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ORIGINAL ARTICLE

Gender inequities in dental research publications: Findings from 20 years

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Abstract

Background: The first steps towards gender equity in science are measuring the magnitude of inequity and increasing awareness of the problem.

Objectives: To describe trends in gender disparities in first and last authorship in the most cited dental publications and general dental literature over a 20-year period.

Methods: Articles and bibliometric data were retrieved from the Scopus database for the period 1996 to 2015. Two groups of 1000 articles each were retrieved: a random sample and another sample of top-cited articles for each year. The gender of the first and last author of each publication was manually identified. When this was not possible, we used an online software platform (https://genderize.io/). Descriptive analyses identified the proportion of women first and last authors in both samples, stratifying by dental discipline and geographic region. Trends were ascertained by frequency metrics across years. Gender disparity was observed in both first and last authorship, with a larger gap being observed in the top-cited sample.

Results: Women led 28.4% and 20.3% of articles in the random and top-cited samples, respectively. A similar pattern was observed for the last authorship group (22.1% and 16.1%, respectively). An increasing trend in the proportion of articles led by women over time was observed in both samples. This increase was larger in the top-cited sample (from 15.0% in 1996–2000 to 25.1% in 2015) than in the random sample (from 26.3% in 1996–2000 to 33.2% in 2011).

Conclusions: Clear gender disparities in dental research publications in the last 20 years were identified in both general and top-cited manuscripts, across dental disciplines, across countries, across first and last authorship, and over time. It is paramount that actions are taken to attract, retain and promote women in science, as well as to monitor and ensure progress towards gender equity.

KEYWORDS
gender differences, inequalities, oral medicine, publishing, social determinants

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1 | INTRODUCTION

Gender equity is a fundamental human right[1] and an important determinant of health and economic development in contemporary societies.[2] Harmful gender norms resulting from inequities intersect with broader systems of oppression to produce substantial excess in morbidity and mortality worldwide.[3] Multiple factors may contribute to this relationship, such as discriminatory societal values and practices, biases in political, social and health systems and biases in health sciences research. Notwithstanding the central role of social movements in challenging gendered power relations, such as intersectional feminism and the global transgender rights movement, gender inequities remain pervasive across multiple sectors of societies, including in key areas of development, such as health and medical sciences.[2]

Pervasive gender disparities are observed in science, including in dentistry and dental research (Elsevier, 2017).[4] Although increasing numbers of women are graduating from undergraduate dental programs in many parts of the world, women generally comprise between 30% and 40% of registered dentists in Europe, Oceania, Asia and Africa.[5] Similarly, the number of women entering dental academia is increasing at a global level, although gender equity in both dental research and the dental workplace has yet to be reached.[6] This is especially true at the more senior/leadership levels of dental academia, and particularly among those who have been successful with competitive research grant funding.[7] In a publication celebrating 50 years of dental public health research, Celeste et al.[8] reported that none of the top 10 most cited researchers were women throughout the period.

Citations from publications are increasingly used in the complex algorithms that are generated to measure the impact of researchers, research teams and universities.[9] Such research impact metrics play a crucial role in obtaining funding from both government and industry sectors.[10] In increasingly competitive research environments, the ability (or otherwise) of dental researchers to sustain a program of work over the long term has important implications for translating findings to dental health policy,[11] industry engagement (Colgate Palmolive[12]), dental technologies, procedures and practice,[13] evidence-based teaching[14] and multidisciplinary collaboration across the health sector.[15] If gender equity is to be reached across these translational outcomes, there must be equity in author positions in publications. In oral health research, first and last are typically the most prestigious authorship positions. Because author gender should not be a factor when citing a paper, the proportion of women among top-cited papers should reflect the overall proportion of women in the underlying search engine's database. With increasing proportions of women in dental research, women authorship is expected to increase, including for publications that are the most cited.

It is only by comparing the most cited literature and the dental literature in general that we can quantify the magnitude and severity of gender disparity in authorship. Accordingly, we aimed to describe trends in gender disparities in first and last authorship in the most cited publications and the general dental literature over a 20-year period and to examine these by dental discipline and geographic region.

