

Global geographic and gender disparities in stem cell-related surgical research: bibliometric review of the top 200 most-cited articles

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Abstract

Objective: The study aimed to identify geographic and gender disparities in the quality, academic impact, and media attention of the top-cited articles related to stem cell-related surgical research.

Methods: The following data was extracted for the top 200 most-cited articles (2011-2021): article- (including citation metrics and country of publication), journal- (including impact factor), and author-level (including corresponding author gender) variables. Article Altmetric Attention Score (AAS), a measure of mass mainstream and social media attention, was also recorded.

Results: Most articles originated from high-income countries (HICs: 175 [87.5%]), with only 7 (3.5%) from lower-middle-income countries. Articles from non-HIC were published in journals with significantly lower impact factors (6.66 [3.75-9.46] vs. 23.2 [7.3-32.5]; $p < 0.001$) and AAS (7 [3-14.5] vs. 30 [11-83]; $p < 0.001$). Only 44 (22%) of articles were authored by a female corresponding author, with these having significantly fewer citations than those authored by a male (289 [250-400] vs. 331.5 [267.25-451.25]; $p=0.031$).

Conclusion: Even amongst the top-cited literature, our results demonstrate worrying disparities in the geographic origins of stem cell-related surgical research. The vast majority originates from HICs, with these articles being published in better journals and receiving greater media attention. We also identified significant gender disparities, with female representation being concerningly low and female-authored articles receiving significantly fewer citations.

Keywords: Female, Male, social media, Factor IX, Stem Cells.

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Introduction

Stem cells have opened numerous windows of opportunity in the field of surgery, including wound healing¹, plastics and reconstruction¹, regenerative spine surgery², cardiac regeneration³, and even solid organ transplantation^{4,5}. Besides representing an exciting, ever-growing avenue for surgical researchers, stem cell research has also caught the attention of the wider public in the mainstream and on social media^{6,7}.

To fully capitalize on the potential of stem cells in surgery, it is essential that stem cell research is directed in a globally equitable fashion. Current research bears evidence of several sources of disparity in stem cell research. In stem cell trials, patient populations are often under-representative of certain races, ethnicities⁸ and, socioeconomic strata⁹, with such inequalities possibly persisting into clinical applications and affecting management outcomes¹⁰. Moreover, geopolitical influences, in the form of legislative policy regarding the use of stem cells, can also impact progress-related research¹¹. However, such systemic disparities in the geographic origin of stem cell research, as well as gender disparities amongst stem cell researchers themselves, have yet to be fully explored.

Bibliometric reviews allow for the statistical evaluation of systemic disparities in the origin, impact, and quality of research using article-, journal- and author-related variables¹². Conventional measures of article impact include the citation count, while the impact factor (IF) of the publishing journal provides a proxy measure of article quality. Additionally, given the increasing interactions between science and mainstream media, the Altmetric Attention Score (AAS) offers a valuable measure of non-academic attention received by articles on media platforms including social media and news outlets¹³. Thus, we aimed to use bibliometric analysis to identify geographic and gender disparities in the quality, academic impact, and media attention, of the top-cited articles related to the use of stem cells in the field of surgery.

Methods

Article Retrieval: The top 200 most-cited articles regarding stem cells in surgery, spanning the decade 2011-2021, were sourced using Publish or Perish software version 6.0¹⁴. Publish or Perish (PoP) is a programme that uses Google Scholar to retrieve journal articles and other meta-data, including their academic citations, journal of publication, year of publications, author count, and weblink.

