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The Under-representation and Stagnation of Female, Black, and Hispanic Authorship in the *Journal of the American Medical Association* and the *New England Journal of Medicine*

Moustafa Abdalla[1,2] · Mohamed Abdalla[3,4] · Salwa Abdalla[3] · Mohamed Saad[5] · David S. Jones[1,6] · Scott H. Podolsky[1,7]

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Abstract
Publication in leading medical journals is critical to knowledge dissemination and academic advancement alike. Leveraging a novel dataset comprised of nearly all articles published in *JAMA* and *NEJM* from 1990 to 2020, along with established reference works for name identification, we explore changing authorship demographics in two of the world's leading medical journals. Our main outcomes are the annual proportion of male and female authors and the proportion of racial/ethnic identities in junior and senior authorship positions for articles published in *JAMA* and *NEJM* since 1990. We found that women remain under-represented in research authorship in both *JAMA* (at its peak, 38.1% of articles had a female first author in 2011) and *NEJM* (peaking at 28.2% in 2002). The rate of increase is so slow that it will take more than a century for both journals to reach gender parity. Black and Hispanic researchers have likewise remained under-represented as first and last authors in both journals, even using the best-case scenario. Their appearance as authors has remained stagnant for three decades, despite attention to structural inequalities in medical academia. Thus, analysis of authorship demographics in *JAMA* and *NEJM* over the past three decades reveals the existence of inequalities in high-impact medical journal authorship. Gender and racial/ethnic disparities in authorship may both reflect and further contribute to disparities in academic advancement.

Keywords Medical journals · Authorship · Gender disparities · Racial disparities · Ethnic disparities

Introduction

The *Journal of the American Medical Association* (*JAMA*, founded in 1883) and the *New England Journal of Medicine* (*NEJM*, founded in 1812) have played critical roles in the development of medical knowledge and practice [1, 2]. *JAMA* is the most widely circulated medical journal in the world (impact factor [IF] of 45.54)[3], and *NEJM* is recognized as having the highest impact factor among all medical journals (IF 74.70) [4]. Publications in *JAMA* and *NEJM* reach millions of readers globally, influencing topics of conversations and behavior among physicians, educators, researchers, and the international medical community. Recent scholarship has demonstrated that while the representation of women in prominent journal publications increased from the 1970s through 2006, such proportional authorship has plateaued in recent years [5, 6]. There have been far fewer studies of the self-identified racial and ethnic composition of medical journal authorship, though recent studies have suggested barriers to non-White authorship

✉ Scott H. Podolsky
scott_podolsky@hms.harvard.edu

1 Harvard Medical School, Boston, MA, USA

2 Department of Statistics, University of Oxford, Oxford, UK

3 Department of Computer Science, University of Toronto, Toronto, Canada

4 The Vector Institute for Artificial Intelligence, Toronto, Canada

5 University of Bahrain & the Royal Academy, Manama, Bahrain

6 Department of the History of Science, Harvard University, Cambridge, MA, USA

7 Center for the History of Medicine, Countway Medical Library, Harvard Medical School, Boston, MA, USA

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[7]. In this manuscript, leveraging computational linguistic techniques and a part of a novel dataset of nearly half-a-million articles published in *JAMA* and *NEJM* over the past 200 years, we analyze gender and racial/ethnic trends concerning who comprises such authorship.

Constructing the Dataset and Methodology

To enable this computational analysis, we constructed a database of the majority of articles ever published in *JAMA* and *NEJM*. For this study, an article is defined as any document with a digital object identifier (DOI), a system that assigns every academic publication a unique identifier. Our database captured 278,461 *JAMA* articles published from 1883 to May 2020, representing > 91% of all articles ever published in *JAMA* through that date, and 182,675 *NEJM* articles published from 1812 to May 2020, which represents > 99.5% of all articles ever published in *NEJM* through that date. The total dataset analyzed in this study was comprised of 461,136 unique articles. For both journals, we have captured 100% of articles published since 1990 (up to the aforementioned end-date of DOI curation).

Our primary analysis focused on authorship trends in "research" article types/"original articles". The "research" article type in *JAMA* became more restrictive in 1998, but we use the journal label (i.e., the label in the table of contents) for all analyses. Articles with study groups or consortia as authors were removed from both analyses, as the authorship order for these articles may not follow traditional arrangements. We performed a smaller secondary analysis focused on authorship trends in editorials and non-commissioned viewpoint/perspective/commentary pieces.

Changing Authorship: Gender Identity

Traditional authorship analyses, drawing on Web of Science and Pubmed, have focused largely on increasing numbers of authors over time and co-authorship networks and citation networks [8–11]. Recent bibliometric studies have begun to engage with gender representation in academic medical journals [12–15].The curated metadata for our dataset allows for multiple forms of analyses, including identification of the likely gender of authors. While recognizing the numerous imperfections in this overly simplistic binary approach (including, most prominently, the inability to identify minority gender groups), this name-based gender prediction is currently the only high-throughput, scalable method to gaining insight into the demographic evolution of the gender identity of medical research authorship on a historical scale. This analysis also enables us to establish an appropriate baseline from which we may engage with the intersectionality of gender and race since 1990 (the analysis described in the "Changing Research Authorship: Intersection of Gender and Racial Identity" section below).