2 | METHODS

2.1 | Journal and article selection and data extraction

Articles and bibliometric data were retrieved from the Scopus database for the years 1996 to 2015. All journals indexed in 1996 under the category 'Dentistry' in the database were selected, comprising 107 titles. To remove possible compositional confounding due to the inclusion or removal of journals over time, 23 journals that did not maintain publications throughout the 1996 to 2015 period were excluded. The final number of selected journals was 84. The dental discipline of each journal was identified based on its title and on the scope. For each journal, two groups of articles were retrieved: a random sample and another sample of top-cited articles for each year. In the first group, 50 random numbers were computer generated and used to select publications out a pool of all articles in a specific year. In the second group, publications in each year were sorted by the number of citations received until 2020. To retrieve all articles in a given year, the search strategy used the journal unique source id (Sourceid) for the 84 selected journals and applied the year filter. A total of 1000 articles were selected for each group. No sample size calculation was used because there had been no previous study to inform the percentage of women as first or last author in dental journals to estimate possible trends. Following article selection, we downloaded bibliometric information available (including author names) in the database for each publication. When the system did not contain information on the address of the corresponding author to ascertain the country of origin, the original publication was sourced. When there was no address for the corresponding author, the address of the first author was used. In the absence of that information, the address of the last author was used.

2.2 | Gender identification

The gender of the first and last author of each publication was identified. Authors' full names were searched in the Scopus and PubMed databases, Google Scholar and ResearchGate, along with the websites of the institution to which authors were affiliated. As far as possible, the name of the author was matched to a profile picture or any photograph available online, especially for names that could be attributed to both men and women. If the gender was unable to be determined from the first name, we used an online software (https://genderize.io/). This software gives the probability of the name being from a man or woman and ≥90% of probability was considered an acceptable cut-off.

2.3 | Analysis

We undertook descriptive analyses to identify the proportion of women as first and last author in the selected publications, both in the random and in the top-cited samples. We then stratified by dental discipline and geographic region. Trends were ascertained by frequency metrics across years. Stata 16.0 was used in all analyses.

3 | RESULTS

Table 1 shows the characteristics of all papers published in the dental literature from 1996 to 2015 and in the random sample of 1000 articles. With exception of journal title, the random sample of 1000 papers had a similar structure to all articles published in the inclusion period. Original articles accounted for 80% of all published articles, followed by reviews, which comprised 6.7%. Most papers were written in English (97%) and one-quarter originated from the United States. The United Kingdom and Japan had a share of 10.3% and 8.1%, respectively. The British Dental Journal had the largest number of publications, with 8423 titles corresponding to 5.1% of all papers. Articles in this journal also contributed 3.5% to the random 1000 sample.

A comparison of the characteristics between the random and the top-cited samples is presented in Table 2. When compared to the random sample, the top-cited sample had a larger proportion of reviews (33.8% vs. 8.5%), articles originating from the United States and Canada (38.9% vs. 29.3%) and articles in the field of Periodontology (20.3% vs. 5.1%). Over half (53.3%) of the random sample articles were published in journals with a low impact factor (<1), while it was only 4.7% in the top-cited sample. One-quarter of the top-cited papers were published in journals with an impact factor higher than 3, while it was 2.6% in the random sample.

Gender disparity was observed in both first and last authorship. This gap was more pronounced in the top-cited sample than in the random sample. In the random sample, 28.4% of articles had a woman as the first author, while only 20.3% of top-cited publications were led by a woman. A similar pattern was observed for the last authorship group, where 22.1% and 16.1% of the articles had a woman as the last author in the random and top-cited samples, respectively.

Figure 1 shows an increasing trend in the proportion of articles led by women over time in both the random and top-cited samples from 1996 to 2015. This increase was larger in the top-cited sample (15.0% in 1996–2000 to 25.1% in 2011) than in the random sample (26.3% in 1996–2000 to 33.2% in 2011). An increase was also observed over time among women in the last authorship position. In the most recent period evaluated, women first-authored one-third of papers in the random sample and one-quarter of papers in the top-cited sample. Papers which had women as last authors also represented around one-quarter of both the random and top-cited samples.

TABLE 1 Characteristics of all publications and random 1000 sample in dental journals followed over 1996–2015 ($n = 50$ for each year in random sample)

	All articles		Random 1000 articles	
	n	col%	*n*	col%
Total	165 467	100.0%	1000	100.0%
Document type				
Original/Research Article	132 283	79.9%	807	80.7%
Review	11 042	6.7%	85	8.5%
Letter	8316	5.0%	34	3.4%
Editorial	5000	3.0%	33	3.3%
Note	4898	3.0%	31	3.1%
Conference Paper	1991	1.2%	7	0.7%
Other	1937	1.2%	3	0.3%
Subtotal	165 467	100.0%	1000	100.0%
Journal title				
British Dental J	8423	5.1%	35	3.5%
J Oral Maxillofacial Surg	7805	4.7%	7	0.7%
J Endodontics	4856	2.9%	10	1.0%
Am J Ortho Dentofacial Orthop	4755	2.9%	21	2.1%
J Periodontology	4749	2.9%	10	1.0%
J The Am Dental Association	4288	2.6%	21	2.1%
J Prosthetic Dentistry	3987	2.4%	10	1.0%
J Dental Research	3952	2.4%	9	0.9%
Dentistry Today	3806	2.3%	11	1.1%
British J Oral Maxillofacial Surg	3476	2.1%	12	1.2%
Others	115 370	69.7%	854	85.4%
Subtotal	165 467	100.0%	1000	100.0%
Language				
English	161 236	97.4%	950	95.0%
Russian	2279	1.4%	20	2.0%
Japanese	1380	0.8%	17	1.7%
Italian	1005	0.6%	8	0.8%
Others	773	0.5%	5	0.5%
Subtotal	166 673	100.7%	1000	100.0%
Country				
United States	42 503	25.7%	228	22.8%
United Kingdom	17 077	10.3%	95	9.5%
Japan	13 356	8.1%	101	10.1%
Brazil	11 801	7.1%	89	8.9%
Germany	8852	5.3%	47	4.7%

