

## Original Research

# Gender of Authors in Laboratory Animal Medicine and Science in 2 Peer-Reviewed U.S. Journals

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Multiple recent surveys have examined the prevalence of female first or senior authors on publications for various scientific and medical disciplines. First and senior authorships are significant achievements for purposes of professional advancement, especially in academia. Such surveys can also provide information regarding diversity and inclusion. In this report, we present the findings of a survey performed to assess how frequently female contributors were first or senior authors in 2 of the most widely-circulated peer-reviewed journals of laboratory animal medicine and science in the United States; data were collected at 3 time points over a recent 20-y span. These data were then compared against estimated populations of potential female authors, as determined from membership rolls in the American Society of Laboratory Animal Practitioners and the American College of Laboratory Animal Medicine. Survey results suggest that female authors increased their representation as influential authors over time, in contrast to representation trends reported for other disciplines. However, whether this increase has mirrored the increase in women overall in the veterinary profession during this time span is unknown. In an era of greater attention and sensitivity to equity and inclusion, this survey is offered as a starting point for further conversation within the field of laboratory animal medicine and science.

**Abbreviations:** ACLAM, The American College of Laboratory Animal Medicine; ASLAP, The American Society of Laboratory Animal Practitioners; *Comp Med*, *Comparative Medicine*; JAALAS, the *Journal of the American Association for Laboratory Animal Science*

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A survey was published in 2018 on the proportion of first and senior female authors of research papers in neuroscience.<sup>9</sup> The objective of that effort was to determine whether the number of women in those 2 categories of authorship, which are critical for career advancement, reflected the number of female post-docs and tenure-track faculty, respectively, in that discipline. The survey analyzed a database of 166,979 articles published from 2005 through 2017. As compared with the gender proportionality of scientists in that field, the analysis showed that female first authors appeared one-third less often than would be expected due to parity, and female senior authors were only half of the expected numbers. The survey's authors concluded this significant disparity was due, in part, to continued gender bias in the experiment-to-publication process.<sup>3</sup>

Another survey analyzed gender authorship trends in 274,764 medical journal articles.<sup>4</sup> This analysis tracked changes in authorship positions for women between January 2008 and August 2018 and then conducted a cumulative comparison between influential authorship positions and participation in the profession by gender, as in the neurosciences survey cited above. This broader survey found that female first and senior authorships increased over the time period analyzed but varied by specialty, with cross-specialty and obstetrics/gynecology journals showing the highest proportion of and most significant percentage increases in female authors in influential and middle authorship

positions. This survey also found a statistically significant correlation between the impact factor for a given journal and the proportion of female authors. Finally, women appeared to take more than twice as long to progress from first to senior author than did men (5 years for men and over 10 years for women). These and other investigations have heightened concerns about gender bias and its adverse consequences across all research fields, with calls for more transparency and equity to improve the recruitment and retention of women in STEM disciplines and beyond.<sup>1,6,7</sup> To evaluate what, if any, gender authorship trends may exist for the field of laboratory animal medicine and science, we screened the 2 most common peer-reviewed U.S. journals of laboratory animal medicine and science for authorship gender, both historically and recently.

## Materials and Methods

Issues of *Comparative Medicine* and JAALAS (and JAALAS' predecessor, *Contemporary Topics in Laboratory Animal Science*) from 1997, 2007, and 2017 were analyzed. All published articles in which the senior author was from a US or Canadian institution (including US military and other governmental research laboratories abroad) were tabulated for the number of authors, the number of female authors, and whether the first or senior author was a woman. If the author's gender was unknown or uncertain, internet searches of the author's name or institutional affiliation were used to establish gender where possible. Publications in our database were hypothesis-driven research, discovery research, literature reviews, assay development, clinical case reports, and other articles of similar length and depth. Editorials and Letters to the Editor were excluded.

