**Freezing Time? The Sociology of Egg Freezing**

**Kit C Myers**Roanoke College

**Lauren Jade Martin**Penn State Berks

ljm37@psu.edu

**Published in *Sociology Compass*** (2021), 15: e12850. <https://doi.org/10.1111/soc4.12850>

**Keywords**: egg freezing, oocyte cryopreservation, assisted reproductive technologies, fertility medicine, medicalization, biomedicalization, gender, family, temporality, gamete markets

**Abstract:** In the past decade, social scientists and bioethicists have produced a significant body of work tracking the technical, legal, ethical, and sociocultural development and implications of human egg freezing. What began as a treatment to “preserve” the fertility of cancer patients has transformed into a technology enabling delayed childbearing. We provide an overview of four research areas that have received the most attention in the sociological and anthropological literature of egg freezing: medicalization, gender, temporality and risk, and markets. What emerges from much of the research is the sense that egg freezing has become entangled with cultural imperatives to take future-oriented responsibility for one’s own health, financial, social, and reproductive needs through self-management, risk reduction, calculation, and optimization. Throughout, we consider the implications of this novel reproductive technology within national and transnational “reproflows” that stratify reproduction along raced and classed lines.

**Freezing Time? The Sociology of Egg Freezing**

The first live birth from frozen eggs was achieved in 1986, shifting the possibility of fertility intervention back in time (Chen, 1986). However oocyte cryopreservation—commonly known as egg freezing—remained relatively uncommon until the early 2000s, when techniques and outcomes improved (Grifo & Noyes, 2010; Setti et al., 2014). During oocyte cryopreservation, ovaries are hormonally stimulated to over-produce mature eggs, which are then surgically retrieved and frozen, then later thawed, fertilized, and implanted via *in vitro* fertilization (IVF) (Chen, 1986). Although no international registry exists to track egg freezing outcomes, by 2008 at least 936 babies had been born worldwide using frozen eggs (Noyes et al., 2009). In the United States, member clinics of the SART reported 31,624 cycles started for oocyte banking for fertility preservation between 2014 and 2017, and a preliminary report of an additional 13,274 cycles in 2018 alone [(Society for Assisted Reproductive Technology, n.d.)](https://www.zotero.org/google-docs/?ThBNDc). In the United Kingdom, the HFEA reports almost 2000 cycles in 2018 [(Human Fertilisation and Embryology Authority, 2020)](https://www.zotero.org/google-docs/?p6Bw2F).

These statistics do not indicate whether the egg freezing cycles were “medically-indicated” (e.g. for female cancer patients at risk of treatment-induced sterility), or “elective” or “social” egg freezing for healthy women delaying childbearing. Distinct narratives accompany these two forms of egg freezing, with medical egg freezers lauded for putting off life saving treatments to enable future motherhood, and elective egg freezers criticized for “selfishly” putting personal development ahead of motherhood (Martin, 2010). Surveys of egg freezing programs suggest that patient populations skew toward high-income unmarried heterosexual White women (e.g. Hodes-Wertz et al., 2013). Unmarried heterosexual women have been the target population for egg freezing from its invention as a means of allowing unmarried cancer patients to freeze unfertilized eggs, rather than freezing embryos with donor sperm, which was the previous best practice. While married women will generally prefer to freeze embryos using their husband’s sperm (or a mutually selected sperm donor), unmarried heterosexual women generally prefer to freeze eggs--despite lower success rates--as this leaves biological paternity open to a future partner (Grifo & Noyes, 2010). While the high price of egg freezing—about $10,000 to $20,000 per cycle—undoubtedly contributes to the income skew, the unequal distribution of access to assisted reproductive technologies (ARTs) is also indicative of broader systems of stratified reproduction that mark the fertility of some raced and classed populations as worthy of preservation and others as in need of prevention (Bell, 2014; Roberts, 2009).

Scholars in reproductive medicine, bioethics, law, and the social sciences have produced a significant body of work tracking the technical, legal, ethical, and sociocultural development and implications of egg freezing. Sociologists and anthropologists, in particular, are well-placed to analyze the rhetoric and meanings associated with egg freezing, which touches on several central topics of these fields, including kinship, technology, medicine, gender, political economy, and social change. Below, we provide an overview of this social science research on egg freezing, focusing on four subjects that we find have received the most attention: medicalization, gender, temporality, and markets. We conclude by providing some ideas for future scholarship.

**Medicalization and Biomedicalization**

Egg freezing proves to be a productive case for the study of the “medicalizing” properties of a new biotechnology. Medicalization is the process by which natural life processes and social problems are recast as medical conditions to be treated by medical practitioners. Medical sociologists cite natural parts of the life course including aging and reproduction as typifying examples of medicalization (Barker, 1998; Brubaker & Dillaway, 2009; Conrad, 2007; Rothman, 2000; Zola, 1976). Researchers also focus specifically on the medicalization of infertility and its treatment, including artificial insemination, IVF, and third-party egg transfer (Bell, 2016; A. Greil et al., 2011; A. L. Greil & McQuillan, 2010; Johnson & Fledderjohann, 2012; Rogalin & Brooks, 2018). By constructing the inability to have biological children as a medical problem, medical practitioners claim authority to both define and treat the condition of infertility. People who cannot have children are transformed into patients obligated to seek professional medical help. The medicalization of infertility also occurs within a business context, in which lucrative procedures and pharmaceuticals are offered and marketed by a multi-billion dollar fertility industry [(Spar, 2006)](https://www.zotero.org/google-docs/?C8Bl7E).

