

Developing leadership in women's health research

Leadership in
women's
health research

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Abstract

Purpose – Recruiting medical students into women's health and gender-based medical research is important internationally. Medical student research training is critical for developing future women's health leaders who are adept at conducting high-impact research. This paper aims to describe a six-month medical student research fellowship in women's health in terms of fellowship recipients' publications related to their research project and future academic careers.

Design/methodology/approach – Targeted searches of fellowship recipients and their fellowship mentors were conducted in PubMed and Scopus from 2001–2017. Prior student fellows were also e-mailed and called to assess whether they held academic positions.

Findings – Since 2001, funds have been secured to support a total of 83 students (69 women, 14 men) in a mentored research experience in women's health and gender-based medicine. In total, 48 out of the 83 (57.8%) medical student fellowship recipients published at least one peer-reviewed research paper or scientific review related to their research project. Of the 50 prior recipients with a least five years of follow-up data (41 women, 9 men), 26 (52%) were in academic careers.

Research limitations/implications – Because this is an observational study and only medical students interested in women's health applied to be a student fellow, there is an inability to infer causality.

Practical implications – Following completion of the medical student research training fellowship in women's health, more than half of recipients published in peer-reviewed medical journals on their research project.

Originality/value – This study explores the association of an innovative medical student experience in women's health research on subsequent fellowship-related publications and career outcomes, contributing to



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the body of knowledge on the influence of a mentored research leadership program for medical students on academic professional development.

Keywords Public health, Women, Health leadership initiatives

Paper type Research paper

Introduction

Women's health research has significantly advanced over the past few decades (Feuerstein *et al.*, 2018). In addition to the traditional female organ-based research, biological and social differences between men and women have been found to influence a vast number of diseases, and addressing these differences is critical for effective prevention, management, and treatment interventions. Recruiting medical students into women's health and gender-based medical research is important in order to continue to advance this research internationally. Although women historically have been underrepresented in clinical research, in the USA in 1993, the National Institutes of Health (NIH) Revitalization Act mandated the inclusion of women in research studies. Recent efforts have further underscored the importance of examining sex and gender differences in the full spectrum of research (Pinn, 2003; Eshera *et al.*, 2015; Liu and Mager, 2016). However, despite these efforts, data analysis and the dissemination of findings rarely incorporate the role and significance of gender differences limiting translation of gender-based inferences into practice (Beery and Zucker, 2011; Foulkes, 2011; Liu and Mager, 2016; Potluri *et al.*, 2017). Research training focused on women's health is essential to foster analysis of sex and gender differences as well as translation of findings into practice across the globe (Clayton, 2016).

In addition, training of medical and other students frequently fails to incorporate a focus on gender-based differences. Modification of training programs to incorporate this focus on a national level is challenging. In the USA, research on gender differences was the focus of a report by the National Academy of Sciences, National Academy of Engineering and the Institute of Medicine. This report recommended that gender should be a fundamental component examined when designing and analyzing research studies in all fields and disciplines (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007). However, despite increases in the representation of women in clinical research, the role of sex or gender is not typically analyzed and translated into clinical and public health practice. Newer initiatives have sought to examine gaps in medical school curriculum regarding gender-based competencies and objectives; they indicate a lack of comprehensive coverage throughout curriculum in the United States (Miller *et al.*, 2012; Pfeleiderer *et al.*, 2012; Miller *et al.*, 2013).

Engaging and mentoring medical students in education and research focused on gender-based differences can aid in transforming future generations of clinicians and researchers to incorporate a gender-informed lens. FOCUS on Health and Leadership for Women is a dean-funded program at the Perelman School of Medicine at the University of Pennsylvania designed to improve the advancement and leadership of women faculty and to promote education and research in women's health. One of the flagship programs of FOCUS is the FOCUS Medical Student Fellowship (MSF) in Women's Health. The FOCUS MSF in Women's Health, which began in 2001, is a funded (a stipend is provided to all student fellows, full-time, six-month opportunity that is supplemental to the medical school curriculum. Selected students (both men and women) in their fourth year of medical school or as part of a "year out" of medical school take time away from the traditional curriculum to enhance their medical training by working intensively in a clinical, basic science, or

community-based setting while conducting an aspect of women's health research under the mentorship of a faculty mentor involved in the field. Overall, the FOCUS MSF program is designed to provide medical students with research, academic, and collaborative skills in the setting of a close, one-to-one mentoring relationship with a faculty member where students can see "close-up" the rewards and challenges of a research-oriented career. Research mentors paired with students applying to the FOCUS MSF program are full-time Perelman School of Medicine faculty who demonstrate commitment to their area of research expertise and enthusiasm for mentoring.

