**Gender Trends in Authorship of Cardiology Academic Literature – A 40-Year Perspective**

David Ouyang MD1, David Sing MD2, Rebecca Tisdale MD1, Sonia Shah1, Robert Harrington MD1, Fatima Rodriguez MD MPH1

1Department of Internal Medicine, Stanford University School of Medicine, Stanford, CA USA

2Department of Orthopedic Surgery, Boston Medical Center, Boston, MA USA.

Word Count:

**Author Contributions:** Dr. Ouyang had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design*: Sing, Ouyang. Rodriguez

*Acquisition of data*: Sing, Ouyang

*Analysis and interpretation of data*: Ouyang, Sing, Tisdale, Shah, Harrington, Rodriguez

*Drafting of the manuscript*: Ouyang, Rodriguez.

*Critical revision of the manuscript for important intellectual content*: Ouyang, Sing, Tisdale, Shah, Harrington, Rodriguez

*Statistical analysis*: Ouyang, Rodriguez.

Corresponding author:

Fatima Rodriguez, MD MPH  
Stanford University Falk Cardiovascular Research Center,   
870 Quarry Rd Ext, Palo Alto, CA 94304   
[frodrigu@stanford.edu](mailto:frodrigu@stanford.edu)

**Abstract**

**Background**: Despite advances in the representation of women in medical training, women continue to be underrepresented in cardiology, academic medicine, and senior positions within academic medicine. This study seeks to determine the representation of female physician-investigators in cardiology through review of published literature in three prominent cardiology journals over time. Understanding disparities in research productivity can highlight barriers to female representation in academic cardiology.  
**Methods**: Authors of original research articles between 1980 and 2017 from three prominent cardiology journals (Journal of the American College of Cardiology, Circulation, and European Heart Journal) were extracted from PubMed. Author sex were determined and the proportion of female first and senior authors were calculated for consecutive time cohorts.   
**Results**: We identified 78,558 unique authors of 54,355 primary research articles. Female authors accounting for 33.1% of all authors, however only 5% of the top 100 most prolific authors. Female first authorship and senior authorship has increased over time, but senior authorship rates lag behind first authorship rates.   
**Conclusions**: Female representation in cardiology research has increased over the last four decades however there is still disproportionate underrepresentation in senior authorship and in authors with the most publications. In addition to recruiting more women into cardiology, further efforts should be made to identify and address barriers in advancement for female physician-scientists.

**Background**

Since 2015, women have represented more than 50% of all matriculating medical students in the United States, however there is still significant under representation of women in cardiology both in clinical practice and in training. Among all American Council for Graduate Medical Education (ACGME) training programs, the subspecialty of interventional cardiology was the most underrepresented with only 8.4% female representation [1]. General cardiology fellowship, at 21.4% female representation, had less female representation than every other specialty with the exceptions of only neuroradiology, neurological surgery, orthopedic surgery, and interventional radiology [1].

The underrepresentation in senior roles has been thought to be multifactorial; attributable in part to fewer research and promotion opportunities [3-5].While gains have been made, women still compose a minority of the authors of published original research [2]. Both among trainees and practicing academic clinicians, female physicians report higher rates of gender discrimination and sexual harassment than male physicians, and these experiences are thought to negatively affect their career advancement [3-4]. Despite efforts to promote gender equality in academic medicine, significant progress must still be made in cardiology towards gender parity. This study seeks to determine trends in authorship of cardiology-related academic literature over the last 40 years. We hypothesize that although women are still less likely to be first or senior author in published research, the gender gap has decreased over time.

**Methods**

*Data Source*PubMed is an online database of over 27 million citations of medical literature developed and maintained by the National Center for Biotechnology Information (NCBI) at the US National Library of Medicine [6]. From Pubmed, articles published from 1980 to 2017 in the Journal of the American College of Cardiology (JACC), Circulation, and European Heart Journal were identified [7-9]. Citation data such as PubMed ID, article type, article title, date of publication, and authorship list was obtained. From all journal articles, primary research articles were included for analysis.

*Author identification*  
Authors were categorized as first, middle, or senior authors based on author list ordering. The first author, last author, and up to fifteen middle authors were identified. For all authors with a complete first name listed, gender was determined by matching first name using an online database containing 216,286 distinct names across 79 countries and 89 languages [10].

*Analysis*

The proportion of female first and senior authors were calculated for consecutive five year cohorts. Student’s t test, chi-square test, and Cox proportional hazards test were used to determine significant between groups. Statistical analysis was performed using R 3.4.2 (R Foundation, Vienna, Austria, [www.r-project.org](http://www.r-project.org)) and ggplot2 [11].

**Results**

We identified a total of 72,362 articles published between 1980 and 2017. 54,355 articles were primary research articles. Of 261,572 total authorships identified, there were 78,558 unique authors. In the queried journals, the authors had a median of 1 article (IQR 1 - 3 articles). The top 100 authors published a median of 130 articles each (IQR 114.8 - 161.2 articles), however there were only five (5%) female authors in the top 100 authors (Supplemental Table 1).

257,328 (93.7%) authorships were matched to gender. Of 71,345 uniquely identified authors, 23,629 (33.1%) were female. With increasing number of publications, there was a higher proportion of male authors (Figure 1).

**Conclusions**

Our analysis has a few limitations. First, we only looked at three major cardiology journals to extrapolate trends in academic cardiology research. A significant body of literature exists outside of these three journals, however limitations of processing power and time narrowed the scope of this initial investigation. That said, JACC, Circulation, and Euro Heart J are among the longest running cardiology journals and cover a breadth of topics of interest in cardiology. Second, many conventional East Asian first names were not able to be algorithmically matched to gender. This analysis would underestimate the representation of both male and female East Asian cardiologists, although we were still able to match 93.7% of all authorships.

[1] https://www.aamc.org/data/workforce/reports/458766/2-2-chart.html

[2] <https://www.ncbi.nlm.nih.gov/pubmed/16855268>

[3]<https://www.ncbi.nlm.nih.gov/pubmed/10836916>

[4] https://jamanetwork.com/journals/jama/fullarticle/2521958

[5]https://medicine.yale.edu/owm/Inadequate%20Progress%20for%20Women%20in%20Academic%20Medicine\_214981\_284\_5\_v1.pdf

[6] <https://www.ncbi.nlm.nih.gov/pubmed/>

[7] <http://www.onlinejacc.org/>

[8] <http://circ.ahajournals.org/>

[9] <https://www.escardio.org/Journals/ESC-Journal-Family/European-Heart-Journal>

[10] [www.genderize.io](http://www.genderize.io)

[11] https://cran.r-project.org/web/packages/ggplot2/citation.html