(Continues)

TABLE 1 (Continued)

	All articles		Random 1000 articles	
	n	col%	*n*	col%
Italy	5868	3.5%	32	3.2%
Turkey	5180	3.1%	37	3.7%
India	4831	2.9%	42	4.2%
Canada	4547	2.7%	24	2.4%
China	4447	2.7%	18	1.8%
Others	47005	28.4%	287	28.7%
Subtotal	165467	100.0%	1000	100.0%

Table 3 presents a comparison between the random and the top-cited samples according to the first author's gender. In the random sample, 42.9% of articles first-authored by a woman also had a woman as the last author. By contrast, when the article was first-authored by a man, only in 14% of the articles was the last author a woman. In the top-cited sample among articles first-authored by a woman, fewer than one-quarter also had a woman as the last author.

Additionally, in the top-cited sample, a lower proportion of articles first-authored by a woman was in the highest citation quartile than for articles first-authored by a man (14.7% vs. 27.7%). Both in the random (23.2% vs. 11.9%) and top-cited samples (13.0% vs. 6.1%), a higher proportion of articles led by a man had one author only. A larger proportion of articles in the random sample first-authored by a woman had been published from Latin America, Asia and Scandinavia, whereas a larger proportion of articles having a man as the first author, had been published from the USA/Canada or Japan. A similar pattern was observed in the top-cited sample.

Table 4 presents a comparison between the random and the top-cited sample according to the last author's gender. For articles last-authored by a woman in the random sample, a lower proportion were published from the USA/Canada and Japan, whereas these countries were overrepresented in the top-cited sample last-authored by a woman. Analysing articles last-authored by women in the random and the top-cited samples, a higher proportion of articles from the fields of paediatric dentistry and dental public health was observed in the random sample, although the numbers were small. In the random sample, when women were senior authors, the proportion of publications that were also first-authored by a woman was 2.6 times higher than publications where the senior author was a man (55.0% vs. 20.9%). Likewise, the proportion of women last authors in publications led by women was three times higher than in publications led by men (42.9% vs. 14.0%). In the top-cited sample, among articles last-authored by a woman, only one fifth also had a woman as the last author. All other characteristics were similar to those observed according to first authorship.

TABLE 2 Characteristics of articles and journals included in the two samples ($n = 50$ random and $n = 50$ top-cited articles per year)

	Random 1000 articles		Top 1000 most cited articles	
Variable	*n*	col%	*n*	col%
First author gender				
Men	676	71.6%	776	79.8%
Women	268	28.4%	197	20.3%
Total articles classified	944	100.0%	973	100.0%
Last author gender				
Men	728	77.9%	816	83.9%
Women	207	22.1%	157	16.1%
Total articles classified	935	100.0%	973	100.0%
Document type				
Original/Research Article	807	80.7%	624	62.4%
Review	85	8.5%	338	33.8%
Others	108	10.8%	38	3.8%
Number of authors				
1 author	211	21.2%	118	11.8%
2 authors	137	13.7%	183	18.3%
3 authors	180	18.0%	186	18.6%
4+ authors	472	47.1%	513	51.3%
First author's country				
USA/Canada	293	29.3%	389	38.9%
Other Western Europe	139	13.9%	275	27.5%
United Kingdom	109	10.9%	83	8.3%
Scandinavia	55	5.5%	104	10.4%
Japan/S Korea	113	11.3%	32	3.2%
Latin America	87	8.7%	34	3.4%
Asia	82	8.2%	26	2.6%
Oceania	27	2.7%	36	3.6%
Middle-East	65	6.5%	16	1.6%
Africa	8	0.8%	4	0.4%
East Europe	22	2.2%	1	0.1%
Journal dental discipline				
General	330	33.0%	256	25.6%
Periodontology	51	5.1%	203	20.3%
Implants	76	7.6%	135	13.5%
Endodontics	20	2.0%	86	8.6%
Dental Materials	26	2.6%	84	8.4%
Prosthodontics	52	5.2%	59	5.9%
Oral Pathology	42	4.2%	46	4.6%
Surgery	62	6.2%	43	4.3%