The fellowship strives to:

- expose selected medical students to an intensive research experience in women's health and gender-based medicine – broadly defined as either traditional women's health (e.g. areas in obstetrics and gynecology) or topics in any field for which the lens of sex and gender are driving the research question;
- encourage interest and investment in women's health and gender-based research early in training, thereby fostering potential career decisions that may build the pipeline to produce the next generation of leaders and researchers in the field; and
- target research toward the improvement of the health of women in vulnerable populations.

Our objective was to examine certain academic outcomes of past recipients of the FOCUS MSF in Women's Health from April 2001 to March 2018: poster and podium research presentations, manuscript publication including original research and scientific reviews, and non-peer reviewed publications related to their research in the FOCUS MSF.

We also assessed whether the prior MSF recipients were currently holding academic positions. We sought to describe the likelihood that recipients of the FOCUS MSF would have one or more research publications related to their research project and be employed in academic faculty positions.

Multiple sources of funding have supported the FOCUS MSF. Currently, consistent funding has been provided through the Bertha Dagan Berman Award, an endowment fund at the Perelman School of Medicine. Past funders have included the Edna G. Kynett Memorial Foundation, Patricia Kind, the Mary Siddons Measey Foundation, the RGK Foundation and Johnson and Johnson. This extramural funding pays for a stipend of \$7,500 for each MSF recipient for their six-month experience and the 5% full-time equivalent faculty director cost associated with running the program.

Methods

Description of the medical student research fellowship in women's health leadership

The FOCUS MSF in Women's Health provides students with far more than a research stipend and short-term opportunity; it offers a highly supervised, in-depth research experience with a skilled Perelman School of Medicine, University of Pennsylvania researcher, broad exposure to the Perelman School of Medicine research community, and a window into a career in academic medicine. A tenet of the FOCUS MSF is that the medical students design and carry out their own projects. The students often obtain institutional review board approval on their own, collect their own data and work on their own analyses. Thus, a key benefit of the FOCUS MSF is that the student researchers are involved in each stage of the research process and are supervised by experienced mentors. The students are also mentored by the FOCUS Director of Research Programs and have access to the skillset of other FOCUS leadership, including the Executive Director, Director of Professional

Development, Managing Director of Research Programs, and Director of Operations. The dedicated research time and mentoring relationships are major draws of the fellowship. Students are encouraged to maintain these relationships throughout medical school and beyond.

The key personnel in the FOCUS MSF include 5% full-time equivalent effort for a Faculty Director of Research Programs who provides the faculty oversight. The duties of the Faculty Director include generating applications for the program; vetting the proposed faculty mentors; ensuring the projects adhere to regulatory requirements; interviewing each applicant; monitoring project progress; overseeing and facilitating four research meetings over the six month research period with the medical students and faculty mentors; reviewing the midpoint and final reports required to complete the fellowship; providing scientific direction as student issues arise; offering career advice as students are interviewing and ranking their residency options; and, speaking at various venues across the Perelman School of Medicine to promote the fellowship. In addition, a small percentage of time is spent by an administrator for program coordination.

Students are selected through a written competitive application process, a Perelman School of Medicine transcript, and an in-person interview. Fellowship and mentorship opportunities are open to both men and women as evidence suggests that the inclusion of both genders in teaching and research may be most effective in promoting a gender perspective in medicine (Risberg *et al.*, 2003). Applications are judged on the following criteria: importance and relevance of the research project to women's health; study design, methodology and data collection; logistics and feasibility; and potential for impact on the medical student's career. Each application is reviewed by at least two members of the FOCUS leadership and all students undergo an in-person interview. Accepted students are required to meet weekly with their mentors and four times over the six months as a group with the FOCUS faculty leadership to discuss project updates, challenges, and career pathway mentoring. One group session covers basic statistical methods for research. At the final meeting, an extended two-hour session, all students make formal research presentations of their respective projects. All participating medical students are encouraged to present posters at a medical student research day and attend selected research presentations of the FOCUS Seminar Series, a lecture series designed for Perelman School of Medicine faculty highlighting cutting edge research at the Perelman School of Medicine.

