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Perceptions and experiences of (in)fertility, contraception, and reproductive health outcomes: A mixed methods study among women and men in Malawi

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Perceptions and experiences of (in)fertility, contraception, and reproductive health outcomes: A mixed methods study among women and men in Malawi

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by

Marta J Bornstein

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ABSTRACT OF THE DISSERTATION

Perceptions and experiences of (in)fertility, contraception, and reproductive health outcomes: A mixed methods study among women and men in Malawi

By

Marta J Bornstein

Doctor of Philosophy in Community Health Sciences

University of California Los Angeles, 2021

Professor Jessica D. Gipson, Chair

Globally, more than 180 million people experience infertility, the condition of being unable to conceive a pregnancy within 1-2 years of attempting to do so (Inhorn & Patrizio, 2015). In Malawi, a small country in south-eastern Africa, approximately 20% of women reported experiencing difficulty becoming pregnant or infertility in studies conducted in 2005 and 2014-2015 (Barden-O'Fallon, 2005b; Rao et al., 2017). At the same time, 40% of pregnancies in Malawi are considered unintended (National Statistics Office (NSO) [Malawi] and ICF, 2017).

This dissertation uses a hybrid exploratory-explanatory mixed methods study design. The first study uses qualitative in-depth interview data from the *Umoyo Wa Thanzi* (UTHA) research program in a rural area of Central Malawi, and the second and third studies use quantitative cross-sectional and longitudinal survey data from the same population. Together, the three

studies explore how infertility and perceived fecundity influence how women make reproductive decisions with their current and future fertility desires in mind. The three studies provide insight into how perceptions of fecundity (ability to become pregnant) and experiences of infertility (not conceiving a pregnancy after two or more years of trying), influence women's contraceptive use, incidence of a subsequent pregnancies, and pregnancy planning/intention.

The first study, which analyzed 20 in-depth interviews from women in the UTHA cohort, showed how women's perceptions of fecundity and experiences of infertility influenced not only *whether* she used contraception or not, but *how* she used contraception in an effort to manage her fertility. The second study explored the association between ever experiencing infertility, perceived certainty of pregnancy, and contraceptive use. Women who reported ever experiencing infertility had 44% lower odds of current contraceptive use than women who did not report infertility (AOR: 0.56; 95% CI: 0.39-0.83). Women who reported 'no chance/unlikely' that they would become pregnant within one year of not using contraception had 70% lower odds of contraceptive use compared to women who were 'certain' they would become pregnant within a year (AOR: 0.30; 95% CI: 0.10-0.92).

These findings led to the third study, which explored associations between ever experiencing infertility at Wave 1 (2014-15) and reporting a subsequent pregnancy by the final wave of data collection in 2019. In this study, women's reports of ever experiencing infertility did not have a significant relationship with reporting a subsequent pregnancy (AOR: 0.89; $p>0.05$). Additionally, there were no statistically significant differences in retrospective pregnancy planning/intentions between women who did and did not report ever experiencing infertility ($p>0.05$). Together, the three studies reveal the importance of perceptions and experiences of fecundity and infertility in influencing women's reproductive decisions.

The dissertation of Marta J Bornstein is approved.

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Chapter 1: Introduction

Globally, more than 180 million people experience infertility, the condition of being unable to conceive a pregnancy within 1-2 years of attempting to do so (Inhorn & Patrizio, 2015). Although estimates vary, sub-Saharan Africa is consistently cited as having one of the highest rates of both primary infertility (the inability to conceive a first pregnancy) and secondary infertility (the inability to conceive a second or higher-order pregnancy) world-wide (Boivin et al., 2007; Inhorn & Patrizio, 2015; Sharma et al., 2009). Two studies in different regions of Malawi found that approximately 20% of women reported experiencing infertility (Barden-O'Fallon, 2005b; Rao et al., 2017). Consequences associated with infertility, including depression, intimate partner violence, and social exclusion, have been documented by previous studies (Starrs et al., 2018).

The Programme of Action from the 1994 International Conference on Population and Development (ICPD) underscored the importance of addressing infertility to achieve optimal health and human rights (Lane, 1994); however, infertility has not been prioritized in public health. Increasingly, however, integrating fertility and infertility research is recognized as critical to understanding both issues and to the fulfillment of individuals' reproductive desires and well-being (Gipson et al., 2020; K. M. Johnson et al., 2018). Recently, the Lancet-Guttmacher Commission on Sexual and Reproductive Health and Rights emphasized the continuing need to focus on infertility as a public health issue (Starrs et al., 2018).

Developing greater understanding and identifying ways to manage infertility across global settings is integral to achieving global development and public health goals. Holistically addressing the reproductive desires of women and couples has long been part of global development and public health goals (Starrs et al., 2018). Efforts to both understand fertility and

identify ways to support women and couples in achieving their reproductive goals are particularly important given the significance of childbearing across contexts, and the persistence of erroneous perceptions linking contraceptive use to infertility that continue to thwart investments in family planning programs (Chipeta et al., 2010; Inhorn, 2009).

This study focuses on Malawi, a small country in south-eastern Africa. The high burden of both infertility and unintended pregnancy in Malawi, along with the critical importance of childbearing in the region (Dyer, 2007), likely influences how people make reproductive decisions with their current and future fertility in mind.

This study focuses on *perceived fecundity*, operationalized as the perceived chance of pregnancy within one year of not using contraception, and self-reported infertility, or the experience of trying to become pregnant for two or more years without conceiving in that time. Both perceived fecundity and self-reported infertility are important because access to a medical diagnosis of infertility in Malawi is rare and infertility is not highly medicalized as it is in some other contexts, meaning that it is not necessarily perceived or experienced as a medical condition (G. Becker & Nachtigall, 1992; P. Brown, 1995; Greil & McQuillan, 2010). It is common to seek treatment for infertility outside of the formal health system (Barden-O'Fallon, 2005b; Cox & Johnson, 2020). Additionally, *perceiving* one's self as subfecund may have a meaningful role in reproductive decision making (S. O. Bell & Gemmill, 2021). There is ample evidence that people make decisions and behave according to their perceptions and beliefs (Carpenter, 2010; K. S. Hall, 2012; Slovic & Peters, 2006). Perceptions are also important to consider in a context where childbearing is imperative, where stigma related to infertility is widespread and consequential, and where there are few alternatives to childbearing to achieve adult status within one's family and community (Alamin et al., 2020; Bornstein, Gipson, et al., 2020; Miall, 1986; Remennick,

2000; Rouchou, 2013; Whiteford & Gonzalez, 1995), and when decisions around childbearing are heavily influenced by social norms and are often made collectively, rather than solely by an individual or couple (Agadjanian, 2005).

Summary

This dissertation uses qualitative and quantitative methods to explore how the perception of infecundity or subfecundity and the experience of infertility influences how women and men manage their fertility and make contraceptive decisions. I conduct three studies that use data from the *Umoyo Wa Thanzi* (UTHA) research program cohort in Central Malawi, conducted from 2014-2019 and an embedded qualitative study conducted in 2018.

Study 1: The first study is qualitative, based on in-depth interviews with a subset of women from the UTHA cohort. This study delves into how women manage their fertility over their reproductive life-course through contraceptive use. The data show that women made decisions regarding contraceptive use (both *if* they used it and *how* they used it) based on their understanding of their biological fecundity and their desire to prevent or achieve a pregnancy, both at the time and in the future. Women's desire to prevent pregnancy while maintaining future fertility was complicated by beliefs that contraception may cause infertility. Women managed their fertility in the context of their relationships and communities, childbearing desires, and shifting childbearing expectations over the reproductive life-course.

Study 2: In the second study, I use cross-sectional quantitative survey data from the UTHA cohort to describe the characteristics of women and men who perceive that they are subfecund, or have a low chance of pregnancy, and who have experienced infertility, or not becoming pregnant after two years of trying. I then model the relationship between perceived

fecundity, experienced infertility, and contraceptive use. This study finds that women who perceive themselves to have a low chance of pregnancy have lower odds of contraceptive use compared to women who do not perceive themselves to have a low chance of pregnancy. Women who have experienced infertility have lower odds of contraceptive use than women who had not experienced infertility. Multivariable models indicate that both mechanisms – perceptions and experiences – were independently associated with contraceptive use among women.

A version of Study 2 is published in *Studies in Family Planning* –

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Study 3: The third study uses longitudinal data from four waves of the UTHA cohort to examine the relationship between ever experiencing infertility and having a future pregnancy among women. Although one would expect the experience of infertility to reduce the odds of a future pregnancy, this study finds that women who have experienced infertility are just as likely to become pregnant later in the study as women who have never experienced infertility. These findings motivated a sub-analysis examining pregnancy planning using the London Measure of Unplanned Pregnancy (LMUP). Pregnancy planning did not differ by whether or not women experienced infertility.

In the following chapters I review the state of infertility research within public health, as well as the causes and consequences of infertility (Chapter 2). I then describe the theories that inform the overall dissertation and each study (Chapter 3), followed by a discussion of the study

context (Chapter 4) and the study aims and hypotheses (Chapter 5). I then describe the overall study design (Chapter 6). In the three empirical chapters (Chapters 7-9), I present the methods and results of each study, followed by a discussion of the findings. Finally, I conclude the dissertation with a discussion of the overall findings and implications for future public health research and programs (Chapter 10).

Chapter 2: Background and Literature Review

Infertility in public health

The field of public health has undergone a paradigm shift over the past several decades. Prior to the International Conference on Population Development in 1994, the field was focused primarily on population control (Crane & Isaacs, 1995; Lane, 1994). After the 1994 conference, there was a shift toward reproductive rights, which manifested in the field focusing on the prevention of unintended pregnancies through access to effective forms of contraception. Although infertility was also included as a pillar of reproductive rights, it has been overlooked amidst efforts to prevent unintended pregnancies and its associated consequences (Inhorn & Patrizio, 2015). Particularly in contexts where total fertility rates are high, there is some controversy around providing support for infertility, which may be resource intensive and take away from what are viewed as more pressing needs (e.g., access to contraception, economic development) (Okonofua, 1996; Pennings, 2008). However, there has been increasing interest in addressing infertility as a public health issue and as a critical aspect of reproductive health and rights (Dierickx et al., 2021; Gipson et al., 2020; K. M. Johnson et al., 2018; Ombelet, 2011).

A recent literature review compared the state of infertility research in 2010 and 2018, showing little progress. The development and integration of infertility into a broader reproductive health framework has been slow (Greil, Slauson-Blevins, & McQuillan, 2010; K. M. Johnson et al., 2018; Shreffler, Greil, & McQuillan, 2017). However, there is increasing recognition that public health *must* address infertility if it is to successfully address unintended pregnancy (Inhorn, 2009; Starrs et al., 2018). Emerging research suggests that one reason high rates of unintended pregnancy persist is because people are reluctant to use contraception to

prevent an *unintended* pregnancy if they are not sure they will be able to achieve an *intended* pregnancy when they desire (K. M. Johnson et al., 2018).

Facilitating women's and men's desire to *achieve* pregnancy, and not only to *prevent* pregnancy, is key to reproductive self-determination and may help address persistent unmet need for contraception, particularly in settings where fear of infertility (and fear that contraception may cause infertility) is prevalent (Boivin et al., 2020).

Priorities in reproductive health

Globally, 44% of pregnancies are unintended, a proportion that has remained relatively constant over the past three decades, despite investment in research and programs aimed at reducing unintended pregnancy via increasing contraceptive use (Bearak et al., 2018). The programmatic and research focus on preventing unintended pregnancy is not without justification. There is a large body of research defining, measuring, and illustrating the negative consequences associated with unintended pregnancy, such as low-birth weight, infant mortality, maternal mortality, and maternal mental health (Eggleston et al., 2001; Tsui et al., 2010). Other studies have found the consequences of unintended pregnancy to be more complex and context dependent (Aiken et al., 2016; Cutler et al., 2018; Gipson et al., 2008; Gomez et al., 2018; Levandowski et al., 2012); however, it is widely agreed that preventing unintended pregnancy should be a priority in reproductive health programs and research.

Unintended pregnancy is a compelling public health issues because it has a known, relatively inexpensive, and effective means of prevention through access and use of contraception and access to safe abortion. Furthermore, reducing unintended pregnancy is congruent with historical population reduction priorities (Lane, 1994). Although the field of

reproductive health has shifted toward a rights-based orientation, the fundamental framework of family planning still largely centers on the idea, and empirical evidence, that many women would like to delay or limit pregnancies. This is reflected in that nearly half (44%) of pregnancies globally are unintended (Bearak et al., 2018). While unrealized fertility desires (Casterline & Han, 2017), involuntary childlessness (Miall, 1986; Rutstein & Shah, 2004), and infertility are acknowledged, funding for and access to infertility prevention, diagnosis, and treatment remains extremely limited in low-resource settings (Chiware et al., 2021; Passet-Wittig & Greil, 2021).

Reproductive decision making and contraceptive use

Given the concurrently high rates of unintended pregnancy (41%) (National Statistics Office (NSO) [Malawi] and ICF, 2017) and self-reported infertility (20%) in Malawi (Rao et al., 2017), it is imperative to assess the extent to which reproductive decisions – specifically contraceptive use – may be affected by one's experience and perceptions of their fertility.

The relationship between perceived subfecundity and contraceptive non-use has been demonstrated in existing literature from the U.S. and other global settings. The belief that one cannot, or is unlikely to, get pregnant is an oft-reported reason for contraceptive non-use among women who do not want to become pregnant. A population-based study in the U.S. that used Pregnancy Risk Assessment Monitoring System (PRAMs) data found that, among more than 7,000 women with a recent unintended pregnancy, 33% were not using contraception at the time they became pregnant because they did not believe that they could become pregnant (Nettleman et al., 2007). A similar study of women seeking abortion care at six abortion clinics in the U.S. found that 42% of women were not using contraception at the time they became pregnant

because they did not think they could become pregnant (Foster et al., 2012). Indeed, knowledge of fecundity over time and from a single act of unprotected sex is low. In a study of a U.S. women attending family planning clinics, 70% underestimated the risk of becoming pregnant after one year of unprotected sex. At the same time, the vast majority of women in the study overestimated the risk of pregnancy from a single act of unprotected sex (Biggs & Foster, 2013)

Another study found that low perceived chance of pregnancy was associated with contraceptive non-use among women in Cote d'Ivoire, Nigeria, and Rajasthan, India (S. O. Bell & Gemmill, 2021). A study examining unmet need for contraception in Malawi found that the perception that one cannot become pregnant for biological reasons may account for more than a quarter (27%) of contraceptive non-use among women in need of contraception (Westoff, 2012). This finding also aligns with nationally-representative Demographic and Health Survey (DHS) data from Malawi indicating that a primary reason for contraceptive non-use among women who do not want to become pregnant is believing one is not at risk for pregnancy (National Statistics Office (NSO) [Malawi] and ICF, 2017). Together, evidence from these studies motivates the need to understand perceived fecundity, along with experienced infertility, as it relates to reproductive decision making. Perceptions drive behavior, particularly in the absence of medically verifiable information and when the outcome carries significant weight, such as infertility (Sunstein, 2003).

Sub-Saharan Africa is widely considered to have one of the highest rates of infertility globally. A comparative report of Demographic and Health Surveys found that 30% of women in sub-Saharan Africa experienced primary or secondary infertility (Rutstein & Shah, 2004), yet several studies have shown that the general population often has misconceptions about the causes of infertility. The belief that contraception may be a cause of infertility is well-documented

(Bornstein, Huber-Krum, et al., 2020; Chipeta et al., 2010; Richards, 2002; Sedlander et al., 2018). A study using UTHA data from Malawi found that women preferred methods of contraception that they perceived would not negatively impact their future fertility (Huber-Krum & Norris, 2020). Similarly, a study in Bangladesh and Kenya, which aimed to measure unintended pregnancy and unmet need for contraception, found that the perception that a specific contraceptive method did not cause infertility was associated with intention to use that method (Machiyama et al., 2018; Mumah et al., 2018).

Although there is no scientific merit to the idea that contraceptive use causes infertility, understanding the origin of this misconception is critical because fear of infertility may cause women to avoid contraceptive use, even if they do not wish to become pregnant (Boivin et al., 2020). Devaluing women's experiences and perceptions is an under-researched cause of unmet need for contraception. Many studies have shown that women associate contraceptive use with infertility, but few have investigated possible biological mechanisms that underlie women's beliefs. However, there have been studies that have shown that some methods of contraception, particularly methods that suppress ovulation, may reduce fecundity after discontinuation. One study found that oral contraception may impact fecundity for two cycles after discontinuation (Nassaralla et al., 2011). Another study found that Depo-Provera, the most commonly used method of contraception in Malawi, may reduce fecundity for 5-8 cycles after discontinuation, the longest of any hormonal method (Yland et al., 2020). Additional studies that examined time-to-pregnancy after discontinuing the injection found that women could be subfecund for more than a year after discontinuing the method (Hassan & Killick, 2004; Kaunitz, 1998). The length of time women were subfecund increased with longer use of the method (Hassan & Killick,

2004). Another study found that the injection could inhibit ovulation for nearly two years in some women (Kaunitz, 1998).

In contexts where there is an expectation that pregnancy will happen quickly, and the consequences for not having a pregnancy when expected are severe, these delays may indeed be a cause for concern.

Defining and measuring infertility

Research in infertility has been plagued by four interrelated issues: (1) multiple definitions, (2) inconsistent measures, (3) lack of measurement validity, and (4) challenges defining exposure to pregnancy and the population at risk for infertility.

Multiple definitions

There are many challenges to studying infertility, but inconsistent definitions and measurements are perhaps the most fundamental. Clinical, epidemiological, and demographic definitions of infertility differ with regard to the length of time without conceiving when infertility is indicated (Leridon, 2007). The Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) define clinical infertility as 'not conceiving after having sex without contraception for a period of one year.' The National Institute of Health (NIH), along with most epidemiologic studies, use two years as the cutoff for infertility. In contrast, demographers often construct a measure of infertility from existing datasets and define infertility according to a woman's marital status, age, contraceptive use status, and time before or between pregnancies of 5-7 years (Gurunath et al., 2011).

Studies often use measures of infertility without clearly defining them. For example, some studies consider infertility to be the inability to become pregnant, while others consider infertility as the inability to have a live-birth. Inconsistencies in measurement make it so studies on infertility are largely incomparable (Larsen, 2005). Terms are often inconsistently defined across studies and each have different inclusion/exclusion criteria and case definitions, making comparison across studies impossible. A 2011 systematic review found that studies used a broad range of terms and definitions for infertility and varying denominators to calculate infertility prevalence across settings (Gurunath et al., 2011). In response to these inconsistencies, there have been calls to create a uniform definition, but doing so also requires consistency in data collection (Mascarenhas, Cheung, et al., 2012; Polis et al., 2017).

Inconsistent measures

Measurement approaches for infertility also vary drastically. Some of the main measures include life-time infertility, current infertility, retrospective time-to-pregnancy, and current duration. Each measure uses different information criteria for infertility; thus, each measure captures a very different phenomenon. Life-time infertility, for example, captures a person ever experiencing a time (typically 1-2 years) in which they tried to become pregnant without conceiving. This measure differs from current infertility, which, as implied, measures a current experience of infertility. Time-to-pregnancy measures how long, defined in months or ovulation cycles, a woman took to conceive a specific pregnancy (Sundaram et al., 2012). Current duration approaches consider the length of time a woman has been at risk of pregnancy to estimate time-to-pregnancy and infertility prevalence in a population (Keiding et al., 2002; Polis et al., 2017). Each of these measures provide insight into the definition of infertility that they measure, and

each has faced methodological and theoretical critiques (Keiding et al., 2002; Olsen, 2016; Stanford & Dunson, 2007). However, there remains little consensus on the best approaches to measuring infertility.

As expected, different measures of infertility yield a wide-range of infertility prevalence estimates (Gnoth et al., 2019; Gurunath et al., 2011; Jacobson et al., 2018; Larsen, 2005). An oft-cited lifetime prevalence of infertility – combining both primary and secondary infertility and using a 12-month definition – is 15% of reproductive aged couples (Boivin et al., 2007; Inhorn, 2009). However, other global estimates are considerably higher, with combined primary and secondary infertility estimated to be up to 25-30% of reproductive-age couples in some regions (Mascarenhas, Cheung, et al., 2012; Mascarenhas, Flaxman, et al., 2012; Nachitgall, 2006; Rutstein & Shah, 2004). A study of pooled Demographic and Health Survey data from 53 countries used a more conservative definition of infertility (five years) and, unsurprisingly, found that primary infertility was much less common (e.g., approximately 1% of women in Malawi) (Mascarenhas et al., 2012). A review article that compiled existing estimates of infertility found that the prevalence of infertility (using a 12-month definition) was approximately 5-15% among women in "less" developed countries, and lifetime experience of infertility was approximately 5-26% (Boivin et al., 2007).

Measures of infertility are also typically unable to distinguish individual versus couple-level infertility. Self-reported infertility – whether it is measured as a single question or time-to-pregnancy – is usually reported by an individual, but s/he cannot be assumed to be the partner with infertility (indeed, male factor infertility contributes to 20-40% of cases of infertility experienced by couples (Agarwal et al., 2015)). In the absence of a clinical diagnosis, many will not know whether the issue of infertility they experienced stems from a male cause, female

cause, or both. This has implications for measurement, as well as future interventions to address infertility.

Lack of measurement validity

Results of studies on the validity of retrospective time-to-pregnancy measures (e.g., measures that ask women to recall how long – typically in months – they had unprotected sex before becoming pregnant) have been mixed. One study asked time-to-pregnancy in the 1980s and again 24-28 years later. The authors found that half of participants were able to recall their time-to-pregnancy accurately, with more accurate recall among women with a very short or long time-to-pregnancy (Jukic et al., 2016). However, another study found that less than a third of women could accurately recall time-to-pregnancy after a decade, and recall was less accurate among women with a longer time-to-pregnancy (Cooney et al., 2009). Other studies have found time-to-pregnancy to be valid over time, but primarily for pregnancies that resulted in a live-birth (Joffe et al., 2005). Time-to-pregnancy also does not capture women who never achieved pregnancy, making it a relatively weak proxy for those who experience infertility and do not conceive.

The current duration approach, which estimates the current amount of time someone has been susceptible to pregnancy without becoming pregnant is promising, but has not yet been validated as a measure of infertility and there are few data sources that allow the direct calculation of current duration (Polis et al., 2017; Thoma, 2015). However, unlike time-to-pregnancy measures, the current duration approach can capture women who have not become pregnant, which may make it a stronger measure overall. The current duration calculation is

adjusted to account for potential over-representation of people who take longer to become pregnant (Thoma, 2015).

Measuring exposure to pregnancy

All measures of infertility are subject to challenges ascertaining aspects of fertility that are necessary for constructing a more valid measure, particularly around exposure to pregnancy. Proxies for exposure include sexual frequency or regularity of sex, consistent contraceptive non-use, and length of time or number of ovulation cycles without conceiving (Gurunath et al., 2011; Larsen, 2005; Mascarenhas, Cheung, et al., 2012). Accurate reporting of time and recall of events is a challenge in many settings, particularly when events are relatively ordinary, such as sexual intercourse (Aiken et al., 2016; Althubaiti, 2016; Moseson et al., 2021; Radin et al., 2015; Santelli et al., 2003; Sedgwick, 2012).

Most self-reported measures of infertility specify "trying" to become pregnant as a proxy for exposure to pregnancy and there have been few efforts to develop more specific language to gather data that are relevant for populations with different fertility norms and expectations. These infertility measures may be problematic because they are predicated on women readily differentiating between periods of time that they tried and did not try to become pregnant. We know that pregnancy intentions can change over relatively short periods of time (Sennott & Yeatman, 2012) and that ambivalence around pregnancy is common (Huber et al., 2017); thus, women may respond to survey questions based on an overall, generalized assessment of a one or two year period in their life, even if she were not trying to get pregnant (or exposed to pregnancy) for the entire duration of two years. Measures that include "trying" to become

pregnant also may underestimate infertility among women who are not trying to become pregnant but may still be considered infertile (Greil, McQuillan, et al., 2010).

Perceived fecundity

Perceived fecundity is relevant to infertility research and reproductive decision making for several reasons. First, unequal access to a clinical diagnosis of infertility limits the utility of clinical measures or measures that can be medically verified. People are much more likely to be able to report that they perceive themselves to be subfecund in the absence of diagnostic resources. Perceptions of fecundity are also important because perceptions drive fertility-related behavior (e.g., contraceptive use) and help-seeking both within and outside of the formal healthcare sector (S. O. Bell & Gemmill, 2021; Greil et al., 2020). Perceived fecundity may also be less complex to measure than time-to-pregnancy or current duration approaches. There are few studies on the relationship between perceived fecundity measures and clinical infertility, however, one study found that self-reported difficulty becoming pregnant was moderately predictive of clinical infertility among women undergoing cervical cancer treatment in Australia (Dick et al., 2003).

Measuring perceived fecundity may also be more consequential in people's lives than precisely how long it took for them to become pregnant. The consequences of subfecundity or infertility depend less on meeting clinical criteria and more on how one perceives themselves or are perceived by others with regard to their ability to become pregnant when they want to or are expected to (Bornstein, Gipson, et al., 2020). Perceptions of fecundity may also have a meaningful role in reproductive decision making. There is ample evidence that people make

decisions and behave according to their perceptions and beliefs (Carpenter, 2010; K. S. Hall, 2012; Slovic & Peters, 2006).

While there is growing acknowledgment that perceptions of fecundity may be important to how women and men make reproductive decisions, there are no standard or agreed upon definitions or measures of perceived fecundity. A recent study in Malawi looked at perceived likelihood of infertility. The authors found that just 8% of women (N=1,064) and 8% of men (N=527) ages 21-29 years perceived they may be *a little, somewhat*, or *very likely* to be infertile, while the remaining 92% said it was *not at all likely* (Polis, Moore, et al., 2020). Constructs related to perceptions of fecundity have been measured in other studies by the percent chance of becoming pregnant (Gemmill, 2018), perceived inability to become pregnant (Foster et al., 2012; Nettleman et al., 2007), perceived likelihood of pregnancy (S. O. Bell & Gemmill, 2021), perceived difficulty becoming pregnant (Polis, Otupiri, et al., 2020), and perceived speed of conception (Fledderjohann, 2017), among others. While these measures are all related, it is difficult to compare across studies without a common definition and measure.

Perceived subfecundity or infecundity may be more prevalent than clinically diagnosable infertility. One study in the U.S. found that 19% of women reported that they were likely infertile (Polis & Zabin, 2012). This study reported that a substantially smaller proportion of U.S. women are infertile from a clinical perspective (approximately 6%).

Etiology of infertility

The etiology of infertility among women in sub-Saharan Africa has largely been attributed to tubal factors, which stem from untreated sexually transmitted infections (STIs) causing Pelvic Inflammatory Disease (PID) and other complications from STIs and

endometriosis (Araoye, 2004; Ravel et al., 2021; Sharma et al., 2009; Tsevat et al., 2017). PID may cause infertility or subfertility even after being treated (Brunham et al., 2015). Bacterial vaginosis, which is common in sub-Saharan Africa (Jespers et al., 2014), has also been associated with lowered fertility (Lokken et al., 2021; Ravel et al., 2021). According to one study, 85% of infertility in Africa is attributable to tubal factors caused by infections (Sharma et al., 2009), nearly all of which are preventable. While the vast majority of infections causing infertility are STIs, tuberculosis and schistosomiasis may also cause infertility when left untreated (Sharma et al., 2009).

A recent meta-analysis examining primary and secondary infertility in Africa found that 54% of infertility in couples was attributed to female causes, 22% to male causes, 21% to both female and male causes, and 10% unknown causes (Abebe et al., 2020). This meta-analysis also found that the majority of female infertility was caused by PID and other tubal factors, including unsafe abortion and unsafe birth. Non-tubal factor infertility in women is also frequently caused by hormonal disorders, life-style factors (e.g., diet, tobacco use), and low ovarian reserve of oocytes (eggs) (Gelbaya et al., 2014). Male causes of infertility included oligospermia and asthenozoospermia (low sperm count and low sperm motility) and varicocele (enlargement of vein/s in the scrotum) (Abebe et al., 2020). Other studies suggest that up to 95% of male infertility is caused by STIs (Bowa & Kachimba, 2012; Cates et al., 1985).

Chlamydia and gonorrhea are two of the most common STIs that can cause infertility in women and men. In women, these STIs may cause PID which can lead to tubal occlusion (Cates et al., 1985), while in men these STIs are shown to reduce semen quality (Deyhoul et al., 2017). A recent meta-analysis examining causes of infertility found that, in the Africa region, approximately 5% of infertile women had a current Gonorrhea infection (Chemaitelly et al.,

2021). This does not account for Gonorrhea that may have been treated on its own or, in the case that it caused PID, in conjunction with PID treatment. Other studies have found that STIs are common among infertile couples (Egbe, Mbaki, et al., 2020; Egbe, Nana-Njamen, et al., 2020).

A recent systematic review of infertility in sub-Saharan Africa found that approximately half of the total burden of infertility was due to primary infertility and half was due to secondary infertility (50% of infertility was considered primary and 50% secondary) (Abebe et al., 2020). However, several studies have found that secondary infertility is more prevalent than primary infertility in sub-Saharan Africa (Benksim et al., 2018; Cates et al., 1985; Dattijo et al., 2016; Idoko, 2017). A study that examined Demographic and Health Survey data found that rates of primary infertility in sub-Saharan Africa had declined from 2.7% of all women desiring a first pregnancy in 1990 to 1.9% in 2010 (Mascarenhas, Flaxman, et al., 2012). The study also found that rates of secondary infertility had declined from 13.5% in 1990 to 11.6% in 2010. The study suggests that these declines may be in response to changes in sexual behavior or STI treatment access (Mascarenhas, Flaxman, et al., 2012).

Infertility prevention and treatment

Sharma, et al. (2009) describes four main preventable causes of infertility, including: reproductive tract infections (commonly STIs and less commonly other infections, e.g., tuberculosis, schistosomiasis, and malaria), health care practices (e.g., unsafe abortion and complications from childbirth), environmental factors (e.g., tobacco use, nutrient deficiencies), and socio-cultural factors that lead to vulnerabilities in terms of STIs and healthcare accessibility, such as women's education (Sharma et al., 2009). Prevention of infertility can thus be addressed through many evidenced-based public health programs that increase access to STI

diagnosis and treatment, safe abortion, delivery, and maternal healthcare, along with tobacco prevention programs, nutrition programs, and social programs that improve the status of women. Given the expense of infertility treatment, some have argued that the majority of resources for infertility in low-resource settings should focus on infertility prevention (Pennings, 2008). And, indeed, few resources have been devoted to treating infertility in low-resource settings (Nachitgall, 2006).

The extent of existing infertility treatment options is limited and not well-studied (Chiware et al., 2021; Passet-Wittig & Greil, 2021), particularly in sub-Saharan Africa (Gerrits & Shaw, 2010). There is a lack of systematic registration of infertility treatment and, importantly, treatment outcomes (Nygren & Zegers-Hochschild, 2008). The scarcity of infertility services, combined with the importance of childbearing, has left a gap that some fear will lead to predatory practices among medical and lay people. Unregulated infertility services may be dangerous and costly (Zandvoort et al., 2001).

Lack of formal infertility treatment means that many rely on sources outside of evidence-based medicine when faced with infertility. Traditional approaches to treating infertility range from prayer and herbal remedies, to sexual practices. Some of these practices may have social and emotional benefits, such as increasing community and psychosocial support, if not biomedical. While some herbal remedies may be effective in treating some cases of infertility, further research is needed to assess their effectiveness (Agbodjento et al., 2020; Telefo et al., 2011). Despite this, seeking herbal treatments is common. A study in Sierra Leone found that more than a third of women experiencing infertility sought herbal remedies (James et al., 2018). In a study in Uganda, three-quarters of women used herbal treatments for infertility prior to

seeking medical consultation (Kaadaaga et al., 2014), thereby potentially delaying effective treatment.

While some traditional approaches to infertility treatment may be harmless (e.g., prayer), others may indeed cause harm to women. Inhorn (1994), in an ethnography of infertility in Egypt, describes various practices that harm women, including unwarranted prescription of fertility drugs (e.g., Clomid), unnecessary surgeries, and practices of "cleaning" and "scraping" that can permanently harm the cervix or uterus. Women often seek these treatments out of feelings of desperation, and healthcare providers may offer them simply to provide hope, or, more nefariously, to exploit them financially. Women may sustain permanent damage from these "treatments" that make an otherwise treatable cause of infertility permanent (Inhorn, 1994).

Some studies and scholars have argued that interventions to address infertility in low-resource settings are both feasible and necessary to ensure reproductive rights (Inhorn, 2009; Ombelet, 2011), and there has been an increase in the availability of biomedical infertility treatment in low- and middle-income countries. A recent review article found that costs of infertility services in sub-Saharan Africa were prohibitive and data systems tracking the availability and efficacy of treatment were lacking (Chiware et al., 2021). Several countries in sub-Saharan Africa, however, are beginning to offer lower cost treatments for infertility, including Uganda, Nigeria, and South Africa (Chiware et al., 2021). Disparities in access to effective treatment for infertility across and within countries and regions remain stark.