For this analysis, we leveraged a validated dictionary of more than 40,000 first names and genders covering the vast majority of first names in the USA and all European countries, as well as some overseas countries (e.g., China, India, Japan) [16]. The dictionary included region-specific probabilities for assigning gender to a given name. The name was assigned to a particular gender group based on this probability, with a subset of names classified as "androgynous" if the gender-name alignment is not statistically obvious. As a sensitivity analysis, we leveraged the US Social Security Administration's (USSA) database of names and genders of newborns. The advantage of this second dataset is that the USSA database is stratified by time and thus can capture shifts in name-gender associations since the 1990s; names are classified as either "male" or "female" in this dataset. Again, it is important to note that neither dataset enables us to capture minority gender groups in our predictions, and thus our analysis exclusively focuses only on the proportion of "male" and "female" authors.

Our gender analysis reveals that, in *JAMA*, the fraction of research articles with a female first author linearly rose through the 1990s, reaching 29.6% in 2000 (Fig. 1a). However, despite a peak of 38.1% in 2011, the overall rate of change has been close to zero since the 2000s; the average annual fraction of articles with a female first author between 2000 and 2019 was 31.6%. At the current rate of change (0.16% per year since 2000), the fraction of *JAMA* research articles with a female first author will reach 50% in 74 years. Senior female authorship exhibits a similar trend, but peaking at a lower fraction: 31.0% of articles had a female senior author in 2005 (Fig. 1c). The fraction of *JAMA* research articles with a female senior author has also since stagnated — with no increase over the past decade. In fact, since 2000, the fraction of *JAMA* articles with a female senior author has decreased slightly (− 0.31% per year). Using the USSA's database, as further sensitivity analysis, we observed nearly identical results (Fig. 2a, c).

In *NEJM*, the fraction of "original articles" with a female first author has increased slowly since the 1990s, peaking at 28.2% in 2002 (Fig. 1b), matching sensitivity analyses performed using the USSA database (Fig. 2b). Since 2000, the rate of increase has been so slow (0.03% per year) that, at its current pace, it will take more than 725 years for the fraction of *NEJM* "original articles" with a female first author to reach 50%. Senior female authorship also had a similar flat-line increase, but peaking later and at lower fraction: 22.9% of "original articles" had a female senior author in 2016 (Fig. 1d), matching closely with the USSA database peak (Fig. 2d).

