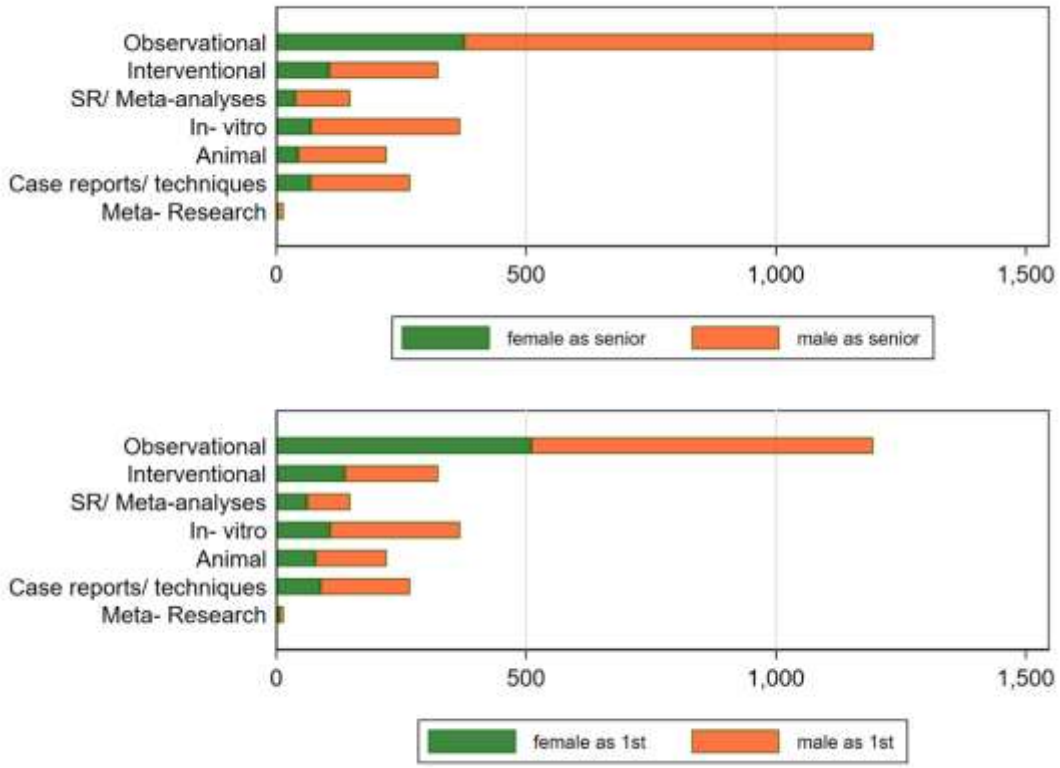
1
2008- 2010
female last author
2018- 2020
2008- 2010
female first author
2018- 2020

Figure 3


Observational
Interventional
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In- vitro
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Case reports/ techniques
Meta- Research
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female as senior
male as senior
Observational
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Case reports/ techniques
Meta- Research
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500
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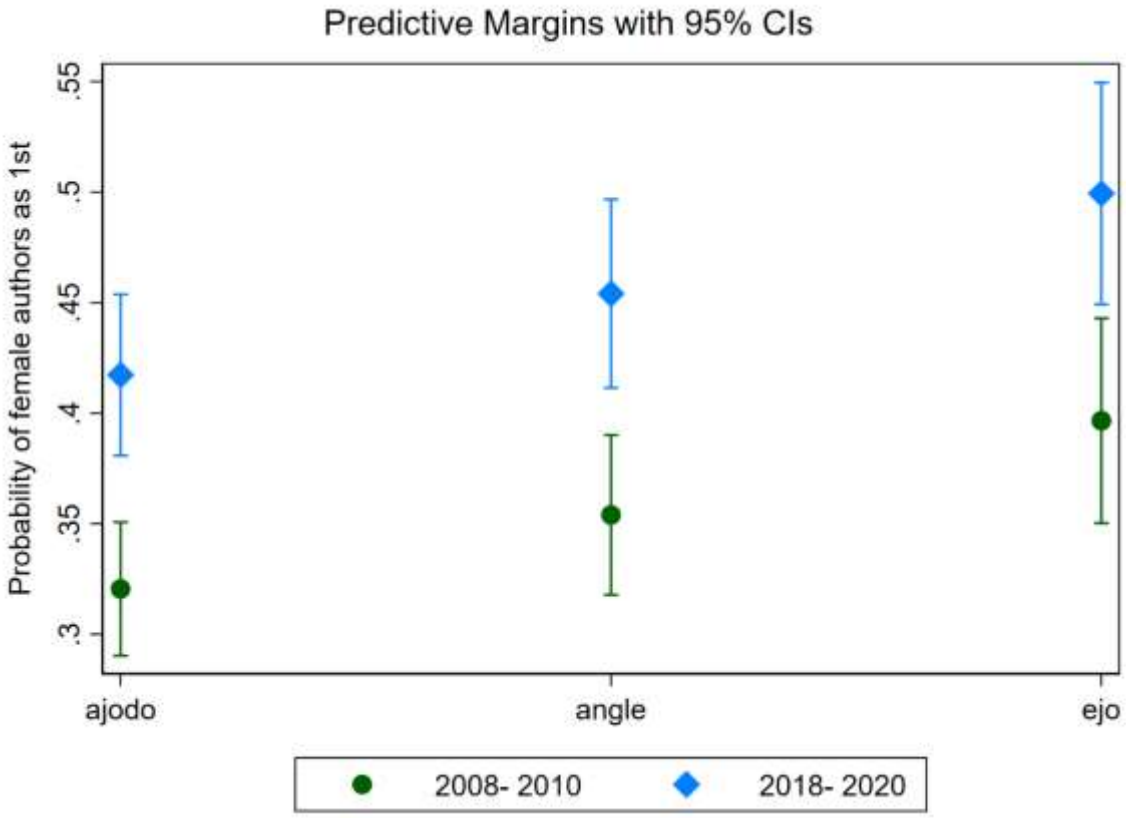
female as 1st
male as 1st

