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The Use of Female Permanent Contraception Among Women Desiring to Limit Childbearing in Sub-Saharan Africa: Analyses of the Spatial Pattern and Individual- and Country-Level Determinants

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THE USE OF FEMALE PERMANENT CONTRACEPTION AMONG WOMEN DESIRING TO LIMIT CHILDBEARING IN SUB-SAHARAN AFRICA: ANALYSES OF THE SPATIAL PATTERN AND INDIVIDUAL- AND COUNTRY-LEVEL DETERMINANTS

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ABSTRACT

Female permanent contraception (FPC) is the most commonly used contraceptive method, globally. It is a convenient, safe, and cost-effective modern contraceptive method that permanently stops childbearing among women. Despite its benefits, previous reports suggest that the increasing proportion of women who desire to limit childbearing in sub-Saharan Africa (SSA) rely more on less effective contraceptive methods, predisposing them to unintended pregnancies and their associated consequences. This study aimed to add to the sparse body of evidence on the use of FPC and the associated determinants among women with demand for limiting childbearing in SSA. Using data from Demographic and Health Surveys (2010-2018) and other global data repositories, this study investigated the proportion of demand for limiting childbearing satisfied with FPC, spatial pattern in the proportion of demand for limiting childbearing satisfied with FPC, and individual- and country-level factors associated with the use of FPC among married or in-union women with demand for limiting childbearing in 33 countries in SSA. Weighted descriptive statistics, exploratory spatial data analysis, and multilevel logistic regression analysis were performed. The findings showed that 6.7% (95% confidence interval [CI]=6.2-7.1%) of the demand for limiting childbearing was satisfied with FPC, ranging from 0.3% (95%CI=0.1-0.8%) in Angola to 27.0% (95%CI=25.3-28.7%) in Malawi. Across all countries, the proportion of demand for limiting childbearing satisfied with FPC was highest among women: 40 years and older (10.4%), with 3-4 living children (7.8%), with secondary education or higher (7.9%), from rich households (8%), and residing in urban areas (7.2%). There was a significant positive spatial autocorrelation in the proportion of

demand for limiting childbearing satisfied with FPC (global Moran's I =0.1, p<0.008), with concentration of low-low clusters (cold spots) located in western and central Africa. The multilevel logistic regression analysis showed a significant variation in the odds of using FPC across the 33 countries (σ^2 =0.815, 95%CI=0.488-1.362). About 20% of the variance in the odds of using FPC was attributable to between-country differences. In the full model, the individual-level factors associated with the use of FPC compared with other modern contraceptive methods were: age (odds ratio [OR]=1.100; 95%CI=1.083-1.118), living children (OR=1.110, 95%CI=1.044-1.159), rich household wealth (OR=1.391, 95%CI=1.180-1.640), rural residence (OR=0.828, 95% CI=0.709-0.968), joint contraceptive decision with partner (OR=1.683, 95%=1.426-1.986), contraceptive decision by partner and others (OR=2.457, 95%=1.966-3.072), and living less than ideal number of children (OR=1.400, 95%CI=1.210-1.619). The associated country-level factors were births attended by skilled health providers (OR=1.025, 95%CI=1.003-1.047) and density of medical doctors (OR=1.369, 95%CI=1.014-1.847). The use of FPC among married or in-union women with demand for limiting childbearing remains low and varies geographically by countries in SSA. The factors influencing the use of FPC exist at both individual and country levels. The implications of the findings for policy, practice, and future research towards improving voluntary and informed uptake of FPC in SSA were discussed.

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DEDICATION

This dissertation is dedicated to my son, Olukoyejo Oluwole Olakunde and my late mother, Mrs. Theodora Ayodele Olakunde.

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ORGANIZATION OF THE DISSERTATION

This dissertation consists of five chapters. Chapter One contains the problem statement and background. It discusses why FPC is important for prevention of unintended pregnancies and its consequences. The study aims are also presented in Chapter One. Chapter Two covers a review of relevant literature on FPC. It discusses the different FPC procedures and expands on the effectiveness and advantages of FPC. The chapter highlights post-FPC effects such as sexual and reproductive problems and regrets. The growing proportion of women who want to limit childbearing in Africa, their use of FPC, and the barriers affecting the uptake of FPC are discussed in Chapter Two. The gaps in the quantitative studies that have examined factors associated with uptake of FPC in Africa are also highlighted in Chapter Two. The chapter ends with the research questions. Chapter Three provides the methods, including the conceptual framework, study design, and data analyses. The data sources, study setting, and variables are also described in this chapter. The results of the analyses are presented in Chapter Four. The chapter starts with the characteristics of the women and countries included in the study. The findings on the proportion of demand for limiting childbearing satisfied with FPC, exploratory spatial data analyses, and multilevel logistic regression analyses are also presented in this chapter. Chapter Five focusses on the interpretation of the findings, and how they compare with similar studies in other settings. The limitations of the study are noted in Chapter Five. The chapter concludes with recommendations for policy, practice, and future research.

CHAPTER 1: INTRODUCTION

The chapter provides a background to the public health issue this study seeks to address. It discusses the burden of unintended pregnancy, and why the use of effective contraceptive methods such as female permanent contraception (FPC) are important in preventing unintended pregnancies and the associated health and socioeconomic consequences. The rationale and aims of the study are also presented in this chapter. The chapter ends with the definitions of key terms used in this study.

Problem Statement

Despite the increasing proportion of women with demand for limiting childbearing in sub-Saharan Africa (SSA) (Westoff, 2012; Westoff & Bankole, 2000), the uptake of female permanent contraception (FPC) which offers a cost-effective, convenient, and safe method to limit births remains low (The RESPOND Project, 2014; Van Lith et al., 2013). The majority of these women do not use contraceptives or rely on reversible methods that are not as effective (Van Lith et al., 2013), increasing their risk of having unintended pregnancies (Bradley et al., 2011; Guttmacher Institute, 2017). Estimates indicate that approximately 1 in 3 pregnancies in SSA are unintended (Darroch et al., 2017). Unintended pregnancies are responsible for nearly 30% of maternal deaths and 26% of newborn deaths in SSA (Darroch et al., 2017). They are also an important driver of the unsustainable growing population, which negatively impacts on economic growth and development in a number of African countries (Cleland & Machiyama, 2017; Ezeh et al., 2012; Headey & Hodge, 2009). While women face multilevel barriers in accessing

modern contraceptive methods in SSA, how these factors affect uptake of FPC have not been comprehensively examined (Olakunde et al., 2019). A better understanding of the factors that influence the uptake of FPC is required in improving its voluntary and informed utilization among women who want to limit childbearing in SSA (Marie Stopes International et al., 2014). This study aims to fill the gap in literature by investigating the proportion of demand for limiting childbearing satisfied with FPC, spatial pattern in the proportion of demand for limiting childbearing satisfied with FPC, and individual- and country-level factors associated with the use of FPC among married or in-union women with demand for limiting childbearing in 33 countries in SSA.