TABLE 2 (Continued)

Variable	Random 1000 articles		Top 1000 most cited articles	
	n	col%	*n*	col%
Dental Public Health	21	2.1%	21	2.1%
Operative Dentistry/ Cardiology	47	4.7%	21	2.1%
Orthodontics	74	7.4%	19	1.9%
Paediatric Dentistry	97	9.7%	4	0.4%
Other	102	10.2%	23	2.3%
Journal cite score (2020)				
Up to 1	533	53.3%	47	4.7%
1.1 to 2	370	37.0%	333	33.3%
2.1 to 3	71	7.1%	378	37.8%
3.1 or more	26	2.6%	242	24.2%
Journal H-Index (2020)				
Up to 90	802	80.2%	178	17.8%
91 to 120	129	12.9%	278	27.8%
121 to 150	40	4.0%	266	26.6%
151 or more	29	2.9%	278	27.8%

4 | DISCUSSION

Our findings show clear gender disparities in dental research publications from 1996 to 2015 in both general and top-cited manuscripts, across dental disciplines, across countries, across first and last authorship, and across time. There is a clear structural problem at a global level. Our findings contribute to the growing body of literature that shows that, while there have been many advances in gender equity in terms of numbers of women graduate dentists and dental academics, this is not yet translating through to gender equity in dental research publications.

To the best of our knowledge, this study is the first to investigate the relationship between first and last author by gender and citation status in the dental literature. Our findings suggest that men are less likely to collaborate with women in dental research. These findings are consistent with the previous literature showing that, although the proportion of women researchers is increasing, they still publish fewer papers and have fewer international collaborations than their men colleagues.[2] Gender disparities in science, as identified in our study, are observed worldwide. Women dental scholars are also particularly underrepresented in the most prestigious roles, such as editorial board memberships, editor in-chief positions (Ioannidou and Rosania, 2015)[16] and being invited speakers at scientific meetings (Schroeder et al., 2013; Casadevall & Handelsman, 2014, Martorell et al., 2021).[17-19] This is somewhat