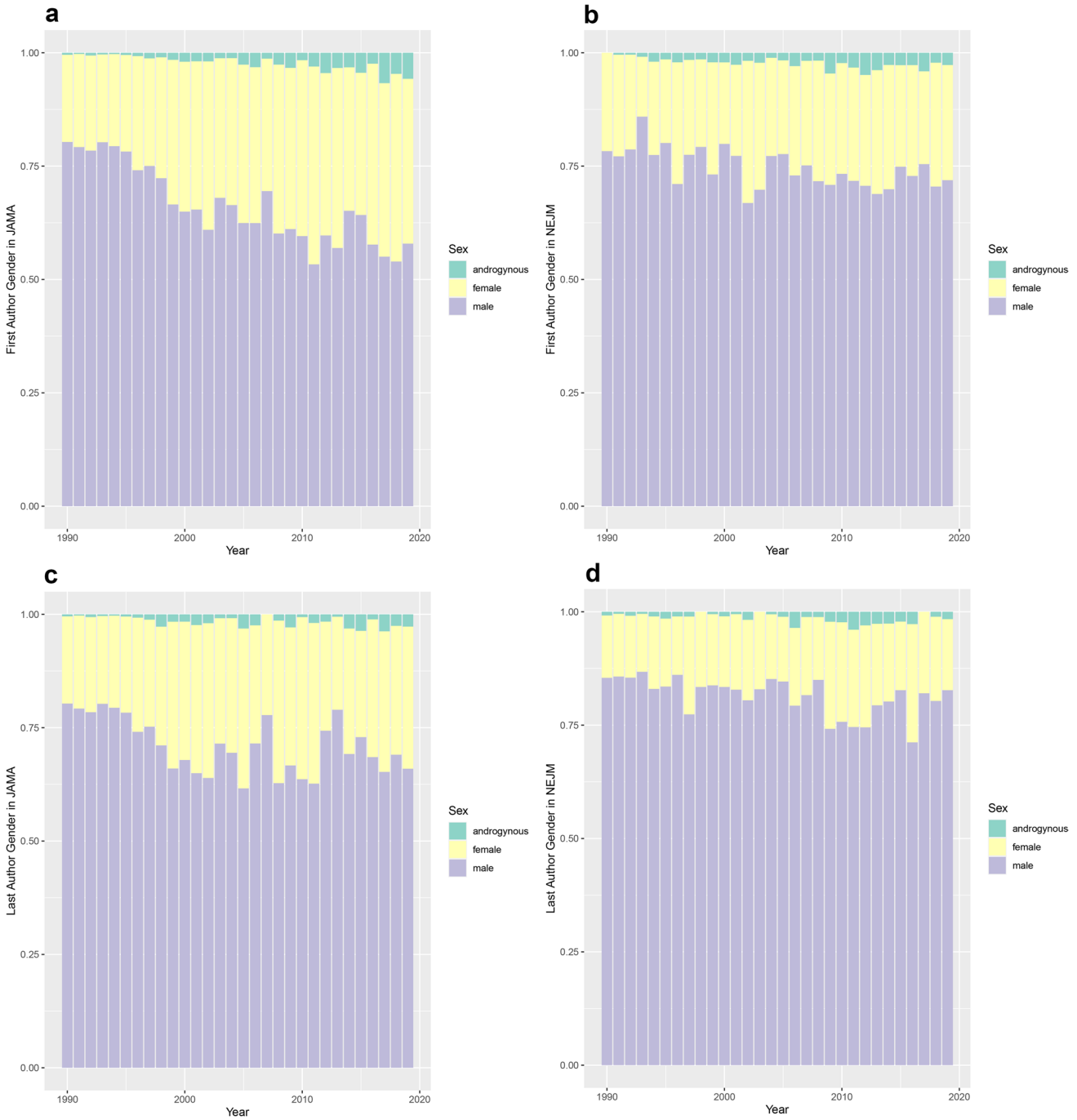

Fig. 1 Stacked bar charts as a function of year, with color denoting gender membership, for the fraction of research articles with a first author belonging to a particular gender group in **a** *JAMA* and **b** *NEJM*; and the fraction of research articles with a last (senior) author belonging to a particular gender group in **c** *JAMA* and **d** *NEJM*. Notes: Androgynous names could not be confidently classified as a "male" or "female". Consortia and study groups were excluded from this analysis

Our results provide still more evidence of gender inequality in lifetime publishing outcomes [14, 17]. This is further corroborated by the observation that women have lower rate of publications and *h-indices* across medical academia [18]. This points to the ongoing need to examine the causes of such persisting inequalities.

Changing Authorship: Racial/Ethnic Identity

The curated metadata for our dataset also allows for identification of likely racial identity, which was labeled using both the 2000 and 2010 US censuses, leveraging the racial percentage breakdown for every last name of all US

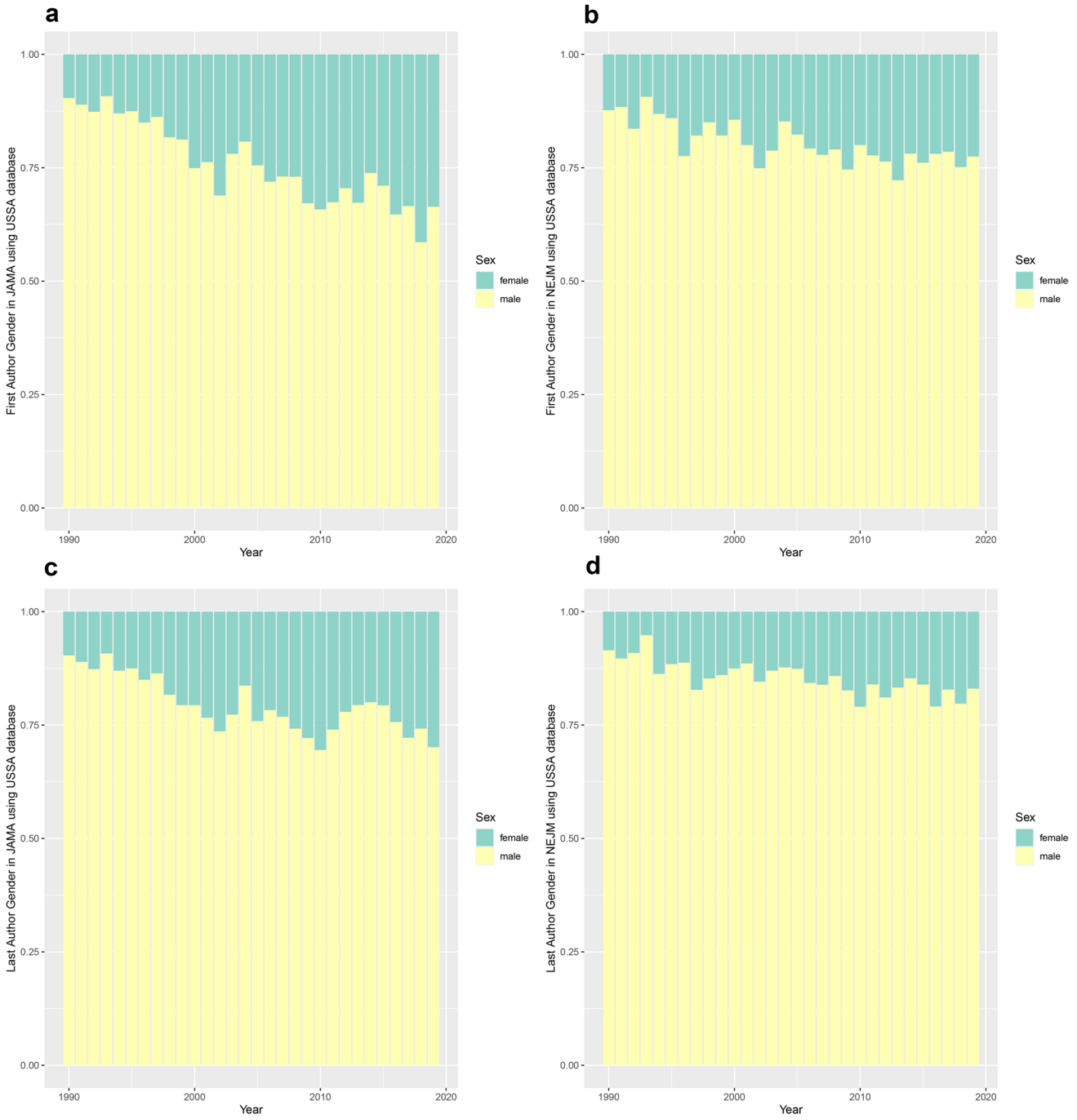

Fig. 2 Stacked bar charts as a function of year, with color denoting gender membership as predicted using the USSA database, for: the fraction of articles with a first author belonging to a particular gender group in **a** *JAMA* and **b** *NEJM*; and the fraction of articles with a last (senior) author belonging to a particular gender group in **c** *JAMA* and **d** *NEJM*. Notes: Consortia and study groups were excluded from this analysis for reasons described in the text