Background

Unintended pregnancies are “pregnancies that are reported to have been either unwanted (i.e., they occurred when no children, or no more children, were desired) or mistimed (i.e., they occurred earlier than desired)” (Santelli et al., 2003, p.94). Although the rate of unintended pregnancy is declining, it still remains an important global health issue (Bearak et al., 2018). From 2010 to 2014, a study estimated that about 44% of pregnancies were unintended worldwide (Bearak et al., 2018). Compared with developed countries with an estimated rate of 45 per 1000 women aged 15-44 years, the burden of unintended pregnancy is higher in developing countries with a rate of 65 per 1000 women aged 15-44 years (Bearak et al., 2018).

Unintended pregnancies are of huge public health importance, given their impact on maternal and child health. Research has indicated that women with unintended pregnancies have poorer maternal and child health outcomes compared with women

with intended pregnancies (Gipson et al., 2008; Hall et al., 2018; Mohllajee et al., 2007; Singh et al., 2015). In 2017, it was estimated that 31% of all maternal deaths and 23% of all newborn deaths in developing regions were related to unintended pregnancies (Guttmacher Institute, 2017). Maternal and newborn care related to unintended pregnancies in developing countries has been estimated to cost about $8.3 billion annually; representing about 32% of the total costs of maternal and newborn care in developing countries (Guttmacher Institute, 2017). In addition to the health and financial burden, unintended pregnancies also have social and economic implications (Sonfield et al., 2013). For example, some studies have reported positive associations between unintended pregnancies and school dropout (Adam et al., 2016; Lloyd & Mensch, 2008; Meekers & Ahmed, 1999; Morara & Chemwei, 2010; Uche, 2013), intimate partner violence (Goodwin et al., 2000; James et al., 2013; Martin-de-las-Heras et al., 2015), stigma (Levandowski et al., 2012) and marital issues (Boden et al., 2015; Maddow-Zimet et al., 2016). Furthermore, unintended pregnancies contribute to the unsustainable population growth in many developing countries (Singh et al., 2017; Yazdkhasti et al., 2015). Unintended pregnancies and the associated consequences on health and socioeconomic development are however preventable with the use of contraception.

Contraceptive use is a critical component of family planning that enables individuals or couples to choose if and/or when to have a child. It enables people to achieve the desired time or spacing of their births as well as limit their family size (World Health Organization [WHO], 2019a). The use of contraception for family planning has been recognized as one of the 10 great public health achievements of the 20th century

(Centers for Disease Control and Prevention, 1999), and it has continued to be featured on the global agenda for economic, social, and environmental development. Universal access to sexual and reproductive healthcare services, including family planning, by 2030 is one of the Sustainable Development Goals (SDGs) that were launched in 2015 by the United Nations (United Nations, n.d.).

Medical literature records indicate that contraceptive use dates back to about 2000 B. C. (Himes, 1936). The Petri papyrus (1850 B.C.) shows that ancient Egyptians prescribed the use of substances such as crocodile dung, honey, and acacia gum as vaginal suppositories for birth control (Stein, 1939). Relatedly, the Ebers papyrus (1550 B.C.) reveals that women were encouraged to have prolonged lactation for proper spacing (Himes, 1934; Stein, 1939). Since these earlier periods, methods for preventing unintended pregnancies have evolved and become more effective and less harmful. According to Himes (1934), “What is new is not the desire for prevention, but effective, harmless means of achieving it on a grand scale” (p.580).

Many types of contraceptive methods are currently available for prevention of unintended pregnancies (WHO, 2019a). These methods can be classified using different criteria, such as effectiveness, reversibility, presence of hormones, or duration of action (Festin et al., 2016) (Table 1).

Table 1: *Classification of contraceptive methods*

Classification Systems of Contraceptive Methods	Female Sterilization	Vasectomy	Implant	Copper Intrauterine Device	Hormonal Intrauterine System	Injectable	Oral Contraceptive Pill	EC Pill, 1.5 mg Levonorgestrel	Male Condom	Female Condom	Diaphragm	LAM	SDM	Two Day Method	Rhythm/ Calendar Method	Withdrawal
Modern or traditional	M	M	M	M	M	M	M	M	M	M	M	M	M	M	T	T
Level or tier of effectiveness	1	1	1	1	1	2	2	3[a]	3	3	3	2	3	3	4	4
Need for program support	Hi	Hi	Hi	Hi	Hi	Me	Lo	Lo	Lo	Lo	Lo	Me	Me	Me	No	No
Duration of labeled use	P	P	LA	LA	LA	MA	SA	SA	SA	SA	SA	MA	SA	SA	SA	SA
Male or female controlled, or both	FC	MC	FC	FC	FC	FC	FC	FC	MC	FC	FC	FC	Both	Both	Both	MC
Coitally dependent/related	N	N	N	N	N	N	N	Y	Y	Y	Y	N	Y	Y	Y	Y
Need for surgical procedure to use	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
Presence of hormones	N	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N
Client's ability to discontinue without needing a provider	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Return to fertility after discontinuation of method	U	U	I	I	I	D	I	I	I	I	I	D	I	I	I	I

Legend to Table:

Modern and traditional	*M — Modern, T — Traditional*	
Level or tier of effectiveness	*1, 2, 3 or 4 (as per Family Planning, Global Handbook for Providers, 2011 update)*	
Need for program support	*Hi — High, Me — Medium, Lo — Low, No — None*	*High — requires a clinic setting with trained and skilled providers* *Medium — can be provided in a nonclinical setting by trained and skilled providers* *Low — can be provided in community distribution programs, over the counter or in informal settings*
Duration of labeled use	*P — Permanent, LA — Long-acting, MA — Medium-acting, SA — Short-acting*	*Note: Medium-acting is not a commonly used category but is presented here to distinguish it from the methods that are labeled for a lesser period of effect.*
Male or female controlled, or both	*MC — Male controlled, FC — Female controlled, Both*	
Coitally dependent/related	*Y — Yes, N — No*	*Coitally dependent: Requires a specific intervention at the time of intercourse.*
Need for surgical procedure to use	*Y — Yes, N — No*	
Presence of hormones	*Y — Yes, N — No*	
Client's ability to discontinue without reliance on a provider	*Y — Yes, N — No*	
Return to fertility after discontinuation of method	*I — Immediate, D — Delayed, Ne — Never, U — Uncertain success after reversal*	

Source: Festin et al. (2016).

Generally, contraceptive methods are broadly classified as “modern” or “traditional”. Nonetheless, despite their wide use, there are no standardized definitions for the two terms (Festin et al., 2016; Hubacher & Trussell, 2015). Consequently, organizations vary in their categorization of the different contraceptive methods as modern or traditional (Hubacher & Trussell, 2015). For example, lactational amenorrhea method (LAM) is classified as a modern method by the WHO and Demographic and Health Surveys (DHS) Program, whereas organizations such as the United Nations Population Fund (UNFPA), Guttmacher Institute, and the Multiple Indicator Cluster Surveys classify it as a traditional method (Festin et al., 2016; Hubacher & Trussell, 2015). To address this inconsistency, Hubacher and Trussell (2015) proposed a definition for modern contraceptive methods as follows: “A product or medical procedure that interferes with reproduction from acts of sexual intercourse” (p. 420). They suggested that the methods that do not fit under the definition of modern methods can alternatively be labeled as “non-modern methods”. Based on their proposed definition, they classified LAM, abstinence, withdrawal, and fertility awareness approaches, including standard days method, two-day method, calendar rhythm method, billing ovulation method, and symptothermal method as non-modern methods (Hubacher & Trussell, 2015). While their intervention has attempted to standardize the definition of modern contraceptive methods, it is yet to receive wide acceptance. Lopez-Del Burgo and de Irala (2016) argued that changing the definition may cause confusion among prospective clients and may negatively affect making an informed decision, as non-modern methods may erroneously be regarded as ineffective. In 2015, a technical consultation organized by the WHO Department of Reproductive Health and Research

and the United States Agency for International Development (USAID), defined modern methods as methods that have “a sound basis in reproductive biology, a precise protocol for correct use and existing data showing that the method has been tested in an appropriately designed study to assess efficacy under various conditions.” (Festin et al., 2016. p.292). It recommended that LAM and fertility awareness based methods be classified as modern methods (Festin et al., 2016).