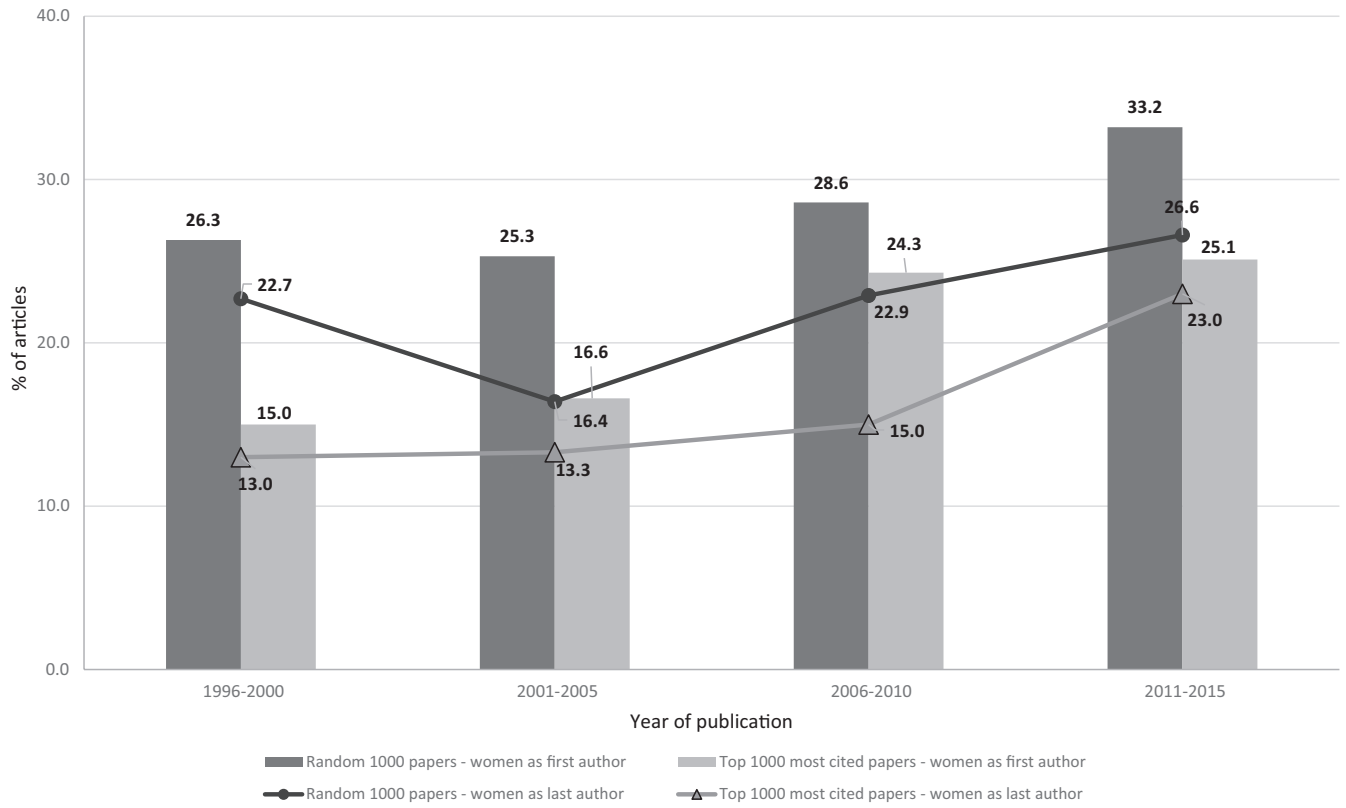

FIGURE 1 Time trend of women as first and last authors in the random and top-cited samples.

TABLE 3 Characteristics of articles in two samples according to first author gender

	Random 1000 articles				Top 1000 most cited articles			
	Women as first author		Men as first author		Women as first author		Men as first author	
	n	col %	*n*	col %	*n*	col %	*n*	col %
Total	268	100.0%	676	100.0%	197	100.0%	776	100.0%
Last author's gender								
Men	148	57.1%	561	86.0%	152	77.2%	649	85.5%
Women	111	42.9%	91	14.0%	45	22.8%	110	14.5%
Total classified	259	100.0%	652	100.0%	197	100.0%	759	100.0%
Year of publication								
1996–2000	59	22.0%	165	24.4%	37	18.8%	209	26.9%
2001–2005	61	22.8%	180	26.6%	40	20.3%	201	25.9%
2006–2010	69	25.7%	172	25.4%	59	29.9%	184	23.7%
2011–2015	79	29.5%	159	23.5%	61	31.0%	182	23.5%
Document type								
Original/Research article	230	85.8%	538	79.6%	116	58.9%	492	63.4%
Review	24	9.0%	56	8.3%	75	38.1%	254	32.7%
Others	14	5.2%	82	12.1%	6	3.0%	30	3.9%
Citation quartile								
1st quartile (lowest)	44	16.4%	167	24.7%	65	33.0%	175	22.6%
2nd quartile	68	25.4%	145	21.4%	53	26.9%	190	24.5%
3rd quartile	78	29.1%	189	28.0%	50	25.4%	196	25.3%
4th quartile (highest)	78	29.1%	175	25.9%	29	14.7%	215	27.7%
Number of authors								
1 author	32	11.9%	157	23.2%	12	6.1%	101	13.0%
2 authors	35	13.1%	97	14.3%	34	17.3%	148	19.1%
3 authors	61	22.8%	111	16.4%	36	18.3%	143	18.4%
4+ authors	140	52.2%	311	46.0%	115	58.4%	384	49.5%
First author's Country								
USA/Canada	64	23.9%	212	31.4%	69	35.0%	308	39.7%
Latin America	46	17.2%	39	5.8%	12	6.1%	22	2.8%
Western Europe	36	13.4%	99	14.6%	50	25.4%	223	28.7%
United Kingdom	29	10.8%	67	9.9%	18	9.1%	64	8.2%
Asia	28	10.4%	53	7.8%	7	3.6%	16	2.1%
Scandinavia	21	7.8%	33	4.9%	23	11.7%	79	10.2%
Japan/S Korea	17	6.3%	91	13.5%	2	1.0%	24	3.1%
Middle-East	15	5.6%	50	7.4%	6	3.0%	10	1.3%
Oceania	6	2.2%	20	3.0%	9	4.6%	26	3.4%
East Europe	4	1.5%	6	0.9%	0	0.0%	1	0.1%
Africa	2	0.7%	6	0.9%	1	0.5%	3	0.4%
Journal dental discipline								
Dental Materials	8	3.0%	17	2.5%	19	9.6%	63	8.1%
Dental Public Health	10	3.7%	10	1.5%	8	4.1%	13	1.7%
Endodontics	4	1.5%	15	2.2%	20	10.2%	62	8.0%
General	87	32.5%	207	30.6%	58	29.4%	187	24.1%
Implants	7	2.6%	67	9.9%	23	11.7%	110	14.2%
Operative Dentistry	14	5.2%	33	4.9%	3	1.5%	17	2.2%