Outcomes of the medical student research fellowship in women's health

This study aimed to determine the publication record and career choice outcomes for recipients of the FOCUS MSF. We obtained contact information from all prior FOCUS MSF students through the University of Pennsylvania's Perelman School of Medicine Registrar's office as well as the Office of Alumni Relations. Consent was obtained from participants and study approval was obtained by the Institutional Review Board of the University of Pennsylvania.

Prior FOCUS MSF participants were initially e-mailed in early January 2018 and were contacted in chronological order, as earlier recipients were expected to be farther along in their professional careers and have more updates to share. An e-mail template was created for reaching out to all past recipients, requesting the following information: accurate contact information, current position, and any publications, posters, or oral presentations that came out of, or were linked to, their research done in the FOCUS MSF. Repeat e-mails were sent to prior FOCUS MSF recipients if no response was received two weeks after the initial e-mail. If no response was obtained after the second e-mail, we attempted to contact prior FOCUS MSF recipients by telephone. In the e-mails, we also asked past recipients if they would be

willing to speak with us on the phone so that our team could learn more about if/how the fellowship may have influenced their academic and professional journeys. Through our e-mail exchanges, we inquired about poster and podium research presentations as well as manuscript publications including original research and scientific reviews related to the FOCUS MSF. We also asked about non-peer-reviewed publications and obtained information on residency match results. Follow-up e-mails were sent in early and late February 2018, and we followed-up with telephone calls in March, April and May 2018.

We conducted PubMed searches of all FOCUS MSF recipients and their fellowship mentors. The same search was conducted in Scopus. We combined and verified the results of the searches with the responses we received over e-mail regarding poster and podium research presentations, manuscript publication including original research, and scientific reviews related to the FOCUS MSF. Many of the e-mail responses shared explicitly which publications, abstracts and presentations were linked to FOCUS MSF research. For those who only sent back a CV as their initial reply, we reviewed the titles of their publications as a preliminary assessment of a link to the FOCUS MSF. If a preliminary link was determined, an internet search was used to peruse the list of additional authors on the paper to link the publication to the FOCUS MSF and the mentor/mentee relationship. Our criteria for counting publications included an examination of the title and abstract to discern whether or not the publication was a result of the MSF as well as co-authorship of the medical student and their mentor. For prior FOCUS MSF recipients who we were unable to contact, we searched on publically available websites for information about current employment in addition to our PubMed and Scopus searches for publications as a result of the MSF. We carefully reviewed websites to confirm that the physician on the website attended the Perelman School of Medicine and the year of graduation matched. The University of Pennsylvania's Perelman School of Medicine Registrar's office as well as the Office of Alumni Relations helped to verify our search results and the current employment and location of prior FOCUS MSF recipients.

Descriptive statistics were employed to examine the characteristics of prior FOCUS MSF recipients within the whole sample. The main outcomes of our study were:

- one or more published peer-reviewed research paper(s) or scientific review(s) that directly resulted from the research done in the FOCUS MSF; and
- retention in academic careers

We considered an academic career to include working for a university or for the government in biomedical research.

Analyses were conducted using STATA (College Station, TX version 14). This study was approved by the Institutional Review Board of the University of Pennsylvania.

Results

Since the inception of the FOCUS MSF in 2001, FOCUS has secured funds to support a total of 83 medical students (69 women, 14 men) in a mentored research experience in women's health. The majority of recipients were women (83.1%). The most commonly matched residency specialties were Internal Medicine (35.0%), Obstetrics and Gynecology (19.4%), Psychiatry (9.6%), and Family Medicine (6%). However, matched residency specialties revealed a diverse range of specialties including Dermatology (4.8%), Radiology (2.4%), Plastic Surgery (2.4%) and Ophthalmology (2.4%) among others. [Table 1](#) contains descriptive statistics for FOCUS MSF recipients completing the FOCUS MSF between 2002–2018.

