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Book

Pregnancy and the origins of illness

The effects of the COVID-19 pandemic are expected to be felt for years after the virus is contained. Alongside the more than 5.5 million COVID-19 deaths globally, there have been massive shifts in how we understand and practise medicine and public health, transformations of global economies, and losses in livelihoods, health, education, and security. There is also the disquieting prospect that our current trauma could have lasting intergenerational impacts—that children gestated or born during this pandemic might carry an imprint of their mother’s experience with lifelong and inheritable consequences. It is this notion—the “bewitching idea that the environment in which you are gestated leaves a permanent imprint on you and your future generations”—that Sarah Richardson explores in her enlightening book, *The Maternal Imprint: The Contested Science of Maternal-Fetal Effects*.

Richardson, a renowned historian and philosopher of science, begins her book with research on the intergenerational impacts of the Holocaust. Citing psychiatrist and neuroscientist Rachel Yehuda’s studies of Holocaust survivors and their children, Richardson introduces the burgeoning field of developmental origins of health and disease (DOHaD) and its use of epigenetics—analyses of heritable changes that affect gene expression but not DNA sequence—as a means to measure and characterise the impact of the gestational environment. In recent years, epigenetic changes traced to gestation have been linked, if tenuously, to a child’s future risk of conditions ranging from obesity to asthma to poor response to stress. In a study now widely cited in academic and social contexts, Yehuda measured levels of DNA methylation at a particular genetic locus in Holocaust survivors and their adult children, and found them to diverge in opposite directions when compared with controls. She and her team pointed to such differences as “support [for] an intergenerational epigenetic priming of the physiological response to stress in offspring of highly traumatized individuals”. The data have been taken up as evidence that trauma can be genetically encoded and inherited, thereby “situating”, as Richardson puts it, “the maternal-fetal interface at the nexus of intergenerational trauma”.

How should we think about the rise of a new science that implicates maternal bodies in this way, especially in the present context of COVID-19? We know that SARS-CoV-2 infection in pregnancy is associated with increased risks of severe COVID-19 and adverse pregnancy outcomes. Despite these risks, some pregnant individuals have not taken up COVID-19 vaccines, partly due to concerns about vaccines untested in pregnant populations. Infection aside, no-one is immune to the wide-ranging stressors that the pandemic has entailed. Although vertical transmission of SARS-CoV-2 is very rare, to what extent might maternal bodies be understood as vectors in the transmission of our collective loss?

Although COVID-19 is not mentioned in *The Maternal Imprint*, Richardson speaks with clarity to such questions, and to policy makers, scientists, physicians, and pregnant people and parents who will inevitably encounter them. Deploying the tools of history, philosophy, and gender studies of science, Richardson’s elegant analysis of the long history and current status of efforts to study so-called maternal effects reveals scientific claims about the “long reach of the womb [to be] at once beguiling, challenging to validate, stubbornly persistent once launched, and beset by scientific controversy” and suggests we ought to interpret such claims with a fair amount of caution.

First is the problem of crypticity—a term Richardson helpfully uses to describe the tenuousness of the links between cause and effect that characterise maternal effects science. Unlike teratology, in which the impact of a prenatal exposure can be immediately observable, as exemplified by major congenital defects linked to the drug thalidomide, the effects of interest in DOHaD studies are typically small, influenced by ongoing social processes and environments (eg, obesity), difficult to measure (eg, response to stress), and often manifest at a temporal distance from the initial exposure. As Richardson’s rich history of maternal effects science makes clear, these are not new challenges—they are emblematised, for instance, by efforts in the 1960s and 1970s to link birthweight, race, and social inequality, to which she attends in detail. Moreover, the challenges of crypticity are not redressed by epigenetic technologies—even, as she argues in a robust chapter-long critique of the emerging science, among the boldest new research programmes.

What is particularly compelling about Richardson’s approach is that by situating the field’s challenges in a
broader social and historical context, we get a sense of why they matter. Crypticity matters, she argues, because it requires a “permissive approach” to constructing narratives of causation, and gives latitude to scientists to ask provocative questions about the impact of developmental exposures on the health of generations to come. Perhaps more importantly, crypticity creates space for social assumptions and values to enter the chain of causal reasoning, which can be powerfully distorting when pregnant people are concerned.