Data Extraction: The following article-, author-, and journal-level data were extracted for each of the top 200 most-cited articles, as of 14th August 2022:

- Article characteristics (from article full-text): Year of publication, multinational authorship (i.e., authorship list included affiliations from more than one country).
- Article metrics (from Publish or Perish software): Citations, citations/year, citations/author, number of authors.
- Corresponding author characteristics: Country of the corresponding author (i.e., country of origin of article), gender of corresponding author (using Gender-API.com, a website that has been widely used in academic research to genderise names with >98% accuracy¹⁵). Countries were classified according to World Bank categories (high-, upper-middle-, lower-middle-, and low-income) and further dichotomized for analysis as high-income countries (HICs) and non-high-income countries (non-HICs).
- Article Altmetric Attention Score (AAS): Overall AAS,

Twitter AAS, Facebook AAS, and News Outlets AAS were sourced using the Bookmarklet (Altmetric) plug-in¹⁶.

- Journal characteristics: Journal IF as per the Journal Impact Factor List 2021 (Clarivate™), journal PubMed indexing.

- Journal Social Media: Presence of a Twitter account, year created (dichotomized as ≤ 2015 or > 2015), number of Twitter followers, and Twitter activity (Tweets/day). Sourced from the Twitter application and via Foller.me¹⁷, a website that mines the Twitter API (Application Programming Interfaces) to provide accurate, real-time insight into Twitter activity.

Statistical Analysis: Analysis was performed using IBM SPSS (Statistical Package for Social Sciences) version 21. Categorical variables were reported using frequencies (n) and percentages (%), and compared using the Chi-squared or Fischer's exact test, as appropriate. The Shapiro-Wilk test for normality confirmed non-parametric distributions of numeric variables which were thereafter reported using median and interquartile ranges (IQR). Numeric variables were compared using the Mann-Whitney U test or Kruskal-Wallis test, as appropriate. Bivariate correlations between numeric variables were assessed using Spearman's correlation, with the correlation coefficient (r) and p-value being reported. A correlation coefficient of 0-0.39 was considered to be a weak, 0.40-0.59 as a moderate, 0.6-0.79 as a strong, and 0.8-1 as a very strong correlation¹⁸. A p-value < 0.05 was considered significant for all analyses.

To generate the figure, the python geospatial data

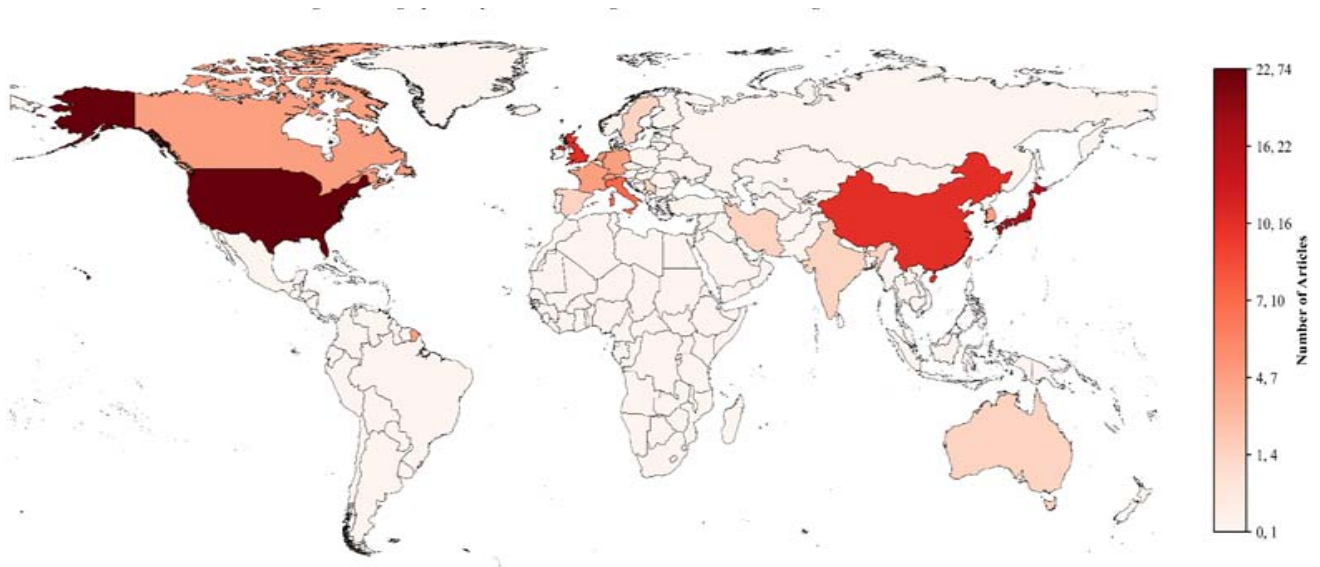


Figure: Geographic disparities in the origin of stem cell-related surgical research.