LHS 33,3	Gender	N (%)
	Male	14 (16.9)
	Female	69 (83.1)
	<i>Residency-matched specialties</i>	
	Anesthesia	1 (1.2)
	Dermatology	4 (4.8)
	Emergency Medicine	3 (3.6)
	Family Medicine	5 (6.0)
	Internal Medicine	29 (35.0)
	Neurology	3 (3.6)
	Obstetrics and Gynecology	16 (19.4)
	Ophthalmology	2 (2.4)
	Otolaryngology	2 (2.4)
	Pediatrics	4 (4.8)
	Plastic Surgery	2 (2.4)
	Preventive Medicine	1 (1.2)
	Psychiatry	8 (9.6)
	Radiology	2 (2.4)
	Surgery	1 (1.2)
	<i>Publications</i>	
	1 or more peer-reviewed publications related to the fellowship project	48 (57.8)

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Table 1.
Characteristics of
FOCUS MSF
recipients completing
fellowships between
2002 and 2018
(N = 83)

In total, 48 (57.8%) FOCUS MSF recipients published a peer-reviewed paper with their mentors; of these recipients, five presented a poster at a national meeting and six gave an oral presentation at a national meeting related to their research project. In total, 35 (42.2%) recipients did not publish a peer-reviewed paper; of this group, one published a non-peer reviewed paper, two presented a poster at a national meeting and two had an oral presentation at a national meeting related to their research project. Of the 50 prior recipients with a least five years of follow-up data (41 women, 9 men), 34 (68 %) responded to our e-mail or telephone call (28 women and 6 men). The remaining prior recipients (13 women, 3 men) all had follow-up information obtained from PubMed and publicly available websites. The Scopus search did not produce any additional findings. Our results demonstrated that, of the 50 prior recipients with a least five years of follow-up data, 26 (52%) were in academic careers. This five-year time frame considers acceptance into and completion of the vast majority of residency training.

Discussion

The FOCUS MSF provides medical students with a unique research opportunity to conduct a women's health research project under the guidance of a faculty mentor. Medical student research programs have been documented in the literature but this is the first publication, to our knowledge, of a women's health research program for medical students where women's health is defined broadly as not only traditional obstetrics and gynecology research but research in any specialty that uses a gender lens to analyze data. Medical student research program outcomes have largely focused on academic productivity and residency selection (Zier and Stagnaro-Green, 2001; Rosenblatt *et al.*, 2006; Dorrance *et al.*, 2008; Allen *et al.*, 2009; Smith *et al.*, 2009; Burge and Hill, 2014; Bierer *et al.*, 2015; Toledo *et al.*, 2016; Steinman *et al.*, 2020). Publication has been shown to be the single strongest correlate with pursuit of a career in academic medicine (Ledley and Lovejoy, 1992). One study focused on medical

students who chose a women's health related research project as part of their program's research requirement and their likelihood of entering women's health related residency programs (Chongsiriwatana *et al.*, 2005). Chongsiriwatana *et al.* (2005) found that students who completed a women's health project were nearly twice as likely to enter a residency in women's health as those who participated in other fields of research.

Since 2001, the FOCUS MSF has trained 83 medical students and over half of them published a peer-reviewed research paper or scientific review that was the result of the research they accomplished as a FOCUS MSF. Over half the FOCUS MSF recipients with at least five years of follow-up data were currently in academic careers. Our results suggest that students who participate in the FOCUS six-month MSF have a high likelihood of achieving important outcomes that reflect a measure of success of the program.

