Editorial: Women in chemical engineering

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Editorial: Women in chemical engineering

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Editorial on the Research Topic
Women in Chemical Engineering

The article Research Topic "*Women in chemical engineering*" is aimed to promote the work of women scientists in all fields of Chemical Engineering.

The representation of women in science, technology, engineering, and mathematics (STEM) fields has increased over the past several decades. For example, the Universiti Teknologi MARA in Malaysia appointed its first ever woman Vice-Chancellor in 2021 ("Leading the Future of UiTM, Roziah Mohd Janor Made History as the First Woman Vice-Chancellor of UiTM." Available at: https://vc.uitm.edu.my/bionote/). Nevertheless, gender disparities still exist. In this Research Topic, we highlight women in STEM and acknowledge that there are other underrepresented genders. Unfortunately, data on transgendered and non-binary individuals are virtually non-existent (Restar and Operario, 2019), and the statistical analyses cited herein only consider female and male genders. Although some progress has been made in the representation of women in STEM, much work lies ahead in order to reach equity for all genders in STEM fields (Maloy et al., 2022).

Global initiatives and calls to action to promote women in STEM, such as UNESCO's International Day of Women and Girls in Science, have helped contribute to greater representation (Pearson et al., 2015; Azoulay, 2023). However, even in fields where women are better-represented in the undergraduate population, they remain vastly underrepresented at higher ranks in academia (National Academies of Sciences, 2020). For example, in 2021 in the United States, 38.5% of Bachelor's degrees in Chemical Engineering were awarded to women, but women comprised only 14.2% of Full Professors (American Society for Engineering Education, 2022). Similarly, at Tecnológico de Monterrey in Mexico, women comprise 34% of researchers but only 18% of research group leaders (Diaz de la Garza, 2019).

There are several complex factors that contribute to the persistence of women in STEM (Brawner et al., 2015), and widened disparities caused by the COVID-19 pandemic may also have a negative impact on retention (Kesler, 2021). Women, especially those from underrepresented groups such as Black, Indigenous, and people of color, bear higher

burdens of service-related activities in what is commonly known as a "minority tax" (Rodríguez et al., 2021; Williamson et al., 2021). Conversely, in metrics that are traditionally rewarded in academia, such as prestigious international awards (Meho, 2021) and peer-reviewed grants and publications (Day et al., 2020; Severin et al., 2020), women are often disadvantaged. For example, a cross-sectional analysis of peer review reports from the Swiss National Science Foundation revealed that grants submitted by male applicants scored more favorably than those submitted by female applicants (Severin et al., 2020). Furthermore, the rate of success in progressing through each stage of publication in Royal Society of Chemistry journals is lower for female authors compared to male authors (Day et al., 2020). In American Chemical Society journals, women are underrepresented in authorship even after accounting for their lower percentages in academia (Cotton and Seiple, 2021).

Since publications are often considered "academic currency" and are frequently used as metrics for tenure and promotion, we should strive for equity in authorship and citations. Nonetheless, bibliographic analyses across millions of scientific papers indicate large gender disparities, particularly in the prestigious first or last author position (Larivière et al., 2013; West et al., 2013; Holman et al., 2018). At least part of this gender gap can be attributed to the fact that women researchers are less likely to be credited with authorship than men (Ross et al., 2022).

