Biological and Social Aspects of Human Infertility: A Global Perspective FREE

Marie Thoma, University of Maryland, School of Public Health, Jasmine Fledderjohann, Lancaster University, Department of Sociology, Carie Cox, St. Catherine University, and Rudolph Kantum Adageba, Komfo Anoyke Teaching Hospital

https://doi.org/10.1093/acrefore/9780190632366.013.184
Published online: 25 March 2021

Summary

Infertility remains a neglected area in sexual and reproductive health, yet its consequences are staggering. Infertility is estimated to impact about 10–25% (estimates range from 48 to 180 million) of couples of reproductive age worldwide. It is associated with adverse physical and mental health outcomes, financial distress, severe social stigma, increased risk of domestic abuse, and marital instability. Although men and women are equally likely to be infertile, women often bear the societal burden of infertility, particularly in societies where a woman's identity and social value are closely tied to her ability to bear children. Despite these consequences, disparities in access to infertility treatment between low- and high-income populations persist given the high cost and limited geographic availability of diagnostic services and assisted reproductive technologies. In addition, a considerable proportion of infertility is a result of preventable factors, such as smoking, sexually transmitted infections, pregnancy-related infection or unsafe abortion, and environmental contaminants.

Accordingly, programs that address the equitable prevention and treatment of infertility are not only in keeping with a reproductive rights perspective but can also improve public health. However, progress on infertility as a global concern in the field of sexual and reproductive health and rights is stymied by challenges in understanding the global epidemiology of infertility, including its causes and determinants, barriers to accessing quality fertility care, and a lack of political will and attention to this issue. The tracking and measurement of infertility are highly complex, resulting in considerable ambiguity about its prevalence and stratification in reproduction globally. A renewed global focus on infertility epidemiology, risk factors, and access to and receipt of quality of care will support individuals in trying to reach their desired number and spacing of children and improve overall health and well-being.

Keywords: infertility, infecundity, subfertility, reproductive health, global health, assisted reproductive technologies

Subjects: Sexual & Reproductive Health

Introduction

Infertility has been broadly defined by the World Health Organization (WHO) as an inability to conceive or maintain a pregnancy to the point of a live birth (World Health Organization, 2020). It can occur regardless of whether one has (secondary infertility) or has not (primary infertility) had a prior birth. However, as outlined in this article, infertility is a difficult concept to define and measure. The prevention and management of infertility have been recognized within the broader sexual and reproductive health and rights (SRHR) agenda since defining language on SRHR was established at the International Conference on Population Health and Development (ICPD) in 1994 (Gipson et al., 2020; Starrs et al., 2018). Accordingly, the definition of reproductive rights, or the ability to "decide freely and responsibly the number, spacing, and timing of their children and to have the information and means to do so," conveys this support.

A focus on infertility as a global health concern, however, predates the ICPD with the inception of the Expanded (later Special) Programme of Research, Development and Research Training in Human Reproduction, or Human Reproduction Programme (HRP) in 1972, but efforts were hindered by shifting prioritization to prevention of unintended pregnancies, resulting in the dissolution of the Infertility Task Force in 1998 (van der Poel, 2012). During this same time, the reproductive justice movement emerged, which recognized inequities in the right to reproduce, including access to fertility care, for marginalized communities (Luna & Luker, 2013). Despite this broader recognition and considerable progress on other components of SRHR, infertility remains a neglected issue in the broader SRHR agenda (Starrs et al., 2018). A renewed global focus on infertility measurement, prevention, and treatment will support individuals in trying to reach their desired number and spacing of children and improve overall health and well-being.

This article provides a large-scale overview of key ideas on the biological and social aspects of human infertility and emerging issues and debates from a range of disciplines (illustrated in boxes 1–5). The themes identified are central to understanding the critical need to address infertility more broadly within SRHR. It begins by examining the societal and health consequences of infertility, which recognizes that the topic of infertility has implications far beyond the ability to conceive. This is followed by a summary of the global epidemiology of infertility and measurement considerations. The second half of the article explores the clinical aspects of infertility and fertility care, including causes, diagnosis, and management and barriers to accessing quality care and treatment. Because information on infertility is derived from several different sources with varying definitions, "infertile/infertility" terminology is used broadly and distinctions are cited, where relevant. In addition, infertility research often focuses on cisgendered men and women, which is not fully inclusive. This issue is discussed further in the section "Measurement of Infertility. "Clinical terminology referenced in this manuscript can be found in the International Glossary on Infertility and Fertility Care (Zegers-Hochschild et al., 2017) or is provided in the endnotes.

Societal and Health Implications of Infertility

Infertility and its treatment have implications for the health and well-being of individuals, families, and societies. This journey can involve delays and uncertainty related to childbearing; complicated health conditions and diagnoses; and mental, physical, financial, and emotional strains related to the experience of infertility and its care and treatment. However, there is substantial variation in these experiences by sociodemographic and sociocultural characteristics, both within and between countries. Accordingly, reducing infertility and its sequelae relies on efforts to integrate infertility prevention and management more broadly into sexual and reproductive health programs (Centers for Disease Control and Prevention, 2014; Gavin et al., 2014; Starrs et al., 2018), as well as efforts to reduce infertility stigma. This section describes some of the most pressing societal and health implications of infertility.

Sociocultural and Interpersonal Issues

Childbearing as a marker of the transition to adulthood is a cross-cultural universal, though recent research also highlights diversification of paths to adulthood and delays in traditional markers such as childbearing (Beguy et al., 2011; Dennison, 2016; Obidoa et al., 2019). Nonetheless, studies from both high- and low- to middle-income countries (HIC and LMIC, respectively) report that having children can be a considerable source of social status, particularly for women (Aronson, 2008; Dyer, 2007; Evens et al., 2015; Fledderjohann, 2012; Hollos & Whitehouse, 2014; Liamputtong, 2009; Okonofua et al., 1997; Rouchou, 2013; Wilkinson & Callister, 2010). Failure to meet this social expectation, then, can sometimes lead to severe stigma, not only externally but also in the form of self-stigma. The social pressure to have children is often especially strong in high-fertility settings, particularly in sub-Saharan Africa (Dyer, 2007; Fledderjohann, 2012; Hollos et al., 2009; Inhorn, 2002; Nachtigall, 2006).

In a similar vein, gender norms often include reproduction as a key marker of adult masculinity/femininity; a very widespread finding across cultural contexts globally is that failure to reproduce may be interpreted both by oneself and by others as a failure to be a "man" or a "woman" (Barnes, 2014; Becker, 2000; Bell, 2019; Birenbaum-Carmeli & Inhorn, 2009; Clarke et al., 2006; de Kok & Widdicombe, 2008; Dimka & Dein, 2013; Dyer, 2007; Dyer et al., 2004; Fledderjohann, 2012; Inhorn, 2004; Inhorn et al., 2009b; Obeisat et al., 2012). Indeed, Wahlberg (2010) points to the growing availability of assisted reproductive technologies alongside the fertility-restricting aims of China's One Child Policy since the 1980s as being rooted in the perception that infertile couples lead "burdened lives" (p. 375). In other words, in China, access to the means to address biological impairments are allowed by the state despite the contradiction between treating infertility and meeting the state's population goals, because the psychosocial burden of infertility one lives with is too great.

Although men and women are equally likely to have conditions that cause infertility, and anyone may experience infertility-specific stigma and distress, evidence from a wide variety of sociocultural contexts globally highlights the greater burden of stigma and blame for infertility that women often face as compared to men (Barnes, 2014; Fledderjohann, 2012; Greil & Johnson, 2014; Inhorn, 1996; Inhorn & Patrizio, 2015; Nahar & Richters, 2011; Okonofua et al., 1997; Slade et al., 2007; Unnithan, 2010). This is particularly the case where a woman’s identity and social value are closely tied to her ability to bear children, as in some high-fertility settings (Dyer, 2007; Fledderjohann, 2012, 2017; Hollos et al., 2009; Inhorn, 2002; Inhorn & Patrizio, 2015; Nachtigall, 2006). Male infertility is frequently concealed or ignored, and women often shoulder the burden of testing and treatment (Fledderjohann, 2012; Gerrits & Shaw, 2010; Inhorn & Patrizio, 2015); however, even when men are tested and treated for infertility, their infertility can still be obfuscated.

For example, in a rich ethnographic account of male infertility in the United States, Barnes (2014) documents how doctors in clinical practice settings use metaphor and indirect language to inform their male clients of their infertility and treatment options; this euphemism around men’s biomedical diagnoses, which Barnes argues serves to protect masculinity, was in many cases so extreme that men did not self-identify as having a fertility problem. This practice stands in contrast to the much more direct approach taken with female patients, and it mirrors women’s greater bodily involvement in the treatment process. As work in the Middle East has shown, engagement with reproductive technologies can compound already acute stigma and secrecy for men, especially when grappling with the application of Islamic religious strictures to reproductive donation (Gürtin et al., 2015; Inhorn, 2004).

The association between infertility and mental distress described in the section “Mental Health ”may have important implications for the quality and stability of romantic relationships; dyadic stress has been shown to negatively impact the quality and longevity of relationships (Randall & Bodenmann, 2009). Several clinical studies have suggested a link between infertility and marital relationship quality. In a longitudinal study of Danish couples who did not achieve a pregnancy within one year of treatment using assisted reproductive technology (ART), Schmidt et al. (2005) found that between one-fifth and one-quarter of individuals in their study felt that their childlessness had brought them closer together. However, there was an asymmetrical gender pattern to this finding, with men being less likely than women to report this marital benefit. Marital benefits or distress associated with infertility appears to be heavily influenced by couple dynamics, such as the congruence of coping strategies (Peterson et al., 2003; Peterson et al., 2006) and partner’s perception of the problem (Benyamini et al., 2009).

Some studies have found that infertile couples experience increased cohesion and intimacy, possibly as a result of bonding during the treatment process (Galhardo et al., 2011). However, infertility has also been tied to sexual infertility stress (Peterson et al., 2007); women who undergo treatment report poor marital quality and sexual dissatisfaction, whereas men report reduced relationship satisfaction (Schmidt, 2006). An Iranian clinical study found that, compared to recalled sexual desire and satisfaction, just over 40% of infertile men reported diminished desire, and over half reported reductions in satisfaction (Ramezanzadeh et al., 2006). Yet others have found no significant difference in sexual satisfaction between fecund and infertile couples (Galhardo et al., 2011). However, diminished sexual function has been tied to reduced marital satisfaction (Alahveriani et al., 2010).

In Latin America, around one-fifth of childless women are divorced or separated, with this figure reaching as high as 40% in Nicaragua and the Dominican Republic (Inhorn & Patrizio, 2015). Where polygyny is common, however, divorce rates may be lower because men have the option to take a second wife rather than ending a relationship due to infertility (Fledderjohann, 2017; Inhorn & Patrizio, 2015). In Malawi, as diagnostic tools for male infertility have become more widely available, and men increasingly undergo testing, clinical confirmation of male infertility can prompt men to reevaluate their virility and masculinity and can be disruptive to social relationships, including marriages (Parrott, 2014). In Egypt, Inhorn (2003) finds that women are blamed for infertility even when the male's infertility is broadly acknowledged. She notes that the availability of ART to address male infertility has contributed to an increased risk of divorce as men with older wives may be able to conceive through ART with a younger partner. Conversely, although there are still large inequalities in the availability of reproductive technologies both within and between countries globally (see section "Barriers to Accessing Fertility Care"), some evidence suggests that the increasing availability of ART since the 1990s has helped to reduce stigma by establishing infertility as a biomedical problem and has improved marital stability among infertile couples in the Middle East (Inhorn, 2004; Inhorn & Patrizio, 2015).

Early literature on infertility and relationship stability focused primarily on heterosexual married couples (Chester, 1972; Gibson, 1980; Orji et al., 2002), reflecting the normative notion that fertility occurs within marriage. However, as individuals or couples increasingly seek to conceive outside the context of marriage, infertility is also associated with relationship disruption among unmarried couples. In Ghana, for example, rates of relationship disruption linked to infertility are substantially higher for unmarried than married couples, possibly reflecting the additional legal barriers married couples face when seeking to end their relationships (Fledderjohann, 2017).

Marriage is often viewed not just as the joining of two individuals but as the joining of two families, with an explicit expectation that the couple will continue the family lineage (Armstrong, 1997; Aryee, 1997; Donkor, 2008; Obeisat et al., 2012; Yao et al., 2018). Where bridewealth is practiced, if a marriage dissolves without any children being produced, the bride's family may be expected to repay the bridewealth, which can place considerable pressure on women in particular (Armstrong, 1997; Aryee, 1997; Feldman-Savelsberg, 1994, 2002; Hollos & Larsen, 2008). Where norms dictate that childbearing is a vital means for women to fulfill their role in the marital contract, failure to conceive or to give birth can lead not only to stigma and verbal abuse but also to physical violence in some cases (Aduloju et al., 2015; Akyuz et al., 2013; Ardabily et al., 2011; Dhont et al., 2011; Fledderjohann, 2012; Liamputtong, 2009; Morse et al., 2012; Okonofua et al., 1997; Omorogbe et al., 2010; Orji et al., 2002; Stellar et al., 2016; Yildizhan et al., 2009). Although the effect of infertility on marriage is not straightforward, some evidence suggests that these gendered differentials may be changing in the 21st century, particularly as couples gain greater access to effective infertility treatments (Inhorn, 2004; Inhorn & Birenbaum-Carmeli, 2008).

Economic Hardship

One of the biggest barriers for individuals facing infertility is the high cost of evaluation and treatment. In many cases, fertility care is cost-prohibitive, and as a result, many do not seek or receive medical treatment or seek alternative therapies, some of which may be ineffective, may be unsafe, or may delay medical treatment (Bardaweel, 2014; Connolly et al., 2010; Dhont et al., 2010; Eisenberg et al., 2010; Moyo & Muhwati, 2013; Rayner et al., 2011; Read et al., 2014; Sundby, 1997; Weiss et al., 2011). For those who do seek medical care, financial burdens can increase not only from the cost of treatments (Katz et al., 2011) but also from costs associated with pursuing fertility care, including missed time from work and other opportunity costs (e.g., travel expenses) (Wu et al., 2013). Insurance coverage for infertility treatment can reduce some of this financial strain, but reimbursements are limited or lacking in many countries (Griesinger et al., 2007; Lord et al., 2001; Pennings et al., 2008). The high cost of and coverage for infertility treatment are discussed in more detail in the section "Access to and Receipt of Quality Fertility Care."

Independent of the costs of fertility care, infertility itself can impact economic well-being. In many LMICs, children can be an important source of economic well-being by, for example, freeing parents for economic activity by running errands and providing free child care for younger siblings, contributing labor and earnings directly to the household economy, and providing financial support and unpaid care for parents in their old age (Dyer, 2007; Geelhoed et al., 2002). In cultures where children are expected to pay funeral expenses, those who experience primary infertility may even be denied funerary and burial rights (Donkor, 2008; Hollos et al., 2009). An important theme from qualitative literature on infertility in sub-Saharan Africa is the idea that infertile women have "no child to send"—that is, they do not have a child who they can send to run errands, meaning that valuable time that could be spent on more economically productive endeavors is instead spent on more menial chores (Dyer, 2007; Fledderjohann, 2012; Gijsels et al., 2001). Not only may this reality mean a reduction in economic assets in the short term, but it also has possible longer-term implications. It can become difficult to generate a surplus of assets that can be exchanged in the informal economy or gifted to generate social capital—a potential source of resilience during periods of scarcity.

Mental Health

The inability to conceive is considered a stressful and uncertain period for many individuals and couples across the globe. Although infertile individuals have shown higher rates of stress, depression, and anxiety and lower life satisfaction and self-esteem compared to their fertile counterparts (Cousineau & Domar, 2007; Hanson et al., 2017; Luk & Loke, 2015; Nahar & Richters, 2011; Schwerdtfeger & Shreffler, 2009), there is considerable variability based on sociocultural norms, gender, and access to care.

Societal expectations related to procreation and biological parenting can shape the experience of infertility and its psychosocial implications (Greil et al., 2010b). The distress of infertility may be most apparent in countries where pronatalism predominates and the visibility of infertility may be more pronounced for couples without children, leading to greater social scrutiny and stigmatization (Ibisomi & Mudege, 2014; Remennick, 2000). In contrast, cultural norms in mostly HICs acknowledge voluntary child-free status as a socially acceptable life choice (Noordhuizen et al., 2010), which affords couples dealing with infertility greater privacy and sheltering from stigma. However, this lack of visibility can perpetuate further silence around the issue, leading to feelings of loneliness and isolation for some infertile individuals and couples (Allison, 2011; Greil, 1991).

Gender differentials in responses to infertility often emerge from the interaction of sociocultural, interpersonal, and biomedical factors discussed throughout this article. Overall, studies of individuals and couples dealing with infertility show that women are more likely to experience poorer mental health outcomes compared to men (Greil et al., 2010b; World

Health Organization, 2010a; Ying et al., 2015). This has been attributed to several factors that may disproportionately impact women and their mental well-being, including social pressure to become a mother, facing greater blame for infertility, and bearing the burden of fertility testing and treatment (Dyer, 2007; Fledderjohann, 2012; Hollos & Larsen, 2008; Inhorn & Patrizio, 2015; Liamputtong, 2009; Rouchou, 2013). Masculinity norms may further contribute to these gender disparities. Men may suppress their emotions and medical providers have been shown to safeguard masculinity by using euphemisms to protect men from the infertile label (Barnes, 2014), potentially leading to fewer men self-identifying as infertile or experiencing infertility-related stress. Although the burden of infertility may be higher in women, men dealing with infertility report more psychological symptoms compared to fertile men, particularly if the infertility is due to male causes (Fisher & Hammarberg, 2012; Fisher et al., 2010; Luk & Loke, 2015). Studies are limited and further research is needed to better understand men's experiences, particularly in LMICs. Emerging evidence suggests that as the diagnosis and treatment of male infertility are becoming increasingly common and accessible in LMICs, both infertility stigma and the gendered manifestation of this stigma may be declining (Inhorn & Patrizio, 2015; Inhorn & Wentzell, 2011; Parrott, 2014).

The psychological effects of infertility may be distinct from those related to infertility treatment but are difficult to disentangle (see box 1). Many studies rely on clinic-based populations of individuals undergoing or seeking treatment, who may not be representative of all individuals dealing with infertility (Greil et al., 2010b). It is possible that the inability to access care and treatment as a means of resolving infertility could exacerbate stress and uncertainty. This may be most prominent for LMICs, where access to fertility care is severely limited, or among socioeconomically marginalized groups, which remain underrepresented in fertility care even in countries that subsidize infertility treatment (Chandra et al., 2014; Dieke et al., 2017; Greil et al., 2011; Griesinger et al., 2007; Hotaling et al., 2012; Jain, 2006; Janitz et al., 2019; Klemetti et al., 2007; Lord et al., 2001; National Institute for Health Care and Excellence, 2014). One study showed that depression after an infertility diagnosis was also a predictor of not seeking treatment (Eisenberg et al., 2010). Independent of infertility, infertility treatments introduce another set of stressors, including extensive and costly treatment, physically demanding protocols, and emotional disappointments (Weaver et al., 1997). What is most telling from these studies is the high dropout rate of couples undergoing fertility treatment, of which the psychological burden was cited as the most common reason for discontinuation (Domar et al., 2018).

Physical Health

In many cases, infertility manifests due to impairments in reproductive function and, accordingly, has been classified as a disease. The links between infertility and physical health, however, extend beyond a biomedical condition. Addressing the preventable causes and risk factors for infertility is a first step toward reducing its magnitude and related sequelae (Centers for Disease Control and Prevention, 2014; Lemoine & Ravitsky, 2013). For example, infertility may arise from a myriad of potentially modifiable lifestyle and health conditions for men and women (discussed in greater detail in the section "Global Epidemiology of Infertility"), such as infections, smoking, obesity, environmental toxicants, and occupational hazards (Buck Louis et al., 2012; Eisenberg et al., 2015; Gaskins et al., 2015, 2017; Macaluso et al., 2010; McKinnon et al., 2016; Sapra et al., 2016; Wise et al., 2013, 2018). Many of these are already components or could be incorporated into existing public health programs and infrastructure (Lemoine & Ravitsky, 2013). Furthermore, prevention efforts have the ability to address risk factors that may disproportionately impact lower socioeconomic groups, which have limited access to fertility care and treatment or which may be at greater risk of exposure to certain risk factors, such as environmental toxicants or occupational hazards (Inhorn & Patrizio, 2015; Macaluso et al., 2010).

In addition to reducing risk factors, understanding and addressing the underlying causes of infertility have the potential to improve overall health. A rapidly emerging area of research demonstrates the association between infertility or infertility-related diagnoses and later-life chronic health conditions, including cardiovascular disease and cancer (Cedars et al., 2017; Gleason et al., 2019; Hanson et al., 2017). It is unclear whether these associations are causal or whether they are the result of shared physiological pathways between reproductive and other organ systems (Tarín et al., 2015). Nevertheless, this relationship suggests that individuals with infertility may be predisposed to develop other somatic health problems in the future. Given that infertility is most often recognized in reproductive-age individuals, the clinical diagnosis of infertility has been proposed as an early marker in which to monitor or intervene to mitigate these later-life health complications (Cedars et al., 2017). This notion also underscores the importance of equitable access to infertility prevention and care as a way of improving population health.

As the use of infertility treatment increases globally (International Federation of Fertility Societies, 2019; Sunderam et al., 2018), there is a growing concern about the effects of infertility treatments on the health of women and children conceived by infertility treatments. While rare, drugs used to induce ovulation may cause ovarian hyperstimulation syndrome (OHSS), which can be severe and require intensive care (Al-Inany et al., 2011). Hyperstimulation of the ovaries and exposure to excess hormones may increase risk for gynecological and breast cancers, but findings are mixed (Bjørnholt et al., 2015; Brinton et al., 2013; Hanson et al., 2017; Impicciatore & Tiboni, 2011; Momenimovahed et al., 2019; Rizzuto et al., 2019; Saso et al., 2015; Skalkidou et al., 2017; L. M. Stewart & Hart, 2015). Because these outcomes are rare and develop over a long period of time, additional longitudinal studies are needed to better understand the impact of infertility treatments on women’s health.

Women who conceive by infertility treatment are also at greater risk of multiple births and often conceive at older ages, which increases the risk for pregnancy complications and adverse birth outcomes (Fauser et al., 2005; Pinborg, 2005; Pinheiro et al., 2019). Population trends in the United States and other European countries have seen a rise in multiple births attributed to increases in infertility treatment (De Geyter et al., 2015; Martin et al., 2012). Adverse outcomes due to multiple births are unquestionably the main perinatal health concern related to infertility treatment, and strategies have been proposed to reduce multiple gestations for women undergoing infertility treatment (McCabe et al., 2014; Pfeifer et al., 2012). However, several studies have also demonstrated a higher risk of adverse perinatal outcomes among singleton births conceived after ART or ovulation induction medications, suggesting that plurality does not entirely account for these increased risks (Pandey et al., 2012; Qin et al., 2017).

The longer-term effects of infertility treatments on fetal and child growth and development are understudied but a growing area of interest. Of the studies that have examined child health outcomes, summaries of the evidence accumulated to date are reassuring, with minimal to no impact of infertility treatment on neurodevelopmental outcomes, physical growth, respiratory disorders, and childhood cancer after accounting for plurality (Berntsen et al., 2019; Rumbold et al., 2017; Turkgeldi et al., 2016). Some evidence suggests suboptimal cardiovascular profiles in children conceived by ART and impaired spermatogenesis among male children conceived by intracytoplasmic sperm injection (ICSI) (Guo et al., 2017). However, it is premature to reach definitive conclusions on these relationships given the paucity of studies, particularly for non-ART infertility treatments and the difficulty of separating effects of infertility treatment from other underlying infertility risk factors (see box 1).

Although infertility may be connected to physical health outcomes through physiological mechanisms, there are a few documented studies in which infertility fears and myths influence health behaviors and risks. In societies with a high prevalence of infertility and stigma surrounding infertility, the perception or fear of infertility may also be further heightened. For example, rumors that infertility-causing chemicals were added to polio vaccinations resulted in the suspension of a World Health Organization (WHO) polio vaccination campaign, contributing to the spread of polio in Nigeria and neighboring countries (Jegede, 2007). Perceived infertility has also been linked to higher-risk sexual behaviors and increased risk of human immunodeficiency virus/sexually transmitted infections (HIV/STIs) (Gijsels et al., 2001; Payne et al., 2016; Polis & Zabin, 2012; Raine et al., 2003; Rainey et al., 1993). Misconceptions related to contraception as a cause of infertility may also exacerbate contraceptive nonuse, despite women reporting the wish to prevent or space their pregnancies (Ackerson & Zielinski, 2017). It has also been argued that lifetime fertility may be higher where fears of infertility are greater, as childbearing is likely to occur earlier and more frequently (Frank, 1983). Consequently, individuals may feel more supported in delaying or postponing childbearing knowing that services are available to achieve pregnancy if they experience difficulties in conceiving (Hammarberg & Kirkman, 2013). Thus, health systems that address fertility care and treatment have the potential to assuage fears of infertility (real or perceived) and, in turn, promote the adoption of other family planning practices.

Box 1. Disentangling the Health Consequences of Infertility and Its Treatment

A challenge for evaluating the health consequences of infertility is distinguishing between outcomes related to underlying infertility or its treatment (Yeung et al., 2018). Heterogeneity in treatment types and protocols adds further ambiguity to this challenge, as some procedures may be more time-intensive or invasive. There is significant heterogeneity in the psychosocial consequences of infertility and infertility treatments. Often individuals enter treatment while still processing the diagnosis of infertility. This distinction may be most apparent in the study by Eisenberg et al., which shows that couples struggling with depression are less likely to seek treatment (Eisenberg et al., 2010). Other studies have reported distress from an infertility diagnosis or with treatment (Greil et al., 2010b). However, time complicates distinctions in interpretation of these findings—is distress heightened with infertility treatment or because more time has passed during which they have not conceived?

Additionally, individuals considering infertility treatments are concerned about the short- and long-term effects on the fetus(es) and child(ren), but few studies have been able to fully differentiate these effects from underlying infertility or across different treatments. Studies that can better-differentiate parental risk factors, causes of underlying infertility, and infertility treatment from one another are complex, but needed for individuals to make more informed decisions regarding the risks and benefits of treatment and to improve health outcomes for women, men, and children. Researchers have argued that the most relevant comparison group for studying the effects of infertility treatment on fetal/child health is singletons born of infertile men or women without treatment, as it removes the confounding effects of plurality and underlying infertility (Berntsen et al., 2019). A better understanding of the underlying pathogenesis and risk and protective factors for infertility is equally essential to appropriately account for these differences (Yeung et al., 2018).

Global Epidemiology of Infertility

Prevalence Estimates and Trends

Although complexities exist in assessing the true burden of infertility, country-level estimates of infertility prevalence indicate that there is a high global burden and potential need for services (Boivin et al., 2007). Globally, approximately 10–25% of couples are estimated to be infertile (World Health Organization, n.d.), but this figure masks considerable variation within and between countries. In a review of 39 global infertility prevalence studies, Gurunanth and colleagues found infertility prevalence estimates ranged between 0.8 and 30.3% for current infertility and 0.8 and 31.8% for lifetime infertility (Gurunath et al., 2011). Another review by Boivin et al. focused on definitions of infertility using 12 or 24 months as the time period of interest and found estimates of current (range: 3.5–16.7%) and lifetime (range: 3.0–26.4%) infertility were comparable in low- to middle-income countries (LMICs) and high-income countries (HICs) (Boivin et al., 2007). Additionally, they estimated almost half of infertile individuals did not seek medical care for infertility. In both reviews, however, conclusions regarding true cross-study differences in infertility were obscured due to variation in definition, population, and study designs (Dyer, 2009; Gurunath et al., 2011).

Using nationally representative data and a consistent algorithm for estimating infertility, Mascarenhas and colleagues estimated global infertility prevalence from reproductive health surveys conducted in 150 countries with childbearing-age females (Mascarenhas et al., 2012a; Mascarenhas et al., 2012b). Applying a demographic five-year definition of infertility, they document regional disparities in infertility prevalence, with the highest rates occurring in South and Central Asia, sub-Saharan Africa, Central/Eastern Europe, and North Africa/Middle East. They report a global primary and secondary infertility prevalence for women ages 20 to 44 of 1.9 and 10.5%, respectively. Their analysis also showed that infertility remained steady between 1990 and 2010 in most regions, but that primary and secondary infertility prevalence declined in sub-Saharan Africa and South Asia. Notably, infertility rates are, on average, highest in countries with higher fertility rates. This seemingly paradoxical relationship may, in part, be driven by a greater recognition of secondary infertility compared with countries in which childbearing is completed sooner (i.e., secondary infertility would not be recognized or diagnosed).