The limitations of this research are worth noting. We evaluated publication and career outcomes of a single program developed within a specific institutional environment in the United States limiting generalizability to other student populations and university environments internationally. For example, comparing publication productivity of medical students at universities without established programs to promote and sustain the advancement of medical students while simultaneously fostering research related to women's health would not be appropriate. Few programs have incorporated gender-based medicine making a comparison of programs challenging. However, our findings may be relevant to other institutions that have similar student populations, research missions and relevant resourced environments. This evaluation was also conducted internally as funding was not available for an independent assessment of the program. Second, participation in the FOCUS MSF was not randomly assigned, and selection bias may influence characteristics of the sample. Thus, implications drawn from these findings may only be applicable to students with particular characteristics associated with the selection process. Furthermore, we needed to supplement our results with searches of publicly available websites to determine the percentage of prior FOCUS MSF recipients currently in academic careers. However, we attempted to verify our search results with the University of Pennsylvania's Perelman School of Medicine Registrar's office as well as the Office of Alumni Relations. Finally, one of our aims was to examine publications related to women's health research conducted as a result of the fellowship and we acknowledge that this is not a full assessment of participants' overall research productivity or their future accomplishments. A higher success rate of the fellowship would be indicated by examining many more outcomes post-fellowship; however, our outcomes were limited by the data that we had available. Future work in this area may benefit from collecting data regarding committee involvement, public policy influence, and participation in commercial fields of research.

Despite limitations, our findings demonstrate that the research of the FOCUS MSF recipients contribute to research in women's health nationally. Medical student research training in women's health is an important approach for attracting and developing future women's health and gender-based medicine researchers. It is likely that the mentoring that students received facilitated their development as researchers and for many, it may have facilitated their entrance into an academic career. Several of the men and women who participated in the fellowship, reported that their longitudinal development has been fostered by the network of mentors in the program and quality of the relationships established between the students and their mentors. Many of the FOCUS MSF recipients expressed a feeling of gratitude for the research experience, mentoring, networking, and research skills obtained.

Other mechanisms available for medical students interested in carrying out a research project include government programs such as at the National Institutes of Health and programs with support from foundations. Most programs for medical students are disease-specific and the role of sex or gender is not a priority. Even at schools with an American Medical Women's Association (AMWA) chapter, designation as a federally funded National Center of Excellence (CoE) in Women's Health, and/or the site of an NIH-funded Building Interdisciplinary Research Careers in Women's Health (BIRCWH) Career Development Program, medical students may not benefit from the full spectrum of women's health research experiences (Henrich *et al.*, 2008). To foster the importance of gender-based medicine in research and academic institutions, we need to report informing evidence of the success of programs specifically targeting women's health and gender-based medicine research experiences for medical students, like the FOCUS MSF, to garner political and institutional support. Integrating competencies related to sex and gender into medical education and clinical practice will provide more effective, tailored and evidenced-based care for all. The FOCUS MSF is one way for sex and gender competencies to be embedded in the University's medical education offerings (McGregor *et al.*, 2013).

The importance of physicians as clinical researchers is evidenced in the literature. Amgad and colleagues conducted an integrated mixed-methods systematic review and meta-analysis of published studies about medical students' participation in research. In all, 79 articles met inclusion criteria. They found that medical student participation in research was associated with improved short- and long-term scientific productivity, informed career choices and improved knowledge about-, interest in- and attitudes towards research. On average, approximately one-third (30%, 0.30, 0.19–0.44) of research performed by medical students resulted in a peer-reviewed journal publication. The review did not explicitly indicate that any of the programs were specifically focused on women's health research which highlights the unique role of the FOCUS MSF program (Amgad *et al.*, 2015). As more training programs incorporate gender-based medicine, an evaluation of comparative effectiveness of program components will enhance our understanding of program success.

Furthermore, the Commission on Education of Health Professionals for the 21st Century, updated the benchmarks for an ideal medical school curriculum. The governing committee strongly recommended a model that encouraged adaptability of the conventionally rigid curricula to include incorporating the role of community-level factors such as through engagement in research activities (Frenk *et al.*, 2010). Nevertheless, the inclusion of research training in medical curriculum has wide variation between programs and findings indicate that there has been a decline in the number of physician-scientists in the USA (Guelich *et al.*, 2002). Medical students represent an underdeveloped, potential pool of future physician-scientists poised to overcome medical challenges (Steinman *et al.*, 2020). With adequate training, medical students become clinicians that can contribute in critical ways to the advancement of women's health and gender-based medicine through direct clinical observation and experience. Lastly, research experience may improve skills (e.g. critical thinking, gender perspective) that are fundamental in clinical practice (Jacobs and Cross, 1995).