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Next, we compared the proportion of female authors to a representative population of possible authors, estimated from membership directories of organizations in the field. Directories of ASLAP and ACLAM were used to estimate the total number of laboratory animal veterinarians and proxy ratios of gender. ASLAP membership rolls were used for each of the years listed above. Available ACLAM membership directories closest to the first 2 years queried above for authorship gender were for 2000 and 2008; the ACLAM membership directory used for the final year was the October 2017 issue. Persons listed in both directories for a given year were tabulated only once for that time period. Persons listed as retired or inactive were included because those members could still be involved in generating publications even in retirement. Persons identified as students in ASLAP membership rolls were excluded.

## Results

The total number of articles evaluated and percentages of articles with more than one female author, a female first author, or a female-senior author were combined for *Comp Med* and *JAALAS* (Table 1). No co-first or co-senior authors were found in either journal in the years examined. Articles with a single author who was female were included in the count as having both a female first author and a female senior author. Only 1% or less of all authors from papers analyzed in both journals could not be confidently identified by gender and were excluded from our calculations.

The total number of veterinarians and percentages of female and male authors for each of the 3 years are presented in Table 2. No effort was made to establish individuals' career status or progression after graduation from veterinary school (that is, whether they were postdoctoral trainees or higher).

Comparing the percentage of first or senior female authors to the percentage of female members in the two laboratory animal medicine organizations for the years tallied yields Figure 1.

## Discussion

Table 1 shows a rise over 20 years, from 1997 to 2017, in the number of papers involving at least one female author, female first author, and female senior author. Those parameters appear to mirror the increase of women in the membership rolls of ASLAP or ACLAM from 2000 to 2017 seen in Table 2. By contrast, a larger disparity was seen between female authorship and female representation in the studies of neuroscience and medical journals, as discussed in the introduction.<sup>4,9</sup>

This analysis has multiple limitations, such as excluding non-veterinarian authors and constituencies, tracking only 2 peer-reviewed journals, and limiting the geographic scope to the United States and Canada. Statistical analyses were omitted in light of these limitations and to avoid giving an impression of "significant" comparisons or trends where none may exist, particularly because membership lists of professional laboratory animal veterinary organizations may not be the best denominators.<sup>5</sup> Nevertheless, we felt that tabulating only persons with advanced veterinary degrees was a reasonable starting point because these authors constituted the majority of possible authors in *Comp Med* and *JAALAS* over the time period surveyed. Furthermore, these 2 journals dominate the number of publications in laboratory animal medicine and science in the United States and Canada. Using the membership lists of 2 easily tracked professional associations composed of veterinarians engaged in or affiliated with laboratory animal medicine and science, with or without additional advanced science degrees or other specialty boards, offered a convenient way to identify authors who are veterinarians participating in the care, medicine, and experimental use of research animals. Expanding or shifting the scope or timeline of the survey inputs could generate different findings. Finally, although significant differences may exist between U.S. and Canadian-based authors who publish in U.S. journals as compared with groups in other parts of the world, we opted to limit our study and allow others to examine those regions.

Our findings also suggest new questions. The proportion of female veterinary students and subsequent entry of women into the profession rose significantly between 1988 and 2007.<sup>2</sup> A survey of US veterinarians published in 2019 showed that women outnumbered men 62% to 38%.<sup>8</sup> Given that general recent trend and the current gender ratio throughout the profession, one may expect the percentage of female members of ASLAP and ACLAM would be higher than 50% in 2017. Perhaps the field of laboratory animal medicine is attracting fewer women than it could, and if that is the case, an obvious question is why. Another question that arises in light of the growing prevalence of women in veterinary student enrollments and the veterinary profession is whether the 43% female senior authorship in 2017 indicates slower proportional advancement to senior roles than men in the field, and if this is the case, then why is this happening?