Nationally representative data to estimate clinical definitions (i.e., unprotected intercourse of more than 12 months) of infertility are limited, particularly in LMICs. A recent study using Demographic and Health Surveys (DHS) data from Nigeria (Polis et al., 2017) found the prevalence of 12-, 24-, and 36-month infertility to be 31.1, 17.7, and 11.5%, respectively, which was comparable to other regional estimates from smaller, nonrepresentative studies in Nigeria (18-month infertility: 30.3%) (Adetoro & Ebomoyi, 1991) and South Africa (12-month infertility: 32%) (Bello et al., 2010). Secondary infertility was also found to be higher than primary infertility, a pattern consistent with other African countries using a different definition (Larsen, 2000; Rutstein & Shah, 2004).

In the United States, current infertility estimates from the National Survey of Family Growth (NSFG) range from 6.0 to 15.5% depending on the data year and infertility measure used (Chandra et al., 2013; Louis et al., 2013; Thoma et al., 2013). Applying a standard measure over time, Chandra et al. (2013) show infertility among married women declined from 8.5% in 1982 to 6.0% in 2006–2010. Using the same data source, but applying a different approach based on time to pregnancy (TTP), another study estimated a higher prevalence of infertility (15.5%) among women trying to become pregnant (Thoma et al., 2013). Regardless of the measure applied, primary infertility was more common than secondary infertility in the United States (Thoma et al., 2013). Other nationally representative infertility studies in Europe have estimated clinical infertility based on TTP and ranged from 10 to 33% depending on the country and study design employed (Joffe, 2000; Karmaus & Juul, 1999; Scheike et al., 2008; Slama et al., 2012). Although the magnitude of infertility appears large regardless of region, the variability in methods to measure infertility precludes comparative statements regarding geographic differences in infertility prevalence. Further studies are needed to assess the validity of these estimates based on other contexts and data sources, including those based on male respondents.

Measurement of Infertility

Definition and Operationalization

Our ability to identify and address the causes and consequences of infertility and improve access to services requires a better understanding of its magnitude and determinants. Definitions of infertility that appropriately reflect both biomedical, clinical, and social perspectives are needed to address these gaps and distinct study aims, including approaches for optimizing diagnosis and treatment, monitoring population health, identifying need for services, and understanding the experiences of infertile individuals. However, owing in part to this diversity of research aims, studying infertility represents unique measurement challenges for researchers. Unlike other types of conditions, infertility is defined by the absence of an event (i.e., not getting pregnant or having a live birth), usually after a defined period of time, and its recognition is often dependent on having tried to become pregnant (Koropatnick et al., 1993). As such, there is considerable variability in measures used to assess infertility across study populations (Gurunath et al., 2011).

Given this variability, standard definitions have been developed to harmonize data collection and enable meaningful comparisons within and across disciplines (Centers for Disease Control and Prevention, 2014; Gurunath et al., 2011; Thoma, 2015; Zegers-Hochschild et al., 2017). Clinical definitions recognize infertility as a medical condition that may be remedied with timely and appropriate diagnosis and treatment. Accordingly, the International Committee for Monitoring Assisted Reproductive Technologies (ICMART), in conjunction with the World Health Organization (WHO), defines infertility as “a disease characterized by the failure to establish a clinical pregnancy [(diagnosed by ultrasonographic visualization of one or more gestational sacs or definitive clinical signs of pregnancy)] after 12 months of regular, unprotected sexual intercourse or due to an impairment of a person’s capacity to reproduce either as an individual or with his/her partner” (Zegers-Hochschild et al., 2017). Twelve months is consistent with clinical recommendations to initiate further diagnostic tests and begin treatment if appropriate (Olsen et al., 1998). For women over 35 years of age, a shorter time period of six months is often applied to account for potential reductions in fertility with age (Practice Committee of American Society for Reproductive Medicine, 2013). Despite declines in fertility with increasing paternal age (S. L. Johnson et al., 2015), there is no equivalent definition applied to men. Infertility can be further delineated into primary infertility (infertility with no prior clinical pregnancy) or secondary infertility (infertility with a prior clinical pregnancy). The term “subfertility” is synonymous with “infertility,” but in some literature it may refer to diminished fertility more generally without reference to a specific period of time (Jenkins et al., 2004; Zegers-Hochschild et al., 2017).

In contrast, because they are often used to identify population-level phenomena, demographic survey definitions of infertility rely on behavioral indicators—that is, the absence of a live birth among sexually active women (or men) who are not using contraception (Larsen, 2005; Mascarenhas et al., 2012a; Rutstein & Shah, 2004). These definitions often rely on longer periods of time in which couples have not conceived a pregnancy ending in a live birth (e.g., two- or five-year periods). Primary and secondary infertility are categorized as infertility at the time of assessment among individuals who have not had a prior live birth or have had a prior live birth, respectively. The reliance of demographic definitions on live births reflects the limited availability and completeness of population-level data on clinically recognized pregnancies, particularly in LMICs (Larsen, 2005). Where data on pregnancy are available, the absence of a pregnancy, rather than a live birth, may be used (Schmidt & Münster, 1995). Demographers also differentiate between the concept of fertility/infertility and fecundity (i.e., the physiological capacity to reproduce)/infecundity (Smarr et al., 2017; Wood, 1989). In this case, demographers may also use the term “infecundity” to refer to a woman who has not yet had a live birth or “involuntary infecundity” to refer to a woman who wants to have a child but has not yet had a live birth (Schmidt & Münster, 1995).

In an attempt to align measures of infertility across disciplines, several authors have proposed using TTP as a functional measure that can be used in both clinical and population-based studies (Gnoth et al., 2005; Gurunath et al., 2011; Joffe, 2003; Thoma, 2015). TTP provides a relatively efficient approach for assessing infertility or conception delay in surveys and is a common question asked of patients attending infertility clinics. It can be measured in months or menstrual cycles and provides information on the full spectrum of fertility—from normal to the complete inability to conceive (Gurunath et al., 2011). Thus, measures of TTP can be adapted to a range of definitional cutoffs (e.g., greater than 12 or 24 months), facilitating comparisons across studies. Different study designs and approaches for measuring TTP have their strengths and limitations and are discussed in greater depth elsewhere (Joffe et al., 2005; Olsen et al., 1998; Scheike & Keiding, 2006; Rémy Slama et al., 2014; Weinberg & Gladen, 1986). It is important to note that standard definitions and proposed measures do not distinguish the cause of infertility, which could be due to male, female, couple, environmental, or unexplained factors. Information on causes of infertility is limited in population-based data (Centers for Disease Control and Prevention, 2014) and, even if collected, may be missing for over half of individuals who do not seek or receive medical care for their infertility (Boivin et al., 2007) (Box 2).

Box 2. Should Fertility Intentions Be Used to Define Infertility?

Even with standard definitions and measures, differences in the operationalization of infertility measures can impact inferences about infertility prevalence and subgroups affected. An area of debate is whether to incorporate fertility intentions into how we measure and define infertility, which can impact inferences regarding who is most affected by infertility (Crawford et al., 2015; Jacobson et al., 2018; Larsen, 2005; Marchbanks et al., 1989; Thoma, 2015). For example, in a U.S. study, Jacobson et al. found that the prevalence of infertility was higher in Black women compared with White women (40.1% vs. 33.7%, respectively) based on months of unprotected intercourse exposure. In contrast, the prevalence of infertility was lower in Black women compared with White women (14.3% vs. 21.8%) when the definition was based on reported months attempting pregnancy (Jacobson et al., 2018).

Some researchers argue that restricting research to couples trying for pregnancy may bias infertility estimates, because this approach excludes couples who may have given up trying (due to the inability to conceive) or are uncertain of their childbearing intentions (Greil et al., 2010a; Slama et al., 2006). Other researchers have argued that population-based measures should take into account whether a respondent reported trying for pregnancy given that regular unprotected intercourse may be less well-documented in population-based surveys (Larsen, 2005). If the research focus is on estimating need for services, incorporation of fertility intentions into the definition may be more informative, as it has been shown to be a useful indicator of treatment seeking and unmet need for services (Greil et al., 2016; White et al., 2006).

Data Collection Considerations

Where and how we collect reproductive health data can also impact our understanding of infertility at the population level and at the interpersonal level. Clinical data are an important source of information on populations who access services but are not representative of the general population. This is because access to treatment is highly unequal. Individuals and couples who make use of clinical services must be motivated to seek help, to opt into these services, and then to be able to access treatment. This is demonstrated by the highly critiqued overrepresentation of White, Western, insured, heterosexual, middle-class women in early literature on infertility (Barnes, 2014; Bell, 2009, 2014; Ceballo et al., 2015; Fledderjohann & Barnes, 2018; Inhorn et al., 2009a; 2009b; Inhorn & Fakih, 2006; Nordqvist, 2008). Although such data are helpful for understanding current practice and service use among a subset of the population, drawing broader conclusions based on these data serves to perpetuate the stratification of reproduction by promulgating an exclusionary picture of infertility.

Therefore, survey data provide an important complementary source of information for monitoring infertility globally (Centers for Disease Control and Prevention, 2019; Greil et al., 2010a; Larsen, 2000; Mascarenhas et al., 2012a; Stephen & Chandra, 2006), but research design choices can still result in an incomplete picture of infertility. These choices are not neutral, but rather they reflect sociocultural notions of who can and should reproduce, and who is deemed responsible for doing so (Daniels, 2008; Fledderjohann & Barnes, 2018; Fledderjohann & Roberts, 2018; Inhorn et al., 2009b; Slauson-Blevins & Johnson, 2016). Survey inclusion criteria together with the design of survey instruments can serve to systematically render invisible some groups and their reproductive needs—that is, to omit the "invisible infertile" (Barnes & Fledderjohann, 2020; Fledderjohann & Barnes, 2018; Fledderjohann & Roberts, 2018).

An example of defining the population at-risk in an exclusionary way can be seen in the Demographic and Health Surveys (DHS) (United States Agency for International Development, n.d.), a large-scale survey of reproductive and general health in ~90 LMICs, widely used to estimate infertility rates (Larsen, 2000; Larsen & Raggers, 2001; Mascarenhas et al., 2012a; Mascarenhas et al., 2012b; Polis et al., 2017). Just under one-fifth of countries with at least one DHS survey available have never collected data for men (Fledderjohann & Roberts, 2018), focusing instead exclusively on women. The availability of men's data in the DHS has increased over time, but some subgroups have been excluded (e.g., divorced and single men) because the inclusion criteria for men at times include a stipulation that they must be married to a woman in the DHS sample. Men's historical exclusion as reproductive actors in their own right reflects and perpetuates a broader cultural notion that women are responsible for reproduction and also renders men's reproductive needs invisible (Barnes, 2014; Dyer et al., 2005; Fledderjohann, 2012; Fledderjohann & Barnes, 2018; Fledderjohann & Roberts, 2018; Goldscheider & Kaufman, 1996; Greene & Biddlecom, 2000; Inhorn, 2003; Inhorn et al., 2009b; Slauson-Blevins & Johnson, 2016).

A second example comes from the Integrated Fertility Survey Series (IFSS) (Fledderjohann & Barnes, 2018). The series started in 1955 to monitor reproduction, including infertility, in the United States. The survey series, which is currently operating as NSFG, is the main data source for tracking infertility to inform public health and family planning policy (Centers for Disease Control and Prevention, 2018, 2019). At its inception, the inclusion criteria for sampling was White married women ages 18–39, explicitly excluding, for example, people of color, men, and single individuals. The IFSS became progressively more inclusive over time, with married women of all races included beginning in 1960; married and single women of all races included since 1970 (though single women had to have been previously married or have children in the household until 1982); and men included beginning in 2002. Yet it still does not capture fully the population at-risk of infertility. For instance, the NSFG still explicitly excludes institutionalized populations, including incarcerated adults (Barnes &

Fledderjohann, 2020; Centers for Disease Control and Prevention, 2019). That this sampling decision is a common practice in household surveys is highly problematic, perpetuating race- and class-based structural inequalities in the way the infertility is tracked and, consequently, the way that healthcare is structured.

Even where sampling is inclusive, however, instrument design can foster invisibility of some groups or issues (Fledderjohann & Barnes, 2018; Fledderjohann & Roberts, 2018). Taking another example from the DHS, in the most recent questionnaires, both male and female respondents are asked whether or not they and/or their partner is medically sterilized (Fledderjohann & Barnes, 2018; Fledderjohann & Roberts, 2018; United States Agency for International Development, 2015).[1] Due to the survey's skip pattern, only respondents who indicate that neither they nor their partner is sterilized are then asked a series of questions where they are able to respond "can't get pregnant"; this is the only opportunity anywhere in the instrument for respondents to indicate self-identified concerns regarding their ability to conceive. Respondents who have a sterilized partner but also self-identify as infertile would not be captured by this skip pattern (Fledderjohann & Barnes, 2018; Fledderjohann & Roberts, 2018). This is significant not least because of both qualitative (Bledsoe, 2002; Gerrits, 1997; Leonard, 2002) and quantitative (Fledderjohann & Johnson, 2015; K. M. Johnson et al., 2019) evidence that there is a poor alignment between self-identified difficulties conceiving and biomedical or demographic measures. Where the aim is to understand the social causes and consequences of infertility, this is a substantial oversight.

Creating a More Inclusive Definition of Infertility

Taken together, the literature on definitions and survey instruments demonstrates how seemingly simple choices about how to define, measure, and collect data on infertility can dramatically shift our understanding of who experiences infertility, and how. These processes both shape and are shaped by how we diagnose and treat infertility; how we document its prevalence; and how we understand the psychosocial, sociocultural, and biobehavioral causes and consequences of infertility.

While interest remains in understanding the biological ability to conceive, other researchers have begun to advocate for a broader definition of infertility—social infertility—which would capture not only biological aspects of ability to conceive but also the social factors which restrict access to reproduction for some individuals and couples (Lo & Campo-Engelstein, 2018). This movement is based in part on the idea that extant definitions of infertility restrict access to services and treatments for those who struggle to conceive due to not having a partner or being in a same-sex relationship (Maxwell et al., 2018).

Clinical Aspects of Infertility

Established and Potential Causes of Infertility

Without intervention, the conception and maintenance of a pregnancy ending in a live birth depend on a series of physiological mechanisms that influence gamete production or reproductive organ quality and function: oogenesis; folliculogenesis; regular ovulation; patent and functional fallopian tubes; and a uterus capable of implantation in females and testicular function; spermatogenesis; and normal semen parameters in males. Established or potential causes (i.e., risk factors) that adversely affect these processes either separately or in combination have the potential to impact fertilization, implantation, intrauterine development, and the ability to maintain a pregnancy (Habbema et al., 2004). Causes of infertility can be divided broadly into female and male factors, which make up about 30–40% (female-only), 20–30% (male-only), and 20–40% (both male and female) of all infertile cases (Thonneau et al., 1991; World Health Organization, 1992). Additionally, there is a significant subset of couples (10–30% of cases) for whom a definite cause of infertility cannot be found after standard investigations have been carried out, referred to as unexplained infertility (Ray et al., 2012; Smith et al., 2003; World Health Organization, 1992).

Risk factors for infertility in both men and women include aging; genetic, medical, and health conditions; lifestyle and behavioral factors; and environmental, occupational, or infectious exposures (Centers for Disease Control and Prevention, 2014). A number of these factors cut across existing public health initiatives, such as smoking prevention and *C. Trachomatis* screening programs (Lemoine & Ravitsky, 2013). However, research is still needed to better identify and understand additional risk and protective factors to reduce infertility. Rather than cover an extensive review of these potential factors, this section discusses key physiological processes that may lead to infertility along with examples of how established and potential causes of infertility disrupt these processes.

Female-Factor Infertility and Related Mechanisms

Ovulatory Dysfunction and Oocyte Quality

Regular ovulation is dependent on very tight and delicate neuroendocrine mechanisms that operate through an intact hypothalamic–pituitary–ovarian (HPO) axis.[2] Any factor or set of factors that cause the HPO axis to malfunction has the potential to result in ovulatory dysfunction. The most common endocrine disorder in women that affects ovulation is polycystic ovary syndrome (PCOS) (Teede et al., 2018). PCOS is a neuroendocrine and metabolic disorder that is diagnosed using the Rotterdam criteria, of which any two of the three criteria should be present for a diagnosis: oligo-ovulation/anovulation,[3] polycystic ovarian morphology, or clinical or biochemical hyperandrogenism. Despite the large pool of antral (i.e., immature) follicles in the ovaries, the hormonal imbalances disrupt normal follicular recruitment and development, which results in amenorrhoea of varying durations in women with PCOS. Women with PCOS and obesity demonstrate a more severe pattern of reproductive imbalance (Broughton & Moley, 2017).

Independent of PCOS, obesity has also been shown to cause ovulatory malfunction that prolongs the time to conception and lowers chances for a live birth after in vitro fertilization (IVF) or intracytoplasmic sperm injection (ICSI) compared to women with normal body mass index (Practice Committee of the American Society for Reproductive Medicine, 2015b). The relationship between reproductive function and body weight involves complex endocrine and metabolic pathways that effect steroid metabolism, insulin, and other hormones, such as leptin and ghrelin, that can result in ovulatory malfunction and impaired implantation

(Broughton & Moley, 2017). Additionally, underweight and extreme weight loss may also interfere with the HPO axis resulting in anovulation and delayed conception (Boutari et al., 2020).

In addition to the frequency of ovulation, the quantity and/or quality of oocytes is another important predictor of fertility (i.e., ovarian reserve). Age is the strongest predictor of declining ovarian reserve; however, the exact mechanism by which age contributes to this decline is unclear (Farquhar et al., 2019). This decline is thought to be gradual prior to the mid- to late 30s and to accelerate thereafter. A number of proposed mechanisms have been postulated for this age-related decline and are discussed elsewhere (Farquhar et al., 2019) but generally relate to the accumulation of DNA damage in oocytes over time or changes in hormones that influence related processes, such as oocyte maturation. Some women may also experience decreased ovarian reserve prematurely, which can lead to an earlier age at menopause. This is referred to as premature ovarian insufficiency (POI), which is defined by the premature occurrence of decreased ovarian reserve (Farquhar et al., 2019).

Tubal and Uterine Abnormalities

The site of natural conception is the ampullary portion (i.e., widest section) of the fallopian tubes. Any structural or functional disturbance of the anatomy of the fallopian tubes can lead to reduced fertility. This is because the fluids produced by the tubes and the cilia found along their course play important roles in transportation of oocytes and sperm and in preparing these gametes for fertilization. Ascending infections from the vagina can cause pelvic inflammatory disease (PID). If untreated, PID leads to scarring, adhesions, or complete blockage of the fallopian tubes. The risk of tubal damage increases with increasing number of episodes of PID (Weström et al., 1992). Sexually transmitted infections (STIs), such as *Neisseria Gonorrhea* and *Chlamydia Trachomatis*, are the most common risk factors for PID (Weström, 1994). In countries with a high prevalence of tuberculosis, such as India, genital tuberculosis is another common cause of tubal infertility (N. Singh et al., 2008). Pregnancy terminations performed in unsafe and unhygienic conditions and untreated infections following delivery also increase the risk of tubal-factor infertility (Weström et al., 1992). Other noninfectious risk factors for tubal damage include pelvic surgeries and endometriosis (Macer & Taylor, 2012; ten Broek et al., 2013). Endometriosis is endometrial tissue that has escaped from the uterine cavity to other areas of the pelvis, including the fallopian tubes. Tubal endometriosis can cause scarring in the fallopian tubes; however, endometriosis may be related to infertility in other ways that have not been fully understood (Macer & Taylor, 2012).

The uterus is the site of implantation and development of the fetus. Risk factors that compromise the ability of the uterus to optimally perform this role may impair implantation or lead to pregnancy loss. Intrauterine adhesions and endometrial scar tissue can develop from infections of the endometrial tissue (i.e., endometritis) or from uterine surgery (Kodaman & Arici, 2007). For example, Asherman's syndrome is a rare acquired condition characterized by amenorrhea or hypomenorrhea and cyclic pelvic pain, which may develop as a result of intrauterine adhesions following curettage or surgery (March, 2011). Other uterine abnormalities can also affect implantation and fetal development, the most common of which are uterine fibroids. The prevalence of fibroids increases with age and generally varies between racial groups, with Black women having the highest prevalence (E. A. Stewart et al., 2017). Even though uterine fibroids do not cause fertility problems per se, fibroids that distort the uterine cavity may impair implantation or result in pregnancy loss (Bozdag et al., 2008). A review of studies on the impact of fibroids on the likelihood of achieving or maintaining a pregnancy concluded that there was insufficient evidence to determine the specific role of fibroids on pregnancy outcomes, given variation in size, number, and location (Penzias et al., 2017). A common surgery to remove symptomatic fibroids is myomectomy, which may optimize pregnancy outcomes in some women (Penzias et al., 2017). However, this surgical procedure may lead to adhesions that affect tubal or uterine anatomy causing infertility (Ikechebelu et al., 2018). Myomectomy should, therefore, be performed only when properly indicated, especially in women who have never conceived before or intend to conceive in the future (Carranza-Mamane et al., 2015).

Male-Factor Infertility and Related Mechanisms

Many of the causes or risk factors for male infertility include congenital or acquired conditions that affect sperm production, transport, and function. Additional, but rare, causes of male infertility relate to coital disorders, such as erectile dysfunction or premature ejaculation (Krausz, 2011). However, a significant proportion (30–40%) of male infertility has no identified cause after extensive evaluation (Jungwirth et al., 2012). Most of these idiopathic forms of male infertility have been attributed to undetermined genetic or environmental factors (Jungwirth et al., 2012).

At the most extreme, a clinical finding of azoospermia, or the absence of sperm in the ejaculate, can result from several different etiological factors that relate to male infertility more broadly. Azoospermia can be differentiated into obstructive or nonobjective mechanisms and special diagnostic investigation is needed to determine the different types (World Health Organization, 2010b). Obstructive azoospermia (OA) is due to the blockage of the ejaculatory system and accounts for about 40% of all cases of azoospermia (Practice Committee of the American Society for Reproductive Medicine in Collaboration with the Society for Male Reproduction and Urology, 2019). Congenital causes of OA include congenital bilateral or unilateral absence of the vas deferens and idiopathic obstructions of the epididymis or ejaculatory ducts. Acquired causes include vasectomy, infection, trauma, and injury. About 2% of vasectomized men request a reversal but usually have reduced sperm quality after the procedure and may require the use of assisted reproductive technologies (Dohle et al., 2012). The most common infectious organisms causing inflammation of the epididymis are *N. Gonorrhoea* and *C. Trachomatis* (Abarikwu, 2013). Childhood viral infection with mumps have also been shown to lead to testicular inflammation (i.e., mumps orchitis) in about 30–40% of cases, which adversely affects semen production in adults (Davis et al., 2010).

Nonobstructive azoospermia relates to mechanisms that affect the intrinsic inability of the testes to produce sperm. This primarily results from testicular dysfunction but may also be due to impairments of the hypothalamus or pituitary gland (Practice Committee of the American Society for Reproductive Medicine, 2018). Cryptorchidism, or undescended testes, is the most frequent congenital birth defect in male children (Jungwirth et al., 2012). Men with undescended testes have higher than normal testicular temperatures and excess heat is known to impair sperm production. Correction of the undescended testes before age 3 has been associated with improved semen parameters in adulthood. Other congenital factors include genetic disorders (e.g., Klinefelter syndrome[4] and Y chromosome microdeletions) that result in disruptions to the endocrine system and other processes necessary for sperm production (Krausz, 2011).

Other acquired factors that impair testicular function include exogenous factors (e.g., environment, excess heat, drugs, and lifestyle) and systemic diseases (e.g., diabetes mellitus, hypo/hyperthyroidism, and obesity). An active area of inquiry is the effects of environment and lifestyle factors on male sperm production (see box 3). Several mechanisms may explain how environmental and lifestyle factors influence spermatogenesis. Some environmental exposures, such as radiation and chemotherapy, may cause direct damage to testicular tissues (Hauser, 2006). Lifestyle factors, such as smoking, alcohol, and obesity, may cause impairments due to oxidative stress, which generates free radicals that lead to DNA mutations in sperm and impair semen parameters (Agarwal et al., 2018). Obesity and other environmental chemicals may also disrupt normal endocrine function necessary for sperm production (Craig et al., 2017; Sikka & Wang, 2008).

Finally, although more attention has been given to the effects of female age on infertility, age-related changes in men can also impact fertility, particularly after the age of 40 years (Sartorius & Nieschlag, 2010). These changes have been attributed to a number of different mechanisms that have been highlighted in this section, including decreased sexual activity, alterations in semen parameters and hormone levels, increased DNA sperm fragmentation, and higher rates of chronic disease with older male age (Harris et al., 2011; Sartorius & Nieschlag, 2010).

Box 3. Trends in Male Reproductive Health and the Environment

There has been considerable scientific debate on whether semen quality, and male fertility in general, has been declining globally (Smarr et al., 2017). Prior and recent meta-analyses support an overall decline in semen quality; however, heterogeneity in populations and designs preclude consensus (Carlsen et al., 1992; Levine et al., 2017; Swan et al., 2000). An extensive review published in 2017 shows that this trend is most apparent in Western countries, with some indication of a nonstatistically significant decline among the general population in non-Western countries (Levine et al., 2017). Researchers argue that these trends in semen quality should be considered along with parallel trends in worsening male reproductive health, including increases in rates of testicular germ cell cancer (TGCC), hypospadias,* and cryptorchidism and declining serum testosterone levels (Paulozzi, 1999; Skakkebaek, 2017; Smarr et al., 2017; Trabert et al., 2015; Znaor et al., 2014). Research has shown a biological relationship between spermatogenic disorders and testicular cancers as well as corresponding country-level patterns of high TGCC and low sperm quality (Berthelsen, 1984; Serrano et al., 2013). The interrelatedness and early occurrence of these conditions suggest the potential for a shared fetal origin of their etiology (Skakkebaek, 2017). The question remains, however, as to what factors may lead to these patterns at the population level.

Changes in environmental and lifestyle factors broadly coincide with changes to male reproductive health indicators. Although causes of male infertility can be due to genetic, anatomical, and infectious causes, it is unlikely that these factors could explain these epidemiological trends (Skakkebaek et al., 2015). TGCC has been linked to excess estrogen exposure in the first trimester of pregnancy (Dieckmann & Pichlmeier, 2004) and hypospadias to increased antiandrogenic agents from environmental chemicals (Manson & Carr, 2003). Independent of fetal etiology, several environmental and lifestyle factors have been associated with reduced sperm count in adult men (Abarikwu, 2013; Durairajanayagam, 2018), including endocrine disrupting chemicals (Bloom et al., 2015; Gore et al., 2015), pesticides (Chiu et al., 2016), diet (Afeiche et al., 2013; Jensen et al., 2013), stress (Gollenberg et al., 2010; Nordkap et al., 2016), smoking (Sharma et al., 2009), and body mass index (Eisenberg et al., 2015; Sermondade et al., 2013). It is important to note that although sperm quality may be on the decline, it is unclear what impact this has had on overall infertility at the population level (Smarr et al., 2017). While the current data appear concerning, this issue requires further research to better understand the potentially complex relationship between environmental and lifestyle factors on male reproductive health and infertility (Akre & Richiardi, 2009).

* *A birth defect in boys where the opening of the urethra is not located at the tip of the penis.*

Diagnosis of Infertility

Before proceeding to investigate the specific cause or causes of infertility, a detailed evaluation of both partners is conducted first, which includes the assessment of age, medical and reproductive history, lifestyle factors (e.g., occupational hazards and use of tobacco, alcohol, and drugs), sexual activity in the fertile window, sexual dysfunction, and time trying to conceive. This is followed by a comprehensive physical examination of the woman (Practice Committee of American Society for Reproductive Medicine, 2015a). The WHO recommends the use of the “toolbox for infertility” designed by the International Federation of Gynecology and Obstetrics (FIGO) for the initial evaluation (International Federation of Gynecology and Obstetrics, n.d.). The FIGO toolbox recommends that further diagnostic investigations of the subfertile couple should start with the male partner providing a seminal fluid analysis (SFA). This is relevant for practical purposes as the SFA report may determine the extent to which the female partner should be investigated. Current reference values for semen analysis are defined by *WHO Laboratory Manual* (World Health Organization, 2010b) (Table 1).

Table 1. Semen Analysis Reference Values

Parameter (units)	Lower reference limits
Semen volume (ml)	1.5
Total sperm count (10^6 per ejaculate)	39

Parameter (units)	Lower reference limits
Sperm concentration (10^6 per ml)	15
Total motility (PR+NP)	40%
Progressive motility (PR)	32%
Nonprogessive motility (NP)	1%
Immotile spermatozoa (IM)	22%
Vitality (live spermatozoa)	58%
Sperm morphology (normal forms)	4%
Other consensus threshold values	
pH	>7.2

The male partner should be instructed to abstain from sexual intercourse or ejaculation for two to five days before producing the sample. The sample should be produced preferably by masturbation at the facility to ensure complete collection. If it has been produced outside the facility, it should be transported close to body temperature and brought to the facility within one hour. If masturbation cannot be done or is unacceptable, the man should be given a sterile nontoxic condom to ejaculate into during sexual intercourse. The ejaculate is then transferred into a sterile container. The last, but least desirable, method is coitus interruptus, which is not recommended as some of the ejaculate may be lost in the vagina during ejaculation.