The different types of contraceptive methods vary in their effectiveness in the prevention of unintended pregnancies (Figure 1). Overall, modern contraceptive methods have been found to be more effective than traditional contraceptive methods (Polis et al., 2016). Permanent (female sterilization and male vasectomy) contraception and long-acting reversible contraception [LARC] (implants and intrauterine devices)] are the most effective types of contraceptive methods currently available, causing less than one pregnancy per 100 women in a year (Figure 1). These methods, which are non-user dependent and do not require adherence to be effective (Trussell & Wynn, 2008), are usually referred to as “Tier 1” methods (Festin et al., 2016; Stanback et al., 2015; Trussell et al., 2018).

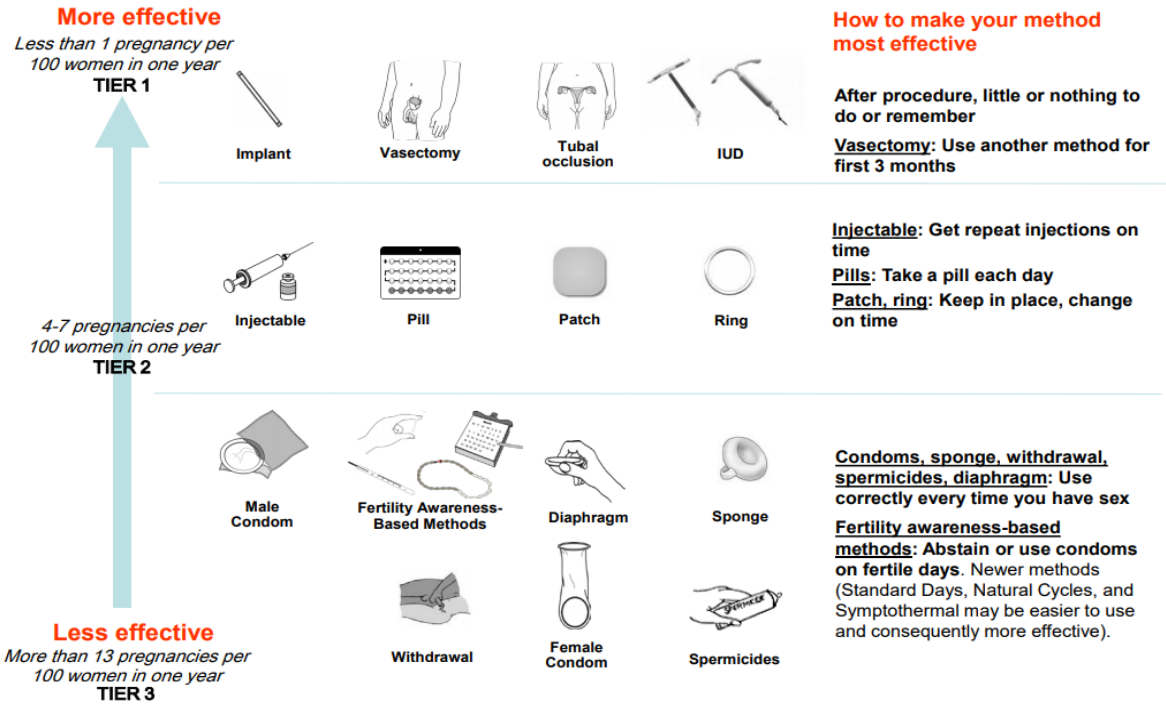

Figure 1: Typical effectiveness of contraceptive methods.
Source: Trussell et al. (2018).
Note: Female permanent contraception was referred to as tubal occlusion in Figure 1.

Remarkably, there has been a significant increase in the proportion of married or in-union women using contraception in the last fifty years. Nevertheless, contraceptive prevalence (percentage of married or in-union women of reproductive age currently using contraception) in still low in developing regions, particularly Africa (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). From 1970 to 2017, contraceptive prevalence increased from 35% to 63%, globally (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). Compared with other regions, Africa recorded the lowest contraceptive prevalence over this period. In 2017, Africa had a contraceptive prevalence of 36% among married or in-union women, while Northern America and Latin America and the Caribbean had the highest

contraceptive prevalence at 75% (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). Notably, changes in contraceptive prevalence in other regions have relatively stabilized since the 2000s, but it has continued to rise in Africa. From 2000 to 2017, Africa had a percentage point change of 11%, whereas other regions had 5% or less (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). Relatedly, in 2017, unmet need for family planning (percentage of married or in-union women of reproductive age who desire to stop or delay childbearing but report not using any method of contraception) was estimated at 12%, globally (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). This varied considerably across continents, with Africa having the highest level of unmet need for family planning (22%) (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). In other regions, unmet need for family planning was estimated at 15% or less (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). Also, the demand for family planning satisfied with modern contraceptive methods (the proportion currently using a modern contraceptive method among married or in-union women of reproductive age who express desire for family planning) was 56% in Africa, and more than 75% in other regions

A myriad of factors are responsible for the low utilization of contraception in developing countries. Sedgh and Hussain (2014) investigated the reasons for nonuse of contraceptive among women with unmet need in developing countries using 51 Demographic and Health Surveys (DHS) conducted between 2006 and 2013. In the study, where women with unmet need were able to provide more than one reasons for

not using a contraception method, concerns about side effects and finding methods inconvenient to use were the most common reason for not using contraception (Sedgh & Hussain, 2014). These reasons were cited by 34% of women in Latin America and the Caribbean, 28% of women in Africa, and 23% of women in Asia (Sedgh & Hussain, 2014). Opposition to contraceptive use by partner or someone close to them was cited by 27%, 25%, and 11% percent of women in Asia, Africa, and Latin America and the Caribbean, respectively (Sedgh & Hussain, 2014). According to the study, 8% of women in Africa, 6% of women in Asia, and 4% of women in Latin American and the Caribbean cited lack of access or cost as a barrier, while 6% of women in Africa, 2% of women in Asia, and 1% of women in Latin American and the Caribbean mentioned lack of knowledge (Sedgh & Hussain, 2014). In the same vein, Bellizzi et al. (2015) explored reasons for not using contraceptives in 35 low- and middle-income countries, using DHS conducted between 2005 and 2012. Among nearly 15,000 sexually active non-pregnant women who did not desire pregnancy, and who cited one primary reason for not using contraception, 37% indicated fear of side effects and health concerns, 22% indicated self or partner's opposition or religious proscription, 18% underestimated the risk of pregnancy, 4% indicated lack of knowledge, 7% indicated other methods-related reasons, and 12% indicated other reasons (Bellizzi et al., 2015). A systematic review of 11 studies conducted in SSA between January 2010 and July 2012 highlighted culture, desires to have large families, costs, and access as some of the major barriers that limited women’s use of family planning services in SSA (Haider & Sharma, 2013). Health systems challenges such as geographical inaccessibility, lack of contraceptive supplies, poor quality of services, and shortage of skilled healthcare providers also

hinder contraceptive use in developing countries (Carr et al., 2012; Jacobstein et al., 2013; Silumbwe et al., 2018).