Conclusion

The FOCUS MSF program is a model of research training and career mentoring associated with markers of leadership, academic success, and proclivity. This unique research experience provides medical students with the opportunity to gain knowledge, skills and confidence to not only perform high quality women's health research but also critically evaluate gender-based biological and social differences and apply inferences in their

research and clinical careers. Programs such as the FOCUS MSF could be developed at other institutions to promote interest and skills in women's health.

References

- Allen, J.G., Weiss, E.S., Patel, N.D., Alejo, D.E., Fitton, T.P., Williams, J.A., Barreiro, C.J., Nwakanma, L. U., Yang, S.C., Cameron, D.E., Gott, V.L. and Baumgartner, W.A. (2009), "Inspiring medical students to pursue surgical careers: outcomes from our cardiothoracic surgery research program", *The Annals of Thoracic Surgery*, Vol. 87 No. 6, pp. 1816-1819.
- Amgad, M., Man Kin Tsui, M., Liptrott, S.J. and Shash, E. (2015), "Medical student research: an integrated Mixed-Methods systematic review and Meta-Analysis", *PLoS One*, Vol. 10 No. 6, p. e0127470.
- Beery, A.K. and Zucker, I. (2011), "Sex bias in neuroscience and biomedical research", *Neuroscience and Biobehavioral Reviews*, Vol. 35 No. 3, pp. 565-572.
- Bierer, S.B., Prayson, R.A. and Dannefer, E.F. (2015), "Association of research self-efficacy with medical student career interests, specialization, and scholarship: a case study", *Advances in Health Sciences Education*, Vol. 20 No. 2, pp. 339-354.
- Burge, S.K. and Hill, J.H. (2014), "The medical student summer research program in family medicine", *Fam Med*, Vol. 46 No. 1, pp. 45-48.
- Chongsiriwatana, K.M., Phelan, S.T., Skipper, B.J., Rhyne, R.L. and Rayburn, W.F. (2005), "Required research by medical students and their choice of a women's health care residency", *American Journal of Obstetrics and Gynecology*, Vol. 192 No. 5, pp. 1478-1480.
- Clayton, J.A. (2016), "Studying both sexes: a guiding principle for biomedicine", *The FASEB Journal*, Vol. 30 No. 2, pp. 519-524.
- Committee on Maximizing the Potential of Women in Academic Science and Engineering (2007), *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, Washington, DC, The National Academies Press.
- Dorrance, K.A., Denton, G.D., Proemba, J., La Rochelle, J., Nasir, J., Argyros, G. and Durning, S.J. (2008), "An internal medicine interest group research program can improve scholarly productivity of medical students and foster mentoring relationships with internists", *Teaching and Learning in Medicine*, Vol. 20 No. 2, pp. 163-167.
- Eshera, N., Itana, H., Zhang, L., Soon, G. and Fadiran, E.O. (2015), "Demographics of clinical trials participants in pivotal clinical trials for new molecular entity drugs and biologics approved by FDA from 2010 to 2012", *American Journal of Therapeutics*, Vol. 22 No. 6, pp. 435-455.
- Feuerstein, I.M., Jenkins, M.R., Kornstein, S.G., Lauer, M.S., Scott, P.E., Raju, T.N.K., Johnson, T., Devaney, S., Lolic, M., Henderson, M. and Clayton, J.A. (2018), "Working together to address women's health in research and drug development: summary of the 2017 women's health congress preconference symposium", *Journal of Women's Health*, Vol. 27 No. 10, pp. 1195-1203.
- Foulkes, M.A. (2011), "After inclusion, information and inference: reporting on clinical trials results after 15 years of monitoring inclusion of women", *Journal of Women's Health*, Vol. 20 No. 6, pp. 829-836.
- Frenk, J., Chen, L., Bhutta, Z.A., Cohen, J., Crisp, N., Evans, T., Fineberg, H., Garcia, P., Ke, Y., Kelley, P., Kistnasamy, B., Meleis, A., Naylor, D., Pablos-Mendez, A., Reddy, S., Scrimshaw, S., Sepulveda, J., Serwadda, D. and Zurayk, H. (2010), "Health professionals for a new century: transforming education to strengthen health systems in an interdependent world", *The Lancet*, Vol. 376 No. 9756, pp. 1923-1958.
- Guelich, J.M., Singer, B.H., Castro, M.C. and Rosenberg, L.E. (2002), "A gender gap in the next generation of physician-scientists: medical student interest and participation in research", *Journal of Investigative Medicine*, Vol. 50 No. 6, pp. 412-418.