If the semen analysis is normal, no further investigations are required of the male partner in most cases. If the semen parameters are abnormal, the semen analysis should be repeated after one month. If the repeat analysis is abnormal, full evaluation should be carried out to find the cause, which includes a thorough medical and developmental history, physical examination, and laboratory investigation. The laboratory investigations include assays of basic reproductive hormones such as testosterone, prolactin, follicle stimulating hormones (FSH) and luteinizing hormone (LH).

In females, hormonal evaluation of female subfertility is normally indicated in cases of ovulatory disorders or when there is clinical evidence of endocrine disease (International Federation of Gynecology and Obstetrics, n.d.). The commonest reproductive hormones that are evaluated in such cases are LH, FSH, prolactin, thyroid function tests, progesterone, and oestradiol. The test for ovulation is normally done using the midluteal progesterone test. A value more than 3ng/ml or 18mmol/L is presumptive evidence of ovulation as long as the sample is obtained at the appropriate time in the cycle (Practice Committee of American Society for Reproductive Medicine, 2015a) To measure ovarian reserve, a serum FSH level can be obtained on menstrual cycle days 2–4 and serum antimüllerian hormone (AMH) concentrations on any day of the menstrual cycle (Practice Committee of American Society for Reproductive Medicine, 2015a).

The female investigations include an ultrasound scan of the uterus and ovaries to determine possible uterine and ovarian causes of the infertility. A transvaginal ultrasound scan is the preferred choice for this evaluation as it provides better visualization of the uterus and ovaries. Uterine pathologies, such as fibroids, can be diagnosed and mapped with a transvaginal scan. The use of saline instillation into the uterus at the time of imaging (saline infusion sonography, or SIS) may assist in accurately identifying and characterizing the pathology. Polycystic ovaries and adnexal pathologies are also better evaluated with transvaginal ultrasound.[5] The volume of the ovary and number of antral (resting) follicles can also provide a measure of ovarian reserve that can be helpful in diagnosis and treatment planning. In obese patients, a transvaginal scan is imperative as an abdominal scan will not permit good visualization of the uterus and ovaries. Where transvaginal ultrasound scan cannot be done, an abdominal scan may be done despite its limitations.

The tubal factor is evaluated using hysterosalpingogram (HSG) or contrast hystero-sonography (HyCOSy) and laparoscopy with dye test (often called chromopertubation), which are the first-line tests.[6] HSG, especially when done under fluoroscopy, is a good first-line test in documenting tubal patency. Uterine defects such as septate uterus, uterine adhesions, submucous leiomyomas, and polyps can be diagnosed with HSG.[7] The limitations of HSG are that it does not provide a panoramic view of the pelvis; hence, conditions like endometriosis and pelvic adhesions cannot be evaluated. Pain is the most reported side effect of HSG (Bachman et al., 2014). HyCoSy is like HSG in terms of advantages and disadvantages, but patients are less likely to report pain with these procedures compared with HSG. Additionally, the patient can directly observe the procedure of HyCoSy on the ultrasound monitor (International Federation of Gynecology and Obstetrics, n.d.).

Laparoscopy with dye test is indicated when HSG and HyCoSy are inconclusive. Laparoscopy may also be used as first-line evaluation of the fallopian tubes and pelvis based on the history of the patient. For instance, if there has been a history of pelvic surgery, PID, or suspected endometriosis, laparoscopy should be the first-line method for tubal evaluation. Laparoscopy allows comprehensive evaluation of the pelvis and fallopian tubes in such cases. The disadvantages of laparoscopy include its invasiveness, high cost, need for anaesthesia, possible surgical complications, and inability to evaluate the uterine cavity. Although laparoscopy used to be undertaken as a routine part of an initial infertility evaluation, it has fallen out of favor due to cost-ineffectiveness and unnecessary risk.

Options for Managing Infertility

Clinical Treatment Options

The management and treatment of infertility should be determined based on evidence and a thorough diagnostic investigation that identifies the underlying etiology of the individual and couple's infertility. Extensive guidelines are produced by the European Society of Human Reproduction and Embryology (ESHRE), the U.K.-based National Institute for Health and Care

Excellence (NICE) and Royal College of Obstetricians and Gynaecologists (RCOG), and the U.S.-based American College of Obstetricians and Gynaecologists (ACOG) and the American Society for Reproductive Medicine (ASRM). Although this section presents options for managing infertility for both male and female factors, it is important to note that infertility treatment tends to focus more extensively on female bodies, even when the cause is attributed to male factors, and may be invasive in nature.

Over half of all couples who have been unable to conceive in one year and have normal testing results and a female partner under 35 will conceive without assistance by the end of their second year of well-timed intercourse (Brandes et al., 2011; National Collaborating Centre for Women's and Children's Health, 2013; te Velde et al., 2000). Thus, expectant fertility management is an appropriate recommendation in these cases (Gunn & Bates, 2016; Lindsay & Vitrikas, 2015). Counseling can also be a first-line approach to managing infertility and/or offered in combination with other treatment options. Both women and men should be counseled to have regular sexual intercourse two to three days per week, attain a normal body mass index (BMI), abstain from smoking and addictive drugs, reduce alcohol intake, and treat any existing psychosexual problems (Kamel, 2010; Lindsay & Vitrikas, 2015; National Collaborating Centre for Women's and Children's Health, 2013; Thurston et al., 2019). Men should also be recommended to avoid occupational or social situations that may cause testicular heating and to wear loose-fitting underwear and pants; however, it is unclear whether the latter can improve fertility (National Collaborating Centre for Women's and Children's Health, 2013; Thurston et al., 2019).

Beyond expectant management and counseling, there are three main types of infertility treatment: medical treatment, surgical procedures, and assisted conception. Treatment of infertility with oral and injectable medication is primarily used for controlled ovarian stimulation (COS; when an increased number of ovulatory follicles are desired) or ovulation induction (OI; when ovulation is not occurring naturally) in female-factor infertility and can be used with timed intercourse or intrauterine insemination (IUI) when there is a concomitant male factor (Stevenson et al., 2016). Oral medications work through negative feedback to central receptors, encouraging increased production of endogenous gonadotropins (Beall & DeCherney, 2012). Clomiphene citrate is an oral medication that is affordable and effective in inducing ovulation in 50–70% of cases of oligo-ovulation and in achieving pregnancy rates of 15–25% per cycle (Ombelet et al., 2008). Other oral medications such as letrozole (Eskew et al., 2019; National Collaborating Centre for Women's and Children's Health, 2013) and tamoxifen (J. Brown & Farquhar, 2016) may be used off-label for oral ovulation induction. Injectable gonadotropins work directly on the ovary to induce ovulation. COS and OI can result in multiple gestation pregnancies or in ovarian hyperstimulation syndrome (OHSS) (more common with gonadotropins), a potentially life-threatening complication (Sharma et al., 2009); thus, patients should be monitored closely for these risks. Medication and other nonsurgical approaches can also be used for the treatment of some causes of male-factor infertility; for example, clomiphene citrate and gonadotropins may be recommended for the management of hypogonadotrophic hypogonadism (Fraietta et al., 2013; National Collaborating Centre for Women's and Children's Health, 2013; Wheeler et al., 2019), PDE5 inhibitors for erectile dysfunction (Gong et al., 2017), and electroejaculation for ejaculatory dysfunction (Kamischke & Nieschlag, 1999).

Surgical treatment for infertility may be indicated for some female- and male-factor infertility. For women, for example, tubal surgery may be beneficial for mild cases of tubal disease (Daniilidis et al., 2017). Uterine surgery may be indicated in certain circumstances; for example, amenorrhoeic women with intrauterine adhesions may benefit from the surgical removal of adhesions through hysteroscopic adhesiolysis (Pabuçcu et al., 1997). Surgical removal of uterine fibroids through myomectomy may be indicated in certain circumstances; however, the impact it has on live birth rates needs to be examined with more rigorous research studies (Zepiridis et al., 2016). Endometriosis may be destroyed or removed through laparoscopic surgery, which has been found to improve reproductive outcomes in mild to moderate cases (Duffy et al., 2014). Women who have had a tubal ligation but later wish to conceive may benefit from tubal ligation reversal (tubal reanastamoses) (Godin et al., 2018).

Some men with infertility may also benefit from surgery. For example, men who have obstructive azoospermia or erectile or ejaculatory dysfunction may benefit from surgical extraction of sperm through procedures such as testicular sperm extraction (TESE) (Agarwal et al., 2020). There may be some benefit from surgical repair of varicoceles in men with oligozoospermia though the evidence on whether this improves spontaneous pregnancy rates is inconclusive (Baazeem et al., 2011). However, among couples undergoing assisted reproductive technology (ART), repairing varicoceles among azoospermic or oligospermic men can, according to a meta-analysis, improve pregnancy and live birth rates (Kirby et al., 2016). Men with vasectomies who desire more children can benefit from vasectomy reversals (vasovasostomies) to restore their fertility (Schwarzer & Steinfatt, 2013; Valerie et al., 2018).

IUI is a procedure by which sperm from a partner or donor is inserted into a woman's uterus prior to ovulation. It is often indicated in cases of male infertility, for unexplained infertility, and in women with minimal or mild endometriosis (ESHRE Capri Workshop Group, 2009). Unstimulated IUI cycles may also be recommended when individuals are unable or find it difficult to have vaginal intercourse, for conditions that require specific consideration in relation to methods of conception such as human immunodeficiency virus (HIV), as part of donor insemination, or when people have social, cultural, or religious objections to IVF (National Collaborating Centre for Women's and Children's Health, 2013). IUI can be carried out in a natural cycle without drugs or in combination with ovarian stimulation. Common stimulation agents include clomiphene citrate, Letrozole, and gonadotrophins (R. Wang et al., 2019). Overall, evidence on the effectiveness and safety of IUI is limited. For male-factor infertility, a review by the ESHRE Capri Working Group (2009) as well as a Cochrane Systematic Review, concluded that there is insufficient evidence on the effectiveness of IUI to be able to recommend or advise against its use with or without stimulation above timed intercourse (Bensdorp et al., 2007). Similarly, for unexplained infertility, the authors of another Cochrane Systematic Review concluded that there was insufficient evidence on the effectiveness of IUI with or without stimulation compared to timed intercourse or expectant management with or without stimulation to conclude that it improves live birth rates *with* acceptable multiple pregnancy rates (Ayeleke et al., 2020). The lack of sufficient high-quality evidence on the effectiveness of IUI in improving live birth rates has resulted in debate over its use in certain circumstances. For example, as of 2013, NICE no longer recommends offering IUI to people with mild male-factor infertility, unexplained infertility, or mild endometriosis (National Collaborating Centre for Women's and Children's Health, 2013). Instead, NICE recommends that people with these conditions try to conceive for a total of two years before considering IVF.

ART is defined as “all interventions that include the in vitro handling of both human oocytes and sperm or of embryos for the purpose of reproduction. This includes, but is not limited to, *in vitro* fertilization (IVF) and embryo transfer (ET), intracytoplasmic sperm injection (ICSI), embryo biopsy, preimplantation genetic testing (PGT), assisted hatching, gamete intrafallopian transfer (GIFT), zygote intrafallopian transfer (ZIFT), gamete and embryo cryopreservation, semen, oocyte and embryo donation, and gestational carrier cycles” (Zegers-Hochschild et al., 2017, p. 1790). Considerable advances have been made in ART procedures since their inception (see box 4 and Figure 1). These procedures continue to change and update as new advancements are made in the optimization of its delivery to improve pregnancy rates and maximize patient safety (Brezina et al., 2012). The most common type of ART is IVF, a procedure in which mature oocytes are extracted from a woman’s ovary/ovaries and then combined with sperm in a laboratory for fertilization. Fertilized oocytes (pre-embryos) are then typically monitored for three to five days before being transferred to the woman’s uterus for implantation (Alexander et al., 2016).

ICSI is a common micromanipulation procedure done in combination with *in vitro* fertilization in which a single sperm is injected directly into an oocyte to assist with fertilization (Zegers-Hochschild et al., 2017). In fact, ICSI has become widely used with an estimated 66.5% of all nondonor ART cycles using the technique worldwide; however, significant variation in use across regions exists ranging from 55% of cycles in Asia to nearly 97% of cycles in the Middle East (Adamson et al., 2018). ICSI was developed in the early 1990s as a technique to address male-factor infertility (Stevenson et al., 2016) and can be used in combination with surgical sperm retrieval (Agarwal et al., 2020). Since its inception, ICSI has been extended for use in a variety of non-male-factor etiologies such as unexplained infertility, advanced maternal age, failed prior ART cycles, low oocyte yield, and use of preimplementation genetic testing (Boulet et al., 2015). The use of ICSI in couples with non-male-factor infertility has increased despite little to no evidence that ICSI improves reproductive outcomes in these cases relative to IVF (Abbas et al., 2020). For example, a study that assessed national trends and reproductive outcomes in the use of ICSI in the United States found that the use of ICSI in fresh IVF cycles increased from 36.4% in 1996 to 76.2% in 2012 despite a lack of improved postfertilization reproductive outcomes relative to conventional IVF (Boulet et al., 2015).

Because one of the greatest risks associated with ART is fetal and maternal complications due to multiple pregnancies (Fauser et al., 2005; Pinborg, 2005), the International Federation of Fertility Societies surveillance found that 48 of 85 responding countries have established guidelines and or regulations on the number of embryos to transfer to a women’s uterus in a given treatment cycle (International Federation of Fertility Societies, 2019). Advances in ART have resulted in higher-quality embryos and improved rates of implantation, which has led to a reduction in the number of embryos being transferred per cycle. In 2011, single-embryo transfer (SET) represented an estimated 31.4% of fresh nondonor IVF/ICSI cycles globally (Adamson et al., 2018), up from 23.4% in 2007 (Ishihara et al., 2015).

Cryopreservation is the process of freezing gametes or embryos for future use and has provided individuals and couples undergoing infertility treatment with safer and more effective options for achieving pregnancy. For example, it allows a woman experiencing OHSS from fertility medications to delay the transfer of embryos to a later and safer time (International Federation of Fertility Societies, 2019) and allows people facing gonadotoxic treatment of cancer, hormonal treatment for gender affirmation, or surgical removal of gonads to preserve their reproductive abilities. Common techniques used in cryopreservation include slow freezing and vitrification. Advances in freezing techniques for cryopreservation of embryos, including the introduction of vitrification, has resulted in equivalent and sometimes superior success in pregnancy and live birth rates for transfers using frozen embryos relative to those using fresh embryos (Z.-J. Chen et al., 2016; Kemper et al., 2019; Shi et al., 2018; Vuong et al., 2018). These promising results have led some experts to question whether a "freeze-all" approach should be used in all ART cycles (Sciorio & Esteves, 2020). This approach would involve the cryopreservation of all viable embryos from controlled ovarian stimulation to then be transferred to the uterus in a subsequent cycle. However, a mini-review of a "freeze-all" approach did not find evidence of additional benefit of this approach for all patients undergoing ART treatment at this time but did find evidence of its utility for certain clinical scenarios, such as for women at risk of OHSS or undergoing PGT at the blastocyst stage (Sciorio & Esteves, 2020).

Third-party reproduction includes the use of donor semen, ooctyes, or embryos as well as gestational carriers.[8] Use of gestational carriers has spurred ethical debate primarily due to the potential for exploitation, commodification, and/or coercion of the carrier when she is compensated for her services (Deonandan et al., 2012; Pande, 2014; Patel et al., 2018), and raising broad questions about autonomy and choice in reproduction (H. D. Singh, 2017). Transnational use of gestational carriers and its impact on how reproductive work is viewed and defined can also compound already complex local systems of inequality (H. D. Singh, 2014). As a result, legality of gestational carrier agreements varies by country and has contributed to cross-border use of these services (Crockin, 2013; Patel et al., 2018). In separate articles, Crockin (2013) and Deonandan (2015) outline multiple ethical; legal; financial; emotional; and physical risks to gestational carriers, intended parents, and or offspring involved in the use of cross-border gestational carriers, highlighting the urgent need for an internationally accepted framework or basic principles that can help minimize risk while respecting the different values and policies across countries.

Preimplantation genetic testing (PGT) can be performed in vitro to test for abnormal chromosomes in a developing embryo prior to being transferred to the uterus for implantation (American Society for Reproductive Medicine, 2014). PGT can assist in selecting and transferring embryos unaffected by certain genetic disorders and or chromosomal abnormalities (American Society for Reproductive Medicine, 2014). This technique is also becoming more common. For example, in the United States, 22% of ART procedures in 2017 included PGT (Centers for Disease Control and Prevention, 2018).

Gene editing of embryos has generated a number of scientific and ethical questions on its use in clinical practice, particularly in relation to its use in ART. Genetic editing is a new technology that employs CRISPR-Cas 9 proteins to knock out harmful genes from DNA molecules in embryos (Yang & Huang, 2019). The ability to edit the genes of embryos by removing disease-causing genes prior to implantation could prevent the development of genetic disorders, such as Duchenne muscular dystrophy and congenital deafness, in susceptible children.[9]

Current research in gene editing can best be described as experimental and the safety and precision of gene editing has not yet been established. In November 2018, a Chinese scientist, Jiankui He, reported the birth of twins in China in whom he had edited the C-C chemokine receptor type 5 (CCR5) genes (Ma et al., 2019). The rationale for this genetic modification was to render the babies, whose parents were discordant for HIV infection, immune from HIV infection. Jiankui He's announcement received widespread condemnation in China and international outcry given that the scientific and ethical basis of gene editing had not yet been established to permit its use in clinical practice. Recently, He and colleagues were found guilty of conducting an illegal medical practice in Chinese courts in December 2019 (Joseph, 2019). More research is needed in this emerging field of ART to establish the safety, precision, and ethical principles of gene editing before clinical application can be approved.

Box 4. Major Milestones in Assisted Reproductive Technology, 1970–2020

Assisted reproductive technologies (ARTs) have emerged as one of the foremost treatments for infertility, but they have not come without controversy. This timeline highlights many of the advances that have shaped the provision of ART over time. The first ever *in vitro* fertilization (IVF) pregnancy was reported in Melborne, Australia in 1973 by the Monash research team (Drs. Carl Wood and John Leeton); however, the pregnancy ended in an early miscarriage (Kamel, 2013) (see figure 1). On July 25, 1978, Louise Brown became the first ever baby to be born through IVF and embryo transfer (IVF-ET) in Oldham General Hospital, Cambridge, United Kingdom (Fishel, 2018). This spectacular achievement in human reproduction, however, was preceded by many years of experimentation and research using animal species that date back to 1890, when professor Walter Heape reported the first known case of embryo transplantation in rabbits.

Following the birth of Louise Brown, ART began to spread rapidly, particularly in India, where the world's second IVF baby was born just months behind Louise Brown (Bharadwaj, 2002; Inhorn & van Balen, 2002). The first IVF birth in Australia was reported by the joint Victorian Monash-Melbourne team in 1980 (Cohen et al., 2005). This was followed by the birth of the first IVF baby in the United States in 1981 using human Menopausal Gonadotropins (hMG) for ovarian stimulation. The first IVF birth in France was reported in 1982 by the Frydman and Testart group, followed by a birth in Sweden in the same year.

Rapid advances in infertility treatments followed the spread of ART, mostly in high-income countries, in the early years of IVF. In 1983, the Monash IVF group reported the first IVF pregnancy using donor oocytes and in the same year reported the birth of the first baby from a frozen embryo (MA Kamel, 2013). In 1984, the birth of the first baby through surrogacy was reported in California, United States. In addition, 1984 marked the first year when gonadotropin releasing hormone (GnRH) agonists and gonadotropins for ovarian stimulation protocols were introduced. This was extremely important as it enabled clinicians to obtain a larger number of follicles through ovarian stimulation, at the same time preventing premature ovulation with GnRH agonists. This ensured retrieval of a good number of mature oocytes for fertilisation. The introduction of gamete intrafallopian transfer (GIFT) in 1984 (Asch et al., 1984) and zygote intrafallopian transfer (ZIFT) (Hamori et al., 1988) improved pregnancy rates; however, the use of laparoscopy and associated surgical risks reduced the utility of these procedures in favor of nonsurgical oocyte retrieval techniques (J. Wang & Sauer, 2006).

By 1985, researchers had reported transvaginal aspiration of follicles and abdominal ultrasound guided embryo transfer (Wikland et al., 1985). The first microinjection of a single sperm into the oocyte occurred in 1987, heralding the era of intracytoplasmic sperm injection (ICSI) (Laws-King et al., 1987). The first baby to be born through the ICSI procedure was reported in 1992 (Palermo et al., 1992). By 1995, pregnancies following testicular sperm extraction (TESE) and ICSI in nonobstructive azoospermia patients were reported by Devroey et al. (1995). This revolutionized the treatment of male infertility by permitting the injection of a single sperm into the cytoplasm of the oocyte.

Concurrently, a number of other advances were occurring in relationship to biopsy procedures, oocyte and embryo freezing, and genetic testing. The first successful pregnancy after oocyte cryopreservation was reported in 1986 (C. Chen, 1986). In 1989, the first human embryo biopsy procedure was reported followed by DNA amplification and gender determination, which was first used to prevent transmission of sex-linked disorders (Handyside et al., 1990). A year later, the first successful cleavage stage vitrification (i.e., freezing embryo in the first four days of development for future use) was carried out, followed by a successful delivery after transfer (Gordts et al., 1990). The first live birth following blastocyst biopsy and preimplantation genetic diagnosis (PGD) was reported by De Boer et al. (2002).

Milestones in the 21st century include refinement and simplification of ART procedures, which enable these procedures to be less invasive and more accessible and affordable (Casper et al., 2017). The first baby conceived with a simplified culture system for clinical IVF and embryo transfer was born in November 2012 and marked a new way forward in low-cost ART procedures (Van Blerkom et al., 2014). This was followed by the first birth in Ghana using a low-cost ART procedure developed by The Walking Egg (The Walking Egg, 2017). Around this same time, a woman who had a congenital absence of a uterus delivered a baby in 2014 after receiving a uterine transplant from a living donor (Brännström et al., 2015). Finally, time-lapse imaging has emerged as a novel method of embryo selection that maintains the integrity of the embryo over other procedures. A recent study suggests improvements in pregnancy rates after applying time-lapse imaging embryo selection strategies (Meseguer et al., 2012).

ART technologies are rapidly changing and new or improved techniques continue to emerge.

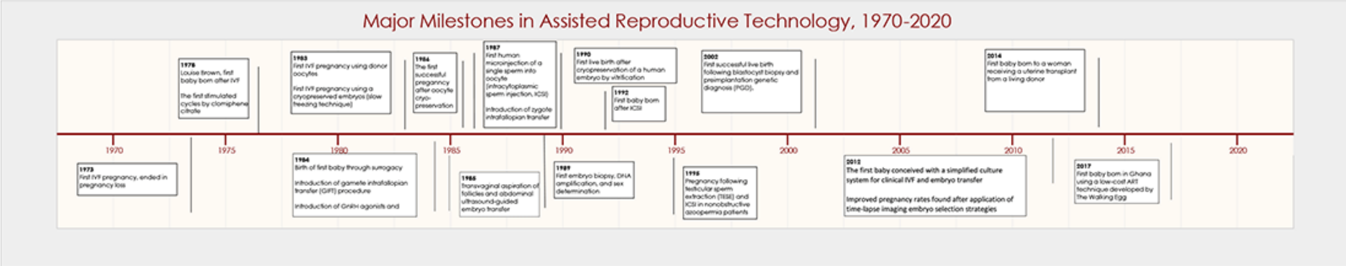

Figure 1. Major milestones in assisted reproductive technologies, 1970–2020.

Nonbiomedical Practices

In both low- to middle-income countries and high-income countries, nonbiomedical practices are often used in combination or succession with clinical management of infertility (Cox & Johnson, 2020; Dierickx et al., 2019; Perry & Hirshfeld-Cytron, 2013; Rayner et al., 2011; Van Balen & Gerrits, 2001). In fact, a systematic scoping review on the use of nonbiomedical practices for fertility enhancement found that most studies reported between 30 and 70% of their participants, most of whom were recruited from fertility clinics, had used at least one nonbiomedical practice to enhance their fertility (Cox & Johnson, 2020). Other studies have documented that, for some individuals experiencing infertility, nonbiomedical treatment is the sole treatment sought, often due to cultural beliefs about the causes of infertility and or the lack of accessible biomedical care (Dierickx et al., 2019; Nahar, 2010; Perry & Hirshfeld-Cytron, 2013; Sarkar & Gupta, 2016; Van Balen & Gerrits, 2001). For example, an ethnographic study conducted in Bangladesh found that many rural women attributed childlessness to an indigenous creature called joha-juhi, which is believed to reside in the wombs of infertile women, eating their embryos when they become pregnant. Herbalists are believed to be able to rid the creature from women's wombs, resulting in little to no perceived need for biomedical treatment for infertility (Nahar, 2010).

Biologically based treatments, particularly herbal medicines, are the most commonly used nonbiomedical practices globally followed by religious and spiritual interventions (Cox & Johnson, 2020). However, individuals engage in a wide variety of nonbiomedical practices to enhance their fertility, including, but not limited to, lifestyle modifications such as diet, exercise, and sexual practices; acupuncture and other energy therapies; manipulative and body-based methods including chiropractic treatment, heat and hydrotherapy, and massage; and mind–body interventions such as meditation (Cox & Johnson, 2020; Rayner et al., 2011). Use of these practices varies by country and context. For example, use of heat and hydrotherapy, such as visits to thermal spas and baths, is commonly asked about and reportedly used for fertility enhancement in studies conducted in Turkey (Ayaz & Efe, 2010; Edirne et al., 2010; Günay et al., 2005; Nazik et al., 2015; Özkan et al., 2018). In a study of infertility in The Gambia, Bledsoe (2002) contextualizes the surprising finding that women who have struggled to conceive or carry a pregnancy to term take oral contraceptives in order to help themselves conceive. She finds that women identify repeated physical strain on their bodies as an underlying cause of infertility, and so seek to rest their bodies by using contraceptives. This practice fits within a broader construction of time as nonlinear; women see the use of contraceptives as a means of reversing aging caused by physical strain on the body, thereby enabling them to conceive in the future.

Despite widespread use of nonbiomedical practices to enhance fertility, there is a dearth of research on the safety and effectiveness of these practices (Miner et al., 2018; Weiss et al., 2011). A scoping review conducted by Miner et al. (2018) examined the evidence on the effectiveness of 12 complementary and alternative medicine methods on improving fertility outcomes. Overall, the authors found a lack of quality evidence due to study design as well as contradictory results, making it challenging to draw conclusions about the effectiveness of these methods. Even acupuncture, which has been the most widely studied nonbiomedical practice and has the highest level of evidence, shows inconclusive results for improving fertility (Miner et al., 2018; Weiss et al., 2011). More research is needed to gain a comprehensive understanding of the use of nonbiomedical practices for managing infertility and the effectiveness and safety of these practices.

Access to and Receipt of Quality Fertility Care

Access to and Receipt of Quality Fertility Care

The proportion of infertile couples who seek medical care for the management of infertility in low- to middle-income countries (LMICs) and high-income countries (HICs) is, on average, slightly more than 50%; however, this varies by country, ranging from 27 to 76% (Boivin et al., 2007). An average of only 22.4% of subfertile couples go on to actually receive any specialized infertility treatment. From these figures, Boivin et al. (2007) conclude that of the estimated 72.4 million women currently living with infertility, only 40.5 million will seek medical care for the management of their infertility. In the United States, the Centers for Disease Control and Prevention (CDC) estimates that approximately 12%, or 7.3 million women, ages 15–44 have used infertility services (Centers for Disease Control and Prevention, 2016).

Of those who receive care, the type of treatment received varies. For example, a study conducted in the United States found that among those who reported receiving infertility treatment, ovulation drug therapy was reported most often, and in vitro fertrilization was reported least often (Kessler et al., 2013). Data on the utilization of assisted reproductive technology (ART) for the treatment of infertility are more readily available than for other treatments. The European Society of Human Reproduction and Embryology (ESHRE) has estimated the optimal utilization of in vitro fertilization/intracytoplasmic sperm injection (IVF/ICSI) to be 1,500 couples per million population per year based on an estimated need and uptake of these services (European Society of Human Reproduction and Embryology, 2001). The necessary number of ART cycles to reach this level would be in excess of this figure since couples may require more than one cycle when trying to conceive. A multiregion study that collected data on ART treatments conducted in 2011 found an overall global utilization rate of only 477 cycles per million population with an estimated 2.0 million ART cycles performed in total, which resulted in 0.5 million babies (Adamson et al., 2018). In this same study, the number of ART cycles performed varied greatly between countries and regions. The countries with the highest utilization rate per capita were Israel, Greece, Lebanon, Belgium, and Australia, whereas the countries with the lowest rate were Indonesia, Nicaragua, Mali, Benin, and Ivory Coast. Regionally, sub-Saharan Africa had the lowest utilization rate per capita whereas Australia/New Zealand had the highest rate.