residents. As a concrete example, in the 2000 US census, there are 14,713 individuals with the last name "Abdalla" — of whom, 23.87% self-identified as "Black", 55.13% as "White", and 16.15% as "Mixed Race"; the remaining percentages belonged to other ethnic groups. There are two approaches we can take: (a) we can average these last-name-race proportions over all articles to get the estimated fraction of articles with an author belonging to any racial group in a given year, or (b) we can assign a single race to every last name ("Abdalla" would be a "White" author as > 50% of individuals with that surname are

"White").[1] The first approach (averaging-of-proportions) for the name "Abdalla" effectively assigns 0.24 Black "points" and 0.55 White "points" for any article with an author whose last name is "Abdalla", allowing us to sum the points in each race category and then make comparisons between those sums. This likely leads to an overestimation of non-White authorship because physicians and medical researchers are more "White" than the general population [19]; that is, the averaging-of-proportions is the "best case" scenario. The second approach (assigning a single racial identity to every last name, i.e., the binary approach) likely represents the "worst case" scenario, as it does not incorporate the very small fraction of non-White individuals with predominantly "White" names. We utilize both approaches as our primary analysis using the 2000 US census; we use the 2010 US census for supporting sensitivity analyses. Similar to the gender analysis, while recognizing the numerous imperfections in this simplistic approach, using the US census is currently the most robust approach to gaining insight into the demographic evolution of the racial identity of medical research authorship on a historical scale.

We recognize that there are two benchmarks with which we can compare racial authorship proportions: the general American population and the population of individuals with an MD. To enable the latter, we applied our "averaging-of-proportions" approach to the CMS National Plan and Provider Enumeration system, which revealed that since 2005, 67.1% of new physicians are White, 14.6% are Asian (or Pacific Islander), 7.9% are Black, 6.8% Hispanic, and 0.5% are American Indian/Alaskan Native.[2] For comparison, using the general population in 2010, 76.3% are White, 6.1% are Asian, 13.4% are Black, 18.5% Hispanic, and 1.3% are American Indian/Alaska native. Additionally, to validate our use of the US census data, we limited our analysis of racial/ethnic identity to original research articles with at least one author or institution from the USA. This was validated by pairing the article DOIs with the corresponding PubMed entries.

Using the 2000 US Census, our racial identity analysis reveals that non-White authorship has risen since the 1990s in both *JAMA* and *NEJM* (Figs. 3 and 4) — consistent between both the averaging-of-proportions and binary approaches. This rise, however, hides other trends. In *JAMA*, using the averaging-of-proportions approach (i.e., the best-case scenario), there had been an actual decrease in the proportion of articles with Black authors between 1990 and 2010, before "rising" back to 1990 levels by 2020. Since 1990, in *JAMA*, at its lowest point, the fraction of articles with a Black first author was 5.2% in 2008, down from its maximum proportion of 8.5% in 1992 (Fig. 3c). While the proportions have improved slightly over the past decade (2010–2019), the fraction of articles has yet to reach its maximum value from the 1990s (Fig. 3c). The proportion of "research articles" with a Black last (senior) author in *JAMA* has exhibited parallel trends, reaching its lowest value of 5.1% in 2008 (Fig. 4c). There remains an overall negative slope of change, − 0.05% per year, between 1990 and 2020.

The trends for Hispanic authors in *JAMA* are similarly stark. Using the averaging-of-proportions approach, the proportion of articles with a Hispanic first author has remained unchanged since 2000 (Fig. 3d). In fact, in 2018, the fraction of articles with a Hispanic first author was 2.8%, the lowest value since the turn of the century. At its current rate of growth (0.04% per year since 2000), it will take more than 337 years for the proportion of *JAMA* "research articles" with a Hispanic first author to match their current proportion in the US population (18.5%). Similar trends were noted for the fraction of articles with Hispanic last authors (Fig. 4d). In 2012, the proportion of articles reached its lowest value since 1990: 2.0% of articles. Since 2000, Hispanic last authorship has increased by 0.08% per year; at its current slope, it will take more than 154 years for the proportion of *JAMA* "research articles" with a Hispanic last author to match the proportion of Hispanic individuals residing in the USA.