***The Medicalization of Anticipated Infertility***

Medicalization is an expansive process, and as Martin (2010) argues, the medicalization of infertility has expanded to include not only those who have received an infertility diagnosis, but also those for whom future infertility is anticipated due to medical treatment or aging. As a relatively recent technology whose scientific protocols and professional guidelines have been in flux since the early 2000s, egg freezing allows us to view medicalization in action. In guidelines published in 2008, the American Society for Reproductive Medicine (ASRM) recommended against non-medical egg freezing in part because the technology was still deemed to be experimental [(Practice Committee of the SART and Practice Committee of the ASRM, 2008)](https://www.zotero.org/google-docs/?qzQz4G). This status remained until another set of guidelines were released by the ASRM in 2013, removing the “experimental” status, and expanding the criteria for which egg freezing would be appropriate. In addition to women who may become infertile as a result of medical treatments, infertile couples undergoing IVF who cannot cryopreserve embryos were also deemed good candidates for egg freezing. Freezing eggs primarily as a means to delay childbearing, however, was still not recommended until 2018, as described below (Daar et al. 2018; Practice Committee of the ASRM and the Practice Committee of the SART, 2013).

Martin (2010) describes egg freezing as a “technomedical” solution aimed at increasing women’s chances of preserving their ability to have genetically-related children. This desire for genetic relatedness is primarily a *social* rather than *medical* concern, Martin argues, even for those whose anticipated infertility will result from medical treatments. Inhorn, Birenbaum-Carmeli, and Patrizio (2017) note that iatrogenic fertility loss may cause psychological and social harm, undermining self-esteem, gender identity, and ontological security. Egg freezing, which precedes and in some cases delays therapy for cancer patients, “treats” the potential stigma and devastation of fertility loss by offering psychological respite. In their ethnographic study of American and Israeli cancer patients, Inhorn et al (2017) find that egg freezing may be viewed by patients as a “hopeful technology” for those who dream of a cancer-free future with biological children. However, the authors write, these dreams cannot displace the reality that egg freezing guarantees neither the ability to have children nor recovery from cancer.

Unlike with iatrogenic fertility loss, medicalization is more straightforwardly apparent with age-related fertility decline. By classifying anticipated infertility as a medical problem that can and should be prevented, egg freezing becomes a prophylactic technology. Shkedi and Hashiloni-Devi (2011) note that whereas, at the time of their publication, American and European reproductive medicine associations and practitioners did not recommend healthy women freeze eggs to delay pregnancy, this was not the case in Israel, where egg freezing was explicitly recommended to prevent the “medical” problem of age-related infertility. The authors regard this as “classic medicalization,” wherein infertility is redefined “to include the inability to conceive naturally beyond women’s fertile years” (Shkedi-Rafid & Hashiloni-Dolev, 2011, p. 293). Meanwhile, American and European professional associations caught up with the Israeli medical field, lifting the experimental label and repackaging egg freezing as a preventative medical technology (Daar et al., 2018; Dondorp et al., 2012). The American Society for Reproductive Medicine adopted the terminology “planned oocyte cryopreservation” to replace “nonmedical,” “elective,” and “social” egg freezing, finding those terms “trivializing and insufficiently respectful of the fact that the treatment is being undertaken to avert infertility that, if it arises, will in fact be a medical condition” (Daar et al., 2018, p. 1023). However, Stoop et al. (2014) argue against the terms “nonmedical” and “social” egg freezing not because they are trivializing, but because they are misnomers since the freezing of oocytes always already occurs in a medicalized context. “Banking for ageing,” they write, “is therefore part of continuous medicalization of society, rather than a medical intervention with a nonmedical or social indication” (Stoop et al., 2014, p. 550). Although different regions of the world produced varied responses and practice guidelines regarding egg freezing for “nonmedical” reasons, there is now a growing international medical consensus greenlighting egg freezing for the purpose of delayed childbearing.

***Biomedicalization***

Sociologists also recognize egg freezing as a sign of biomedicalization. Working from Clarke et al’s (2010) definition, these authors argue that biomedicalization extends medicalization by integrating the need to manage and mitigate risks and threats to health through preventative efforts and surveillance (Baldwin, 2019a, 2019b; Bhatia & Campo-Engelstein, 2018; Martin, 2010). Baldwin (2019a, 2019b) argues that technologies intended to monitor and/or extend fertility (including egg freezing and ovarian reserve testing) advance the biomedicalization of reproductive aging. These technologies help optimize the timing of conception and provide a type of “individualised risk knowledge” about fertility potential through “pseudo quantification” of the number of eggs they have “banked” for the future (Baldwin, 2019b). Bhatia and Campo-Engelstein (2018) support the biomedicalization framework by outlining shifting discourses about nonmedical egg freezing in statements by professional medical associations and in media narratives. They identify a “two-step process” of biomedicalization. First, anticipated infertility is pathologized and medicalized, with egg freezing offered up as treatment. Second, egg freezing is reimagined as a feminist tool to simultaneously optimize women’s life and fertility options (Bhatia & Campo-Engelstein, 2018). Pushing this further within a reproductive justice framework, biomedicalized imperatives to optimize fertility could support nationalist, patriarchal, and white supremacist projects of reproductive control, tasking some groups and individuals to expand their fertility while clamping down on the reproductive options of others.