TABLE 3 (Continued)

	Random 1000 articles				Top 1000 most cited articles			
	Women as first author		Men as first author		Women as first author		Men as first author	
	n	col %	*n*	col %	*n*	col %	*n*	col %
Orthodontics	20	7.5%	50	7.4%	7	3.6%	12	1.5%
Paediatric Dentistry	43	16.0%	53	7.8%	3	1.5%	1	0.1%
Pathology	8	3.0%	32	4.7%	10	5.1%	36	4.6%
Periodontology	9	3.4%	41	6.1%	29	14.7%	173	22.3%
Prosthodontics	10	3.7%	41	6.1%	9	4.6%	47	6.1%
Surgery	8	3.0%	50	7.4%	6	3.0%	35	4.5%
Other	40	14.9%	60	8.9%	2	1.0%	20	2.6%
Journal cite score								
Up to 1	147	54.9%	345	51.0%	6	3.0%	40	5.2%
1 to 2	90	33.6%	267	39.5%	69	35.0%	253	32.6%
2 to 3	21	7.8%	48	7.1%	62	31.5%	307	39.6%
3 or more	10	3.7%	16	2.4%	60	30.5%	176	22.7%
Journal H-Index								
Up to 90	223	83.2%	527	78.0%	31	15.7%	143	18.4%
90 to 120	26	9.7%	99	14.6%	55	27.9%	214	27.6%
120 to 150	9	3.4%	31	4.6%	56	28.4%	204	26.3%
150 or more	10	3.7%	19	2.8%	55	27.9%	215	27.7%

consistent with our findings, where gender disparities were observed across all dental publications but were more marked within the most cited literature. A study of gender distribution in dental research workforce across 11 countries showed an increase in women's participation from 1996 to 2015, with a 40% share most recently. In addition, women also represented 58% of the total attendees in the 2018 General Session of the International Association for Dental Research (IADR).[5] Our findings suggest that this participation has not yet translated into first and last authorship in scientific papers and that the gap is even wider in high-impact publications.

Sartori et al. (2021)[20] showed that women comprised 37% and 22% of first and last authors (respectively) in top dental journals, while we observed that proportion to be 28% and 20% within the most cited papers. Such a difference in the magnitude of disparities in first authorship could be attributed to methodological differences between the two studies, such as the sampling strategy (specific calendar years rather than articles published over the entire period), and the way in which the 'most cited literature' was defined (journals with the highest impact factor rather than the most cited papers). Defining the most cited literature based on the journals with the highest impact factor has the potential to exclude all highly cited papers published in journals with lower impact factors. In fact, over one-third of the papers included in the top-cited sample had been published in journals with a Scopus CiteScore of up to 2, while all journals included in the study by Sartori and colleagues had an impact factor higher than 2. Furthermore, selecting specific journals may systematically exclude journals from specific areas of knowledge, such as paediatric dentistry, where representation of women may be different from other areas that are traditionally published in journals with higher impact factors.

The study findings should be interpreted in light of their limitations. First, only manuscripts indexed in Scopus were included. However, it is the largest database in the peer-reviewed literature, and therefore, we do not expect it to differ in important ways from samples from other databases. Second, even though manual and automated strategies were used to assign author gender, our analysis had some missing information. This may be explained by the fact that some journals report only initials for the authors' given names, and, in some cases, we could not identify the author by the bibliographic information provided, meaning that gender could not be assigned for those. Third, gender was assigned based on the first name in a binary (man/woman) assessment, thereby missing the more nuanced aspects of gender identification and expression, and ignoring socially constructed roles and identities. Ideally, gender would be assessed through self-identification, but this evaluation would be unfeasible in a large-scale bibliometric study such as the one reported here. Fourth, some journals were excluded from the analysis because they did not maintain publications over the 1996 to 2015 inclusion period. Even though this strategy may be seen as a limitation, it was used to avoid potential compositional confounding introduced by articles from journals that did not publish over the 20-year observational period. Fifth, analyses were restricted to journals indexed under the category 'Dentistry'; thus, dental research articles published in other journals, such as general health and public health journals, were not retrieved. While we possibly missed a number of manuscripts, there

TABLE 4 Characteristics of articles in two samples according to last author gender