Figure 4


Predictive Margins with 95% CIs
Probability of female authors as 1st
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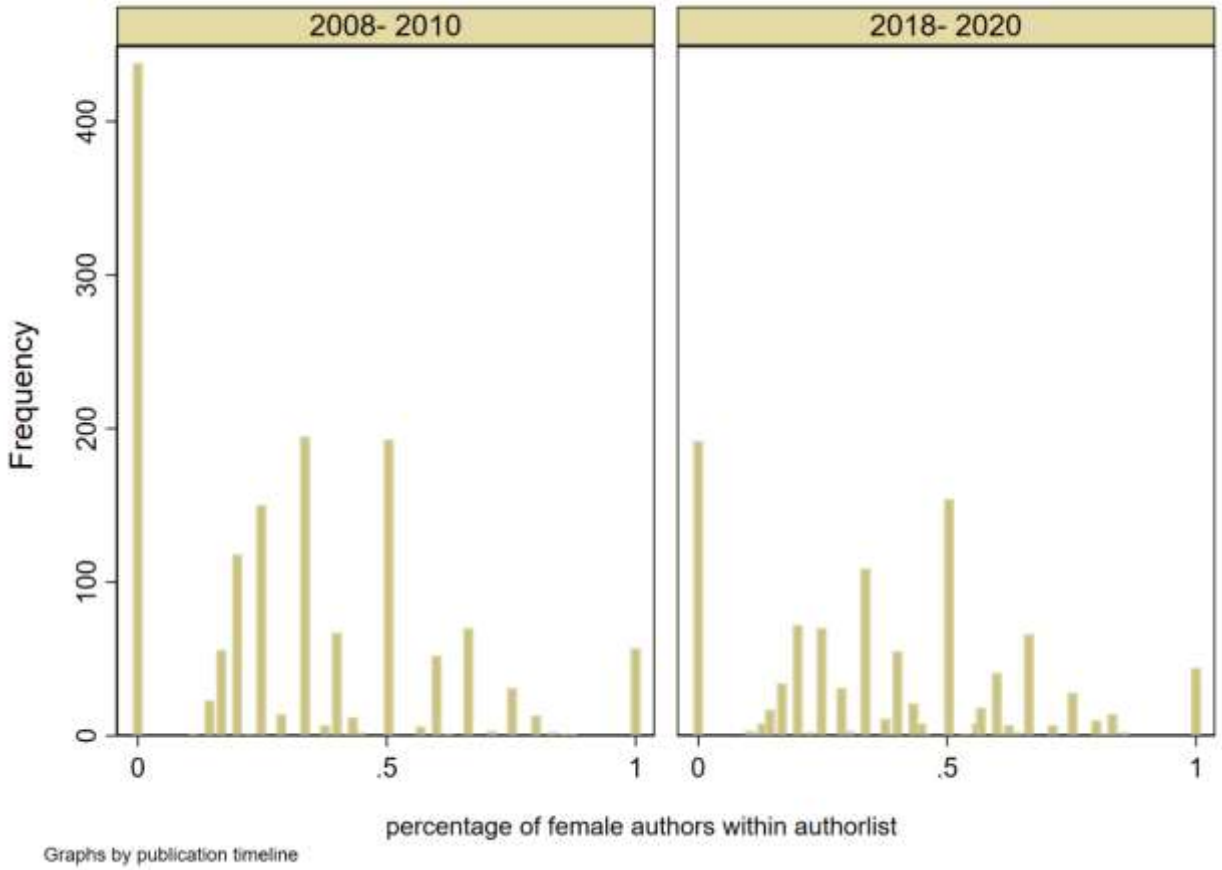
2008- 2010
2018- 2020

Figure 5


2008- 2010
2018- 2020
Frequency
0
100
200
300
400
0
.5
1
0
.5
1
percentage of female authors within authorlist
Graphs by publication timeline