**Gender and Motherhood**

Studies of egg freezing raise important sociological questions about gender ideology, norms, and inequality. What influence do existing gendered social structures play in the use and promotion of egg freezing technologies and, alternatively, how does/will egg freezing influence gender norms and social relations? Sociologists and anthropologists of reproduction examine the gendered aspect of technologies such as IVF (Becker, 2000; S. Franklin, 1997; A. L. Greil et al., 1988), artificial insemination and sperm banking (Daniels & Golden, 2004; Moore, 2007; Wahlberg, 2018), egg donation and vending (Almeling, 2011; Leve, 2013), and surrogacy (Jacobson, 2016; Ziff, 2019). Demand for and use of ARTs are inflected with norms of maternal sacrifice and altruism, stigma related to infertility and childlessness, associations of fertility and virility with femininity and masculinity, and heteronormative biogenetic familial relations. By attending to whose bodies ARTs and fertility treatments manipulate, draw organic materials from, and substitute for, it becomes evident how these technologies are not only gendered but also *racialized* (Deomampo, 2019; Martin, 2018; Roberts, 2011; Speier, 2016). Egg freezing continues and expands conversations about gender’s role in assisted reproduction, raising new questions about gender, including norms of kinship, mothering, heteronormativity, and reproductive justice and autonomy.

***Intensive Mothering and Gendered Ideologies of Motherhood***

As with other ARTs, egg freezing extends the possibility of biological (and genetic) parenthood to those who might otherwise remain childless or adopt because of social or biomedical status. Technologies that prioritize biogenetic kinship could in turn reinforce stigma associated with childlessness and adoption.The marketing of egg freezing and ovarian reserve testing, along with public awareness campaigns about age-related fertility decline, increases the imperative for women to not only *think* proactively about their reproductive futures, but to *act* upon them (Baldwin, 2019a, 2019b; Kyweluk, 2020; van de Wiel, 2020; Waldby, 2015a). This reinforces the gender ideology linking womanhood to motherhood--particularly *biological* and *genetic* motherhood--as a social obligation (Bühler, 2015; Martin, 2010). As more women can have biological children at later ages, public perceptions and legal standards of motherhood likewise shift (Bühler, 2015; Rothmar Herrmann & Kroløkke, 2018; van de Wiel, 2020).

Oocyte cryopreservation is only available to those who can afford to pay thousands of dollars to freeze and store eggs or whose insurance or workplace covers it. This dynamic may uphold and exacerbate class-based social norms about the timing of pregnancy as it relates to ideas about good parenting. Drawing on qualitative interviews with users of egg freezing technology in the U.K. and U.S., respectively, Baldwin (2017, 2018, 2019a) and Myers (2017) explore how gendered ideologies of mothering factor into women’s motivations to cryopreserve ova. Gendered expectations of parenting, particularly intensive mothering (Hays, 1996), play a role in women’s decisions to delay children by freezing eggs. Ambivalence and anxiety about culturally-based and gendered norms of mothering--including self-sacrifice, stable relationships, child-centeredness, and financial investment--contribute to a desire to put off parenting until women’s relationships, careers, and emotional maturity can handle those burdens. By freezing eggs, interview participants put off deciding about motherhood while mitigating the risks of fertility decline associated with delayed childbearing (Baldwin, 2017, 2018, 2019a; Myers, 2017). Providers, marketers, the public at large, and users themselves may frame egg freezing as a responsible choice for young women to make when they do not feel ready to become mothers. Those women who put eggs on ice could be championed for displaying foresight and responsibility by both enabling future genetic kinship and extending time they may use to improve their social, emotional, and financial positions to eventually become “good” intensive mothers.

Having a committed romantic partner as a co-parent is a central component of this form of “good” motherhood and the absence of a committed partner is the most common motivation for elective egg freezing, despite the widespread narrative of women delaying pregnancy in order to advance their careers (Baldwin et al., 2019; Brown & Patrick, 2018; Ikhena-Abel et al., 2017; Inhorn, Birenbaum-Carmeli, Birger, et al., 2018; Inhorn, Birenbaum-Carmeli, Westphal, et al., 2018; Waldby, 2015a). When the goal of romantic partnership is just as strong as the goal of having a child, desiring a child at some point is not always enough to motivate people to pursue child rearing on their own, as single women did in Hertz’s (2006) study on single-mothers-by-choice. Instead, some choose to delay childbearing until a partner is found. Heterosexual women may use this neoliberal strategy that Carroll and Kroløkke (2018) define as “responsible reproductive citizenship” in their study of U.S. women who froze their eggs. Women bear primary cultural responsibility for childbearing, child rearing within committed relationships, ensuring future healthy children, and securing financial security, and therefore freezing eggs while relatively young and healthy is the mark of a responsible reproductive citizen who acts to manage risk at the limits of fecundity (Carroll and Kroløkke 2018; Rottenberg 2016).

