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## Revisiting menstruation: the misery, mystery, and marvel

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Pad Man, a Bollywood film inspired by an Indian man's quest to create and distribute low-cost sanitary pads, debuted to critical and box office success worldwide in 2018. This artistic accomplishment for menstrual health coverage was no small feat considering that at the time of the film's release, 40% of girls in Delhi were missing school during their period,<sup>1</sup> with up to 23% of Indian girls estimated to drop out completely when they begin menstruating.<sup>2</sup> Many women in India and throughout the world still face shame and stigma during their period, being forced into potentially dangerous isolation because of the belief that they are unclean, immoral, or associated with evil.

Although the statistics related to school absenteeism or the exclusion of menstruating girls and women are not as dire in the United States, the stigmatization of menstruation still has far-reaching implications. In the United States, for example, most states offer sales tax exemptions for necessities (groceries, medical purchases, etc) but offer no such exemptions for menstrual hygiene products such as pads or tampons. This lack of exemption, called by activists the tampon tax, has come under fire in recent years, with even the US House of Representatives being called out for refusing to allow funds to pay for menstrual hygiene products in congressional offices.

Society's conversation about menstruation, or the deafening lack thereof, may be changing. Former First Lady Michelle Obama spoke directly about menstrual hygiene management at the World Bank in April 2016, and Meghan Markle has chosen menstrual health hygiene as a signature issue.<sup>3</sup> Writing for the *Time Magazine* in 2017, she highlighted the stigma surrounding menstruation, especially in low-resource settings wherein feminine hygiene supplies, proper sanitation and facilities, education, and open dialogue are all lacking, and called for increased efforts to break the cycle of "period poverty."

Capitalist interest seems not far behind these humanitarian calls: the global feminine hygiene market, currently more than \$23 billion, is expected to grow to \$34 billion by 2023. In

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addition, “femtech”—software, diagnostics, products, and services that use technology to improve women’s health—is predicted to be a \$50 billion industry by 2025 (a staggering increase considering the term was only coined in 2016).<sup>4</sup> Companies such as Thinx (absorbent underwear for periods), Clue (one of hundreds of period and ovulation-tracking applications [apps]), and NextGen Jane (working toward a “smart tampon” and described by its founder in the manuscript by Hilary Critchley [submitted]) have all seen commercial success or increasing venture capital interest in recent years.

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Even the sports world is joining the conversation: amid the celebrations of the US Women’s Soccer Team’s World Cup win came news of 1 of the “secret weapons.” Team trainers had brought in menstruation research consultants to help personalize training, sleep, and diet regimens tailored to each player’s menstrual cycles.<sup>5</sup> The tactic made headlines; even world-class athletes and training teams had until this point simply overlooked the impact of menstruation on overall health and wellness.

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Capitalizing on this public shift in interest and emerging science, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) held the “Menstruation: Science and Society” meeting on September 20–21, 2018. The goal of the meeting was to discuss promising new discoveries and avenues of research surrounding menstruation. Speakers and attendees included leaders in the field with expertise in endometrial biology, “omic” analysis of the endometrium or menstrual effluent, new sampling or imaging modalities, smart technologies and apps and mobile health platforms, and health literacy and dissemination frameworks. The meeting was designed to help answer, from an array of perspectives, “What can we (as investigators, healthcare providers, and patients) learn from the uterine endometrium and menstruation?” The meeting encompassed both insights provided by the normally functioning endometrium, as well as the potential of diagnostics for abnormal functioning and disease. Most importantly, the meeting incorporated the science of menstruation with the broader societal implications of that process, including the unique considerations necessary in menstrual health communications, population health research, and public health outreach.

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The manuscript that follows carries forward discussions started at the meeting between the diverse group of speakers and participants, seeking to break down academic, linguistic, and logistic barriers between disciplines that study menstruation. By simple necessity, the meeting and the resulting manuscript are limited in scope. By no means an indicator of importance, aspects of the cyclicity of menstruation and the symphony of hormonal players required for this cycling are not covered in any detail. However, the process and experience of menstruation are probed from multiple perspectives. The basic biology of the endometrium is investigated by leading experts in the basic sciences, covering the latest research in the endometrial microbiome and stem cell populations and revisiting what we know about the biology of menstruation, both healthy and in conditions such as fibroids and abnormal uterine bleeding. Pioneering new research into using menstruation and effluent as a biofluid for disease diagnosis is discussed by the researchers and small business leaders at the forefront of these technologies. These coauthors put forward the pragmatic, yet provocative, message that menstrual effluent is a monthly natural biopsy that can be directly collected by the menstruator and that utilizing this previously discarded biospecimen could

empower menstruators as drivers of their own gynecologic health inquiries. Finally, and key to the importance and lasting impact of this work, the authors frame these scientific advances within the experience of menstruation, asking “How does society communicate, manage, and understand menstruation, both domestically and globally?” Through these sections, the authors track the typically private act of menstruation through its public understanding and political ramifications.

Responding to the societal context of menstrual health management and literacy, the scientific opportunities for menstruation research, and the dialogue of the 2018 meeting and the manuscript that follows, the NICHD Strategic Plan 2020<sup>6</sup> states that, “Understanding the basic biology of healthy reproductive development, especially the role of menstruation and endometrial biology, could lead to new avenues for addressing gynecologic conditions.” The NICHD sees this research, and its integration with the broader clinical and cultural implications, as fundamental to achieving its newly unveiled vision of “Healthy Pregnancies. Healthy Children. Healthy and Optimal Lives.”

The 2018 Menstruation: Science and Society meeting and the robust discussion that follows this editorial are intended to serve as a call to action for all stakeholders interested in menstrual health research. For its part, the NICHD remains committed to encouraging new research insights and expanding partnerships to address interrelated basic, translational, and societal questions about menstruation and menstrual health. Menstrual health is a fundamental aspect of health, and the time of taboo should be ended. Period.

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