Impact of Mentoring on Academic Career Success for Women in Medicine: A Systematic Review

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Abstract

Purpose

Research has shown that barriers to career success in academic medicine disproportionately affect women. These barriers include inadequate mentoring, which may perpetuate the underrepresentation of women in senior leadership positions. The purpose of this review was to summarize the qualitative and quantitative evidence of the impact of mentoring on women's career outcomes and to inform future interventions to support the promotion and retention of women in academic medicine.

Method

The authors conducted a systematic review of original research published in English-language, peer-reviewed journals through March 20, 2020. Search terms related to mentorship, women, and academic medicine. The authors searched MEDLINE, Embase, Scopus, Current Contents Connect via Web of Science, Cochrane Library, and PsycINFO. They excluded studies not specifically addressing women and those without gender-stratified outcomes. They extracted and analyzed the following data: study design, population, sample size, response rate, participant age, percentage of women, mentoring prevalence, and outcomes.

Results

Of 2,439 citations identified, 91 studies met the inclusion criteria, including 65 quantitative and 26 qualitative studies. Mentoring was associated with objective and subjective measures of career success. Women perceived mentorship to be more valuable to their career development yet were more likely to report having no mentor. Additionally, women were more likely to report lower levels of research productivity, less career satisfaction, and greater barriers to promotion. Qualitative results indicated that women had less access to informal mentoring and family responsibilities had a greater effect on their career outcomes. Professional networking, female mentors, and relational aspects of mentoring were common themes.

Conclusions

This review examined gender disparities in mentoring and the impact on research productivity, promotion success, and career satisfaction for women in academic medicine. Institution-supported mentoring programs are needed to facilitate identification of appropriate mentors and promotion of a more equitable academic career environment for women.

In the United States, individuals identifying as women (subsequently referred to as women) comprise over half of medical school graduates but represent only 21% of full professors and 15% of department chairs.[1] Potential contributions to this "leaky pipeline" include pay inequity, caregiving responsibilities, discrimination, and inadequate mentoring.[2–4] Increasing access to effective mentoring is an actionable strategy for institutions to improve the retention and promotion of women in academic medicine.

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In 2006, a systematic review examined the prevalence of mentorship and its association with career choice, career progression, and scholarly productivity in academic medicine.[3] However, only 6 included studies (14%) explored gender differences in mentoring. One study found that women reported a lower prevalence of mentorship, suggesting that insufficient mentorship has a greater negative impact on women's career experiences compared with men's experiences.[3]

Since then, barriers to career advancement and retention specific to women in academic medicine have gained attention, but women still face significant obstacles. Few institutions have gender-specific mentoring programs. For example, a systematic review of the literature on mentoring programs for academic physicians showed that only 22% of existing programs were aimed toward women.[5] Establishing a baseline of knowledge regarding the efficacy of mentoring women in academic medicine is necessary to direct future interventions.

We conducted a systematic review of the literature examining the association between all types of mentoring and career development outcomes in academic medicine. We defined mentoring as a "dynamic, reciprocal relationship in a work environment between an advanced career incumbent (mentor) and a beginner (protégé)"[6] that promotes the development of both. We considered a range of modalities including dyad, peer, facilitated peer, speed, functional, group, and distance.

Our work advances the literature in 2 important directions. First, we specifically examined gender disparities in mentoring and role modeling and the impact on professional success for women in academic medicine. Second, whereas previous reviews have focused on quantitative studies, we included both

quantitative and qualitative studies to provide a comprehensive interpretation of the literature.

Method

Search strategy

A medical librarian (R.M.) developed algorithms to search MEDLINE (PubMed), Embase and Scopus (Elsevier), Current Contents Connect via Web of Science, the Cochrane Library, and PsycINFO (EBSCO) from database inception through November 30, 2017, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search was repeated on March 20, 2020. Search terms included the concepts of mentoring, women, and academic medicine and used a combination of subject headings and keywords (see Supplemental Digital Appendix 1, at http://links.lww.com/ACADMED/B217, for the search strategy). References were extracted and imported into EndNote (Clarivate, Philadelphia, Pennsylvania), and duplicates were removed. All studies were assigned a unique identification number.

Inclusion and exclusion criteria

We included original research published in English-language, peer-reviewed journals reporting on mentoring women in academic medicine. Study populations included academic female physicians in all specialties (practicing and nonpracticing), residents, and medical students. Forms of mentoring included formal and informal, dyad, group mentoring, comprehensive programs with a mentoring component, and role modeling. Studies reporting prevalence of mentoring or outcomes or self-evaluation in areas such as research productivity (publications, grant funding, authorship), career success (promotions, awards, retention, salary equity), work–life balance (marriage/partner, children), well-being (depression, stress levels, anxiety, burnout), and confidence were included. Studies not specifically addressing women and studies without gender-stratified outcomes were excluded.

Study selection

We worked in pairs (M.R.S., E.A., W.L.) to independently screen the titles and abstracts of the identified studies, then we (M.R.S., E.T., E.A., K.W.) independently reviewed the full-text quantitative studies for inclusion. Two authors (E.T. and K.W.) independently reviewed the full-text qualitative studies. Discrepancies were resolved by the senior author (E.M.).

Data extraction

Four authors (M.R.S., E.T., E.A., and K.W.) extracted data from the included quantitative studies. Two authors (E.T. and K.W.) extracted data from the included qualitative studies. The following data were extracted and recorded using a standardized electronic form: study design, population/setting, sample size, response rate, participant age, percentage of women in the sample, prevalence of mentoring, and mentoring-related outcomes.

Data analysis

The included quantitative studies were heterogeneous with respect to study design, population, and reported outcomes and therefore were not amenable to meta-analysis. We synthesized the qualitative studies using qualitative meta-summary,[7] which is a quantitative aggregation of qualitative research results. We grouped the study findings into themes, then organized the findings according to the levels of the socioecological model (individual, interpersonal, institutional).[8,9] We further refined the findings within each level into subthemes.