***Gender Inequalities***

Work-family conflict, the gender pay gap, lack of universal paid family leave policies, and child care expenses all contribute to fundamental gender inequalities. By extending the so-called biological clock and allowing women time to accumulate savings and advance in their careers, egg freezing for nonmedical reasons is described by proponents as a way to reduce gender inequality and increase reproductive autonomy (Daar et al., 2018; Goold & Savulescu, 2009). In their qualitative study of Turkish women, the majority of whom were highly educated and in professional and managerial occupations, Göçmen and Kılıç (2018) find that structural inequalities played a role in their participants’ decisions to freeze their eggs, and that many of them used the language of “empowerment” to describe this choice. The authors note, however, this is only a “palliative” solution that does not change social and political conditions that drive delayed childbearing or the demand for egg freezing in the first place (see also Browne, 2018; Cattapan et al., 2014). This would seem to buttress the point made by Inhorn (2017) about the demographics of European and North American women who have frozen their eggs in order to delay childbearing: the technology is highly skewed towards professional, highly educated white women. We posit that egg freezing should be brought into discussions about the ambivalent role of ARTs in achieving reproductive justice.Any individual benefits of egg freezing would not extend towards reducing inequalities for the majority of women who do not have access to egg freezing and/or who would prefer to make work compatible with family rather than put off childbearing(Smietana et al., 2018). Instead of placing the burden on individual women to resolve the “hard choices” (Gerson, 1985) of work and family commitments by freezing their eggs, we need collective responses by governments and employers.

**Temporality and Risk**

Egg freezing also presents a productive case for a theoretically rich interrogation of temporality. Proponents tout the purported ability of egg freezing to “stop,” “snooze,” or “freeze” the biological clock (Blyth et al., 2013; Dana, 2012; Helft, 2016; Weigel, 2016), which helps reveal the socially constructed nature of time. Using ARTs to delay pregnancy produces a number of potentially destabilizing identities, including “eleventh hour moms,” “miracle moms,” “the radiant forties mother,” and the “grandmother mother” (Bühler, 2015; Friese et al., 2006; van de Wiel, 2014, 2020). Egg freezing both responds to and contributes to a broader shift from a smooth, standardized, linear understanding of the reproductive life course to an increasingly flexible, de-standardized, non-linear life course marked by iterative cycles (Beck, 1992; Giddens, 1991).

Egg freezing subverts our commonsense understanding of linear time. First, egg freezing is fundamentally future-oriented and therefore rooted in abductive reasoning (Adams et al., 2009; Bowker et al., 2016; Myers, 2014; van de Wiel, 2015, 2020). Second, egg freezing allows for novel means of temporal management of conflicting timelines (Baldwin 2019a; Baldwin et al., 2019; Brown & Patrick, 2018; Martin, 2010; Waldby, 2015a).

***Abduction, Prudentialism, and Risk Society***

Abductive reasoning involves making decisions in the present moment based on projected or anticipated futures. In this way, individuals “tack back and forth” between present and future, projecting a range of possible futures, judging their likelihood and implications, and making decisions about present action on the basis of these imagined futures (Adams et al., 2009). Egg freezing exemplifies abductive reasoning; in deciding to freeze eggs, the patient calculates her chances of future infertility—drawing on general knowledge of age-related fertility decline, family and personal medical history, individual ovarian reserve testing, and personal education, career, or relationship goals—and concludes that she should preserve some reproductive materials as a means of addressing this anticipated future infertility (Martin, 2010; Myers, 2014; van de Wiel, 2020; Waldby, 2015a). In the quintessential abductive move, egg freezers are making present decisions based on their imagined futures, illuminating the non-linear relationship between present and future. Egg freezing provides a valuable case for studying abduction and extending theory on temporality and the means by which social actors arrive at decisions under conditions of uncertainty.

The future discursively “colonizes” the present through this abductive loop of present-future-present (Myers, 2014). As described earlier, embedded within the medicalization of childless women is the long-standing gendered ideal of self-sacrifice in service of motherhood and a relatively novel repro-genetic imperative that establishes genetic continuity as the “gold standard of motherhood” (Baldwin, 2018, 2019a; Bühler, 2015; Carroll & Kroløkke, 2018; Martin, 2010; Myers, 2017). ARTs, in general, and elective egg freezing, in particular, are emblematic of the neoliberal risk society, in which individuals are expected to accept greater responsibility for risk management (Beck, 1992; Giddens, 1990). Egg freezing is a fundamentally prudential and actuarial technology, evident in the common representation of egg freezing as “fertility insurance” or a “fertility savings account” (Martin, 2010; Myers, 2017; Waldby, 2015a).

Risk society, characterized by the disintegration of traditional value systems, is fundamentally linked to the increasing destabilization of the life course that sets patients up for future infertility (Beck, 1992; Giddens, 1990). Most patients engage in elective egg freezing because they are currently delaying childbearing due to difficulties establishing a stable conjugal household or to pursue education or career development. In these ways the detraditionalization of the life course—the expansion of non-domestic opportunities for women, higher levels of relationship instability and dissolution, and increasingly de-standardized and non-linear life course trajectories—sets the stage for elective egg freezing.