Nonetheless, among women who use contraception in Africa, modern contraceptive methods are the most commonly used. In 2017, they accounted for 89% of all the contraceptive methods used among married or in-union women of reproductive age (United Nations, Department of Economic and Social Affairs, Population Division, 2017a). Although decision making on contraceptive choice is a complex process, factors such as accessibility (physical and economic), previous experience, safety, effectiveness, and side effects play a key role (Madden et al., 2015; Mumah et al., 2018; Tibaijuka et al., 2017). In addition to these factors, fertility intention of prospective client is also an important determinant. Contraceptive choice may be different depending on if the individual/couple is a “delayer” (without children but subsequently wants to become a parent), “spacer” (with children and eventually wants more children in the future) or “limiter” (does not want more children in the future).

Globally, FPC is the most widely used contraceptive method (Joshi et al., 2015; United Nations, Department of Economic and Social Affairs, Population Division, 2015); representing 30.2% of the method mix among married or in-union women using contraceptives (Table 2). It is the most commonly used method in regions like Asia, Latin America and the Caribbean, and Northern American (Table 2). However, its use is low in Africa (Darroch & Singh, 2013; Ewerling et al., 2018), where it accounts for less than 5% of the method mix among married or in union women using contraceptives (United Nations, Department of Economic and Social Affairs, Population Division, 2015).

Table 2: *Contraceptive prevalence among married or in-union women (%)*

Contraceptive method	World	Africa	Asia	Europe	Latin America and the Caribbean	Northern America	Oceania
Any method	63.6	33.4	67.8	69.2	72.7	74.8	59.4
Female permanent contraception	19.2	1.6	23.7	3.7	25.7	20.6	8.0
Male permanent contraception	2.4	0.0	2.2	3.3	2.6	11.9	6.3
Pill	8.8	8.7	6.4	21.9	15.0	16.5	21.6
Injectable	4.6	9.8	3.9	0.4	6.8	0.1	5.0
Implant	0.7	2.3	0.4	0.2	0.3	0.9	1.9
Intrauterine device	13.7	3.8	17.4	11.3	6.4	4.7	1.1
Male condom	7.7	2.1	7.6	16.7	9.6	11.9	10.2
Vaginal barrier methods	0.1	0.1	0.1	0.9	0.1	0.3	0.5
Other modern methods	0.2	0.1	0.1	0.4	0.2	2.4	0.2
Rhythm	2.6	2.2	2.7	2.4	2.8	1.2	2.1
Withdrawal	3.1	1.3	2.9	7.8	2.6	4.3	1.7
Other traditional methods	0.5	1.3	0.4	0.2	0.6	0.0	0.8

Source: United Nations, Department of Economic and Social Affairs, Population Division (2015).

Study Rationale and Significance

Lack of contraceptive use is the leading cause of unintended pregnancies in SSA, accounting for about 84% of the burden (Darroch et al., 2017). Unintended pregnancies also occur from method failure resulting from inconsistent or incorrect use of effective contraceptive methods or the use of ineffective contraceptive methods (Bradley et al., 2011; Darroch et al., 2017; Klima, 1998). Undoubtedly, ensuring access

to family planning services and uptake of effective contraceptive methods will help in reducing the burden of unintended pregnancies among women who want to limit, delay or space birth in many developing countries (Singh et al., 2017). While all these different categories of women are important, targeting and preventing unwanted pregnancies among individuals who want to limit childbearing can contribute more to reducing total fertility rate in SSA (Van Lith et al., 2013). In some countries, higher proportion of unintended pregnancies have been found among women who reported desire for limiting compared with spacing (Speizer & Lance, 2015).

FPC is an effective modern contraceptive method that permanently stops childbearing among women. For individuals or couples who do not desire children in future, FPC offers a good option for preventing unintended pregnancies. It has a low failure rate, no hormonal side effects, and it is cost effective (Jensen, 2015; Micks & Jensen, 2015; WHO, 1992). However, its use remains very limited in Africa (Van Lith et al., 2013) among the increasing proportion of women with demand for limiting childbearing (Westoff, 2012; Westoff & Bankole, 2000). The majority of the women using contraceptives to stop childbearing use reversible methods that are less effective and liable to failure (Van Lith et al., 2013). In order to increase voluntary use of permanent contraceptive methods such as FPC in low-income settings, a consortium of stakeholders recommended more research to better understand the determinants of its uptake, among other things (Marie Stopes International et al., 2014). A recent review concluded that limited quantitative studies have comprehensively examined the factors influencing the utilization of FPC in SSA (Olakunde et al., 2019).

The use of FPC can prevent unintended pregnancy, and consequently the need for abortion, an important cause of maternal mortality in Africa (Haddad & Nour, 2009; Say et al., 2014; WHO, 2011). Of the estimated unintended pregnancies from 2010-2014 in Africa, 38% ended in abortion (Bearak et al., 2018). Unfortunately, nearly half of the abortions in developing regions are unsafe (Ganatra et al., 2017), i.e., performed either by someone who lacks the requisite skills or in a setting below minimal medical standard, or both (WHO, 2019b). According to estimates by Ganatra et al. (2017), 76% of the abortions that occurred annually from 2010 to 2014 in Africa were unsafe.

Additionally, the use of FPC can help reduce the direct impact of pregnancy on health and well-being of women, particularly among those who are at increased risk of mortality or morbidity from pregnancy and childbirth such as older or grand multiparous women (Al-Shaikh et al., 2017; Brown et al., 2015; Cleary-Goldman et al., 2005; Ganchimeg et al., 2014; Laopaiboon et al., 2014; Mgaya et al., 2013; Ziadeh & Yahaya, 2001). A previous study which modeled maternal mortality averted by contraceptive use in 172 countries in 2008, indicated that contraceptive use reduced maternal mortality by 44% (Ahmed et al., 2012). According to the study, satisfying unmet need for contraception could reduce maternal deaths in SSA by 29%, annually (Ahmed et al., 2012). A more recent analysis in developing counties reported that meeting 100% coverage of contraception with the current level of maternal care will reduce maternal mortality by 25% (Guttmacher Institute, 2017).