Risk of bias assessment

Randomized controlled trials, observational studies, and qualitative studies were evaluated using the Cochrane Collaboration's tool for assessing risk of bias,[10] the Agency for Healthcare Research and Quality standards,[11] and the Critical Appraisal Skills Programme qualitative checklist,[12] respectively.

Results

The database searches yielded 2,439 citations. Results were exported to EndNote and 936 duplicates were removed, yielding 1,503 unique citations that were manually screened for relevance (see Figure 1). Sixty-five quantitative studies[13–77] and 26 qualitative studies[78–103] met inclusion criteria, for a total of 91 studies included in our review. Appendix 1 summarizes the characteristics of the included studies and their respective quality assessments.

Quantitative results

Thirty-five studies examined the impact of mentoring on indicators of academic success, including research productivity, career success, and career satisfaction (see Supplemental Digital Appendix 2 at http://links.lww.com/ACADMED/B217).[13,15,17,19–22,25,29,32,34–37,39,45–47,51,52,56,59,60,62,63,66,69–76,100]

The impact of mentoring on research productivity was reported in 11 studies.[13,15,20,29,37,51,52,56,62,69,73] Women were less likely to report having a research mentor and reported fewer peer-reviewed publications than men.[15,29,51] A strong mentoring relationship was associated with more publications[52] and achieving professional goals.[37] For early-career faculty, mentoring programs were associated with improved research skills, research productivity,[56,73] and satisfaction with academic achievement.[73]

Nineteen studies examined mentoring and career success.[17,21,22,25,34–36,39,45–47,59,60,66,70–72,74,76] Women were more likely than men to report mentorship as important to their career development,[34,47,66] yet they reported less mentoring,[22,35,72] career training,[47] career success,[21,22,45] and satisfaction with their mentoring experience[21,39,71] compared with men. In a study of psychiatry chief residents, having a defined mentor was associated with preparedness for independent practice (odds ratio, 1.99; 95% confidence interval, 1.18–3.36).[104] Mentoring was also associated with objective measures of career success,[70] including promotion.[36,76]

Similarly, despite regarding mentorship networks as more valuable, women were less likely to report effective mentoring in critical areas required for promotion, including clinical knowledge and technical skills.[71] Female physicians with male mentors of high academic rank reported more effective career sponsorship but were less likely to receive personal advice than female physicians with female mentors.[60] One study demonstrated that direct mentorship around leadership skills, as well as the presence of a female program director, was significantly associated with more interest in women in pursuing leadership roles.[17] In another study, the percentage of women among principal investigators increased from 10% to 55% ($P = .02$) after the implementation