Further, egg freezing is emblematic of the neoliberal turn toward individual “responsibilization” for risk management and “entrepreneurialism of self,” in which individuals must “invest” in themselves to optimize their outcomes and bear the consequences of “inadequate” risk management (Giddens, 1990; Gordon, 1987; Rose, 1999, 2007). By “optimizing” fertility timing to proactively address risks of age-related infertility and fetal chromosomal abnormality, elective egg freezing illustrates neoliberal rationality within family structure, gender norms, life course sequencing, and the medicalization of reproduction (Baldwin, 2017, 2018; Baldwin et al., 2019; Carroll & Kroløkke, 2018; Kılıç & Göçmen, 2018; Myers, 2017).

Rottenburg (2016, 2018) uses egg freezing as an exemplary technology of neoliberal feminism and governmentality for affluent women. She argues that the expansion of elective egg freezing and, particularly, the inclusion of egg freezing in employee benefits packages places pressure on upwardly-mobile women to invest in their own futures through careful planning, smart self-investment, and postponing fertility to enable career development (Rottenberg, 2016, 2018). Reproduction is increasingly stratified such that professional-class women outsource the reproductive labor of childcare and even gestation to “disposable” women who are not “properly responsibilized” neoliberal citizens (Rottenberg, 2016, 2018). These observations clarify the role of egg freezing in broader systems of stratified reproduction and raced and classed hierarchies that structure and enable the exploitation of reproductive labor (Bell, 2014; Colen, 1995; Myers, 2017; Rottenberg, 2016).This line of research extends our understanding of how ARTs, including egg freezing, enable and reveal the differential value of reproductive materials and labor, reinforcing raced and classed hierarchies of maternal worth and reproductive citizenship.

***Temporal Management***

In line with Martin’s (2017) proposed integration of biological and sociocultural limits to fertility, several scholars have engaged productively with egg freezing as a means of managing conflicting timelines (Baldwin 2019a; Baldwin et al., 2019; Brown & Patrick, 2018; Inhorn, Birenbaum-Carmeli, Birger, et al., 2018; Inhorn, Birenbaum-Carmeli, Westphal, et al., 2018; Waldby, 2015a). The popular press tends to focus on how egg freezing may reconcile conflicts between the reproductive timeline and educational and career timelines, enabling women to save “eggs for later” so they can focus on developing their careers during their twenties and early thirties (van de Wiel, 2014, 2015, 2020). Egg freezing is proposed as a treatment for many of the temporal disruptions of late modernity, including the extension of education and the destabilization and extension of the life course (Inhorn, Birenbaum-Carmeli, Westphal, et al., 2018; Waldby, 2015a).

Just as the changing nature of education and work have produced extended, non-linear timelines in public life, personal timelines relating to relationship and household formation have also become non-linear and less predictable (Waldby, 2015a). Several elements of the political economies of household formation complicate fertility timing, particularly the rising costs of household formation and childrearing, as well as the growing disparity between college education among men and women, leaving highly educated women with an increasingly limited supply of equally highly educated men (Inhorn, Birenbaum-Carmeli, Birger, et al., 2018; Waldby, 2015a). Given the challenges many women face in achieving successful household formation, many study participants see elective egg freezing as a way to disentangle their romantic and reproductive timelines, to avoid “panic partnering” or unintended childlessness (Baldwin 2019a; Baldwin et al., 2019; Brown & Patrick, 2018; Myers, 2017). Brown and Patrick (2018) further note that, though most patients only desire a *temporary* disentanglement of romance and fertility to enable eventual re-bundling through married motherhood, egg freezing also opens up a trajectory of single-motherhood-by-choice, in which these timelines become *permanently* decoupled.

**Markets and Commodities**

Egg freezing also touches upon financial and market considerations. First, the ability to freeze eggs impacts the commodification of oocytes by rendering a previously scarce and “perishable” resource “shelf-stable.” Second, egg freezing operates within “economies of hope,” creating financial conflicts of interest for fertility clinicians. Third, egg freezing has become a high-status employee benefit offered by some corporations, prompting questions about potential coercion. This latter consideration brings us full circle with regard to the neoliberal character of egg freezing, highlighting yet again how the technology promotes an individual “solution” to structural problems.

***Bodily Commodification***

Frozen eggs provide a valuable example for the study of bodily commodification. Through close attention to the social construction of frozen eggs within the continua of bodily and reproductive commodification, sociologists of body and embodiment have illuminated the logics and narratives used to govern, justify, or condemn their exchange.

Historically, eggs have commanded a much higher price than sperm because of differences in scarcity, time constraints, and risk and invasiveness of retrieval procedures (Almeling, 2011; Waldby, 2019). Sperm “donation” (hereafter “transfer”) operates much like blood donation—both are renewable resources that can be retrieved with little discomfort by minimally invasive means and placed in cold storage for future use—and, as such, sperm vendors are paid a relatively small incentive for their deposits. Eggs are not a renewable resource, and their surgical retrieval requires full anesthesia. Additionally, intended parents often hold different expectations for egg producers as compared to sperm producers and generally have a greater degree of personal connection with the egg producer, which may have an impact on the degree to which eggs are “alienated” from the producer (Almeling, 2007, 2011; Culley & Hudson, 2009; Hertz et al., 2015).