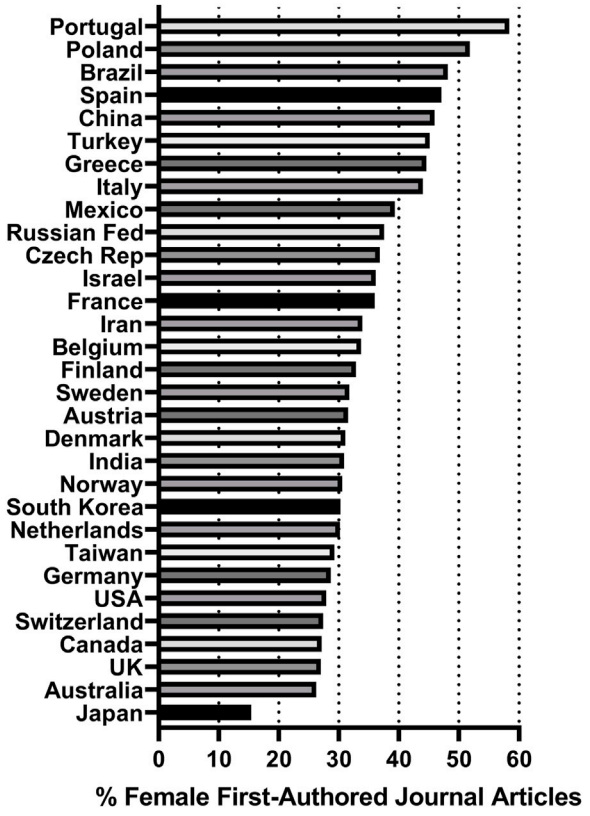

FIGURE 1
Percentages of female first-authored journal articles published between 2014 and 2018 by Scopus category of Chemical Engineering for the 31 countries with the most Scopus-indexed articles. Data from Thelwall and Mas-Bleda (2020)

Specifically within Chemical Engineering, an analysis of 31 countries with the most Scopus-indexed articles from 2014–2018 revealed global disparities in the percentage of female first-authored articles (Figure 1) (Thelwall and Mas-Bleda, 2020). Moreover, female-authored papers are cited less frequently (Ray et al., 2022), and female-authored papers in Chemistry and Chemical Engineering fields that are accompanied by an author photograph and biography have an additional citation disadvantage (Dehdarirad, 2022).

This Research Topic of Frontiers in Chemical Engineering "*Women in chemical engineering*" highlights the achievements of women and promotes their authorship in the first or last position. The Research Topic comprises seven contributions (four original research articles, two reviews, and one mini-review) from Chemical Engineering women across four countries. Broadly, these articles address two grand challenges facing society, healthcare and sustainability, through Chemical Engineering research. More specifically, they fall into the specialty sections of Biochemical Engineering, Computational Methods in Chemical Engineering, Separation Processes, and Sustainable Process Engineering.

In the area of biotechnology, Yazdani and Willits review components of the brain microenvironment that houses neural stem cells, including the interactions between cells, growth factors, and extracellular matrix. They also review biomaterials approaches to recapitulate this environment with a focus on engineering design constraints which may enable better understanding and control of stem cell fate in diseased and aged tissues. Pacheco et al., in the laboratory of Whitney Stoppel, provide a mini review on silk and silk-inspired materials for drug delivery. The review focuses on the main classes of silk and silk-inspired polymers, processing and fabrication techniques used to form nanomaterials, and functionalization for use in a variety of drug delivery applications.

Sudduth et al., in the laboratory of Catherine Fromen, contribute an original research article on the nebulization of hydrogel nanoparticles. They develop a workflow to enable the evaluation of nanoparticle behavior at the air-liquid interface and find that nanoparticle formulation plays an important role in cell uptake, which has implications for pulmonary drug delivery. Paruchuri et al. report the development of enzyme-responsive polymer vesicles for applications in lysosomal storage disorders. In this original research article, they show that sustained delivery of β-galactosidase promotes cellular self-healing and is a promising delivery system to treat GM1 gangliosidosis.

In the area of sustainability, Papadaki et al. review nut shells as adsorbents of pollutants or raw materials to produce activated carbon. They discuss how different shells have been used to remove pollutants from synthetic wastewaters as well as the challenges that remain before they can be applied to large scale water sources. In a more established method of water treatment, Guthausen et al. provide an original research article on a novel polymeric ultrafiltration membrane. They discuss the development of a multichannel membrane and characterize its structure, wettability, and flow distribution with *in situ* magnetic resonance imaging. Idris et al. contribute an original research article on the recovery of palm oil resources to reduce their negative effects on the environment. Their work evaluates

microwave-assisted pyrolysis of palm oil industrial wastes to convert them to renewable fuel sources.

Overall, these women make valuable contributions to diverse fields within Chemical Engineering. We are excited to publish this Research Topic, showcasing the work of successful scientific women, as a means for inspiration and promotion of "*Women in chemical engineering*" with the eventual goal of reaching authorship equity for all genders.

Author contributions

LV wrote the editorial. All authors edited, contributed to, and approved the editorial.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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