One of the few multi-country interventions addressing infertility in low-resource settings is the Walking Egg Project (Ombelet, 2013; Starrs et al., 2018). This project focuses on achieving global access to assistive reproductive technologies, such as intrauterine insemination and in vitro fertilization. It considers access to infertility treatment to be both cost effective and a

human right. Despite this effort, infertility, and infertility treatment, remain largely unaddressed as a public health issue in low-resource settings.

Consequences of infertility

Multiple empirical studies in sub-Saharan Africa have focused on understanding the social and emotional consequences of infertility, particularly among women. Studies in Malawi have shown that the consequences of infertility stemmed, at least in part, from the expectation that couples would conceive quickly, well before the timeframe when clinical infertility is indicated (Barden-O'Fallon, 2005a; Bornstein, Gipson, et al., 2020).

Studies across various contexts have described psychosocial consequences of infertility, including anxiety, depression, social isolation and sanctions, divorce, and intimate partner violence (Ameh et al., 2007; Chachamovich et al., 2010; Cui, 2010; de Kok, 2009; Dierickx, 2020; Dyer et al., 2002; Hansanpoor-Azghady et al., 2015; Hemmings, 2007; Hollos & Larsen, 2008; Koster-Oyekan, 1999; Luk & Loke, 2015; Maximova & Quesnel-Vallee, 2009; Naab et al., 2013; Okonofua et al., 1997; Stellar et al., 2015; Tabong & Adongo, 2013b). A systematic review published in 2021 found that depression was common among women with infertility across diverse country contexts (Kiani et al., 2021). Infertility has also been associated with sexual dysfunction and dissatisfaction (Potur et al., 2020; Zayed & El-Hadidy, 2020). Taken together, these studies suggest that infertility has negative consequences across a wide variety of life domains.

The experience and consequences of infertility are driven by social norms, gendered expectations around parenthood, and the overall status of women (Alamin et al., 2020; Bornstein, Gipson, et al., 2020; Greenhalgh, 1995; Whiteford & Gonzalez, 1995; Woods et al., 1991).

Studies suggest that the experience of infertility is highly context-dependent based on societal views about acceptable means of family formation and alternatives to childbearing (Alamin et al., 2020; Greil et al., 2011). Critically, most studies regarding consequences of infertility do not include men's experiences (Fledderjohann & Barnes, 2018; Gannon et al., 2004; Hanna & Gough, 2017). One of the most insidious consequences of infertility for women and men is that of loss or threat to identity, as well as family and community roles (Alamin et al., 2020; Bornstein, Gipson, et al., 2020). A study in Malawi found that women and men both faced social sanctions if they were perceived to be infertile, although the specific consequences differed based on their gendered social roles. The study found that:

> "Womanhood was achieved primarily through motherhood. Similarly, an acceptable display of masculinity was achieved through virility, as demonstrated by having biological children. While we found evidence that while men may more easily escape a reputation of infertility than women, being labeled as infertile was deeply discrediting to both women's and men's identities. Women's identities were more closely tied to parenthood, however, and not only were women more frequently blamed for infertility, they also may be disproportionately affected by the stigma of childlessness. In contrast, when a man was perceived as infertile, his masculinity was questioned" (Bornstein, Gipson, et al., 2020).

Studies have also found that stigma is associated with infertility in sub-Saharan Africa because of the high value that is placed on childbearing and the normative expectation of having children (Dyer, 2007). A study in Ghana found that couples who experienced infertility were highly stigmatized (Tabong & Adongo, 2013b). Another study from Ghana highlighted the importance of understanding infertility as a social condition, given that it is often attributed to social causes (e.g., being bewitched) and the consequences of infertility are also social (e.g., isolation from peers) (Tabong & Adongo, 2013a). An earlier study, also in Ghana, found that women who were seeking treatment for infertility faced stigma and diminished social status

(Donkor & Sandall, 2007). These studies demonstrate the need to address infertility from a social, as well as a biomedical, perspective (Rouchou, 2013).

A need for additional research

Studies have shown that women feel vulnerable to infertility, even – and perhaps especially – in contexts where there are large family size norms and the total fertility rate is relatively high (Feldman-Savelsberg, 1994; Hollos et al., 2009). Separately, we also know that there may be severe consequences of infertility, (e.g., Bornstein, et al., 2020; Fledderjohann, 2012; Okonofua et al., 1997), as well as for unintended pregnancy (Gipson et al., 2008; Levandowski et al., 2012). Qualitatively, studies show that women and men often attribute infertility to abortion and contraceptive use (Chipeta et al., 2010; Goncalves et al., 2011; Schwarz et al., 2019; Sedlander et al., 2018), and indeed, abortion and infertility are associated in contexts where abortion is unsafe (Koster, 2010). It is likely that fear of infertility and the desire to avoid infertility may cause people to also avoid behaviors or exposures that they believe might lead to infertility (e.g., contraceptive use) (Boivin et al., 2020).

Although there is no relationship between contraceptive use and long-term infertility, the potential impact on short-term fecundity and perceptions that contraception may impact long-term infertility necessitate a more holistic perspective on the reproductive life-course. Past reproductive events and experiences shape future behaviors and expectations. As a field, we must progress toward ensuring universal reproductive rights and acknowledge that people may experience a range of events over their reproductive life-course, including both unintended fertility, periods of subfecundity, or infertility.

Chapter 3: Theoretical Approach

This study incorporates constructs from several different theories and theoretical perspectives, including the Health Belief Model, the affect heuristic, the reproductive career, and the social-ecological framework.

Health Belief Model

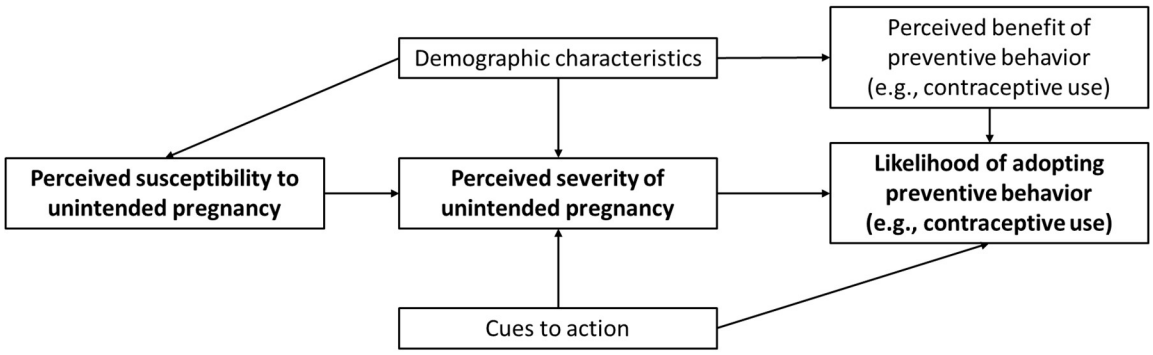
One of the most common theories applied to preventive health behaviors is the Health Belief Model (Rosenstock, 1974). This is a social-cognitive theory, the main tenets of which are that an individual must perceive that they are at risk for a particular outcome, believe that the outcome is undesirable, and believe that there is a behavior (i.e., stopping, starting, or maintaining a health behavior) that they can do to effectively prevent the undesirable outcome (Rosenstock, 1974). The Health Belief Model has been adapted to understand many health outcomes that can be prevented through behavior change (Green & Murphy, 2014).

Although studies of theoretically grounded approaches to contraceptive use interventions are limited (Lopez et al., 2009), the Health Belief Model has been applied to a small set of interventions seeking to prevent unintended pregnancy through improved contraceptive uptake and use (W. Brown et al., 2011; K. S. Hall, 2012). However, applying the Health Belief Model to contraceptive use is limited for several reasons. First, the Health Belief Model was designed to explain preventive behaviors for life-style related health outcomes. Pregnancy is a unique outcome in that, even when unintended, a pregnancy may not be entirely undesired (Higgins et al., 2012). This is particularly poignant in Malawi, where childbearing is highly valued and a critical event in a normative life-course (Dyer, 2007; Gennaro et al., 1998) and pregnancy intentions may change over short periods of time (J. A. Hall et al., 2019; Sennott & Yeatman,

2012). Additionally, the Health Belief Model does not propose mechanisms that would allow the inclusion of the complex feelings people may have toward pregnancy, no matter their intention. Such feelings, such as ambivalence, are known to shape contraceptive use (Cutler et al., 2018; Gomez et al., 2018; Higgins et al., 2012).

Figure 1 applies the Health Belief Model to contraceptive use and unintended pregnancy prevention. In this model, perceived susceptibility to unintended pregnancy and perceived severity of unintended pregnancy precedes contraceptive use.

Figure 1. Health Belief Model applied to unintended pregnancy prevention[1]



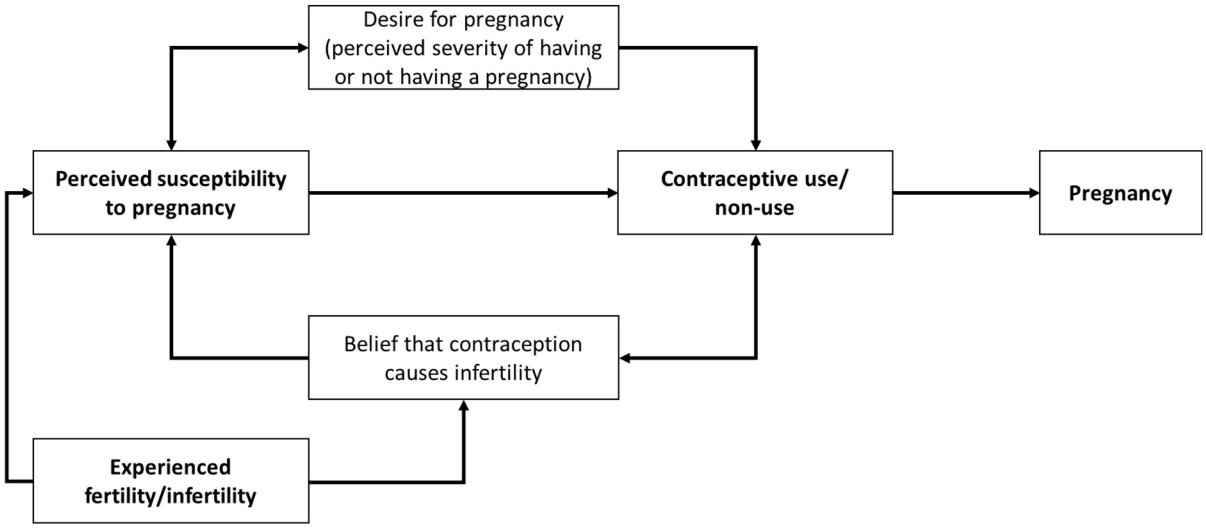
[1]Adapted from Rosenstock, 1974

Examining the Health Belief Model (Figure 1) as applied to *perceived fecundity*, or susceptibility to pregnancy, is further limited because of the complexity associated with preventing infertility. However, perceived subfecundity and experienced infertility may have implications for contraceptive use and, thus, the prevention of unintended pregnancies. Studies have shown that women feel susceptible to infertility, even in contexts where the total fertility rate is high (Feldman-Savelsberg, 1994) and that perceived subfecundity may influence contraceptive use (S. O. Bell & Gemmill, 2021; Gemmill, 2018), such that people who believe they are likely to be infertile or have a low chance of pregnancy may not perceive that

contraception is necessary to prevent an unintended pregnancy (i.e., they have a low perceived susceptibility to pregnancy). Furthermore, the belief that contraception may be a cause of infertility is also well-documented (Bornstein, Huber-Krum, et al., 2020; Chipeta et al., 2010; Richards, 2002; Sedlander et al., 2018), but this complexity is not captured in the Health Belief Model, which views a preventive behavior (e.g., contraceptive use), as purely beneficial.

Figure 2 uses Health Belief Model concepts to explain possible mechanisms between perceived susceptibility to pregnancy, experienced infertility, and contraceptive use. It integrates the competing beliefs that contraceptive use will both prevent an unintended pregnancy and may have anticipated consequences of preventing a future intended pregnancy as well.

Figure 2. Modified Health Belief Model applied to perceived susceptibility to pregnancy



Integrating additional theories is necessary to allow for uncertainty and competing or coexisting desired outcomes.

Decision making theories – affect heuristic

Incorporating decision making theory along with Health Belief Model constructs (e.g., susceptibility and severity) may improve our ability to understand behaviors that some believe may have conflicting consequences, such as contraceptive use as a behavior to prevent pregnancy, that may also lead to infertility. Contemporary decision-making theories that take a dual-process approach consider two components of decision making in the face of (perceived) risk: feeling (affect) and reason (analysis) (Fischhoff et al., 1978; E. J. Johnson & Tversky, 1983; Slovic & Peters, 2006). Reason encompasses how people use logic and available information to inform their decisions. However, the affect heuristic, described by Slovic and Peters (2006), focuses on the role of feelings, or affect, in decision making. The authors describe affect as "a subtle feeling" that may play a disproportionate role in decision making.

Psychologists, Kahneman and Tversky (1973), in their seminal work suggest that individuals assess their risk based on their own beliefs, experiences, and social narratives. Individuals are not able to assess risk using statistical probability or odds, and so they rely on anecdotal evidence and personal experience (Kahneman & Tversky, 1973). Studies have also shown that when strong emotions or feelings are tied to a behavior or outcome, it is difficult to change the perception of risk (Sunstein, 2003), even in the presence of information about true risk. Sunstein (2003) used terrorism as an example. Even though one is unlikely to be a victim of terrorism, the intense emotions related to it create a higher than "accurate" perception of risk. Although pregnancy and infertility are much different outcomes, they are also laden with emotion and high economic, social, and personal stakes. Therefore, no matter the statistical risk of experiencing unintended pregnancy or infertility, accurate information alone is unlikely to change perceptions and, therefore, behavior.

Applying the affect heuristic in decision making explains how a positive or negative affect toward a behavior (e.g., contraceptive use) might influence how people interpret the risks and benefits of the behavior with the anticipated outcomes in mind. Affect toward contraception, for example, could be shaped by perceptions that it causes infertility. Affect may also be context dependent, rather than enduring. For example, an unmarried woman may have a negative affect toward contraception because she has been told that using it before she is married is unacceptable. When she is at a different stage of life (e.g., after marriage and/or childbearing), her orientation toward contraception, and therefore how she interprets the risks and benefits of contraception, may shift. A limitation of the affect heuristic is that it does not explicitly consider the external and contextual factors that shape an individual's orientation toward a behavior. Women's contraceptive decisions are influenced not only by her individual orientation toward the outcome, but by her relationships and community norms. Furthermore, women live within political, social, and cultural contexts that may influence their contraceptive choices at any given time. Thus, incorporating aspects of the reproductive career and the social ecological framework better situate how women experience fertility and make contraceptive decisions dynamically over their life-course with dual motivations to prevent both unintended pregnancy and infertility.

Reproductive career

In a recent review, Johnson and co-authors (2018) contrasted the theoretically grounded approaches often used in fertility research with the largely atheoretical approaches in infertility research. To address this issue, the authors proposed that fertility and infertility should both be studied under a life-course adjacent framework called the reproductive career (K. M. Johnson et al., 2018). A reproductive career approach allows us to examine decision making as dynamic and

context dependent. For example, an individual may weigh the risks and benefits of a behavior differently depending on their social context, where they are in their life-course (e.g., age, parity, relationship status), their past fertility-related experiences (e.g., miscarriage), and the meaning attached to unintended pregnancy and/or infertility at any given time.

Social-ecological framework

Integrating a social-ecological framework helps address the limitations of both the Health Belief Model and the affect heuristic because it places behavioral decision making within the social, political, family, and individual/reproductive life-course (or reproductive career) context. The social-ecological framework situates both unintended pregnancy and infertility as possible outcomes that exist within a broader structural context, for example: pronatalist norms, family planning policies and programs, and structural incentives for childbearing/limiting (e.g., social security and elderly care). The social context also shapes how people consider behaviors to avoid unintended pregnancy and/or infertility: the social and cultural meaning attached to childbearing, fertility norms and expectations, and other possible social implications of infertility and/or unintended pregnancy, such as stigma, divorce, and exclusion. There are also community-level and relational factors that influence how an individual or couple may balance behavior toward preventing unintended pregnancy and infertility. In many settings, community or family members play integral roles in decisions around family formation (e.g., marriage, pregnancy, and pregnancy prevention) (Agadjanian, 2005). Unintended pregnancy and infertility are also frequently experienced in the context of a relationship and, as such, both unintended pregnancy and infertility may have consequences on the relationship, as well as the individual. Children are often viewed as a means of solidifying a relationship. In many contexts, the primary reason for

marriage is to produce children (Gennaro et al., 1998; Reniers, 2003). Additionally, women are often blamed for infertility – as well as for unintended pregnancy – which may have consequences for her relationship, including intimate partner violence, economic strain, and divorce (Dhont et al., 2011; Fledderjohann, 2012)

Integrated framework

The overall conceptual framework that motivates this study (Figure 3) integrates constructs from the theories and frameworks described above. Key aspects of the social-ecological model are included in the section enclosed in a dashed-line box at the top of the figure. The broad social and political context is specific to Malawi. Family planning was banned in Malawi until 1982, when it became permitted for child-spacing only. Family planning became more widely available in 1994, after Malawi adopted the International Conference on Population and Development (ICPD) guidelines (Chimbwete et al., 2005). Despite nearly universal awareness of contraception (98%+) and relatively high levels of life-time contraceptive use, it is typical for women to have more children than they report wanting over their reproductive life-course (National Statistics Office (NSO) [Malawi] and ICF, 2017). Almost half of women in Malawi marry before age 18, and the average age of first birth is approximately 19 years (National Statistics Office (NSO) [Malawi] and ICF, 2017). Early childbearing expectations likely influence how both unintended pregnancy and infertility are experienced.

The medicalization of fertility and infertility is also included in the broad context of the conceptual framework. Medicalization is a process whereby a condition transitions from an individual negative symptom or experience to a socially/medically accepted condition within the range of "normal" experiences (G. Becker & Nachtigall, 1992; P. Brown, 1995). This process

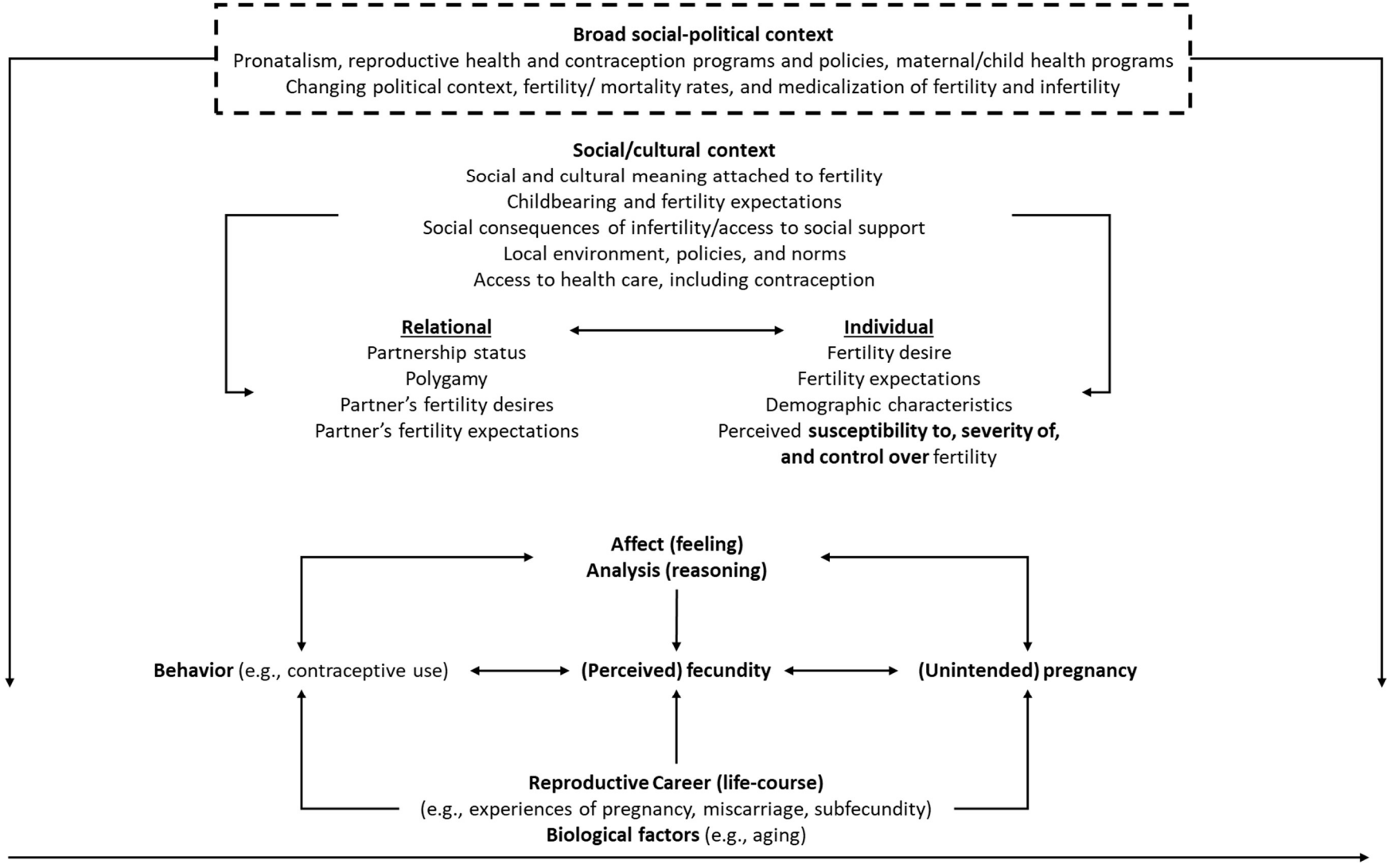
typically follows medical advancements in the diagnosis or treatment of a condition. Unintended pregnancy is considered preventable through medicine (contraception) that can be accessed in the formal health sector. In contrast, infertility is not highly medicalized. Infertility is often addressed outside of the formal medical sector and it is rare to get a clinical diagnosis or treatment. However, like unintended pregnancy, infertility is often attributed to social or moral causes, such as promiscuity, particularly among women. This contrast creates an environment wherein decision making about fertility and infertility are often viewed in opposition.

The social/cultural context in Figure 3 capture how fertility and childbearing are valued in Malawi, as well as the social meaning of pregnancy or the absence of pregnancy. These community level norms around childbearing are integral to shaping how people for their own fertility expectations and express fertility preferences. An arrow connects the social/cultural context to relational and individual factors. This portion of the framework integrates aspects of the Health Belief Model that influence behavior at the relational or individual level. The relational aspect of this framework centers on how decision making around fertility, as well as the consequences of unintended pregnancy and infertility, are often experienced within couples and families. A woman's fertility desires (how many children she wants) and expectations (how many children she expects to have) are important, but they often exist within a dyad. In many cases, a partner's preferences and expectations may be prioritized (Gebreselassie, 2008; Gipson & Hindin, 2009; Voas, 2003). Partner's views on contraception are also predictive of contraceptive use in Malawi (Palamuleni, 2013). Therefore, partner's perception of susceptibility to and severity of infertility and unintended pregnancy are included. The concepts of perceived susceptibility and severity are included in this section to capture both their individual and relational properties. Although relational and individual factors are included separately, the dual

arrow between the two indicates that they mutually influence and reinforce each other. Perceived severity, susceptibility, and control are listed under the individual, but they too are influenced by relational factors, such as partner's fertility preferences and expectations.

The bottom portion of the conceptual framework integrates the affect heuristic – both affect (feeling) and analysis (reasoning) as components of behavior (contraceptive use), perceived fecundity, and pregnancy. There are dual arrows between affect/analysis and behavior, as well as affect/analysis and pregnancy because decisions around contraceptive use and pregnancy may be in response to different realities and expectations depending on the timing and social, cultural, relational, and individual contexts. The arrow from affect/analysis to (perceived) fecundity indicates how one's feelings and reasoning shape perceptions. Perceived fecundity influences contraceptive use and, thus, chance of pregnancy. At the same time, contraceptive use may influence perceived fecundity (e.g., if a woman is using contraception or has in the past, she may perceive herself to be infecund). Pregnancy, whether intended or unintended, also influences perceived fecundity as pregnancy may offer evidence to reinforce or shift perceptions. This reflects a key tenet of the reproductive career: past experiences influence future behavior (K. M. Johnson et al., 2018).

Figure 3. Integrated theoretical framework



Chapter 4: Study Aims

This chapter summarizes the aims, sub-aims, and hypotheses for each of the three dissertation studies. In Chapter 5, I describe the overall study design and data sources for each aim.

Aim 1

Using qualitative in-depth interview data, explore how women manage their fertility (prevent unintended pregnancies and achieve wanted pregnancies) through contraceptive management (patterns of use and non-use) over their reproductive lives.

Sub-aims:

1.1) What strategies do women use to prevent unintended pregnancies?

1.2) What strategies do women use to achieve wanted pregnancies?

1.3) What are the contextual factors that influence how women manage their fertility via contraceptive use over their reproductive life-course?

Aim 1 is a qualitative, hypothesis generating study.

Aim 2

Using cross-sectional data from the fourth wave of data collection, examine the relationship between experienced infertility, perceived chance of future pregnancy, and contraceptive use.

Sub-aims:

2.1) Describe the prevalence of and characteristics of women and men who report experiencing infertility and how they differ from women and men who have not experienced infertility.

2.2) Describe the characteristics of women and men who report various levels of certainty of their ability to become pregnant and how they differ from women and men who do not perceive a low chance of pregnancy.

2.3) Examine the association between experienced infertility and contraceptive use among women.

2.4) Examine the association between certainty of ability to become pregnant and contraceptive use among women.

Hypotheses:

2.1) Women and men who report that they have experienced infertility will be older and have more children than women and men who do not report infertility.

2.2) Women and men who perceive a low chance of pregnancy will be older, have fewer children, and less education than women and men who do not perceive a low chance of pregnancy.

2.3) Women who report that they have experienced infertility will be less likely to use contraception than women who have not experienced infertility.

2.4) Women who report that they have a low chance of pregnancy will be less likely to use contraception than women who do not perceive a low chance of pregnancy.

Aim 3

Using data from multiple waves of data collection, examine the relationship between ever experienced infertility and subsequent pregnancy and unplanned or unintended pregnancy. [1]

[1] We used a scale of unplanned pregnancy, however, the authors of the scale use the terms unplanned and unintended interchangeably in their work (Barrett et al., 2004).

Sub-aims:

3.1) Are women who have ever experienced infertility less likely to report a new pregnancy during the study period than women who have not experienced infertility?

3.2) Are women who have ever experienced infertility and have a new pregnancy during the study period less likely to have an unintended or unplanned pregnancy than women who have not experienced infertility?

Hypotheses:

3.1) Women who have ever experienced infertility will be less likely to report a new pregnancy during the study period than women who have not experienced infertility.

3.2) Among women who report a new pregnancy, women who have ever experienced infertility will have greater odds of reporting that their pregnancy was unintended or unplanned compared to women who have not experienced infertility.

Chapter 5: Context and Study Site

This study takes place in Rural Lilongwe District, Central Region, Malawi (Figure 4). People in the Central Region of Malawi are primarily of the Chewa ethnic group and practice various denominations of Christianity, although often intermixed with traditional religious practices. Economically, the country is relatively poor with a per capita gross domestic product (GDP) of $323 USD. It ranks 37th of 54 countries in Africa according to GDP (*The World Bank, Malawi*, 2019). The median age in Malawi, is 17 – meaning that a large proportion of the population is of reproductive age or will be in the next decade. The average age of first marriage is reported to be 18 for women and 23 for men (National Statistics Office (NSO) [Malawi] and ICF, 2017).

Marriage and divorce

Although there is not a rigid tradition of marriage in Malawi, it is still ubiquitous. By age 30, less than 2% of women have never been married (National Statistics Office (NSO) [Malawi] and ICF, 2017). The average age of first birth for women in Malawi is 19, approximately one year after marriage. Divorce and remarriage are also common (Kaler, 2016; Reniers, 2003). Reniers (2003) found that the life-time hazard of divorce was between 40-65% in Malawi and that 75% of women re-married within five years of a divorce. Another study suggested that marriages that were less economically beneficial were more likely to result in divorce (Cherchye et al., 2016).

Divorce has a differential impact on women and men. Although in the Central Region of Malawi, marriage traditions are both matrilocal and patrilocal (meaning that at the time of marriage, the husband may move to the wife's village or the wife may move to the husband's

village) (Reniers, 2003), women are more likely to lose status – material or otherwise – after a divorce. Polygamy is relatively common in Malawi, particularly in a second or higher-order marriage for women. Polygamous unions are complex, but one study in Malawi found that women in higher-order polygamous relationships were less likely to reside with their partner, which could impact the stability of the relationship as well as women's access to resources (Reniers, 2003). Multiple marriages have also been associated with an increased risk of HIV infection among women in Malawi (Muula, 2010). In Malawi, divorce is inversely associated with parity, such that for every additional child within a relationship, the likelihood of divorce decreases (Cherchye et al., 2016).

Historically, child marriage in Malawi is common. Marriage before the age of 18 years only became illegal in all circumstances in 2017 (*Ending Child Marriage in Malawi*, 2017). The rates of child marriage in Malawi are some of the highest in the world (and 9th highest in sub-Saharan Africa). The shifting legal status of child marriage, as well as the commonality of informal marriage that is governed locally, means that child marriage is also likely underreported. Child marriage disproportionately impacts girls (i.e., girls under age 18 are married to men over age 18 years) and is often associated with early childbearing, increased risk of maternal mortality, increased risk of intimate partner violence, and lower levels of educational attainment (Lee-Rife, 2012)

Fertility and childbearing

Fertility and infertility are experienced within the broader social context of marriage, family formation, and gendered expectations. The total fertility rate in Malawi, at 4.4 children per woman, exceeds the reported wanted fertility rate of 3.4 children per woman. Despite a

steady decline in unmet need for contraception (19% of women as of 2015-2016), approximately 30% of pregnancies in Malawi are mistimed and an additional 11% are considered unwanted (National Statistics Office (NSO) [Malawi] and ICF, 2017). Malawi also has one of the highest maternal mortality ratios in sub-Saharan Africa, at 439/100,000 live births (Mandiwa et al., 2018).

Malawi's relatively high total fertility rate and the discrepancy between total fertility and wanted fertility obscures the fact that Malawi also has a high self-reported rate of infertility. Two studies in different areas of Malawi that took place over ten years apart found that approximately 20% of women (Rao) and 20% of women and men (Barden-O'Fallon) reported ever experiencing infertility (Barden-O'Fallon, 2005b; Rao et al., 2017). While neither of these studies were representative of the total population, the findings indicate that infertility may be a common experience in Malawi. Sub-Saharan Africa is widely considered to have one of the highest rates of infertility globally.

Women are disproportionately impacted by the health consequences of unintended pregnancy in Malawi (e.g., they may have increased risk of maternal morbidity and mortality) (Tsui et al., 2010) and may also bear the responsibility and consequences of infertility, regardless of whether or not they are the infertile partner (Greenhalgh, 1995; Remennick, 2000; Whiteford & Gonzalez, 1995; Woods et al., 1991). Women are also frequently responsible for securing contraceptive methods and using them effectively, although efforts have been made to promote the inclusion of male partners and recognize the role of men's fertility preferences (Evens et al., 2015; Shattuck et al., 2011; Yeatman & Sennott, 2014).

Both infertility and unintended pregnancy are stigmatized and associated with negative social and health outcomes in Malawi. Contraceptive use is common: 59% of married women

and 44% of sexually active unmarried women use a method of contraception (National Statistics Office (NSO) [Malawi] and ICF, 2017). The contraceptive method mix is skewed toward the injection method (30% of married women use injection and 15% of unmarried women), and few women report using non-modern methods of contraception (1%) (National Statistics Office (NSO) [Malawi] and ICF, 2017). Consistent use of contraception, however is difficult to measure (Dasgupta et al., 2015). The DHS reports that 41% of injection users stop using the method within one year of adopting it (National Statistics Office (NSO) [Malawi] and ICF, 2017). Abortion is illegal and highly stigmatized (Levandowski et al., 2012). Both contraceptive use and abortion are also cited by women and men as possible causes of infertility in Malawi and elsewhere (Bornstein, Huber-Krum, et al., 2020; Koster, 2010; Tabong & Adongo, 2013b). A recent study found that at least some of the stigma associated with infertility was related to the unacceptability of the presumed causes (e.g., abortion) (Bornstein, Gipson, et al., 2020).

Although the importance of fertility may be hypothesized to decline as parity and age increase, the commonality of remarriage in Malawi may prompt a renewed importance of demonstrating fertility within a new partnership. Childbearing is viewed as a way to solidify a relationship and childless unions are considered fragile in many contexts (Tilson, 2000). Because of the commonality of divorce and remarriage in Malawi, and the need to be fecund in order to be marriageable, particularly for women, maintaining fertility over the reproductive life-course may be valued more highly than in other settings.

Sex preference

Like in other settings, there are diverse motivations for childbearing in Malawi, including achieving the desired sex composition of the family. It is generally considered favorable to have

both sons and daughters, as each play a different role in the well-being of the family. A study in Malawi showed that a desire to have a balance between sons and daughters was associated with higher fertility (Adebowale & Palamuleni, 2015).

Land ownership

Land ownership in Malawi is also gendered. Women view themselves as vulnerable when it comes to land ownership and inheritance due to traditional practices of men owning land, particularly when women are living patrilocally after marriage (Kaarhus, 2010). However, even when living matrilocally, women are still unlikely to own or inherit land due to cultural practices that allocate land outside of a national legal framework, which does allow women to own and inherit land (Kaarhus, 2010).