	Random 1000 articles				Top 1000 most cited articles			
	Women as last author		Men as last author		Women as last author		Men as last author	
	n	col %	*n*	col %	*n*	col %	*n*	col %
Total	207	100.0%	728	100.0%	157	100.0%	816	100.0%
First author's gender								
Men	91	45.0%	561	79.1%	110	71.0%	649	81.0%
Women	111	55.0%	148	20.9%	45	29.0%	152	19.0%
Total classified	202	100.0%	709	100.0%	155	100.0%	801	100.0%
Year of publication								
1996–2000	50	24.2%	170	23.4%	31	19.7%	207	25.4%
2001–2005	39	18.8%	199	27.3%	32	20.4%	208	25.5%
2006–2010	55	26.6%	185	25.4%	37	23.6%	210	25.7%
2011–2015	63	30.4%	174	23.9%	57	36.3%	191	23.4%
Document type								
Original/Research article	168	81.2%	590	81.0%	94	59.9%	509	62.4%
Review	22	10.6%	58	8.0%	58	36.9%	276	33.8%
Others	17	8.2%	80	11.0%	5	3.2%	31	3.8%
Times the paper was cited by								
1st quartile (lowest)	35	16.9%	169	23.2%	56	35.7%	186	22.8%
2nd quartile	43	20.8%	167	22.9%	38	24.2%	204	25.0%
3rd quartile	70	33.8%	201	27.6%	31	19.7%	214	26.2%
4th quartile (highest)	59	28.5%	191	26.2%	32	20.4%	212	26.0%
Number of authors								
1 author	32	15.5%	157	21.6%	12	7.6%	101	12.4%
2 authors	31	15.0%	98	13.5%	32	20.4%	149	18.3%
3 authors	41	19.8%	132	18.1%	27	17.2%	154	18.9%
4+ authors	103	49.8%	341	46.8%	86	54.8%	412	50.5%
Corresponding author's country								
USA/Canada	44	21.3%	231	31.7%	67	42.7%	312	38.2%
Latin America	41	19.8%	45	6.2%	10	6.4%	24	2.9%
Western Europe	30	14.5%	105	14.4%	36	22.9%	236	28.9%
United Kingdom	23	11.1%	76	10.4%	11	7.0%	72	8.8%
Asia	21	10.1%	55	7.6%	4	2.5%	22	2.7%
Middle-East	18	8.7%	46	6.3%	2	1.3%	14	1.7%
Scandinavia	17	8.2%	38	5.2%	21	13.4%	78	9.6%
Oceania	5	2.4%	22	3.0%	2	1.3%	34	4.2%
Japan/S Korea	5	2.4%	100	13.7%	4	2.5%	19	2.3%
Africa	2	1.0%	5	0.7%	0	0.0%	4	0.5%
East Europe	1	0.5%	5	0.7%	0	0.0%	1	0.1%
Journal dental discipline								
Dental Materials	2	1.0%	24	3.3%	17	10.8%	65	8.0%
Dental Public Health	10	4.8%	9	1.2%	5	3.2%	16	2.0%
Endodontics	3	1.4%	16	2.2%	8	5.1%	76	9.3%
General	66	31.9%	229	31.5%	47	29.9%	203	24.9%

TABLE 4 (Continued)

	Random 1000 articles				Top 1000 most cited articles			
	Women as last author		Men as last author		Women as last author		Men as last author	
	n	col %	*n*	col %	*n*	col %	*n*	col %
Implants	10	4.8%	61	8.4%	12	7.6%	119	14.6%
Other	27	13.0%	70	9.6%	5	3.2%	15	1.8%
Operative dentistry	10	4.8%	36	4.9%	7	4.5%	14	1.7%
Orthodontics	15	7.2%	55	7.6%	4	2.5%	14	1.7%
Paediatric Dentistry	28	13.5%	66	9.1%	1	0.6%	3	0.4%
Pathology	9	4.3%	33	4.5%	9	5.7%	36	4.4%
Periodontology	11	5.3%	38	5.2%	29	18.5%	169	20.7%
Prosthodontics	11	5.3%	39	5.4%	7	4.5%	50	6.1%
Surgery	5	2.4%	52	7.1%	6	3.8%	36	4.4%
Journal cite score								
Up to 1	103	49.8%	374	51.4%	8	5.1%	38	4.7%
1 to 2	84	40.6%	279	38.3%	57	36.3%	262	32.1%
2 to 3	14	6.8%	55	7.6%	51	32.5%	321	39.3%
3 or more	6	2.9%	20	2.7%	41	26.1%	195	23.9%
Journal H-Index								
Up to 90	171	82.6%	568	78.0%	32	20.4%	140	17.2%
90 to 120	23	11.1%	106	14.6%	52	33.1%	218	26.7%
120 to 150	8	3.9%	31	4.3%	42	26.8%	218	26.7%
150 or more	5	2.4%	23	3.2%	31	19.7%	240	29.4%

is no plausible reason to believe that the trends observed in dental journals would not be similar to those for dental manuscripts published in other areas of knowledge. Logistical constraints meant that only 50 manuscripts per year were included in each sample, giving a total of 2000 papers for evaluation. Our analysis was carried out until 2015, and it is possible that changes in the proportion of women in first and last authorship positions has slightly changed since then. Nevertheless, this was a deliberate decision because 2015 was the most recent year in which highly cited papers could be identified.