A systematic review of worldwide trends in ART uptake between 2004 and 2013 found moderate increases in the volume of ART cycles across most studied regions including the United States, Australia, New Zealand, Canada, Europe, the United Kingdom, and Latin America with substantial increases identified in Japan (no other regions or countries were included in the systematic review other than those listed) (Kushnir et al., 2017). In Africa, where uptake and expansion of ART have been slower than in other regions, the African Network and Registry for Assisted Reproductive Technology (ANARA) was first established in 2015 (Ombelet & Onofre, 2019), and thus trends over time in this region are less available. However, the first results from the ANARA technology reported a total of 25,770 initiated cycles performed in 2013 across 13 countries (Dyer et al., 2019).

The advent of ART and the unequal access to these services between countries has resulted in cross-border reproductive care—the provision of reproductive health services for individuals or couples outside the boundaries of their legal country of residence (Zegers-Hochschild et al., 2017). This practice is informally known as “reproductive tourism”; however, an ethnographic analysis by Inhorn and Shrivastav (2010) found this term to be “cavalier and insensitive” to those engaging in cross-border reproductive care, concluding that the term “reproductive exile” more accurately reflects the experiences of these individuals and couples. An estimated 25,000 couples travel abroad each year for infertility treatments (Simopoulou et al., 2019). Research conducted in the United Arab of Emirates illustrates how, within a single country, there are patient couples traveling out of the country, traveling into the country, traveling to and from the country, and not traveling at all to receive their desired reproductive care (Inhorn & Shrivastav, 2010). Common reasons for engaging in cross-border reproductive care include cost of treatment, quality of care, avoidance of waiting lists, anonymity, and accessibility or legal issues regarding the country of origin (Simopoulou et al., 2019).

Given the physical and emotional toll that infertility can have on individuals and couples, the importance of delivering high-quality, patient-centered care has been recognized as an important component of fertility care (Dancet et al., 2011; Duthie et al., 2017; van Empel et al., 2010). In several European studies, patients identified information provision and communication, doctor’s attitude and relationship, and medical care and competence of staff as the most important factors in the provision of quality fertility care (Dancet et al., 2011; Holter et al., 2014a; Mourad et al., 2010). Unfortunately, the limited literature on the measurement of quality of fertility care is based almost exclusively in HICs (Dancet et al., 2010; Duthie et al., 2017; Holter et al., 2014b; Mourad et al., 2007; van Empel et al., 2010), highlighting the need to better understand how to measure quality of fertility care, especially in the context of LMICs.

Several studies, all in HICs, have found that patients receiving fertility care were generally satisfied with the quality of their care (Gonen, 2016; Huppelschoten et al., 2015; Mourad et al., 2010; Schmidt et al., 2003; Shandley et al., 2020), an important finding given that satisfaction with and quality of care is associated with well-being during treatment (Gameiro et al., 2013; Mourad et al., 2010; Van Empel et al., 2010) and achieving pregnancy (Mourad et al., 2010; Schmidt et al., 2003; Van Empel et al., 2010). Although overall satisfaction with fertility care has been found to be high, studies have identified weaknesses in the provision of quality fertility care, especially regarding emotional and psychosocial support (Kussiwaah et al., 2016; Mourad et al., 2010; Van Empel et al., 2010). This is particularly concerning given that the psychological burden is a primary reason for discontinuing IVF treatment in some settings (Domar et al., 2018; H. D. Singh, 2020).

In high-fertility settings in LMIC, there has long been political interest and investment in family planning programs and services that aim to increase contraceptive use and decrease fertility, while infertility services and those in need of such services have largely been neglected (Van Balen & Gerrits, 2001). In an ethnographic analysis, H. D. Singh (2020) explored the connection between media and political discourse to healthcare services provided to Muslim women in Uttar Pradesh, India. She found that political and social concerns about high fertility rates in Muslim communities had contributed to negative representations of Muslim women's fertility and, subsequently, rendered infertility invisible among healthcare workers in these settings. Although infertility services are increasing across LMICs, many subfertile individuals and couples are only able to afford care from public-sector clinics that do not offer ART and where services have been described, specifically in sub-Saharan Africa, as "haphazard and incomplete" (Gerrits & Shaw, 2010). A mixed-method study conducted with gynecologists in India revealed that the public sector's role in the management of infertility was weak, citing issues with infrastructure, management, and training as well as a lack of necessary protocols and regulations (Widge & Cleland, 2009). Studies have found that practitioners working in lower-level public-sector clinics in LMICs often lack training in fertility care and, as a result, may attempt procedures that could be potentially harmful to patients' fertility, such as dilation and curettage, cervical electrocauterization, and vaginal douching (Asemota & Klatsky, 2015; Gerrits & Shaw, 2010; Van Balen & Gerrits, 2001).

Barriers to Accessing Fertility Care

Although some infertile couples willingly choose not to seek clinical care for managing infertility, there are many couples who want to receive this care but are unable to do so due to existing barriers, such as a lack of geographic accessibility, high costs, and restrictive policies and regulations (all of which are explored in more detail in this section). Inequalities in access to infertility diagnostics and treatment can result not only from limited geographic availability of clinics and experts and financial constraints but also from factors such as inadvertent bias and even discrimination from medical practitioners, constraints on time available to pursue treatment, and psychosocial barriers, such as stigma, that prevent help-seeking (Bell, 2014; Ceballo et al., 2015; Fledderjohann & Roberts, 2018; Greil et al., 2011; Inhorn et al., 2009a; Inhorn & Fakih, 2006; Kessler et al., 2013; Kissil & Davey, 2012; Mehta et al., 2016; Wu et al., 2013). Taken together, these inequalities mean that middle- and upper-class heterosexual women in urban areas are most likely to make use of clinical services, whereas working class individuals, racial and ethnic minorities, sexual minorities, and those in more remote areas are much less likely to have access to treatment. Although these inequalities exist on a global scale, there are also within-country disparities. Chow and Mahalingaiah (2016) contend that improving access to and coverage for infertility treatment has multiple benefits including improved safety in the use of these technologies, reduced use of potentially harmful treatments, and increased first-birth rates for women over 35 years of age. Based on anthropological research emerging from several countries in the Middle East, Inhorn and Patrizio (2015) further assert that increased access to ART can lead to improvements in gender relations and marital quality by offering couples hope and opportunities to seek treatment together and by altering cultural beliefs about manhood and masculinity in relation to infertility through increased knowledge of both male and female infertility and the normalization of infertility as a medical condition that can be overcome. The emergence of ICSI, the authors argue, has been particularly important in facilitating these changes, since it provides a potential solution for male-factor infertility, which is highly prevalent in the Middle East.

Geographic Accessibility

Despite a global increase in the number of facilities offering ART services, many infertile couples remain without access to such facilities. Based on an international surveillance project implemented by the International Federation of Fertility Societies (IFFS), an estimated 132 nations have existing ART programs (International Federation of Fertility Societies, 2019)—a dramatic increase since 2000 when only 45 countries reported ART programs (Inhorn & Patrizio, 2015). Unfortunately, regional disparities in access to ART facilities continue to persist with a large proportion of existing facilities clustered in a handful of countries with only two countries reporting more than 500 clinics—Japan and India (International Federation of Fertility Societies, 2019). Notable increases in the availability of IVF services have been observed throughout Asia, the Middle East, and Latin America; however, within-region disparities exist. For example, in Latin America, the majority of clinics reporting to the Latin America Registry are located in just three countries—Brazil, Argentina, and Mexico (Zegers-Hochschild et al., 2019). Progress in increasing access to IVF services in Central Asia and sub-Saharan Africa remains limited (Inhorn & Patrizio, 2015) as well as in many island nations (International Federation of Fertility Societies, 2019). A systematic review published in 2018 reported that ART services are available in only 10 sub-Saharan African countries primarily through the private sector (Botha et al., 2018). The lack of ART services in sub-Saharan Africa is particularly concerning given high rates of tubal and male factor infertility for which treatment with IVF is often indicated (Nachtigall, 2006). Significant barriers to increasing the availability of ART facilities, especially in LMICs, exist given the high-tech nature of ART as well as the necessary training needed for fertility specialists, which is often only available outside the host country (Horbst, 2012). Limited access to male infertility specialists has also been documented in places such as the United States where, in 2010, there were only 197 male infertility specialists and 13 of 50 states had no male infertility provider (Nangia et al., 2010) and in the United Kingdom where only 3.6% of urology trainees reported exposure to training in the management and investigation of male-factor infertility (Grey et al., 2012).

Within both LMICs and HICs there are huge disparities in rural–urban access to ART services. ART facilities are largely concentrated in urban, metropolitan cities. For example, a 2016 report from the CDC includes a map titled, *Locations of ART Clinics in the United States and Puerto Rico, 2016*, which visually highlights the unequal geographical access to ART facilities with entire states showing only one to two facilities, whereas states with multiple facilities show clustering around major metropolitan cities (see figure 2) (Centers for Disease Control and Prevention, 2018).

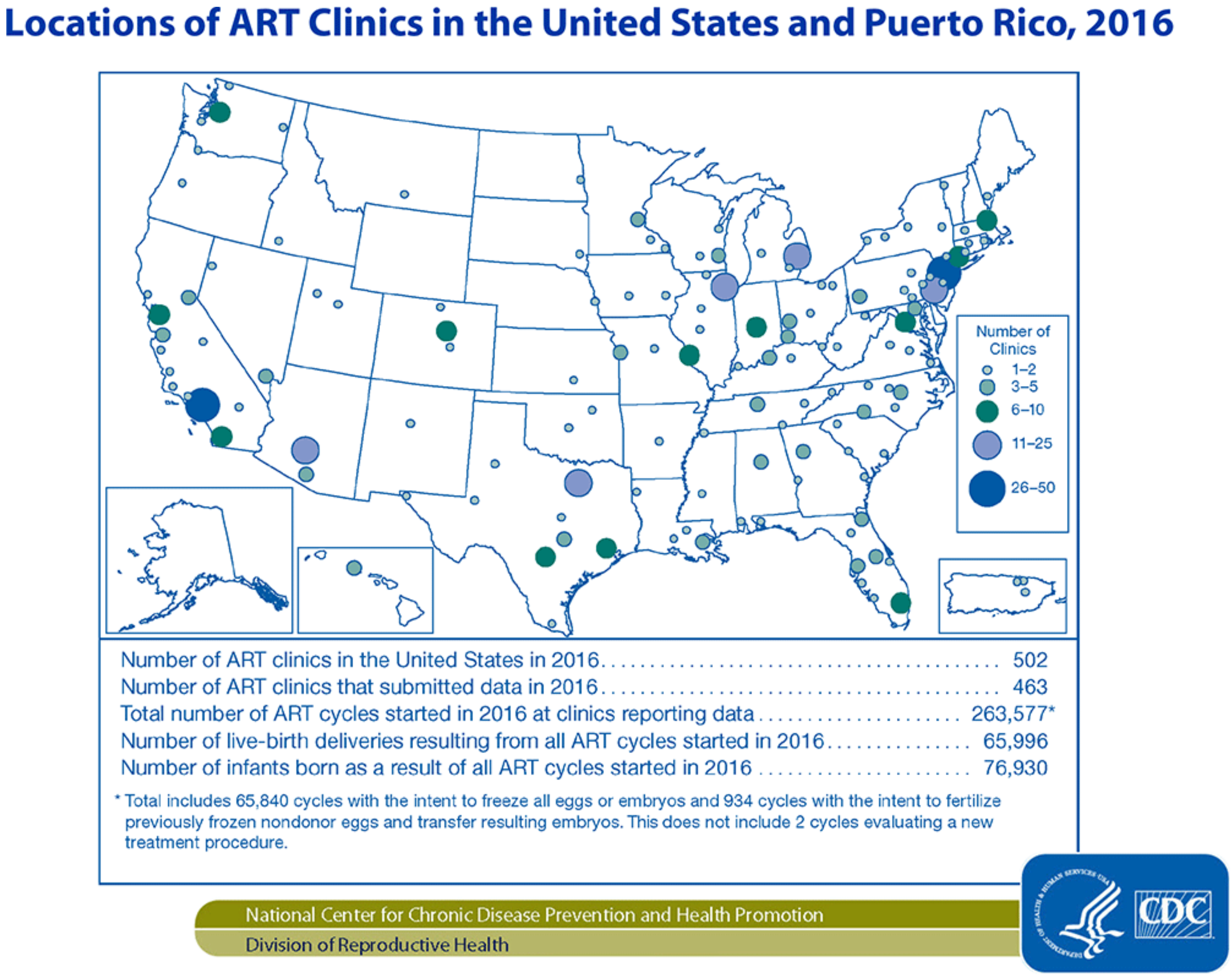

Figure 2. Locations of ART clinics in the United States and Puerto Rico, 2016.

Source: Centers for Disease Control and Prevention, American Society for Reproductive Medicine, & Society for Assisted Reproductive Technology (2018).

Similarly, a systematic review of ART facilities in sub-Saharan Africa noted that most facilities were largely unavailable to rural communities (Botha et al., 2018). For example, a study in Sudan found that all ART services are located in Khartoum and only offered through private facilities. Even diagnostic services can often only be accessed in private facilities and secondary- and tertiary-level public facilities (Khalifa & Ahmed, 2012). These geographic disparities are seen in countries throughout the world, forcing individuals and couples with infertility in rural communities to travel long distances to receive ART services or to forego these services altogether.

Financial Costs

Even when ART services are geographically accessible, high costs often prohibit individuals and couples from utilizing these services. The cost of a single ART cycle varies significantly between countries with most countries, HIC as well as LMIC, falling within the range of $1,000–$6,000 (Chambers et al., 2013; Giwa-Osagie, 2010; Inhorn & Gurtin, 2012). The United States is a notable exception, with an average cost of $13,000 for a single cycle of IVF

(Chambers et al., 2013). In countries without ART financial assistance, related costs are unattainable for most couples. For example, minimum wage in Nigeria is $52–$60 per month yet one cycle of IVF, which is largely paid for out of pocket, costs an average of $2,000–$2,700 (Giwa-Osagie, 2010). Collins (2002) estimates that a 10% decrease in costs would result in a 30% increase in the utilization of ICV/ICSI, highlighting the impact of cost on access to ART services. It is also important to note that not all cases of infertility require ART, in which case lower-cost options that require staff with less training are often sufficient for managing infertility (Ombelet et al., 2008) (see box 5).

The 2019 IFFS surveillance survey found that 47% of the 85 participating countries reported either insurance coverage or government funding for infertility treatment; however, less than 20% reported complete coverage, which would include diagnostic evaluation, fertility medications, IUI, and/or ART (International Federation of Fertility Societies, 2019). When coverage is unavailable, the use of ART services can place individuals at risk for overwhelming expenditures, as was found in a study conducted in South Africa (Dyer et al., 2013). Progress for infertility treatment coverage is being observed in both HICs and LMICs. Most HICs countries provide some level of coverage for infertility treatment within their national health policies (Nachtigall, 2006), though restrictions may apply. In the United States, where fertility-related expenses are paid for either out of pocket or through private insurance, some states have passed legislation mandating full or partial coverage for infertility services to be covered by private insurers (Hornstein, 2016). Recently, the CDC and Office of Population Affairs have established recommendations for the provision of quality family planning services in publicly funded family planning clinics, which include services to support pregnancy achieving and basic fertility care (Gavin et al., 2014). In Turkey, the government provides its citizens two cycles of IVF treatment through state and social insurance (Inhorn & Gurtin, 2012). Even in sub-Saharan Africa, where the expansion of infertility services has been slower than in other regions, progress in providing coverage has been reported. For example, Burkina Faso is beginning to fund insurance for ART services (Inhorn & Gurtin, 2012), the National Health Insurance in Sudan covers doctor's fees, fees for diagnostic tests at public and private facilities and, in some cases, one cycle of ovulation induction drugs for ART (Khalifa & Ahmed, 2012), and some clinics in Mali are providing "package solutions" that allow patients to purchase multiple cycles up front at a discounted rate (Horbst, 2012).

In addition to explicit, codified barriers to accessing treatment, structural social inequalities may also impair access more indirectly. For example, in the United States, publicly funded reproductive healthcare through family planning programs focuses on pregnancy prevention, preconception care, sexually transmitted infection (STI) prevention and treatment, and cancer screening, with less of a focus on helping individuals achieve a desired pregnancy (Barnes & Fledderjohann, 2020). Although some of these efforts may prevent infertility or help couples achieve pregnancy, fewer services are offered related to basic fertility care and treatment within publicly funded clinics (Loyola Briceno et al., 2019), but recent guidelines emphasize that services to achieve pregnancy in publicly funded clinics should be offered within the broader spectrum of family planning (Gavin et al., 2014). Accordingly, infertility services are more likely to be covered by private insurance (though this coverage is not universal), which is inaccessible for many less privileged people. Taken together, the gradient in private health insurance access and lack of provision for fertility care through the public system in the United States means that these services are less accessible for older, non-White, working-class, geographically remote, less educated, HIV-positive, and disabled people (Barnes & Fledderjohann, 2020; Ceballo et al., 2015; Chandra & Stephen, 2010; Fledderjohann & Barnes, 2018; Greil et al., 2011; Inhorn, et al., 2009a; Inhorn & Fakih, 2006; Kessler et al., 2013; Kissil & Davey, 2012; Mehta et al., 2016).

Restrictive Policies and Regulations

Some policies and regulations exist in certain countries that restrict access to and/or reimbursement of ART services, often based on individual attributes (Nachtigall, 2006). Restrictions may occur through various avenues including federal laws; statutes; ordinances; oversight by professional organizations or government agencies with jurisdiction; or mandates by professional organizations, cultural practice, or religious degree (International Federation of Fertility Societies, 2019). The 2019 IFFS surveillance survey identified 40 countries with female age restrictions for reimbursement of ART service costs ranging from 38 years in Latvia and Lithuania to 50 years in Australia (International Federation of Fertility Societies, 2019). Only two countries—Austria and Germany––reported imposing male age restrictions on reimbursement. In England, guidance is provided from the National Institute for Health and Care Excellence (NICE) on reimbursement of ART services through the National Health Service (NHS) based on the age of women (National Health Service, 2018); however, further constraints on eligibility and treatment through the NHS are decided by local Clinical Commissioning Groups (CCGs), and so can vary quite substantially between different areas of the country. The imposition of additional restrictions beyond those recommended by NICE and the geographic variation in eligibility requirements and treatment access options have led the CCG system to be heavily criticized as a “postcode lottery” system, responsible for stark inequalities in access across the country (National Institute for Health Care and Excellence, 2014). This example underscores the importance of examining the implementation of restrictions and regulations within a country to identify, and subsequently ameliorate, inequities in access to ART services at more local levels.

Marital status and sexual orientation are other attributes by which a number of countries restrict access to ART services and/or reimbursement (International Federation of Fertility Societies, 2019). For example, in the Asia-Oceania region, Australia and New Zealand are the only two countries to report access to ART for both unmarried individuals and same-sex couples (Li et al., 2018). In sub-Saharan Africa, ART is restricted to heterosexual, married couples in some countries such as Cameroon, Mali, and Senegal (Botha et al., 2018). In the United Kingdom, fertility tests are not universally available; rather, same-sex couples and single women are generally required to attempt several rounds of IUI at their own expense through private means before they are able to seek fertility testing through the NHS (Human Fertilisation & Embryology Authority, n.d.). Likewise, in the United States, some states have adopted laws requiring insurance coverage of either infertility diagnoses or treatment; however, these laws often include heteronormative language that the “patient’s oocytes” be fertilized by the “spouse’s sperm” (Stabile, 2016) and/or they require a medical diagnosis of infertility (National Conference of State Legislatures, 2019), thereby limiting access for unmarried and same-sex couples. Furthermore, only 8 of 15 U.S. states with mandates for infertility coverage mention coverage for men with infertility, which restricts the type of care provided and increases the burden on women (Dupree, 2018). Other factors that have been used to restrict or deny access to or reimbursement of ART services include duration of infertility, personal income, number of embryos transferred, concern for the welfare of a future child (International Federation of Fertility Societies, 2019), body weight (R. C. H. Brown, 2019), and HIV status (Khalifa & Ahmed, 2012).

Religion has also played a role in determining access to ART services in certain countries in both direct and indirect ways. In a review article on religious aspects of assisted reproduction, Sallam and Sallam (2016) report variation in acceptance of ART practices across and within religions with Judaism, Hinduism, and Buddhism accepting nearly all forms of ART practices and Roman Catholicism rejecting all forms (Sallam & Sallam, 2016). One of the most contentious types of ART is third-party reproductive assistance. For example, Islam has widely endorsed the use of ART among heterosexual married couples; however, research from the Middle East reveals variation in Islam's response to and regulation of specific aspects of ART, particularly third-party reproductive assistance (Gürtin et al., 2015; Inhorn & Tremayne, 2016). For example, in a book chapter on Islam and assisted reproduction in the Middle East, Gürtin, Inhorn, and Tremayne describe that third-party reproductive assistance is banned in Sunni Muslim countries as it is considered an act of adultery; has the potential for incest among offspring of unknown donors; and introduces implications for kinship, descent, and inheritance (Gürtin et al., 2015). In contrast, Shia Muslim countries have been more accepting of third-party reproductive assistance though religious leaders remain divided. In Iran, the Shia extended the definition of marriage to include a form of temporary marriage that allowed for third-party reproductive assistance if the donor became a legitimate spouse, even if only temporarily.

The Roman Catholic Church's prohibition of the use of ART is rooted in a 1956 proclamation defining artificial fecundation as immoral and illegal, because it separates procreation and sexual normal function and due to the church's belief that the embryo is an individual with rights that should be protected (Sallam & Sallam, 2016). Given the Roman Catholic Church's complete opposition to assisted reproduction, country-level restrictions and regulations of ART have been influenced by the Catholic Church in countries with a high presence of Catholicism. For example, across Latin America, the Catholic Church has placed moral pressure on governments and the public at large to prevent access to and utilization of ART services (Nachtigall, 2006; Torres et al., 2019). Italy, another example, instated strict restrictions on numerous ART practices through the Medically Assisted Reproduction Law in 2004, a law believed to be inspired and supported by the Catholic Church (Inhorn et al., 2010). Since 2004, much of the law has been dismantled by the Italian Constitutional Court; however, in 2016, Riezzo and colleagues contend that some groups continue to be excluded from access to ARTs in Italy including same-sex couples, single women, and women of a certain age (Riezzo et al., 2016).

Box 5. Addressing Access Through Low-Cost In Vitro Fertilization

Given the financial costs associated with both establishing and accessing in vitro fertilization (IVF), especially in low- to middle-income countries (LMICs), creating a viable and effective low-cost IVF (LCIVF) option is essential. The ESHRE Special Task Force on "Developing Countries and Infertility" aims to make infertility diagnosis and treatment in LMICs more affordable and accessible (Ombelet et al., 2008). The coordinator of the task force, Willem Ombelet of Genk Institute for Fertility Technology in Belgium, is one of four founding members of a nonprofit organization called The Walking Egg (The Walking Egg, 2019), which developed a low-cost simplified method of IVF culturing called the tWE (the Walking Egg) lab method. This method is specifically designed for low-resource settings with the aim of eliminating certain costs associated with traditional IVF laboratories commonly found in high-resource settings (Ombelet, 2013). The tWE lab method has proven successful in clinical trials (Van Blerkom et al., 2014) and has been introduced in multiple countries. Clinicians in Ghana were the first in Africa to achieve a successful baby through the use of the Walking Egg technology (The Walking Egg, 2017). Continuing to develop and roll out low-cost solutions for diagnosing and treating infertility is essential for providing equitable access to fertility care.

Conclusion

Progress in sexual reproductive health and rights (SRHR) requires renewed attention and efforts to address infertility. This position is centered on the recognition that support of individuals who want to have children is in keeping with a reproductive rights perspective. However, these rights are not equitably distributed within the population. Accordingly, large disparities in infertility and fertility care persist within and between countries due to significant geographic, economic, social, and regulatory barriers. Women often face greater blame for and consequences of infertility, particularly in settings where a woman's identity and social value are closely tied to her ability to bear children. Infertility-related stigma experienced by both men and women can further exacerbate these gender inequities, perpetuate the silence around infertility, and hinder quality care and support. The omission of infertility within global SRHR programs and research has led to considerable gaps in our understanding of the prevalence, causes, and consequences of infertility and has hindered efforts to address these inequities.

In addition to a rights-based framework, there is a strong rationale for greater public health investment in addressing infertility and its consequences (Centers for Disease Control and Prevention, 2014; Starrs et al., 2018). Infertility is considered a disease, but its public health implications extend far beyond a diagnosis. Improved data systems and further research are needed to better understand the magnitude, disparities, and potential risk and protective factors of infertility. Many established risk factors for infertility can be prevented but require additional cross-sector efforts focused on environmental, behavioral, and health factors. For infertility that cannot be prevented, other options for family formation and parenthood should be accessible, including cost-effective diagnostic and treatment options for infertility (Inhorn & Patrizio, 2015). Given that the consequences of infertility are also public health issues (e.g., intimate partner violence), the public health sector has a further commitment to mitigating these effects from infertility.

Efforts to address the reproductive needs of populations have tended to narrowly focus on preventing unintended pregnancy and increasing access to contraception (Gipson et al., 2020). Although these efforts remain critical for ensuring reproductive autonomy, considerable work remains to be done in this area; in addition, such efforts fail to acknowledge the coexisting reality of individuals who want to become pregnant and the overwhelming impact on their lives when they cannot. The field of SRHR can no longer afford to ignore these realities. Successful programs to address infertility and infertility-related stigma require the consideration and integration of the biological and social aspects of infertility examined in this article. By prioritizing infertility alongside other global SRHR priorities, we can ensure that appropriate, ethical, feasible, and locally relevant approaches can be developed to best meet the sexual and reproductive health needs of individuals globally.

Acknowledgments

We gratefully acknowledge Dr. Ginny Ryan for her detailed feedback on the clinical sections of the manuscript and Zeina Alkhalaf for her careful review and assistance in developing figures and compiling references for this manuscript.

Further Readings

Davis, M. F., & Khosla, R. (2020). Infertility and human rights: A jurisprudential survey. *Columbia Journal of Gender and Law*, *40*(1), 1–45.

El-Toukhy, T. (2019). Reproductive medicine in 2020 and beyond *<https://doi.org/10.1111/1471-0528.15352>*. *BJOG: An International Journal of Obstetrics and Gynaecology, 126*(2), 133–134.

Greil, A. L. (1991). *Not yet pregnant: Infertile couples in contemporary America*. Rutgers University Press.

References

Abarikwu, S. O. (2013). Causes and risk factors for male-factor infertility in Nigeria: A review. *African Journal of Reproductive Health*, *17*(4), 150–166.

Abbas, A. M., Hussein, R. S., Elsenity, M. A., Samaha, I. I., El Etriby, K. A., Abd El-Ghany, . . . Khodry, M. M. (2020). Higher clinical pregnancy rate with in-vitro fertilization versus intracytoplasmic sperm injection in treatment of non-male factor infertility: Systematic review and meta-analysis *<https://doi.org/10.1016/j.jogoh.2020.101706>*. *Journal of Gynecology Obstetrics and Human Reproduction*, *49*(6), Article 101706.

Ackerson, K., & Zielinski, R. (2017). Factors influencing use of family planning in women living in crisis affected areas of sub-Saharan Africa: A review of the literature *<https://doi.org/10.1016/j.midw.2017.07.021>*. *Midwifery*, *54*, 35–60.

Adamson, G. D., de Mouzon, J., Chambers, G. M., Zegers-Hochschild, F., Mansour, R., Ishihara, O., Banker, M., & Dyer, S. J. (2018). International committee for monitoring assisted reproductive technology: World report on assisted reproductive technology, 2011 *<https://doi.org/10.1016/j.fertnstert.2018.06.039>*. *Fertility and Sterility*, *110*(6), 1067–1080.

Adetoro, O. O., & Ebomoyi, E. W. (1991). The prevalence of infertility in a rural Nigerian community. *African Journal of Medicine and Medical Sciences*, *20*(1), 23–27.

Aduloju, P. O., Olagbuji, N. B., Olofinbiyi, A. B., & Awoleke, J. O. (2015). Prevalence and predictors of intimate partner violence among women attending infertility clinic in south-western Nigeria *<https://doi.org/10.1016/j.ejogrb.2015.02.027>*. *European Journal of Obstetrics, Gynecology, and Reproductive Biology*, *188*, 66–69.