Study site

This study was conducted in a rural community in Central Malawi. The study site mirrored the larger population of rural Malawi in that most residents were subsistence farmers with low levels of education. As of 2014 when the study began, approximately three-quarters (73%) of the cohort earned less than two dollars per day (Rao et al., 2017). Additionally, just 4% of the cohort had access to piped water and 70% lived in a home with a non-metal roof (Norris et al., 2016).

Almost half of women in the cohort (46%) identified as having a functional limitation/disability and 20% reported ever experiencing infertility, or a period of trying to become pregnant unsuccessfully for at least two years (Rao et al., 2017). The location of the cohort within Malawi is shown in Figure 4 (Norris et al., 2016).

Figure 4. Study site location in Malawi

Figure 1b. Malawi with Traditional Authority Kalolo marked
279x279mm (300 x 300 DPI)

Chapter 6: Study Design

Cohort study

Data for this study come from the *Umoyo Wa Thanzi* (UTHA; Health for Life) research program, a cohort study focused on sexual and reproductive health decision making among women and their male partners in Central Malawi. The research program was developed by researchers at The Ohio State University in collaboration with a private hospital in Rural Lilongwe District, Malawi and the Malawi College of Medicine. The cohort was recruited from the catchment area (approximately 20,000 residents) of a rural, non-profit hospital in 2013 after a complete household census of the area. In total, the 68 villages within the catchment area were collapsed into 43 clusters based on size and geographic proximity. The clusters were then stratified into three geographic groups: rural, plantation, and trading center. Within these three categories, 11 clusters (19 villages) were randomly selected for inclusion in the cohort, resulting in eight rural, one plantation, and two trading center clusters (Huber et al., 2017).

All women aged 15-49 years residing in the selected 11 clusters were eligible to participate. Overall, there were 1,502 households within the selected clusters, however, 35% of households did not have an eligible woman and 4% of women declined to participate. The overall response rate was 96% in Wave 1 (N=1,030). Upon enrollment, women were invited to provide information about their primary male partner so that he could be contacted and invited to enroll in the study. All participants with partners (N=841) gave information for their partners and 441 male partners subsequently enrolled in the study. Despite numerous attempts, the research team did not successfully make contact with the 400 men who did not enroll due to long periods of time spent outside of the home engaged in work (Norris et al., 2016). In total, there were 1,471 participants in Wave 1 (N=1,030 women and 441 male partners).

Subsequent data collection occurred in Wave 2 (2015), Wave 3 (2016-2017), Wave 4 (2017-2018), and Wave 5 (2019). There was new enrollment at follow up Waves 3 and 4 of people in the cohort villages who were eligible for the study, but had not previously enrolled. New participants were enrolled through a convenience sample. When the data collectors presented in a village, residents were invited to be screened for eligibility. At Wave 4, men were eligible to join the study whether or not they were partnered with a female cohort member. At Wave 5, only women were invited to participate and there was no additional study enrollment. Only women who participated in at least one previous wave were eligible at Wave 5.

Using Wave 1 as the reference point, there was an 83% retention rate between Waves 1 and 3; 76% between Waves 1 and 4; and 63% between Waves 1 and 5 among women (Table 1). It is not appropriate the calculate a retention rate between Waves 1 and 2, as Wave 2 included only a select group of participants from the cohort. Given that men are included only at Wave 4 in this dissertation (Study 2) when there was significant new enrollment of male participants, it is also not appropriate to calculate a retention rate among men.

Table 1. Sample size for each wave and retention rate between Wave 1 and subsequent waves

	Total N[1]	N of Wave 1 participants[2]	Retention rate from Wave 1 (%)[3]
W1 (2014-15)	1,030	1,030	-
W1 & 3 (2016-17)	859	857	83%
W1 & 4 (2017-2018)	1,159	781	76%
W1 & 5 (2019)	885	646	63%

[1]This column includes all participants from the wave, including those who were recruited after Wave 1.
[2]This column includes only those who also participated in Wave 1.
[3]Retention rates are calculated based on Wave 1 enrollment and do not include participants who entered the study for the first time after Wave 1.

As expected, among women who entered at Wave 1, the average age increased over the waves, as did the number of pregnancies and number of children that women reported.

Sterilization also increased substantially between each wave (Tables 2 and 3). Table 2 describes the socio-demographic characteristics of all women enrolled at each wave. Table 3 describes the socio-demographic characteristics of women at each wave who were retained from the group enrolled at Wave 1. Demographic tables for each of the analytic samples are included in the relevant chapters. Demographics of male participants are included in Study 2.

Table 2. Socio-demographic characteristics of women in each wave

	Wave 1 N=1,030	**Wave 3 N=859**	**Wave 4 N=1,159**	**Wave 5 N=885**
Age[1]	25.8 (14-41)	28.9 (16-51)	27.7 (15-45)	29.7 (17-46)
Missing (n)	4	31	74	32
# pregnancies	3.07 (0-12)	3.47 (0-13)	3.03 (0-13)	3.44 (0-12)
Missing (n)	82	1	0	5
# living children	2.29 (0-8)	2.83 (0-9)	2.63 (0-9)	2.93 (0-9)
Missing (n)	0	5	4	31
Married/living as married	83.0%	83.1%	78.0%	82.7%
Missing (n)	16	0	3	0
Sterilized	2.3%	8.7%	11.6%	16.4%
Missing (n)	4	0	1	0

[1]Fluctuations in age are due to reporting errors; subsequent analyses use age reported at Wave 1, which is considered the most accurate.

Table 3. Socio-demographic characteristics of women in each wave who entered at Wave 1

	Wave 1 N=1,030	**Wave 3 N=857**	**Wave 4 N=781**	**Wave 5 N=646**
Age[1]	25.8 (14-41)	28.9 (16-51)	29.9 (18-45)	31.4 (19-46)
Missing (n)	4	31	35	3
# pregnancies	3.07 (0-12)	3.47 (0-13)	3.64 (0-13)	3.90 (0-12)
Missing (n)	82	1	0	4
# living children	2.29 (0-8)	2.83 (0-9)	3.14 (0-9)	3.25 (0-9)
Missing (n)	0	5	0	10
Married/living as married	83.0%	83.2%	83.9%	83.1%
Missing (n)	16	0	0	0
Sterilized	2.3%	8.6%	15.8%	20.4%
Missing (n)	4	0	0	0

[1]Fluctuations in age are due to reporting errors; subsequent analyses use age reported at Wave 1, which is considered the most accurate.

Each wave of data collection included survey modules that were consistent across waves (demographic, relationship dynamics, reproductive decisions, and contraceptive use), as well as new modules developed from on-going analyses and emerging interests and priorities (Table 4). Prior to Wave 1, a qualitative study was conducted which informed the initial survey. For all waves, new survey items were piloted prior to the beginning of data collection.

Main constructs

Studies two and three have key independent and dependent variables constructed from the UTHA survey data. Specific issues of data management and coding are discussed in the relevant chapters. Briefly, the following constructs and survey items shaped these studies.

Study 2

The second study examines the relationship between experienced infertility and contraceptive use, as well as perceived certainty of pregnancy and contraceptive use.

Self-reported ever experienced infertility was defined as attempting to becoming pregnant for two years or longer without conceiving in that time. The survey question asked: *"Have you ever tried to conceive a pregnancy for two years or longer without conceiving in that time?"* The response options were yes, no, do not know, and never tried to conceive.

Perceived certainty of pregnancy was defined as one's perception of their chance of becoming pregnant within one year of having sex and not using a contraceptive method. The survey question asked: *"If you were to have sex and not use any method of contraception, how likely is it that you would become pregnant in the next year?"* The response options were no

chance, unlikely, likely, certain, and do not know. This was a pilot measure, as no validated measures of perceived certainty of pregnancy currently exist.

Current contraceptive use was defined as whether or not the participant was currently using any method to prevent pregnancy. The survey question asked: *"Currently, are you using any method to avoid pregnancy in your relationship, whether it is a traditional or modern method?"* The response options were yes or no.

Study 3

The primary constructs in the third study included self-reported experienced infertility (defined and measured in the same way as Study 2), incidence of a new pregnancy after Wave 1 of data collection, and pregnancy planning.

Incident of a new pregnancy after Wave 1 was defined as any new pregnancy reported in Wave 3, 4, or 5 of data collection. The variable was constructed by subtracting the total number of pregnancies a woman reported at each follow up wave from the number she reported at Wave 1.

Pregnancy planning was defined using the London Measure of Unplanned Pregnancy (LMUP). This six-item scale was originally developed after conducting qualitative research and testing the scale in a sample in western Europe (Barrett et al., 2004). Qualitative findings suggested there were six dimensions of pregnancy planning, including:

> *"(1) Expressed intentions; (2) desire for motherhood; (3) contraceptive use; (4) pre-conceptual preparations; (5) personal circumstances/timing; and (6) partner influences"* (Barrett et al., 2004).

The Cronbach's alpha was 0.92 and the re-test reliability was 0.97, indicating that the measure was highly reliable and measured a consistent construct (Barrett et al., 2004). The scale was subsequently tested and validated in additional languages and contexts, including a slightly modified version in Chichewa in Malawi, where the Cronbach's alpha for the six-items was 0.78 and the re-test reliability was 0.80, indicated relatively strong reliability and construct validity (J. A. Hall et al., 2013). An English translation of the Chichewa version of the LMUP is included in Chapter 9.

Table 4. UTHA data collection years and wave-specific modules[1]

Wave 1 2014-2015	Wave 2[2] 2015	Wave 3 2016-2017	Wave 4 2017-2018	Qualitative 2018	Wave 5 2019
• Baseline data • Resource inventory • Household composition • Reproductive history	• Biomarkers	• Contraceptive knowledge • Contraceptive side-effects	• Contraceptive history • Barriers to contraceptive use	• Experiences and perceptions of infertility/ difficulty becoming pregnant • Fertility norms and experiences • Experiences managing fertility	• Sexual pleasure/ function • Fertility perception • Infertility stigma • Unintended pregnancy stigma • Pregnancy intentions/ planning • London Measure of Unplanned Pregnancy

[1]All waves included modules on socio-demographic characteristics, relationship dynamics, reproductive decisions, and contraceptive use.
[2]Wave 2 data are not included in this dissertation.

Data collection

At each wave of data collection, the surveys were developed in English and then translated into Chichewa through an iterative process with both English-speaking and bilingual English-Chichewa team members. Translations were reviewed for meaning, with the final wording determined through collaborative consensus (Colina et al., 2016). Participants gave verbal and written consent to participate and re-consented at each wave. Participants were compensated with MK 1,500-2,000 (approximately $1.50-2.00 USD) at each wave. This study was approved by the Institutional Review Boards (IRB) at The Ohio State University, University of California – Los Angeles, and the Malawi College of Medicine.

All surveys were conducted in Chichewa by Malawian research assistants who spoke Chichewa as their native language. Prior to data collection, the researchers were trained and assessed for competency in survey research and research ethics. The surveys were tablet-based and used Magpi electronic survey software (Magpi, Washington DC, USA). The research team administered the surveys in-person at the participants' home or in another private space chosen by the participant. The questionnaires varied in length depending on the wave, taking from 45 to 120 minutes.

Qualitative study

The qualitative study included in this dissertation occurred from July-September 2018 and utilized focus group discussions (FGDs) (women and men) and in-depth interviews (IDIs) (women) of reproductive age (15-49 years). The overall aim of this study was to understand how women and men perceived and understood infertility, the individual and community-level consequences of infertility, and how people managed their fertility through contraceptive use and

other practices. During data collection, we explored new themes as they emerged in subsequent focus groups and in-depth interviews (e.g., contraceptive use patterns, sexual pleasure, and time-to-pregnancy norms). This dissertation uses the in-depth interview data only, as findings from the focus group discussion have been published elsewhere (Bornstein, Gipson, et al., 2020). However, I will briefly describe the FGD portion of the study because findings from the FGDs informed the in-depth interview guides and recruitment.

As with the cohort study, this study was also approved by the Institutional Review Boards (IRB) at The Ohio State University, University of California – Los Angeles, and the Malawi College of Medicine. All participants provided verbal and written consent prior to participation and were compensated MK 2,000 (approximately $2.00 USD).

Focus group discussions

We conducted 12 FGDs (6 male; 6 female) in 11 villages from July-September 2018. Each had 8-10 participants and lasted for 90-150 minutes. In total, 104 people participated (n=53 women; n=51 men). Groups were homogenous by sex to help ensure that participants were among peers and would feel comfortable speaking openly. Half of female and male FGDs were with older participants (approximately ages 30-39 for women and 35-48 for men) and half were with younger participants (under age 30 for women and under age 35 for men).

FGDs took place in villages that were located within the UTHA/hospital catchment area, but are not included in the 11 UTHA cohort clusters to lessen the burden on cohort participants and to mitigate potential bias in the data from repeated exposure to data collection about reproductive health and behavior. FGD villages were selected purposively based on proximity to the hospital (both near and far from the hospital as a proxy for ease of accessing healthcare).

Individuals were eligible to participate if they were not pregnant (women) and were ages of 15-49 years. Before conducting the FGDs, the research team met with village chiefs for permission to conduct FGDs in the village and for assistance with recruiting eligible participants.

The focus group discussion guides intentionally started out broadly, asking participants to describe the meaning of childbearing in their community. This led to discussions about what it meant to have or not have children when expected. The guides were flexible, allowing us to make adjustments during data collection based on feedback from facilitators and emerging findings. Two vignettes were included in the focus group guides to allow participants to respond to realistic scenarios regarding experiences of difficulty becoming pregnant and infertility.

Focus group discussion analysis

We analyzed the data using a holistic approach that started during data collection. During team debrief meetings, we began the process of organizing and interpreting new findings (Glaser, 1965). Notes from these meetings were included as part of the dataset. Additionally, research assistants who collected, translated, and transcribed the data provided insights and context during data collection and analysis (e.g., providing insight into non-literal translations, interpreting findings). Their role as collaborators and cultural translators helped ensure that our interpretations are firmly grounded in the data.

We also developed topic-based memos synthesizing emerging themes within the data throughout data collection and analysis. We used the memos and FGD guides as an initial codebook framework (Saldaña, 2016). Two researchers independently coded two transcripts and met to develop a structured codebook with comprehensive code definitions. This coding scheme was then applied to the remaining transcripts. All codes were reviewed constantly during coding

to ensure consistency and structural logic. We used a mix of thematic, in vivo, and pattern codes (Hennink et al., 2011; Saldaña, 2016). Data were managed and coded using Dedoose version 8.0.35.

In-depth interviews

Once we reached saturation in the focus group discussions, we used the findings to develop an in-depth interview guide aimed at eliciting individual experiences around fertility, contraceptive use, and pregnancy. We conducted in-depth interviews with women only because in the focus groups women tended to have more nuanced insights into the issues we discussed. Other studies from Malawi have shown that women have better recall regarding health events, particularly events where women are central, such as contraceptive use and pregnancy (Miller et al., 2001).

In-depth interviews followed a reproductive life-history approach. Research assistants used major reproductive events as pillars (e.g., the birth of a child) to discuss women's experiences and actions before and between such events. For example, after being told about the birth of a second child, the interviewer would probe to find out about experiences and actions between the first and second child (did the participant use contraception? When/why did they stop? Did they have any pregnancies in between the first and second child? Etc.). The in-depth interview topic guide is included in Appendix A.

As part of the interview process, the interviewer took notes and developed a written reproductive timeline to organize the events, beginning with first sexual partner and ending at the present time. The interviews were also recorded, translated, and transcribed independently by two trained researcher assistants. Interviews lasted 30 to 60 minutes and took place in the

participant's home or another private space of the participant's choice, with no other household members present.

In-depth interview sampling

We conducted in-depth interviews with 20 women who participated in Wave 4 (2017-2018) of the UTHA cohort study. Sampling was conducted in three steps (Table 5). First, using responses from the Wave 4 survey, women were selected as in-depth interview participants if they were under 40 years of age, partnered, had at least one child, and wanted more children in the future. We chose to interview women who were partnered and had at least one child so that they would be able to speak to their experiences before, during, and after pregnancies, including their past and anticipated ease or difficulty becoming pregnant. From the FGDs, we knew that recruiting participants who presented as infertile (i.e., were substantially past the average age at first birth and did not have any children) would be difficult and potentially stigmatizing. Therefore, we focused on recruiting participants who identified as having various degrees of difficulty becoming pregnant by purposively recruiting women who reported it was easy or difficult to become pregnant compared to others.

Given the cultural expectations of having children within marriage, we interviewed women who were currently married or were living with a partner. We also wanted to ensure that the women we interviewed were aware of and had experience with family planning methods. We chose to interview participants who were not pregnant during Wave 4 or between Wave 4 and the time of the interview, to ensure that the perspectives women shared would be comparable. Women were also excluded if they were over age 40, in order to focus on women who were actively navigating reproductive decisions with regard to preventing and achieving pregnancy.

We further narrowed the sample by randomly selecting villages where at least 10 eligible women lived in stage 2, and then through purposive selection in stage 3 (Table 5). When a woman was not available for an interview, an alternate woman who met the inclusion criteria was selected. Ultimately, we conducted 20 in-depth interviews and stopped data collection when we reached saturation on the main research questions. Participant characteristics are including in Table 6.

Table 5. In-depth interview participant sampling scheme

Stage	Selection criteria	N
1: Selection based on Wave 4 data	• Married/living with partner • At least one child • Wanted another child (ever) • Ever used a method of contraception • Not sterilized • Not pregnant • Reported becoming pregnant was either 'easy' or 'difficult'	365
2: Identify villages	• Nine villages had at least 10 eligible women • Randomly selected 7 villages to conduct interviews	190
3: Select participants and alternates	Participants and alternates were selected to ensure variation of: • Age • Parity • Difficulty/ease of becoming pregnant	45
Total number of interviews		**20**

Table 6. In-depth interview participant characteristics (N=20)

	Mean	**Range**
Age (reported at IDI)	28.9	22-38
Number of Children (reported at IDI)	2.75	1-5
	%	**N**
Experienced infertility[1]	20%	4
Becoming pregnant is…		
Difficult compared to others	45%	9
Easy compared to others	55%	11

[1]Tried to become pregnant for a period of two or more years without becoming pregnant

In-depth interview analysis

I used a two-stage analytic approach, combining a method of indexing and qualitative coding. In the first stage I indexed, or summarized the content of the transcripts according to broad themes (Ritchie & Lewis, 2003). Themes were first identified from the interview guide and the reproductive timelines generated in the interviews. The index themes included: (1) actions before and between pregnancies (e.g., contraceptive use), (2) intention/disposition toward becoming pregnant before and between pregnancies, (3) non-live births and miscarriage experiences, (4) difficulty/ease of becoming pregnant, and (5) experiences with contraceptive methods and reasons for switching or discontinuing a method. Indexing prior to coding allowed us to establish the chronology of events and experiences for each participant (Ritchie & Lewis, 2003), even though participants did not necessarily discuss events chronologically. Indexing also ensured that each interview was reviewed as a unit and I took notes and developed analytic memos based on the context around each theme. Each of the 20 interviews were summarized according to five themes, for a total of 100 summaries.

In the second stage of analysis, I coded the transcripts in Dedoose using a combination of narrative, process, and thematic coding. Narrative coding helped identify *how* participants talked about their experiences. Narrative coding is typically used in ethnographic and life-history research to analyze how people tell their stories from multiple different view-points (Abrams, 2016). In contrast, process coding helped to identify transitions in the reproductive life-course and how women moved between different states (e.g., using contraception, pregnancy). Process codes were also applied to decisional processes or actions (e.g., initiating contraception). Thematic codes identify broad topics that women discussed or concrete events. The in-depth interview coding structure is included in Table 7. Examples of narrative codes include

'difficulty/ease of pregnancy' and 'infertility (hypothetical or experienced).' Examples of process codes include 'contraception between pregnancies – action and cognition/affect' and 'contraception before first pregnancy.' Examples of thematic codes include 'experience with contraceptive method' and 'information from others.'

Table 7. In-depth interview coding scheme

Code/ sub-code	Description
Chronology	Discussion or clarification of when an event occurred (either by month/year or 'before'/ 'after' another event)
Interviewer summary	Apply when the interviewer is repeating back or summarizing the participants words
Demographic information	Apply when interviewer confirms demographic characteristics (e.g., age, relationship status)
Children	Reference to the number of children, birth order, or year of birth
Pregnancies	Discussion of the number of pregnancies, order, years, and pregnancy outcomes
Couple dynamic/relationship	Discussion of communication with partner or partner's influence, opinions, or preferences; also apply to discussion of sex, marriage, polygamy, and divorce
Extramarital	Reference to sex with someone outside of primary relationship (e.g., infidelity or achieving a pregnancy with another partner)
Metaphor	Apply when participant uses a metaphor
Place to get contraception	Apply when participant discusses where or how they obtained contraception
Contraception before first pregnancy	Any reference to use of contraception, traditional or modern, before a first pregnancy (or before a first pregnancy with a new partner)
Contraception between pregnancies	Discussion of the time between pregnancies (apply per sub-code definitions)
Action	Actions between pregnancies (not including before a first pregnancy), including contraceptive use, sexual activity, etc.
Cognition/affect	Feelings or thoughts between pregnancies (e.g., desire to delay or achieve a pregnancy, deciding to use contraception or not, ambivalence, etc.)
Experience with contraceptive method	Reference to experience with a specific method of contraception (e.g., if and why they liked a method)
Reason for method use/nonuse	Explicit discussion of reasons for using or not using a method (apply based on method discussed)
Condom	Condom
Injection	Injection

Code/ sub-code	Description
Loop (IUD)	Loop (IUD)
Norplant (implant)	Norplant (implant)
Pills	Pills
Sterilization	Sterilization
Non-modern method	Non-modern methods (e.g., lactation amenorrhea, herbs)
Difficult/ease of pregnancy	Discussion or characterization of the process of becoming pregnant or trying to become pregnant, including unintended pregnancies
Infertility (hypothetical or experienced)	Discussion of infertility or difficulty becoming pregnant, including experiencing infertility, self-perceptions of infertility, trying to determine if they were infertile, or how they reacted/would react to infertility
Unintended pregnancy (hypothetical or experienced)	Any discussion of an unintended pregnancy, including experiences of unintended pregnancy and contextual factors, reaction to unintended pregnancy, or desire to prevent unintended pregnancy
Wanting/not wanting future children	Any discussion of desire to have or not have more children in the future, including discussion of number of children desired, sex composition, and desired timing for future pregnancies/children
Information from others (formal or informal)	Any advice or information received regarding pregnancy, fertility, contraception, etc. (friends, family, health care workers, traditional healers, etc.); includes unsolicited advice or information
Masungu	Any reference to masungu

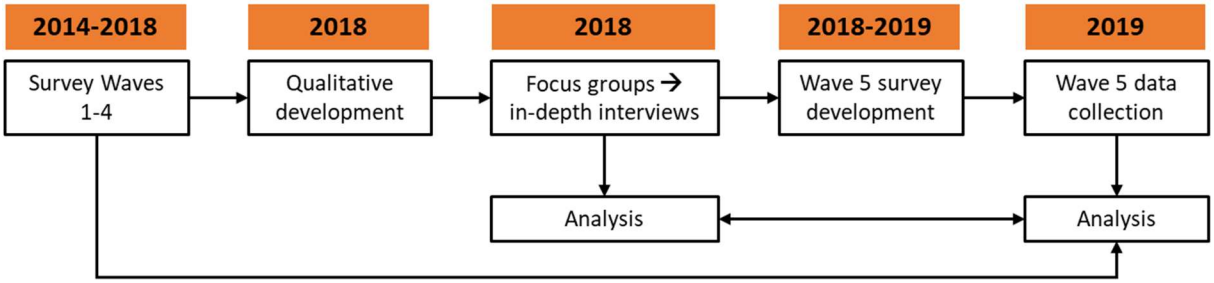
Mixed-methods approach

This dissertation integrates multiple waves of data from a large cohort study conducted from 2014-2019 and an embedded qualitative study (2018) to address the research aims described in Chapter 4. The mixed-methods study design is well suited to the breadth of research questions and hypotheses in this study, as I am examining phenomena that are not well understood, not easily measured, and have not been studied in-depth in the context of Malawi previously (Axinn & Pearce, 2006).

This study is a hybrid exploratory-explanatory mixed-methods design (Cresswell & Plano Clark, 2018). Qualitative data collection is embedded between Waves 4 and 5 of the cohort study. Findings from Waves 1-4 informed the design of the qualitative study which, in turn,

informed the design of the Wave 5 survey (Figure 5). A traditional explanatory mixed-methods approach leads with quantitative data collection and analysis and is followed by qualitative data collection and analysis. In contrast, a traditional exploratory approach begins with qualitative data collection and analysis, followed by quantitative (Cresswell & Plano Clark, 2018). A strength of the hybrid design with qualitative data collection embedded within the survey data collection is that it allowed us to develop a study that is both theoretically and empirically grounded. The qualitative study introduced new topics (e.g., focusing on infertility and contraceptive management) and provided rich and detailed accounts of how infertility was perceived and experienced, how ideas about fertility and infertility shaped contraceptive decisions, and the contextual factors that influenced such decisions. From these findings, we developed survey items that were grounded in the data to understand overall patterns within the cohort around infertility and contraceptive management that we would otherwise not have had the insight to develop.

Figure 5. Overall mixed-methods study design



The methods used in each phase were directly informed by the nature of the research questions. For example, data from Waves 1-4 were insufficient for us to understand *how* infertility was perceived and experienced within the context of people's lives and communities.

The responses in Waves 1-4 indicated that infertility, or the experiencing of trying for two or more years to become pregnant without becoming pregnant in that time, was common (20% of women). The responses to questions around perceived subfecundity were also highly skewed, but in the opposite direction. The overwhelming majority of participants felt that they were likely or certain they could become pregnant within a year. These findings led us to believe that we were not capturing how people perceived and experienced infertility, and that our survey items were inadequate. The research questions we developed necessitated a qualitative study.

In the qualitative study, we also used a mixed-qualitative methods sequential approach, beginning with focus group discussions which provided the language and information necessary to conduct in-depth interviews. The focus group discussions yielded broad ideas about infertility and perceived fecundity, as well as community norms around fertility broadly. Findings from the focus groups allowed us to narrow in to relevant in-depth interview topics and informed our decision to use a life-history approach. The in-depth interviews allowed us to understand how broad issues around infertility and the context of community norms applied to women's experiences.

The qualitative findings heavily informed the development of the wave 5 survey. Based on the qualitative findings, we developed new survey items, including the development and piloting of a scale to measure perceived susceptibility, severity, and fear of infertility, to better capture the concepts discussed in focus groups and interviews. This allowed us to see how the concepts discussed qualitatively could be measured within the larger cohort sample.

Chapter 7 (Study 1): *"I know my body and I just can't get pregnant that easily"* – women's use and non-use of the injection to manage fertility

Introduction

Fertility norms have changed dramatically in Malawi over the past several decades; the total fertility rate reduced from 6.3 to 4.4 births per woman between 2000 and 2016 (National Statistics Office (NSO) [Malawi] and ICF, 2017). Unmet need for contraception, or the percentage of women who are not using contraception but would like to postpone or limit pregnancies, has decreased from 30% in 2000 to 18.7% in 2016 (National Statistics Office (NSO) [Malawi] and ICF, 2017). Despite these changes in fertility and contraceptive use, women consistently report a desired family size that is smaller than their current family size by about one child (National Statistics Office (NSO) [Malawi] and ICF, 2017). This indicates that fertility reduction and decreasing family size norms are shifting in tandem, yet the disparity between women's fertility and their wanted fertility remains.

The population-level trends around fertility and contraceptive use mask the ways in which high expectations around fertility and pronatalism have persisted over time. Childbearing is integral to life in Malawi and a key expectation of marriage (Dyer, 2007; Reniers, 2003). The context of simultaneously highly valued fertility and changing fertility norms contributes to the challenges of assessing the congruence between pregnancy desires and outcomes. Fertility desires of an individual change based on a number of evolving factors, including relationship formation or dissolution, household finances, and pregnancies (Sennott & Yeatman, 2012). A quantitative study among women ages 15-39 years in the *Umoyo Wa Thanzi* (UTHA) cohort found that a third (32%) of women were "indifferent" toward pregnancy, meaning that they did not want to become pregnant, but also did not want to prevent a pregnancy (Huber et al., 2017). A qualitative study in Malawi found that women ages 18-24 years frequently did not want to

become pregnant, but also reported that becoming pregnant would be acceptable to them (Gomez et al., 2018). Taken together, these studies suggest that women in Malawi have complex orientations toward pregnancy and that attitudes outside of the typical binary – wanting to prevent or achieve pregnancy – are common. Thus, the traditional paradigm researchers use to classify pregnancies as planned versus unplanned or intended versus unintended may be incongruent with how women experience and think about pregnancy. Additionally, several studies in Malawi have demonstrated that a prospective pregnancy intention question on a survey may not be aligned with the multi-dimensional feelings people have toward a pregnancy when one occurs (Gibby & Luke, 2019; Gomez et al., 2018; J. A. Hall et al., 2019).

While understanding fertility desires is complex, we do know that contraceptive use in Malawi is common. As of 2015-2016, 59% of married women were using a form of contraception (58% modern methods) and about a third (30%) of women reported using the Depo-Provera injection method (National Statistics Office (NSO) [Malawi] and ICF, 2017). However, excess fertility remains prevalent, indicating that contraception, even when used, may not be meeting women's needs. Two studies in Mozambique found that decisions to prevent or pursue pregnancy were ongoing and guided by overarching, long-term goals as well as temporal phenomena, such as changes in relationship status or income, rather than guided by a specific plan of when to have children and when to stop having children (Hayford & Agadjanian, 2017, 2019). The juxtaposition of long-term goals and responsiveness to immediate circumstances may create a tension that influences contraceptive use, contraceptive method continuation, and, ultimately, women's reproductive self-determination.

In this qualitative study, we investigate how women use the Depo-Provera injection (hereafter referred to as injection) as a method of contraception and as a tool to manage their

ability to prevent and become pregnant when desired. The injection is the most common method of contraception used in Malawi (National Statistics Office (NSO) [Malawi] and ICF, 2017), as well as in the UTHA cohort, where 42.5% of women reported using the injection in 2017-2018 (Huber-Krum et al., 2021). The injection, which prevents pregnancy through suppressing ovulation, has unique qualities as a contraceptive method. It is a method that protects against pregnancy for three months and must be reinjected every three months for continued protection (Hatcher, 2018). Clinical guidelines recommend that women have a two week "grace period" to receive their injection if they miss their scheduled dose. Although some studies suggest that a four-week grace period may be appropriate given low rates of pregnancy after two weeks (Baumgartner et al., 2007; Steiner et al., 2008). However, after the grace period, women are unable to reinject until they menstruate, leaving them vulnerable to pregnancy (Steiner et al., 2008). Reinjection every three months constitutes "perfect" use of the method to optimally prevent pregnancy, but it may not be aligned with how women use the method. One study, using data from the Karonga demographic surveillance site in Northern Malawi, found that approximately half of women who initiated the injection did not receive their second injection at the indicated time, and 85% of women discontinued the method after one year (Dasgupta et al., 2015). The study also found that fertility desires were not associated with contraceptive adherence (Dasgupta et al., 2015). Moreover, nationally-representative Demographic and Health Survey (DHS) data indicate that 41% of women in Malawi discontinue the injection within one year (National Statistics Office (NSO) [Malawi] and ICF, 2017).

A second unique aspect of the injection is how it may reduce fecundity in the period after discontinuation. Although there is no evidence that the injection causes long-term infertility, there is evidence that it may reduce fecundity for up to eight menstrual cycles following

discontinuation, the longest of any contraceptive method (Yland et al., 2020). Another study, among women in Europe, found that women who discontinued the injection method because they wanted to become pregnant had a mean time-to-pregnancy of greater than one year (Hassan & Killick, 2004). Clinical guidelines have suggested that the injection is not appropriate for women who may want to conceived within two years because of its lingering effects on fecundity (Kaunitz, 1998).

Along with the biomedical attributes of the injection, contextual factors influence women's use of the method. The injection is female controlled and may be used covertly by women. Almost three-quarters (71%) of women in the UTHA cohort perceived that the injection was very or somewhat easy to use covertly, and the ability to use a specific method covertly was associated with 38% higher odds of preferring that method (Huber-Krum & Norris, 2020). A qualitative study in Ethiopia, Nigeria, and Uganda found that women used contraception covertly if their partner(s) did not agree that they should use contraception or if they generally considered contraception to be a woman's responsibility (Kibira et al., 2020). While it is important that women have the option to use contraception covertly and exercise their reproductive autonomy, it is also possible that the injection may strengthen the idea that contraception is solely a woman's responsibility and, in turn, reinforce the notion that women are to blame for the reproductive outcomes within their relationship, including unintended pregnancy, difficulty conceiving, or infertility.