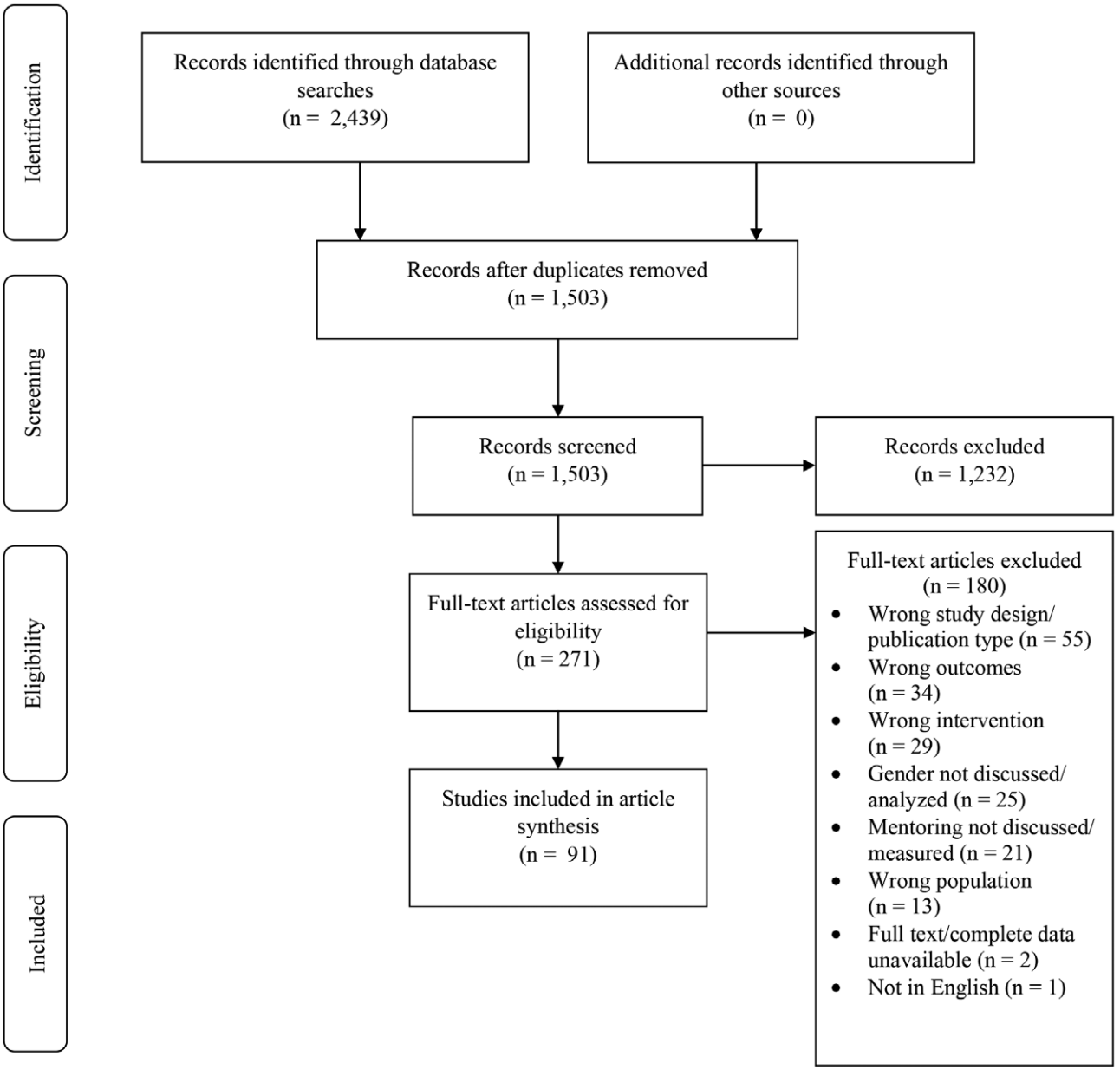

Figure 1 Study review and selection process for a systematic review of the literature on the impact of mentoring on women in academic medicine. The initial search was conducted on November 30, 2017, then repeated on March 20, 2020, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[136]

of a mentorship program.[25] However, women were more likely to report barriers to promotion, including little to no mentorship and limited time due to family responsibilities.[76]

Four studies examined mentorship and career satisfaction.[19,32,63,75] Retention and career satisfaction were lower for women than men. In one study, fewer female than male faculty members (56% vs 70%) reported an intention to remain in academic medicine for 10 years.[32] Additionally, female researchers reported receiving less support and finding less career satisfaction than male researchers.[19] Mentoring also predicted greater career satisfaction.[63,75]

Qualitative results

Descriptive characteristics of the included qualitative studies, most of which were high quality, are presented in Appendix 1. We identified 4 themes: (1) qualities of a desired mentor, (2) actions of a desired mentor, (3) barriers to successful mentoring, and (4) strategies for successful mentoring. Within each theme, we categorized the study findings according to the levels of the socioecological model: individual, interpersonal, and institutional. Within each level, we further categorized the findings into subthemes.

Qualities of a desired mentor. Sixteen studies reported findings on the qualities of a desired mentor (see Supplemental Digital Appendix 3 at http://links.lww.com/ACADMED/B217),[33,82,84,86,88–92,94–96,98–101] highlighting the importance of individual-level qualities in mentors. Gender match was desired by female mentees, as were role models for balancing family and career.[33,86,89–92,94,96,98–100] Female mentors notably provided advice regarding personal issues and work–life balance[86,89,90,92,98,100] and were especially

helpful for women in traditionally male-dominated fields.[91,96] Specific professional and personal attributes of desired mentors were also described,[84,86,88,89,91,95,100] as was the importance of a mentor's ability to create a personal connection and support a mentee.[88,91,95]

Actions of a desired mentor. Seventeen studies reported findings on the actions of a desired mentor (see Supplemental Digital Appendix 3 at http://links.lww.com/ACADMED/B217).[79,82,84,86–88,91–95,97,99–103] On the interpersonal level, ideal mentors helped mentees develop necessary skills for an academic career[86,87,99] by providing feedback,[95,100] promoting mentees,[94,95] and providing networking opportunities.[86,101] Mentors played an instrumental role in developing mentees' careers by advising and supporting concrete career steps,[82,84,86,99,100] helping mentees market their abilities,[95] and building their character.[82,86,87,92,95,97] On the institutional level, strong mentors promoted and sponsored their mentees in the department and in academic circles.[92,101,102]

Barriers to successful mentoring. Twenty-one studies reported findings on the barriers to successful mentoring (see Supplemental Digital Appendix 4 at http://links.lww.com/ACADMED/B217).[79–81,83,85,86,88–91,93–103] On the individual level, female mentees reported lacking time to find a mentor and maintain a mentoring relationship[80,93,99,101] and saw potential mentors as being overextended.[86,91,93]

On the interpersonal level, mentees reported a lack of appropriate mentors, based on gender,[80,81,85,96–98,100,102] underrepresented status,[94,101] and/or career stage.[98,100] Poor position or personality matches[79,90,95,99,102] and dissimilar values[89,90] were frequently reported as barriers. Three studies highlighted a perceived gender disadvantage. Women described limited strategies for finding a mentor[93] and less exposure to informal mentoring.[90,91] Female mentors were perceived to have limited influence to provide sponsorship and networking opportunities,[91] while male mentors were seen as less comfortable with discussions about work–life balance.[89] Instances of mentors' inappropriate behavior also were reported as barriers.[79,88]

Three studies reported female mentees' own insecurities as barriers, including their reluctance to initiate contact or share career decisions with mentors with influence over their career path.[91,93,101]

On the institutional level, barriers to successful mentoring included little incentive for faculty to provide mentorship,[83] policies that did not prioritize mentoring for female faculty,[83] and lack of structured mentoring programs.[80,101] Institutional culture was cited in 4 studies as another barrier.[80,93,94,101]

Strategies for successful mentoring. Nineteen studies suggested strategies for successful mentoring (see Supplemental Digital Appendix 4 at http://links.lww.com/ACADMED/B217).[81–84,86,88–97,99–102] On the individual level, mentees reported a desire for assistance in identifying potential mentors[93] and for senior professionals to take more initiative in forming mentoring relationships.[101]

On the interpersonal level, establishing a network of multiple mentors was repeatedly suggested as an approach to meet mentoring needs.[81,84,86,89,99,100,102] Mentees emphasized access to a variety of mentors, within and outside their department,[84] sharing key demographic characteristics and experiences.[88,94,97,100,101] One study suggested that relational mentoring was more important than gender concordance.[91] In developing mentoring networks, including an influential champion within the organization was recommended.[92,95]