Table-1: Differences in Article Characteristics with respect to Gender of Corresponding Author (CA).

Variable	Overall	Male CA	Female CA	P-Value
Citations	324.5 [261.5-438.25]	331.5 [267.25-451.25]	289 [250-400]	0.031
Citations/year	43.82 [32.73-60.77]	46.65 [32.68-63.69]	40.57 [33.03-53.7]	0.172
Citations/author	74 [55.25-98]	76 [57.25-106.25]	68.5 [52.25-83.75]	0.141
Number of Authors	5 [4-5.75]	5 [4-6]	5 [4-5]	0.449
CA Country WBHigh-Income CountryUpper- Middle-Income CountryLower-Middle-Income Country	175 (87.5)18 (9.0)7 (3.5)	135 (86.5)14 (9.0)7 (4.5)	40 (90.9)4 (9.1)0 (0)	0.169
Multinational Authorship	62 (31.0)	46 (29.5)	16 (36.4)	0.384
Overall AAS	25.5 [10-76]	26 [10-84.5]	20 [10.5-46.5]	0.432
Twitter AAS	9.5 [3-28]	9.5 [2-28.75]	9 [4-21.25]	0.902
Facebook AAS	1 [0-3]	1 [0-3.75]	1 [0-2]	0.266
News Outlets AAS	1 [0-3]	1 [0-4.75]	0.5 [0-2]	0.177
Journal IF	19.32 [6.66-27.2]	21.33 [5.85-38.90]	14.04 [7.29-25.26]	0.356
Journal on PubMed	198 (99.0)	154 (98.7)	44 (100)	> 0.999
Journal on Twitter	183 (91.5)	143 (91.7)	40 (90.9)	> 0.999
Year Twitter CreatedAfter 2010In or before 2010	103 (56.3)80 (43.7)	76 (53.1)67 (46.9)	27 (67.5)13 (32.5)	0.106
Twitter Followers	42587 [4096-62782]	42806 [4170-80288]	31859 [3678.75-50217.50]	0.185
Tweets/day	1.82 [0.63-2.48]	1.82 [0.67-2.48]	1.82 [0.42-2.70]	0.725

Table-2: Differences in Article Characteristics with respect to Country of Origin Variable High Income Middle and Low Income P-Value

Variable	High Income	Middle and Low Income	P-Value
Citations	329 [261-440]	296 [272-388.5]	0.461
Citations/year	46.8 [33.9-61]	33.8 [30.2-53.8]	0.094
Citations/author	74 [57-100]	74 [48-91.5]	0.285
Number of Authors	5 [4-5]	5 [4-6]	0.740
Gender of Corresponding AuthorMaleFemale	135 (77.1)40 (22.9)	21 (84.0)4 (16.0)	0.439
Multinational Authorship	55 (31.4)	7 (28.0)	0.729
Overall AAS	30 [11-83]	7 [3-14.5]	< 0.001
Twitter AAS	11 [4-30]	2 [1-4]	< 0.001
Facebook AAS	1 [0-3]	0 [0-5]	< 0.001
News Outlets AAS	1 [0-4]	0 [0-1]	0.007
Journal IF	23.2 [7.3-32.5]	6.66 [3.75-9.46]	< 0.001
Journal on PubMed	174 (99.4)	24 (96.0)	0.235
Journal on Twitter	165 (94.3)	18 (72.0)	0.002
Year Twitter CreatedAfter 2010In or before 2010	93 (56.4)72 (43.6)	10 (55.6)8 (44.4)	0.948
Twitter Followers	42824 [4167-68869.5]	16407 [3405.75-47298.5]	0.085
Tweets/day	1.82 [0.63-2.48]	1.40 [0.59-3.05]	0.495

processing package GeoPandas (version 0.9.0) was used, running on Python version 3.9.12. The map used was downloaded from the online data repository datahub.io.