There are pervasive cultural narratives around the injection in terms of how it works, its side effects, and how often or long women should use it to effectively prevent pregnancy (Bornstein, Huber-Krum, et al., 2020). These narratives are informed by the biological mechanisms through which the injection suppresses ovulation to prevent pregnancy and its

lingering effects on fecundity after discontinuation. The narratives around the injection are also based on side effects that women experience, including amenorrhea, unpredictable or frequent bleeding, weight gain, mood changes, and sexual side effects (Hatcher, 2018). A study at a district hospital in Malawi found that 40% of women who used the injection experienced amenorrhea, and that women who experienced amenorrhea were concerned about infertility (Mwafulirwa, 2016). In addition to these clinical side effects, evidence from Malawi, Ghana, the Democratic Republic of the Congo, and Kenya also demonstrate that women themselves may attribute a host of other symptoms and conditions to the injection, including physical weakness and general sickness, infertility, cancer, and male impotence (Chipeta et al., 2010; Hindin et al., 2014; Schwarz et al., 2019; Sedlander et al., 2018). Narratives around contraception – and the injection method specifically – as a cause of infertility are common in Malawi (Bornstein, Huber-Krum, et al., 2020; Chipeta et al., 2010). Such narratives may proliferate in settings like Malawi where infertility is highly stigmatized and where there is limited access to infertility diagnostics, treatment, or medical information about the causes of infertility (G. Becker & Nachtigall, 1992; A. V. Bell, 2016; Miall, 1986). As with other conditions that are not highly medicalized, the dearth of information around infertility in this context may create a vacuum wherein people attribute infertility – a stigmatized condition – to behaviors that may themselves be stigmatized, including contraceptive use and induced abortion (G. Becker & Nachtigall, 1992; Bornstein, Gipson, et al., 2020). While medically inaccurate, it is possible to see how narratives that attribute infertility to a contraceptive method are derived.

In this study, we conducted qualitative in-depth interviews to explore how women manage and monitor their fertility over their reproductive life-course and use the injection as a

tool to prevent pregnancy while ensuring that they maintain their ability to become pregnant when they want to.

Methods

Data collection methods and sampling are described in Chapter 6. Briefly, we conducted 20 in-depth interviews with women in Central Malawi from July-September 2018. The interview guides were developed based on focus group findings regarding perceptions and experiences of infertility with a similar population of women and men who also resided in the UTHA cohort catchment area. The in-depth interviews were designed using a life-history approach (Abrams, 2016) in order to understand women's personal experiences with family formation, family planning, and reproduction. Potential interview participants were provided with written and verbal information about the study and, if they agreed to participate, they provided written and verbal consent. All interviews were conducted in Chichewa by Malawian research assistants. Interviews were recorded, and subsequently translated and transcribed independently by two research assistants. Conflicts in the transcripts between the two independent translators and transcribers were reconciled by re-listening to the recorded interview to ensure accuracy. Once transcribed, the data were managed using Excel and Dedoose to facilitate content indexing and coding.

The full English/Chichewa in-depth interview guide is included in Appendix A. Three research questions guided the in-depth interviews guides and subsequent analysis:

1. **How do women make decisions around contraceptive use?**
2. **What are women's contraceptive use patterns in the context of high fertility/highly valued fertility?**
3. **What factors influence contraceptive decision making in this context? e.g.,**
    - Perceptions of fecundity (i.e., ability to become pregnant)
    - Perceptions of contraceptive side-effects that could impact future fertility

- Parity and met/unmet fertility desires
- Partner/relationship characteristics
- General demographic factors: age, socio-economic status, education, etc.

Based on these overarching research questions, we limited the interviews to women under age 40 years who were partnered and had at least one child. We used this selection criteria to maximize the likelihood that the women we interviewed were in the midst of making reproductive decisions and had past experiences of pregnancy. We purposively selected women with varying parity (1-5) and varying responses to the Wave 4 UTHA survey item regarding the ease/difficulty becoming pregnant (*"Considering your life, is it easier or more difficult for you to become pregnant compared to others?).* Participants were selected so that approximately half responded that they found it easier and half responded that they found it more difficult to become pregnant compared to others. Women who said becoming pregnant was "about the same" as others were excluded.

Interviews covered a wide-range of topics. Participants were first asked about anchoring life-events, such as children (*how many children do you have? What order were they born? How old are they?*), partners/marriages (*thinking back to before you were married, tell me about your first relationship? Do you remember when you first had sex? Who was your next partner?*), and contraceptive methods (*What methods have you used? Did you use a method between these two children? Why? When did you start and when did you stop? Why?*)

After the interviewer and participant established key anchoring events, interviewers asked women about time between events, focusing specifically on transition periods between events (e.g., starting/stopping contraception, method switching, time between pregnancies). Interviews focused heavily on periods of time before and between pregnancies, asking women to recall contraceptive use between pregnancies and their feelings and actions prior to becoming

pregnant (again) or preventing pregnancy indefinitely. Finally, women were asked about how they saw their future in terms of relationships, contraceptive use, child spacing and limiting, and factors that might influence their ability to fulfill their reproductive desires in the future.

We concluded data collection when we reached saturation of key themes (Guest et al., 2006). This allowed us to examine differences by key stratifying variables, specifically differences between the women who reported that pregnancy was "easy" or "difficult" to achieve (Hennink et al., 2017).

Analysis

I used a two-stage analytic approach, combining a method of indexing and qualitative coding (Ritchie & Lewis, 2003). In the first stage I indexed, or summarized the content of the transcripts according to broad themes (Ritchie & Lewis, 2003; Saldaña, 2016). In this study, I focus on specific index themes related to transition periods and contraceptive use, including: actions before and between pregnancies (e.g., contraceptive use), difficulty/ease of becoming pregnant, experiences with contraceptive methods, and reasons for switching or discontinuing a method. During the analysis I developed memos summarizing both broad themes across interviews and unique cases and shared them with the research team.

Indexing further assisted in developing women's narratives. Although the interviews followed a life-history approach, women did not discuss their lives in a chronological order. Women themselves interpreted their experiences as they shared them. Through indexing, I was able to develop a rough chronology of events for each woman in order to understand broad patterns across interviews, such as contraceptive use before a first pregnancy or signs of fertility after a birth.

The constant comparative method guided the coding stage of analysis (Glaser, 1965). I continually compared codes and coding sorts with the interview transcripts and index summaries to ensure that the analysis was grounded in the data and women's accounts. I coded the transcripts in Dedoose, using a combination of narrative, process, and thematic coding. Narrative coding helped identify *how* participants talked about their experiences. Narrative coding is typically used in ethnographic and life-history research to analyze how people tell their stories from multiple different view-points (Abrams, 2016). Examples of narrative codes include 'difficulty/ease of pregnancy' and 'infertility (hypothetical or experienced).' In contrast, process coding helped to identify transitions in the reproductive life-course and how women moved between different events. Process codes were also applied to decisional processes or actions (e.g., initiating contraception). Examples of process codes include 'contraception between pregnancies – action and cognition/affect' and 'contraception before first pregnancy.' Thematic codes were applied to broad topics that women across interviews discussed or concrete events, such as 'experience with contraceptive method' and 'information from others.' The in-depth interview coding structure is included in Chapter 6, Table 7.

In the analysis process, I continually balanced the tension between individual narratives and building themes across interviews, which is necessary when using in-depth interviews to understand processes which have components that are both highly individual, as well as common across individuals and groups. I used coding sorts to understand common themes and delved back into the interview transcripts to ensure that the analysis captured the nuance and context surrounding women's experiences and decisions.

In a final stage of the analysis, I focused on prominent themes, including how women managed their fertility through contraceptive use. It was evident that the injection method of

contraception was used not only as a way to prevent pregnancy at the time of use, but also as a way to manage fertility in the short- and long-term. This study explores this theme and relevant sub-themes in depth.

Results

The women interviewed (N=20) were between the ages of 22-38 years (mean: 29 years) and had an average of 2.75 children (range: 1-5 children). Four participants had experienced infertility (i.e., reported being unable to become pregnant for at least two years). As per the study design, about half (n=9; 45%) reported that it was difficult for them to become pregnant, the other half (n=11; 55%) reported that it was easy for them to become pregnant compared to other women (Table 8). Nearly all of the women (n=19) had used a method of contraception and, of those 19, all had ever used the injection (not shown).

Table 8. Characteristics of in-depth interview participants (N=20)

	Mean	**Range**
Age (reported at IDI)	28.9	22-38
Number of Children (reported at IDI)	2.75	1-5
	%	**N**
Experienced infertility[1,2]	20%	4
Becoming pregnant is…[2]		
Difficult compared to others	45%	9
Easy compared to others	55%	11

[1]Tried to become pregnant for a period of two or more years without becoming pregnant
[2]Reported in the UTHA Wave 4 survey

Several key themes emerged in the data, including the importance of knowing one's fertility before using the injection (and before using any method of contraception), using the injection as a tool to actively manage their fertility, and periodically testing their ability to become pregnant through delaying re-injection. There was an important and logical order to how

women managed their fertility that few deviated from: first women learned about their fertility through having children without using contraception, then they applied what they learned from how long it took them to get pregnant to make decisions about if and how they used the injection to regulate the timing of future pregnancies.

Knowing fertility

Women spoke of the value of learning about their fertility and the process of gaining knowledge about their fertility before using contraception. Women expressed that every woman's "natural" fertility (and her ability to become pregnant within a specific relationship) was unique. This perception underscored the importance that women placed on understanding their fertility before ever using contraception. Women viewed contraceptive use as something that could inhibit their ability to ever become pregnant in the future, which was particularly problematic if they did not yet have children. Once women knew about their fertility, typically through having two children, most of them initiated contraceptive use. With the injection in particular, women applied what they learned about their fertility through their experiences getting pregnant to make decisions about when they initiated the injection and how frequently they received subsequent injections. While women knew that healthcare workers instructed women to get the injection every three months, this was seen as standardized medical advice and, generally, a simplification of how the injection should really be used by women. Women felt that getting the injection every three months did not apply uniformly to all women because everyone's fertility was unique. One participant highlighted the varying effects that the injection could have on women's fecundity:

> "[Health care workers] advise us that some people can take time to get pregnant after using a lot of injection, others they may even take more than 2 years, while others just

> after they stop using the injection, they may get pregnant. It just depends on the body of the person." –*Judith*[2]*, age 38, 4 children, 'difficult to get pregnant*[3]*'*

Another woman described how getting the injection less frequently than every three months, as the healthcare provider instructed, was more compatible with her "natural" fertility. In this quotation, she emphasizes how everyone's fertility is different, which prompted her decision to wait to use contraception until she knew how easy or difficult it was for her to become pregnant. She shared her experience and how it impacted her choice to wait to get the injection until after having her second child. She said,

> "I know that for me to get pregnant is not that easy, so I am scared to use injection continuously in fear that I might not get pregnant again. That's why I skip some months. Others, they can get pregnant just soon after delivering [a child] and we say that *nsana wapafupi,* while others they can stay for a year or more to get another pregnancy and we call this *nsana ozama* or *nsana wapatali*. So, if you menstruate just [a] few months after giving birth it means you can get pregnant sooner and have to go and get contraception before you get pregnant, while for others like me that can't happen, we have to wait for a certain period of time to get pregnant again." –*Charity, age 28, 3 children, 'easy to get pregnant'*

The term *nsana wapafupi* refers to someone who gets pregnant easily. It translates as having a shallow back or spine, referring to the position of the uterus as lower in the abdomen. *Nsana wapatali* and *nsana ozama* refer to someone who has difficulty becoming pregnant. *Nsana ozama* translates as having a deep back, referring to the position of the uterus as higher in the abdomen. Women used these terms frequently as a way to explain their "natural" ability to become pregnant.

A woman with two children explained that she did not use contraception between her first and second pregnancy because she did not yet know her fertility:

[2] Pseudonyms are used to identify quotations.
[3] Quotations are tagged with women's response to the Wave 4 survey question regarding ease/difficulty of becoming pregnant.

> "It is said you do not start on contraceptives with only one child, you have to first realize that you are very active [fertile] then afterwards you can." *–Mary, age 32, 2 children, 'difficult to get pregnant'*

Women often reflected that knowing their fertility took precedence over their fertility desires. Women frequently said that a pregnancy came "too soon" or they would have preferred to wait longer before becoming pregnant, but, at the time of the pregnancy, delaying pregnancy through contraceptive use was not an option because they did not yet know their fertility. Thus, while women knew that contraception would help them prevent a mistimed pregnancy, it was not worth the potential long-term impact of using contraception (i.e., threat of infertility) before knowing their fertility.

One woman described how becoming pregnant with her first child too soon had severe consequences, including leading her to drop out of school. However, she was clear that she could not have used contraception before she became pregnant because,

> "Some people threatened to lose fertility if one use contraceptives before giving birth." *–Mphatso, age 24, 2 children, easy to get pregnant*.

Her desire to ensure fertility over her reproductive life-course (her long-term fertility desires) took precedence over her immediate circumstances that caused her to want to delay pregnancy.

Another woman faced a similar situation where her long-term desire for more children and, therefore, her need to prevent the possibility of infertility, influenced her decision not to use contraception between her first and second pregnancy. This woman, who said that she became pregnant when her older child was one-year-old, explained why she did not use contraception:

> "People were saying that after your first born you are not supposed to use any contraception because it can make you barren. It can happen that the contraception won't be compatible with your body. So, [after my first child] I didn't use any contraception and I got the second." *–Prisca, age 24, 2 children, 'difficult to get pregnant'*

This woman went on to reflect on how she did not want to get pregnant with her second child so soon, but that she was afraid to use contraception, saying,

> "At this time, I was scared [to use contraception], I knew I would not get pregnant any time soon."

When she did become pregnant, she framed it as both a surprise and an inevitability, saying *"I just realized I was pregnant."*

Women were often not clear about whether contraception could cause infertility at any time, or if there was a specific mechanism that made contraception cause infertility only if used before a first or second pregnancy, such as "drying up all the eggs." One woman shared her reasoning for not using contraception after her first pregnancy:

> "People told me that after delivering you're not supposed to go for contraception right away, I have to wait and see if I can take long to get pregnant or not because if I use contraception just after my first child, [the contraception] may end up drying up all the eggs." *–Judith, age 38, 4 children, 'difficult to get pregnant'*

Her statement, "*I have to wait and see if I can take long to get pregnant or not*," was a common way of explaining the importance of knowing one's fertility before the interference of contraception. Whether or not contraception could uniquely cause infertility before a second child, it was clear that part of the reason for not using contraception before a second child was because the social consequences of future infertility were worse if women had not yet had two children. Regardless of intentions or desires, if a couple had two children, any future infertility was concealable. Having just two children, although not particularly common, was seen as a possible choice a woman or couple might make. Once a couple had two children, not being able to have children in the future was more of a manageable threat, and, thus, contraception was often considered worth the risk to ensure desired birth spacing. One woman reflected on her decision to use contraception after she had two children:

> "This time I was satisfied with two children so I didn't care if I may become pregnant again or not." *–Alice, age 26, 3 children, 'difficult to get pregnant'*

Most women initiated contraceptive use at some point following the birth of their section child, but a few deviated from this pattern. One woman decided to begin using the injection after having her first child, while acknowledging that *"most people are unable to conceive again because of [the injection] method" –Alinafe, age 29, 1 child, 'easy to get pregnant.'* The interviewer questioned why she used injection, given what she heard, and the woman responded, *"I just said whatever happens, to let it happen."* Given that this woman considered it 'easy' for her to become pregnant, it is plausible that her nonchalance about using the injection was based on her experience becoming pregnant easily, rather than the general narrative she heard from others about the injection making women be unable to conceive.

In contrast, if a woman observed that she "took long" to become pregnant, this could indicate that she did not need to use contraception to prevent pregnancy and that if she did use contraception, a desired pregnancy may be even more delayed. One woman, who had never used contraception, reported a 17-year gap between her first and second child (and during which time she was married). When asked if she wanted a third child she said yes, but only after another five years had passed. However, based on what she knew about her fertility, she was not using, or planning to use, contraception. She stated,

> "I fear that when I use contraceptive methods, I might even stay longer than I did previously. If I was using contraceptives, how long would it take for me to fall pregnant?" *–Mary, age 32, 2 children, 'difficult to get pregnant'*

Managing fertility

Once women knew how easy or difficult it was for them to become pregnant, most decided to initiate contraception. They used what they learned about their "natural" ability to

become pregnant to make decisions about how they used contraception, specifically the injection. They also continued to monitor their fertility while using the injection through signs and symptoms from their body that they believed indicated whether or not they were fertile. Women believed that the injection worked to prevent pregnancy, but they also believed that "too much" of the injection (getting it too frequently or using it for too long) could cause infertility. Women expressed the precarious balance between getting the injection frequently enough to prevent pregnancy, but infrequently enough to also prevent infertility. The frequency and number of injections that would cause infertility was considered unique to each person. Therefore, women needed to determine for themselves how to use the injection as a tool to prevent pregnancy and to ensure future fertility. One of the main ways they did this was by relying on signs and symptoms from their bodies to determine if and when they needed to get another injection.

Two women shared that sexual desire was an indicator of fertility returning after using the injection. The injection reduced their sexual desire and when they felt it coming back, they associated it with a return to fertility and a sign to get another injection if they wanted to continue to prevent pregnancy:

> "The body changes, even when you just got [injection] you feel it that the injection is working. When it's about to stop working you feel it too, you start having sexual desires, so this is how [I] know that I am supposed to go for another injection." … "When you have the injection, you don't have any sexual desire [laughter] but after the injection has stopped working you start feeling the sexual desires and that's how you know." –*Charity, age 28, 3 children, 'easy to get pregnant'*

More commonly, and because many women experienced amenorrhea while using the injection, women relied on menstruation or bleeding as an indicator of fertility. Women saw menstruation or bleeding as a sign that they could become pregnant and, therefore, many waited until they

began to bleed before getting another injection. One woman said that she stopped menstruating after two injections:

> "After two injections I was just staying [without menstruating], I didn't use any contraceptive method […] I just thought the injection was still working in my body." – *Alice, age 26, 3 children, 'difficult to get pregnant'*

This woman, who wanted a pregnancy, became pregnant two years after discontinuing the injection. In that time, she was worried, saying: *"I was thinking that I have become infertile because of the injection I was using."* After her next child was born, however, she used the injection again, but she was not concerned when she got the injection irregularly because she said, *"I know my body and I just can't get pregnant that easily (nsana wanga umazama) [deep or sinking back]."*

Another woman explained how she decided when to get another injection based on her menstruation:

> "When I get the injection, I wait until I have my menses. I don't go on my appointment date. When I notice that I have had menses, [that is] when I go [for injection] because when I get the injection I don't menstruate [for] maybe 3 months or 5 months" … "I know that if I'm not menstruating that means the method is still working. When it's no longer working, that's when I start menstruating." *–Pricilla, age 22, 2 children, 'easy to get pregnant'*

Based on her perception that menstruation was a sign of a return to fecundity, one woman explained how she waited over a year between injections:

> "I have heard from people that they don't menstruate when using this [injection] so after it happened to me, I knew it was normal. I only go to the hospital [for injection] when I have seen my menstruation. I can stay a year or a year and months without menstruating and I go to the hospital the month I have menstruated [to get an injection]." *–Joyce, age 32, 2 children, 'difficult to get pregnant'*

When women decided to discontinue the injection to pursue a pregnancy, some expected that it might take time to get pregnant based on their previous experiences with the method. One woman reflected on the year between her last injection and becoming pregnant:

> "I had injection in December and was told to go in March …I didn't go then. I stayed until [the next] December, that's when I noticed I was pregnant" … "I stayed from December to December without using injection and didn't get pregnant. I noticed the pregnancy in January the [next] year" *I: So, during this time were you not scared that you may not become pregnant again?* "No, I knew it's because of the injection was still working." –*Charity, age 28, 3 children, 'easy to get pregnant'*

Many women used menstruation to gauge the return of their fecundity after discontinuing the injection. One woman who discontinued the injection because she wanted to get pregnant spent a year without menstruating. She reasoned that it took a year, which she regarded as a long time, because she got the injection "frequently" in the past, meaning she got it every three months:

> "I was getting the injection frequently. When I stopped, I spent a year and three months without having the menses. [In] the fourth [month] I started menstruating, then in the fifth month I didn't menstruate. That time I was pregnant." –*Agness, age 37, 5 children, 'easy to get pregnant'*

Experiences with the injection, menstruation, and pregnancy added to women's knowledge of their own fertility and helped them make decisions about when and how often to use the injection between future pregnancies.

In pursuit of balancing preventing pregnancy and ensuring future fertility by getting the injection as infrequently as possible, many women shared that they became pregnant when they did not want to be. One woman began to menstruate months after her last injection, but felt that her fertility would not return until she menstruated a second time, after which she planned to get another injection. Instead, she became pregnant, stating,

> "I saw that I started menstruating and I thought I will menstruate again in the next month. But it did not work like that. I did not menstruate. Another pregnancy had taken place." –*Agness, age 37, 5 children, 'easy to get pregnant'*

Another woman also discussed that she skipped her injection because she was not menstruating, but, in fact, the amenorrhea was not because the previous injection was still effective, but because she was pregnant.

> "[Becoming pregnant] was painful because at this time I didn't want to have another child. The other [child] was not old enough for me to have another child. I was very sad during this time. At the hospital when they told me that if you skipped a day [getting the injection] you may be pregnant and they can't give me another injection. Here people were telling me that since I wasn't menstruating it is quite clear that I am pregnant. It was very difficult for me." *–Annie, age 24, 2 children, 'easy to get pregnant'*

Testing fertility

Women described monitoring their fecundity within their current relationship by periodically "testing" it through delaying getting an injection. These women did not actively want to become pregnant, but said things like, "*I wanted to see what will happen*." One woman shared that she did not plan for one of her pregnancies, but then clarified that she was not using contraception at the time because she was testing her and her partner's fertility:

> "[I] should say we planned for it because we did not use contraceptives. **We wanted to check if we are more fertile**." *–Grace, age 38, 4 children, 'easy to get pregnant'*

Another woman delayed getting an injection between births, even though she did not want to become pregnant. When asked if she was afraid that she might become pregnant while waiting, she said,

> "I wanted to start menstruating [before using injection] … at this time **I also wanted to see if I can get pregnant sooner or not**. That's why I didn't use contraception soon after delivering a child." *–Joyce, age 32, 2 children, 'difficult to get pregnant'*

In contrast, one woman shared that she wanted to "*wait and see*" if she could become pregnant again after giving birth to her first child, but ultimately, she decided to get the injection. She was willing to prevent a pregnancy even though, admittedly, she did not yet know her fertility. This level of conviction to avoid a pregnancy before "knowing" fertility was rare, but stemmed from a common desire that women expressed to space their children so that they could grow up healthily before having another child.

> "So, I wanted to see first [if I was fertile], but then I got scared that I might end up being pregnant so I just went to get the injection in fear of being pregnant again. I didn't even

> care if my body is not capable of getting pregnant soon or not." –*Judith, age 38, 4 children, 'difficult to get pregnant'*

When this participant decided she wanted to become pregnant, she said she wasn't worried when she did not become pregnant immediately after discontinuing the injection because she learned at the hospital that the injection could have this effect, but it was temporary. She said,

> "During the healthy talk at the hospital, they tell us about this that after using injection the pregnancy maybe delayed, that's why I wasn't worried […] I knew I will get pregnant when the injection has stopped working in my body." –*Judith, age 38, 4 children, 'difficult to get pregnant'*

Although this woman was not worried about her fertility after using the injection, most others were. The idea that some women may take more than two years to become pregnant, while others could get pregnant just after stopping the injection, contributed to feelings of uncertainty around fertility and the need to manage the injection carefully.

Discussion

Findings from this study suggest that there may be significant barriers to continued injection use outside of those typically studied (e.g., needing to receive the method from a healthcare provider). Recent studies have examined the acceptability and efficacy of self-injection (Burke et al., 2018; Cover et al., 2017) in an effort to make the method more accessible. However, the findings of this study suggest that changing the mode of administration may not improve the consistent use of the method. Although seeing a healthcare provider every three months may indeed be a barrier, women's desire to manage and preserve their fertility may underlie the structural barriers to consistent injection use.

This study also shows that women actively manage their fertility in order to reach their immediate and long-term reproductive goals, which is compatible with the idea that women's

pregnancy desires change (Sennott & Yeatman, 2012). We found that a woman's desire to *avoid* pregnancy was often flexible (and, in some cases, ambivalent), but when she *wanted* to become pregnant, the desire to become pregnant tended to be quite firm. When a woman wanted to become pregnant, or felt that she needed to within her relationship, not becoming pregnant had major consequences. While unintended pregnancy also had consequences, most women reflected that they were open to becoming pregnant and an unintended pregnancy was less of a concern than a delayed pregnancy or infertility. Other studies have reported similar findings in Malawi regarding the relative acceptability of unplanned pregnancies (Gomez et al., 2018). With that in mind, it is important to take a critical look at how contraception is often framed as a safe-guard *against* pregnancy rather than a tool to help women have pregnancies when they want them. Although this difference is subtle, framing contraception as a tool to manage fertility may better resonate with some women who live in highly pronatalist societies. In Malawi, the commonality of divorce and remarriage, and the importance of childbearing in new relationships, may influence women's desire to preserve their fertility regardless of their current pregnancy intentions (Reniers, 2003).

Although in this study women's desire to actively manage their fertility manifested in clinically suboptimal injection use, women's desire to actively manage their fertility is a strength when it comes to engaging women in family planning. Family planning programs can take the opportunity to encourage women's active participation in their fertility and appreciate that they are not passive consumers of contraception. The advent and availability of contraceptive methods has been lauded as a way to promote women's autonomy, and, indeed, contraception has allowed women to make unprecedented social, economic, and educational gains (Bernstein

& Jones, 2019). The present study shows that contraception is extremely important to women *and* that women want to play an active role in their fertility while using contraception.

It would be a great disservice to women to take away their agency in the use of the injection, or to undermine their knowledge of their own bodies. Instead, it is prudent to consider how contraceptive methods can better fit within women's worldviews and meet their reproductive needs. Contraceptive counseling may play an important role in helping women choose contraceptive methods that fit their needs. A study that examined reasons for contraceptive non-adherence suggested that counseling should include conversations specifically around how methods work and potential fears about specific methods and side effects (Clark, 2001). Some of the items Clark (2001) suggested that may be of particular relevance to the present study population include, "*do you understand how [OCPs, Depo Provera, or Norplant] works to prevent pregnancy?*" and "*what side effects of [OCPs, Depo Provera, or Norplant] worry you the most?*" (Clark, 2001). Other counseling protocols that may be beneficial in this population include in-depth conversations about menstruation and possible changes that women may experience in terms of bleeding (Rademacher et al., 2018).

Counseling protocols that focus on women's perceptions, fears, and existing knowledge may be useful among this study population, as it could give healthcare providers and patients an opportunity to discuss how the injection works physiologically and the reasons why women may experience different side effects and take varying amounts of time to become pregnant after discontinuation. Many women in our study observed how the injection impacted their ability to become pregnant after discontinuing the method and were discontent with the time between discontinuation and pregnancy. However, women who knew how long it could take, generally

knowledge that was gained only through experience, were less discontent. Knowing what they could expect seemed to make the difference.

While contraceptive counseling certainly may help, the challenge remains that women in this study relayed that they received mixed messages from healthcare providers: if they did not get the injection every three months, they could become pregnant *and* that when they discontinued the injection it could take months for them to become pregnant. The truth in both of these statements presents a challenge in communication between healthcare providers and their clients. While accurate, the messages that delaying the injection past three months may result in an unintended pregnancy *and* that after discontinuing the injection they may take months to become pregnant, are nonetheless confusing and may seem contradictory. This apparent contradiction may reinforce women's beliefs that the injection works differently for everyone and therefore must be managed according to their unique physiology in order to preserve their ability to become pregnant when desired. It is, indeed, reasonable that women would feel the need to tailor their use of injection to their own bodies and fertility desires given that the injection can have idiosyncratic effects on fecundity. In an ideal world, women could "know" their fertility without needing to become pregnant first, and perhaps the advent of technology to assess fertility prior to pregnancy could provide women with the control over their fertility that they desire.

There are persistent cultural narratives and beliefs around the injection as a cause of infertility, which may influence women to use the method differently from the recommended regimen (Bornstein, Gipson, et al., 2020; Bornstein, Huber-Krum, et al., 2020; Chipeta et al., 2010; Machiyama et al., 2018), as observed in the present study. Women in the present study associated the frequency of receiving the injection with the probability of becoming pregnant or

experiencing infertility in the future. Nearly all participants shared that using the method more frequently or for longer periods of time could negatively impact their ability to become pregnant in the future. There was an underlying desire for women to find the right frequency of injection for their bodies – just enough to prevent pregnancy during the time of use. Any injection use above the minimum needed to prevent pregnancy was seen as a threat to future fertility. The injection was understood to interact with a woman's "natural" ability to become pregnant, such that a woman who had difficulty becoming pregnant (*nsana ozama*), must be especially careful in how she used the injection to prevent further difficulty becoming pregnant or infertility. Most women in our study would have rather erred on the side of injections that were too infrequent and become pregnant unintentionally, than erred of on the side of injections that were too frequent and struggle to become pregnant in the future. That said, unintended pregnancies still carried consequences and women expressed a strong desire to space their pregnancies for the wellbeing of their children.

Although the injection remains the most common method of contraception in Malawi, there has been an increase in use of other methods in recent years, particularly the implant, which is a long-acting method that works to prevent pregnancy for up to five-years (National Statistics Office (NSO) [Malawi] and ICF, 2017). In the UTHA cohort (Wave 4, 2017-2018), 45% of women reported that they preferred the implant, although only 65% of women who preferred the implant were using it (Huber-Krum et al., 2021). The popularity of the implant suggests that women may be open to methods of contraception in which they have a less active role in managing as compared to the injection. One reason could be that the implant has fewer cultural narratives around it and thus does not seem to carry the same association with infertility. However, for the implant to continue to be a viable option, women must be able to control when

it is placed and when they have it removed. One barrier to the implant is that healthcare providers may suggest the method only for women who want to delay pregnancy for five years. In fact, the implant is a highly effective method that can be removed at any time and, according to two studies across multiple sites in Europe and Asia, 80-90% of women who get the implant removed and want to become pregnant do so within one year of removal (Buckshee et al., 1995; Singh et al., 1989). While most studies report that the return to fecundity is shorter with the implant than the injection, a literature review on fertility after discontinuing contraception identified some studies suggesting that the implant and the injection had similar effects on fecundity after discontinuation (Mansour et al., 2011). Additional evidence is needed to better understand both how different methods impact fecundity, and the acceptability of a delayed return to fecundity in various populations.

In this study, women wanted to control their fertility and the injection appeared to provide that option for them, if imperfectly. However, the injection also made women feel that they *needed* to manage their fertility because of how the method could have different, idiosyncratic effects on fecundity for each woman. One woman may experience a pregnancy immediately after discontinuing the method, while another could take a year or longer. This uncertainty created a dynamic where women felt that they needed to carefully manage the frequency with which they received the injection. A method like the implant, if women were able to get it removed on demand, may actually better offer women the control over their fertility that they desire, even though it is longer-acting than the injection. Given that women wanted to control their fertility and used the injection to do so, it is somewhat surprising that non-hormonal methods (e.g., condoms) or non-modern methods (e.g., fertility awareness) were not more popular among the women interviewed in this study. However, condoms are stigmatized in

Malawi (Chimbiri, 2007), and non-modern family planning methods are uncommonly reported (Huber-Krum et al., 2021, p.). Additionally, condoms and fertility awareness methods depend on male involvement, which may not be preferable to all women (Bornstein, Huber-Krum, et al., 2020).

While studies that discuss contraceptive side effects exist, many are framed as "perceived" side effects with no real harm except in how perceived side effects inhibit women's contraceptive behaviors. The present study found that these "perceived" side effects of the injection (e.g., prolonged infecundity) are very much based on women's lived experiences, as well as cultural narratives around contraception and fertility. These findings, which move beyond side effects, fit within existing literature using a social lens to understand how women experience contraception (DiMaggio, 2014), as well as the idea that contraceptive methods must be compatible with a woman's body in order to preserve "normal" function, including fertility (Henry, 2001). Dismissing women's experiences with contraceptive side effects as mere perceptions devalues women's experiences, priorities, and realities when it comes to fertility and, thus, undermines their ability to exercise agency in their reproductive lives.

The scientific community may consider contraceptive side effects, such as amenorrhea or delayed return to fecundity, harmless and temporary; however, these side effects may carry a much greater weight in Malawi and similar contexts where women are expected to become pregnant quickly (Bornstein, Gipson, et al., 2020). While clinical guidelines suggest that a woman or couple has a fertility problem after a year has passed without becoming pregnant, women may consider that they have a fertility problem well before a year has lapsed and face real consequences of not becoming pregnant when they want or are expected to become pregnant (Bornstein, Gipson, et al., 2020). The injection may reduce fecundity for up to a year in some

cases (Hassan & Killick, 2004; Kaunitz, 1998). This delay in becoming pregnant after discontinuing the injection may be incompatible with social expectations, as well as the frequency of shifting fertility desires.

The undesirable delay in return to fecundity with the injection for some women calls into question the suitability of the method for women in this context, particularly because there are other methods with a shorter duration of subfecundity after discontinuation (Yland et al., 2020). A year delay in return to fecundity implies that a woman or couple can (and want to) project their fertility desires months in the future. This may not only be unrealistic, but it may also be an imposition of imperialism in public health where the researchers' paradigm of pregnancy planning as morally 'good' is privileged above other ways of thinking or being. Other studies have similarly challenged the idea that pregnancy planning or intentions are the best indicators of reproductive autonomy across all settings (Potter et al., 2019; Senderowicz, 2020), but have not looked at how specific attributes of contraceptive methods may unintentionally impose and reflect paradigms around the most acceptable way to plan and project fertility.