However, this scarcity model is based on the necessity of fresh cycles for egg transfer. Sociologists of medical markets and bodily exchange have addressed the ways in which the ability to freeze eggs alter their commodity status and value. Because of low success rates using frozen eggs, many fertility clinics continue to use fresh cycles from eggs produced “on demand.” Egg freezing could radically alter the commodity status of eggs by enabling “self-donation” and the banking of third-party eggs, driving the value and commoditization of eggs in opposing directions. While “self-donation” works against market exchange, cryobanking allows for greater rationalization of the egg market.

Egg freezing primarily functions as a form of “autologous donation”—that is, banking one’s biomaterials for one’s own use—allowing women to donate their viable eggs to their older and presumably infertile selves (Martin, 2010; van de Wiel, 2020; Waldby, 2015b). Waldby (2015b) argues that for systems of exchange to overcome scarcity, eggs must be rendered interchangeable. In a scarcity economy of “donor” egg markets, an egg’s value lies solely in its reproductive potential, which is realized through exchange. In contrast, egg freezing allows for “an economy of singularities,” where an egg’s value lies in its unique genetic code (and, specifically, in its concordance with the intended parent). Under conditions of singularity, eggs are *not* interchangeable and their value must be realized through preservation and private retention, rather than exchange (Waldby, 2015b, 2019). Egg freezing shifts oocytes from a “generic” to a “personal” product. The ability to freeze eggs also enables egg banking for third-party reproduction, shifting eggs from an “artisanal” product to a “commodity” that can be stockpiled for later use. This shift enables greater distance between the vendor and recipient, greater alienation of the vendor’s labor, and the further rationalization of the egg market.

***Markets and Labor Relations***

We use “assisted reproductive labor” to refer to the constellation of work that enables assisted reproduction, including the labor of sperm and egg producers, gestational carriers, reproductive specialists, lab techs, donor coordinators, and all of the other clinical and lay actors bound up in the ART actor-network (Latour, 2005). Assisted reproductive labor is less focused on reproducing *labor value* and more focused on reproducing other *social values*, including values embedded within family and gender ideologies. Egg freezing also preserves *genetic value*. Situating the work of gamete producers—whether third-party or autologous—within a framework of assisted reproductive labor enables productive analysis of politico-economic relations within the reproductive arena, from the micro-level of labor relations and alienation to the macro-level of global markets and racial formation.

***Labor Relations.*** To date, relatively little research on egg freezing has focused on the structures and relations of reproductive markets, so our discussion here is largely speculative, drawing on research on markets and labor relations in other spheres of assisted reproduction to suggest productive avenues for future research. Most notably, egg freezing has bearing on the labor relations embedded within gamete markets. First, by enabling time-lagged autologous donation, egg freezing will certainly alter the market for “donor” gametes, likely reducing demand in some sectors. Nevertheless, frozen eggs are no guarantee of future childbearing and many women will still encounter infertility without frozen eggs, so the demand for third-party eggs will persist. Further, as discussed above, egg freezing also enables further expansion, rationalization, and global restructuring of third-party egg markets. Longitudinal and/or comparative study of fresh vs frozen cycle egg transfer will illuminate whether and how egg freezing alters micro-level labor relations between egg vendors and recipients and/or agencies, as well as how it reshapes the process of “donor” selection. The shift from fresh cycles to frozen egg banking will create further distance between egg provider and recipient, with the potential to increase the alienation and devaluation of the provider’s labor.

Waldby (2015b, 2019) has laid the cornerstone for this line of research in her qualitative studies of the clinical actors, egg vendors, and recipients bound up in egg “donation.” In her insightful analysis of egg markets, Waldby (2019) traces the historical trajectory of the perceived value of human eggs, how they become open to management and exchange, and the power dynamics embedded within the global human egg market. Human egg exchange has long been stratified by age and class, with younger poor women generally acting as producers and older affluent women as recipients, which raises serious ethical concerns regarding these markets (Daniels and Heidt-Forsythe 2012; George 2008; Heidt-Forsythe 2018; Waldby 2019; Waldby and Cooper 2010).

***Global Markets.*** At the macro-level, a shift from fresh to frozen egg transfer is likely to reinforce the global stratification of assisted reproductive labor. This dynamic has been identified in a variety of contexts, stretching from flows within the Americas, to Eastern Europe, and Southeast Asia (Gupta 2012; Harrison 2016; Rapp 2011; Whittaker and Speier 2010). Power dynamics currently shape who acts as a vendor and who acts as a recipient, as well as who has access to assisted reproduction (Bell 2009, 2010, 2014; Raphael-Leff 2010). In these cycles of exchange, the valorization and promotion of white women’s fertility and the demonization and suppression of the fertility of women of color lay side by side, opposing faces of the same coin. Egg freezing technology will likely extend the rationalization and globalization of third-party reproduction, further stratifying reproduction along lines of race, class, nationality, and age. Van de Wiel (2020) establishes a foundation for this line of research through her study of the movement of frozen eggs from the US-based World Egg Bank to UK clinics; finding that regulations, matching practices, financial incentives, online platforms, and marketing strategies move through these transnational “reproflows” along with the frozen eggs.