Using the averaging-of-proportions approach ("best case" scenario), the proportion of articles in *NEJM* with a Black first author has also remained virtually unchanged since 1990, with a 0.03% annual increase (Fig. 3e, f, g). The slope of the line of best fit suggests that the proportion of articles with a Black first author will reach 13.4% (the proportion of Black individuals presently in the USA) after more than two centuries and more than a century to match the proportion of Black individuals with an MD. At its lowest point, in 1996, the fraction of *NEJM* "original articles" with a Black first author was 4.8%. Black senior authorship in *NEJM* has similarly stagnated. In 2006, the proportion of articles with a Black last author in *NEJM* was 4.1% — its lowest value among both journals since 1990 — before rising to 6.9% in 2019 (Fig. 4e, g). Since 2000, the fraction of Black last authors has increased at 0.05% per year; it would take more than 140 years for the proportion of Black senior authors to match the proportion of Black individuals residing in the USA.

[1] Note that approximately 80% of names are associated with greater than or equal to a 70% probability of being assigned to a single race/ethnicity (i.e., they would receive greater than or equal to 0.7 "points" for that race/ethnicity), while approximately 60% of names are associated with greater than or equal to a 90% probability of being assigned to a single race/ethnicity,

[2] Note that numbers do not total to 100% because of rounding, and individuals who belong to two or more races. We do not use the AAMC 2018 workforce self-reported estimates because they do not cover a large enough time period, and 13.7% of active physicians from the AAMC estimate have an unknown race.

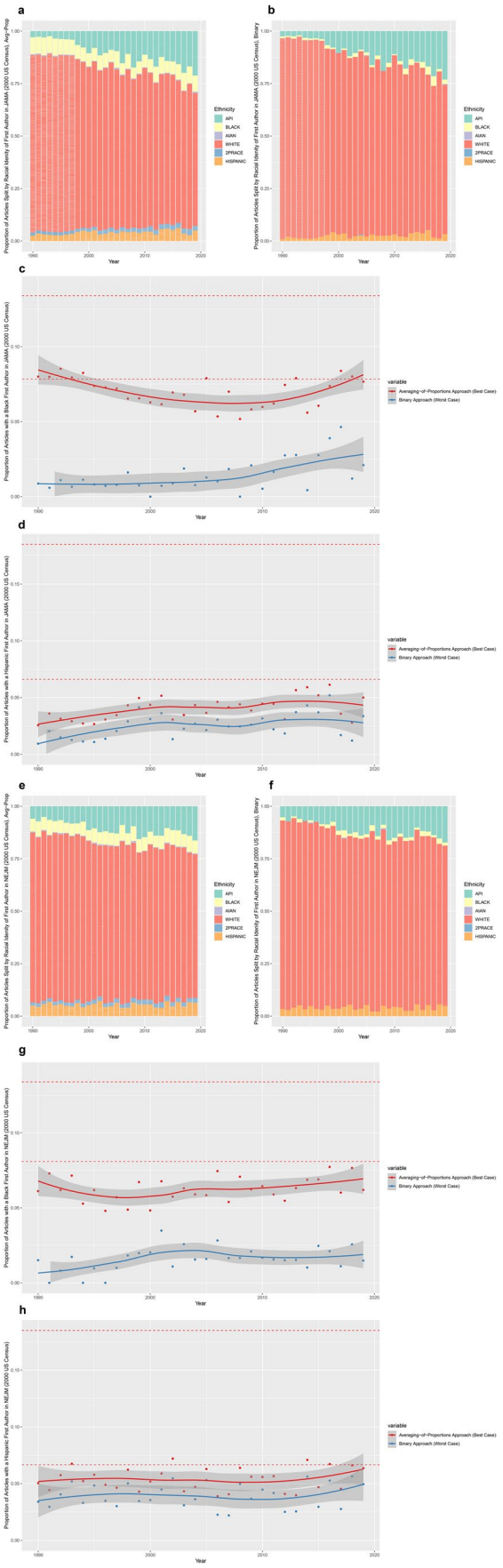

Fig. 3 Percent stacked bar chart depicting the probability that a first (junior) author of a research article belongs to any particular racial group, as estimated using the 2000 US census, as a function of year for *JAMA* using the **a** averaging-of-proportions approach and **b** binary approach, with line plots summarizing fraction of articles with a **c** Black first author and **d** Hispanic first author; and for *NEJM* "original articles" using the **e** averaging-of-proportions approach and **f** binary approach, with line plots summarizing fraction of articles with a **g** Black first author and **h** Hispanic first author. The dashed lines indicates the proportion of Black (13.4%) and Hispanic (18.5%) individuals in the USA in 2019, as well as the proportion of Black (7.9%) and Hispanic (6.8%) individuals with an MD since 2005. Abbreviations: API, non-Hispanic Asian and Native Hawaiian and Other Pacific Islander alone; AIAN, non-Hispanic American Indian and Alaska Native alone; 2PRACE, non-Hispanic two or more races. Notes: These categories and abbreviations are defined by the US Census

Hispanic authorship in *NEJM* has also remained unchanged over the past three decades: The fraction of articles with a Hispanic first author reached its lowest value of 3.9% in 2016 and has been growing at a rate of 0.01% since 2000 (slope of the line of best fit; Fig. 3e, h). At this rate, it will take more than 1213 years for the proportion of *NEJM* original articles with a Hispanic first author to reach 18.5% (the proportion of Hispanic individuals presently in the US population) and 290 years to reach 6.8% (the proportion of Hispanic individuals with an MD). The fraction of *NEJM* original articles with a Hispanic last author also reached its lowest value in 2019: 3.0% of articles (Fig. 4e, h). Growing at 0.02% annually since 2000, it will take more than 775 years for the proportion of articles with a Hispanic last author to match the proportion of Hispanic individuals in the USA.