Afeiche, M., Williams, P. L., Mendiola, J., Gaskins, A. J., Jørgensen, N., Swan, S. H., & Chavarro, J. E. (2013). Dairy food intake in relation to semen quality and reproductive hormone levels among physically active young men *<https://doi.org/10.1093/humrep/det133>*. *Human Reproduction*, *28*(8), 2265–2275.

Agarwal, A., Majzoub, A., Parekh, N., & Henkel, R. (2020). A schematic overview of the current status of male infertility practice *<https://doi.org/10.5534/wjmh.190068>*. *The World Journal of Men's Health*, *38*(3), 308–322.

Agarwal, A., Rana, M., Qiu, E., AlBunni, H., Bui, A. D., & Henkel, R. (2018). Role of oxidative stress, infection and inflammation in male infertility *<https://doi.org/10.1111/and.13126>*. *Andrologia*, *50*(11), Article e13126.

Akre, O., & Richiardi, L. (2009). Does a testicular dysgenesis syndrome exist? *<https://doi.org/10.1093/humrep/dep174>* *Human Reproduction*, *24*(9), 2053–2060.

Akyuz, A., Seven, M., Şahiner, G., & Bilal, B. (2013). Studying the effect of infertility on marital violence in Turkish women. *International Journal of Fertility & Sterility*, *6*(4), 286–293.

Alahveriani, K., Rajaie, H., Shakeri, Z., & Lohrasbi, A. (2010). Studying the relationship between sexual disorder and marriage satisfaction in those suffering from depression. *Procedia - Social and Behavioral Sciences*, *5*, 1672–1675.

Alexander, L. L., LaRosa, J. H., Bader, H. Garfield, S., & Alexander, W. J. (2016). *New dimensions in women's health* (7th ed.). Jones & Bartlett Learning.

Al-Inany, H. G., Youssef, M. A., Aboulghar, M., Broekmans, F., Sterrenburg, M., Smit, J., & Abou-Setta, A. M. (2011). Gonadotrophin-releasing hormone antagonists for assisted reproductive technology *<https://doi.org/10.1002/14651858.CD001750.pub3>*. *The Cochrane Database of Systematic Reviews*, *5*, Article CD001750.

Allison, J. (2011). Conceiving silence: Infertility as discursive contradiction in Ireland *<https://doi.org/10.1111/j.1548-1387.2010.01123.x>*. *Medical Anthropology Quarterly*, *25*(1), 1–21.

American Society for Reproductive Medicine. (2014). Preimplantation genetic testing *<https://www.reproductivefacts.org/news-and-publications/patient-fact-sheets-and-booklets/documents/fact-sheets-and-info-booklets/preimplantation-genetic-testing/?_ga=2.193580589.1285230163.1561739537-1372045309.1561739537>*. ASRM. *ReproductiveFacts.Org*.

Ardabily, H. E., Moghadam, Z. B., Salsali, M., Ramezanzadeh, F., & Nedjat, S. (2011). Prevalence and risk factors for domestic violence against infertile women in an Iranian setting. *International Journal of Gynaecology & Obstetrics*, *112*(1), 15–17.

Armstrong, A. (1997). Law and the family in Southern Africa. In A. Adepoju (Ed.), *Family, population and development in Africa* (pp. 183–202). Zed Books.

Aronson, P. (2008). The markers and meanings of growing up: Contemporary young women's transition from adolescence to adulthood. *Gender & Society*, *22*(1), 56–82.

Aryee, A. F. (1997). The African family and changing nuptiality patterns. In A. Adepoju (Ed.), *Family, population and development in Africa* (pp. 78–96). Zed Books.

Asch, R. H., Ellsworth, L. R., Balmaceda, J. P., & Wong, P. C. (1984). Pregnancy after translaparoscopic gamete intrafallopian transfer <https://doi.org/10.1016/s0140-6736(84)91127-9>. *Lancet*, *2*(8410), 1034–1035.

Asemota, O. A., & Klatsky, P. (2015). Access to infertility care in the developing world: The family promotion gap <https://doi.org/10.1055/s-0034-1395274>. *Seminars in Reproductive Medicine*, *33*(1), 17–22.

Ayaz, S., & Efe, S. Y. (2010). Traditional practices used by infertile women in Turkey. *International Nursing Review*, *57*(3), 383–387.

Ayeleke, R. O., Asseler, J. D., Cohlen, B. J., & Veltman-Verhulst, S. M. (2020). Intra-uterine insemination for unexplained subfertility <https://doi.org/10.1002/14651858.CD001838.pub6>. *The Cochrane Database of Systematic Reviews*, *3*(3), Article CD001838.

Baazeem, A., Belzile, E., Ciampi, A., Dohle, G., Jarvi, K., Salonia, A., Weidner, W., & Zini, A. (2011). Varicocele and male factor infertility treatment: A new meta-analysis and review of the role of varicocele repair <https://doi.org/10.1016/j.eururo.2011.06.018>. *European Urology*, *60*(4), 796–808.

Bachman, E. A., Senapati, S., Sammel, M. D., & Kalra, S. K. (2014). Randomized controlled trial of benzocaine versus placebo spray for pain relief at hysterosalpingogram <https://doi.org/10.1016/j.rbmo.2014.02.012>. *Reproductive BioMedicine Online*, *28*(6), 748–752.

Bardaweel, S. K. (2014). Alternative and antioxidant therapies used by a sample of infertile males in Jordan: A cross-sectional survey <https://doi.org/10.1186/1472-6882-14-244>. *BMC Complementary and Alternative Medicine*, *14*(1), 1–8, article no. 244.

Barnes, L. W. (2014). *Conceiving masculinity: Male infertility, medicine, and identity*. Temple University Press.

Barnes, L. W., & Fledderjohann, J. (2020). Reproductive justice for the invisible infertile: A critical examination of reproductive surveillance and stratification <https://doi.org/10.1111/soc4.12745>. *Sociology Compass*, *14*(2), Article e12745.

Beall, S. A., & DeCherney, A. (2012). History and challenges surrounding ovarian stimulation in the treatment of infertility <https://doi.org/10.1016/j.fertnstert.2012.02.030>. *Fertility and Sterility*, *97*(4), 795–801.

Becker, G. (2000). *The elusive embryo: How women and men approach new reproductive technologies*. University of California Press.

Beguy, D., Kabiru, C. W., Zulu, E. M., & Ezeh, A. C. (2011). Timing and sequencing of events marking the transition to adulthood in two informal settlements in Nairobi, Kenya <https://doi.org/10.1007/s11524-011-9547-8>. *Journal of Urban Health*, *88*(2), 318–340.

Bell, A. V. (2009). “It’s way out of my league”: Low-income women’s experiences of medicalized infertility. *Gender & Society*, *23*(5), 688–709.

Bell, A. V. (2014). *Misconception: Social class and infertility in America*. Rutgers University Press.

Bell, A. V. (2019). “I’m not really 100% a woman if I can’t have a kid”: Infertility and the intersection of gender, identity, and the body. *Gender & Society*, *33*, 629–651.

Bello, B., Kielkowski, D., Heederik, D., & Wilson, K. (2010). Time-to-pregnancy and pregnancy outcomes in a South African population. *BMC Public Health*, *10*(1), 1–8.

Bensdorp, A. J., Cohlen, B. J., Heineman, M. J., & Vanderkerchove, P. (2007). Intra-uterine insemination for male subfertility <https://doi.org/10.1002/14651858.CD000360.pub4>. *The Cochrane Database of Systematic Reviews*, *4*, Article CD000360.

Benyamini, Y., Gozlan, M., & Kokia, E. (2009). Women’s and men’s perceptions of infertility and their associations with psychological adjustment: A dyadic approach. *British Journal of Health Psychology*, *14*(1), 1–16.

Berntsen, S., Söderström-Anttila, V., Wennerholm, U.-B., Laivuori, H., Loft, A., Oldereid, N. B., Romundstad, L. B., Bergh, C., & Pinborg, A. (2019). The health of children conceived by ART: “The chicken or the egg? <https://doi.org/10.1093/humupd/dmz001> ”*Human Reproduction Update*, *25*(2), 137–158.

Berthelsen, J. G. (1984). Andrological aspects of testicular cancer <https://doi.org/10.1111/j.1365-2605.1984.tb00804.x>. *International Journal of Andrology*, *7*(6), 451–483.

Bharadwaj, A. (2002). Conception politics: Medical egos, media spotlights, and the contest over test-tube firsts in India. In M. C. Inhorn & F. van Balen (Eds.), *Infertility around the globe: New thinking on childlessness, gender, and reproductive technologies* (pp. 315–333). University of California Press.

Birenbaum-Carmeli, D., & Inhorn, M. C. (2009). Masculinity and marginality: Palestinian men’s struggles with infertility in Israel and Lebanon. *Journal of Middle East Women’s Studies*, *5*(2), 23–52.

Bjørnholt, S. M., Kjaer, S. K., Nielsen, T. S. S., & Jensen, A. (2015). Risk for borderline ovarian tumours after exposure to fertility drugs: Results of a population-based cohort study <https://doi.org/10.1093/humrep/deu297>. *Human Reproduction*, *30*(1), 222–231.

Bledsoe, C. H. (2002). *Contingent lives: Fertility, time, and aging in West Africa*. University of Chicago Press.

Bloom, M. S., Whitcomb, B. W., Chen, Z., Ye, A., Kannan, K., & Buck Louis, G. M. (2015). Associations between urinary phthalate concentrations and semen quality parameters in a general population <https://doi.org/10.1093/humrep/dev219>. *Human Reproduction*, *30*(11), 2645–2657.

Boivin, J., Bunting, L., Collins, J. A., & Nygren, K. G. (2007). International estimates of infertility prevalence and treatment-seeking: Potential need and demand for infertility medical care. *Human Reproduction*, *22*(6), 1506–1512.

Botha, B., Shamley, D., & Dyer, S. (2018). Availability, effectiveness and safety of ART in sub-Saharan Africa: A systematic review *<https://doi.org/10.1093/hropen/hoy003>*. *Human Reproduction Open*, *2018*(2), 1–12.

Boulet, S. L., Mehta, A., Kissin, D. M., Warner, L., Kawwass, J. F., & Jamieson, D. J. (2015). Trends in use of and reproductive outcomes associated with intracytoplasmic sperm injection *<https://doi.org/10.1001/jama.2014.17985>*. *JAMA*, *313*(3), 255.

Boutari, C., Pappas, P. D., Mintziori, G., Nigdelis, M. P., Athanasiadis, L., Goulis, D. G., & Mantzoros, C. S. (2020). The effect of underweight on female and male reproduction *<https://doi.org/10.1016/j.metabol.2020.154229>*. *Metabolism: Clinical and Experimental*, *107*, Article 154229.

Bozdag, G., Aksan, G., Esinler, I., & Yarali, H. (2008). What is the role of office hysteroscopy in women with failed IVF cycles? *<https://doi.org/10.1016/s1472-6483(10)60226-x>* *Reproductive BioMedicine Online*, *17*(3), 410–415.

Brandes, M., Hamilton, C. J. C. M., van der Steen, J. O. M., de Bruin, J. P., Bots, R. S. G. M., Nelen, W. L. D. M., & Kremer, J. A. M. (2011). Unexplained infertility: Overall ongoing pregnancy rate and mode of conception *<https://doi.org/10.1093/humrep/deq349>*. *Human Reproduction*, *26*(2), 360–368.

Brännström, M., Johannesson, L., Bokström, H., Kvarnström, N., Mölne, J., Dahm-Kähler, P., Enskog, A., Milenkovic, M., Ekberg, J., Diaz-Garcia, C., Gäbel, M., Hanafy, A., Hagberg, H., Olausson, M., & Nilsson, L. (2015). Livebirth after uterus transplantation *<https://doi.org/10.1016/S0140-6736(14)61728-1>*. *The Lancet*, *385*(9968), 607–616.

Brezina, P. R., Ning, N., Mitchell, E., Zacur, H. A., Baramki, T. A., & Zhao, Y. (2012). Recent advances in assisted reproductive technology *<https://doi.org/10.1007/s13669-012-0019-2>*. *Current Obstetrics and Gynecology Reports*, *1*(4), 166–173.

Brinton, L. A., Westhoff, C. L., Scoccia, B., Lamb, E. J., Trabert, B., Niwa, S., & Moghissi, K. S. (2013). Fertility drugs and endometrial cancer risk: Results from an extended follow-up of a large infertility cohort *<https://doi.org/10.1093/humrep/det323>*. *Human Reproduction*, *28*(10), 2813–2821.

Broughton, D. E., & Moley, K. H. (2017). Obesity and female infertility: Potential mediators of obesity's impact *<https://doi.org/10.1016/j.fertnstert.2017.01.017>*. *Fertility and Sterility*, *107*(4), 840–847.

Brown, J., & Farquhar, C. (2016). Clomiphene and other antioestrogens for ovulation induction in polycystic ovarian syndrome *<https://doi.org/10.1002/14651858.CD002249.pub5>*. *The Cochrane Database of Systematic Reviews*, *12*(12), Article CD002249.

Brown, R. C. H. (2019). Irresponsibly infertile? Obesity, efficiency, and exclusion from treatment *<https://doi.org/10.1007/s10728-019-00366-w>*. *Health Care Analysis*, *27*(2), 61–76.

Buck Louis, G. M., Sundaram, R., Schisterman, E. F., Sweeney, A. M., Lynch, C. D., Gore-Langton, R. E., Chen, Z., Kim, S., Caldwell, K., & Barr, D. B. (2012). Heavy metals and couple fecundity, the LIFE study *<https://doi.org/10.1016/j.chemosphere.2012.01.017>*. *Chemosphere*, *87*(11), 1201–1207.

Carlsen, E., Giwercman, A., Keiding, N., & Skakkebaek, N. E. (1992). Evidence for decreasing quality of semen during past 50 years. *BMJ: British Medical Journal*, *305*(6854), 609–613.

Carranza-Mamane, B., Havelock, J., Hemmings, R., Cheung, A., Sierra, S., Carranza-Mamane, B., Case, A., Cathie, D., Graham, J., Havelock, J., Hemmings, R., Liu, K., Murdock, W., Vause, T., Wong, B., & Burnett, M. (2015). The management of uterine fibroids in women with otherwise unexplained infertility *<https://doi.org/10.1016/S1701-2163(15)30318-2>*. *Journal of Obstetrics and Gynaecology Canada*, *37*(3), 277–285.

Casper, R., Haas, J., Hsieh, T.-B., Bassil, R., & Mehta, C. (2017). Recent advances in *in vitro* fertilization *<https://doi.org/10.12688/f1000research.11701.1>*. *F1000Research*, *6*, Article 1616.

Ceballo, R., Graham, E. T., & Hart, J. (2015). Silent and infertile: An intersectional analysis of the experiences of socioeconomically diverse African American women with infertility. *Psychology of Women Quarterly*, *39*(4), 497–511.

Cedars, M. I., Taymans, S. E., DePaolo, L. V., Warner, L., Moss, S. B., & Eisenberg, M. L. (2017). The sixth vital sign: What reproduction tells us about overall health *<https://doi.org/10.1093/hropen/hox008>*. Proceedings from a NICHD/CDC workshop. *Human Reproduction Open*, *2017*(2), 1–8.

Centers for Disease Control and Prevention. (2014). *National public health action plan for the detection, prevention, and management of infertility*. CDC.

Centers for Disease Control and Prevention. (2016, July 15). Infertility *<http://www.cdc.gov/nchs/fastats/infertility.htm>*. *FastStats*.

Centers for Disease Control and Prevention. (2018, February 7). About us *<https://www.cdc.gov/reproductivehealth/drh/about-us/index.htm>*. *CDC.Gov*.

Centers for Disease Control and Prevention. (2019, January 4). About NSFG. *CDC.Gov*.

Centers for Disease Control and Prevention, American Society for Reproductive Medicine, & Society for Assisted Reproductive Technology. (2018). *2016 assisted reproductive technology: National summary report* (p. 74). U.S. Department of Health and Human Services.

Chambers, G. M., Adamson, G. D., & Eijkemans, M. J. C. (2013). Acceptable cost for the patient and society *<https://doi.org/10.1016/j.fertnstert.2013.06.017>*. *Fertility and Sterility*, *100*(2), 319–327.

Chandra, A., Copen, C. E., & Stephen, E. H. (2013). Infertility and impaired fecundity in the United States, 1982–2010: Data from the National Survey of Family Growth. *National Health Statistics Reports*, *67*, 1–19.

Chandra, A., Copen, C. E., & Stephen, E. H. (2014). Infertility service use in the United States: Data from the National Survey of Family Growth, 1982–2010. *National Health Statistics Reports, 73*, 1–21.

Chandra, A., & Stephen, E. H. (2010). Infertility service use among U.S. women: 1995 and 2002 *<https://doi.org/10.1016/j.fertnstert.2008.10.049>*. *Fertility and Sterility*, *93*(3), 725–736.

Chen, C. (1986). Pregnancy after human oocyte cryopreservation *<https://doi.org/10.1016/s0140-6736(86)90989-x>*. *Lancet*, *1*(8486), 884–886.

Chen, Z.-J., Shi, Y., Sun, Y., Zhang, B., Liang, X., Cao, Y., . . . Legro, R. S. (2016). Fresh versus frozen embryos for infertility in the polycystic ovary syndrome *<https://doi.org/10.1056/NEJMoa1513873>*. *The New England Journal of Medicine*, *375*(6), 523–533.

Chester, R. (1972). Is there a relationship between childlessness and marriage breakdown? *Journal of Biosocial Science*, *4*(4), 443–454.

Chiu, Y.-H., Gaskins, A. J., Williams, P. L., Mendiola, J., Jørgensen, N., Levine, H., Hauser, R., Swan, S. H., & Chavarro, J. E. (2016). Intake of fruits and vegetables with low-to-moderate pesticide residues is positively associated with semen-quality parameters among young healthy men *<https://doi.org/10.3945/jn.115.226563>*. *The Journal of Nutrition*, *146*(5), 1084–1092.

Chow, E. T., & Mahalingaiah, S. (2016). Clinical vignettes and global health considerations of infertility care in under-resourced patients *<https://doi.org/10.1186/s40738-016-0017-6>*. *Fertility Research and Practice*, *2*, Article 4.

Clarke, L. H., Martin-Matthews, A., & Matthews, R. (2006). The continuity and discontinuity of the embodied self in infertility. *Canadian Review of Sociology/Revue Canadienne de Sociologie*, *43*(1), 95–113.

Cohen, J., Trounson, A., Dawson, K., Jones, H., Hazekamp, J., Nygren, K.-G., & Hamberger, L. (2005). The early days of IVF outside the UK *<https://doi.org/10.1093/humupd/dmi016>*. *Human Reproduction Update*, *11*(5), 439–460.

Collins, J. A. (2002). An international survey of the health economics of IVF and ICSI *<https://doi.org/10.1093/humupd/8.3.265>*. *Human Reproduction Update*, *8*(3), 265–277.

Connolly, M. P., Hoorens, S., & Chambers, G. M., on behalf of the ESHRE Reproduction and Society Task Force. (2010). The costs and consequences of assisted reproductive technology: An economic perspective *<https://doi.org/10.1093/humupd/dmq013>*. *Human Reproduction Update*, *16*(6), 603–613.

Cousineau, T. M., & Domar, A. D. (2007). Psychological impact of infertility *<https://doi.org/10.1016/j.bpobgyn.2006.12.003>*. *Best Practice & Research: Clinical Obstetrics & Gynaecology*, *21*(2), 293–308.

Cox, C. M., & Johnson, C. L. (2020). Engagement in nonbiomedical practices for fertility enhancement: A scoping review *<https://doi.org/10.1089/acm.2020.0092>*. *The Journal of Alternative and Complementary Medicine, 26*(11), 1000–1014.

Craig, J. R., Jenkins, T. G., Carrell, D. T., & Hotaling, J. M. (2017). Obesity, male infertility, and the sperm epigenome *<https://doi.org/10.1016/j.fertnstert.2017.02.115>*. *Fertility and Sterility*, *107*(4), 848–859.

Crawford, S., Fussman, C., Bailey, M., Bernson, D., Jamieson, D. J., Murray-Jordan, M., & Kissin, D. M. (2015). Estimates of lifetime infertility from three states: The behavioral risk factor surveillance system *<https://doi.org/10.1089/jwh.2014.5102>*. *Journal of Women's Health*, *24*(7), 578–586.

Crockin, S. L. (2013). Growing families in a shrinking world: Legal and ethical challenges in cross-border surrogacy *<https://doi.org/10.1016/j.rbmo.2013.06.006>*. *Reproductive BioMedicine Online*, *27*(6), 733–741.

Dancet, E. A. F., Nelen, W. L. D. M., Sermeus, W., De Leeuw, L., Kremer, J. A. M., & D'Hooghe, T. M. (2010). The patients' perspective on fertility care: A systematic review *<https://doi.org/10.1093/humupd/dmq004>*. *Human Reproduction Update*, *16*(5), 467–487.

Dancet, E. A. F., Van Empel, I. W. H., Rober, P., Nelen, W. L. D. M., Kremer, J. A. M., & D'Hooghe, T. M. (2011). Patient-centred infertility care: A qualitative study to listen to the patient's voice *<https://doi.org/10.1093/humrep/der022>*. *Human Reproduction*, *26*(4), 827–833.

Daniels, C. R. (2008). *Exposing men: The science and politics of male reproduction*. Oxford University Press.

Daniilidis, A., Balaouras, D., Chitzios, D., Theodoridis, T., & Assimakopoulos, E. (2017). Hydrosalpinx: Tubal surgery or *in vitro* fertilisation? An everlasting dilemma nowadays; a narrative review *<https://doi.org/10.1080/01443615.2017.1287685>*. *Journal of Obstetrics and Gynaecology*, *37*(5), 550–556.

Davis, N. F., McGuire, B. B., Mahon, J. A., Smyth, A. E., O'Malley, K. J., & Fitzpatrick, J. M. (2010). The increasing incidence of mumps orchitis: A comprehensive review. *BJU International*, *105*(8), 1060–1065.

de Boer, K. A., McArthur, S., Murray, C., & Jansen, R. P. S. (2002). O-54. First live birth following blastocyst biopsy and PGD analysis *<https://doi.org/10.1016/S1472-6483(12)60073-X>*. *Reproductive BioMedicine Online*, *4*(2), 35.

De Geyter, C., Fehr, P., Moffat, R., Gruber, I. M., & von Wolff, M. (2015). Twenty years' experience with the Swiss data registry for assisted reproductive medicine: Outcomes, key trends and recommendations for improved practice *<https://doi.org/10.4414/smw.2015.14087>*. *Swiss Medical Weekly*, *145*, Article 14087.

de Kok, B. C., & Widdicombe, S. (2008). "I really tried": Management of normative issues in accounts of responses to infertility. *Social Science & Medicine*, *67*(7), 1083–1093.

Dennison, R. P. (2016). Transition to adulthood *<https://onlinelibrary.wiley.com/doi/abs/10.1002/9781119085621.wbefs267>*. In *The Wiley Blackwell encyclopedia of family studies* (pp. 1–5). John Wiley & Sons.

Deonandan, R. (2015). Recent trends in reproductive tourism and international surrogacy: Ethical considerations and challenges for policy *<https://doi.org/10.2147/RMHP.S63862>*. *Risk Management and Healthcare Policy*, *8*, 111–119.

Deonandan, R., Green, S., & van Beinum, A. (2012). Ethical concerns for maternal surrogacy and reproductive tourism <https://doi.org/10.1136/medethics-2012-100551>. *Journal of Medical Ethics*, *38*(12), 742–745.

Devroey, P., Liu, J., Nagy, Z., Goossens, A., Tournaye, H., Camus, M., Van Steirteghem, A., & Silber, S. (1995). Pregnancies after testicular sperm extraction and intracytoplasmic sperm injection in non-obstructive azoospermia <https://doi.org/10.1093/humrep/10.6.1457>. *Human Reproduction*, *10*(6), 1457–1460.

Dhont, N., Luchters, S., Ombelet, W., Vyankandondera, J., Gasarabwe, A., van de Wijgert, J., & Temmerman, M. (2010). Gender differences and factors associated with treatment-seeking behaviour for infertility in Rwanda <https://doi.org/10.1093/humrep/deq161>. *Human Reproduction*, *25*(8), 2024–2030.

Dhont, N., van de Wijgert, J., Coene, G., Gasarabwe, A., & Temmerman, M. (2011). "Mama and papa nothing": Living with infertility among an urban population in Kigali, Rwanda <https://doi.org/10.1093/humrep/deq373>. *Human Reproduction*, *26*(3), 623–629.

Dieckmann, K.-P., & Pichlmeier, U. (2004). Clinical epidemiology of testicular germ cell tumors <https://doi.org/10.1007/s00345-004-0398-8>. *World Journal of Urology*, *22*(1), 2–14.

Dieke, A. C., Zhang, Y., Kissin, D. M., Barfield, W. D., & Boulet, S. L. (2017). Disparities in assisted reproductive technology utilization by race and ethnicity, United States, 2014: A commentary <https://doi.org/10.1089/jwh.2017.6467>. *Journal of Women's Health*, *26*(6), 605–608.

Dierickx, S., Balen, J., Longman, C., Rahbari, L., Clarke, E., Jarju, B., & Coene, G. (2019). "We are always desperate and will try anything to conceive": The convoluted and dynamic process of health seeking among women with infertility in the West Coast Region of The Gambia <https://doi.org/10.1371/journal.pone.0211634>. *PLoS ONE*, *14*(1), Article e0211634.

Dimka, R. A., & Dein, S. L. (2013). The work of a woman is to give birth to children: Cultural constructions of infertility in Nigeria. *African Journal of Reproductive Health*, *17*(2), 102–117.

Dohle, G. R., Diemer, T., Kopa, Z., Krausz, C., Giwercman, A., Jungwirth, A., & European Association of Urology Working Group on Male Infertility. (2012). European Association of Urology guidelines on vasectomy <https://doi.org/10.1016/j.eururo.2011.10.001>. *European Urology*, *61*(1), 159–163.

Domar, A. D., Rooney, K., Hacker, M. R., Sakkas, D., & Dodge, L. E. (2018). Burden of care is the primary reason why insured women terminate in vitro fertilization treatment <https://doi.org/10.1016/j.fertnstert.2018.02.130>. *Fertility and Sterility*, *109*(6), 1121–1126.

Donkor, E. S. (2008). Socio-cultural perceptions of infertility in Ghana. *Africa Journal of Nursing and Midwifery*, *10*(1), 22–34.

Duffy, J. M. N., Arambage, K., Correa, F. J. S., Olive, D., Farquhar, C., Garry, R., Barlow, D. H., & Jacobson, T. Z. (2014). Laparoscopic surgery for endometriosis <https://doi.org/10.1002/14651858.CD011031.pub2>. *The Cochrane Database of Systematic Reviews*, *4*, Article CD011031.

Dupree, J. M. (2018). Insurance coverage of male infertility: What should the standard be? <https://doi.org/10.21037/tau.2018.04.25> *Translational Andrology and Urology*, *7*(S3), S310–S316.

Durairajanayagam, D. (2018). Lifestyle causes of male infertility <https://doi.org/10.1016/j.aju.2017.12.004>. *Arab Journal of Urology*, *16*(1), 10–20.

Duthie, E. A., Cooper, A., Davis, J. B., Schoyer, K. D., Sandlow, J., Strawn, E. Y., & Flynn, K. E. (2017). A conceptual framework for patient-centered fertility treatment <https://doi.org/10.1186/s12978-017-0375-5>. *Reproductive Health*, *14*, Article 114.

Dyer, S. J. (2007). The value of children in African countries: Insights from studies on infertility. *Journal of Psychosomatic Obstetrics and Gynecology*, *28*(2), 69–77.

Dyer, S. J. (2009). International estimates on infertility prevalence and treatment seeking: Potential need and demand for medical care. *Human Reproduction*, *24*(9), 2379–2380.

Dyer, S. J., Abrahams, N., Mokoena, N. E., Lombard, C. J., & van der Spuy, Z. M. (2005). Psychological distress among women suffering from couple infertility in South Africa: A quantitative assessment. *Human Reproduction*, *20*(7), 1938–1943.

Dyer, S. J., Abrahams, N., Mokoena, N. E., & van der Spuy, Z. M. (2004). “You are a man because you have children”: Experiences, reproductive health knowledge and treatment-seeking behaviour among men suffering from couple infertility in South Africa. *Human Reproduction*, *19*(4), 960–967.

Dyer, S. J., Archary, P., de Mouzon, J., Fiadjoe, M., & Ashiru, O. (2019). Assisted reproductive technologies in Africa: First results from the African Network and Registry for Assisted Reproductive Technology, 2013 <https://doi.org/10.1016/j.rbmo.2018.11.001>. *Reproductive BioMedicine Online*, *38*(2), 216–224.