On the institutional level, institutional commitment was seen as a prerequisite for successful mentoring, with mentoring being formally recognized as part of the organization's corporate strategy.[82] Recognizing individuals' mentoring contributions was also advised.[82,100] Formal mentoring programs were suggested to reinforce the importance of mentoring,[94,100,101] as was leveraging existing resources to create new mentoring programs.[86] Also discussed were institutional policies promoting mentoring and the creation of a diverse academic faculty to retain women and underrepresented individuals in academia so they may mentor others.[90,94]

Discussion

Ours is the first review to establish a baseline of knowledge regarding the efficacy of all forms of mentorship for female physicians, residents, and medical students and to include both quantitative and qualitative studies. Including both types of studies enabled us to provide a more comprehensive summary of the factors that influence the effectiveness of mentoring. The purpose of our review was to gather evidence of the impact of mentoring on women's career outcomes, as well as to enable institutions to instill evidence-based policies to promote the retention of women in academic medicine. We identified 91 studies that related to this topic. Our results add to the findings of previous systematic reviews[3–5,105] describing mentoring programs for women in academic medicine in that we explored both informal and formal mentoring and the effects of these programs on women's professional success and personal satisfaction.

We found several associations between mentoring and indicators of academic success, with important differences for women compared with men. Specifically, we identified consistent relationships between mentoring and research productivity, promotion, barriers to career advancement, career satisfaction, and network building.

Research productivity is integral to a successful career in academia. Yet, women are less likely to have research training and have lower publication rates than men, and men tend to have significantly more research scholarships, grants, and awards than women.[15,29] In our review, 7 studies reported that, regardless of gender, a strong mentoring relationship was associated with increased research productivity, based on both subjective reports of achieving professional goals and skills and objective measures such as research publications.[15,20,37,52,56,73,104] Mentoring could therefore be one strategy to offset gender disparities in research productivity.[106–108] Studies have proposed that lower research productivity for women may be due to different priorities (e.g., time spent on direct patient care, service, prioritizing teaching over research), time limitations given family obligations, lack of sponsorship, and lack of mentoring.[109–111] The recent impact of the COVID-19 pandemic on research productivity for women underscores this suggestion. A recent report described decreases in the number of manuscript submissions, first authorship, last authorship, and corresponding

authorship for women during the COVID-19 pandemic.[112]

Academic rank also plays an important role in research productivity for women. Studies show that women who achieve senior positions have comparable research productivity to their male counterparts.[52,110,113–116] A study by Kramer and colleagues showed that, even when women are publishing, they are underrepresented in terms of last authorship and have less access to key authorship positions, which could be rectified by adequate mentoring during manuscript creation.[111]

Levine and colleagues examined multiple reasons for women's early-career departure from academic medicine, detailing poor research mentorship as a contributing factor.[90] Another study suggested that early-career development and mentorship of female faculty could reduce productivity disparities.[109] Yet, few studies have looked at early-career research interventions and their effect on productivity. One such study examining a peer mentoring pilot program found an increase in the number of published papers, promotion in academic rank, and skills acquisition among female participants.[36]

The exact causes of gender disparities in research productivity are unclear and are likely multifactorial. Comparing research productivity among women with primary caregiving responsibilities and those without would be revealing. Future studies with larger sample sizes should examine the impact of mentoring interventions on improving research productivity and skills for women early in their career.

In the studies included in our review, women tended to report less career training and lower satisfaction with mentoring than men.[39,51] A cross-sectional study conducted by Levinson and colleagues found that mentorship positively correlated with time in research and numbers of publications.[52] While many of the aforementioned factors (e.g., time limitations) are difficult to address, organizing mentoring for women by facilitating mentor matches, providing mentor training, creating mentor networks, and supporting peer mentoring may provide tangible solutions to improving women's career satisfaction.

Women are underrepresented in higher ranking positions in academia due to persistent inequities that inhibit their advancement.[117] Female faculty are less likely to be full professors compared with male faculty, despite similar professional roles and achievements.[117] Furthermore, a survey of academic surgery faculty by Colletti and colleagues found that men were more likely than women to report intent to continue in their academic surgery careers.[32] In this context, we examined the relationship between mentoring and career development. Interestingly, quantitative studies reported that women were more likely than men to value mentoring as an important part of their career development, yet women reported a lower prevalence of mentoring.[21,48] In addition, in these studies, women reported relatively less career advancement and less satisfaction with their mentoring experience compared with their male colleagues.[21,39,48] Quantitative data also revealed that mentoring positively affected academic promotion and retention for junior faculty,[57] suggesting that institutions should invest more in formalized mentoring programs to help women connect with effective mentors.

Career satisfaction is another important facet of retaining women in academia. In a study of faculty with children at 24 randomly selected medical schools in the United States, women had less institutional support and lower career satisfaction than men.[63] In addition, female physicians have reported gender-based and sexual harassment as well as lower salaries and increased personal/family obligations, which also detract from their career satisfaction. Higher rates of divorce and suicide completion in female physicians have been reported as well.[118–120] However, several studies demonstrated that the presence of a mentor and/or role model was associated with increased career satisfaction.[19,32,63,75] Increasing access to mentoring and support in the form of sharing strategies to cope or navigate gender-specific stressors may improve well-being, career satisfaction, and retention for women in academic medicine.