Using the binary approach, the results are much worse for both journals (Figs. 3 and 4). It should also be noted that the numbers for American Indian/Alaska Native (AI/AN) authors are extraordinarily low; in fact, even with the averaging-of-proportions (best case) approach, they are so low that in both *JAMA* and *NEJM*, the cumulative fraction of articles with an AI/AN first author in both journals has consistently been less than 1% since 1990 (range 0.3 to 0.9%), with a slope of zero for the past 3 decades; AI/AN individuals make up 1.7% of the US population. The fraction of articles with an AI/AN last author, in either journal, using the averaging-of-proportions (best case) approach, has been consistently equal to or less than 0.7% since 1990 (range 0.3 to 0.7%), with a rate of change of 0.

Sensitivity analyses with the 2010 US census leads to similar, albeit slightly better, results for both the averaging-of-proportions (best case) and binary approaches (Figs. 5 and 6).

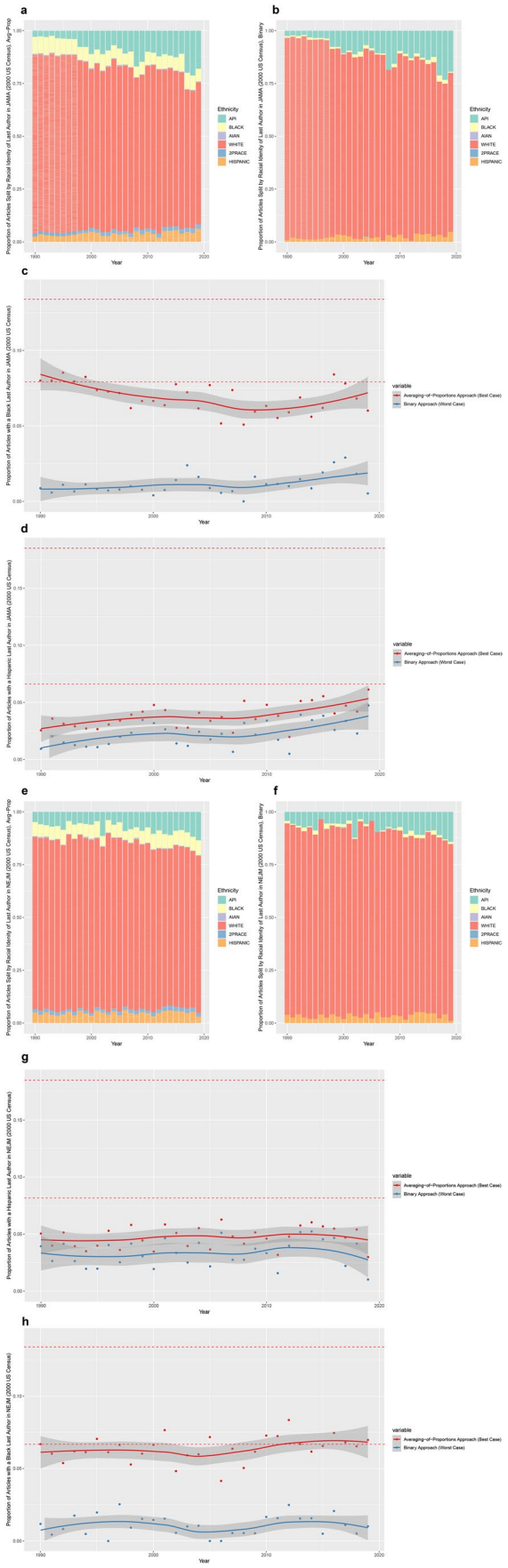

Fig. 4 Percent stacked bar chart depicting the probability that a last (senior) author of a research belongs to any particular racial group, as estimated using the 2000 US census, as a function of year for *JAMA* using the **a** averaging-of-proportions approach and **b** binary approach, with line plots summarizing fraction of articles with a **c** Black last author and **d** Hispanic last author; and for *NEJM* "original articles" using the **e** averaging-of-proportions approach and **f** binary approach, with line plots summarizing fraction of articles with a **g** Black last author and **h** Hispanic last author. The dashed lines indicates the proportion of Black (13.4%) and Hispanic (18.5%) individuals in the USA in 2019, as well as the proportion of Black (7.9%) and Hispanic (6.8%) individuals with an MD since 2005. Abbreviations: API, non-Hispanic Asian and Native Hawaiian and other Pacific Islander alone; AIAN, non-Hispanic American Indian and Alaska Native alone; 2PRACE, non-Hispanic two or more races. Notes: These categories and abbreviations are defined by the US Census

Changing Research Authorship: Intersection of Gender and Racial Identity

Recent scholarship has drawn attention to the role of intersectionality and its impacts on health outcomes and academic advancement alike [20–22]. Having demonstrated the underrepresentation and stagnation of female and Black, Hispanic, and AI/AN authors in *JAMA* and *NEJM*, we attempted to engage with the intersectionality of gender and race in our analysis by investigating changes in the proportion of Black and Hispanic female authors since 1990.