Likewise, the use of FPC to avoid unintended pregnancies is also important to improving infant and child health. Empirical evidence has shown positive relationship between unintended pregnancies and poor infant outcomes. A meta-analysis that

included 15 studies found that the odds of low birth weight and preterm births in women with unintended pregnancies were 1.4 and 1.3 times that of women with intended pregnancies, respectively (Shah et al., 2011). Babies born to older women have also been reported to have higher risk of preterm and low birth weight (Ates et al., 2013; Carolan, 2013). Furthermore, results from longitudinal studies in SSA have also suggested that children who lose their mother from early maternal deaths (some of which may have been prevented through the use of contraceptives such as FPC), face higher risk of dying compared to children whose mother survived (Houle et al., 2015; Moucheraud et al., 2015). FPC can also be used in preventing unintended pregnancies among HIV-infected women, thereby reducing the risk of vertical transmission of HIV (Delvaux & Nöstlinger, 2007; Hladik et al., 2009; Mitchell & Stephens, 2004).

Using contraceptives such as FPC to prevent unintended pregnancies can also contribute to socioeconomic growth and development. Indeed, the use of contraception has been linked to improved women's earning and participation in paid labor (Longwe et al., 2013; Miller, 2010). Moreover, the use of contraception, particularly to limit childbearing can contribute to reduction in fertility (Bongaarts, 2011; Singh et al., 2017), and in turn reduce the dependency ratio (the number of dependent individuals [i.e., those below 15 or above 64 years of age] divided by the total population) (Canning & Schultz, 2012). This is quite important in Africa where many countries are faced with unsustainable population growth. Africa is estimated to have the highest annual population growth rate compared with other regions (United Nations, Department of Economic and Social Affairs, Population Division, 2017b). Between 2017 and 2050, 26 African countries are projected to increase their current population by at least 100%

(United Nations, Department of Economic and Social Affairs, Population Divison, 2017b). Unlike other regions where fertility rates have reduced to less than three births per woman, the average fertility rate in SSA is more than five children per woman (Ezeh et al., 2012). The economic benefits derived from transition to low fertility has been termed the “demographic dividend” (Bloom et al., 2003; Bongaarts, 2017b; United Nations Population Fund, 2016). According to the United Nations Population Fund, “A demographic dividend is the potential for economic growth that can result from shifts in a population’s age structure when the share of the working-age population (15 to 64) expands relative to the non-working age population (14 and younger, and 65 and older)” (2016b, p.60). A decline in fertility gradually lowers the number of dependent young people, resulting in an increase in the ratio of the working-age population to the dependent population (Bloom et al., 2003; Canning & Schultz, 2012). Such population structure allows resources at household or state levels that would have been used to support dependent population to be invested in developmental programs such as education and health that can have positive effects on the economy (Bloom et al., 2003; Carr et al., 2012). For example, in poor households, a lower number of children may lead to more investment per child. The children of families with access to family planning have been found to be healthier and better educated than children of those families who do not have access to family planning services (Gribble & Voss, 2009).

Access to family planning services as a fundamental right and the increasing need for socioeconomic development have stimulated renewed global interest in family planning. With the goal of improving access to quality family planning services and protecting the rights of women and girls, the Bill & Melinda Gates Foundation and the

United Kingdom Government in July 2012 organized a family planning summit in London, which had in attendance national leaders, donors, civil society groups, non-governmental organizations and private-sector representatives. The Family Planning 2020 Initiative which aims at reaching an additional 120 million women residing in the 69 poorest countries with modern contraceptives by 2020 (120 by 20) was launched at the summit (Brown et al., 2014; Cohen, 2012). As of the end of 2017, a total of 44 countries had made political commitment to Family Planning 2020 (Family Planning 2020, 2017). However, only about 46 million additional women have been reached with modern contraceptive methods as of June 2018 (Family Planning 2020, 2018). To meet the target, it has been estimated that the annual growth rate of the prevalence of modern contraceptive methods must increase from 0.7% at baseline to 1.4% by 2020 across the 69 countries (Brown et al., 2014). An analysis by Cahill et al. (2018) showed that 61% (22/33) of the countries that have made a commitment to Family Planning 2020 have equaled or achieved more than pre-Family Planning 2020 expectations (i.e., the probability that countries would attain present levels of modern contraceptive prevalence was ≤50% in 2012).

Similar to Family Planning 2020, improving access to modern contraceptive methods such as FPC is one of the targets of the SDGs. The SDGs, ratified by United Nations Member States in 2015, contained 17 goals and 169 targets across social, economic, and environmental areas of sustainable development (United Nations, n.d.). The SDGs, with a much wider scope, replaced the Millennium Development Goals (MDGs) which ended in 2015. Reference to family planning is found in Target 3.7 of Goal 3 of the SDGs (United Nations, 2019b) (see Table 3). A number of indicators,

including contraceptive prevalence, unmet need, and demand satisfied are used in monitoring uptake of contraception (RamaRao & Jain, 2015). For MDG 5, Target B, contraceptive prevalence and unmet need for family planning were used to monitor progress (Bongaarts & Hardee, 2017; United Nations, 2015). However, because of the issues associated with the indicators, particularly unmet need (Bongaarts & Hardee, 2017; Bongaarts, 2014; Bradley & Casterline, 2014), SDG uses demand for family planning satisfied with modern methods for monitoring Target 3.7 (Bongaarts & Hardee, 2017; Kali, 2016; United Nations, 2019b). A benchmark of at least 75% of the demand for family planning satisfied with modern methods by the year 2030 has been proposed (Fabic et al., 2015), and to meet this target in the 63 least developed countries, it has been estimated that demand for family planning satisfied with modern methods needs to increase by 2.2% points annually in between 2014 and 2030 (Choi et al., 2015). A study which examined the 75% benchmark goal by 2030, concluded that meeting the goal will bring a substantial benefits to developing countries (Goodkind et al., 2018).

Table 3: *SDG, target, and indicator related to family planning*

Goal	Target	Indicator
3: Ensure healthy lives and promote well-being for all at all ages	3.7: By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	3.7.1: Proportion of women of reproductive age (15-49 Years) who have their need for family planning satisfied with modern methods

Source: United Nations (2019).

In line with these global initiatives, there is a need for robust evidence that can inform practice and policy for provision of quality, right-based family planning services, such as FPC for individuals who desire to limit childbearing in SSA (Marie Stopes International et al., 2014). The results of this study can stimulate national discourse on interventions for improved voluntary use of FPC in SSA, with the aim of reducing unintended pregnancies among women with demand for family planning to limit childbearing. Findings from this study can also inform policy and practice towards reducing the disparities in access to FPC in SSA, so that desiring individuals or couples can achieve their reproductive goal of permanently limiting childbearing. Finally, this research can form the basis for future studies on FPC in SSA.

Study Aims

The overall goal of this study was to determine the variation in and factors associated with the use of FPC among married or in-union women with demand for limiting childbearing in SSA. The aims of this study were:

1. To determine the proportion of demand for limiting childbearing satisfied with FPC among married or in-union women in SSA.
2. To determine the proportion of demand for limiting childbearing satisfied with FPC among married or in-union women in SSA by sociodemographic characteristics.
3. To examine the spatial pattern in the proportion of demand for limiting childbearing satisfied with FPC among married or in-union women in SSA.

4. To investigate the influence of individual- and country-level factors on the use of FPC among married or in-union women using modern contraceptive methods to limit childbearing in SSA.