***Economies of Hope***. ARTs operate as “hope technologies” within “economies of hope” (Becker, 2000; Franklin, 1997, 1998; Franklin & Roberts, 2006). Franklin and other social scientists argue that the availability of ARTs compels women to “have a try” even in the face of very high failure rates and that the psychosocial dynamics of the “economies of hope” embedded in IVF keep patients’ hope alive through a succession of failed treatments (Becker, 2000; Franklin, 1997; Franklin, 1998; Franklin & Roberts, 2006). This dynamic produces what Harwood (2007) dubs the “infertility treadmill,” in which there is always another cycle, always another procedure that patients can try. These economies of hope underlie ethical concerns about egg freezing within clinical and employer relationships.

Kyweluk (2020) extends Martin’s (2010) ontological category of “anticipated infertility” and the linked domain expansion of reproductive medicine, proposing “the new (in)fertility pipeline” to conceptualize the broader social and medical project dedicated to addressing anticipated future infertility and promoting ongoing engagement with reproductive technologies across the life course. Kyweluk (2020) suggests that direct-to-consumer ovarian reserve testing operates as an entry point into this “(in)fertility pipeline,” confounding individual’s reproductive decision making and priming them for recruitment into use of ARTs, including egg freezing. Others have drawn attention to the potential conflicts of interest that fertility clinicians may face, given the affective power of hope, the relative absence of evidence of effectiveness of egg freezing, and the potential financial motivations tied to this expensive elective procedure (Mayes et al., 2018). Given the questionable medical benefit but intense emotional significance of egg freezing, clinical management of expectations and communication of benefits when advising patients on fertility preservation will remain a valuable area of research.

***Employer Sponsored Egg Freezing***. Ethical concerns also extend to the workplace. In October of 2014, Apple and Facebook announced that they would cover elective egg freezing cycles as part of their employee benefit package, setting off a new wave of public commentary, (premature) celebration of the death of the biological clock, and hand wringing about the future of motherhood and the American family. While some hail this move as a “great equalizer” for women in the workforce (Bennett, 2014) or a means of reconciling fertility and work (Zeno 2020), others raise concerns about the impact of employer-sponsored egg freezing (Ikhena-Abel et al., 2017; Mertes, 2015; Zoll et al., 2015). At present, the results are unclear. Ikhena-Abel et al. (2017) found that over 70% of female medical students surveyed were open to egg freezing, would consider it if offered by an employer, did not view employer coverage as coercive, and reported that they would *not* delay childbearing due to employer coverage. However, they also note that most of the respondents reported feeling pressure to delay childbearing, especially those who were potential egg freezers (Ikhena-Abel et al., 2017). Given the complex linkages between work demands and structures, relationship formation, and fertility decision making, this suggests that employer sponsored egg freezing might contribute to pressures to delay childbearing and, as Ikhena-Able et al. (2017) note, further research is needed to clarify the relationship between employer coverage for egg freezing and work-related pressures to delay childbearing. Mertes (2015) draws particular attention to the low success rates associated with frozen eggs. While acknowledging that there is no reason to prevent well-informed patients from taking a gamble on egg freezing, Mertes (2015) suggests that employer-sponsored programs may be structurally coercive and may promote the use of an uncertain technology in lieu of necessary structural changes. To ensure that employer-sponsored egg freezing programs live up to the liberating hype, they must include a robust informed consent process, an absence of pressure from the employer, and unaltered access to other family-friendly policies, regardless of whether workers freeze eggs or not (Mertes, 2015).

**Directions for Future Research**

We believe the study of egg freezing will be a growing sub-topic in scholarship on the social impact of reproductive technologies, and that there is significant room for further research. We identify four areas ripe for future sociological research: time limits on frozen egg storage; non-use of frozen eggs and frozen egg disposition; egg freezing by nonbinary and transmasculine individuals; and the impact of egg freezing on third party reproductive labor markets.

In most countries that permit egg freezing, there are no time limits for storing frozen eggs. In Denmark eggs may be cryopreserved for five years, with extensions for medical reasons (Rothmar Herrmann & Kroløkke, 2018). U.K. regulations allow for only ten years of frozen storage--temporarily extended for an additional two years because of COVID-19 (Human Fertilisation and Embryology Authority, 2020). Given that it might take longer than five to ten years to decide to use or dispose of eggs, there is ongoing debate in both countries regarding keeping, extending, or removing time limits (Bowker et al., 2016; Rothmar Herrmann & Kroløkke, 2018). Future comparative research may examine how storage time limits in countries with and without such regulations affect decision-making around egg freezing use, storage, and thawing.

A related area of research is non-use and disposal of frozen eggs. Patients have several options for disposing of unwanted frozen eggs: they may have them destroyed, donated to science, or (in select cases) donated for use by infertile patients. Gürtin et al. (2019) estimate that 95% of women in the U.S. and U.K. who froze their eggs for nonmedical reasons have not returned to thaw and use their eggs for fertilization. Their study following up with women at two U.K. clinics who returned to use their eggs is informative not only because it provides insights as to who is likely to return and why, but because it raises questions about those 95% of women who do not return. Since the majority of women have yet to remove their eggs from storage, we would like to see future research focus on this population, asking such questions as how long they plan to keep their eggs frozen, how they decide when to cut their losses, how they plan to dispose of unused frozen eggs, and what meanings and social lives they attribute to their frozen gametes.Friedrich (2020) expands this line of inquiry, noting that unused frozen eggs are likely to be drawn into biomedical research, unintentionally recruiting the consumers of ARTs as producers of scarce bio-resources, raising questions about exploitation and informed consent. Along these lines, Van de Wiel (2020), engages with frozen eggs as the reference point for distributed reproductive aging in the “Reproductive-Industrial” arena and a form of “capital investment” in self (see also: Rottenberg 2016, 2018). As such, the disposal of frozen eggs is likely to be complicated by both the politics of “embryonic life” that already shape embryo disposal and by still emerging structures of individual and industrial bio-value of frozen eggs.