Finally, this qualitative study provides evidence that survey items that ask women about their current contraceptive use may not adequately capture how women use the injection method. For example, the Demographic and Health Survey asks women, *"Are you or your partner currently doing something or using any method to delay or avoid getting pregnant?"* and follows up by asking what method they use and how long they have been using it (National Statistics Office (NSO) [Malawi] and ICF, 2017). Women in the present study considered themselves contraceptive users if they received the injection less frequently than every three months. Thus, future studies should examine both *if* women are using contraception, as well as *how* they are using contraception. For example, a survey could ask when a woman received her most recent

injection or when she planned to get her next injection. There is strong evidence from the present study that using the injection is a complex series of behaviors that are not adequately understood by researchers. If public health programs are to continue to make progress helping women achieve their desired fertility, it is prudent to better understand how women use the injection and, more importantly, how research and programs might use this information to better support women to achieve their short- and long-term reproductive goals.

Chapter 8 (Study 2): Infertility, perceived certainty of pregnancy, and contraceptive use

Introduction

Globally, 44% of pregnancies are unintended, a proportion that has remained relatively constant over the past three decades, despite investment in research and programs aimed at reducing unintended pregnancy via increasing contraceptive use (Bearak et al., 2018), At the same time, a significant proportion of couples experience infertility, or the inability to become pregnant after 1-2 years of trying.[4] Accurate estimates of infertility are plagued by varying definitions and measures. Measurement is hindered by challenges ascertaining aspects of infertility that are necessary for constructing a more valid measure, including sexual frequency, length of time without conceiving, specifying between primary infertility (i.e., the inability to conceive a first pregnancy) and secondary infertility (i.e., the inability to conceive a second or higher order pregnancy), and distinguishing between infertility at the individual or couple-level (i.e., male/female/both), among many others (Mascarenhas, Cheung, et al., 2012). Based on differences in definition and data collection, estimates of infertility prevalence vary widely. An oft-cited lifetime prevalence of infertility – combining both primary and secondary infertility and using a 12-month definition – is 15% of couples of reproductive age (Boivin et al., 2007; Inhorn, 2009; Mascarenhas, Cheung, et al., 2012). However, other global estimates are considerably higher, with combined primary and secondary infertility estimated to be up to 25-30% of reproductive-age couples in some regions (Mascarenhas, Cheung, et al., 2012; Mascarenhas, Flaxman, et al., 2012; Nachitgall, 2006; Rutstein & Shah, 2004).

[4] There are multiple definitions and ways of calculating infertility, which vary based on discipline. Clinicians usually use a 12-month exposure timeframe, epidemiologists use 24-months, and demographers typically use 5-7 years (Larsen, 2005).

The dual burden of unintended pregnancy and infertility has rarely been explored within public health; however, emerging research suggests that one reason high rates of unintended pregnancy persist is because people are reluctant to use contraception to prevent an *unintended* pregnancy if they are not sure they will be able to achieve an *intended* pregnancy when they desire (K. M. Johnson et al., 2018). While preventing unintended pregnancies and achieving intended pregnancies are pillars of reproductive rights (UNFPA, 1994), the latter has been largely ignored in public health and reproductive health, receiving substantially less monetary and intellectual investment than efforts focused on preventing unintended pregnancy (Gipson et al., 2020).

The present study explores the relationships between self-reported experienced infertility, perceptions of infertility (certainty of ability to become pregnant), and contraceptive use in Malawi. We hypothesize that low perceived chance of becoming pregnant – influenced by both past experiences with infertility (i.e., inability to conceive after two years of trying) and low certainty of one's ability to become pregnant – lower the odds of contraceptive use (Figure 6). In Malawi, pronatalist norms exist alongside a growing desire for smaller families (National Statistics Office (NSO) [Malawi] and ICF, 2017) and relatively high rates of self-reported infertility (Barden-O'Fallon, 2005b; Rao et al., 2017). These joint realities create a dynamic and multifaceted context in which individuals make decisions about preventing and pursuing pregnancy. Yet, there remain significant gaps in our understanting of how women and men make contraceptive decisions with their current and future pregnancy desires in mind.

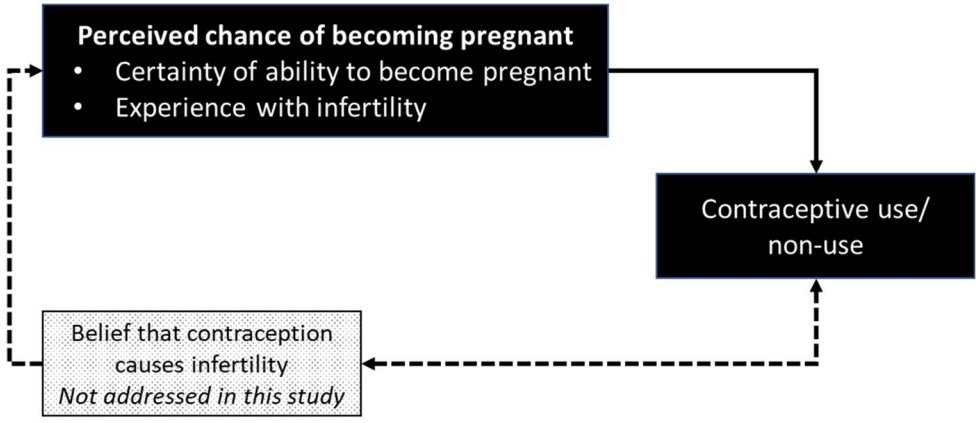
This study has four aims: (1) to describe the prevalence of and characteristics of women and men who report experiencing infertility; (2) to describe the characteristics of women and men who report various levels of certainty of their (or their partner's) ability to become pregnant;

(3) to examine the associations between experienced infertility and contraceptive use among women; and, (4) to examine the association between certainty of ability to become pregnant and contraceptive use among women. Understanding these relationships may be critical to addressing persistently high rates of unintended pregnancy, both in Malawi and globally.

Infertility-related Constructs and Contraceptive Use

We hypothesize that perceived certainty of becoming pregnant in the future and past experiences of infertility contribute to one's overall perceived chance of becoming pregnant and, in turn, contraceptive use (Figure 6). Although fear of infertility, or other perceived side effects from contraception, are not addressed in this study, there is a growing body of literature around fear of side effects (including infertility) as a reason for contraceptive non-use. We acknowledge that there may be a bidirectional relationship between contraceptive use and fear/belief that contraception may cause infertility (Figure 6) (Boivin et al., 2020; Huber-Krum & Norris, 2020; Sedlander et al., 2018).

Figure 6. Hypothesized mechanisms between infertility-related constructs and contraceptive use



Perceived chance of becoming pregnant

Several theories of health behavior (e.g., Theory of Reasoned Action and the Health Belief Model) highlight the role of perceived risk of an outcome or ailment (e.g., risk of becoming pregnant when a pregnancy is not desired) as a necessary precursor to implementing a preventative behavior (e.g., contraceptive use) (K. S. Hall, 2012; Rosenstock, 1974). Thus, low perceived risk (what we refer to as chance) of pregnancy may be a factor that contributes to contraceptive non-use.

The relationship between low perceived chance of pregnancy and contraceptive non-use has been demonstrated in existing literature. The belief that one cannot, or is unlikely to, get pregnant is an oft-reported reason for contraceptive non-use among women who do not want to become pregnant. In two U.S. studies, 33-42% of pregnant women with undesired pregnancies were not using contraception at the time they became pregnant because they did not believe they could become pregnant (Foster et al., 2012; Nettleman et al., 2007). One study examining unmet need for contraception in Malawi found that the perception that one cannot become pregnant for biological reasons may account for more than a quarter (27%) of contraceptive non-use among women in need of contraception (Westoff, 2012). We hypothesize that two potentially related constructs make up perceived chance of pregnancy: certainty of ability to become pregnant and past experience with infertility, that is the inability to become pregnant after 1-2 years of trying. These two related constructs represent both anticipation of future fertility and past experiences with fertility, which, along with other factors, may influence decisions around contraceptive use. Separately and together, we will test if certainty of ability to become pregnant and experiences with infertility are associated with contraceptive use.

Certainty of ability to become pregnant

Findings from a nascent body of literature indicate important and understudied linkages between perceived infertility, certainty of ability to become pregnant, and contraceptive use. However, the few studies that examine constructs related to certainty of becoming pregnant vary considerably, likely due to the lack of standardized and/or validated measures (Biggs & Foster, 2013; Foster et al., 2012; Gemmill, 2018; Polis & Zabin, 2012). In one study (Gemmill, 2018), using a question from the National Longitudinal Survey of Youth (NLSY), *"Suppose you started to have unprotected intercourse today. What is the percent chance you would have a child within the next two years?"* (0-100%), investigators found that women who reported a lower chance (0-50%; 50-75%) were less likely to use contraception, as compared to women who reported a higher chance of having a child (75-100%) (Gemmill, 2018).

Experiences with infertility

The relationship between experienced infertility (i.e., unsuccessfully achieving pregnancy after 1-2 years of trying) and contraceptive use is largely unknown. However, theories of health behavior support that past experiences influence future behavior (K. S. Hall, 2012; Rosenstock, 1974). Thus, experiencing infertility may reduce one's perceived chance of pregnancy and their motivation to use contraception to prevent an unintended pregnancy.

There has also been remarkably little research on who reports infertility, particularly in low-resource settings where a clinical diagnosis of infertility and infertility treatment are historically and currently rare (K. M. Johnson et al., 2018; Ombelet, 2014; Starrs et al., 2018). Even in higher-resource settings, studies on infertility often only include those who seek treatment, which is a select group and not representative of the broader population who

experience infertility (Greil, Slauson-Blevins, et al., 2010). Having data solely from these highly selective samples from relatively high-resource settings has limited our understanding of the magnitude of infertility, the characteristics of people who experience infertility, and their contraceptive behaviors.

Belief that contraception causes infertility

While not directly addressed in this study, the belief that contraception may be a cause of infertility is well-documented (Bornstein, Huber-Krum, et al., 2020; Chipeta et al., 2010; Richards, 2002; Sedlander et al., 2018). A study in Malawi found that women's perceptions that a contraceptive method would affect their future fertility was associated with contraceptive method preference (Huber-Krum & Norris, 2020). Another study found that perceiving that a specific contraceptive method did not cause infertility was associated with intention to use that method (Machiyama et al., 2018; Mumah et al., 2018).

Context

In Malawi, fertility and infertility are experienced within the broader social context of marriage, divorce, and family formation. Relationships are solidified through childbearing. Divorce and remarriage are also common (Reniers, 2003). The commonality of relationship changes and remarriage underscore the importance of maintaining fertility, even after one achieves their desired number of children with a particular partner (Reniers, 2003). Should a divorce occur, one's fertility regains importance to solidify a new relationship (Reniers, 2003). Even within a single partnership, pregnancy intentions and desired family size can change frequently (Gibby & Luke, 2019; Yeatman et al., 2013; Yeatman & Sennott, 2015).

The total fertility rate in Malawi, at 4.4 children per woman, exceeds the reported wanted fertility rate of 3.4 children per woman. Despite a steady decline in unmet need for contraception (19% of women as of 2015-2016), approximately 30% of pregnancies in Malawi are mistimed and an additional 11% are considered unwanted (National Statistics Office (NSO) [Malawi] and ICF, 2017). Malawi's relatively high total fertility rate and the discrepancy between total fertility and wanted fertility obscures the fact that Malawi also has a high rate of self-reported infertility. Two studies in different areas of Malawi from 2005 and 2018 found that approximately 20% of women (Rao et al., 2017) and 20% of women and men (Barden-O'Fallon, 2005b) reported ever experiencing infertility or difficulty becoming pregnant. The former (Rao et al., 2017) measured self-reported infertility using a two-year definition within a cohort of 915 women ages 22-32 years in rural Malawi. The latter (Barden-O'Fallon, 2005b) examined self-reported difficulty becoming pregnant among a population of 678 women and 362 men. Among the 20% of women and men who self-identified as experiencing difficulty getting pregnant, 38% of women and 27% of men considered themselves or their partner to be infertile.

Sub-Saharan Africa is widely considered to have one of the highest rates of infertility globally (Mascarenhas, Flaxman, et al., 2012), yet several studies have shown that the general population often has misconceptions about the causes of infertility (Bornstein, Huber-Krum, et al., 2020; Chipeta et al., 2010; Richards, 2002; Sedlander et al., 2018). Moreover, treatment is rarely available within the formal healthcare system for women or men and people commonly rely on traditional interventions (Barden-O'Fallon, 2005b; Parrott, 2014). Given the concurrently high rates of unintended pregnancy (41%) (National Statistics Office (NSO) [Malawi] and ICF, 2017), and self-reported infertility (20%) in Malawi (Rao et al., 2017), it is imperative to assess

the extent to which reproductive decisions – specifically contraceptive use – may be affected by one's experience and perceptions of their fertility.

Methods

Study design

Data for this study come from the *Umoyo Wa Thanzi* (UTHA; Health for Life) research program, a cohort study focused on sexual and reproductive health decision making among women and their male partners in Central Malawi. The cohort was recruited from the catchment area (approximately 20,000 residents) of a rural, non-profit hospital in 2013. In total, 68 villages were collapsed into 43 clusters based on size and geographic proximity. The clusters were then stratified into three geographic groups: rural, plantation, and trading center. Within these three categories, 11 clusters (19 villages) were randomly selected for inclusion in the cohort, resulting in eight rural, one plantation, and two trading center clusters (Huber, Esber, Garver, Banda, & Norris, 2017). All women ages 15-49 residing in households within the selected villages were eligible to participate. Women could also refer their male partner(s) for enrollment. In total, 1,034 women participated in Wave 1 (2014), representing a 96% response rate (Rao et al., 2017). Subsequent data collection occurred in Wave 2 (2016), Wave 3 (2017), and Wave 4 (2017-2018). There was a 75% retention rate between Waves 1 and 4 and an 85% retention rate between Waves 3 and 4. For Wave 4, enrollment efforts were expanded such that women and men living within the selected villages and who met the inclusion criteria, but were not previously enrolled in the study were invited to participate. Data for this analysis are from Wave 4, where the total sample size was 1,787 (1,161 women and 626 men). Because men were

initially recruited only if they were a partner of a woman in the study, our sample of men is biased toward partnered men, even in Wave 4 when non-partnered men were permitted to enroll.

At each data collection point, the surveys were developed in English and then translated into Chichewa through an iterative process with both English-speaking and bilingual English-Chichewa team members. Translations were reviewed for meaning, with the final wording determined through collaborative consensus (Colina et al., 2016). Participants gave verbal and written consent to participate and re-consented at each wave. At Wave 4, participants were compensated with 2,000 MK (approximately $1.50-2.00 U.S. dollars). This study was approved by the Institutional Review Boards (IRB) at The Ohio State University, the Malawi College of Medicine, and the University of California – Los Angeles.

Analytic sample

This study uses two analytic samples: one for women and one for men from the fourth wave of UTHA data in 2017-2018. Of the total 1,161 women who participated in Wave 4, the analytic sample excludes women who had never had sex (n=44), were sterilized (n=127), had post-partum amenorrhea or were post-menopausal (n=10), or were pregnant at the time of data collection (n=106) (total n=874). We additionally excluded women for whom we did not have full information available, resulting in a total of 749 women. The majority of women excluded due to missing information did not report age (n=45) or whether or not they experienced infertility (n=49). From the original sample of 626 men, we excluded those who had never had sex (n=7), resulting in a total possible sample of 619.

There were some statistical differences between the analytic and excluded population (data not shown). About half of the 80 women who had age data but were excluded based on

other missing data were between the ages of 15-19, compared to about 7% of the 749 women included in the analysis. Excluded women were more likely to be unmarried (61% of excluded vs. 15% of included women), and just under half of excluded women reported having sex in the previous three months, compared to 80% of women in the analytic sample. Excluded women had lower rates of contraceptive use compared to women in the analytic sample (62% vs. 77%) and were also less likely to report that they were certain to become pregnant within a year (63% vs. 78%). There were no differences between the analytic and excluded population in terms of desire for a(nother) child or experienced infertility.

Variables

Independent variables:

Self-reported ever experienced infertility: Self-reported ever experienced infertility was constructed from the survey question, *"Have you ever tried to conceive a pregnancy for two years or longer without conceiving in that time?"* Two years is a definition of infertility commonly used in epidemiological studies (Mascarenhas, Cheung, et al., 2012). Response options were yes, no, and never tried to conceive. The full distribution is included in Table 9. The majority of participants selected yes or no and those who responded 'never tried to conceive' were excluded in multivariable analyses.

Certainty of pregnancy: There are no validated measures of certainty of ability to become pregnant. Because of this, we used a novel measure developed for the UTHA study. We measured this construct using the following survey question: *"If you were to have sex and not use any method of contraception, how likely is it that you (or your partner) would become pregnant in the next year?"* There were five response options: no chance, unlikely, likely,

certain, and don't know. Men were asked about certainty in regards to their partner becoming pregnant. A one year timeframe was used because it is a typical medical definition of infertility (Mascarenhas, Cheung, et al., 2012) and, in Malawi, is also commonly considered to be the greatest length of time that it should take for conception to occur before people assume there is a problem (Bornstein, Gipson, et al., 2020). Due to the highly skewed distribution of this variable and precedence from the use of a similar measure in Malawi (Polis, Moore, et al., 2020) we recoded it as a trichotomous variable (certain vs. likely vs. no chance/unlikely).

Dependent variable:

In the multivariable analyses, we examined current contraceptive use among women, assessed using the question, *"Currently, are you using any method to avoid pregnancy in your relationship, whether it is a traditional or modern method?"* If participants responded yes to this question, they were asked what method(s) they were using and less than 1% of women reported using a traditional method. Contraceptive use was coded as yes/no. We examined contraceptive use among women only, as men had substantial missing data for contraceptive use and the method mix in this population is heavily skewed toward female controlled methods. In this study, 60% of women who used contraception were using injection and 35% were using an implant (data not shown).

Covariates:

We examined sociodemographic variables that are often associated with contraceptive use, including marital/cohabitation status as a categorical variable (current monogamous relationship, current polygamous relationship, not currently married/cohabiting, and never

married/cohabited), ever divorced (yes/no), age (categorical in 5-year increments), sexual activity in the previous three months (yes/no), years of education (continuous), number of living children (continuous), and desire for a(nother) pregnancy (yes/no) (Digitale et al., 2017; Huber et al., 2017; Mandiwa et al., 2018). Covariates included in the multivariable models were selected based on significant bivariate relationships, theoretical associations with contraceptive use, and model selection techniques to minimize multicollinearity, including correlation matrices and assessing Variance Inflation Factor (VIF).

Analyses

We first looked at the characteristics of women and men who reported ever experiencing infertility (Table 10) and certainty of becoming pregnant within one year of having sex without using any method of contraception (Table 11). We used chi^2 tests of independence and F-tests to examine differences in means. After examining the characteristics of individuals who reported ever experiencing infertility and certainty of becoming pregnant, we assessed the association between each variable and current contraceptive use only among women, also using chi^2 tests of independence and F-tests (Table 12). Finally, we constructed three multivariable logistic regression models examining the relationship between ever experiencing infertility and contraceptive use; certainty of becoming pregnant and contraceptive use; and a third model that examined contraceptive use controlling for both ever experienced infertility and certainty of becoming pregnant among women (Table 13).

Model selection: We refined the multivariable models examining contraceptive use among women by assessing correlations and multicollinearity between independent variables using a correlation matrix prior to inclusion. Age and number of living children were highly

correlated ($r=0.76$; $p<0.001$) (not shown). We omitted number of living children from the multivariable models because it was not associated with contraceptive use among women in an F-test (Table 12). We also excluded the 'ever divorced' indicator variable in multivariable models because of its relationship with current marital/cohabiting status. In our final multivariable models (Table 13), we examined Variance Inflation Factor (VIF) values to assess multicollinearity of our independent variables. VIF values ranged from 1.13-5.38 (not shown). Acceptable VIF values are typically considered <10, and because relatively high VIF values were only observed in control variables, and not central to our interpretations, a slightly higher VIF is considered an insufficient reason to exclude the variable (Allison, 2012; O'Brien, 2016).

We conducted a series of sensitivity analyses to assess the robustness of our findings. First, we included number of living children instead of age in the multivariable models; however, results did not vary substantially for any of the independent variables (not shown). We also included alternative configurations of the desire for more children variable (now/in the next two years, after two years, undecided timing, never) and there were no substantial changes in the magnitude, direction, or significance of findings (not shown).

We conducted two additional sensitivity analyses to look at sub-groups within our sample. First, we looked at the multivariable models removing women who wanted to become pregnant now. Results did not change in significance or magnitude. Ultimately, we kept women who wanted to become pregnant now in the multivariable models (n=35), as 37% of them were currently using contraception (not shown). This may reflect challenges in measuring pregnancy desires: someone may want to become pregnant now, but act in accordance with other realities of their lives that lead them to prevent pregnancy (Santelli et al., 2003).

Ultimately, we constructed three logistic regression models examining women's contraceptive use as the outcome. The first model focused on the relationship between experienced infertility and contraceptive use; the second model focused on certainty of becoming pregnant and contraceptive use; and the third model included both main independent variables.

Results

Participant characteristics

Women

Most (85%) of women in the sample were married/cohabiting, whether in a monogamous or polygamous relationship. About a third had been divorced at least once (31%), (Table 9). On average, women reported 2.8 children and 79% wanted a(nother) child sometime in the future. Three-quarters were currently using a method of contraception (77%) and approximately the same proportion were *certain* that they would become pregnant if they had sex and did not use a method of contraception for one-year (78%). Approximately 16% of women reported ever experiencing infertility (having ever tried unsuccessfully to become pregnant for a period of at least two years).

Men

Among male participants, 84% were married and 34% had been divorced at least once. Men reported an average of 3.1 children, 69% wanted a(nother) child at some point in the future, and 64% reported that they or their partner were currently using contraception. Over two-thirds (69%) of men were *certain* their partner would become pregnant within a year of not using contraception and 13% reported ever experiencing infertility with a partner (Table 9).

Table 9. Participant characteristics by sex[1]

	Women (N=749)	Men (N=619)
Number of living children	2.79	3.06
Missing (%, n)	2.8% (n=21)	6.8% (n=42)
Number of years of education	5.3	5.61
Missing (%, n)	0% (n=0)	4.2% (n=26)
Age	28.1	31.5
Missing (%, n)	0% (n=0)	3.1% (n=19)
Age group		
15-19	6.8%	8.9%
20-24	29.0%	14.5%
25-29	26.0%	17.8%
30-34	20.0%	21.0%
35-39	12.3%	15.2%
40-45	5.9%	12.3%
46 + (men only)	0.0%	7.3%
Missing (%, n)	0% (n=0)	3.1% (n=19)
Marital/cohabitation status		
Current monogamous relationship	68.0%	74.5%
Current polygamous relationship	17.2%	9.2%
Not currently married nor cohabiting	12.6%	3.1%
Never married nor cohabited	2.3%	13.3%
Missing (%, n)	0% (n=0)	0% (n=0)
Ever been divorced (among ever-married)		
Yes	31.2%	34.1%
No	68.9%	65.9%
Missing (%, n)	0% (n=0)	0% (n=0)
Ever wants a(nother) child		
Yes	78.8%	69.0%
No	23.2%	29.4%
Missing (%, n)	0% (n=0)	1.6% (n=10)
Had sex in previous 3 months		
Yes	80.0%	85.6%
No	20.0%	14.2%
Missing (%, n)	0% (n=0)	0.2% (n=1)
Current contraceptive use		
Yes	77.4%	63.8%
No	22.6%	17.5%
Missing (%, n)	0% (n=0)	18.7% (n=116)
Certainty of pregnancy[2]		
Certain	78.0%	68.7%
Likely	16.7%	16.6%
No chance/ unlikely	5.3%	6.5%
Missing (%, n)	0% (n=0)	8.2% (n=51)
Self-reported infertility[3]		
Yes	16.2%	13.4%
No	83.8%	75.8%

Never tried to conceive	0.0%	2.4%
Missing (%, n)	0% (n=0)	8.4% (n=52)

[1] Columns may not total to 100% due to rounding
[2] If you were to have sex and not use any method of contraception, how likely is it that you would become pregnant in the next year?
[3] Have you ever tried to conceive a pregnancy for two years or longer without conceiving in that time?

Correlates of ever experienced infertility and certainty of pregnancy measures

Ever experienced infertility

We next examine relationships between sociodemographic factors and self-reported ever experienced infertility for women and men (Table 10). Women who reported that they ever experienced infertility were older (30 vs. 28; $p<0.01$) and more likely to have been divorced 51% vs. 29%; $p<0.05$) than women who did not report ever experiencing infertility (Table 10). Women who reported ever experiencing infertility were more likely to report that there was 'no chance' or it was 'unlikely' that they could become pregnant (14% vs. 4%) and less likely to report that they were 'likely' to become pregnant (11% vs. 18%), yet a similar proportion of women who did and did not ever experience infertility expressed that they were 'certain' they could become pregnant (75% vs. 79%) ($p<0.001$) (Table 10).

Men who ever experienced infertility with a partner were older than men who did not ever experience infertility (36 vs. 33; $p<0.01$). Like women, men who ever experienced infertility were more likely to report that there was 'no chance' or it was 'unlikely' that their partner would become pregnant within a year of not using contraception (15% vs. 6%) and less likely to report that pregnancy was 'likely' (7% vs. 20%) ($p<0.01$) (Table 10). There were no other significant associations between sociodemographic characteristics and self-reported ever experienced infertility among men.

Table 10. Relationships between sociodemographic characteristics and self-reported ever experiencing infertility (N=749 women; men maximum N=552)[1, 2]

	Women			Men		
	No infertility	**Ever experienced infertility**	**p-value**	**No infertility**	**Ever experienced infertility**	**p-value**
Total	83.8%	16.2%		85.0%	15.0%	
Number of living children (mean)	2.75	2.93	0.292	3.25	3.65	0.134
Number of years of education (mean)	5.35	5.17	0.559	5.66	5.24	0.281
Age (mean)	27.7	29.8	0.0013**	32.5	35.8	0.002**
Age group			0.026*			0.003**
15-19	7.3%	4.1%		4.6%	5.1%	
20-24	30.3%	22.3%		14.0%	7.6%	
25-29	26.4%	24.0%		19.7%	17.7%	
30-34	18.8%	26.5%		24.1%	19.0%	
35-39	12.3%	12.4%		18.6%	11.4%	
40-45	4.9%	10.7%		12.9%	21.5%	
46 + (men only)	0.0%	0.0%		6.1%	17.7%	
Currently married/cohabiting			0.124			0.344
Current monogamous relationship	68.6%	64.5%		82.7%	81.9%	
Current polygamous relationship	16.2%	22.3%		9.6%	14.5%	
Not currently married nor cohabiting	12.4%	13.2%		1.9%	1.2%	
Never married nor cohabited	2.7%	0.0%		5.8%	2.4%	
Ever been divorced (among ever-married)	29.3%	50.5%	0.015*	32.1%	38.3%	0.280
Ever wants a(nother) child	77.7%	71.9%	0.166	67.8%	62.6%	0.356
Had sex in previous 3 months	80.7%	76.0%	0.237	91.5%	90.4%	0.745
Certainty of pregnancy			0.000***			0.001**
Certain	78.5%	75.2%		73.6%	78.3%	
Likely	17.8%	10.7%		20.1%	7.2%	
No chance/unlikely	3.7%	14.1%		5.8%	14.5%	

[1]p-values are for chi-square tests (categorical) and F-tests (continuous); columns may not total to 100% due to rounding; *p<0.05, **p<0.01. ***p<0.001

[2]Maximum N for men is the total sample size for the dependent variable (see Table 9)

Certainty of pregnancy

Next, we examined the relationships between sociodemographic factors and certainty of pregnancy within a year of not using contraception (no chance/unlikely, likely, certain) (Table 11). A smaller proportion of women who were married in a monogamous relationship said 'no chance/unlikely' compared to 'likely' or 'certain' (48% vs. 69% for both likely and certain; $p<0.001$) (Table 11). Among women who said 'no chance/unlikely,' 43% reported infertility, while 10% of women who said pregnancy was 'likely' experienced infertility and 16% of women who said pregnancy was certain reported infertility ($p<0.001$). Women who were 'certain' of pregnancy had the least number of children (2.7 vs. 3.0-3.1; $p<0.05$).

Men who reported that there was 'no chance' or it was 'unlikely' that their partner would become pregnant were more likely to report that they were never married (20%) compared to men who said it was 'likely' (1%) or 'certain' (8%) that their partner would become pregnant ($p<0.01$) (Table 11). Like women, a larger proportion of men who said 'no chance/unlikely' reported infertility (31%) compared to men who said pregnancy was 'likely' (6%) or 'certain' (16%) ($p<0.01$).

Table 11. Relationships between sociodemographic characteristics and certainty of pregnancy after one year without using contraception (N=749 women; men maximum N=568)[1, 2]

	Women				Men			
	No chance/ unlikely	**Likely**	**Certain**	**p-value**	**No chance/ unlikely**	**Likely**	**Certain**	**p-value**
Total	5.3%	16.7%	78.0%		7.0%	18.1%	74.8%	
Number of living children (mean)	3.00	3.09	2.7	0.042*	3.13	4.03	3.05	0.000***
Number of years of education (mean)	5.23	5.49	5.29	0.806	5.59	5.42	5.67	0.7797
Age (mean)	28.3	28.5	27.9	0.632	32.5	35.4	32.0	0.002**
Age group				0.016*				0.006**
15-19	5.0%	4.0%	7.5%		15.4%	1.9%	5.9%	
20-24	40.0%	31.2%	27.7%		12.8%	12.6%	14.2%	
25-29	25.0%	24.0%	26.5%		20.5%	11.7%	20.8%	
30-34	5.0%	20.0%	21.1%		12.8%	21.4%	24.2%	
35-39	7.5%	12.8%	12.5%		10.3%	20.4%	16.9%	
40-45	17.5%	8.0%	4.6%		20.5%	17.5%	12.2%	
46 + (men only)					7.7%	14.6%	5.9%	
Currently married/cohabiting				0.000***				0.002**
Current monogamous relationship	47.5%	68.8%	69.2%		65.0%	87.4%	80.7%	
Current polygamous relationship	10.0%	20.0%	17.1%		10.0%	8.7%	10.4%	
Not currently married nor cohabiting	32.5%	9.6%	11.8%		5.0%	2.9%	1.2%	
Never married nor cohabited	10.0%	1.6%	1.9%		20.0%	1.0%	7.8%	
Ever been divorced (among ever-married)	41.7%	28.5%	31.1%	0.321	28.1%	33.3%	33.4%	0.828
Ever wants a(nother) child	70.0%	78.4%	76.9%	0.544	61.5%	58.3%	71.0%	0.031*
Had sex in previous 3 months	67.5%	80.8%	80.7%	0.128	85.0%	92.2%	90.8%	0.402
Self-reported infertility	42.5%	10.4%	15.6%	0.000***	30.8%	5.8%	15.9%	0.001**

[1]p-values are for chi-square tests (categorical) and F-tests (continuous); columns may not total to 100% due to rounding; *p<0.05, **p<0.01. ***p<0.001

[2]Maximum N is the total sample size for the dependent variable (see Table 9)

Infertility measures and contraceptive use among women

Both self-reported ever experienced infertility and certainty of pregnancy were significantly associated with current contraceptive use among women (Table 12). Women who ever experienced infertility were less likely to use contraception than those who had never experienced infertility (68% vs. 79%; $p<0.01$). Women who said they were 'certain' or 'likely' to become pregnant within a year of not using contraception were more likely to be using contraception than women who said there was 'no chance' or said it was 'unlikely' they would become pregnant (80% contraceptive use among women who were certain, 76% among likely, and 48% for no chance/unlikely) ($p<0.001$) Women who were married/cohabiting in monogamous or polygamous partnerships also had higher rates of contraceptive use than women who were not married/cohabiting (84% of monogamous, 83% of polygamous, and 40% of not married/cohabiting were using contraception) ($p<0.001$). Sex in the previous three months was also associated with contraceptive use, such that 86% of women who had sex in the past three months were using contraception compared to 43% of women who had not had sex in the previous three months ($p<0.001$) (Table 12).

Table 12. Relationship between independent variables and contraceptive use among women (N=749)[1,2]

	Currently using contraception		
	No	**Yes**	**p-value**
Total	22.6%	77.4%	
Number of living children (mean)	2.85	2.76	0.52
Number of years of education (mean)	4.8	5.47	0.015*
Self-reported infertility			0.005**
Yes	32.2%	67.8%	
No	20.7%	79.3%	
Certainty of pregnancy			0.000***
Certain	20.2%	79.8%	
Likely	24.0%	76.0%	
No chance/ unlikely	52.5%	47.5%	
Age (mean)	28.8	27.8	0.086
Age group			0.000***
15-19	47.1%	52.9%	
20-24	16.1%	83.9%	
25-29	19.5%	80.5%	
30-34	19.3%	80.7%	
35-39	23.9%	76.1%	
40-45	47.7%	52.3%	
Currently married/cohabiting			0.000***
Current monogamous relationship	15.7%	84.3%	
Current polygamous relationship	17.0%	83.0%	
Not currently married/cohabiting[3]	60.4%	39.6%	
Ever wants a(nother) child			0.571
Yes	22.1%	77.9%	
No	24.1%	75.9%	
Had sex in previous 3 months			0.000***
Yes	14.0%	86.0%	
No	56.7%	43.3%	

[1]p-values are for chi-square tests (categorical) and F-tests (continuous); rows total to 100%; *p<0.05, **p<0.01. ***p<0.001

[2]N is the women's analytic sample

[3]Category combines 'not currently' and 'never' married or cohabiting

Multivariable analysis

Table 13 reports on the bivariable relationships between all independent variables and contraceptive use, as well as three multivariable models examining: self-reported ever experienced infertility and contraceptive use (Model 1), certainty of pregnancy and contraceptive

use (Model 2), and a third multivariable model examining contraceptive use with both ever experienced infertility and certainty of pregnancy as independent variables (Model 3).