Definitions of Key Terms

Based on DHS description and guide (Croft et al., 2018), the following are the definitions of the key terms used in the study.

Modern contraceptive methods. These include female sterilization (or female permanent contraception), male sterilization, implants, intrauterine device (IUD), injectables, pill, male condom, female condom, emergency contraception, vaginal methods, lactational amenorrhea method, or other modern methods.

Unmet need for limiting childbearing. A woman has an unmet need for limiting childbearing if she was not using any method of contraception and she was: fecund and did not want any more children; pregnant and did not want any more children at time the time of pregnancy or later; or postpartum amenorrheic and did not want any more children at the time of last birth or later.

Met need for limiting childbearing. A woman has a met need for limiting childbearing if she was using a method of contraception and she: wanted no more children; was sterilized; or said she could not get pregnant in response to question on desire for future children.

Demand for limiting childbearing. Women with met or unmet need for limiting childbearing.

Demand for limiting childbearing satisfied with modern contraceptive methods. Women using modern contraceptive methods out of those who have demand for limiting childbearing (met and unmet need).

Demand for limiting childbearing satisfied with FPC. Women using FPC out of those who have demand for limiting childbearing (met and unmet need).

CHAPTER 2: LITERATURE REVIEW

This chapter provides a review of literature relevant to this study. It begins with information on the different types of FPC procedures and discusses literature on the effects, effectiveness, and advantages of FPC. Evidence on the growing population of women who want to limit childbearing and the barriers affecting the uptake of FPC, particularly in SSA are presented. Gaps in the studies that have examined factors associated with the uptake of FPC in SSA are also highlighted in this chapter. This chapter concludes with the research questions the study seeks to answer.

Female Permanent Contraception Procedures

FPC is also referred to as female sterilization, tubal sterilization, tubectomy, tubal ligation, bi-tubal ligation, tying the tubes, or voluntary surgical contraception (World Health Organization Department of Reproductive Health and Research [WHO/RHR] et al., 2018). Although “female sterilization” has long been the popular nomenclature, some authors have expressed preference for the term “permanent contraception” (Jensen, 2014). According to Micks and Jensen (2015), permanent contraception is “politically neutral and medically accurate” (p. 769), given the history of coerced or forced sterilization. Alton and Jenson (2018) opined that the antiquated terminology “sterilization” limits the uptake of permanent contraception because of the negativity associated with it. Based on this, the term “female permanent contraception” was used in this study, to differentiate it from the male type of permanent contraception (vasectomy).

FPC is a modern contraceptive method that permanently stops childbearing among women. It involves blocking, cutting, or removal of the fallopian tubes (EngenderHealth, 2002); which are two narrow tubes through which the eggs released by the ovaries pass into the uterus (Edddy & Pauerstein, 1980). By interrupting the fallopian tubes, FPC acts by preventing sperm from reaching and fertilizing released eggs (Alton & Jensen, 2018; EngenderHealth, 2002) (see Figure 2). Apart from interrupting the fallopian tubes, other procedures such as the removal of the ovaries or uterus can result in sterility (EngenderHealth, 2002). However, these procedures are not recommended solely for FPC (EngenderHealth, 2002). Although FPC is regarded as permanent, it is potentially reversible (Siegler et al., 1985). But the reversal procedures are highly specialized and costly, and may not be widely available, particularly in SSA (EngenderHealth, 2002). Furthermore, success rate is dependent on a number of factors (Deffieux et al., 2011). Thus, it is recommended that intending clients should be counselled to consider the procedure as permanent and probably irreversible (WHO/RHR et al., 2018).

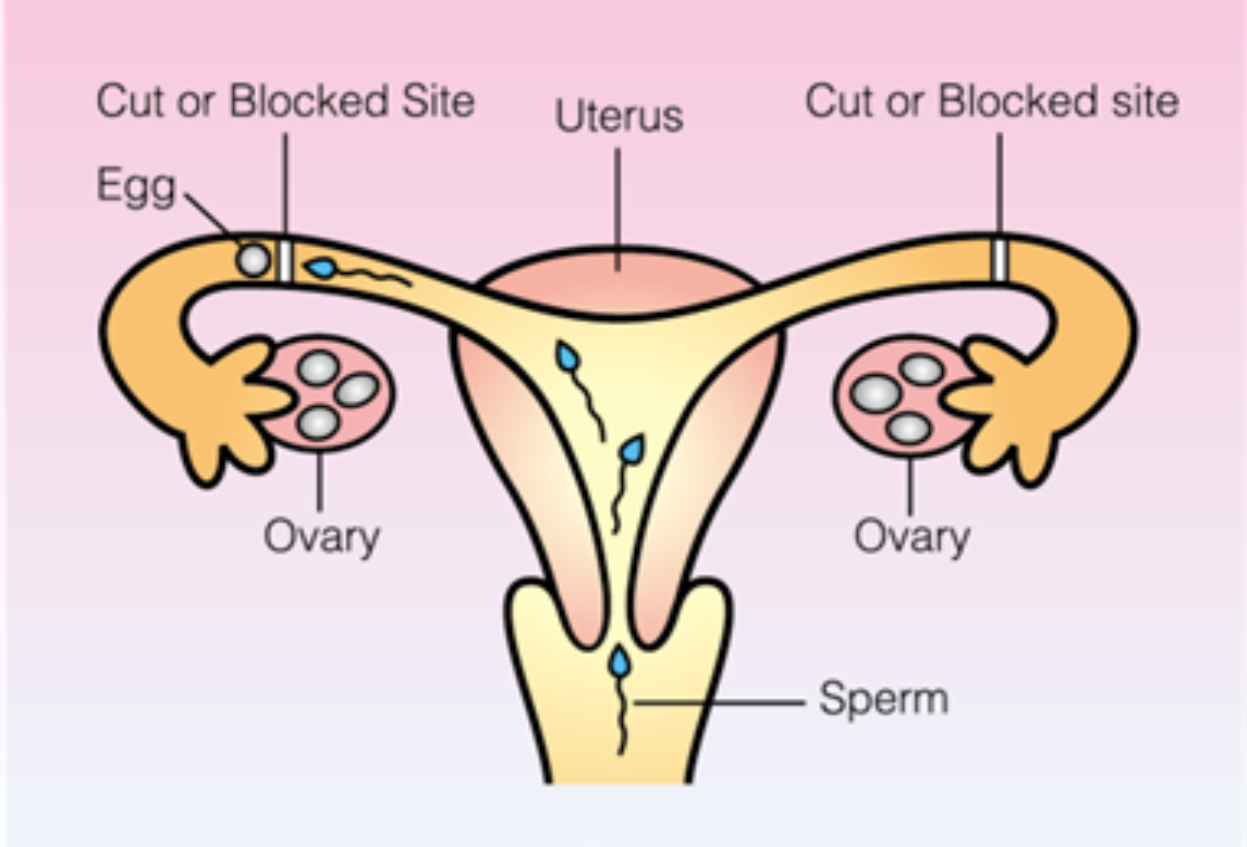

Figure 2: Tubal ligation or occlusion for female permanent contraception.
Source: https://www.ekhuft.nhs.uk/EasySiteWeb/GatewayLink.aspx?alId=472648.