Next, barriers to promotion must be considered. Wise and colleagues found that female obstetrics and gynecology faculty in Canada were more likely to report barriers to promotion compared with male faculty.[76] Similarly, Buckley and colleagues found women were more likely to report that promotion and tenure criteria had not been reviewed with them and that they had received less career development guidance.[121] In a qualitative study examining barriers to career advancement in women, Carr and colleagues found that gender discrimination, lack of mentoring, limited time for professional work, and the perception that the hierarchal structure in academia works against women all contributed to promotion barriers.[83] Interestingly, one study demonstrated that having a mentor doubled the likelihood of gaining promotion.[122] Further research addressing these barriers to promotion is paramount. Such studies should examine the impact of subsidized childcare and/or on-site childcare on women's rate of promotion.[123]

Our findings suggest that creating professional mentoring relationships and support networks may benefit women in academic medicine, specifically given the importance of mentors serving as advocates for female mentees.[79,84,94,95,103] Work by Wasserstein and colleagues suggests that building mentoring networks, including with peer mentors, may particularly benefit women by addressing disparities in career training and increasing overall career satisfaction.[75] Despite the importance of male mentors as sponsors,[60] another study found that female mentors are critical for providing personal advice and role modeling.[59]

The qualitative studies included in our review highlighted relationship building[88,91,93,95] as important to mentoring women, consistent with previous work. For example, women reported less exposure to informal mentoring and more difficulty finding mentors compared with men.[90,91] A study of 2 focus groups divided by gender conducted by McNamara and colleagues found that men had more strategies for finding mentors (e.g., identifying mentors through research, similar interests, friendship, networking), while women used more passive approaches,[93] possibly contributing to the lower prevalence of mentoring for women. The qualitative studies also emphasized that expanding access to mentoring networks across departments would benefit mentees professionally and personally.[86,89,100]

The included qualitative studies also pointed to factors that may contribute to more positive career outcomes and minimize barriers for women. Female mentors and mentors as role models emerged as important factors for women learning how to balance an academic career and family, as male mentors were perceived to be less comfortable discussing work–life balance. At the institutional level, these studies supported the funding, creation, and monitoring of formal mentoring programs, incentives for mentoring, and the inclusion of mentoring in institutional strategic planning.[83]

Limitations

We acknowledge several limitations in this review. As with prior reviews on mentoring women in academic medicine,[2] our search yielded mostly cross-sectional studies, small sample sizes, and low/missing response rates. In almost all studies comparing genders, women were only included in small numbers and were underrepresented relative to men. Despite these limitations and the potential for type II error, significant and consistent gender differences emerged in the quantitative data we reviewed. These studies suggested that women were disadvantaged in receiving mentoring and in the outcomes of research productivity, career success, and career satisfaction.

The quantitative studies with higher numbers of participants were primarily cross-sectional in nature. The controlled study of mentoring is challenging. How might one control for personality/interpersonal characteristics that could vary among mentors and mentees? How might one measure those potentially subjective characteristics that may contribute to effective mentoring? In addition, providing mentoring to one subset and withholding it from another is difficult to control and ethically worrisome, rendering the randomized controlled trial approach potentially ill-suited for studying the effects of such a socially complex issue. Not only is there variability in "dosages" of mentoring interactions, in terms of different amounts or depths of mentoring received, but there are also multiple mediating, moderating, and environmental complexities and conflicting goals of stakeholders, making an experimental design challenging. Finally, we recognize the limitations of comparing women and men and hope that future research can incorporate those who identify as nonbinary or third gender.

Future work

There has been increased support on a national level for studying the components of mentoring that contribute to academic success, including the Science of Mentoring, Networking, and Navigating Career Transition Points U01 Awards Program from the National Research Mentoring Network.[124] In addition, the National Science Foundation's ADVANCE grant program was founded to promote career development for women in science, technology, engineering, and medicine.[125] The ADVANCE program aims to enhance women's careers and eliminate gender inequities via mentoring models[125] as well as provide evidence for the benefits of faculty mentoring, as female assistant professors with a mentor had a higher probability of receiving grants than those without.[126] The ADVANCE Strategies for Effecting Gender Equity and Institutional Change Toolkit offers evidence-based recommendations to address system-wide barriers in the context of bias against women in academia.[127] Despite these resources, only a small number of academic institutions offer formal mentoring programs tailored for women. A recent systematic review identified 19 formal mentorship programs for women in academic medicine at the 190 identified medical institutions in the United States.[105] Significant barriers to implementing mentoring programs for women are not surprising; they include cost, lack of support staff, and time.[105]

The reported differences in mentoring experiences between men and women are multifactorial and require further study. Traditional gender roles may influence how men and women seek and use mentorship, and it is possible that mentors prefer mentees who are similar to themselves.[128] There also may be gender differences in the benefits mentees derive from various types of mentoring, ranging from the traditional dyad mentor–mentee relationship to peer and group mentoring.[129]

Future studies should explore the role of mentoring for women experiencing intersectional disadvantage, including social, economic, and political. Research should aim to understand the experiences of women who face structural barriers to mentorship and advancement, such as those based on race, sexual identity/orientation, age, and disability. Given the recent finding that topic choice may lead African American/Black scientists to receive lower rates of National Institutes of Health awards compared with White scientists,[130] future research should investigate the role of mentorship to improve diversity in academic medicine in the context of intersecting barriers to advancement. These issues call for broader research examining the impact on underrepresented faculty of mentoring strategies like creating an "intersectional research team,"[131,132] ensuring the inclusion of diverse study participants,[133] and incorporating an intersectionality analysis as part of the study design.[132,134]

Overall, the impact of mentoring on women in academic medicine warrants not only continued study but also action. A proactive approach from mentors to create personal connections may be beneficial to female mentees,[86,93] given reported barriers including time, limited strategies for identifying potential mentors, and a reluctance to initiate contact due to insecurities and traditional gender roles,[93] as well as stereotype threat and impostor syndrome. Resources that enable the development and optimization of formal mentoring programs are particularly important because, according to the literature, women have less access to informal mentoring than men.[38] It is also important to consider how women can effectively mentor other women.[135] Expanding access to informal networks of peers and diverse mentors and building networking skills are key. Furthermore, support and recognition for mentoring and tracking both career outcomes and personal gains for women are recommended. By establishing a baseline of knowledge in this review, our hope was to provide a foundation for future implementation and dissemination science research to ultimately mobilize institutional change.