Dyer, S. J., Sherwood, K., McIntyre, D., & Ataguba, J. E. (2013). Catastrophic payment for assisted reproduction techniques with conventional ovarian stimulation in the public health sector of South Africa: Frequency and coping strategies <https://doi.org/10.1093/humrep/det290>. *Human Reproduction*, *28*(10), 2755–2764.

Edirne, T., Arica, S. G., Gucuk, S., Yildizhan, R., Kolusari, A., Adali, E., & Can, M. (2010). Use of complementary and alternative medicines by a sample of Turkish women for infertility enhancement: A descriptive study <https://doi.org/10.1186/1472-6882-10-11>. *BMC Complementary and Alternative Medicine*, *10*, Article 11.

Eisenberg, M. L., Chen, Z., Ye, A., & Buck Louis, G. M. (2015). The relationship between physical occupational exposures and health on semen quality: Data from the LIFE study <https://doi.org/10.1016/j.fertnstert.2015.02.010>. *Fertility and Sterility*, *103*(5), 1271–1277.

Eisenberg, M. L., Smith, J. F., Millstein, S. G., Nachtigall, R. D., Adler, N. E., Pasch, L. A., & Katz, P. P. (2010). Predictors of not pursuing infertility treatment after an infertility diagnosis: Examination of a prospective U.S. cohort <https://doi.org/10.1016/j.fertnstert.2010.03.068>. *Fertility and Sterility*, *94*(6), 2369–2371.

ESHRE Capri Workshop Group. (2001). Social determinants of human reproduction. *Human Reproduction*, *16*(7), 1518–1526.

ESHRE Capri Workshop Group. (2009). Intrauterine insemination <https://doi.org/10.1093/humupd/dmp003>. *Human Reproduction Update*, *15*(3), 265–277.

Eskew, A. M., Bedrick, B. S., Hardi, A., Stoll, C. R. T., Colditz, G. A., Tuuli, M. G., & Jungheim, E. S. (2019). Letrozole compared with clomiphene citrate for unexplained infertility: A systematic review and meta-analysis <https://doi.org/10.1097/AOG.0000000000003105>. *Obstetrics and Gynecology*, *133*(3), 437–444.

Evens, E., Tolley, E., Headley, J., McCarraher, D. R., Hartmann, M., Mtimkulu, V. T., Manenzhe, K. N., Hamela, G., Zulu, F., & FEM-PrEP SBC Preparedness Research Groups in South Africa & Malawi. (2015). Identifying factors that influence pregnancy intentions: Evidence from South Africa and Malawi <https://doi.org/10.1080/13691058.2014.968806>. *Culture, Health & Sexuality*, *17*(3), 374–389.

Farquhar, C. M., Bhattacharya, S., Repping, S., Mastenbroek, S., Kamath, M. S., Marjoribanks, J., & Boivin, J. (2019b). Female subfertility <https://doi.org/10.1038/s41572-018-0058-8>. *Nature Reviews Disease Primers*, *5*(1), Article 7.

Fauser, B. C. J. M., Devroey, P., & Macklon, N. S. (2005). Multiple birth resulting from ovarian stimulation for subfertility treatment <https://doi.org/10.1016/S0140-6736(05)66478-1>. *Lancet*, *365*(9473), 1807–1816.

Feldman-Savelsberg, P. (1994). Plundered kitchens and empty wombs: Fear of infertility in the Cameroonian grassfields. *Social Science & Medicine*, *39*(4), 463–474.

Feldman-Savelsberg, P. (2002). Is infertility an unrecognized public health and population problem? The view from the Cameroon grassfields. In M. C. Inhorn & F. van Balen (Eds.), *Infertility around the globe: New thinking on childlessness, gender, and reproductive technologies* (pp. 215–232). University of California Press.

Fishel, S. (2018). First in vitro fertilization baby—This is how it happened <https://doi.org/10.1016/j.fertnstert.2018.03.008>. *Fertility and Sterility*, *110*(1), 5–11.

Fisher, J. R. W., Baker, G. H. W., & Hammarberg, K. (2010). Long-term health, well-being, life satisfaction, and attitudes toward parenthood in men diagnosed as infertile: Challenges to gender stereotypes and implications for practice <https://doi.org/10.1016/j.fertnstert.2009.01.165>. *Fertility and Sterility*, *94*(2), 574–580.

Fisher, J. R. W., & Hammarberg, K. (2012). Psychological and social aspects of infertility in men: An overview of the evidence and implications for psychologically informed clinical care and future research <https://doi.org/10.1038/aja.2011.72>. *Asian Journal of Andrology*, *14*(1), 121–129.

Fledderjohann, J. (2012). “Zero is not good for me”: Implications of infertility in Ghana <https://doi.org/10.1093/humrep/des035>. *Human Reproduction*, *27*(5), 1383–1390.

Fledderjohann, J. (2017). Difficulties conceiving and relationship stability in sub-Saharan Africa: The case of Ghana <https://doi.org/10.1007/s10680-016-9401-5>. *European Journal of Population*, *33*(1), 129–152.

Fledderjohann, J., & Barnes, L. W. (2018). Reimagining infertility: A critical examination of fertility norms, geopolitics and survey bias <*https://doi.org/10.1093/heapol/czx148*>. *Health Policy and Planning*, *33*(1), 34–40.

Fledderjohann, J., & Johnson, D. R. (2015). Impaired fertility and perceived difficulties conceiving in Ghana: Measurement problems and prospects <*https://doi.org/10.1017/S0021932015000310*>. *Journal of Biosocial Science*, *48*(4), 431–456.

Fledderjohann, J., & Roberts, C. (2018). Missing men, missing infertility: The enactment of sex/gender in surveys in low- and middle-income countries. *Population Horizons, 15*(2), 66–87.

Fraietta, R., Zylberstejn, D. S., & Esteves, S. C. (2013). Hypogonadotropic hypogonadism revisited <*https://doi.org/10.6061/clinics/2013(sup01)09*>. *Clinics*, *68*(S1), 81–88.

Frank, O. (1983). Infertility in sub-Saharan Africa: Estimates and implications. *Population and Development Review*, *9*(1), 137–144.

Galhardo, A., Cunha, M., & Pinto-Gouveia, J. (2011). Psychological aspects in couples with infertility <*https://doi.org/10.1016/j.sexol.2011.08.005*>. *Sexologies*, *20*(4), 224–228.

Gameiro, S., Canavarro, M. C., & Boivin, J. (2013). Patient centred care in infertility health care: Direct and indirect associations with wellbeing during treatment <*https://doi.org/10.1016/j.pec.2013.08.015*>. *Patient Education and Counseling*, *93*(3), 646–654.

Gaskins, A. J., Chavarro, J. E., Rich-Edwards, J. W., Missmer, S. A., Laden, F., Henn, S. A., & Lawson, C. C. (2017). Occupational use of high-level disinfectants and fecundity among nurses <*https://doi.org/10.5271/sjweh.3623*>. *Scandinavian Journal of Work, Environment & Health*, *43*(2), 171–180.

Gaskins, A. J., Rich-Edwards, J. W., Lawson, C. C., Schernhammer, E. S., Missmer, S. A., & Chavarro, J. E. (2015). Work schedule and physical factors in relation to fecundity in nurses <*https://doi.org/10.1136/oemed-2015-103026*>. *Occupational and Environmental Medicine*, *72*(11), 777–783.

Gavin, L., Moskosky, S., Carter, M., Curtis, K., Glass, E., Godfrey, E., Marcell, A., . . . Zapata, L. (2014). Providing quality family planning Services: Recommendations of CDC and the U.S. Office of Population Affairs <*https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6304a1.htm*>. *Morbidity and Mortality Weekly Report*, *63*(4), 1–54.

Geelhoed, D. W., Nayembil, D., Asare, K., Schagen van Leeuwen, J. H., & van Roosmalen, J. (2002). Infertility in rural Ghana. *International Journal of Gynecology & Obstetrics*, *79*(2), 137–142.

Gerrits, T. (1997). Social and cultural aspects of infertility in Mozambique. *Patient Education and Counseling*, *31*(1), 39–48.

Gerrits, T., & Shaw, M. (2010). Biomedical infertility care in sub-Saharan Africa: A social science review of current practices, experiences and view points. *Facts, Views & Vision in ObGyn*, *2*(3), 194–207.

Gibson, C. (1980). Childlessness and marital instability: A re-examination of the evidence. *Journal of Biosocial Science*, *12*(2), 121–132.

Gijsels, M., Mgalla, Z., & Wambura, L. (2001). “No child to send”: Context and consequences of female infertility in northwest Tanzania. In J. T. Boerma & Z. Mgalla (Eds.), *Women and infertility in sub-Saharan Africa: A multidisciplinary perspective* (pp. 203–222). KIT.

Gipson, J. D., Bornstein, M. J., & Hindin, M. J. (2020). Infertility: A continually neglected component of sexual and reproductive health and rights *<https://doi.org/10.2471/BLT.20.252049>*. *Bulletin of the World Health Organization*, *98*(7), 505–506.

Giwa-Osagie, O. F. (2010). ART in developing countries with particular reference to sub-Saharan Africa. In E. Vayena, P. J. Rowe, & P. D. Griffin (Eds.), *Current practices and controversies in assisted reproduction* (pp. 22–30). World Health Organization.

Gleason, J. L., Shenassa, E. D., & Thoma, M. E. (2019). Self-reported infertility, metabolic dysfunction, and cardiovascular events: A cross-sectional analysis among U.S. women *<https://doi.org/10.1016/j.fertnstert.2018.10.009>*. *Fertility and Sterility*, *111*(1), 138–146.

Gnoth, C., Godehardt, E., Frank-Herrmann, P., Friol, K., Tigges, J., & Freundl, G. (2005). Definition and prevalence of subfertility and infertility. *Human Reproduction*, *20*(5), 1144–1147.

Godin, P. A., Syrios, K., Rege, G., Demir, S., Charitidou, E., & Wery, O. (2018). Laparoscopic reversal of tubal sterilization: A retrospective study over 135 cases *<https://doi.org/10.3389/fsurg.2018.00079>*. *Frontiers in Surgery*, *5*, 79.

Goldscheider, F. K., & Kaufman, G. (1996). Fertility and commitment: Bringing men back in. *Population and Development Review*, *22*, 87–99.

Gollenberg, A. L., Liu, F., Brazil, C., Drobnis, E. Z., Guzick, D., Overstreet, J. W., Redmon, J. B., Sparks, A., Wang, C., & Swan, S. H. (2010). Semen quality in fertile men in relation to psychosocial stress *<https://doi.org/10.1016/j.fertnstert.2008.12.018>*. *Fertility and Sterility*, *93*(4), 1104–1111.

Gonen, L. D. (2016). Satisfaction with in vitro fertilization treatment: Patients’ experiences and professionals’ perceptions *<https://doi.org/10.1186/s40738-016-0019-4>*. *Fertility Research and Practice*, *2*, Article 6.

Gong, B., Ma, M., Xie, W., Yang, X., Huang, Y., Sun, T., Luo, Y., & Huang, J. (2017). Direct comparison of tadalafil with sildenafil for the treatment of erectile dysfunction: A systematic review and meta-analysis *<https://doi.org/10.1007/s11255-017-1644-5>*. *International Urology and Nephrology*, *49*(10), 1731–1740.

Gordts, S., Roziers, P., Campo, R., & Noto, V. (1990). Survival and pregnancy outcome after ultrarapid freezing of human embryos *<https://doi.org/10.1016/S0015-0282(16)53342-1>*. *Fertility and Sterility*, *53*(3), 469–472.

Gore, A. C., Chappell, V. A., Fenton, S. E., Flaws, J. A., Nadal, A., Prins, G. S., Toppari, J., & Zoeller, R. T. (2015). EDC-2: The Endocrine Society’s second scientific statement on endocrine-disrupting chemicals *<https://doi.org/10.1210/er.2015-1010>*. *Endocrine Reviews*, *36*(6), E1–E150.

Greene, M. E., & Biddlecom, A. E. (2000). Absent and problematic men: Demographic accounts of male reproductive roles. *Population and Development Review*, *26*(1), 81–115.

Greil, A. L. (1991). A secret stigma: The analogy between infertility and chronic illness and disability. *Advances in Medical Sociology*, *2*(1), 17–38.

Greil, A. L., & Johnson, K. M. (2014). Gender attitudes: Infertility *<https://doi.org/10.1002/9781118410868.wbehibs046>*. In *The Wiley-Blackwell encyclopedia of health, illness, behavior, and society* (pp. 589–594). Wiley-Blackwell.

Greil, A. L., McQuillan, J., Johnson, K., Slauson-Blevins, K., & Shreffler, K. M. (2010a). The hidden infertile: Infertile women without pregnancy intent in the United States *<https://doi.org/10.1016/j.fertnstert.2009.08.024>*. *Fertility and Sterility*, *93*(6), 2080–2083.

Greil, A. L., McQuillan, J., Shreffler, K. M., Johnson, K., & Slauson-Blevins, K. S. (2011). Race-ethnicity and medical services for infertility: Stratified reproduction in a population-based sample of U.S. women. *Journal of Health and Social Behavior*, *52*(4), 493–509.

Greil, A. L., Slauson-Blevins, K., & McQuillan, J. (2010b). The experience of infertility: A review of recent literature *<https://doi.org/10.1111/j.1467-9566.2009.01213.x>*. *Sociology of Health & Illness*, *32*(1), 140–162.

Greil, A. L., Slauson-Blevins, K. S., Tiemeyer, S., McQuillan, J., & Shreffler, K. M. (2016). A new way to estimate the potential unmet need for infertility services among women in the United States *<https://doi.org/10.1089/jwh.2015.5390>*. *Journal of Women's Health*, *25*(2), 133–138.

Grey, B. R., O'Flynn, K. J., & Payne, S. R. (2012). UK urology trainees' exposure to dedicated infertility training: How good is that training? *British Journal of Medical and Surgical Urology*, *5*(1), 34–38.

Griesinger, G., Diedrich, K., & Altgassen, C. (2007). Stronger reduction of assisted reproduction technique treatment cycle numbers in economically weak geographical regions following the German healthcare modernization law in 2004 *<https://doi.org/10.1093/humrep/dem293>*. *Human Reproduction*, *22*(11), 3027–3030.

Günay, O., Cetinkaya, F., Naçar, M., & Aydin, T. (2005). Modern and traditional practices of Turkish infertile couples *<https://doi.org/10.1080/13625180500034911>*. *The European Journal of Contraception & Reproductive Health Care*, *10*(2), 105–110.

Gunn, D. D., & Bates, G. W. (2016). Evidence-based approach to unexplained infertility: A systematic review *<https://doi.org/10.1016/j.fertnstert.2016.02.001>*. *Fertility and Sterility*, *105*(6), P1566–P1574.E1.

Guo, X.-Y., Liu, X.-M., Jin, L., Wang, T.-T., Ullah, K., Sheng, J.-Z., & Huang, H.-F. (2017). Cardiovascular and metabolic profiles of offspring conceived by assisted reproductive technologies: A systematic review and meta-analysis *<https://doi.org/10.1016/j.fertnstert.2016.12.007>*. *Fertility and Sterility*, *107*(3), P622–P631.E5.

Gürtin, Z. B., Inhorn, M. C., & Tremayne, S. (2015). Islam and assisted hreproduction in the Middle East: Comparing the Sunni Arab World, Shia Iran and Secular Turkey *<https://doi.org/10.1007/978-94-017-9376-6_165>*. In S. D. Brunn (Ed.), *The changing world religion map: Sacred places, identities, practices and politics* (pp. 3137–3153). Springer.

Gurunath, S., Pandian, Z., Anderson, R. A., & Bhattacharya, S. (2011). Defining infertility: A systematic review of prevalence studies. *Human Reproduction Update*, *17*(5), 575–588.

Habbema, J. D. F., Collins, J., Leridon, H., Evers, J. L. H., Lunenfeld, B., & teVelde, E. R. (2004). Towards less confusing terminology in reproductive medicine: A proposal. *Human Reproduction*, *19*(7), 1497–1501.

Hammarberg, K., & Kirkman, M. (2013). Infertility in resource-constrained settings: Moving towards amelioration <https://doi.org/10.1016/j.rbmo.2012.11.009>. *Reproductive BioMedicine Online*, *26*(2), 189–195.

Hamori, M., Stuckensen, J. A., Rumpf, D., Kniewald, T., Kniewald, A., & Marquez, M. A. (1988). Zygote intrafallopian transfer (ZIFT): Evaluation of 42 cases <https://doi.org/10.1016/s0015-0282(16)60145-0>. *Fertility and Sterility*, *50*(3), 519–521.

Handyside, A. H., Kontogianni, E. H., Hardy, K., & Winston, R. M. (1990). Pregnancies from biopsied human preimplantation embryos sexed by Y-specific DNA amplification <https://doi.org/10.1038/344768a0>. *Nature*, *344*(6268), 768–770.

Hanson, B., Johnstone, E., Dorais, J., Silver, B., Peterson, C. M., & Hotaling, J. (2017). Female infertility, infertility-associated diagnoses, and comorbidities: A review <https://doi.org/10.1007/s10815-016-0836-8>. *Journal of Assisted Reproduction and Genetics*, *34*(2), 167–177.

Harris, I. D., Fronczak, C., Roth, L., & Meacham, R. B. (2011). Fertility and the aging male. *Reviews in Urology*, *13*(4), e184–e190.

Hauser, R. (2006). The environment and male fertility: Recent research on emerging chemicals and semen quality <https://doi.org/10.1055/s-2006-944422>. *Seminars in Reproductive Medicine*, *24*(3), 156–167.

Hollos, M., & Larsen, U. (2008). Motherhood in sub-Saharan Africa: The social consequences of infertility in an urban population in northern Tanzania. *Culture, Health & Sexuality*, *10*(2), 159–173.

Hollos, M., Larsen, U., Obono, O., & Whitehouse, B. (2009). The problem of infertility in high fertility populations: Meanings, consequences and coping mechanisms in two Nigerian communities <https://doi.org/10.1016/j.socscimed.2009.03.008>. *Social Science & Medicine*, *68*(11), 2061–2068.

Hollos, M., & Whitehouse, B. (2014). Women in limbo: Life course consequences of infertility in a Nigerian community. *Human Fertility*, *17*(3), 188–191.

Holter, H., Sandin-Bojo, A.-K., Gejervall, A.-L., Wikland, M., Wilde-Larsson, B., & Bergh, C. (2014a). Patient-centred quality of care in an IVF programme evaluated by men and women <https://doi.org/10.1093/humrep/deu254>. *Human Reproduction*, *29*(12), 2695–2703.

Holter, H., Sandin-Bojo, A.-K., Gejervall, A.-L., Wikland, M., Wilde-Larsson, B., & Bergh, C. (2014b). Quality of care in an IVF programme from a patient’s perspective: Development of a validated instrument <https://doi.org/10.1093/humrep/det421>. *Human Reproduction*, *29*(3), 534–547.

Hörbst, V. (2012). “You need someone in a grand boubou”—Barriers and means to access ARTs in West Africa. *Facts, Views & Vision in ObGyn*, 46–52.

Hornstein, M. D. (2016). State of the ART: Assisted reproductive technologies in the United States <https://doi.org/10.1177/1933719116667227>. *Reproductive Sciences*, *23*(12), 1630–1633.

Hotaling, J. M., Davenport, M. T., Eisenberg, M. L., VanDenEden, S. K., & Walsh, T. J. (2012). Men who seek infertility care may not represent the general U.S. population: Data from the National Survey of Family Growth <https://doi.org/10.1016/j.urology.2011.09.021> (NSFG). *Urology*, *79*(1), 123–127.

Human Fertilisation & Embryology Authority. (n.d.). *Costs and funding* [Government]. Human Fertilisation & Embryology Authority <https://www.hfea.gov.uk/treatments/explore-all-treatments/costs-and-funding/>.

Huppelschoten, A. G., Nelen, W. L. D. M., Westert, G. P., van Golde, R. J. T., Adang, E. M. M., & Kremer, J. A. M. (2015). Improving patient-centredness in partnership with female patients: A cluster RCT in fertility care <https://doi.org/10.1093/humrep/dev041>. *Human Reproduction*, *30*(5), 1137–1145.

Ibisomi, L., & Mudege, N. N. (2014). Childlessness in Nigeria: Perceptions and acceptability <https://doi.org/10.1080/13691058.2013.839828>. *Culture, Health & Sexuality*, *16*(1), 61–75.

Ikechebelu, J. I., Eleje, G. U., Joe-Ikechebelu, N. N., Okafor, C. D., & Akintobi, A. O. (2018). Comparison of the prevalence of adhesions at the time of diagnostic laparoscopy for infertility between patient who had open myomectomy and those who had no previous pelvic-abdominal surgery or pelvic inflammatory disease <https://www.ajol.info/index.php/njcp/article/view/182849>. *Nigerian Journal of Clinical Practice*, *21*(11), 1415–1421.

Impicciatore, G. G., & Tiboni, G. M. (2011). Ovulation inducing agents and cancer risk: Review of literature. *Current Drug Safety*, *6*(4), 250–258.

Inhorn, M. C. (1996). *Infertility and patriarchy: The cultural politics of gender and family life in Egypt*. University of Pennsylvania Press.

Inhorn, M. C. (2002). Sexuality, masculinity, and infertility in Egypt: Potent troubles in the marital and medical encounters. *The Journal of Men’s Studies*, *10*(3), 343–359.

Inhorn, M. C. (2003). “The worms are weak”: Male infertility and patriarchal paradoxes in Egypt. *Men and Masculinities*, *5*(3), 236–256.

Inhorn, M. C. (2004). Middle Eastern masculinities in the age of new reproductive technologies: Male infertility and stigma in Egypt and Lebanon. *Medical Anthropology Quarterly*, *18*(2), 162–182.

Inhorn, M. C., & Birenbaum-Carmeli, D. (2008). Assisted reproductive technologies and culture change <https://doi.org/10.1146/annurev.anthro.37.081407.085230>. *Annual Review of Anthropology*, *37*, 177–196.

Inhorn, M. C., Ceballo, R., & Nachtigall, R. (2009a). Marginalized, invisible, and unwanted: American minority struggles with infertility and assisted conception. *Marginalized Reproduction: Ethnicity, Infertility and Reproductive Technologies*, *11*, 181–197.

Inhorn, M. C., & Fakih, M. H. (2006). Arab Americans, African Americans, and infertility: Barriers to reproduction and medical care. *Fertility and Sterility*, *85*(4), 844–852.

Inhorn, M. C., & Gurtin, Z. B. (2012). Infertility and assisted reproduction in the Muslim Middle East: Social, religious, and resource considerations. *Facts, Views & Vision in ObGyn*, Monograph: 24–29.

Inhorn, M. C., & Patrizio, P. (2012). The global landscape of cross-border reproductive care: Twenty key findings for the new millennium *<https://doi.org/10.1097/GCO.0b013e328352140a>*. *Current Opinion in Obstetrics & Gynecology*, *24*(3), 158–163.

Inhorn, M. C., & Patrizio, P. (2015). Infertility around the globe: New thinking on gender, reproductive technologies and global movements in the 21st century *<https://doi.org/10.1093/humupd/dmv016>*. *Human Reproduction Update*, *21*(4), 411–426.

Inhorn, M. C., Patrizio, P., & Serour, G. I. (2010). Third-party reproductive assistance around the Mediterranean: Comparing Sunni Egypt, Catholic Italy and multisectarian Lebanon *<https://doi.org/10.1016/j.rbmo.2010.09.008>*. *Reproductive BioMedicine Online*, *21*(7), 848–853.

Inhorn, M. C., & Shrivastav, P. (2010). Globalization and reproductive tourism in the United Arab Emirates *<https://doi.org/10.1177/1010539510373007>*. *Asia-Pacific Journal of Public Health*, *22*(S3), S68–S74.

Inhorn, M. C., Tjørnhøj, T., Goldberg, H., & la Cour Mosegaard, M. (2009b). *Reconceiving the second sex in reproduction? Men, sexuality, and masculinity*. Berghahn Books.

Inhorn, M. C., & Tremayne, S. (2016). Islam, assisted reproduction, and the bioethical aftermath *<https://doi.org/10.1007/s10943-015-0151-1>*. *Journal of Religion and Health*, *55*(2), 422–430.

Inhorn, M. C., & van Balen, F. (2002). *Infertility around the globe: New thinking on childlessness, gender, and reproductive technologies*. University of California Press.

Inhorn, M. C., & Wentzell, E. A. (2011). Embodying emergent masculinities: Men engaging with reproductive and sexual health technologies in the Middle East and Mexico *<https://doi.org/10.1111/j.1548-1425.2011.01338.x>*. *American Ethnologist*, *38*(4), 801–815.

International Federation of Fertility Societies' Surveillance. (2019). International Federation of Fertility Societies' surveillance (IFFS) 2019: Global trends in reproductive policy and practice, 8th edition *<https://doi.org/10.1097/GRH.0000000000000029>*. *Global Reproductive Health*, *4*(1), e29.

International Federation of Gynecology and Obstetrics. (n.d.). *The fertility toolbox*. FIGO.

Ishihara, O., Adamson, G. D., Dyer, S., de Mouzon, J., Nygren, K. G., Sullivan, E. A., Zegers-Hochschild, F., & Mansour, R. (2015). International Committee for Monitoring Assisted Reproductive Technologies: World report on assisted reproductive technologies, 2007 *<https://doi.org/10.1016/j.fertnstert.2014.11.004>*. *Fertility and Sterility*, *103*(2), 402–413.

Jacobson, M. H., Chin, H. B., Mertens, A. C., Spencer, J. B., Fothergill, A., & Howards, P. P. (2018). "Research on infertility: Definition makes a difference" revisited *<https://doi.org/10.1093/aje/kwx240>*. *American Journal of Epidemiology*, *187*(2), 337–346.

Jain, T. (2006). Socioeconomic and racial disparities among infertility patients seeking care <https://doi.org/10.1016/j.fertnstert.2005.07.1338>. *Fertility and Sterility*, *85*(4), 876–881.

Janitz, A. E., Peck, J. D., & Craig, L. B. (2019). Racial/ethnic differences in the utilization of infertility services: A focus on American Indian/Alaska natives <https://doi.org/10.1007/s10995-018-2586-y>. *Maternal and Child Health Journal*, *23*(1), 10–18.

Jegede, A. S. (2007). What led to the Nigerian boycott of the polio vaccination campaign? <https://doi.org/10.1371/journal.pmed.0040073> *PLoS Medicine*, *4*(3), Article e73.

Jenkins, J., Daya, S., Kremer, J., Balasch, J., Barratt, C., Cooke, I., . . . Nygren, K. (2004). European Classification of Infertility Taskforce (ECIT) response to Habbema et al., "towards less confusing terminology in reproductive medicine: A proposal." <https://doi.org/10.1093/humrep/deh499> *Human Reproduction*, *19*(12), 2687–2688.

Jensen, T. K., Heitmann, B. L., Blomberg Jensen, M., Halldorsson, T. I., Andersson, A.-M., Skakkebæk, N. E., . . . Jørgensen, N. (2013). High dietary intake of saturated fat is associated with reduced semen quality among 701 young Danish men from the general population <https://doi.org/10.3945/ajcn.112.042432>. *The American Journal of Clinical Nutrition*, *97*(2), 411–418.

Joffe, M. (2000). Time trends in biological fertility in Britain <https://doi.org/10.1016/S0140-6736(00)02328-X>. *The Lancet*, *355*(9219), 1961–1965.

Joffe, M. (2003). Invited commentary: The potential for monitoring of fecundity and the remaining challenges <https://doi.org/10.1093/aje/kwf177>. *American Journal of Epidemiology*, *157*(2), 89–93.

Joffe, M., Key, J., Best, N., Keiding, N., Scheike, T., & Jensen, T. K. (2005). Studying time to pregnancy by use of a retrospective design <https://doi.org/10.1093/aje/kwi172>. *American Journal of Epidemiology*, *162*(2), 115–124.

Johnson, K. M., Greil, A. L., McQuillan, J., Leyser-Whalen, O., & Shreffler, K. M. (2019). Infertility and self-identification: The indeterminacy of the illness-self relationship <https://doi.org/10.1177/0731121419867691>. *Sociological Perspectives*, *63*(3), 388–405.

Johnson, S. L., Dunleavy, J., Gemmell, N. J., & Nakagawa, S. (2015). Consistent age-dependent declines in human semen quality: A systematic review and meta-analysis <https://doi.org/10.1016/j.arr.2014.10.007>. *Ageing Research Reviews*, *19*, 22–33.

Joseph, A. (2019, December 30). Scientist He Jianku sentenced to three years for creating CRISPR'd babies <https://www.statnews.com/2019/12/30/he-jiankui-who-created-worlds-first-crisprd-babies-sentenced-to-three-years-in-prison-for-illegal-medical-practice/>. *STAT*.