Ever experienced infertility and contraceptive use (Model 1): Reporting infertility was associated with significantly lower odds of contraceptive use (AOR: 0.51; 95% CI: 0.35-0.74). Additionally, women who wanted a(nother) child had lower odds of contraceptive use compared to women who did not want more children (AOR: 0.52; 95% CI: 0.28-0.96), as did women who were not married/cohabiting compared to women in monogamous relationships (AOR: 0.34; 95% CI: 0.20-0.56). Education was significant, such that with every additional year of education, women had 7% higher odds of using contraception (AOR: 1.07; 95% CI: 1.02-1.12). The youngest women (15-19 years) and the oldest women (40-45 years) had significantly lower odds of contraceptive use compared to women ages 20-24 years (15-19 years AOR: 0.31; 95% CI: 0.15-0.66; 40-45 years AOR: 0.18; 95% CI 0.09-0.37).

Certainty of pregnancy and contraceptive use (Model 2): The relationship between certainty of pregnancy and contraceptive use was significant after adjusting for sociodemographic variables: compared to reporting 'certain', women who reported 'no chance/unlikely' had 74% lower odds of using contraception (AOR: 0.26; 95% CI: 0.09-0.72). There was no significant difference in contraceptive use for women who reported 'likely' vs. 'certain.' Covariate results were similar in magnitude and significance as Model 1.

Ever experienced infertility, certainty of pregnancy, and contraceptive use (Model 3): With the inclusion of both main independent variables (self-reported ever experienced infertility and certainty of pregnancy), each was significantly and independently associated with contraceptive use and effects were similar in magnitude and significance as the previous models. Controlling for all other covariates, women who reported ever experiencing infertility had 44%

lower odds of using contraception than women who did not report ever experiencing infertility (AOR: 0.56; 95% CI: 0.39-0.83) and women who reported ‘no chance/unlikely’ that they would become pregnant after one year without using contraception had 70% lower odds of contraceptive use compared to women who were ‘certain’ they would become pregnant (AOR: 0.30; 95% CI: 0.10-0.92). All other covariates performed similarly in Model 3 as the previous models (Table 13).

Table 13. Bivariable and multivariable logistic associations between infertility variables, sociodemographic characteristics and current contraceptive use (outcome) among women (N=749)[1]

	Bivariable		Model 1		Model2		Model 3	
	OR	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**
Self-reported infertility	0.54**	0.37-0.82	0.51***	0.35-0.74	- -	- -	0.56**	0.39-0.83
Certainty of pregnancy			- -	- -				
Certain	1				1		1	
Likely	0.80	0.48-1.34			0.73	0.45-1.17	0.70	0.43-1.13
No chance/unlikely	0.23***	0.11-0.50			0.26*	0.09-0.72	0.30*	0.10-0.92
Age group								
15-19	0.21***	0.13-0.37	0.31**	0.15-0.66	0.28**	0.13-0.61	0.28**	0.13-0.61
20-24 *(ref)*	1		1		1		1	
25-29	0.79	0.50-1.27	0.65	0.38-1.13	0.61	0.36-1.04	0.62	0.36-1.07
30-34	0.80	0.47-1.38	0.71	0.41-1.23	0.59*	0.35-0.99	0.63	0.37-1.08
35-39	0.61	0.30-1.24	0.55	0.28-1.06	0.49*	0.26-0.92	0.50*	0.27-0.94
40-45	0.21***	0.12-0.38	0.18***	0.09-0.37	0.17***	0.09-0.35	0.19***	0.10-0.37
Currently married/cohabiting								
Current monogamous relationship	1		1		1		1	
Current polygamous relationship	0.91	0.52-1.57	1.12	0.67-1.86	1.09	0.66-1.79	1.12	0.67-1.88
Not currently married/cohabiting[2]	0.12***	0.08-0.19	0.34***	0.20-0.56	0.41**	0.23-0.75	0.38**	0.21-0.71
Had sex in previous 3 months	8.02***	5.38-11.95	4.67***	2.59-8.40	5.19***	2.84-9.46	5.02***	2.64-9.53
Ever want a(nother) child	1.12	0.70-1.79	0.52*	0.28-0.96	0.51*	0.28-0.94	0.51*	0.28-0.95
Years of education	1.07**	1.02-1.12	1.07**	1.02-1.12	1.07**	1.02-1.12	1.07**	1.02-1.12

[1]*p<0.05; **p<0.01; ***p<0.001

[2]Category combines 'not currently' and 'never' married or cohabiting

Discussion

Our findings indicate that one's fertility – both experienced infertility and perceived certainty of becoming pregnant in the future – may be consequential for women's contraceptive use, even when accounting for pregnancy intentions, marital status, and other sociodemographic characteristics commonly associated with contraceptive use. We found that women who ever experienced infertility were less likely to use contraception. The hypothesized and observed relationship between ever experienced infertility and contraceptive use is self-evident – if someone has experienced infertility they may, accurately or not, assume they do not need to use contraception. Behavior following this logic could be problematic, however, if one's experience of infertility does not accurately reflect their actual chance of becoming pregnant in the future.

Following a similar logic, we found that women who said there was 'no chance' or it was 'unlikely' they would become pregnant within one year of not using contraception had significantly lower odds of current contraceptive use than women who were certain they would become pregnant. This finding aligns with constructs from existing health behavior theories – i.e., perceived susceptibility to an outcome (e.g., pregnancy) is associated with implementing a preventative behavior (e.g., contraceptive use) (Rosenstock, 1974). Our study provides evidence that levels of certainty of becoming pregnant may be associated with contraceptive use, indicating that women may make contraceptive decisions based on their perception of their likelihood of becoming pregnant, which may or may not align with their biological likelihood of becoming pregnant. Indeed, among women who said that there was no chance or they were unlikely to become pregnant, under half (43%) also reported experiencing infertility. Therefore, it is possible that women are making determinations about their future fertility based on factors that may not be reliable (Gemmill et al., 2021).

The relationships we found between ever experienced infertility, certainty of pregnancy, and contraceptive use each remained statistically significant in multivariable models. This finding supports our hypothesis that certainty of pregnancy and experienced infertility may act as independent mechanisms influencing perceived chance of becoming pregnant and contraceptive use (Figure 6).

Rates of experienced infertility in our study are similar to those found in other studies in Malawi (Barden-O'Fallon, 2005b; Rao et al., 2017). Given that there were no significant differences in number of children and reported infertility among women or men, it may be that experiences of infertility are episodic and do not reflect true childbearing experiences or potential. Because of the commonality of secondary infertility due to sexually transmitted infections (STIs), unsafe abortion, and previous pregnancy or delivery complications (Inhorn, 2003, 2009), participants may already have children before experiencing infertility, contributing to the apparent lack of relationship between number of children and experienced infertility.

We found high rates of certainty of pregnancy in this population. One possible explanation for high rates of certainty may be that it is a "default" response that represents pronatalist norms and optimism commonly observed in Malawi (Garver, 2016). The people in our sample contend with extreme poverty and uncertainty in their everyday lives, but are still likely to respond positively on measures about hopefulness and the future (Garver, 2016, 2018). Given the severity of the consequences and stigma associated with not being able to become pregnant (Bornstein, Gipson, et al., 2020), it is reasonable that people erred on the side of reporting that they were likely or certain to become pregnant. It is also not surprising that certainty of pregnancy and experienced infertility were associated among both women and men. Past experiences often influence future expectations.

Gender differences

Overall, we found that different factors were associated with reporting infertility and certainty of pregnancy for women and men. Women who were older and divorced at least once were more likely to report that they ever experienced infertility, while the only significant association for men was older age. This reflects both diminished biological fertility with age, as well as a longer exposure period (exposure to pregnancy and, therefore, exposure to the possibility of not becoming pregnant) among older women and men.

A notable bivariate finding was around divorce and infertility for women: 51% of women who ever experienced infertility had been divorced at least once, while 29% of women who had not experienced infertility had been divorced ($p<0.05$). Because the data are cross-sectional, we do not know whether divorce preceded or followed the experience of infertility; however, other studies point to abandonment and divorce as a consequence of experiencing infertility, particularly for women (Fledderjohann, 2012, 2017). Along with divorce, polygamy may be considered a "solution" for a couple experiencing infertility (de Kok, 2009) and, indeed, we found that 21% of women who ever experienced infertility were in polygamous relationships compared to 16% of those who had not (although this finding was not significant). Future interventions regarding infertility should address the consequences of infertility, particularly for women, given the negative social and economic consequences of divorce and complexities of polygamy (Dhont et al., 2011; Reniers, 2003), which may compound the negative consequences of infertility.

Factors associated with varying levels of certainty also differed between women and men. Men who said 'likely' had the highest average number of children compared to men who said no chance/unlikely or certain. For women, number of children did not vary by certainty at

all. Sex in the previous three months was associated with certainty for women, but not for men. However, sexual activity among men was high for all levels of certainty (85%-92%). Certainty also differed by age group and marital/cohabitation status for both women and men. These findings point to the need to better understand the factors that contribute to both women's and men's perceptions around their fertility.

In addition to having substantial missing data for contraceptive use, we did not examine the association between ever experienced infertility or certainty of pregnancy and contraceptive use among men in multivariable models. Research among couples indicates that men often inaccurately report contraceptive use, particularly when methods are mostly women-centered (S. Becker et al., 2006), as is the case in Malawi as a whole (National Statistics Office (NSO) [Malawi] and ICF, 2017) and in our data. Men's reports are further complicated by polygamous unions where men are not able to specify within what relationship they use or do not use contraception, as was this case in our data. Women may also use contraception covertly, which would impact the accuracy of men's reports (Kibira et al., 2020). However, men are known to influence contraceptive use within couples (Mbweza et al., 2008; Shattuck et al., 2011). Scholarship around male-controlled contraceptive method use (e.g., condoms) *and* more specific and accurate reporting of contraceptive use among men are important in future efforts to understand the relationships between infertility, certainty of pregnancy, and men's contraceptive support and use.

Measurement

Among women, current contraceptive use was considerably higher than found in other studies in Malawi. Contraceptive prevalence was 77% in the analytic sample, considerably

higher than in the DHS, which reported a contraceptive use rate of 58% among married women in 2016 (National Statistics Office (NSO) [Malawi] and ICF, 2017). Contraceptive use may be higher in the UTHA cohort, as all participants live within the catchment area of a hospital that provides a range of free contraceptive methods. Additionally, as the primary method used in our sample was injection, we could not ascertain whether or not women received the injection every three-months. One study in Malawi found that only half of women received a second injection after first initiating the method, which could inflate contraceptive prevalence (Dasgupta et al., 2015). Furthermore, asking about contraceptive method use rather than pregnancy prevention broadly may have led to under-reporting of traditional contraceptive methods, as shown in a previous study in Ghana that found vast underreporting of traditional contraceptive use in surveys compared to in-depth interviews (Staveteig, 2017). However, in the contraceptive use question, we specified that we meant modern or traditional methods. Regardless, it may be that if we probed further participants may have reported more traditional method use or if they were using their current method correctly.

While there is growing acknowledgment that perceptions of infertility may be important to how women and men make reproductive decisions, there are no standard or agreed upon definitions or measures of perceived infertility. Other studies have examined adjacent constructs to the certainty of pregnancy measure that we used. A recent study in Malawi looked at perceived likelihood of infertility. The authors found that just 8% of women (N=1,064) and men (N=527) ages 21-29 years perceived they may be a little, somewhat, or very likely to be infertile, while the remaining 92% said it was not at all likely (Polis, Moore, et al., 2020). This study used a measure of perceived infertility that is different from the certainty measure we used, but the findings similarly reflect high perceived fertility in Malawi. Our use of two measures – ever

experienced infertility and perceived certainty of pregnancy – allows us to examine nuances in how people may perceive their chance of pregnancy. The first variable (infertility) captures past (or current) experiences, which are known to influence future behavior. The latter (certainty of pregnancy) captures one's anticipated ability to become pregnant in the future, within a culturally acceptable timeframe (Bornstein, Gipson, et al., 2020).

Additional measures that studies have used related to certainty of pregnancy include percent chance of becoming pregnant (Gemmill, 2018), perceived inability to become pregnant (Foster et al., 2012; Nettleman et al., 2007) and perceived speed of conception (Fledderjohann, 2017), among others. While these measures are all related, it is difficult to compare across studies without a common definition and measure. Our findings suggest that certainty of pregnancy may be an important factor in contraceptive use, but in order to build the necessary body of evidence to support or refute our hypotheses around certainty and related constructs, consistent measurement is needed. After agreeing on standard definitions, it would be ideal to develop a set of psychometrically tested and standardized measures that are culturally and contextually appropriate in various settings.

Our measure of self-reported ever experienced infertility in this study is limited in that someone who experienced a period of unsuccessfully trying to become pregnant for two or more years in the past – perhaps at the beginning of their reproductive life-course – is categorized the same as someone who is currently experiencing infertility. Given that infertility is not well defined in terms of exposure (i.e., timing and frequency of sex), the commonality of divorce and remarriage in Malawi (Bertrand-Dansereau & Clark, 2016; Reniers, 2003), and the fact that the cause of infertility is often unknown at the couple-level (i.e., male/female/both), the possibility exists that an individual's report of infertility may reflect the inability of their previous partner to

conceive, rather than their own inability. Thus, experiencing a period of trying to become pregnant for two or more years unsuccessfully may *not* be indicative of an individual's subsequent pregnancy experiences or one's perceived certainty of pregnancy in the future.

The measure also captures both primary and secondary infertility, which are not only different etiologically, but are also likely to have differential social and relational consequences, as well as effects on contraceptive use. One can imagine that experiencing a period of infertility followed by successfully having a child or children will have a different impact on future fertility expectations and perceived need to use contraception than having never successfully become pregnant.

Our cross-sectional data, however, do not allow us to parse out causality. We cannot determine the directionality of infertility, certainty of pregnancy, and contraceptive use. While we hypothesize that infertility and certainty of pregnancy influences contraceptive use, it may also be that contraceptive use leads one to report infertility or uncertainty. Longitudinal data that reveals *when* women and men experienced a period of infertility, followed with a detailed reproductive history, will provide insight into how timing of infertility, type of infertility (i.e., primary or secondary), and certainty of pregnancy are related. Longitudinal data may also allow us to understand if women respond to the certainty question based on recent experiences or perceptions that using a contraceptive method continues to suppress fertility for a time after discontinuation.

Implications

Despite limitations, this is one of the first studies to look at the independent relationships between ever experienced infertility, certainty of becoming pregnant and contraceptive use. It is

also among the first to describe possible characteristics of men who report infertility and certainty of pregnancy. Given our findings, it appears that women may make contraceptive decisions based on their experience with infertility and how certain they are that they can become pregnant in the future. To the extent that women who do *not* wish to become pregnant and whose perceptions of low fertility or infertility may be incorrect they may be at risk of having an unintended pregnancy. Our findings suggest that addressing perceptions of infertility and certainty has the potential to reduce unintended pregnancy.

Programs that aim to reduce unintended pregnancy through promoting contraceptive use need to be cognizant of both experiences and perceptions of infertility and address these issues during contraceptive counseling. Women and men may not contracept if they believe they may not become pregnant easily or ever. Additionally, family planning programs should intentionally include women and men who have experienced infertility or report that they are unlikely to become pregnant. These individuals may not identify as needing contraception and self-select out of such interventions. Therefore, programs must specifically target these groups so as to not inadvertently exclude them. Including people who opt out of family planning due to experienced or perceived subfecundity or infertility is particularly important in the absence of access to infertility diagnostics.

Although less widely recognized, addressing infertility is an important public health goal, along with reducing unintended pregnancy (Gipson et al., 2020; Starrs et al., 2018). Measuring the prevalence and consequences of infertility should be treated equally important as unintended pregnancy (Gipson et al., 2020). Treatment for infertility is largely inaccessible globally, particularly in low-resource settings (Starrs et al., 2018), which magnifies the impact of infertility and, perhaps, its salience in making reproductive decisions. Moreover, focusing

exclusively on unintended pregnancy undervalues the experience of infertility, as well as the role of experienced and perceived subfecundity or infertility in reproductive decision making.

Our findings indicate that experiences and perceptions surrounding fertility are associated with contraceptive behaviors, thus, potentially how people manage their fertility to reach their reproductive goals. We also found evidence that experiences of infertility and certainty of ability to become pregnant may operate independently. Our study findings underscore the need to holistically understand how experiences and perceptions of both infertility and fertility shape reproductive decision making. Such efforts are necessary to best meet the needs of women and couples in reaching their reproductive goals.

A version of Study 2 is published in *Studies in Family Planning* –

Bornstein, M., Huber-Krum, S., Norris, A.H., Gipson, J.D., (2021). Perceived infertility, certainty of pregnancy, and contraceptive use in Malawi. *Studies in Family Planning*. doi: 10.1111/sifp.12152 (Bornstein et al., 2021)

Chapter 9 (Study 3): Experienced infertility and subsequent pregnancy

Introduction

At the population level, the coexistence of high rates of infertility and total fertility presents a paradox that is not typically addressed in public health research. One of the challenges in addressing this paradox is difficulty assessing the intersection of these experiences (i.e., infertility, fertility) in individuals. The relationship between experiences with infertility and fertility are rarely investigated longitudinally within individuals, although concurrently high rates of infertility and total fertility are demonstrated in population-level estimates/statistics. In Malawi, approximately 20% of women report infertility or difficulty becoming pregnant (Barden-O'Fallon, 2005b; Rao et al., 2017) and 41% of pregnancies are considered unintended (National Statistics Office (NSO) [Malawi] and ICF, 2017). Both infertility and unintended fertility are common, yet there is no research that examines the possibility that people may experience both infertility and unintended fertility within their reproductive life course. Much remains unknown about the fertility experiences of women who become pregnant after experiencing a period of infertility or subfecundity; if women who become pregnant after experiencing infertility do not wish to become pregnant, there may be an opportunity to intentionally include these women in family planning programs, even if they perceive, based on their experience of infertility, that they are not likely to become pregnant. Recently, there have been calls to examine the reproductive life course (also referred to as the reproductive career) in a way that integrates the multitude of reproductive experiences women may have in their lifetime, including both infertility and (unintended) fertility (K. M. Johnson et al., 2018).

There are many limitations to studying infertility and unintended fertility together. Doing so requires longitudinal data that ideally spans the reproductive life-course in order to understand

the temporality of infertility[5] and unintended fertility. Studying infertility and unintended fertility also requires nuanced and time-specific measures of both phenomena. Both infertility and unintended fertility are difficult to measure. While there are continued and more recent attempts to capture the nuances of unintended fertility, for example through the development of multi-dimensional scales (Barrett et al., 2004; Rocca et al., 2019; Stulberg et al., 2020), there are but notably fewer efforts to measure the nuances of infertility and subfertility, as well as how and when women identify as infertile or subfertile (Gipson et al., 2020). Measures of infertility tend to be for the purpose of clinical, epidemiologic, and demographic studies (Mascarenhas, Cheung, et al., 2012) that aim to understand patterns of infertility within populations, infertility prevention, and infertility treatment needs. One of the primary challenges in studying fertility and infertility is that, in most settings, we cannot confirm infertility clinically. Instead, we rely on self-reported measures of a complex construct with multiple exposure components, including sexual activity without contraception over a specific time-period. As shown in the qualitative study of this dissertation, reporting on contraceptive use/non-use may be complicated by the various ways that women use contraceptive methods to regulate their fertility.

Studies that examine the incidence of pregnancy after an experience of infertility are often focused on the clinical phenomenon of becoming pregnant after a one- or two-year period of exposure to unprotected sex. While the vast majority of pregnancies occur within one year of attempting to become pregnant (Gnoth et al., 2019), studies in clinical settings have found that around half of women who met the clinical definition for infertility – no pregnancy after one year

[5]Unlike sterility, which is not discussed in this paper, infertility refers to a specific period of time (usually 1-2 years), not necessarily a permanent state; thus, it is possible that unintended fertility could follow a period of infertility.

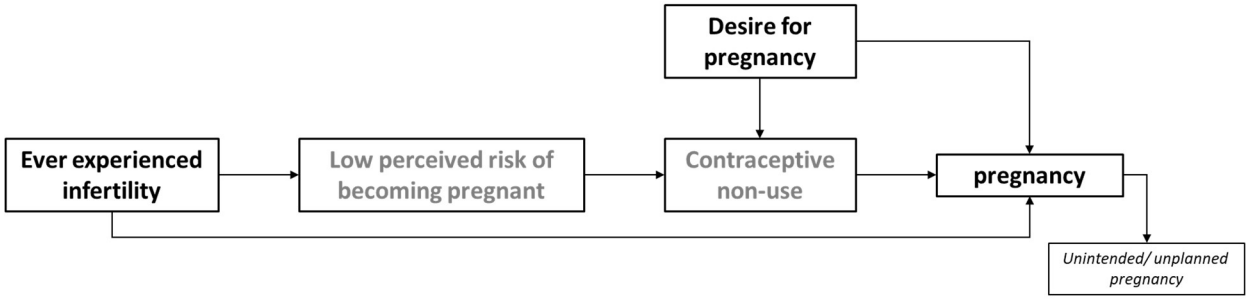
– eventually became pregnant without infertility treatment[6] (Brandes et al., 2010; Righarts et al., 2017; Snick et al., 1997). These studies clearly demonstrate the potential to experience a period of infertility and still be able to conceive a pregnancy at some point within the reproductive life course. None of the studies, however, consider pregnancy intention, as there is a common assumption that women who experience infertility want to become pregnant, even though this may not be an accurate or enduring assumption (Greil, McQuillan, et al., 2010). Fertility preferences may change, even among women and couples who once tried to become pregnant for a 1–2-year period and were not able to.

Understanding the potential for women to have an *unintended* pregnancy after experiencing infertility requires longitudinal data to establish temporality of these events. There have been no studies, to my knowledge, that examine the rate of unintended pregnancy after experiencing infertility. Knowing this information is critical to ensuring that family planning programs address the needs of women and couples, both while they are experiencing difficulty becoming pregnant, as well as after (if they eventually conceive). Given findings from the second paper of this dissertation, that women who experienced infertility were less likely to use contraception, it is important to understand the possible implications of contraceptive non-use (i.e., unintended pregnancy) among women who have experienced infertility. A conceivable mechanism for this relationship is shown in Figure 7 and links back to constructs within the Health Belief Model (Rosenstock, 1974). Ever experiencing infertility may lower one's perceived risk of becoming pregnant, contributing to contraceptive non-use (observed in the second paper of this dissertation), which in turn may lead to unintended pregnancy. Of course,

[6]Women who become pregnant after meeting the definition for experiencing infertility are sometimes referred to as having resolved infertility or are referred to as "truly fertile." In this study, I refer to all women who have ever met the definition of infertility as having ever experienced infertility.

women who experience infertility may want to become pregnant (and, indeed, may only report infertility if they want to become pregnant) which would potentially influence both contraceptive use and unintended pregnancy (Greil, McQuillan, et al., 2010).

Figure 7. Analytic framework examining ever experienced infertility and unintended pregnancy[1]



[1]Constructs in grey are not examined in this study

This study aims to answer two main questions: (1) Are women who have ever experienced infertility less likely to experience a subsequent pregnancy than women who have not experienced infertility? And, (2) among women who become pregnant, are those who have experienced infertility more likely to report that their pregnancy was unintended or unplanned compared to women who had not experienced infertility?

Methods

Details of the UTHA study design and cohort are included in Chapter 6. In this analysis, I focus on the population of women who were recruited at Wave 1 (2014-2015) and then create two analytic samples based on participation in follow up waves.

Analytic samples

Pooled sample – participated in Wave 1 and at least one additional wave

The pooled analytic sample includes women who participated in Wave 1 of the UTHA cohort (2014-2015) and at least one additional wave of data collection (2016-2017, 2017-2018, and/or 2019). Of the 1,030 women who participated in Wave 1, I excluded women who were sterilized (n=24), over the age of 45 years (n=4), or never had sex (n=77) at Wave 1, for a total of 925 eligible women. An additional 94 women were excluded because they did not participate in any follow up waves and, for whom I was not able to capture a possible subsequent pregnancy. Finally, 55 women were excluded because they had missing data for a key Wave 1 covariate (e.g., number of pregnancies as of Wave 1, ever experienced infertility at Wave 1). Multiple imputation to address missing data was considered, but ultimately not done due to the fact that women were frequently missing on multiple variables, including the variable used to construct the main outcome (number of pregnancies at Wave 1).

Table 14 describes the pooled analytic sample (N=776) and compares the pooled analytic sample to those who were excluded because they did not participate in a follow up wave or because they had missing data (N=149). There were several important differences between the pooled analytic sample and those who were excluded. A greater proportion of women in the analytic sample were married or cohabiting at Wave 1 than those who were excluded (92% vs. 70%; $p<0.001$). The analytic sample was also older on average (26.6 vs. 25.5 years; $p<0.001$). Women who were excluded from the analytic sample were more likely to be nulliparous than women in the included sample (24% vs. 7%; $p<0.001$), and had fewer living children (30% of women in the excluded sample had no living children compared to 10% in the analytic sample; $p<0.001$) (Table 14). These differences are likely due to the increased mobility of women who

are younger, not married, or do not have children. Such women may have been more likely to relocated outside of the UTHA cohort area due to marriage.

Table 14. Wave 1 characteristics of the pooled analytic sample (N=776) compared to those excluded due to lack of follow up (n=94) or missing data (n=55)[1]

	Analytic sample N=776 %/mean (range)	Excluded %/mean (range)	p	Excluded sample N[2]
Reported at least one pregnancy after W1				
Yes	64.8%	62.0%	0.686	50
No	35.2%	38.0%		
Infertility				
Yes	19.7%	22.1%	0.550	113
No	80.3%	77.9%		
Relationship status				
Married/cohabiting	92.1%	70.2%	<0.001***	141
Not married or cohabiting	7.9%	29.8%		
Age group				
14-19	12.2%	26.2%	<0.001***	149
20-24	31.6%	25.5%		
25-29	21.4%	14.8%		
30-34	20.0%	19.5%		
35-41	14.8%	14.1%		
Age (mean (range))	26.6 (14-40)	25.5 (14-41)	0.049*	149
STI history				
Yes	10.4%	7.6%	0.293	145
No	89.6%	92.4%		
Pregnancies				
None	7.2%	23.8%	<0.001***	143
1	16.6%	14.0%		
2	20.0%	12.6%		
3	17.8%	13.3%		
4+	38.4%	36.4%		
Pregnancies (mean (range))	3.07 (0-12)	2.73 (0-12)	0.068	143
Living children				
None	10.3%	29.5%	<0.001***	149
1	20.2%	16.1%		
2	24.6%	16.1%		
3	18.3%	11.4%		
4+	26.6%	26.9%		
Living children (mean (range))	2.49 (0-8)	2.10 (0-6)	0.010*	149
Desire for another child (ever)				
Yes	70.8%	67.6%	0.445	145
No	29.3%	32.4%		
Years education (mean (range))	5.17 (0-12)	5.46 (0-12)	0.309	145
Years in cohort (mean (range))	4.3 (1.7-5.1)	4.26 (1.8-5.1)	0.963	49

[1]*p<0.05; **p<0.01; ***p<0.001

[2]Sample size varies for those excluded based on available data

Subsample: Women who participated in Waves 1 and 5

I constructed a subsample of women who participated in both Wave 1 (2014-2015) and Wave 5 (2019) (Wave 1/Wave 5 sample) of the study in order to examine the relationship between ever experiencing infertility, as reported in Wave 1, and retrospective pregnancy planning/intention among women who became pregnant between Waves 1 and 5. The scale of pregnancy planning/intention used as the dependent variable in this analysis was only measured at Wave 5, necessitating the exclusion of women who did not participate in Wave 5. Among the 1,030 women who participated in Wave 1, 105 were excluded because they did not meet the inclusion criteria (sterilized, over age 45 years, or never had sex at Wave 1), for a total of 925 eligible women. An additional 337 women were excluded because they did not participate in Wave 5, and 41 women were excluded because they had missing data for key Wave 1 covariates. Thus, the sample in the analysis includes 547 women.

There were differences between the Wave 1/Wave 5 analytic sample and those who did not participate in Wave 5 or had missing data at Wave 1. By virtue of being in the Wave 1/Wave 5 sample, these women were able to be followed up with during Wave 5 because they lived within UTHA catchment in both 2014-2015 and 2019. The group is also select because not all women were asked to participate in Wave 5 due to data collection constraints. Most notably, while in other waves multiple attempts were made to survey women who were unavailable at the first visit, in Wave 5 only one attempt was made. Women in the analytic sample were more likely to be married at Wave 1 (93% vs. 83%; $p<0.001$) and older (27 vs. 26 years; $p<0.01$). Women in the analytic sample also reported more pregnancies (3.2 vs. 2.8; $p<0.01$) and more living children (2.6 vs. 2.2; $p<0.01$) at Wave 1 compared to women who were excluded (Table

15). These patterns reflect the fact that women who were married, older, and had more children were likely more established in their community and less likely to move away.

Table 15. Wave 1 characteristics of the Wave 1 and Wave 5 participants (N=547) compared to those excluded due to lack of follow up at Wave 5 (n=337) or missing data (n=41)[1]

	Analytic sample N=547 %/mean (range)	Excluded %/mean (range)	p	Excluded sample N[2]
Reported at least one pregnancy by W5				
Yes	68.6%			
No	31.4%			
Infertility				
Yes	19.9%	20.2%	0.928	342
No	80.1%	19.8%		
Relationship status				
Married/cohabiting	92.7%	83.0%	<0.001***	370
Not married or cohabiting	7.3%	17.0%		
Age group				
14-19	10.1%	20.9%	<0.001***	378
20-24	31.8%	28.8%		
25-29	22.5%	17.2%		
30-34	19.7%	20.1%		
35-41	15.9%	13.0%		
Age (mean (range))	26.9 (15-39)	25.7 (14-41)	0.004**	378
STI history				
Yes	9.1%	11.2%	0.299	374
No	90.9%	88.8%		
Pregnancies				
None	5.9%	15.6%	<0.001***	372
1	15.5%	17.2%		
2	19.9%	17.2%		
3	17.6%	16.4%		
4+	41.1%	33.5%		
Pregnancies (mean (range))	3.20 (0-12)	2.76 (0-12)	0.002**	372
Living children				
None	8.9%	20.1%	<0.001***	378
1	18.7%	20.9%		
2	26.1%	19.1%		
3	18.7%	15.1%		
4+	27.8%	24.9%		
Living children (mean (range))	2.57 (0-8)	2.22 (0-7)	0.002**	378
Desire for another child (ever)				
Yes	68.7%	72.5%	0.225	374
No	31.3%	27.5%		374
Years education (mean (range))	4.90 (0-12)	5.69 (0-12)	0.309	374
Years in cohort (mean (range))	4.8 (4.3-5.1)	3.3 (1.7-5.1)	<0.001***	278

[1]*p<0.05; **p<0.01; ***p<0.001

[2]Sample size varies for those excluded based on available data

Variables

Dependent variables

New pregnancy after Wave 1 was calculated by subtracting the number of lifetime pregnancies women reported at Wave 1 from the number they reported at each subsequent wave. This variable was then recoded as binary (1 indicated that they had *ever* reported a new pregnancy after Wave 1 and 0 indicated that they reported no new pregnancies after Wave 1).

Number of pregnancies was chosen rather than number of living children because living children may fluctuate due to child mortality. Thus, reporting fewer living children in subsequent waves than at Wave 1 is possible and cannot be assumed to be a reporting error (Mandiwa et al., 2018).

Among women who had at least one pregnancy between Waves 1-5, I examined retrospective pregnancy planning/intention using the **London Measure of Unplanned Pregnancy (LMUP).** The authors of this scale use the terms 'unintended' and 'unplanned' interchangeably when describing pregnancy desires (Barrett et al., 2004). This six-item scale was first developed by a research team who conducted qualitative research and psychometrically tested and validated the scale in a sample of women in western Europe (Barrett et al., 2004). Qualitative findings suggested there were six dimensions of pregnancy planning, including:

> *"(1) Expressed intentions; (2) desire for motherhood; (3) contraceptive use; (4) pre-conceptual preparations; (5) personal circumstances/timing; and (6) partner influences"* (Barrett et al., 2004).

The Cronbach's alpha in the western European sample was 0.92 and the re-test reliability was 0.97, indicating that the measure was highly reliable and measured a consistent construct (Barrett et al., 2004). The scale was subsequently tested and validated in additional languages

and contexts, including a modified version in Chichewa in Malawi, where the Cronbach's alpha for the six-items was 0.78 and the re-test reliability was 0.80 (J. A. Hall et al., 2013). An English translation of the Chichewa version of the LMUP, along with how each response option is scored, is included in Table 16. As suggested by the authors of the LMUP scale, I constructed the LMUP as a continuous variable, with scores ranging from 0 (least planned) to 12 (most planned) (Barrett et al., 2004).