Results

Amongst the 200 articles, most originated from HICs 175(87.5%) such as the United States of America (USA: 73 [36.5%]), Japan (22 [11%]), China (16 [8%]), the United Kingdom (UK: 14 [7%]), and France (6 [3%]). The geographic origins of articles are depicted in Figure 1. The

commonest journals published in were Cell Stem Cell 20 (10%), Blood 15 (7.5%), and Stem Cell Reports 8(4%)

Overall, the median number of citations was 324.5 [261.5-438.25], median AAS was 25.5 [10-76], and median journal IF was 19.32 [6.66-27.2]. The majority of journals were indexed in PubMed (198 [99%]) and had a Twitter account (183 [91.5%]). Citations correlated poorly with the AAS ($r = 0.291$).

Only 44 (22%) of articles were authored by a female corresponding author. Articles published from HICs, and upper-middle-income countries (UMICs) had similar female representation (40 [22.9%] and 4 [22.2%], respectively), while none of the articles from lower-middle-income countries (LMICs) had a female corresponding author. Articles published with a female corresponding author had significantly fewer citations than those published by a male corresponding author (289 [250-400] vs. 331.5 [267.25-451.25]; $p = 0.031$). Apart from this, there were no other significant differences due to the gender of the corresponding author (Table 1).

Only 25 (12.5%) of articles were published in non-HICs, with 18 (9%) in UMICs and 7 (3.5%) in LMICs. Compared to those from HICs, articles published from non-HICs had comparable citations but were published in journals with lower IFs (6.66 [3.75-9.46] vs. 23.2 [7.3-32.5]; $p < 0.001$) and those less likely to have a Twitter account (72% vs. 94.23%; $p = 0.002$). Additionally, articles from non-HICs had significantly lower AAS scores overall (7 [3-14.5] vs. 30 [11-83]; $p < 0.001$), on Twitter (2 [1-4] vs. 11 [4-30]; $p < 0.001$), Facebook 0 [0-5] vs. 1 [0-3]; $p < 0.001$) and news outlets (0 [0-1] vs. 1 [0-4]; $p = 0.007$). These results are shown in Table 2.

Even amongst HICs, articles from the US were published in journals with significantly higher IFs than those originating from other HICs (25.27 [19-65.28] vs. 14.09 [5.85-25.48]; $p < 0.001$). The overall AAS (49 [23-104.5] vs. 21 [9.75-52.25]; $p = 0.001$), as well as the Twitter (15 [6.5-48] vs. 8 [2.75-22]; $p = 0.004$) and news outlet (2 [0-6.5] vs. 0.5 [0-3]; $p = 0.014$) AAS components, were significantly higher in the US as compared to other HICs

Discussion

To the best of our knowledge, this is the first study to explore geographic and gender disparities in the quality and impact of top-cited research related to stem cells in the field of surgery. Our results revealed significant inequalities, with < 25% of articles being authored by a female corresponding author and < 15% of research originating from non-HICs. Articles with a female corresponding author received significantly fewer

academic citations, while articles from non-HICs were published in journals with lower IFs and received significantly less media attention.