Jungwirth, A., Giwercman, A., Tournaye, H., Diemer, T., Kopa, Z., Dohle, G., & Krausz, C. (2012). European Association of Urology guidelines on male infertility: The 2012 update <https://doi.org/10.1016/j.eururo.2012.04.048>. *European Urology*, *62*(2), 324–332.

Kamel, R. M. A. (2010). Management of the infertile couple: An evidence-based protocol <https://doi.org/10.1186/1477-7827-8-21>. *Reproductive Biology and Endocrinology*, *8*(1), 21.

Kamel, R. M. A. (2013). Assisted reproductive technology after the birth of Louise Brown <https://doi.org/10.4172/2161-0932.1000156>. *Gynecology & Obstetrics*, *3*(03), Article 156.

Kamischke, A., & Nieschlag, E. (1999). Treatment of retrograde ejaculation and anejaculation <https://doi.org/10.1093/humupd/5.5.448>. *Human Reproduction Update*, *5*(5), 448–474.

Karmaus, W., & Juul, S. (1999). Infertility and subfecundity in population-based samples from Denmark, Germany, Italy, Poland and Spain <https://doi.org/10.1093/eurpub/9.3.229>. *European Journal of Public Health*, *9*(3), 229–235.

Katz, P., Showstack, J., Smith, J. F., Nachtigall, R. D., Millstein, S. G., Wing, H., . . . Adler, N. (2011). Costs of infertility treatment: Results from an 18-month prospective cohort study <https://doi.org/10.1016/j.fertnstert.2010.11.026>. *Fertility and Sterility*, *95*(3), 915–921.

Kemper, J. M., Wang, R., Vuong, L. N., & Mol, B. W. (2019). Single embryo transfer with frozen transfer of all remaining embryos without further embryonic testing should be the standard of care in IVF <https://doi.org/10.1111/1471-0528.15486>. *BJOG: An International Journal of Obstetrics and Gynaecology*, *126*(2), 142–144.

Kessler, L. M., Craig, B. M., Plosker, S. M., Reed, D. R., & Quinn, G. P. (2013). Infertility evaluation and treatment among women in the United States <https://doi.org/10.1016/j.fertnstert.2013.05.040>. *Fertility and Sterility*, *100*(4), 1025–1032.

Khalifa, D. S., & Ahmed, M. A. (2012). Reviewing infertility care in Sudan; socio-cultural, policy and ethical barriers. *Facts, Views & Vision in ObGyn, 3*, 53–58.

Kirby, E. W., Wiener, L. E., Rajanahally, S., Crowell, K., & Coward, R. M. (2016). Undergoing varicocele repair before assisted reproduction improves pregnancy rate and live birth rate in azoospermic and oligospermic men with a varicocele: A systematic review and meta-analysis <https://doi.org/10.1016/j.fertnstert.2016.07.1093>. *Fertility and Sterility*, *106*(6), 1338–1343.

Kissil, K., & Davey, M. (2012). Health disparities in procreation: Unequal access to assisted reproductive technologies. *Journal of Feminist Family Therapy*, *24*(3), 197–212.

Klemetti, R., Gissler, M., Sevón, T., & Hemminki, E. (2007). Resource allocation of in vitro fertilization: A nationwide register-based cohort study <https://doi.org/10.1186/1472-6963-7-210>. *BMC Health Services Research*, *7*, 210.

Kodaman, P. H., & Arici, A. (2007). Intra-uterine adhesions and fertility outcome: How to optimize success? <https://doi.org/10.1097/GCO.0b013e32814a6473> *Current Opinion in Obstetrics & Gynecology*, *19*(3), 207–214.

Koropatnick, S., Daniluk, J., & Pattinson, H. A. (1993). Infertility: A non-event transition <https://doi.org/10.1016/S0015-0282(16)55633-7>. *Fertility and Sterility*, *59*(1), 163–171.

Krausz, C. (2011). Male infertility: Pathogenesis and clinical diagnosis <https://doi.org/10.1016/j.beem.2010.08.006>. *Best Practice & Research: Clinical Endocrinology & Metabolism*, *25*(2), 271–285.

Kushnir, V. A., Barad, D. H., Albertini, D. F., Darmon, S. K., & Gleicher, N. (2017). Systematic review of worldwide trends in assisted reproductive technology 2004–2013 <https://doi.org/10.1186/s12958-016-0225-2>. *Reproductive Biology and Endocrinology*, *15*(1), Article 6.

Kussiwaah, D. Y., Donkor, E. S., & Naab, F. (2016). "Management gap in the treatment of infertility in Ghana": The cry of childless women. *International Journal of Nursing and Health Science*, *3*(6), 53–58.

Larsen, U. (2000). Primary and secondary infertility in sub-Saharan Africa. *International Journal of Epidemiology*, *29*(2), 285–291.

Larsen, U. (2005). Research on infertility: Which definition should we use? <https://doi.org/10.1016/j.fertnstert.2004.11.033> *Fertility and Sterility*, *83*(4), 846–852.

Larsen, U., & Raggers, H. (2001). Levels and trends in infertility in sub-Saharan Africa. In J. T. Boerma & Z. Mgalla (Eds.), *Women and infertility in sub-Saharan Africa: A multidisciplinary perspective* (pp. 25–70). KIT.

Laws-King, A., Trounson, A., Sathananthan, H., & Kola, I. (1987). Fertilization of human oocytes by microinjection of a single spermatozoon under the zona pellucida <https://doi.org/10.1016/S0015-0282(16)59478-3>. *Fertility and Sterility*, *48*(4), 637–642.

Lemoine, M.-E., & Ravitsky, V. (2013). Toward a public health approach to infertility: The ethical dimensions of infertility prevention <https://doi.org/10.1093/phe/pht026>. *Public Health Ethics*, *6*(3), 287–301.

Leonard, L. (2002). Problematizing fertility: "Scientific" accounts and Chadian women's narratives. In M. C. Inhorn & F. van Balen (Eds.), *Infertility around the globe: New thinking on childlessness, gender, and reproductive technologies* (pp. 193–214). University of California Press.

Levine, H., Jørgensen, N., Martino-Andrade, A., Mendiola, J., Weksler-Derri, D., Mindlis, I., Pinotti, R., & Swan, S. H. (2017). Temporal trends in sperm count: A systematic review and meta-regression analysis <https://doi.org/10.1093/humupd/dmx022>. *Human Reproduction Update*, *23*(6), 646–659.

Li, H. W. R., Tank, J., & Haththotuwa, R., on behalf of Asia and Oceania Federation of Obstetrics and Gynaecology. (2018). Updated status of assisted reproductive technology activities in the Asia-Oceania region: ART activities in Asia-Oceania region <https://doi.org/10.1111/jog.13742>. *Journal of Obstetrics and Gynaecology Research*, *44*(9), 1667–1672.

Liamputtong, P. (2009). Treating the afflicted body: Perceptions of infertility and ethnomedicine among fertile Hmong women in Australia. In L. Culley, N. Hudson, & F. Van Rooij (Eds.), *Marginalized reproduction: Ethnicity, infertility and reproductive technologies* (pp. 151–164). Routledge.

Lindsay, T. J., & Vitrikas, K. R. (2015). Evaluation and treatment of infertility. *American Family Physician*, *91*(5), 308–314.

Lo, W., & Campo-Engelstein, L. (2018). Expanding the clinical definition of infertility to include socially infertile individuals and couples. In L. Campo-Engelstein & P. Burcher (Eds.), *Reproductive ethics II* (pp. 71–83). Springer.

Lord, J., Shaw, L., Dobbs, F., & Acharya, U. (2001). A time for change and a time for equality—Infertility services and the NHS <https://doi.org/10.1080/1464727012000199621>. *Human Fertility*, *4*(4), 256–260.

Louis, J. F., Thoma, M. E., Sørensen, D. N., McLain, A. C., King, R. B., Sundaram, R., Keiding, N., & Buck Louis, G. M. (2013). The prevalence of couple infertility in the United States from a male perspective: Evidence from a nationally representative sample <https://doi.org/10.1111/j.2047-2927.2013.00110.x>. *Andrology*, *1*(5), 741–748.

Loyola Briceno, A. C., Ahrens, K. A., Thoma, M. E., & Moskosky, S. (2019). Availability of services related to achieving pregnancy in U.S. publicly funded family planning clinics <https://doi.org/10.1016/j.whi.2019.07.005>. *Women's Health Issues, 29*(6), P447–P454.

Luk, B. H.-K., & Loke, A. Y. (2015). The impact of infertility on the psychological well-being, marital relationships, sexual relationships, and quality of life of couples: A systematic review <https://doi.org/10.1080/0092623X.2014.958789>. *Journal of Sex & Marital Therapy*, *41*(6), 610–625.

Luna, Z., & Luker, K. (2013). Reproductive justice <https://doi.org/10.1146/annurev-lawsocsci-102612-134037>. *Annual Review of Law and Social Science*, *9*(1), 327–352.

Ma, Y., Zhang, L., & Qin, C. (2019). The first genetically gene-edited babies: It's "irresponsible and too early <https://doi.org/10.1002/ame2.12052>." *Animal Models and Experimental Medicine*, *2*(1), 1–4.

Macaluso, M., Wright-Schnapp, T. J., Chandra, A., Johnson, R., Satterwhite, C. L., Pulver, A., . . . Pollack, L. A. (2010). A public health focus on infertility prevention, detection, and management <https://doi.org/10.1016/j.fertnstert.2008.09.046>. *Fertility and Sterility*, *93*(1), 16.e1–16.e10.

Macer, M. L., & Taylor, H. S. (2012). Endometriosis and infertility: A review of the pathogenesis and treatment of endometriosis-associated infertility <https://doi.org/10.1016/j.ogc.2012.10.002>. *Obstetrics and Gynecology Clinics of North America*, *39*(4), 535–549.

Manson, J. M., & Carr, M. C. (2003). Molecular epidemiology of hypospadias: Review of genetic and environmental risk factors <https://doi.org/10.1002/bdra.10084>. *Birth Defects Research Part A: Clinical and Molecular Teratology*, *67*(10), 825–836.

March, C. M. (2011). Asherman's syndrome <https://doi.org/10.1055/s-0031-1272470>. *Seminars in Reproductive Medicine*, *29*(2), 83–94.

Marchbanks, P. A., Peterson, H. B., Rubin, G. L., & Wingo, P. A. (1989). Research on infertility: Definition makes a difference <https://doi.org/10.1093/oxfordjournals.aje.a115332>. *American Journal of Epidemiology*, *130*(2), 259–267.

Martin, J. A., Hamilton, B. E., & Osterman, M. J. K. (2012). Three decades of twin births in the United States, 1980–2009. *NCHS Data Brief*, *80*, 1–8.

Mascarenhas, M. N., Cheung, H., Mathers, C. D., & Stevens, G. A. (2012a). Measuring infertility in populations: Constructing a standard definition for use with demographic and reproductive health surveys. *Population Health Metrics*, *10*(1), 17.

Mascarenhas, M. N., Flaxman, S. R., Boerma, T., van der Poel, S., & Stevens, G. A. (2012b). National, regional, and global trends in infertility prevalence since 1990: A systematic analysis of 277 health surveys. *PLoS Medicine*, *9*(12), Article e1001356.

Maxwell, E., Mathews, M., & Mulay, S. (2018). More than a biological condition: The heteronormative framing of infertility. *Canadian Journal of Bioethics*, *1*(2), 63–66.

McCabe, E. R. B., Carrino, G. E., Russell, R. B., & Howse, J. L. (2014). Fighting for the next generation: US prematurity in 2030 <https://doi.org/10.1542/peds.2014-2541>. *Pediatrics*, *134*(6), 1193–1199.

McKinnon, C. J., Hatch, E. E., Rothman, K. J., Mikkelsen, E. M., Wesselink, A. K., Hahn, K. A., & Wise, L. A. (2016). Body mass index, physical activity and fecundability in a North American preconception cohort study <https://doi.org/10.1016/j.fertnstert.2016.04.011>. *Fertility and Sterility*, *106*(2), 451–459.

Mehta, A., Nangia, A. K., Dupree, J. M., & Smith, J. F. (2016). Limitations and barriers in access to care for male factor infertility <https://doi.org/10.1016/j.fertnstert.2016.03.023>. *Fertility and Sterility*, *105*(5), 1128–1137.

Meseguer, M., Rubio, I., Cruz, M., Basile, N., Marcos, J., & Requena, A. (2012). Embryo incubation and selection in a time-lapse monitoring system improves pregnancy outcome compared with a standard incubator: A retrospective cohort study <https://doi.org/10.1016/j.fertnstert.2012.08.016>. *Fertility and Sterility*, *98*(6), P1481–P1489.E10.

Miner, S. A., Robins, S., Zhu, Y. J., Keeren, K., Gu, V., Read, S. C., & Zelkowitz, P. (2018). Evidence for the use of complementary and alternative medicines during fertility treatment: A scoping review <https://doi.org/10.1186/s12906-018-2224-7>. *BMC Complementary and Alternative Medicine*, *18*(1), 158.

Momenimovahed, Z., Taheri, S., Tiznobaik, A., & Salehiniya, H. (2019). Do the fertility drugs increase the risk of cancer? A review study <https://doi.org/10.3389/fendo.2019.00313>. *Frontiers in Endocrinology*, *10*, 313.

Morse, D. S., Paldi, Y., Egbarya, S. S., & Clark, C. J. (2012). “An effect that is deeper than beating”: Family violence in Jordanian women <https://doi.org/10.1037/a0027137>. *Families, Systems, & Health*, *30*(1), 19–31.

Mourad, S. M., Hermens, R. P. M. G., Nelen, W. L. D. M., Braat, D. D. M., Grol, R. P. T. M., & Kremer, J. A. M. (2007). Guideline-based development of quality indicators for subfertility care <https://doi.org/10.1093/humrep/dem215>. *Human Reproduction*, *22*(10), 2665–2672.

Mourad, S. M., Nelen, W. L. D. M., Akkermans, R. P., Vollebergh, J. H. A., Grol, R. P. T. M., Hermens, R. P. M. G., & Kremer, J. A. M. (2010). Determinants of patients’ experiences and satisfaction with fertility care <https://doi.org/10.1016/j.fertnstert.2009.07.990>. *Fertility and Sterility*, *94*(4), 1254–1260.

Moyo, S., & Muhwati, I. (2013). Socio-cultural perspectives on causes and intervention strategies of male infertility: A case study of Mhondoro-Ngezi, Zimbabwe. *African Journal of Reproductive Health/La Revue Africaine de La Santé Reproductive*, *17*(2), 89–101.

Nachtigall, R. D. (2006). International disparities in access to infertility services *<https://doi.org/10.1016/j.fertnstert.2005.08.066>*. *Fertility and Sterility*, *85*(4), 871–875.

Nachtigall, R. D., Becker, G., & Wozny, M. (1992). The effects of gender-specific diagnosis on men’s and women’s response to infertility *<https://doi.org/10.1016/S0015-0282(16)54786-4>*. *Fertility and Sterility*, *57*(1), 113–121.

Nahar, P. (2010). Health seeking behaviour of childless women in Bangladesh: An ethnographic exploration for the special issue on: Loss in child bearing *<https://doi.org/10.1016/j.socscimed.2010.07.026>*. *Social Science & Medicine*, *71*, 1780–1787.

Nahar, P., & Richters, A. (2011). Suffering of childless women in Bangladesh: The intersection of social identities of gender and class. *<https://doi.org/10.1080/13648470.2011.615911>* *Anthropology & Medicine*, *18*(3), 327–338.

Nangia, A. K., Likosky, D. S., & Wang, D. (2010). Distribution of male infertility specialists in relation to the male population and assisted reproductive technology centers in the United States *<https://doi.org/10.1016/j.fertnstert.2009.02.012>*. *Fertility and Sterility*, *94*(2), 599–609.

National Collaborating Centre for Women’s and Children’s Health. (2013). *Fertility: Assessment and treatment for people with fertility problems*[*<https://www.ncbi.nlm.nih.gov/books/NBK247932/>*. Royal College of Obstetricians & Gynaecologists.

National Conference of State Legislatures. (2019, June 12). *State laws related to insurance coverage for infertility treatment*. NCSL.

National Health Service. (2018, June 11). *Availability: IVF <https://www.nhs.uk/conditions/ivf/availability/>* [Government]. UK National Health Service.

National Institute for Health and Care Excellence. (2014, October 23). *NICE calls for an end to postcode lottery of IVF treatment. <https://www.nice.org.uk/news/article/nice-calls-for-an-end-to-postcode-lottery-of-ivf-treatment>* NICE.

Nazik, E., Apay, S., Özdemir, F., & Nazik, H. (2015). Traditional practices of Turkish infertile women: An example from a rural county. *Collegium Antropologicum*, *39*(1), 21–25.

Noordhuizen, S., de Graaf, P., & Sieben, I. (2010). The public acceptance of voluntary childlessness in the Netherlands: From 20 to 90 per cent in 30 years *<https://doi.org/10.1007/s11205-010-9574-y>*. *Social Indicators Research*, *99*(1), 163–181.

Nordkap, L., Jensen, T. K., Hansen, Å. M., Lassen, T. H., Bang, A. K., Joensen, U. N., Blomberg Jensen, M., Skakkebæk, N. E., & Jørgensen, N. (2016). Psychological stress and testicular function: A cross-sectional study of 1,215 Danish men *<https://doi.org/10.1016/j.fertnstert.2015.09.016>*. *Fertility and Sterility*, *105*(1), P174–P187.E1.

Nordqvist, P. (2008). Feminist heterosexual imaginaries of reproduction: Lesbian conception in feminist studies of reproductive technologies. *Feminist Theory*, *9*(3), 273–292.

Obeisat, S., Gharaibeh, M. K., Oweis, A., & Gharaibeh, H. (2012). Adversities of being infertile: The experience of Jordanian women. *Fertility and Sterility*, *98*(2), 444–449.

Obidoa, C. A., Dodor, B. A., Tackie-Ofosu, V., Obidoa, M. A., Kalisch, H. R., & Nelson, L. J. (2019). Perspectives on markers of adulthood among emerging adults in Ghana and Nigeria *<https://doi.org/10.1177/2167696818778906>*. *Emerging Adulthood*, *7*(4), 270–278.

Okonofua, F. E., Harris, D., Odebiyi, A., Kane, T., & Snow, R. C. (1997). The social meaning of infertility in Southwest Nigeria. *Health Transition Review*, *7*(2), 205–220.

Olsen, J., Juul, S., & Basso, O. (1998). Measuring time to pregnancy. Methodological issues to consider *<https://doi.org/10.1093/humrep/13.7.1751>*. *Human Reproduction*, *13*(7), 1751–1753.

Ombelet, W. (2013). The Walking Egg Project: Universal access to infertility care—from dream to reality. *Facts, Views &Vision in ObGyn*, *5*(2), 161–175.

Ombelet, W., Cooke, I., Dyer, S., Serour, G., & Devroey, P. (2008). Infertility and the provision of infertility medical services in developing countries *<https://doi.org/10.1093/humupd/dmn042>*. *Human Reproduction Update*, *14*(6), 605–621.

Ombelet, W., & Onofre, J. (2019). IVF in Africa: What is it all about? *Facts, Views & Vision in ObGyn*, *11*(1), 65–76.

Omorogbe, S. K., Obetoh, G. I., & Odion, W. E. (2010). Causes and management of domestic conflicts among couples: The Esan case *<https://doi.org/10.1080/09718923.2010.11892837>*. *Journal of Social Sciences*, *24*(1), 57–63.

Orji, E. O., Kuti, O., & Fasubaa, O. B. (2002). Impact of infertility on marital life in Nigeria. *International Journal of Gynecology & Obstetrics*, *79*(1), 61–62.

Özkan, F. S., Karaca, A., & Sarak, K. (2018). Complementary and alternative medicine used by infertile women in Turkey *<https://www.ajol.info/index.php/ajrh/article/view/175091>*. *African Journal of Reproductive Health*, *22*(2), 40–48.

Pabuçcu, R., Atay, V., Orhon, E., Urman, B., & Ergün, A. (1997). Hysteroscopic treatment of intrauterine adhesions is safe and effective in the restoration of normal menstruation and fertility *<https://doi.org/10.1016/s0015-0282(97)00375-0>*. *Fertility and Sterility*, *68*(6), 1141–1143.

Palermo, G., Joris, H., Devroey, P., & Steirteghem, A. C. V. (1992). Pregnancies after intracytoplasmic injection of single spermatozoon into an oocyte. *<https://doi.org/10.1016/0140-6736(92)92425-F>* *The Lancet*, *340*(8810), 17–18.

Pande, A. (2014). *Wombs in labor: Transnational commercial surrogacy in India*. Columbia University Press.

Pandey, S., Shetty, A., Hamilton, M., Bhattacharya, S., & Maheshwari, A. (2012). Obstetric and perinatal outcomes in singleton pregnancies resulting from IVF/ICSI: A systematic review and meta-analysis *<https://doi.org/10.1093/humupd/dms018>*. *Human Reproduction Update*, *18*(5), 485–503.

Parrott, F. R. (2014). “At the hospital I learnt the truth”: Diagnosing male infertility in rural Malawi. *Anthropology & Medicine*, *21*(2), 174–188.

Patel, N. H., Jadeja, Y. D., Bhadarka, H. K., Patel, M. N., Patel, N. H., & Sodagar, N. R. (2018). Insight into different aspects of surrogacy practices. *Journal of Human Reproductive Sciences*, *11*(3), 212–218.

Paulozzi, L. J. (1999). International trends in rates of hypospadias and cryptorchidism. *Environmental Health Perspectives*, *107*(4), 297–302.

Payne, J. B., Sundstrom, B., & DeMaria, A. L. (2016). A qualitative study of young women's beliefs about intrauterine devices: Fear of infertility *<https://doi.org/10.1111/jmwh.12425>* *Journal of Midwifery & Women's Health*, *61*(4), 482–488.

Pennings, G., de Wert, G., Shenfield, F., Cohen, J., Tarlatzis, B., & Devroey, P. (2008). ESHRE Task Force on Ethics and Law 14: Equity of access to assisted reproductive technology *<https://doi.org/10.1093/humrep/den037>*. *Human Reproduction*, *23*(4), 772–774.

Penzias, A., Bendikson, K., Butts, S., Coutifaris, C., Falcone, T., Fossum, G., . . . Vernon, M. (2017). Removal of myomas in asymptomatic patients to improve fertility and/or reduce miscarriage rate: A guideline *<https://doi.org/10.1016/j.fertnstert.2017.06.034>*. *Fertility and Sterility*, *108*(3), 416–425.

Perry, T. E., & Hirshfeld-Cytron, J. (2013). Role of complementary and alternative medicine to achieve fertility in uninsured patients *<https://doi.org/10.1097/OGX.0b013e318286f780>*. *Obstetrical & Gynecological Survey*, *68*(4), 305–311.

Peterson, B. D., Newton, C. R., & Feingold, T. (2007). Anxiety and sexual stress in men and women undergoing infertility treatment *<https://doi.org/10.1016/j.fertnstert.2006.12.023>*. *Fertility and Sterility*, *88*(4), 911–914.

Peterson, B. D., Newton, C. R., & Rosen, K. H. (2003). Examining congruence between partners' perceived infertility-related stress and its relationship to marital adjustment and depression in infertile couples. *Family Process*, *42*(1), 59–70.

Peterson, B. D., Newton, C. R., Rosen, K. H., & Schulman, R. S. (2006). Coping processes of couples experiencing infertility. *Family Relations*, *55*(2), 227–239.

Pfeifer, S., Fritz, M., McClure, R., Adamson, G., Barnhart, K., Catherino, W., . . . La Barbera, A. (2012). Multiple gestation associated with infertility therapy: An American Society for Reproductive Medicine Practice Committee opinion *<https://doi.org/10.1016/j.fertnstert.2011.11.048>*. *Fertility and Sterility*, *97*(4), 825–834.

Pinborg, A. (2005). IVF/ICSI twin pregnancies: Risks and prevention *<https://doi.org/10.1093/humupd/dmi027>*. *Human Reproduction Update*, *11*(6), 575–593.

Pinheiro, R. L., Areia, A. L., Mota Pinto, A., & Donato, H. (2019). Advanced maternal age: Adverse outcomes of pregnancy, a meta-analysis *<https://doi.org/10.20344/amp.11057>*. *Acta Medica Portuguesa*, *32*(3), 219–226.

Polis, C. B., Cox, C. M., Tunçalp, Ö., McLain, A. C., & Thoma, M. E. (2017). Estimating infertility prevalence in low-to-middle-income countries: An application of a current duration approach to demographic and health survey data. *Human Reproduction*, *32*(5), 1064–1074.

Polis, C. B., & Zabin, L. S. (2012). Missed conceptions or misconceptions: Perceived infertility among unmarried young adults in the United States. *Perspectives on Sexual and Reproductive Health*, *44*(1), 30–38.

Practice Committee of the American Society for Reproductive Medicine. (2013). Definitions of infertility and recurrent pregnancy loss: A committee opinion *<https://doi.org/10.1016/j.fertnstert.2012.09.023>*. *Fertility and Sterility*, *99*(1), 63.

Practice Committee of the American Society for Reproductive Medicine. (2015a). Diagnostic evaluation of the infertile female: A committee opinion *<https://doi.org/10.1016/j.fertnstert.2015.03.019>*. *Fertility and Sterility*, *103*(6), e44–e50.

Practice Committee of the American Society for Reproductive Medicine. (2015b). Obesity and reproduction: A committee opinion *<https://doi.org/10.1016/j.fertnstert.2015.08.018>*. *Fertility and Sterility*, *104*(5), 1116–1126.

Practice Committee of the American Society for Reproductive Medicine. (2018). Management of nonobstructive azoospermia: A committee opinion *<https://doi.org/10.1016/j.fertnstert.2018.09.012>*. *Fertility and Sterility*, *110*(7), 1239–1245.

Practice Committee of the American Society for Reproductive Medicine in Collaboration with the Society for Male Reproduction and Urology. (2019). The management of obstructive azoospermia: A committee opinion *<https://doi.org/10.1016/j.fertnstert.2019.02.013>*. *Fertility and Sterility*, *111*(5), 873–880.

Qin, J.-B., Sheng, X.-Q., Wu, D., Gao, S.-Y., You, Y.-P., Yang, T.-B., & Wang, H. (2017). Worldwide prevalence of adverse pregnancy outcomes among singleton pregnancies after in vitro fertilization/intracytoplasmic sperm injection: A systematic review and meta-analysis *<https://doi.org/10.1007/s00404-016-4250-3>*. *Archives of Gynecology and Obstetrics*, *295*(2), 285–301.

Raine, T., Minnis, A. M., & Padian, N. S. (2003). Determinants of contraceptive method among young women at risk for unintended pregnancy and sexually transmitted infections *<https://doi.org/10.1016/s0010-7824(03)00107-0>*. *Contraception*, *68*(1), 19–25.

Rainey, D. Y., Stevens-Simon, C., & Kaplan, D. W. (1993). Self-perception of infertility among female adolescents. *American Journal of Diseases of Children (1960)*, *147*(10), 1053–1056.

Ramezanzadeh, F., Aghssa, M. M., Jafarabadi, M., & Zayeri, F. (2006). Alterations of sexual desire and satisfaction in male partners of infertile couples *<https://doi.org/10.1016/j.fertnstert.2005.07.1285>*. *Fertility and Sterility*, *85*(1), 139–143.

Randall, A. K., & Bodenmann, G. (2009). The role of stress on close relationships and marital satisfaction *<https://doi.org/10.1016/j.cpr.2008.10.004>*. *Clinical Psychology Review*, *29*(2), 105–115.

Ray, A., Shah, A., Gudi, A., & Homburg, R. (2012). Unexplained infertility: An update and review of practice *<https://doi.org/10.1016/j.rbmo.2012.02.021>*. *Reproductive BioMedicine Online*, *24*(6), 591–602.

Rayner, J.-A., Willis, K., & Burgess, R. (2011). Women's use of complementary and alternative medicine for fertility enhancement: A review of the literature *<https://doi.org/10.1089/acm.2010.0435>*. *The Journal of Alternative and Complementary Medicine*, *17*(8), 685–690.

Read, S. C., Carrier, M.-E., Whitley, R., Gold, I., Tulandi, T., & Zelkowitz, P. (2014). Complementary and alternative medicine use in infertility: Cultural and religious influences in a multicultural Canadian setting <https://doi.org/10.1089/acm.2013.0329>. *The Journal of Alternative and Complementary Medicine*, *20*(9), 686–692.

Remennick, L. (2000). Childless in the land of imperative motherhood: Stigma and coping among infertile Israeli women <https://doi.org/10.1023/A:1011084821700>. *Sex Roles*, *43*(11), 821–841.

Riezzo, I., Neri, M., Bello, S., Pomara, C., & Turillazzi, E. (2016). Italian law on medically assisted reproduction: Do women's autonomy and health matter? <https://doi.org/10.1186/s12905-016-0324-4>. *BMC Women's Health*, *16*, Article 44.