Multiple systematic factors operate simultaneously to shape gender inequities in academia. These include organizational practices and norms that may lead to unequal career opportunities, gender bias in recruitment and the effects of differential work and family demands. Women face barriers and discrimination at each phase of their career, from recruitment and selection, to recommendation, evaluation, promotion, training and compensation (Kang et al., 2019).[21] It is important to stress that none of these are related to women's *ability* to progress in their careers.[2] While there are no straightforward solutions to address such disparities, editors, funding agencies, universities and research institutes need to be cognisant of these unfair differences and actively promote initiatives that seek to reduce the gender disparity gap in dental research. O'Brien et al.[22] highlighted the importance of a holistic understanding of gender inequities in science, providing some scenarios showing how simplistic pro-equity initiatives may have unintended consequences. For example, by promoting gender balance in leadership roles and using this as a 'metric of success', such initiatives might discourage women from engaging in part-time work and even discriminate against the ones who do. Moreover, it might not solve the problem of 'horizontal stratification', whereby fewer women work in the more prestigious and higher paid areas that are traditionally dominated by men.[22] Another pro-gender equity initiative that might generate unintentional effects is allocating the same number of women and men across different academic roles, or better rewarding the roles in which women are overrepresented, such as teaching and community work. The issue in doing so is that such initiatives in isolation reinforce the notion that the problem of gender inequities can be resolved by 'fixing women', and it does not solve the issue with the organizational culture that devalues such roles.[22] Furthermore, this ignores the broader societal issue of men choosing to not engage with child-rearing or other home-based duties that traditionally have meant that women remain less engaged in the workforce.

To promote gender equity, structural and systemic changes are mandatory. The first step is quantifying and recognizing this systemic problem. Our findings throw light on the dental research domain by highlighting the nature and magnitude of gender disparities in the field from 1996 to 2015. Publicly reporting disparities, in addition to acknowledging the problem, gives means of measuring progress towards gender equity over time.[23] Gender equity in science should start with equal access to science education and training by girls and women, as promoted by the World Health Organization and the United Nations.[2] At the organizational level,

gender bias training is encouraged, and it is especially important to raise conscious awareness of gender bias for those in leadership roles and selection committees, because they have a higher potential for promoting organizational change.[23,24] To achieve durable and sustainable changes; however, responsibility for promoting gender equity cannot be held only by individuals; instead, there must be an objective action plan with measurable goals facilitated by organizations and society more broadly. To advocate for and support gender equity, organizations must implement specific policies to minimize men privilege in all career stages, from student training, hiring, to promotion and salaries, and to promote an institutional culture of respect and acceptance. Some examples include the language used in hiring and promoting procedures and the facilitation of safe spaces for discussing diversity in the workplace. Gender-inclusive language should be employed in professional evaluations, such as recruitment, retention, promotion and funding assessments. Active strategies to increase the diversity of applicants should be undertaken.[23-25]

The problem of gender disparities is complex and so is its solution. To promote lasting and meaningful changes, multipronged interventions need to be implemented, tackling distinct aspects that contribute to this problem. Our findings suggest that women are under-represented in the most prestigious roles in dental publications, and this disparity is even larger in the top-cited papers. They show a more substantial increase over time (around 10% for both first and last authorship) of women in the top-cited articles than in the general dental literature (random sample) but, despite this, persistent and pervasive gender disparities were evident. Taken together, these findings highlight clear gender inequities in dental research, and achieving gender equity in science will require multidimensional structural and cultural transformation. In order to advance science in a fair manner, it is paramount that actions are taken to attract, retain and promote women in dental science, as well as to monitor this progress towards gender equity over time.

AUTHOR CONTRIBUTIONS

Haag DG and Schuch HS conceived the idea of the manuscript, conducted the statistical analysis and drafted the manuscript. Jamieson LM conceived the idea of the manuscript, contributed to drafting and critically reviewed the manuscript. Celeste RK conceived the idea of the manuscript, conducted the statistical analysis, contributed to drafting and critically reviewed the manuscript. Sonia Nath conducted the statistical analysis and critically reviewed the manuscript. Baker SR and Thomson WM conceived the idea and critically reviewed the manuscript. All authors read and approved the final version.

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CONFLICT OF INTEREST

None declared.

DATA AVAILABILITY STATEMENT

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

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