Using the 2000 US census and the aforementioned averaging-of-proportions approach (i.e. 'best case' scenario), the fraction of *JAMA* research articles with a Black female first author ranged between 1.3 and 3.6% for every year between 1990 and 2020. Similarly, the fraction of *JAMA* research articles with a Black female last author ranged between 1.2 and 3.4%. These results match the proportion of male-to-female results discussed above and suggest that there is no perceived additional inequality beyond the multiplicative effect between race and gender. However, it is important to note that the numbers are small, and an effect may only be seen once representation for either demographic group increases. Similarly, the fraction of *JAMA* research articles with a Hispanic female first author ranged between 0.4 and 2.4% since 1990, and the fraction of *JAMA* research articles with a Hispanic female last author ranged between 0.4 and 1.9% — never exceeding 2% in the past 3 decades. This also matches the expectations with respect to male-to-female authorship described above.

The results for *NEJM* are slightly worse: for instance, the fraction of "original articles" with a Black female first author ranged between 0.8 and 2.5%, and between 0.3 and 2.1% for Black female last authorship. The proportion of articles with a Hispanic female first author fluctuated between 0.4 and 2.5% and between 0.2 and 1.9% for Hispanic female last authorship. As with *JAMA*, this closely matches the male-to-female divide described in the gender analysis.

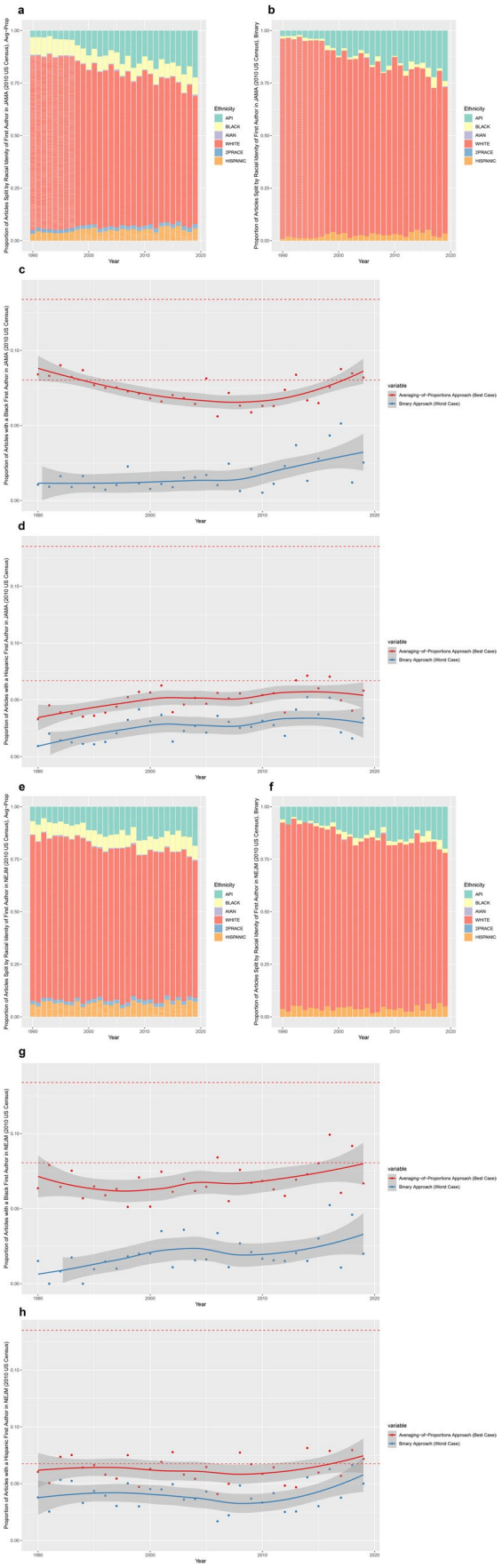

Fig. 5 Percent stacked bar chart depicting the probability that a first (junior) author of a research article belongs to any particular racial group, as estimated using the 2010 US census, as a function of year for *JAMA* using the **a** averaging-of-proportions approach and **b** binary approach, with line plots summarizing fraction of articles with a **c** Black first author and **d** Hispanic first author; and for *NEJM* "original articles" using the **e** averaging-of-proportions approach and **f** binary approach, with line plots summarizing fraction of articles with a **g** Black first author and **h**Hispanic first author. The dashed lines indicate the proportion of Black (13.4%) and Hispanic (18.5%) individuals in the USA in 2019, as well as the proportion of Black (7.9%) and Hispanic (6.8%) individuals with an MD since 2005. Abbreviations: API, non-Hispanic Asian and Native Hawaiian and other Pacific Islander alone; AIAN, non-Hispanic American Indian and Alaska Native alone; 2PRACE, non-Hispanic two or more races. Notes: These categories and abbreviations are defined by the US Census