Gender equity can and undoubtedly should be assessed in other ways because not all laboratory animal veterinarians publish papers in peer-reviewed journals, including but not limited to the 2 we examined. Categorizing authorship

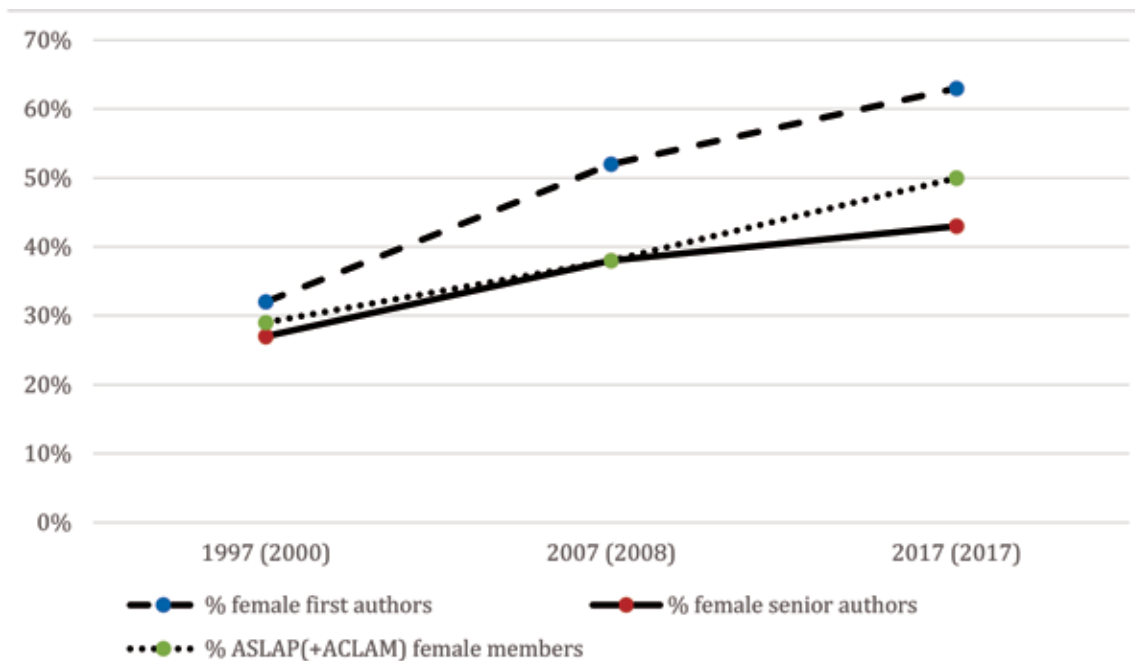
**Table 1.** Combined number and percentage of articles with female authors from *Comp Medicine* and *JAALAS* for the years surveyed.

Year	Number of articles evaluated	Number (and %) of articles with at least 1 female author	Number (and %) of articles with female first authors	Number (and %) of articles with female senior authors
1997	124	81 (65%)	40 (32%)	34 (27%)
2007	112	94 (84%)	58 (52%)	42 (38%)
2017	134	131 (98%)	84 (63%)	57 (43%)

**Table 2.** Number and percentage of female members of ASLAP in 1997, 2007, and 2017 and ACLAM in 2000, 2008, and 2017.

Year	Total number	Number (%) female	Number (%) male	Number (%) unidentified
1997/2000 <sup>a</sup>	1,085	319 (29%)	765 (71%)	1 (<1%)
2007/2008 <sup>a</sup>	1,135	434 (38%)	696 (61%)	5 (<1%)
2017	1,508	752 (50%)	753 (50%)	3 (<1%)

<sup>a</sup>The first year in the row pertains to ASLAP membership, the second year pertains to ACLAM membership (see Materials and Methods).



**Figure 1.** Percentage of first or senior female authors from Table 1 compared with the percentage of female members of ASLAP and ACLAM from Table 2.

of textbooks by gender may provide additional information, as demonstrated in other life science realms.<sup>10</sup> Another approach could be to track senior management positions in laboratory animal care programs across the US over the years, elections to leadership roles in various veterinary organizations (ACLAM, ASLAP, AALAS, and AAALAC), or appointments to AAALAC Council and other organizations such as ILAR. Finally, personal surveys of those engaged in laboratory animal care and medicine at all operational levels about their perceptions and experiences involving gender bias could contribute to a comprehensive picture. Our results provide a snapshot and a possible baseline. We hope this information will encourage others to explore further this important aspect of our field.

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