Conclusions

Our review strongly suggests that mentoring in academic medicine is associated with increased research productivity, promotion success, career satisfaction, and academic retention

for both women and men. Yet, women report less mentoring, less research productivity, greater barriers to promotion, and lower levels of career satisfaction than men. Mentoring that includes relationship building and access to female mentors and role models is needed to improve the retention of women in academic medicine. Institutional efforts promoting formal mentoring programs, access to informal mentoring, incentives for mentoring, and flexible work policies are critical to promote an equitable academic career environment for women.

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Appendix 1

Characteristics and Quality Assessment of All Studies Included in a Systematic Review of the Literature on the Impact of Mentoring on Women in Academic Medicine

First author, year	Study design	Population/setting	Sample size	Response rate (%)	Participant age in years	% women in sample	Quality assessment
Qualitative studies							
Ayyala, 2019[78]	Thematic analysis	Johns Hopkins University School of Medicine faculty	23	Not reported	Not reported	Sponsors: 0%; protégés: 55%	High
Berlingo, 2019[79]	Mixed methods	Obstetrics–gynecology postgraduate trainees in France	204	70.7%	27.1	83.3%	High
Bernardi, 2020[80]	Mixed methods	Surgery residents and faculty at 4 academic surgery programs in United States	36	34%	Not reported	38.9%	High
Bettis, 2019[81]	Mixed methods	Female surgical faculty, surgical residents, and aspiring medical students at a single academic institution	83	Not reported	Not reported	42%	High
Buddeberg-Fischer, 2004[82]	Grounded theory	Junior medical faculty in Switzerland	40	Questionnaires: 80%; interviews: 85%	Not reported	58%	High
Carr, 2017[83]	Grounded theory	Medical faculty in United States	44	Not reported	Not reported	80%	High
Cochran, 2019[84]	Grounded theory	Female midcareer and senior academic surgeons in United States	15	Not reported	Not reported	100%	High
Dahlke, 2018[85]	Mixed methods	General surgery residents in United States	Questionnaires: 7,395; interviews: 98	Questionnaires: 99%; interviews: not applicable	Not reported	41%	High
DeCastro, 2013[86]	Thematic analysis	NIH K award recipients and mentors in United States	128	~20%	Not reported	76%	High
DeCastro, 2013[87]	Thematic analysis	NIH K award recipients and mentors in United States	128	~20%	Not reported	76%	High
Elliott, 2010[103]	Thematic analysis	Native American female faculty in United States	5	Not reported	Range: 42–60	100%	High
Jackson, 2003[88]	Thematic analysis	Junior medical faculty in United States	16	Not reported	Mean: 45	44%	High
Kass, 2006[89]	Thematic analysis	Senior medical faculty in United States	10	91%	Not reported	100%	High
Levine, 2011[90]	Thematic analysis	Junior medical faculty in United States	20	Not reported	Not reported	100%	High
Levine, 2013[91]	Thematic analysis	Medical students in United States	48	Not reported	Mean: 27; range: 24–35	100%	High
Lin, 2019[92]	Thematic analysis	Leaders of a women-focused academic emergency medicine organization	17	Not reported	Not reported	100%	High
McNamara, 2008[93]	Grounded theory	Medical residents in United States	21	27.7%	75% of women were 25–29; 25% were 30–34	57%	High
Roberts, 2020[94]	Thematic analysis	African American medical students interested in surgery at a single academic institution	16	Not reported	25	50%	Moderate
Salas-Lopez, 2011[95]	Case study	Senior leaders in United States	8	Not reported	Not reported	100%	High
Samuriwo, 2020[96]	Mixed methods	Female medical students at a single institution in United Kingdom	31	Not reported	Not reported	65.2%	High
Sánchez, 2018[97]	Mixed methods	Residents attending national professional conferences in United States	Questionnaires: 173; focus groups: 48	Questionnaires: 73%	85% of men were 18–34; 9% were > 34; 6% missing. 80% of women were 18–34; 10% were > 34; 10% missing.	52%	High

(*Appendix continues*)

Appendix 1
(Continued)

First author, year	Study design	Population/setting	Sample size	Response rate (%)	Participant age in years	% women in sample	Quality assessment
Seemann, 2016[98]	Mixed methods	Medical faculty in Canada	81	38%	2% were 25–35; 53% were 36–45; 33% were 46–55; 11% were > 55	100%	Low
Smith, 2019[99]	Mixed methods	Female gastroenterology trainees and consultant gastroenterologists	Questionnaires: 19; interviews: 11	Questionnaires: 31%; interviews: 31%	Not reported	100%	Low
Steele, 2013[100]	Mixed methods	Junior medical faculty in Canada	Focus groups: 8; interviews: 19	Focus groups: 7%; interviews: 23%	23% born between 1945 and 1962; 77% born after 1963	34%	High
Thackwell, 2018[101]	Thematic analysis	Black African medical specialists in South Africa	10	10%	35	50%	Low
Thompson-Burdine, 2019[102]	Thematic analysis	Current and former female surgical faculty at a single academic institution in United States	26	46%	Range: 32–64	100%	High
Quantitative studies							
Amonoo, 2019[13]	Cross-sectional	Senior residents at an academic medical center in United States	204	62%	65.2% were 30–39	47.1%	Low
Arlow, 2002[14]	Cross-sectional	Training program directors, graduating trainees in gastroenterology in United States	Program directors: 176; trainees: 393	Program directors: 80.7%; trainees: 49.7%	Not reported	19% of trainees	Moderate
Athanasiou, 2016[15]	Cross-sectional	Professors in the Faculty of Medicine at a public university in United Kingdom.	104	48%	Not reported	33%	Moderate
Bakken, 2005[16]	Cross-sectional	Medical students, postgraduate trainees, clinical instructors, assistant professors from the University of Wisconsin-Madison	124 (95 in analysis)	49.4%	Not reported	54%	Moderate
Bavan, 2019[17]	Cross-sectional	Obstetrics–gynecology residents in United States	202	4%	53% were 25–29; 43% were 30–34	86%	Moderate
Berry, 2017[18]	Cross-sectional	First-year psychiatry residents at Columbia University/New York Psychiatric Institute	Survey 1: 18/47; survey 2: 38/46	Survey 1: 38%; survey 2: 83%	Not reported	Not reported	Moderate
Biondi-Zoccai, 2015[19]	Cross-sectional	International cardiovascular researchers (undergraduate, graduate, assistant/associate/ full professors, resident/fellow, consultant)	247 (4 incomplete)	12%	31–40	31.6%	Low
Blood, 2012[20]	Cross-sectional	Faculty at Harvard Medical School and School of Dental Medicine	1,179	33.5%	Median: 44 (25th percentile: 38, 75th percentile: 52)	100%	High
Buddeberg-Fischer, 2012[21]	Cross-sectional	Radiologists in Switzerland	270	39.20%	29–75	23.7%	Moderate
Buddeberg-Fischer, 2005[24]	Cross-sectional	Medical school graduates in Switzerland	497	Not reported	23–44	54.7%	High
Buddeberg-Fischer, 2010[22]	Cross-sectional	Medical school graduates in Switzerland	579	81.4%	Mean: 35.1; range: 31–50	50.4%	Moderate
Buddeberg-Fischer, 2008[23]	Cross-sectional	Medical school graduates in Switzerland	406	Not reported	Mean: 33.2; range: 29–47	51.7%	Moderate