Several factors are responsible for the underrepresentation of low- and middle-income countries (LMICs) with regards to stem cell-related surgical research. Most notably, LMICs generally possess significantly less robust research capacities compared to HICs^{19, 20}. This is particularly pronounced in the field of stem cell research, which requires highly specialized and expensive research infrastructure and resources. In contrast, stem cell research in HICs is driven and supported by government and private investment, due to the potential for both life-changing medical therapies and considerable financial return to be gained by breakthrough applications^{21,22}. Interestingly, political²³, religious²⁴, and ethical²⁵ influences may also play a role in the progress of stem cell research in some countries. In Pakistan, a Muslim-majority LMIC in South Asia, the Human Organ Transplantation Authority (HOTA)²⁶ describes regulations pertaining to transplantation and stem cell research in accordance with the culture and religious sensitivities of Pakistan. However, the Transplantation of Human Organs and Tissues Act (2010), which also discusses the use of stem cells in transplantation, was met with significant religiopolitical resistance before it was passed in 2010²⁷. The multifactorial reasons for the underrepresentation of LMICs in stem cell-related surgical research will inevitably confer a delay in the acquisition of novel therapies, which may translate downstream to significant disparities in patient management outcomes.

Our results also revealed that stem cell-related surgical research published in HICs, particularly the US, received significantly greater mainstream mass and social media attention than articles originating from elsewhere. Given that most social media and internationally-followed news agencies are Western-centric, it is understandable that stem cell-related surgical research originating from HICs, particularly in the US, receives greater mass media attention. Given the lack of regulation of the quality and scientific rigor of research being disseminated on social media, the intersection of mass media and medical academia, especially in the relatively contentious domain of stem cell research, is a double-edged sword²⁸. While social media offers researchers and journals a quick and cost-effective platform to disseminate research in order to increase its viewership, such behaviour also holds potential to manifest in dangerous misinformation and sensationalism in the public eye. This impact on public opinion can reciprocally shape federal policies which

would impact stem cell research²⁹. Interestingly, our results demonstrated a poor correlation between media attention (AAS) and article citations, suggesting that increased social media viewership may not necessarily translate into eventual academic impact. Nevertheless, researchers and journals must assume responsibility for the quality of stem cell-related surgical research disseminated on social media. Moreover, as discussions around the ethical and political ramifications of stem cell research are greatly influenced by the media, news agencies and outlets have an obligation to exhibit responsible journalism³⁰.

Lastly, our findings also demonstrated concerning disparities in female representation amongst researchers, which remains a perennial problem in most forms of surgical academia. Though women are slowly gaining ground in the field of clinical and academic surgery, gender-specific biases and deterrents are still impeding progress, particularly in LMICs such as Pakistan. These factors include implicit biases, sociocultural norms and expectations, familial responsibilities, gender discrimination, and even workplace harassment and bullying³¹⁻³³. Worryingly, our results also revealed that articles published with women as corresponding authors received significantly fewer citations than those published by their male counterparts. However, the quality of research published by females was of broadly comparable quality, as evidenced by the similar journal IFs for articles published with male or female corresponding authors. Such disparities have been described before, with inequitable citations for female surgical researchers being recognized as a key barrier to the professional progression of women surgeons³⁴.

Our study has a few limitations that we wish to acknowledge. Firstly, due to inherent limitations in bibliometric software such as Publish or Perish, we were limited in the number of variables that we were able to source. In addition, we were unable to account for several article-level confounders, including the type of article and study level of evidence, and author-level confounders, such as academic credentials and author metrics. Nevertheless, ours is the first study that provides evidence for undeniable disparities in the geographic origin of articles and gender of stem cell researchers in the field of surgery.

Conclusion

Our results demonstrate worrying disparities in the geographic origins of stem cell research in the field of surgery. The vast majority of research related to stem cells in surgery is published from HICs, with articles from HICs

being published in higher quality journals and garnering significantly more social and mainstream media attention than those from other countries. Moreover, we also identified significant gender disparities at the level of the stem cell researcher, with female representation being concerningly low and female-authored articles receiving significantly fewer citations. Thus, as stem cells lead surgical research to newer frontiers, it is important to remain cognizant of existing disparities and seek to achieve global equity by engaging and supporting underrepresented regions and researchers.

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