The procedure for FPC was first described by Dr. James Blundell, as far back as the early 1820s (Popenoe, 1934; Siegler & Grunebaum, 1980). According to Siegler and Grunebaum (1980), Dr. Blundell “in his Lectures on the Principles and Practice of Midwifery given at Guy's Hospital in London, suggested that tubal resection could be performed during cesarean section or as an interval procedure for the purpose of sterilization” (p. 610). However, there was no record that Dr. Blundell performed the procedure (Popenoe, 1934; Siegler & Grunebaum, 1980). The first recorded FPC procedure in human was performed in 1880, by Dr. SS Lungren in Toledo, Ohio

(Popenoe, 1934; Siegler & Grunebaum, 1980; Wulf, 1981; Zurawin & Rivlin, 2018). During a 2nd cesarean section procedure, rather than removing the ovaries of the patient to prevent future pregnancy, Dr. Lungren decided to tie her fallopian tubes (Siegler & Grunebaum, 1980). He published the procedure in the American Journal of Obstetrics and Diseases of Children in an article titled "A Case of Cesarean Section Twice Successfully Performed on the Same Patient" (Lungren, 1881). In 1891, a French surgeon, Dr. A. Crimail, in addition to tying the tubes of his patient during cesarean section, also excised them, to prevent the risk of future pregnancy (Popenoe, 1934). Since these procedures in the 19th century, the methods and techniques for performing FPC have continued to evolve (Wilson, 1995). Nonetheless, it was not until the early 1970s, that the use of FPC became generally acceptable for prevention of pregnancies for nonmedical reasons (Peterson, 2008).

The different methods for performing FPC can be described based on the timing of the procedure, approach, and the occlusion methods (EngenderHealth, 2002). In selecting the best procedure suitable for a prospective client, some factors should be considered. These factors include: timing of the procedure with regard to pregnancy, indications for other gynecological procedures, previous gynecological and or abdominal surgery, provider's expertise, availability of tools and equipment, and cost (EngenderHealth, 2002).

Timing. This refers to the period when FPC procedure is carried out. These periods include: (i) postpartum (soon after a vaginal delivery or during caesarean section); (ii) postabortion (immediately following an uncomplicated first trimester abortion); or (iii) interval period (at least six weeks after delivery or any period that is

independent of pregnancy (EngenderHealth, 2002). In Africa, studies have reported interval as the most common period. In a study that used DHS to investigate the uptake of FPC in developing countries, of the six African countries included in the analysis, interval period accounted for the majority of the procedures in four countries; over 80% in two countries (Morocco and Tunisia) and 60% in two countries (Zimbabwe and Egypt) (Rutenberg & Landry, 1993). In Nigeria, retrospective studies utilizing clinical records have reported interval period as the most dominant, accounting for 79-87% of the procedures (Aisien & Oronsaye, 2007; Mutihir & Nyango, 2011; Nwogu-Ikojo et al., 2009).

Approach. This is used to describe the channel of accessing or reaching the fallopian tubes during the procedure. It includes transabdominal, transcervical, or transvaginal (EngenderHealth, 2002). Transabdominal approach is invasive, and is often referred to as surgical FPC (Micks & Jensen, 2015). Transcervical approach do not require surgical incisions to the abdomen, and are sometimes referred to as non-surgical FPC (Ripley & Salem, 2012). Transvaginal approach is no longer recommended (EngenderHealth, 2002; Micks & Jensen, 2015).

Transabdominal. This includes minilaparotomy, laparoscopy, microlaparoscopy, and laparotomy.

Minilaparotomy. It involves making an incision of less than five centimetres (cm) in the abdomen and bringing out the fallopian tubes to be blocked or severed (EngenderHealth, 2002). It is usually preformed under local anesthesia, and it can be performed at postpartum, postabortion, or in the interval period. In many resource-

limited settings where highly specialized equipment and expertise may not be available, minilaparotomy is more commonly used (Alton & Jensen, 2018).

Laparoscopy. It involves making an incision of about one cm in the abdomen, and inserting a laparoscope (a thin tube with telescope and light source) for proper visualization of the fallopian tubes (Ripley & Salem, 2012). The procedure can be done under general, regional, or local anesthesia (Ripley & Salem, 2012). Laparoscopy is more appropriate for postabortion and interval procedures (Micks & Jensen, 2015). When used for postpartum FPC, there could be limited visibility, which may increase the risk of injury to the uterus and other organs (EngenderHealth, 2002). With laparoscopy, the pelvic and abdominal regions can be inspected, particularly in women with pelvic pain (EngenderHealth, 2002). Compared with minilaparotomy, laparoscopic procedure is more expensive and requires a higher level of expertise (Alton & Jensen, 2018; EngenderHealth, 2002; Micks & Jensen, 2015). Its advantages include smaller incisions and quicker recovery time (Alton & Jensen, 2018; Zurawin & Rivlin, 2018). Laparoscopy is more commonly used in developed countries than minilaparotomy (Kulier et al., 2004).

Microlaparoscopy. It involves the use of a flexible scope of about 1.2 to 2 millimetres in diameter (Zurawin & Rivlin, 2018). Compared with laparoscopy or minilaparotomy, it requires a smaller incision. It can be performed under local anesthesia, and in an office setting (Zurawin & Rivlin, 2018). However, its comparative advantage of less pain and quicker recovery time is yet to be evaluated by randomized controlled trials (RCT) (Zurawin & Rivlin, 2018). Despite nearly two decades of existence, microlaparoscopy has not gained much popularity (Zurawin & Rivlin, 2018).

Laparotomy. It involves making an incision greater than five cm in the abdomen (Ripley & Salem, 2012). It is usually done under general or regional anesthesia (EngenderHealth, 2002). Compared with minilaparotomy or laparoscopy, laparotomy has longer recovery time and higher risk of complication (Ripley & Salem, 2012). Laparotomy is not recommended for the primary aim of performing FPC (Ripley & Salem, 2012). However, FPC can be done when laparotomy is being performed for procedures such as cesarean section or ovarian cystectomy (EngenderHealth, 2002). It can also be used in cases where minilaparotomy or laparoscopy will not provide adequate exposure (EngenderHealth, 2002).

Transcervical. It is a minimally invasive approach that involves occluding the fallopian tubes with agents introduced through the cervix and uterus (Castaño & Adekunle, 2010; Palmer & Greenberg, 2009). This method was developed to make FPC safer, more accessible, and acceptable (Jensen, 2015). For introduction of the occluding agents, the fallopian tubes may be approached blind or through the use of a hysteroscope (a thin telescope-like instrument inserted into the uterus) (Abbott, 2007). Transcervical is used for interval procedure only (EngenderHealth, 2002; Micks & Jensen, 2015). Due to the high cost of hysteroscope, hysteroscopic tubal occlusion is not very common in developing countries (Babigumira et al., 2015). Its advantages include minimal invasion, less risk of complications, and quicker time for recovery (Castaño & Adekunle, 2010). It can also be performed in an office setting (Hodges & Swaim, 2013).