(*Appendix continues*)

Appendix 1
(Continued)

First author, year	Study design	Population/setting	Sample size	Response rate (%)	Participant age in years	% women in sample	Quality assessment
Byington, 2016[25]	Retrospective cohort	Junior faculty at the school of medicine and health sciences at the University of Utah	20	Not reported	Not reported	53%	Unclear
Caniano, 2004[26]	Cross-sectional	Pediatric surgeons in North America	75	79%	≤ 44, 45–55, > 55	100%	Moderate
Carapinha, 2017[28]	Cross-sectional	Faculty from 13 medical schools in United States	3,127	39%	≤ 44, 45–55, > 55	100%	High
Carapinha, 2016[27]	Cross-sectional	Faculty from 13 medical schools in United States	3,127 (3,100 met criteria)	39%	≤ 44, 45–55, > 55	100%	High
Chaiyachati, 2019[29]	Cross-sectional	Generalists in United States, graduates of research-intensive fellowship	162	51%	Not reported	64%	Moderate
Cochran, 2013[30]	Cross-sectional	Senior residents and early-career faculty at 8 academic medical centers in United States	Faculty: 69; residents: 85	53%	Residents mean (SD): 35.6 (7.2); faculty mean (SD): 44.1 (5.9)	Residents: 51.76%; faculty: 37.6%	Moderate
Coleman, 2005[31]	Cross-sectional	Obstetrics–gynecology residents in United States	4,590	97.2%	Not reported	75%	Moderate
Colletti, 2000[32]	Cross-sectional	Surgeons at 1 academic medical center in United States	54	47%	Not reported	17%	Moderate
DeCastro, 2014[33]	Cross-sectional	Clinician-researchers with NIH K08 and K23 awards in United States	1,275 (1,227 sample)	75%	Not reported	45.56%	Moderate
Donovan, 2009[34]	Cross-sectional	Program directors in dermatology in United States	53	49%	Not reported	17%	Moderate
Doyle-Scharff, 2014[35]	Cross-sectional	Psychiatry chairs at academic institutions in United States	45	Women: 10/12 (83%); men: 33/97 (34%)	Women (mean): 54.8; Men (mean): 58.0	27%	Moderate
Files, 2008[36]	Cross-sectional	Internists in internal medicine at 1 institution in United States	4	Not reported	Not reported	100%	Moderate
Fleming, 2015[37]	Case series	Early-career junior faculty in the Department of Pediatrics at Vanderbilt University School of Medicine	104	45%	Not reported	66%	Moderate
Foster, 2000[38]	Cross-sectional	Faculty at the University of Wisconsin Medical School	507 (489 complete)	61%	Not reported	26%	Moderate
Frank-Bertoncelj, 2014[39]	Cross-sectional	Young clinicians and researchers in rheumatology in Europe	248	Not reported	Median: 33	69%	Moderate
Fried, 1996[40]	Case series	Medical faculty at Johns Hopkins University	127	68%	Not reported	24%	Moderate
Gargiulo, 2006[41]	Cross-sectional	Residents in surgery and obstetrics–gynecology and medical students at the University of Vermont	141	47%	Not reported	63.8%	Low
Han, 2014[42]	Cross-sectional	Interns during medical internship in South Korea	61	70%	With mentors mean (SD): 26.5 (2.2); without mentors: 26.7 (2.0)	15.4%	Moderate
Harris, 2007[43]	Cross-sectional	Medical students from 3 academic vascular residency training programs in United States	140	38.9%	Not reported	100%	Moderate
Howell, 2015[44]	Cross-sectional	Faculty pathologists at a sample of medical schools in United States; APC members	Faculty: 9,600; APC members: 104	Faculty: 61.7%; APC members: 55%	63% were 46–65	Faculty: 40%; APC members: 8.6%	Moderate
Jagsi, 2017[45]	Cohort	Clinician-researchers receiving K08 and K23 awards in United States	1,275	75%	40	46.2%	High

(*Appendix continues*)

Appendix 1
(Continued)