In their opinion approving egg freezing to prevent anticipated infertility, the Ethics Committee of the ASRM include “planned female-to-male gender transition” in a list of reasons why people besides cancer patients may elect to cryopreserve oocytes for future reproductive purposes (Daar et al. 2018:1023). We recognize egg freezing and banking by transmasculine and nonbinary individuals prior to hormone therapy as a third area for future research. While there have been a handful of interview- and survey-based studies of opinions regarding “fertility preservation” for trans people in the United States and Australia (e.g. Bartholomaeus & Riggs, 2020; Goldman et al., 2017; Kyweluk et al., 2018; Riggs & Bartholomaeus, 2018), we see room for further research about how transmasculine individuals incorporate cryopreserved eggs into their gender identities. Researchers could also compare egg freezing with cryobanking sperm, given that egg retrieval is a longer and more involved process requiring taking synthetic “feminizing” hormones and delaying gender transition. Comparison of fertility preservation decision-making among egg-producing and sperm-producing transgender and nonbinary people could inform both sociological understanding of the significance of fertility in gender transition and improved clinical guidelines for treating and advising transgender and nonbinary people.

Lastly, future research should also explore how the shift from fresh to frozen egg transfer reinforces the global stratification of assisted reproductive labor. Egg freezing could reinforce flows of reproductive materials and labor from poor women in Eastern Europe, the Global South, and the United States into the reproduction of “white babies” (Gupta 2012; Harrison 2016; Rapp 2011; Whittaker and Speier 2010). Egg freezing could also decrease demand for transnational egg exchange by preserving more of the recipient’s own genetic and reproductive materials. Egg freezing could thus be another technology explored by scholars of reproductive tourism and the global stratification of assisted reproductive labor.

Gamete exchange has become a key site for the geneticization of race and ethnicity in ways that both reinforce and shift the boundaries, emphasizing the genetic, rather than socio-cultural foundations of race, ethnicity, nationhood, and citizenship (Andreassen 2017; Bokek-Cohen 2017; Svendsen 2007; Whittaker and Speier 2010). Scholars of racial formation might explorehow frozen eggs operate as resources for racial projects, and ask whether frozen egg banking alters the openness of human eggs to integration into nationalist citizenship projects.Notably, in these cycles of exchange, the valorization and promotion of white women’s fertility and the demonization and suppression of the fertility of women of color move in tandem. Researchers looking to bring a critical lens to egg freezing should turn their attention to the narratives and logics of inclusion and exclusion in fertility preservation (see: Bell 2009, 2010, 2014; Raphael-Leff 2010).

**Conclusion**

Sociologists and anthropologists have produced rich insights about egg freezing in the past decade. In this article we have selected four research areas in which egg freezing makes a particularly productive and interesting case for analysis: medicalization, gender, temporality and risk, and markets. Looking at this body of work holistically, a unifying theme is the role of a neoliberal ideology in which the state and collective responses to social problems are largely absent, and individuals are expected to enact productive citizenship by taking responsibility for their own health, financial, social, and reproductive needs through self-management, risk reduction, calculation, and optimization.

In discussing egg freezing as a (bio)medicalizing technology, scholars emphasize how young women are entreated to think proactively about and optimize their future fertility through self-surveillance and prophylactic treatment (Baldwin 2019; Bhatia and Campo-Engelstein 2018; Martin 2010). This relates to the concept of “responsible reproductive citizenship” articulated by Carroll and Kroløkke (2018), in which egg freezing is part of a neoliberal strategy enacted by young women to fulfill their heteronormative, reproductive, and financial obligations as future intensive mothers and to “disentangle” romantic and reproductive timelines (Baldwin, 2017, 2019a; Brown & Patrick, 2018; Myers, 2017). Reorganizing heterosexual relations, enacting social policies such as universal family leave and childcare, and ensuring more flexible and equitable workplaces would go a lot farther to help individuals of all class backgrounds than does making neoliberal demands on professional and highly educated young women to calculate, optimize, and freeze their fertility in order to accrue more social and financial capital while delaying childbearing (Rottenberg, 2016). With no guarantees that frozen oocytes will be viable when thawed and the majority of egg freezers yet to return to clinics to unfreeze their eggs, egg freezing remains a speculative and “hopeful” technology (Bach & Kroløkke, 2019; Gürtin et al., 2019; Mayes et al., 2018).

We have witnessed oocyte cryopreservation transform from a “fertility preservation” treatment for cancer patients to an elective procedure for healthy women to delay childbearing. As technological and procedural changes occur, social scientists analyze egg freezing’s sociocultural, political, and economic implications. By providing an overview of existing social science research on this topic and ideas for future studies, we hope to anchor this emerging field within the sociology of reproduction and inspire future research.

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