Rizzuto, I., Behrens, R. F., & Smith, L. A. (2019). Risk of ovarian cancer in women treated with ovarian stimulating drugs for infertility <https://doi.org/10.1002/14651858.CD008215.pub3>. *The Cochrane Database of Systematic Reviews*, *6*, Article CD008215.

Rouchou, B. (2013). Consequences of infertility in developing countries <https://doi.org/10.1177/1757913912472415>. *Perspectives in Public Health*, *133*(3), 174–179.

Rumbold, A. R., Moore, V. M., Whitrow, M. J., Oswald, T. K., Moran, L. J., Fernandez, R. C., Barnhart, K. T., & Davies, M. J. (2017). The impact of specific fertility treatments on cognitive development in childhood and adolescence: A systematic review <https://doi.org/10.1093/humrep/dex085>. *Human Reproduction*, *32*(7), 1489–1507.

Rutstein, S. O., & Shah, I. H. (2004). *Infecundity, infertility, and childlessness in developing countries* (DHS Comparative Reports No. 9). ORC Macro and the World Health Organization.

Sallam, H. N., & Sallam, N. H. (2016). Religious aspects of assisted reproduction. *Facts, Views & Vision in ObGyn*, *8*(1), 33–48.

Sapra, K. J., Barr, D. B., Maisog, J. M., Sundaram, R., & Buck Louis, G. M. (2016). Time-to-pregnancy associated with couples' use of tobacco products <https://doi.org/10.1093/ntr/ntw132>. *Nicotine & Tobacco Research*, *18*(11), 2154–2161.

Sarkar, S., & Gupta, P. (2016). Socio-demographic correlates of women's infertility and treatment seeking behavior in India. *Journal of Reproduction and Infertility*, *17*(2), 123–132.

Sartorius, G. A., & Nieschlag, E. (2010). Paternal age and reproduction <https://doi.org/10.1093/humupd/dmp027>. *Human Reproduction Update*, *16*(1), 65–79.

Saso, S., Louis, L. S., Doctor, F., Hamed, A. H., Chatterjee, J., Yazbek, J., Bora, S., Abdalla, H., Ghaem-Maghami, S., & Thum, M.-Y. (2015). Does fertility treatment increase the risk of uterine cancer? A meta-analysis <https://doi.org/10.1016/j.ejogrb.2015.09.002>. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *195*, 52–60.

Scheike, T. H., & Keiding, N. (2006). Design and analysis of time-to-pregnancy <https://doi.org/10.1191/0962280206sm435oa>. *Statistical Methods in Medical Research*, *15*(2), 127–140.

Scheike, T. H., Rylander, L., Carstensen, L., Keiding, N., Jensen, T. K., Stromberg, U., Joffe, M., & Akre, O. (2008). Time trends in human fecundability in Sweden <https://doi.org/10.1097/EDE.0b013e31816334ad>. *Epidemiology*, *19*(2), 191–196.

Schmidt, L. (2006). Psychosocial burden of infertility and assisted reproduction. *The Lancet*, *367*(9508), 379–380.

Schmidt, L., Holstein, B. E., Boivin, J., Tjørnhøj-Thomsen, T., Blaabjerg, J., Hald, F., Rasmussen, P. E., & Nyboe Andersen, A. (2003). High ratings of satisfaction with fertility treatment are common: Findings from the Copenhagen Multi-Centre Psychosocial Infertility (COMPI) Research Programme <https://doi.org/10.1093/humrep/deg505>. *Human Reproduction*, *18*(12), 2638–2646.

Schmidt, L., Holstein, B., Christensen, U., & Boivin, J. (2005). Does infertility cause marital benefit? An epidemiological study of 2250 women and men in fertility treatment. *Patient Education and Counseling*, *59*(3), 244–251.

Schmidt, L., & Münster, K. (1995). Infertility, involuntary infecundity, and the seeking of medical advice in industrialized countries 1970–1992: A review of concepts, measurements and results <https://doi.org/10.1093/HUMREP/10.6.1407>. *Human Reproduction*, *10*(6), 1407–1418.

Schwarzer, J. U., & Steinfatt, H. (2013). Current status of vasectomy reversal <https://doi.org/10.1093/HUMREP/10.6.1407>. *Nature Reviews Urology*, *10*(4), 195–205.

Schwerdtfeger, K. L., & Shreffler, K. M. (2009). Trauma of pregnancy loss and infertility among mothers and involuntarily childless women in the United States <https://doi.org/10.1080/15325020802537468>. *Journal of Loss and Trauma*, *14*(3), 211–227.

Sciorio, R., & Esteves, S. C. (2020). Clinical utility of freeze-all approach in ART treatment: A mini-review <https://doi.org/10.1016/j.cryobiol.2019.11.041>. *Cryobiology*, *92*, 9–14.

Sermondade, N., Faure, C., Fezeu, L., Shayeb, A. G., Bonde, J. P., Jensen, T. K. ,. . . Czernichow, S. (2013). BMI in relation to sperm count: An updated systematic review and collaborative meta-analysis <https://doi.org/10.1093/humupd/dms050>. *Human Reproduction Update*, *19*(3), 221–231.

Serrano, T., Chevrier, C., Multigner, L., Cordier, S., & Jégou, B. (2013). International geographic correlation study of the prevalence of disorders of male reproductive health <https://doi.org/10.1093/humrep/det111>. *Human Reproduction*, *28*(7), 1974–1986.

Shandley, L. M., Hipp, H. S., Anderson-Bialis, J., Anderson-Bialis, D., Boulet, S. L., McKenzie, L. J., & Kawwass, J. F. (2020). Patient-centered care: Factors associated with reporting a positive experience at United States fertility clinics <https://doi.org/10.1016/j.fertnstert.2019.12.040>. *Fertility and Sterility*, *113*(4), 797–810.

Sharma, S., Mittal, S., & Aggarwal, P. (2009). Management of infertility in low resource countries <https://doi.org/10.1111/j.1471-0528.2009.02311.x>. *BJOG: An International Journal of Obstetrics & Gynaecology*, *116*(S1), 77–83.

Shi, Y., Sun, Y., Hao, C., Zhang, H., Wei, D., Zhang, Y., . . . Chen, Z.-J. (2018). Transfer of fresh versus frozen embryos in ovulatory women <https://doi.org/10.1056/NEJMoa1705334>. *The New England Journal of Medicine*, *378*(2), 126–136.

Sikka, S. C., & Wang, R. (2008). Endocrine disruptors and estrogenic effects on male reproductive axis <https://doi.org/10.1111/j.1745-7262.2008.00370.x>. *Asian Journal of Andrology*, *10*(1), 134–145.

Simopoulou, M., Sfakianoudis, K., Giannelou, P., Pierouli, A., Rapani, A., . . . Koutsilieris, M. (2019). Treating infertility: Current affairs of cross-border reproductive care <https://doi.org/10.1515/med-2019-0026>. *Open Medicine*, *14*, 292–299.

Singh, H. D. (2014). “The world’s back womb?”: Commercial surrogacy and infertility inequalities in India. *American Anthropologist*, *116*(4), 824–828.

Singh, H. D. (2017). Fertility control: Reproductive desires, kin work, and women’s status in contemporary India. *Medical Anthropology Quarterly*, *31*(1), 23–39.

Singh, H. D. (2020). Numbering others: Religious demography, identity, and fertility management experiences in contemporary India. *Social Science & Medicine*, *25*, Article 112534.

Singh, N., Sumana, G., & Mittal, S. (2008). Genital tuberculosis: A leading cause for infertility in women seeking assisted conception in North India <https://doi.org/10.1007/s00404-008-0590-y>. *Archives of Gynecology and Obstetrics*, *278*(4), 325–327.

Skakkebaek, N. E. (2017). Sperm counts, testicular cancers, and the environment <https://doi.org/10.1136/bmj.j4517>. *BMJ*, *359*, Article j4517.

Skakkebaek, N. E., Rajpert-De Meyts, E., Buck Louis, G. M., Toppari, J., Andersson, A.-M., . . . Juul, A. (2015). Male reproductive disorders and fertility trends: Influences of environment and genetic susceptibility <https://doi.org/10.1152/physrev.00017.2015>. *Physiological Reviews*, *96*(1), 55–97.

Skalkidou, A., Sergentanis, T. N., Gialamas, S. P., Georgakis, M. K., Psaltopoulou, T., Trivella, M., Siristatidis, C. S., Evangelou, E., & Petridou, E. (2017). Risk of endometrial cancer in women treated with ovary-stimulating drugs for subfertility <https://doi.org/10.1002/14651858.CD010931.pub2>. *The Cochrane Database of Systematic Reviews*, *3*, Article CD010931.

Slade, P., O’Neill, C., Simpson, A. J., & Lashen, H. (2007). The relationship between perceived stigma, disclosure patterns, support and distress in new attendees at an infertility clinic <https://doi.org/10.1093/humrep/dem115>. *Human Reproduction*, *22*(8), 2309–2317.

Slama, R., Ballester, F., Casas, M., Cordier, S., Eggesbø, M., Iniguez, C., . . . Vrijheid, M. (2014). Epidemiologic tools to study the influence of environmental factors on fecundity and pregnancy-related outcomes <https://doi.org/10.1093/epirev/mxt011>. *Epidemiologic Reviews*, *36*(1), 148–164.

Slama, R., Ducot, B., Carstensen, L., Lorente, C., de La Rochebrochard, E., Leridon, H., Keiding, N., & Bouyer, J. (2006). Feasibility of the current-duration approach to studying human fecundity <https://doi.org/10.1097/01.ede.0000221781.15114.88>. *Epidemiology*, *17*(4), 440–449.

Slama, R., Hansen, O. K. H., Ducot, B., Bohet, A., Sorensen, D., Giorgis Allemand, L., . . . Bouyer, J. (2012). Estimation of the frequency of involuntary infertility on a nation-wide basis <https://doi.org/10.1093/humrep/des070>. *Human Reproduction*, *27*(5), 1489–1498.

Slauson-Blevins, K., & Johnson, K. (2016). Doing gender, doing surveys? Women’s gatekeeping and men’s non-participation in multi-actor reproductive surveys <https://doi.org/10.1111/soin.12122>. *Sociological Inquiry*, *86*(3), 427–449.

Smarr, M. M., Sapra, K. J., Gemmill, A., Kahn, L. G., Wise, L. A., Lynch, C. D., . . . Buck Louis, G. M. (2017). Is human fecundity changing? A discussion of research and data gaps precluding us from having an answer <https://doi.org/10.1093/humrep/dew361>. *Human Reproduction*, *32*(3), 499–504.

Smith, S., Pfeifer, S. M., & Collins, J. A. (2003). Diagnosis and management of female infertility <https://doi.org/10.1001/jama.290.13.1767>. *JAMA*, *290*(13), 1767–1770.

Stabile, B. (2016). Reproductive policy and the social construction of motherhood <https://doi.org/10.1017/pls.2016.15>. *Politics and the Life Sciences*, *35*(2), 18–29.

Starrs, A. M., Ezeh, A. C., Barker, G., Basu, A., Bertrand, J. T., Blum, R., . . . Ashford, L. S. (2018). Accelerate progress—sexual and reproductive health and rights for all: Report of the Guttmacher– Lancet Commission <https://doi.org/10.1016/S0140-6736(18)30293-9>. *The Lancet*, *391*(10140), 2642–2692.

Stellar, C., Garcia-Moreno, C., Temmerman, M., & van der Poel, S. (2016). A systematic review and narrative report of the relationship between infertility, subfertility, and intimate partner violence. *International Journal of Gynecology & Obstetrics*, *133*(1), 3–8.

Stephen, E. H., & Chandra, A. (2006). Declining estimates of infertility in the United States: 1982–2002 <https://doi.org/10.1016/j.fertnstert.2006.02.129>. *Fertility and Sterility*, *86*(3), 516–523.

Stevenson, E. L., Hershberger, P. E., & Bergh, P. A. (2016). Evidence-based care for couples with infertility <https://doi.org/10.1016/j.jogn.2015.10.006>. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, *45*, 100–110.

Stewart, E. A., Cookson, C. L., Gandolfo, R. A., & Schulze-Rath, R. (2017). Epidemiology of uterine fibroids: A systematic review <https://doi.org/10.1111/1471-0528.14640>. *BJOG: An International Journal of Obstetrics & Gynaecology*, *124*(10), 1501–1512.

Stewart, L. M., & Hart, R. (2015). Long-term cancer risks in women after treatment with IVF: Do we have any answers yet? <https://doi.org/10.2217/WHE.14.58>. *Women's Health*, *11*(1), 7–10.

Sundby, J. (1997). Infertility in the Gambia: Traditional and modern health care <https://doi.org/10.1016/S0738-3991(97)01006-9>. *Patient Education and Counseling*, *31*(1), 29–37.

Sunderam, S., Kissin, D. M., Crawford, S. B., Folger, S. G., Boulet, S. L., Warner, L., & Barfield, W. D. (2018). Assisted reproductive technology surveillance—United States, 2015 <https://doi.org/10.15585/mmwr.ss6703a1>. *Morbidity and Mortality Weekly Report Surveillance Summaries*, *67*(3), 1–28.

Swan, S. H., Elkin, E. P., & Fenster, L. (2000). The question of declining sperm density revisited: An analysis of 101 studies published 1934–1996. *Environmental Health Perspectives*, *108*(10), 961–966.

Tarín, J. J., García-Pérez, M. A., Hamatani, T., & Cano, A. (2015). Infertility etiologies are genetically and clinically linked with other diseases in single meta-diseases <https://doi.org/10.1186/s12958-015-0029-9>. *Reproductive Biology and Endocrinology*, *13*(1), 31.

te Velde, E. R., Eijkemans, R., & Habbema, H. D. (2000). Variation in couple fecundity and time to pregnancy, an essential concept in human reproduction <https://doi.org/10.1016/s0140-6736(00)02320-5>. *Lancet*, *355*(9219), 1928–1929.

Teede, H. J., Misso, M. L., Costello, M. F., Dokras, A., Laven, J., Moran, L., Piltonen, T., & Norman, R. J. (2018). Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome <https://doi.org/10.1016/j.fertnstert.2018.05.004>. *Fertility and Sterility*, *110*(3), 364–379.

ten Broek, R. P. G., Issa, Y., van Santbrink, E. J. P., Bouvy, N. D., Kruitwagen, R. F. P. M., Jeekel, J., Bakkum, E. A., Rovers, M. M., & van Goor, H. (2013). Burden of adhesions in abdominal and pelvic surgery: Systematic review and meta-analysis <https://doi.org/10.1136/bmj.f5588>. *British Medical Journal*, *347*, Article f5588.

The Walking Egg. (2017, August 8). First tWE baby in Ghana <https://thewalkingegg.com/news/20170810/first-twe-baby-in-ghana>. *The Walking Egg*.

The Walking Egg. (2019). The Walking Egg <https://thewalkingegg.com/the-project>. *The Walking Egg*.

Thoma, M. E. (2015). Measuring infertility: Searching for consensus <https://doi.org/10.1089/jwh.2015.5399>. *Journal of Women's Health*, *24*(7), 541–543.

Thoma, M. E., McLain, A. C., Louis, J. F., King, R. B., Trumble, A. C., Sundaram, R., & Buck Louis, G. M. (2013). Prevalence of infertility in the United States as estimated by the current duration approach and a traditional constructed approach. *Fertility and Sterility*, *99*(5), 1324–1331.

Thonneau, P., Marchand, S., Tallec, A., Ferial, M. L., Ducot, B., Lansac, J., Lopes, P., Tabaste, J. M., & Spira, A. (1991). Incidence and main causes of infertility in a resident population (1,850,000) of three French regions (1988–1989) <https://doi.org/10.1093/oxfordjournals.humrep.a137433>. *Human Reproduction*, *6*(6), 811–816.

Thurston, L., Abbara, A., & Dhillo, W. S. (2019). Investigation and management of subfertility <https://doi.org/10.1136/jclinpath-2018-205579>. *Journal of Clinical Pathology*, *72*(9), 579–587.

Torres, G., Shapiro, A., & Mackey, T. K. (2019). A review of surrogate motherhood regulation in south American countries: Pointing to a need for an international legal framework <https://doi.org/10.1186/s12884-019-2182-1>. *BMC Pregnancy and Childbirth*, *19*(1), 46.

Trabert, B., Chen, J., Devesa, S. S., Bray, F., & McGlynn, K. A. (2015). International patterns and trends in testicular cancer incidence, overall and by histologic subtype, 1973–2007 <https://doi.org/10.1111/andr.293>. *Andrology*, *3*(1), 4–12.

Turkgeldi, E., Yagmur, H., Seyhan, A., Urman, B., & Ata, B. (2016). Short and long term outcomes of children conceived with assisted reproductive technology <https://doi.org/10.1016/j.ejogrb.2016.10.010>. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *207*, P129–P136.

United States Agency for International Development. (n.d.). *DHS overview*. Demographic & Health Surveys <https://www.dhsprogram.com/What-We-Do/Survey-Types/DHS.cfm>.

United States Agency for International Development. (2015, October). *DHS Model Questionnaire-Phase 7 (English, French) <https://dhsprogram.com/publications/publication-dhsq7-dhs-questionnaires-and-manuals.cfm>*. Demographic & Health Surveys.

Unnithan, M. (2010). Learning from infertility: Gender, health inequities and faith healers in women's experiences of disrupted reproduction in Rajasthan *<https://doi.org/10.1080/19472491003593068>*. *South Asian History and Culture*, *1*(2), 315–327.

Valerie, U., De Brucker, S., De Brucker, M., Vloeberghs, V., Drakopoulos, P., Santos-Ribeiro, S., & Tournaye, H. (2018). Pregnancy after vasectomy: Surgical reversal or assisted reproduction? *<https://doi.org/10.1093/humrep/dey101>* *Human Reproduction*, *33*(7), 1218–1227.

van Balen, F., & Gerrits, T. (2001). Quality of infertility care in poor-resource areas and the introduction of new reproductive technologies. *Human Reproduction*, *16*(2), 215–219.

Van Blerkom, J., Ombelet, W., Klerkx, E., Janssen, M., Dhont, N., Nargund, G., & Campo, R. (2014). First births with a simplified culture system for clinical IVF and embryo transfer *<https://doi.org/10.1016/j.rbmo.2013.11.012>*. *Reproductive BioMedicine Online*, *28*(3), 310–320.

van der Poel, S. Z. (2012). Historical walk: The HRP special programme and infertility *<https://doi.org/10.1159/000343058>*. *Gynecologic and Obstetric Investigation*, *74*(3), 218–227.

van Empel, I. W. H., Aarts, J. W. M., Cohlen, B. J., Huppelschoten, D. A., Laven, J. S. E., Nelen, W. L. D. M., & Kremer, J. A. M. (2010). Measuring patient-centredness, the neglected outcome in fertility care: A random multicentre validation study *<https://doi.org/10.1093/humrep/deq219>*. *Human Reproduction*, *25*(10), 2516–2526.

van Empel, I. W. H., Nelen, W. L. D. M., Tepe, E. T., van Laarhoven, E. A. P., Verhaak, C. M., & Kremer, J. A. M. (2010). Weaknesses, strengths and needs in fertility care according to patients. *Human Reproduction*, *25*(1), 142–149.

Vuong, L. N., Dang, V. Q., Ho, T. M., Huynh, B. G., Ha, D. T., Pham, T. D., Nguyen, L. K., Norman, R. J., & Mol, B. W. (2018). IVF transfer of fresh or frozen embryos in women without polycystic ovaries *<https://doi.org/10.1056/NEJMoa1703768>*. *The New England Journal of Medicine*, *378*(2), 137–147.

Wahlberg, A. (2010). Assessing vitality: Infertility and good life in urban China. In J. Yorke (Ed.), *The right to life and the value of life: Orientations in law, politics and ethics* (pp. 371–398). Routledge.

Wang, J., & Sauer, M. V. (2006). In vitro fertilization (IVF): A review of 3 decades of clinical innovation and technological advancement *<https://doi.org/10.2147/tcrm.2006.2.4.355>*. *Therapeutics and Clinical Risk Management*, *2*(4), 355–364.

Wang, R., Danhof, N. A., Tjon-Kon-Fat, R. I., Eijkemans, M. J., Bossuyt, P. M., Mochtar, M. H., . . . van Wely, M. (2019). Interventions for unexplained infertility: A systematic review and network meta-analysis *<https://doi.org/10.1002/14651858.CD012692.pub2>*. *Cochrane Database of Systematic Reviews*, Article CD012692.

Weaver, S. M., Clifford, E., Hay, D. M., & Robinson, J. (1997). Psychosocial adjustment to unsuccessful IVF and GIFT treatment <https://doi.org/10.1016/S0738-3991(97)01005-7>. *Patient Education and Counseling*, *31*(1), 7–18.

Weinberg, C. R., & Gladen, B. C. (1986). The beta-geometric distribution applied to comparative fecundability studies <https://doi.org/10.2307/2531205>. *Biometrics*, *42*(3), 547–560.

Weiss, D. A., Harris, C. R., & Smith, J. F. (2011). The use of complementary and alternative fertility treatments <https://doi.org/10.1097/GCO.0b013e3283455246>. *Current Opinion in Obstetrics and Gynecology*, *23*, 195–199.

Weström, L. V. (1994). Sexually transmitted diseases and infertility. *Sexually Transmitted Diseases*, *21*(S2), S32–S37.

Weström, L. V., Joesoef, R., Reynolds, G., Hagdu, A., & Thompson, S. E. (1992). Pelvic inflammatory disease and fertility. A cohort study of 1,844 women with laparoscopically verified disease and 657 control women with normal laparoscopic results. *Sexually Transmitted Diseases*, *19*(4), 185–192.

Wheeler, K. M., Sharma, D., Kavoussi, P. K., Smith, R. P., & Costabile, R. (2019). Clomiphene citrate for the treatment of hypogonadism <https://doi.org/10.1016/j.sxmr.2018.10.001>. *Sexual Medicine Reviews*, *7*(2), 272–276.

White, L., McQuillan, J., & Greil, A. L. (2006). Explaining disparities in treatment seeking: The case of infertility <https://doi.org/10.1016/j.fertnstert.2005.11.039>. *Fertility and Sterility*, *85*(4), 853–857.

Widge, A., & Cleland, J. (2009). The public sector's role in infertility management in India <https://doi.org/10.1093/heapol/czn053>. *Health Policy and Planning*, *24*(2), 108–115.

Wikland, M., Enk, L., & Hamberger, L. (1985). Transvesical and transvaginal approaches for the aspiration of follicles by use of ultrasound <https://doi.org/10.1111/j.1749-6632.1985.tb37519.x>. *Annals of the New York Academy of Sciences*, *442*(1), 182–194.

Wilkinson, S. E., & Callister, L. C. (2010). Giving birth: The voices of Ghanaian women. *Health Care for Women International*, *31*(3), 201–220.

Wise, L. A., Palmer, J. R., & Rosenberg, L. (2013). Body size and time-to-pregnancy in black women <https://doi.org/10.1093/humrep/det333>. *Human Reproduction*, *28*(10), 2856–2864.

Wise, L. A., Wesselink, A. K., Hatch, E. E., Rothman, K. J., Mikkelsen, E. M., Sørensen, H. T., & Mahalingaiah, S. (2018). Marijuana use and fecundability in a North American preconception cohort study <https://doi.org/10.1136/jech-2017-209755>. *Journal of Epidemiology and Community Health*, *72*(3), 208–215.

Wood, J. W. (1989). Fecundity and natural fertility in humans. *Oxford Reviews of Reproductive Biology*, *11*, 61–109.

World Health Organization. (n.d.). *Infertility/subfertility: Controversies and innovative solutions* <https://www.who.int/reproductivehealth/topics/infertility/guidelines/en/>. WHO.

World Health Organization. (n.d.). *Infertility is a global public health issue <http://www.who.int/reproductivehealth/topics/infertility/perspective/en/>*. WHO.

World Health Organization. (1992). *Recent advances in medically assisted conception <https://apps.who.int/iris/handle/10665/38679>*. WHO.

World Health Organization. (2010a). Mother or nothing: The agony of infertility *<https://www.who.int/news-room/fact-sheets/detail/infertility>*. *Bulletin of the World Health Organization*, *88*, 881–882.

World Health Organization. (2010b). *WHO laboratory manual for the examination and processing of human semen*. WHO.

World Health Organization. (2020). *Infertility*. WHO.

Wu, A. K., Elliott, P., Katz, P. P., & Smith, J. F. (2013). Time costs of fertility care: The hidden hardship of building a family *<https://doi.org/10.1016/j.fertnstert.2013.01.145>*. *Fertility and Sterility*, *99*(7), 2025–2030.

Yang, Y., & Huang, Y. (2019). The CRIPSR/Cas gene-editing system—an immature but useful toolkit for experimental and clinical medicine *<https://doi.org/10.1002/ame2.12061>*. *Animal Models and Experimental Medicine*, *2*(1), 5–8.

Yao, H., Chan, C. H. Y., & Chan, C. L. W. (2018). Childbearing importance: A qualitative study of women with infertility in China *<https://doi.org/10.1002/nur.21846>*. *Research in Nursing & Health*, *41*(1), 69–77.

Yeung, E. H., Kim, K., Purdue-Smithe, A., Bell, G., Zolton, J., Ghassabian, A., Vafai, Y., Robinson, S. L., & Mumford, S. L. (2018). Child health: Is it really assisted reproductive technology that we need to be concerned about? *<https://doi.org/10.1055/s-0038-1675778>*. *Seminars in Reproductive Medicine*, *36*(3/4), 183–194.

Yildizhan, R., Adali, E., Kolusari, A., Kurdoglu, M., Yildizhan, B., & Sahin, G. (2009). Domestic violence against infertile women in a Turkish setting *<https://doi.org/10.1016/j.ijgo.2008.10.007>*. *International Journal of Gynecology & Obstetrics*, *104*(2), 110–112.

Ying, L. Y., Wu, L. H., & Loke, A. Y. (2015). Gender differences in experiences with and adjustments to infertility: A literature review *<https://doi.org/10.1016/j.ijnurstu.2015.05.004>*. *International Journal of Nursing Studies*, *52*(10), 1640–1652.

Zegers-Hochschild, F., Adamson, G. D., Dyer, S., Racowsky, C., de Mouzon, J., Sokol, R., . . . van der Poel, S. (2017). The international glossary on infertility and fertility care, 2017 *<https://doi.org/10.1016/j.fertnstert.2017.06.005>*. *Fertility and Sterility*, *108*(3), 393–406.

Zegers-Hochschild, F., Schwarze, J. E., Crosby, J. A., Musri, C., & Urbina, M. T. (2019). Assisted reproductive techniques in Latin America: The Latin American registry, 2016 *<https://doi.org/10.5935/1518-0557.20190037>*. *JBRA Assisted Reproduction*, *23*(3), 255–267.

Zepiridis, L. I., Grimbizis, G. F., & Tarlatzis, B. C. (2016). Infertility and uterine fibroids *<https://doi.org/10.1016/j.bpobgyn.2015.12.001>*. *Best Practice & Research: Clinical Obstetrics & Gynaecology*, *34*, 66–73.

Znaor, A., Lortet-Tieulent, J., Jemal, A., & Bray, F. (2014). International variations and trends in testicular cancer incidence and mortality <https://doi.org/10.1016/j.eururo.2013.11.004>. *European Urology*, *65*(6), 1095–1106.

Notes

1. See Fledderjohann and Barnes (2018) and Fledderjohann and Roberts (2018) for a more comprehensive overview of how instrument design choices in extant survey data serve to render invisible the reproductive needs of some groups.

2. Refers to the hypothalamus, pituitary gland, and the gonadal glands as a single entity that controls development and regulation of the reproductive and immune systems.

3. Oligo-ovulation is a condition that causes irregular or infrequent periods. Anovulation is when the ovaries do not release an oocyte during a menstrual cycle.

4. A genetic condition that results when a boy is born with an extra X chromosome.

5. Near the uterus, ovaries, fallopian tubes, and the connecting tissues.

6. HSG is an X-ray procedure used to see whether the fallopian tubes are patent (open) and if the inside of the uterus is normal; HyCOSy is a noninvasive technique using a slow infusion of sterile saline into the uterine cavity during ultrasound imaging.

7. Septate uterus is a congenital uterine anomaly in which a thin membrane, called a septum, divides the uterus either partially or completely.

8. The term “gestational carrier” has replaced the term “surrogate” according to the International Glossary on Infertility and Fertility Care, 2017 (Zegers-Hochschild et al., 2017). Gestational carrier is defined as “a woman who carries a pregnancy with an agreement that she will give the offspring to the intended parent(s). Gametes can originate from the intended parent(s) and/or a third party or parties.”

9. Duchenne muscular dystrophy is a genetic disorder characterized by progressive muscle degeneration and weakness due to the alterations of a protein called dystrophin that helps keep muscle cells intact.

Related Articles

Sexual and Reproductive Health in India

Male Reproductive Function and Fecundity