First author, year	Study design	Population/setting	Sample size	Response rate (%)	Participant age in years	% women in sample	Quality assessment
Kaderli, 2015[48]	Cross-sectional	Surgical society members in Switzerland	512	58.9%	Median: 43	12.5%	Moderate
Kaderli, 2011[47]	Cross-sectional	Surgical society members in Switzerland	189	59.4%	Median: 33	100%	Moderate
Kaderli, 2010[46]	Cross-sectional	Surgical society members in Switzerland	189	59.4%	Not reported	100%	Moderate
Kosoko-Lasaki, 2006[49]	Cohort	Female faculty at 2 medical schools in United States	Unclear	Unclear	Unknown	100%	Unclear
Ku, 2011[50]	Cross-sectional	Medical students in United States	MSQ surveys: 10,508; GQ surveys: 10,502	Not reported	MS1: 23; MS4: 27	40%	High
Leibenluft, 1993[51]	Cross-sectional	Full-time doctoral faculty in academic departments of psychiatry in United States	1,923	55.2%	Not reported	18.7%	Moderate
Levinson, 1991[52]	Cross-sectional	Female faculty in departments of medicine in United States	558	83%	38	100%	Moderate
Lewis, 2016[53]	Randomized controlled trial	Underrepresented graduate students, fellows, junior faculty mentees, and medical faculty mentors in New York	150	Unknown	Not reported	83% (47% racial minority)	High
Lightner, 2005[54]	Cross-sectional	Female academic urologists trained in United States	121	61%	Not reported	100%	Low
Mason, 2016[55]	Retrospective observational cohort	Medical students completing an orthopedic surgery summer internship program in United States	118	98%	Not reported	24%	Moderate
Mayer, 2014[56]	Retrospective cohort	Female physicians at the instructor or assistant professor rank from a number of departments and disciplines at the Mayo Clinic in Arizona and Florida	16	79%	Not reported	48%	Moderate
Mayer, 2001[57]	Cross-sectional	General surgery residency graduates at the University of California, Davis	42	59%	Mean: 38	48%	Moderate
Morrison, 2014[58]	Retrospective cohort	Full-time medical faculty at the University of Toronto	611	100%	Not reported	35%	Moderate
Neumayer, 1993[59]	Cross-sectional	Members of the Association of Women Surgeons	676	45%	Mean: 39.6; range: 25–84	100%	Moderate
Ochberg, 1989[60]	Cross-sectional	Physician members of the American Medical Women's Association	241	48%	Not reported	100%	Moderate
Osborn, 1992[61]	Cross-sectional	Medical students, house staff, postdoctoral fellows, and junior faculty at the University of California, San Francisco School of Medicine	Medical students: 245; house staff: 186; postdoctoral fellows: 174; junior faculty: 115	Medical students: 58%; house staff: 15%; postdoctoral fellows: 21%; junior faculty: 57.5%	Not reported	39%	Moderate
Osborn, 2019[62]	Cross-sectional	Female radiation oncology residents in United States	125	74%	Birth year: 1986 (~31)	100%	Unclear

(*Appendix continues*)

Appendix 1
(Continued)

First author, year	Study design	Population/setting	Sample size	Response rate (%)	Participant age in years	% women in sample	Quality assessment
Palepu, 1998[63]	Cross-sectional	Medical faculty at 24 randomly selected medical schools in United States	1,302	43%	Mean among junior faculty with mentors: 41; mean among junior faculty without mentors: 45	54.6%	High
Pololi, 2015[64]	Cross-sectional	Faculty from a random sample of medical schools in United States	2,178	52%	Mean: 49	34%	High
Rohde, 2016[65]	Cross-sectional	Female medical student, resident, and practicing orthopedic surgeons in United States	232	42%	Not reported	100%	Moderate
Schrager, 2007[66]	Cross-sectional	Female academic family physicians in United States	159	13%	> 30	100%	Low
Shollen, 2009[67]	Cross-sectional	Female full-time faculty at the University of Minnesota Medical School	354	57%	Not reported	31%	Moderate
Shortell, 2008[68]	Cross-sectional	Vascular surgeons	135	5.6%	25 to > 46	12.5%	Low
Siddle, 2019[69]	Cross-sectional	Authors of emergency medicine research in United States	276	63%	55% women under 40	36%	Moderate
Stamm, 2011[70]	Cohort	Medical school graduates in clinical specialist training in Switzerland	711 at baseline and 326 at fifth follow-up	46%	Mean: 35.2; range: 32–49	52.8%	Moderate
Stephens, 2018[71]	Cross-sectional	Surgery residents in United States	288	78%	Not reported	25%	Moderate
Tosi, 1998[72]	Cross-sectional	Faculty and residents in academic orthopedics in United States and Canada	45 in panel	17% for panel	84% were < 45	Survey: 100%; panel: 47%	Moderate
Varkey, 2012[73]	Cohort	Female faculty (instructor or assistant professor) in the Department of Medicine at the Mayo Clinic in Rochester, Minnesota	19 mentees in 5 peer groups	17.9%	Not reported	100%	Moderate
Von Feldt, 2009[74]	Cohort	Junior medicine faculty at the University of Pennsylvania	Mentees: 61; mentors: 63	67%	Not reported	100%	Low
Wasserstein, 2007[75]	Cross-sectional	Faculty at the University of Pennsylvania School of Medicine	1,046	73%	Not reported	25%	Moderate
Wise, 2004[76]	Cohort	Faculty in departments of obstetrics–gynecology at 15 medical schools in Canada	Responded: 376; used: 299	72%	Mean: 43	37%	Moderate
Zakus, 2015[77]	Cross-sectional	Anesthesiology residency program directors; residents in anesthesiology in Canada	Program directors: 13; residents: 203	Program directors: 76%; residents: 39%	Mostly 25–34	39%	Moderate

Abbreviations: NIH, National Institutes of Health; MSQ, Matriculating Student Questionnaire; GQ, Graduation Questionnaire; SD, standard deviation; MS1, first-year medical student; MS4, fourth-year medical student; APC, Association of Pathology Chairs.