Conclusions

Our analysis, leveraging novel methodologies and the novel database we have constructed, extends from recent analyses to demonstrate the reduced and stagnating representation of non-male and non-White authors in *JAMA* and *NEJM* over the past three decades. Such under-representation and stagnation suggest that more work is needed before gender and racial equity is achieved in publishing in high-impact medical journals. In addition to the already-stated limitations regarding minority gender status, there are several other potential limitations to our study. First, *JAMA* and *NEJM* represent only two high-impact medical journals, and it is not certain that such findings can be generalized to all other high-impact journals. Second, we use the US Census as the source of our racial/ethnic name correspondence, though we acknowledge that not all *JAMA* and *NEJM* authors are from the USA. Nevertheless, not only are both journals based in the USA, but a manual review of author affiliation of all original articles published since 2000 demonstrates that the majority of contributing authors are from or reside in the USA. Furthermore, our analysis focused on research articles, as those represent the primary scholarly credential for researchers. We did also look at trends for editorials, viewpoints, and perspectives. Results (not shown) suggest higher levels of diversity in the viewpoints and perspective, but again a preponderance of White men for editorials. The choice of White men to author editorials likely reflects the lack of diversity at senior levels in academia. Overall, our findings may especially contribute to discussions of why women, Black, Hispanic, and AI/AN individuals make up a much lower, non-representative percentage of full-time faculty positions — among other factors, they have been less able to publish in high-impact journals that would further support their applications for funding or when they seek academic promotions [23]. There is a long chain of potential forces contributing to such outcomes, including education that starts well before medical or other graduate

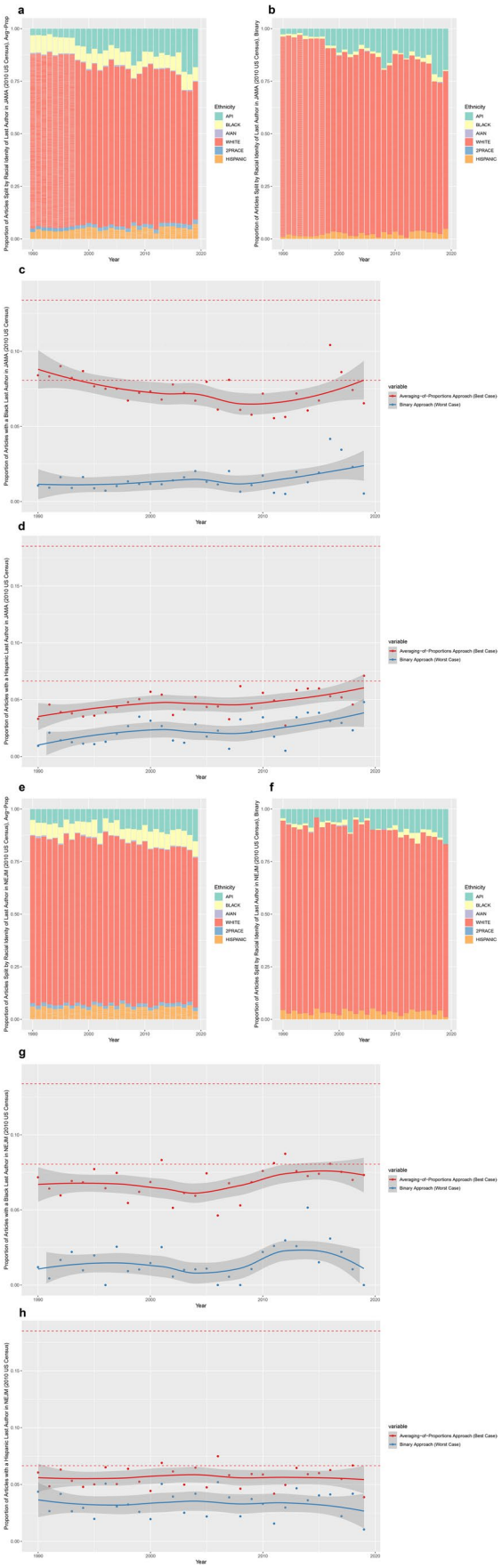

Fig. 6 Percent stacked bar chart depicting the probability that a last (senior) author of a research article belongs to any particular racial group, as estimated using the 2010 US census, as a function of year for *JAMA* using the **a** averaging-of-proportions approach and **b** binary approach, with line plots summarizing fraction of articles with a **c** Black last author and **d** Hispanic last author; and for *NEJM* using the **e** averaging-of-proportions approach and **f** binary approach, with line plots summarizing fraction of articles with a **g** Black last author and **h** Hispanic last author. The dashed lines indicates the proportion of Black (13.4%) and Hispanic (18.5%) individuals in the USA in 2019, as well as the proportion of Black (7.9%) and Hispanic (6.8%) individuals with an MD since 2005. Abbreviations: API, non-Hispanic Asian and Native Hawaiian and other Pacific Islander alone; AIAN, non-Hispanic American Indian and Alaska Native alone; 2PRACE, non-Hispanic two or more races. Notes: These categories and abbreviations are defined by the US Census

schools, admissions policies to medical and other graduate schools and hospital training programs, insufficient mentorship within academia, and differential journal submission and acceptance rates [24, 25]. These require additional examination and analysis. For instance, we acknowledge that our analysis cannot assess the proportion of article submissions by gender or race. Indeed, this is critical, given that the COVID-19 pandemic has already been demonstrated to have exacerbated gender imbalances in submissions of scientific research [26, 27]. Moreover, the trends described in this paper are likely a two-way process, in which lack of promotion likewise impacts the ability to publish in high-impact journals. Our research suggests that the causal forces that underpin these stagnating (at best) high-impact medical journal publishing trends continue to warrant further investigation — and correction.

Author Contribution All authors contributed to the study conception and design. The first draft of the manuscript was written by Moustafa Abdalla, David Jones, and Scott Podolsky. All authors read and approved the final manuscript.

Declarations

Ethics approval No human or animal subjects were involved in this study.

Competing Interests The authors declare no competing interests.

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