Table 16. LMUP items back-translated from Chichewa to English

1.	**In the month I became pregnant, I**
	Always used contraception (0)
	Always used contraception, but knew that the method had failed (1)
	Used contraception, but not every time (1)
	Was not using contraception (2)
2.	**Pregnancy happened at**
	Wrong time (0)
	Not quite right time (1)
	The right time (2)
3.	**Just before I became pregnant, I**
	Did not intend to get pregnant (0)
	Intention kept changing (1)
	Intended to get pregnant (2)
4.	**Just before I became pregnant, I**
	Did not want a baby (0)
	Mixed feelings about a baby (1)
	Wanted to have a baby (2)
5.	**Before I became pregnant…**
	My partner and I never discussed having children together (0)
	My partner and I discussed children, but did not agree I should become pregnant (1)
	My partner and I agreed for me to become pregnant (2)
6.	**Before becoming pregnant did you do anything to improve your health (e.g., took iron, saved money, ate healthily, sought advice from healthcare worker, or something else?)[1]**
	No (0)
	Yes (2)

Independent variables

All independent variables in this analysis were measured at Wave 1 (2014-2015). The main independent variable of interest was **ever experienced infertility**. The survey item – *have you ever tried to conceive a pregnancy for two years or longer without conceiving in that time?* – was asked and coded as binary (yes/no).

Covariates described Tables 14 and 15 were also included as independent variables. Age, number of pregnancies, and number of living children are all shown as categorical and continuous in bivariable analyses. In multivariable analyses age was used as categorical and number of living children was included as continuous. Number of pregnancies was omitted as it was used to construct the dependent variable. Covariates were selected for inclusion in the multivariable models based on previous theoretical and empirically established associations with pregnancy and/or pregnancy planning (Digitale et al., 2017; Huber et al., 2017; Mandiwa et al., 2018).

In both the pooled sample and the Wave 1/Wave 5 sample, I examined bivariate associations between sociodemographic characteristics typically associated with incidence of pregnancy (e.g., relationship status, age, parity, education) and reporting a pregnancy at any point during the participant's time in the cohort (up to 5.1 years). In the pooled sample, the length of time in the cohort varied based on how many and which follow up waves they participated in. A longer time under observation would increase the odds of reporting a pregnancy, and thus length of time in the cohort was included as an independent variable. The date of each survey was recorded as part of the data set. To construct the length of time in the cohort, the date of the participants first survey (sometime between 2014-2015) was subtracted from the date of the last survey participated in (sometime between 2016-2019) to establish the

length of time each participant was under observation. Days were then converted into years by dividing by 365 days.

Analysis

The dependent variables (reporting a pregnancy after Wave 1 and pregnancy planning) were measured using follow up data to establish temporality in the main relationship of interest – ever experienced infertility (Wave 1) and reporting a subsequent pregnancy (after Wave 1).

In both the pooled sample and the Wave 1/Wave 5 sample I examined bivariable associations between sociodemographic characteristics and the main independent variable (ever experienced infertility) and bivariable associations between sociodemographic characteristics and the dependent variable (reporting a pregnancy after Wave 1). I used chi^2 test of independence and F-tests to assess differences in distributions and means. I then constructed multivariable logistic regression models examining the odds of reporting a new pregnancy after Wave 1, controlling for sociodemographic characteristics. In multivariable analyses, age is included as a categorical variable and number of living children is included as a continuous variable to reduce multicollinearity in the models. Including age as continuous and living children as categorical had no effect on the results.

I conducted a multinomial multivariable model examining new pregnancy after Wave 1 as a categorical outcome: no pregnancies, one pregnancy, and more than one pregnancy (not shown). In this model, the only differences observed were between 0 vs. 1 pregnancy and 0 vs. 2 or more pregnancies, indicating that women who reported one pregnancy or more than one pregnancy were similar. This suggested that the logistic model was appropriate. I conducted an additional sensitivity analysis excluding women who reported being sterilized in a subsequent

Wave (women who were sterilized by Wave 1 were excluded), but the results did not change substantially in terms of coefficient magnitude, direction, or significance (not shown). Thus, women who became sterilized at some point after Wave 1 (n=121) are retained in the multivariable models under the assumption that they were at risk for pregnancy during at least part of the follow up period. A survival analysis, which censored for sterilization, is included in Appendix B.

Among women in the Wave 1/Wave 5 sample who became pregnant between Waves 1 and 5 (n=375; 69% of the sample), I examined pregnancy planning/intention using the LMUP. The purpose of examining the LMUP only among women who became pregnant between Waves 1 and 5 was to ensure that only pregnancies that happened after reporting ever experiencing infertility were assessed for planning/intention. Additionally, the LMUP was only measured at Wave 5. While some women had multiple pregnancies between Waves 1 and 5, the LMUP is measured for a woman's most recent pregnancy. I used one-way ANOVAs to test the association between various sociodemographic characteristics, including infertility, and the LMUP as a continuous outcome. Two participants did not respond to one of the six LMUP items, thus, their scores were imputed based on their responses to the other five items.

In the Wave 5 UTHA data, all six items were correlated and the entire scale yielded a Cronbach's Alpha of 0.90 (Table 17). Item six was the least correlated with other items, but all six items loaded onto a single factor (not shown), thus all six items were retained.

Table 17. LMUP item correlation (N=375)[1,2]

	LMUP 1	LMUP 2	LMUP 3	LMUP 4	LMUP 5	LMUP 6
LMUP 1						
LMUP 2	0.56***					
LMUP 3	0.47***	0.92***				
LMUP 4	0.51***	0.91***	0.91***			
LMUP 5	0.52***	0.90***	0.91***	0.94***		
LMUP 6	0.13*	0.21***	0.17***	0.20***	0.18***	

[1]Cronbach's Alpha (items 1-6) = 0.90; Cronbach's Alpha (items 1-5): 0.94
[2]*p<0.05; **p<0.01; ***p<0.001

Results

Pooled sample

Characteristics of women in the pooled analytic sample are described in the methods section (Table 14). Overall, 65% of the sample (n=503) became pregnant after Wave 1.

Among the pooled analytic sample, I examined differences between women who did and did not report ever experiencing infertility at Wave 1 (Table 18). Women who reported infertility at Wave 1 were more likely to have ever experienced a Sexually Transmitted Infection (STI) than women who did not report infertility (16% vs. 9%; $p<0.05$). Women who reported infertility also had fewer years of education, on average, than women who did not report infertility (4.3 vs. 5.4 years). Notably, there were no differences in number of pregnancies or number of living children at Wave 1 between women who did and did not report ever experiencing infertility.

Table 18. Wave 1 characteristics of women by ever experiencing infertility at Wave 1 (N=776)[1]

	No infertility at W1 N=623 %/mean (range)	Infertility at W1 N=153 %/mean (range)	p
New pregnancy reported after W1			
Yes	64.9%	64.7%	0.974
No	53.2%	35.3%	
Relationship status			
Married/cohabiting	91.7%	94.1%	0.310
Not married or cohabiting	8.4%	5.9%	
Age group			
14-19	12.0%	13.1%	0.158
20-24	33.1%	25.5%	
25-29	21.0%	22.9%	
30-34	21.4%	18.3%	
35-41	13.5%	20.3%	
Age (mean (range))	26.4 (14-39)	27.2 (15-40)	0.147
STI history			
Yes	9.2%	15.7%	0.018*
No	90.9%	84.3%	
Pregnancies			
None	6.9%	8.5%	0.896
1	16.9%	15.7%	
2	20.4%	18.3%	
3	18.0%	17.0%	
4+	37.9%	40.5%	
Pregnancies (mean (range))	3.06 (0-12)	3.12 (0-7)	0.758
Living children			
None	9.3%	14.4%	0.434
1	20.4%	19.6%	
2	24.6%	24.8%	
3	18.5%	17.7%	
4+	27.3%	23.5%	
Living children (mean (range))	2.53 (0-8)	2.31 (0-6)	0.137
Desire for another child (ever)			
Yes	70.1%	73.2%	0.456
No	29.9%	26.8%	
Years education (mean (range))	5.38 (0-12)	4.32 (0-12)	<0.001***
Years in cohort (mean (range))	4.3 (1.7-5.1)	4.3 (2.0-5.1)	0.702

[1]*p<0.05; **p<0.01; ***p<0.001

Table 19 describes characteristics of women who did and did not report a new pregnancy after Wave 1, the main outcome of interest. Among the subsample of 547 women who participated in Waves 1 and 5, 69% (n=375) reported becoming pregnant between Waves 1 and 5. On average, women who became pregnant after Wave 1 were younger than women who did

not (26 vs. 28 years as of Wave 1; $p<0.001$), had experienced fewer pregnancies by Wave 1 (2.6 vs. 3.9; $p<0.001$), and had fewer living children (2.2 vs. 3.0; $p<0.001$) at Wave 1 than women who did not report a pregnancy after Wave 1. Additionally, women who reported that they wanted to become pregnant (again) at Wave 1 were more likely to report becoming pregnant after Wave 1 (77% vs. 59%; $p<0.001$). As expected, the longer a woman stayed in the cohort, the more likely she was to report a new pregnancy, such that women who reported a new pregnancy were in the cohort for an average of 4.3 years compared to 4.1 years among women who did not report a new pregnancy ($p<0.001$). Approximately 20% of both women who did and did not report a pregnancy after Wave 1 had ever experienced infertility by Wave 1.

Table 19. Wave 1 characteristics of women who reported a new pregnancy after Wave 1 (N=776)[1]

	No pregnancy (N=273) %/mean (range)	Pregnancy (N=503) %/mean (range)	p
Infertility			
Yes	19.8%	19.7%	0.974
No	80.2%	80.3%	
Relationship status			
Married/cohabiting	92.7%	91.9%	0.683
Not married or cohabiting	7.3%	8.1%	
Age group			
14-19	7.7%	14.7%	<0.001***
20-24	22.0%	36.8%	
25-29	26.0%	18.9%	
30-34	24.9%	17.3%	
35-41	19.4%	12.3%	
Age (mean (range))	28.2 (15-40)	25.7 (14-39)	<0.001***
STI history			
Yes	13.2%	9.0%	0.065
No	86.8%	91.0%	
Pregnancies			
None	0.7%	10.7%	<0.001***
1	8.8%	20.9%	
2	16.5%	21.9%	
3	20.2%	16.5%	
4+	53.9%	30.0%	
Pregnancies (mean (range))	3.86 (0-12)	2.64 (0-10)	<0.001***
Living children			
None	5.1%	13.1%	<0.001***
1	13.2%	24.1%	
2	22.3%	25.8%	
3	23.1%	15.7%	
4+	36.3%	21.3%	
Living children (mean (range))	3.01 (0-7)	2.21 (0-8)	<0.001***
Desire for another child (ever)			
Yes	59.3%	76.9%	<0.001***
No	40.7%	23.1%	
Years education (mean (range))	5.14 (0-12)	5.19 (0-12)	0.852
Years in cohort (mean (range))	4.1 (1.7-5.1)	4.3 (2.1-5.1)	<0.001***

[1]*p<0.05; **p<0.01; ***p<0.001

In bivariable analyses examining the odds of reporting a pregnancy after Wave 1, older age at Wave 1 (OR: 0.93; p<0.001) and more living children at Wave 1 (OR: 0.74; p<0.001) were both associated with lower odds of reporting a pregnancy after Wave 1 (Table 20). Women who reported that they wanted a(nother) child at Wave 1 had 2.29 times the odds of reporting a

pregnancy after Wave 1 (p<0.001). For every additional year spent in the cohort, women had 39% higher odds of reporting a pregnancy p<0.001).

In the multivariable model, only number of living children, desire for another child, and years in the cohort remained associated with reporting a pregnancy after Wave 1. For every additional living child that a woman had at Wave 1, she had 23% lower odds of reporting a subsequent pregnancy (AOR: 0.77; p<0.01). Women who wanted a(nother) child at Wave 1 had 59% higher odds of reporting a pregnancy compared to women who did not want a(nother) child at Wave 1 (AOR: 1.59; p<0.05). For every additional year in the cohort, women were 51% more likely to report a pregnancy (AOR: 1.51; p<0.001).

Table 20. Bivariable and multivariable models examining odds of reporting a pregnancy after Wave 1 (N=776)[1]

	Bivariable			Multivariable		
	OR	**95% CI**	**p**	**OR**	**95% CI**	**p**
Ever experienced infertility	0.99	0.69 - 1.44	0.974	0.89	0.60 - 1.34	0.585
Married/cohabiting	0.89	0.51 - 1.55	0.684	0.91	0.50 - 1.68	0.772
Age group[2]						
14-19	ref			ref		
20-24	0.88	0.50 - 1.54	0.643	1.02	0.56 - 1.85	0.961
25-29	0.38	0.21 - 0.67	0.001*	0.62	0.31 - 1.21	0.161
30-34	0.36	0.20 - 0.65	0.001*	0.87	0.41 - 1.83	0.714
35-41	0.33	0.18 - 0.61	<0.001***	0.95	0.41 - 2.20	0.904
Age (continuous)	0.93	0.91 - 0.96	<0.001***	-		
History of an STI	0.65	0.41 - 1.03	0.067	0.75	0.45 - 1.23	0.250
Living children[2]						
None	ref					
1	0.71	0.36 - 1.42	0.334			
2	0.45	0.24 - 0.87	0.017*			
3	0.27	0.14 - 0.52	<0.001***			
4+	0.23	0.12 - 0.34	<0.001***			
Living children (continuous)	0.74	0.68 - 0.81	<0.001***	0.77	0.65 - 0.90	0.001**
Desire for another child (ever)	2.29	1.66 - 3.14	<0.001***	1.59	1.06 - 2.39	<0.025*
Years education (continuous)	1.00	0.96 - 1.05	0.852	0.95	0.90 - 1.01	0.920
Years in cohort (continuous)	1.39	1.17 - 1.64	<0.001***	1.51	1.26 - 1.81	<0.001***

[1]*p<0.05; **p<0.01; ***p<0.001

[2]In bivariable models, both age and living children are shown as categorical and continuous variables. In the multivariable model, age was included categorically and number of living children was included as a continuous variable.

Subsample: Women who participated in Waves 1 and 5

Characteristics of women in the Wave 1/Wave 5 analytic sample are described in the methods section (Table 15). Among the subsample of 547 women who participated in Waves 1 and 5, 69% (N=375) reported becoming pregnant between Waves 1 and 5.

Among the women who participated in Wave 1 and Wave 5, I examined the characteristics of those who had ever experienced infertility by Wave 1 and those who had not. The results were similar to those in the pooled sample. Among women who reported ever experiencing infertility, 15% had experienced an STI by Wave 1 compared to 8% of women who had not experienced infertility ($p<0.05$). Reporting infertility was also associated with fewer years of education. Women who reported infertility had, on average, 3.8 years of education compared to 5.2 years for women who did not report infertility ($p<0.001$) (Table 21).

Table 21. Wave 1 characteristics of women who reported ever experiencing infertility at Wave 1 (N=547)[1]

	No infertility at W1 N=438 %/mean (range)	Infertility at W1 N=109 %/mean (range)	p
New pregnancy reported after W1			
Yes	69.9%	63.3%	0.187
No	30.1%	36.7%	
Relationship status			
Married/cohabiting	91.8%	96.3%	0.103
Not married or cohabiting	8.2%	3.7%	
Age group			
14-19	9.8%	11.0%	0.089
20-24	34.3%	22.0%	
25-29	21.7%	25.7%	
30-34	19.9%	19.3%	
35-41	14.4%	22.0%	
Age (mean (range))	26.7 (15-39)	27.9 (16-39)	0.062
STI history			
Yes	7.8%	14.7%	0.025*
No	92.2%	85.3%	
Pregnancies			
None	5.9%	5.5%	0.705
1	15.8%	14.7%	
2	21.0%	15.6%	
3	17.4%	18.4%	
4+	40.0%	45.9%	
Pregnancies (mean (range))	3.14 (0-12)	3.43 (0-7)	0.164
Living children			
None	8.5%	10.1%	0.960
1	19.0%	17.4%	
2	26.3%	25.7%	
3	18.3%	20.2%	
4+	28.1%	26.6%	
Living children (mean (range))	2.58 (0-8)	2.53 (0-6)	0.765
Desire for another child (ever)			
Yes	68.3%	70.6%	0.632
No	31.7%	29.4%	
Years education (mean (range))	5.16 (0-12)	3.84 (0-12)	<0.001***
Years in cohort (mean (range))	4.8 (4.3-5.1)	4.8 (4.3-5.1)	0.123

[1]*p<0.05; **p<0.01; ***p<0.001

I also examined differences between women who did and did not report a pregnancy by Wave 5 (Table 22). Women who became pregnant between Waves 1 and 5 were younger (26 vs. 29 years; p<0.001) and were less likely to have reported experiencing an STI by Wave 1 (7.5%

vs. 13%; $p<0.05$) compared to women who did not become pregnant between Waves 1 and 5. Women who became pregnant also reported fewer pregnancies 1 (2.8 vs. 4.1; $p<0.001$) and fewer living children (2.3 vs. 3.1; $p<0.001$) at Wave 1 than women who did not become pregnant. Similar proportions of women who did and did not have a pregnancy after Wave 1 reported that they had experienced infertility at Wave 1 (18-23%; $p>0.05$).

Table 22. Wave 1 characteristics of women who reported a new pregnancy after Wave 1 (N=547)[1]

	No pregnancy (N=172) %/mean (range)	Pregnancy (N=375) %/mean (range)	p
Infertility			
Yes	23.3%	18.4%	0.187
No	76.7%	81.6%	
Relationship status			
Married/cohabiting	92.4%	92.8%	0.881
Not married or cohabiting	7.6%	7.3%	
Age group			
14-19	5.2%	12.3%	<0.001***
20-24	19.8%	37.3%	
25-29	28.5%	19.7%	
30-34	25.6%	17.1%	
35-41	20.9%	13.6%	
Age (mean (range))	28.9 (15-39)	26.0 (15-39)	<0.001***
STI history			
Yes	12.8%	7.5%	0.045*
No	87.2%	92.5%	
Pregnancies			
None	1.2%	8.0%	<0.001***
1	4.7%	20.5%	
2	15.1%	22.1%	
3	20.4%	16.3%	
4+	58.7%	33.1%	
Pregnancies (mean (range))	4.08 (0-12)	2.79 (0-10)	<0.001***
Living children			
None	5.2%	10.4%	<0.001***
1	8.7%	23.2%	
2	23.3%	27.5%	
3	23.3%	16.5%	
4+	39.5%	22.4%	
Living children (mean (range))	3.13 (0-7)	2.32 (0-8)	<0.001***
Desire for another child (ever)			
Yes	52.9%	76.0%	<0.001***
No	47.1%	24.0%	
Years education (mean (range))	4.81 (0-12)	4.94 (0-12)	0.659
Years in cohort (mean (range))	4.8 (4.3-5.1)	4.8 (4.3-5.1)	0.086

[1]*p<0.05; **p<0.01; ***p<0.001

I constructed bivariable and multivariable models examining the odds of reporting a pregnancy between Waves 1 and 5. In these models, I omit years in the cohort because all women who participated in Waves 1 and 5 had similar durations in the cohort. By definition, all women in the sample participated in Wave 1 (2014-2015) and Wave 5 (2019). The average

length of time in the cohort was 4.8 years, ranging from 4.3-5.1 years. Including years in the cohort in the multivariable model did not alter the results.

In bivariable analyses examining the odds of reporting a pregnancy after Wave 1, older age at Wave 1 (OR: 0.93; $p<0.001$) and more living children at Wave 1 (OR: 0.73; $p<0.001$) were associated with lower odds of reporting a pregnancy between Waves 1 and 5 (Table 23). Women who reported that they wanted a(nother) child at Wave 1 had 2.82 times the odds of reporting a pregnancy after Wave 1 ($p<0.001$).

In the multivariable model, only number of living children at Wave 1 and desire for a(nother) child were associated with reporting a pregnancy between Waves 1 and 5. For every additional living child a woman had at Wave 1, she had 19% lower odds of reporting a subsequent pregnancy (AOR: 0.81; $p<0.05$). Women who wanted a(nother) child at Wave 1 had almost two times the odds of reporting a pregnancy (AOR=1.95; $p<0.01$).

Table 23. Bivariable and multivariable models examining odds of reporting a pregnancy after Wave 1 (N=547)[1]

	Bivariable			Multivariable		
	OR	**95% CI**	**p**	**OR**	**95% CI**	**p**
Ever experienced infertility	0.74	0.48 - 1.16	0.188	0.7	0.44 - 1.13	0.146
Married/cohabiting	1.05	0.53 - 2.10	0.881	0.97	0.46 - 2.04	0.946
Age group[2]						
14-19	ref			ref		
20-24	0.81	0.36 - 1.81	0.599	0.99	0.43 - 2.27	0.982
25-29	0.30	0.13 - 0.66	0.003**	0.54	0.23 - 1.30	0.170
30-34	0.28	0.13 - 0.64	0.002**	0.74	0.29 - 1.90	0.527
35-41	0.28	0.12 - 0.64	0.003**	0.95	0.34 - 2.67	0.917
Age (continuous)	0.93	0.90 - 0.95	<0.001***	-		
History of an STI	0.55	0.30 - 0.99	0.047*	0.65	0.36 - 1.19	0.164
Living children[2]						
None	ref					
1	1.34	0.54 - 3.32	0.529			
2	0.59	0.26 - 1.34	0.209			
3	0.36	0.16 - 0.82	0.015*			
4+	0.29	0.13 - 0.63	0.002**			
Living children (continuous)	0.73	0.65 - 0.82	<0.001***	0.81	0.67 - 0.97	0.021*
Desire for another child (ever)	2.82	1.92 - 4.13	<0.001***	1.95	1.19 - 3.20	0.008**
Years education (continuous)	1.01	0.96-1.07	0.658	0.95	0.89 - 1.02	0.157

[1]*p<0.05; **p<0.01; ***p<0.001

[2]In bivariable models, both age and living children are shown as categorical and continuous variables. In the multivariable model, age was included categorically and number of living children was included as a continuous variable.

Pregnancy planning/intention

Among the 375 women (69%) who became pregnant between Waves 1 and 5, I examined the six items that comprise the LMUP scale individually (Table 24). Overall, pregnancies tended to be planned. Approximately 81% (80.8-81.8%) of women reported that their pregnancy happened at the right time (item 2), that they intended to get pregnant (item 3), that they wanted to have a baby (item 4), and that they agreed with their partner to have a child before becoming pregnant (item 5). The majority (91%) of women were not using contraception when they became pregnant (item 1). Finally, 35% of women engaged in some kind of pro-active behavior prior to becoming pregnant (e.g., eating healthily, seeking advice) (item 6). There were no

differences in any of the LMUP items by whether or not a woman reported ever experiencing infertility at Wave 1 (Table 24).

Table 24. Distribution of LMUP items for the total sample and by reported infertility at Wave 1 (N=375)

		Total sample (N=375)	No infertility W1 (N=306)	Infertility W1 (N=69)	p
1.	**In the month I became pregnant, I**				
	Always used contraception (0)	5.3%	5.6%	4.4%	0.887
	Used contraception, but not every time (1)	3.7%	3.6%	4.4%	
	Was not using contraception (2)	90.9%	90.9%	91.3%	
2.	**Pregnancy happened at**				
	Wrong time (0)	15.2%	14.4%	18.8%	0.418
	Not quite right time (1)	3.5%	3.9%	1.5%	
	The right time (2)	81.3%	81.6%	79.7%	
3.	**Just before I became pregnant, I**				
	Did not intend to get pregnant (0)	17.1%	16.3%	20.3%	0.633
	Intention kept changing (1)	2.1%	2.0%	2.9%	
	Intended to get pregnant (2)	80.8%	81.7%	76.8%	
4.	**Just before I became pregnant, I**				
	Did not want a baby (0)	18.4%	18.0%	20.3%	0.812
	Mixed feelings about a baby (1)	0.3%	0.3%	0.0%	
	Wanted to have a baby (2)	81.3%	81.7%	79.7%	
5.	**Before I became pregnant…**				
	My partner and I never discussed children (0)	15.8%	15.4%	17.4%	0.873
	My partner and I discussed children (1)	2.4%	2.3%	2.9%	
	My partner and I agreed to have a child (2)	81.8%	82.3%	79.7%	
6.	**Before becoming pregnant did you do anything to improve your health (e.g., took iron, saved money, ate healthily, sought advice from HC worker)**				
	No (0)	65.1%	63.4%	72.5%	0.154
	Yes (2)	34.9%	36.6%	27.5%	

The average LMUP score among the sample was 9.13 (median: 10; range: 0-12). The score only varied significantly by whether or not a woman reported that she wanted a(nother) child at Wave 1, such that women who wanted a(nother) child at Wave 1 had a mean LMUP score of 9.35 compared to a mean score of 8.43 among women who did not want a(nother) child at Wave 1 ($p<0.05$) (Table 25). Although not statistically significant, women who had experienced infertility did tend to have slightly lower LMUP scores (less planned) than women

who had not experienced infertility (8.8 vs. 9.2; NS). The LMUP score for women who experienced infertility was relatively low – only women over age 30 (LMUP=8.45) and women who had four or more pregnancies (LMUP=8.57) or living children (LMUP=8.33) reported less planned pregnancies.

Given lack of significant associations between infertility, sociodemographic characteristics, and the LMUP score, I did not conduct a multivariable linear regression predicting the LMUP score.

Table 25. Mean LMUP score by Wave 1 characteristics (N=375)[1,2]

	N	Mean LMUP score	Std. Dev.	p
Average LMUP score	375	9.13 (0-12)	3.50	-
Infertility				
Yes	69	8.81	3.62	0.933
No	306	9.21	3.48	
Relationship status				
Married/cohabiting	348	9.12	3.54	0.847
Not married or cohabiting	27	9.26	3.06	
Age group				
14-19	46	9.48	3.22	0.136
20-24	140	9.28	3.41	
25-29	74	9.70	2.93	
30-34	64	8.45	4.04	
35-41	51	8.45	3.91	
STI history				
Yes	28	10.04	2.40	0.157
No	347	9.06	3.57	
Pregnancies				
None	30	9.00	3.47	0.178
1	77	9.78	2.87	
2	83	9.20	3.44	
3	61	9.43	3.49	
4+	124	8.57	3.86	
Living children				
None	39	9.30	3.12	0.201
1	87	9.48	3.19	
2	103	9.40	3.31	
3	62	9.16	3.61	
4+	84	8.33	4.04	
Desire for another child (ever)				
Yes	285	9.35	3.33	0.029*
No	90	8.43	3.95	
Years education[2]				
0-5 years	236	8.98	3.49	0.266
6-12 years	139	9.40	3.52	

[1]*p<0.05; **p<0.01; ***p<0.001

[2]Years of education is categorized by primary (0-5 years) and secondary (6-12 years) to allow comparison of mean LMUP scores.

Discussion

This study found that experiencing infertility, or not becoming pregnant after two years of trying, may not indicate sustained infertility in this population. Two-thirds (65%) of women in the pooled sample became pregnant after Wave 1, regardless of whether or not they reported ever

experiencing infertility at Wave 1. In the more restricted Wave 1/Wave 5 sample, 70% of women who had not experienced infertility and 63% of women who had experienced infertility reported becoming pregnant between Waves 1-5, but this difference was not statistically significant. The study also found no differences in the level of pregnancy planning/intention (measured retrospectively) between women who did and did not report ever experiencing infertility.

There are many possible explanations for the lack of difference in subsequent incidence of pregnancy between women who ever experienced and those who had not experienced infertility. It is first important to understand who reported infertility at Wave 1 and how they differed from those who did not report infertility. Notably, the women who reported infertility at Wave 1 (20%) were generally fecund and fertile at some point, indicated by the fact that nearly all (92%) of the women who reported ever experiencing infertility reported that they had been pregnant at least once. Almost as many (86%) had at least one living child. Neither number of pregnancies nor number of living children at Wave 1 differed significantly by ever experiencing infertility. Unfortunately, the measure of infertility used does not specify when a woman experienced a period of two years trying to become pregnant without conceiving in that time. It is possible that women experienced infertility prior to their first pregnancy and had since been able to conceive one or more pregnancies. It is equally possible that women experienced infertility when trying to conceive a second or higher order pregnancy, or that they were currently experiencing infertility at the time of the Wave 1 survey.

There were only two women in the study who reported zero pregnancies throughout their observation period. However, it is important to note that women who were excluded from the analytic sample were younger, more likely to be unmarried, and more likely to be nulliparous than women in the analytic sample. It is possible that women who were excluded due to lack of

follow up were more likely to have experienced infertility, but are not captured because they relocated outside of the UTHA cohort area for marriage, perhaps because of divorce/remarriage, which we know may be a consequences of experiencing infertility (Reniers, 2003).

Although the two-year definition of infertility used in this study surpasses the threshold required for a clinical diagnosis of infertility (one year of trying to become pregnant without conceiving in that time), it appears that women may have experienced infertility episodically. This indicates that reports of infertility, as measured in this sample, are likely caused by factors that, if treated before disease progression, may only cause temporary infecundity. This reflects larger patterns in the region that suggest that 85% of infertility in the Africa region is attributable to tubal factors caused by infections (Sharma et al., 2009). While the vast majority of infections causing infertility are STIs, tuberculosis and schistosomiasis may also cause infertility when left untreated (Sharma et al., 2009). Indeed, at Wave 1, women who reported infertility were also more likely to report that they had ever experienced an STI than women who did not report infertility. In the sample, it appears that a majority of infertility "resolved." The high rate of pregnancy following a report of ever experiencing infertility is similar to what has been found in studies in the Netherlands and New Zealand, where, among cases of untreated infertility or subfertility in women, approximately half spontaneously conceived (Brandes et al., 2010; Righarts et al., 2017). Given the lack of available infertility treatment in Malawi, it is likely that women who reported infertility and then conceived a pregnancy did so without biomedical treatment.

Another important note regarding the measure of infertility is that recalling past experiences using a two-year time marker may not be salient in this population. Another study using UTHA cohort data suggested that recalling specific events may be inaccurate in this low-

numeracy population (Moseson et al., 2021). It is possible that women reported trying for two years to become pregnant, but, in fact, they had tried for a shorter amount of time. Two years is a relatively long time, and yet, we know from qualitative research that women may consider themselves infertile, and be perceived by others as being infertile, after a much shorter period of time in this context due to social pressures and norms around childbearing (Bornstein, Gipson, et al., 2020).

The measure of infertility used also implies that women will readily differentiate between periods of time that they tried and did not try to become pregnant. We know that pregnancy intentions can change over relatively short periods of time (Sennott & Yeatman, 2012) and that ambivalence around pregnancy is common in Malawi (Huber et al., 2017); thus, women may have responded based on an overall, generalized assessment of a two-year period in their life, even if she was not trying to get pregnant (or exposed to pregnancy) for the entire duration of two years. Although the infertility question specifies exposure to pregnancy by asking if the woman "tried" to become pregnant, the concept of trying for pregnancy is highly subjective and relies on women accurately recalling and reporting many different components of sexual behavior. It also simplifies what it means to try to become pregnant, which may be complex internal and relational processes.

While infertility is typically experienced at the couple-level, the measure used in this study does not distinguish between whether a woman was reporting a history of male or female infertility. A recent review (2020) found that 21% of infertility is attributable to male factors alone and an additional 20% is attributable to both female and male factors in the Africa region (Abebe et al., 2020). In this context, the origin of infertility may not be known, but previous research suggests that women and men sometimes attribute infertility to a lack of compatibility

between partners (Bornstein, Gipson, et al., 2020). Divorce and re-marriage are common (Reniers, 2003); thus, women may have "resolved" infertility through re-partnering.

There are additional limitations in the multivariable models predicting the odds of having a pregnancy after Wave 1. Although I controlled for desire for a(nother) child at Wave 1, fertility desires are known to change frequently (Sennott & Yeatman, 2012). Given the frequency of UTHA data collection and limitations based on retention, I only controlled for fertility desires at Wave 1. I also did not control for contraceptive use, something that would impact the likelihood of having a pregnancy. Contraceptive use is excluded from this analysis because there was no measure of continuous contraceptive use in the data. Additionally, as demonstrated in the first paper of this dissertation, contraception is frequently used intermittently. However, given the commonality of contraceptive use in the cohort overall (Huber-Krum et al., 2021), it is likely that women's exposure to the possibility of becoming pregnant was less than the time presumed in the analysis (i.e., the length of time a woman persisted in the cohort). Although many methods of contraception are vulnerable to imperfect use (e.g., the injection), some women likely used these methods efficaciously or used methods of contraception with close to perfect efficacy and little possibility of user error (e.g., the implant) (Hatcher, 2018). These women may have been almost entirely invulnerable to pregnancy for part of or even for the entirety of the follow up period, but because there is no measure of continuous or effective contraceptive use, this cannot be assumed. Thus, contracepting women are still included in the denominator. After conducting a sensitivity analysis excluding women who were sterilized after Wave 1, women who became sterilized after Wave 1 were retained in the sample (n=121). Among these women, more than half reported a new pregnancy before they reported undergoing sterilization, indicating that they were appropriately considered in the denominator.