A second reason for caution, then, is that in maternal effects science, social assumptions can have an outsized and distorting role because they concern the gendered politics of reproduction. Given the entanglement of reproduction with broad political, economic, and cultural institutions and ideologies, such assumptions can reflect and amplify inequality and oppression when applied to scientific questions about the maternal-fetal interface. One of the most powerful social assumptions is that mothers are responsible for the outcomes of pregnancy. In many contexts, the tendency to ascribe responsibility to mothers has led to realms of everyday advice directed at pregnant people, which may lack robust evidence or accentuate precaution, as well as blaming mothers for pregnancy outcomes well beyond their control. This stance has also led to a range of ethical violations, including the incarceration of pregnant people for adverse pregnancy outcomes and efforts to restrict the autonomy of pregnant individuals who do not follow medical advice or appear not to act in the best interests of their offspring. Maternal effects science manifests at least two additional concerns. The first is that a focus on maternal responsibility allows for the accumulation of causal attributions in DOHaD principally around pregnancy and maternal experiences of those who may or may not be responsible for their offspring. As Richardson notes, the proximate foundations of fetal origins science can be traced to the work of British epidemiologist David Barker who postulated that conditions of poverty during gestation can lead to heart disease in adulthood. Indeed, contexts of deprivation or disaster—the Holocaust, the Dutch famine, a major ice storm in Quebec—continue to ground the field’s most prominent research streams. To the extent that DOHaD research has consistently looked outside the maternal body for sources of harm, it reminds us of the importance of the social determinants of health, and that the “gestational environment” is best understood not as the womb but as the much broader environment in which a person gestates. And it is that broader environment—rather than maternal behaviours or choices—towards which we might best direct ameliorative efforts, such as by mitigating the harms of climate change, racism, and a range of structural inequities and inequalities. These efforts are especially relevant in the context of the collective trauma of and the immense disparities laid bare during the COVID-19 pandemic.

In the likelihood that epigenetics might be used to explore the long shadow of our current trauma, Richardson’s book offers an important lens through which we can regard claims about the role of maternal bodies, highlighting reasons for caution. As Richardson notes, some regard epigenetics as evidence of an “embodied mechanism of memory”—a way for the body to convey and perhaps honour the past. She reminds us too that fetal programming science must also recognise and honour the interests and experiences of those who may or may not, through gestation, pass such histories along.

Anne Drapkin Lyerly
Department of Social Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-7240, USA
alyerly@email.unc.edu

Further reading

Erskine KT. Everything in its path: destruction of community in the Buffalo Creek flood. New York: Simon & Schuster, 1976

Iacovacci G. Covid-19 and pregnancy: vaccine hesitancy and how to overcome it. BMJ 2021; published online Sept 14. https://doi.org/10.1136/bmj.n2862

Jamaesdj DJ, Rasmussen SA. An update on COVID-19 and pregnancy. Am J Obstet Gynecol 2021; published online Sept 14. https://doi.org/10.1016/j.ajog.2021.08.054

Lyerly AD, Mitchell LM, Armstrong EM, et al. Risk and the pregnant body. Hastings Cent Rep 2009; 39: 34–42

Lyerly AD, Little MO, Faden RR. A critique of the “fetus as patient”. Am J Bioeth 2008; 8: 42–44

Rosner E. Survivor cafe: transforming the legacy of intergenerational trauma. Berkeley, CA: Counterpoint, 2017

Paltrow LM, Flavin J. Arrests of and forced interventions on pregnant women in the United States, 1973–2005: implications for women’s legal status and public health. J Health Polit Policy Law 2013; 38: 299–343

Rovin-Fish M, Buchinder M, Walker R, eds. Understanding health inequalities and justice. Chapel Hill, NC: University of North Carolina Press, 2016

Silver RC, Holman EA, Gafin DR. Coping with cascading collective traumas in the United States. Nat Hum Behav 2021; 5: 4–6

Weiss SQ, Bilodeau-Bertrand M, Liu S, Auger N. The impact of COVID-19 on pregnancy outcomes: a systematic review and meta-analysis. CMAJ 2021; published online July 15. 193: E540–48

WHO. Definition and categorisation of the timing of mother-to-child transmission of SARS-CoV-2: scientific brief, 21 April 2021. Geneva: World Health Organization, 2021

Yehuda R, Daskalakis NP, Birrer LM, et al. Holocaust exposure induced intergenerational effects on FKBP5 methylation. Biol Psychiatry 2016; 80: 372–80

Yuko E. COVID-19 is traumatizing all of us. How will we cope after it’s over? Rolling Stone, May 5, 2020

Richardson SS, Daniels CR, Gillman MW, et al. Society: don’t blame the mothers. Nature 2014; 522: 131–32