- Henrich, J.B., Viscoli, C.M. and Abraham, G.D. (2008), "Medical students' assessment of education and training in women's health and in sex and gender differences", *Journal of Women's Health*, Vol. 17 No. 5, pp. 815-827.
- Jacobs, C.D. and Cross, P.C. (1995), "The value of medical student research: the experience at stanford university school of medicine", *Medical Education*, Vol. 29 No. 5, pp. 342-346.
- Ledley, F.D. and Lovejoy, F.H. Jr (1992), "Prospects for academically trained pediatricians in academic medicine", *Clinical and Investigative Medicine. Medecine Clinique et Experimentale*, Vol. 15 No. 6, pp. 518-526.
- Liu, K.A. and Mager, N.A. (2016), "Women's involvement in clinical trials: historical perspective and future implications", *Pharmacy Practice*, Vol. 14 No. 1, p. 708.
- McGregor, A.J., Templeton, K., Kleinman, M.R. and Jenkins, M.R. (2013), "Advancing sex and gender competency in medicine: sex and gender women's health collaborative", *Biology of Sex Differences*, Vol. 4 No. 1, p. 11.
- Miller, V.M., Flynn, P.M. and Lindor, K.D. (2012), "Evaluating sex and gender competencies in the medical curriculum: a case study", *Gender Medicine*, Vol. 9 No. 3, pp. 180-186 e183.
- Miller, V.M., Rice, M., Schiebinger, L., Jenkins, M.R., Werbinski, J., Nunez, A., Wood, S., Viggiano, T.R. and Shuster, L.T. (2013), "Embedding concepts of sex and gender health differences into medical curricula", *Journal of Women's Health*, Vol. 22 No. 3, pp. 194-202.
- Pfleiderer, B., Burghaus, D., Bayer, G., Kindler-Rohrborn, A., Heue, M. and Becker, J.C. (2012), "Integration of gender-specific aspects into medical curricula—status quo and future perspectives", *GMSZ Med Ausbild*, Vol. 29 No. 5, No Doc65.
- Pinn, V.W. (2003), "Sex and gender factors in medical studies: implications for health and clinical practice", *JAMA*, Vol. 289 No. 4, pp. 397-400.
- Potluri, T., Engle, K., Fink, A.L., Vom Steeg, L.G. and Klein, S.L. (2017), "Sex reporting in preclinical microbiological and immunological research", *mBio*, Vol. 8 No. 6.
- Risberg, G., Johansson, E.E., Westman, G. and Hamberg, K. (2003), "Gender in medicine - an issue for women only? A survey of physician teachers' gender attitudes", *International Journal for Equity in Health*, Vol. 2 No. 1, p. 10.
- Rosenblatt, R.A., Desnick, L., Corrigan, C. and Keerbs, A. (2006), "The evolution of a required research program for medical students at the university of Washington school of medicine", *Acad Med*, Vol. 81 No. 10, pp. 877-881.
- Smith, W.H., Rogers, J.G., Hansen, T.N. and Smith, C.V. (2009), "Early career development in academic pediatrics of participants in the APS-SPR medical student research program", *Pediatric Research*, Vol. 65 No. 4, pp. 474-477.
- Steinman, R.A., Proulx, C.N. and Levine, A.S. (2020), "The highly structured physician scientist training program (PSTP) for medical students at the University of Pittsburgh", *Acad Med*.
- Toledo, P., McLean, S., Duce, L., Wong, C.A., Schubert, A. and Ward, D.S. (2016), "Evaluation of the foundation for anesthesia education and research medical student anesthesia research fellowship program participants' scholarly activity and career choices", *Anesthesiology*, Vol. 124 No. 5, pp. 1168-1173.
- Zier, K. and Stagnaro-Green, A. (2001), "A multifaceted program to encourage medical students' research", *Academic Medicine: Journal of the Association of American Medical Colleges*, Vol. 76 No. 7, pp. 743-747.

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