Given the assumptions and likelihood that not everyone in the denominator was exposed to equal risk of becoming pregnant, it is notable that 65% of women still reported a pregnancy after Wave 1. With better measures of pregnancy exposure (e.g., continuous contraceptive use, sexual frequency), it is possible that the pregnancy rate would have been even higher by removing women who were invulnerable to pregnancy from the denominator or adjusting for level of pregnancy exposure. There is also a strong possibility that pregnancies were under-reported in the data due to early miscarriage. Upwards of 20-30% of pregnancies result in a miscarriage (Savitz et al., 2002; Zinaman et al., 1996) and women may have a more difficult time recalling attributes of a pregnancy that did not result in a live birth (Joffe et al., 2005). In some cases, a woman may have a miscarriage before she is aware that she is pregnant; these pregnancies would not be reported, contributing to a possible under-estimation of the number of women who became pregnant in the cohort.

The premise of this study encounters the same conundrum that women face: equating pregnancy with fecundity. In the analysis, I used "becoming pregnant" as a proxy for fecundity. My basic assumption in this analysis was that a pregnancy indicated fecundity and lack of pregnancy indicated infecundity or, perhaps, persistent or recurrent infertility among women who reported ever experiencing infertility. This is flawed in multiple ways. For example, if women were followed for longer, it is possible that some of those who did not become pregnant would have become pregnant. It is also possible – even likely – that some of the women who did not become pregnant during the study were fecund. Perhaps they were not having sex or they were using a method of contraception for some or all of the follow up period. Just because a woman reported ever experiencing a period of infertility in the past and did not become pregnant during the study period does not indicate that she was not capable of becoming pregnant.

There are additional limitations of this study that must be considered. In the LMUP analysis, women were asked to respond in reference to their most recent pregnancy, although they may have had more than one pregnancy after Wave 1. In this study, the LMUP was skewed toward planned pregnancies and women rarely reported the middle response options on the LMUP survey items (e.g., pregnancy happened at *not quite* the right time). The LMUP findings here differed from a previous application of the LMUP in Malawi, which observed more nuance in the measure (J. A. Hall et al., 2013). Hall (2013) found that the median LMUP score was six among the 125 women surveyed. The median LMUP score in the present study was 10. However, Hall (2013) examined the LMUP among a smaller population of women in Malawi (N=125) who were, on average younger than the women in the present study (mean age of 24 vs. 27 years in the present study) and less likely to be married (80% vs. 93% in the present study). In the Malawian context, where childbearing is expected within marriage (Reniers, 2003), it is possible that younger and unmarried women have less planned/intended pregnancies. Additionally, 69% of women in the present study reported prospectively that they wanted another child (measured as a binary yes/no variable) at Wave 1, which may contribute to the overall finding of high levels of pregnancy planning/intention reported retrospectively.

Despite limitations, this study fills an important gap in the existing literature by acknowledging that women may experience both infertility and unintended pregnancy within their reproductive life course and, not only that, but they may experience an unintended pregnancy *after* experiencing infertility. This finding is critical in public health and reproductive rights, as it indicates not only the importance of addressing infertility and unintended pregnancy alone, but the intersection of these experiences within individuals. The reproductive life course is complex – individuals may experience a range of events, including infertility, intended fertility,

and unintended fertility. Due to data limitations and the quest to demonstrate specific causal relationships, most studies aim to isolate single events. However, doing so is contrary to how women live their lives and navigate reproduction. This study found that infertility and unintended pregnancy are decidedly not mutually exclusive experiences.

Conclusion

Contrary to my hypothesis that women who reported ever experiencing infertility at Wave 1 would be less likely to become pregnant after Wave 1 than women who did not report infertility, this study found that ever experiencing infertility was not associated with differential odds of becoming pregnant. There was also no association between ever experiencing infertility at Wave 1 and pregnancy planning/intention among the 375 women became pregnant between Waves 1 and 5. This is also contrary to my hypothesis that women who had experienced infertility may not think they can get pregnant and therefore not plan for pregnancy (see Figure 7 in the introduction). Future studies must disentangle these relationships through developing better measures of perceived fertility or fecundity as a mediating factor between experienced infertility, contraceptive use, and pregnancy. Although women who had experienced infertility were less likely to report using contraception (as observed in the second paper of this dissertation), they do not appear to be more likely to have an unplanned/unintended pregnancy than women who had not experienced infertility. However, contraceptive use was not included in this study, which limits how the two studies can be interpreted together, but does indicate an area for further research with datasets that include continuous measures of contraceptive use.

One of the strongest predictors of reporting a pregnancy in the multivariable models was the desire for a(nother) child at Wave 1. Wanting a(nother) child was the only covariate

associated with higher LMUP scores. Although there are many caveats, this finding indicates that women may be successfully aligning their fertility desires and pregnancy outcomes, which should be encouraged in all family planning efforts. It is also possible that women who had experienced infertility were less likely to retrospectively report that their pregnancy was unplanned or unintended if they did not expect to become pregnant again, but wanted to. There were no differences in prospective desire for a(nother) child between women who did and did not report ever experiencing infertility.

Similar rates of pregnancy between women who ever experienced infertility and those who had not suggests that women who have experienced infertility must still be included in programs and research that aim to prevent unintended pregnancies. Women who reported infertility were not only just as likely to have a pregnancy as women who did not report infertility, but they were also just as likely to have an unplanned/unintended pregnancy. Excluding women who have experienced infertility, either explicitly or inadvertently, from family planning programs leaves them at risk for an unintended pregnancy.

Chapter 10: Discussion

The studies in this dissertation provide novel evidence of how experiences and perceptions of infertility and subfecundity impact how women navigate their reproductive lives. The studies build on an emerging body of evidence around the factors that influence perceived risk of becoming pregnant (Gemmill et al., 2021; Polis, Moore, et al., 2020), as well as research that examines how perceived risk of becoming pregnant may influence contraceptive use (S. O. Bell & Gemmill, 2021). The studies in this dissertation provide one of the first assessments of how both perceptions and experiences of fecundity (ability to become pregnant) and infertility (not conceiving a pregnancy after two or more years of trying), influence women's reproductive lives and decision making. Together, the three studies reveal important factors that shape and contextualize perceptions and experiences of fecundity and infertility.

Synthesis of key findings

The first study demonstrated that women's perceptions and experiences of fecundity influenced not only *whether* they used contraception or not, but *how* they used contraception as a way to manage their fertility. Focusing on the injection, the most commonly used method of contraception in Malawi and among the participants in the UTHA cohort (Huber-Krum et al., 2021; National Statistics Office (NSO) [Malawi] and ICF, 2017), revealed the complexity of women's experiences with contraception and their desire to play an active role in managing their fertility. Women used the injection method according to their experiences with becoming pregnant and expectations of future fecundity, which frequently differed from medical guidelines. Women's experiences becoming pregnant – whether they felt it took too long to become pregnant or, perhaps, they became pregnant unexpectedly – influenced their

contraceptive behavior. The study found that women used contraception as a way to manage their fertility– to prevent pregnancy in the short-term while maintaining their ability to become pregnant when they wanted to or were expected to. One of the main findings of the qualitative study was that women may consider themselves contraceptive users even if they did not use contraception consistently or in a way that is considered clinically efficacious.

Findings from the second study indicate that both experienced infertility and perceived certainty of becoming pregnant in the future may play a role in women's contraceptive decision making and use. Women who had ever experienced infertility were less likely to use contraception than women who had not experienced infertility. Likewise, women who believed they were 'certain' to become pregnant within one-year of not using contraception were more likely to use contraception. These findings persisted in both significance and magnitude, even when accounting for characteristics commonly associated with contraceptive use. The relationship between experienced infertility and contraceptive non-use is rational. If someone has experienced infertility they may, accurately or not, assume they do not need to use contraception. Behavior following this logic could be problematic, however, if one's experience of infertility does not accurately reflect their actual chance of becoming pregnant in the future.

The findings of the second study raised an important question: do women who have experienced infertility *need* to use contraception to prevent pregnancy? In other words, are women who have experienced infertility unlikely to become pregnant in the future? The third study answered this question. Findings from a subsample of women from the UTHA cohort who ever experienced infertility were just as likely to experience a subsequent pregnancy as women who had not experienced infertility. In sum, studies two and three found that women who had

experienced infertility were less likely to use contraception than women who had not experienced infertility, but were just as likely to go on to have another pregnancy.

The third study also revealed that there were no statistically significant differences in retrospective pregnancy planning/intentions between women who did and did not report ever experiencing infertility. Among women who became pregnant between Wave 1 (2014-2015) and Wave 5 (2019), women who had ever experienced infertility reported similar levels of retrospective pregnancy planning/intention as women who had not experienced infertility, as measured by the London Measure of Unplanned Pregnancy (LMUP).

There were some contradictions between the qualitative and quantitative findings in this dissertation. For example, the qualitative study revealed that women expected to become pregnant quickly when they wanted to *and* that they perceived they may have difficulty becoming pregnant after using contraception. In contrast, the quantitative findings in the second study found that the vast majority of women believed that they were very likely or certain to become pregnant within a year of not using contraception. One explanation for this apparent contradiction lies in the potential conflict between the societal view that pregnancy should happen quickly when desired and the lived experiences of women trying to become pregnant and experiencing an unacceptably (either personally or socially) long delay after discontinuing contraception.

Examined alone, responses to the survey item regarding certainty of ability to become pregnant would indicate that women were confident in their ability to become pregnant after using contraception. However, the qualitative component of the mixed methods study, designed to provide a more holistic understanding of complex issues, revealed more nuance (Cresswell & Plano Clark, 2018). Women may have answered the survey question based on societal

expectations to become pregnant quickly, while in interviews women had the opportunity to delve deeper into their individual experiences, which were often characterized by stigma and fear of not becoming pregnant when they wanted or were expected to. Furthermore, the survey item asked about women's certainty that they could become pregnant within a year of not using contraception, but we know from the qualitative study that a year may be considered a long time.

Limitations and strengths

There are several overarching limitations of the dissertation. Given the lack of measurement consensus for infertility and the lack of validated measures of perceived certainty of pregnancy, the measures in studies two and three are inherently limited. The measure of infertility is also not well defined in terms of exposure (i.e., timing and frequency of sex), thus it could include individuals in the denominator who were not at risk for pregnancy. Additionally, the commonality of divorce and remarriage in Malawi (Bertrand-Dansereau & Clark, 2016; Reniers, 2003) and the fact that the causes of infertility are often unknown at the couple-level (i.e., male/female/both), create the possibility that an individual's report of infertility may reflect the inability of a previous or current partner to conceive, rather than their own. As demonstrated in the third study, experiencing a period of trying to become pregnant for two or more years without conceiving may *not* be indicative of an individual's subsequent pregnancy experiences.

The measure of infertility also combined both primary and secondary infertility, which frequently have different causes and treatments, and are also likely to have differential social and relational consequences, as well as effects on contraceptive use. One can imagine that experiencing a period of infertility followed by successfully having a child or children would have a different impact on future fertility expectations and perceived need to use contraception

than having never successfully become pregnant. However, just two women in this study persistently reported zero pregnancies over the data collection period (2014-2019), indicating that secondary infertility (or primary infertility caused by factors with accessible treatment) may have been the primary driver of the infertility measure in the second and third studies. This is corroborated by the fact that women who had ever experienced infertility in the cohort did not have significantly smaller families than women who did not experience infertility. It also should be noted that the measure of infertility intentionally captured infertility episodes (i.e., a period of two or more years trying to become pregnant without conceiving, regardless of pregnancies before or after that two-year period) rather than permanent infertility or sterility.

The measure of current contraceptive use in the second study is a simplification of a much more complex construct. Current contraceptive use was used as a binary variable (yes/no); however, there was strong evidence from the qualitative study that women used contraception in ways that could not be captured this way. Women considered themselves contraceptive users even if they were not using the injection according to medical guidelines. This may have led to an overestimation of contraceptive use in the cohort as a whole. The qualitative findings around contraception may, in the future, inform new ways of measuring contraceptive use, which would improve the validity of the findings in the second study.

There are several strengths of this dissertation. The overall hybrid exploratory-explanatory mixed methods study design allowed for the exploration of complex constructs that are just starting to be explored within public health. A benefit of the mixed methods study design is the ability to provide insight into complex and multifaceted issues, such as pregnancy desires and timing (Cresswell & Plano Clark, 2018). The UTHA cohort study also included multiple waves of data that informed how qualitative participants were sampled according to their

perceived difficulty becoming pregnant. The fifth wave of the cohort study was designed based on qualitative findings around how women considered fertility and infertility in reproductive decision making. Specifically, the qualitative data informed the use of the LMUP as a better measure of the nuances of pregnancy planning and intention than the typical binary survey item used to assess retrospective pregnancy intention.

The inclusion of men in the second study is a departure from most studies on infertility which typically focus exclusively on women (Culley et al., 2013). However, men, as well as women, experience infertility and face infertility-related stigma (Bornstein, Gipson, et al., 2020; Dhont et al., 2011; Hanna & Gough, 2017). More than a fifth (22%) of infertility in couples is attributable to male causes alone, and an additional 21% of infertility is attributable to both female and male causes (Abebe et al., 2020). The second study of this dissertation provides a unique view into the characteristics of men who report infertility and certainty of their ability to impregnate their partner, although much more work is needed. Although men were not included in the first or third dissertation studies, there are several qualitative and quantitative UTHA studies that include men in areas of research that predominantly focus on women, such as contraceptive use and family formation (Bornstein, Gipson, et al., 2020; Bornstein, Huber-Krum, et al., 2020; Garver, 2016; Huber-Krum & Norris, 2020; Norris et al., 2019).

Another strength of this dissertation is that it explores ideas that are not yet mainstream in reproductive health. Despite attempts to rally support around infertility as a public health issue (Gipson et al., 2020; K. M. Johnson et al., 2018), there are few programs that address infertility from a public health perspective (Chiware et al., 2021; Starrs et al., 2018). While part of this dissertation focused on contraception and unintended pregnancy as possible consequences of perceived or experienced infertility, this does not negate the critical need to address women's

perceptions and experiences of infertility as fundamentally significant in their own right. Future work must explicitly incorporate infertility into efforts to advance reproductive rights.

Implications

This dissertation raises issues that challenge existing research and programs in reproductive health, including: implications for measuring infertility and implications for public health interventions.

Measuring infertility

As described in Chapter 2, measuring infertility in populations is challenging and done inconsistently. There have been calls for measurement standardization, which is important in order to assess global patterns and inequities in who experiences infertility (Gurunath et al., 2011; Larsen, 2005). However, in addition to standardized measures, the studies in this dissertation suggest the need to critically evaluate what researchers intend to measure when they measure infertility. The need to choose appropriate measures is equally important to developing and validating standard measures. For example, if the goal of a study is to understand the burden of infertility-related stigma, the measure of infertility should reflect the amount of time in which women (and men) are expected to achieve pregnancy. This may be different depending on the context and should be tailored to specific populations. If women face consequences when they do not become pregnant after three months, for example, infertility-related stigma may be relevant after three months rather than the standard one-year or two-year definitions used in clinical or epidemiological studies. Measuring infertility using a standard definition will greatly under-estimate the potential burden of infertility-related stigma and the need to address it.

The dissertation also reiterates the need to better define who is at risk for infertility. Measures of infertility, including the one used in this dissertation, do not typically account for important factors that can increase or decrease the risk of pregnancy for women, including exposure (e.g., sexual frequency) and factors that can influence fecundity, such as amenorrhea, sexual maturation, STDs, or frequency and consistency of contraceptive use (Gurunath et al., 2011; Larsen, 2005; Mascarenhas, Cheung, et al., 2012). If women are getting the injection sporadically, as the qualitative study in this dissertation indicates, it may be difficult for them to report on a length of time they were having sex without using contraception, which is an important component of assessing infertility. The injection method prevents pregnancy for three-months, but may have lingering effects on fecundity for up to a year (Hassan & Killick, 2004; Yland et al., 2020). Thus, women may report infertility when they were temporarily infecund (e.g., not at risk for pregnancy). This would not be indicative of long-term infertility or the need for infertility treatment.

Public health interventions

The studies in this dissertation suggest that how contraception is currently framed in public health may not resonate with all women. Contraception is framed as a safe-guard *against* pregnancy rather than as a tool to help women have pregnancies when they want to. Although this difference is subtle, framing contraception as a tool to manage fertility may better resonate with some women who live in highly pronatalist societies.

There are many public health programs in Malawi and beyond that focus on reducing the rates of unintended pregnancy by increasing contraceptive use. This dissertation reveals that such programs must be aware of and actively address how experiences and perceptions of infertility and subfecundity impact contraceptive decision making. Programs that focus on preventing

unintended pregnancy should make an effort to include those who have experienced infertility or believe they are subfecund. These individuals may not identify as at risk for pregnancy and, therefore, not use contraception, even if they do not wish to become pregnant. This dissertation suggests that the risk of pregnancy is similar for women who have and have not ever experienced infertility.

This dissertation also has implications for the current contraceptive method mix in many countries, including Malawi. While the injection is the most commonly used method, there may be attributes of the injection that are fundamentally incongruent with women's needs. Specifically, the injection may be problematic for women who believe, either through experience or otherwise, that they may not become pregnant easily or ever after discontinuing the method. It may also be ill-advised for women who want or expect to become pregnant quickly after discontinuing use, given that the injection causes a known delay in return to fecundity (Hatcher, 2018; Yland et al., 2020). A delay in return to fecundity suggests that a woman or couple can (and want to) anticipate their fertility desires months in advance. Yet, we know that fertility desires are far more complex and subject to both long-term and temporal shifts in circumstances (Hayford & Agadjanian, 2017).

Contraceptive methods were developed and brought to market with known side effects, such as a delay in return to fecundity. However, the scientific communities' tolerance of this specific side effect was not inevitable (and there are several methods that have shown an immediate return to fecundity) (Hatcher, 2018; Yland et al., 2020). Scientific advances are not only subject to the limited knowledge at the time of advancement, but also frequently reflect societal priorities and values (Hughes, 2015). Whether intentional or not, the injection reflects a world-view that privileges a highly specific vision of how women and couples plan their

families. While some have questioned the idea that pregnancy planning should be privileged in reproductive health (Potter et al., 2019; Senderowicz, 2020), studies have not looked at how specific attributes of contraceptive methods may impose and reflect paradigms around the most acceptable way to plan and project fertility that may not be resonant in all contexts. As a field, we must examine the ways in which research, public health programs, and some contraceptive method attributes may impose and reinforce certain values and norms.

As a field, we should also consider the connotations of the terms we use when reporting contraceptive efficacy. For example, "perfect" use of a method is viewed as something every contraceptive user should aspire to (Awadalla, 2020). However, it is clear that some women use contraception "imperfectly" but intentionally, based on their experiences with becoming pregnant. In some cases, women's attempts to manage their fertility through when they received the injection led to mistimed pregnancies. However, women's use of injection also led to delays in becoming pregnant when desired. Women experienced both of these suboptimal outcomes in the pursuit of managing their fertility using the injection.

Conclusion

This dissertation provides insight into how past reproductive events and experiences shape future behaviors, expectations, and outcomes. As a field, we must progress toward ensuring universal reproductive rights and acknowledge that people may experience a range of events over their reproductive life-course, including unintended fertility, periods of subfecundity, and infertility. To ensure reproductive rights, women must have access to support and resources to address all circumstances that emerge over the reproductive life-course.

Appendix A: In-depth interview guide (English/Chichewa)

Over-arching research questions:

- How do women make decisions around contraceptive use and what are their contraceptive use patterns in the context of high fertility/highly valued fertility?
- What influences contraceptive decision making in this context, e.g.,
    - Perceptions of fertility (i.e., ability to become pregnant)
    - Perceptions of contraceptive side-effects that could impact future fertility
    - Parity and met/unmet fertility desires
    - Partner/relationship characteristics
- Who influences contraceptive decision making?

Timeline exercise

Children: Can you first tell me about your children - How many children do you have? How old are they/what years were they born? Choyamba mungandiuzeko za ana anu? Muli ndi ana angati? Ali ndi zaka zingati/ anabadwa chaka chiti?

- Probe: Can you tell me about other pregnancies you may have had that ended in an abortion? A miscarriage? A stillbirth? Mungandiuzeko za mimba zanu zakale zomwe munakhalapo nazo; munachotsa? kapena kupititsa padera? Kapena munabereka okufa?
- GENTLY Probe: Did you give birth to any children who are now no longer living? Any children who have passed/died? Munakhalapo ndi ana omwe anamwalira?

Partners/marriages: Thinking back to the very first time you had sex, please tell me about the partnerships you have had. [NOTE AGE/YEAR OF FIRST SEX] Pongoganizira nthawi imene munagonanapo koyamba, mungandizueko za zibwenzi zomwe munakhalapo nazo?

- First, do you remember the year/or your age when you first had sex? Who was that with? Who was your next partner? Mukukumbukira kuti munali ndi zaka zingati nthawi yomwe munagonana koyamba? Anali ndani? Kunabweranso wina atachoka oyambawo?
- [CONTINUE; VERIFY PARTNERSHIPS WITH CHILDREN] So, then let's review…in total it seems there have been X partners…are there any we missed?
- Probe on any transitions or gaps between partners. Probe non-marital or concurrent partners.

Contraceptive Methods: Now, going back across your partnerships, can you tell me about any methods you may have used or things you may have done to regulate your fertility? Did you use any contraceptive methods, herbs, or anything else to help get pregnant? Or to prevent pregnancy? Tsopano tikaona maubwenzi anu mwakhala nawo, mungandiuzeko njira zomwe mwagwiritsako ntchito kapena zomwe mwachitapo pofuna kuchepetsa kapena kuchulukisa

chonde? Munagwiritsa ncthito njira zakulera, mankhwala azitsamba kapena zina kuti mutenge mimba? Kapena kuti mupewe mimba?

Ask relevant questions about each event and time between events.

Relationships

- When did you first have sex? Who did you have sex with? Munagonanapo ndimwamuna koyamba liti? Munagonana ndi ndani?
- Did you have other sex partners before you were married the first time? When? Who? Munakhalapo ndi ma ubwenzi ena ogonana nawo musanakwatire? Liti? Ndi ndani?
- Did you use any kind of contraception with these (pre-marriage) partners (include all modern methods and traditional, including withdrawal, herbs, etc.)? Munagwiritsako njira ina iliyonse yakulera musanakwatiwe (kuphatikizapo njira zonse zamakono ndi zamakolo, kuphatikiza ndiyothira pambali, zitsamba ndi zina?)
    - Why? Why not? How did you decide to use/not use? Chifukwa chani? Ayi chifukwa chani? Munasankha bwanji kuti mugwiritse ntchito njirayi kapena ayi?
    - What methods did you consider? What method(s) did you use? Munaganizirapo njira ziti? Munagwiritsa ntchito njira iti?
- When did you first get married? Subsequent divorce(s)? Remarriage(s)? munakwatiwapo koyamba liti? Banja lanu linathapo? Munakwatiwaponso?
- Have you had any other partners, including partners during your marriage(s)? munakhalapo ndi okondedwa ena anseri muli pa banja?
- Have we listed all of your partners in the right order? Talondoloza ndandanda wa okondedwa anu?

Contraceptive use

- When did you first use contraception? Which partner was that with? Ndiliti munagwiritsapo ntchito njira zakulera koyamba? Munagwiritsapo ntchito ndiwokondedwa wake uti?
- When else did you use contraception? [FOR EACH CONTRACEPTIVE EPISODE] ndiliti munagwiritsaponso njira yakulera?
    - Why did you decide to use contraception at this time? Munaganiza zogwiritsa ntchito njira yakulera nthawi iyi chifukwa chani?
    - What method did you use? How did you decide to use that method? Munagwiritsa ntchito njira iti? Munasankha njira iyi pazifukwa ziti?
    - How long did you use it for? When and why did you stop? Munagwiritsa ntchito kwa nthawi yayitali bwanji? Munasiya kugwiritsa ntchito liti ndipo munasiya chifukwa chani?

    - If non-LARC, how often did you use it? E.g., how many injections do you think you got? ngati si njira za nthawi yayitali, munagwiritsapo ntchito mowirikiza bwanji? Monga jakisoni munabayitsapo kangati?
    - What was important to you when you chose this method? Chinali chofunikira ndi chani pomwe munasankha njirayi?
    - Where and how did you go about getting this method? Munakatenga kuti ndipo zinali bwanji?
- Did you have any discussions with your partner(s) about using this method? Did your partner(s) know you were using this method? Munakambirana ndi okondedwa anu pofuna kugwiritsa ntchito njirayi? Amuna anu anali akudziwa kuti mukugwiritsa ntchito njirayi?
- Contraceptive use periods
    - Finite time period(s), e.g., from age 19-20 and again from age 22-24 molekeza lekeza
- Contraceptive discontinuation
    - For each time a method was stopped, why was it stopped? Nthawi ina iliyonse mumasiya kugwiritsa ntchito njirayi, panali zifukwa zanji?
- Contraceptive method switching
    - For each time a new method was used, why did you switch methods? (Ask even if there was a period between two methods where no method was used, including pregnancy) nthawi ina iliyonse mumagwiritsa ntchito njira yatsopano, ndichifukwa chani mumasintha njirayi?

Pregnancies

- Did you want to get pregnant at that time? Sooner? Later? What about your partner? Munali mukufuna kutenga mimba panthawi iyi? Mwachangu? Mochedwerapo? Nanga okondedwa anu?
- Why do you think you got pregnant at that time? Mukuganiza kuti munatenga mimba nthawi iyi chifukwa chani?
- Did you think it would be easy/hard to become pregnant? Why did you think so? Munkaganiza kuti ndizovuta kapena zosavuta kukhala ndi mimba? Chifukwa chani mumaganiza choncho?
- Did it end up being easy/hard to become pregnant? Why do you think so? Zinali zosavuta kapena zovuta kuti mukhale ndi mimba? Chifukwa chani mukuganiza choncho?
- Were you worried about getting pregnant? Munkadandaula zakutenga mimba?
- Were you using contraception before this pregnancy? Munkagwiritsa ntchito njira zakulera musanatenge mimbayi?
    - What were you using? Munkagwiritsa ntchito njira yanji?
    - How long before you became pregnant did you stop using? Panapita nthawi yayitali bwanji chisiyireni kugwiritsa ntchito njira zakulera ndi nthawi yomwe munatenga mimba?

- Why did you stop using? Ndichifukwa chani munasiya kugwiritsa ntchito?

Additional questions

- Do you think you want to have any (more) children with your current partner? Another partner? Mukuganiza kuti mukufunanso kukhala ndi ana ena ndi okondedwa anu? Nanga okondedwa ena?
  - Do you think it will be easy/hard to have another child? Why? Mukuona ngati zizakhala zovuta kapena ayi kuti mukhale ndi mwana wina?
  - When do you want to have another child? Mukufuna mutakhala ndi mwana wina liti
  - What will you do to make sure you can have another child at that time? Ndichani chomwe mungazapange kuti mukhalenso ndi mwana wina pa nthawi imeneyo?
  - What would happen if you had another child sooner than you want? Chingachitike ndichani mutakhala ndi mwana mofulumira kusiyana ndi nthawi yomwe mufunira?
  - What would happen if you could not have another child? Chingachitike ndichani mutapezeka kuti simungakhalenso ndi mwana wina?
- In general, do you think it is more difficult or easier for you to become pregnant than other people? Why do you think that is? Muzonse, mukuganiza kuti ndikovuta kapena ndikosavuta kuti mukhale ndi mimba kuyerekeza ndi anthu ena? Mukuganiza chonchi chifukwa chani?
- Tell me about the contraceptive method you are currently using. What do you like about it? What don't you like? When do you think you will stop using it? Why? Are there other methods you would like to try? Mundiuzeko za njira yakulera yomwe mukugwiritsa ntchito panopa. Imakusangalasani chani? Sikusangalasani chani? Mukuona ngati muzasiya kugwiritsa ntchito liti? Chifukwa chani? Pali njira zina zomwe mumafuna mutagwiritsako ntchito?
- In general, what factors do you consider when choosing a contraceptive method? Muzonse, mukamasankha njira yakulera mumasankhiranji?
- How many children would you like to have in your whole life? Do you think you will achieve that goal? Why or why not? How will it impact your life if you do not reach that number of children? Mumafuna mutakhala ndi ana angati m'moyo wanu? Mukuona ngati zidzatheka? Chifukwa chani? Zidzasintha bwanji moyo wanu ngati simuzatha kukhala ndi ana omwe mumafuna m'moyo wanu?
- Have you been pregnant any other times? (Record miscarriage, abortion, still birth, neonatal death, etc.) munayamba mwakhalapo ndi mimba? (kupititsa padera, kuchosa mimba, kubereka mwana okufa, infa ya khanda ndi zina)

Appendix B: Survival estimates (Study 3)

I also conducted a survival analysis to look at differences in *when* a new pregnancy was reported by ever experienced infertility at Wave 1 among the subsample of women who participated in UTHA Waves 1, 3, 4, and 5 (N=477). This is a highly select group because these women remained in the cohort and available for data collection at every time point (2016-2017, 2017-2018, and 2019). Additionally, because the date of pregnancy was not collected, "time" is represented in wave units. Moreover, data collection waves were not equally spaced, meaning that regardless of when a pregnancy occurred between Waves 1 and 3, they were recorded as occurring at the date of the Wave 3 survey.

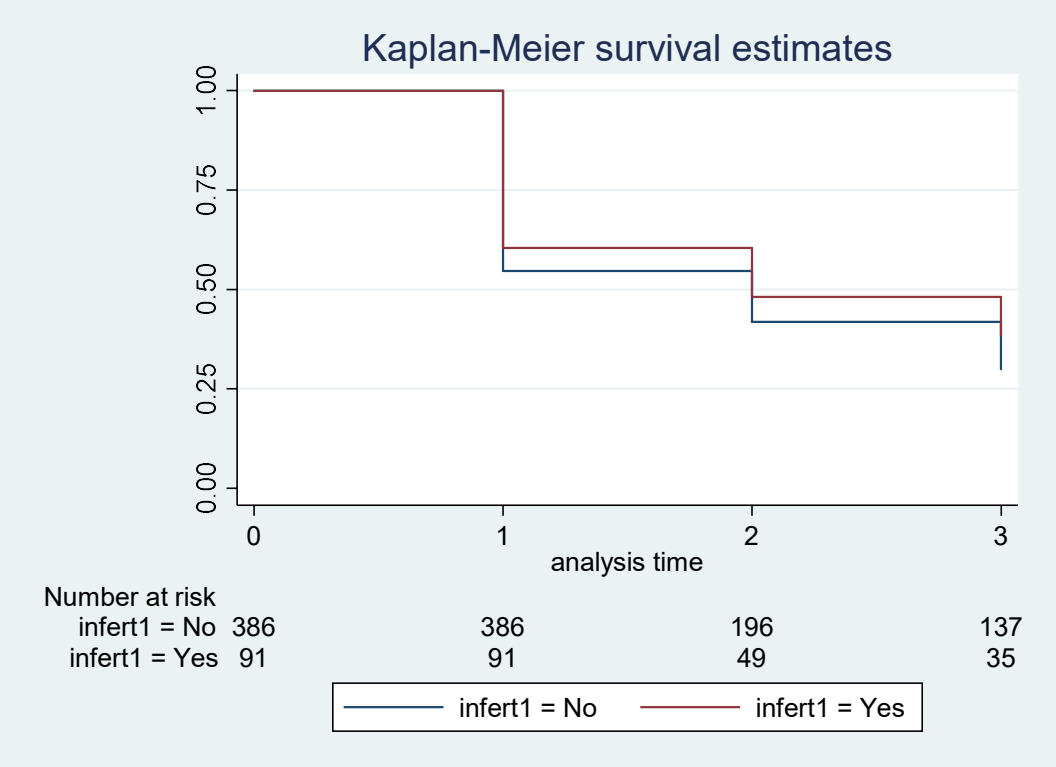
The survivor function (Table 26) is interpreted as the proportion of women who did *not* become pregnant by the corresponding wave. For example, in comparing the Wave 5 survival functions between women who did not experience infertility (0.30) and those who did (0.38), it can be interpreted as women who experienced infertility were more likely to have not an event (become pregnant) by Wave 5, although this finding was not statistically significant (Table 26, Figure 8).

Table 26. Survivor time (not reporting a pregnancy) for each wave following Wave 1[1]

	Beginning total	Fail	Net lost	Survivor function	95% CI
Total					
Wave 3	477	211	21	0.56	0.51 - 0.60
Wave 4	245	56	17	0.43	0.38 - 0.47
Wave 5	172	46	126	0.32	0.27 - 0.36
No infertility					
Wave 3	386	175	15	0.55	0.50 - 0.59
Wave 4	196	46	13	0.42	0.37 - 0.47
Wave 5	137	39	98	0.30	0.25 - 0.35
Infertility					
Wave 3	91	36	6	0.60	0.50 - 0.70
Wave 4	49	10	4	0.48	0.37 - 0.58
Wave 5	35	7	28	0.38	0.28 - 0.49

[1]Failure indicates reporting a new pregnancy, upon which the participant exits the risk set. Net lost indicates women who were censored due to sterilization.

Figure 8. Kaplan-Meier survival estimates comparing time-to-pregnancy (measured in waves) between women who did and did not report ever experiencing infertility at Wave 1[1]



[1]On the x-axis:
0=Wave 1
1=Wave 3
2=Wave 4
3=Wave 5

[2]The y-axis is the survival function

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