Transvaginal. In this method, the fallopian tubes are accessed through a small incision below the posterior vaginal wall (EngenderHealth, 2002). It can be performed

by direct visualization (colpotomy) or through a scope (culdoscope) (EngenderHealth, 2002). Transvaginal approach is associated with high rates of infection. Consequently, it is no longer recommended for FPC (EngenderHealth, 2002; Kulier et al., 2004).

Occlusion agents or methods. These are the agents or methods use to interrupt the fallopian tubes.

Ligation and excision. This involves tying and cutting or removing a part of the fallopian tube (partial salpingectomy) (Ripley & Salem, 2012). This occlusion method is usually used with minilaparotomy or laparotomy. Techniques used for partial salpingectomy include Pomeroy, modified Pomeroy, Uchida, Parkland, and Irving methods (Peterson, 2008)

Mechanical device. This involves applying mechanical device such as rings, bands, or clips externally to the fallopian tubes (Ripley & Salem, 2012). This is commonly used with laparoscopy. It can also be used with minilaparotomy and laparotomy (Ripley & Salem, 2012).

Electrical method. This involves cauterizing a part of the fallopian tube using electrical current. It is commonly used with laparoscopy (Ripley & Salem, 2012). Compared with unipolar electrocoagulation, bipolar electrocoagulation is associated with lower thermal injuries (EngenderHealth, 2002).

Chemical method. This involves introducing a chemical compound (quinacrine pellets) into the uterine cavity to induce sclerosis of the fallopian tubes (Abbott, 2007; Lippes, 2015). It was commonly used in developing countries because of its reduced cost (Lippes, 2015). However, with concerns about quinacrine safety and dearth of

evidence on its effectiveness, the WHO recommended that should it not be used for non-surgical FPC in either clinical or research settings (WHO, 2009).

Essure and Adiana. These are two devices commonly used with transcervical approach to occlude the fallopian tubes (Palmer & Greenberg, 2009). Essure (mechanical) is spring-like (micro-coils) device made up of a nitinol outer coil and stainless steel inner coil with polyethylene terephthalate (PET) fibers that cause plugging of the fallopian tubes (la Chapelle et al., 2015; Micks & Jensen, 2015; Palmer & Greenberg, 2009). It can be introduced into the fallopian tubes through the use of hysterocope and a disposable delivery catheter (Micks & Jensen, 2015). It acts by stimulating inflammatory reaction and tissue growth which occludes the tubes (Micks & Jensen, 2015). Adiana (thermal) is plastic implant (silicone matrix) introduced into the fallopian tubes after cauterization of the tissue with a radiofrequency energy delivered for 60 seconds by a disposable catheter (Micks & Jensen, 2015). It causes tubal occlusion by stimulating tissue ingrowth response into the silicone matrix (Herbst & Evantash, 2010). The process of occluding the fallopian tubes by the two products may take up to three months. Thus, clients are required to use a temporary contraceptive method within that period. Confirmation through hysterosalpingogram (HSG), pelvic X-ray, or ultrasound (depending on the recommendation) is routinely conducted three months after the insertion to ascertain proper placement and tubal occlusion (Micks & Jensen, 2015; Palmer & Greenberg, 2009). However, as a result of plummeting sales, as well as litigations with increasing report off adverse effects such as pain, uterine or tubal perforation, device migration, heavy or irregular bleeding, suspected allergy or

hypersensitivity reactions, and failure rates, both devices have been withdrawn from the market (Casassus, 2017; Horwell, 2017; Murthy et al., 2017).

Ovabloc. This involves injection of a silicone matrix into the fallopian tube. The silicone matrixes solidify within five minutes after introduction. Due to high failure rates, Ovabloc was withdrawn from the market in 2009 (Murthy et al., 2017).

Salpingectomy. The removal of the fallopian tubes (the fimbria and ampulla in particular) is increasingly being used to achieve permanent contraception (Alton & Jensen, 2018; Danis et al., 2016; Powell et al., 2017). A retrospective assessment of the use of salpingectomy for FPC in an integrated health care system in the United States (U.S.) reported that from June 2011 to May 2016, salpingectomy for FPC increased from 0.4% to 35.5% (Westberg et al., 2017). Salpingectomy accounted for 78% of the interval laparoscopic sterilization in the final year of the study. Because of its safety, efficacy, and added advantage of protection against ovarian cancer, salpingectomy has been recommended as a feasible option for those at risk of ovarian cancer (Danis et al., 2016). According to the American College of Obstetrics and Gynecology:

> "Salpingectomy at the time of hysterectomy or as a means of tubal sterilization appears to be safe and does not increase the risk of complications such as blood transfusions, readmissions, and postoperative complications, infections, or fever compared with hysterectomy alone or tubal ligation" (2019, p. 843).

Emerging occlusion agents. FemBloc® is a degradable biopolymer liquid method that is currently being investigated for tubal occlusion (Alton & Jensen, 2018). It is a device that is delivered by catheter through the uterus to cause scarring and

occlusion of the tubes. Transcervical polidocanol (hydroxy-polyethoxy-dodecane) is a synthetic long-chain fatty alcohol that is also being investigated as an occlusion agent for FPC (Alton & Jensen, 2018). Preliminary findings among nonhuman primates (macaques and baboons) have shown that the agent is effective for tubal occlusion (Jensen et al., 2016; Slayden et al., 2016).

Effectiveness of Female Permanent Contraception

FPC is one of the most effective modern contraceptive methods, resulting in less than one pregnancy per 100 women in one year (Trussell et al., 2018). Failure of FPC refers to occurrence of pregnancy (utero or ectopic) after the procedure (EngenderHealth, 2003). A landmark prospective study conducted in the U.S. provided some of the earliest evidence on long-term effectiveness of FPC (Peterson, 2008). The Collaborative Research on Sterilization Techniques (CREST)—a multicenter observational study—was initiated in 1978 in 16 teaching institutions in the U.S. to investigate the effectiveness of different methods of FPC (Peterson et al., 1996). From 1978 to1986, the study enrolled 10,863 women who were followed through 1994. Of the women enrolled, the long-term follow up included 10,685 women who completed the study (Peterson et al., 1996). One hundred and seventy eight women were excluded for reasons including death, lost to follow-up, drop out, hysterectomy, or luteal phase pregnancies (Peterson et al., 1996). From 10,685 women, the study reported the 10-year cumulative pregnancy rate as 18.5 (95%CI=15.1-21.8) per 1,000 procedures (Peterson et al., 1996). The rate varied by the type of procedure, ranging from 7.5 per 1,000 procedures with both postpartum partial salpingectomy and unipolar coagulation

to 36.5 per 1,000 procedures for spring-clip application (Peterson et al., 1996). The effectiveness also differed by age, race, and study site (Peterson et al., 1996). Except for interval partial salpingectomy, the cumulative probability of pregnancy was higher for women 27 years or younger compared with those 28 years and older (Peterson et al., 1996). After adjusting for sites, methods, and age, the relative risks of failure among black, non-Hispanic and Hispanic women were 2.5 and 1.2 times that of white, non-Hispanic women, respectively (Peterson et al., 1996). Although the landmark research provided evidence on the long-term effectiveness of FPC, an important limitation was that the study was conducted in only teaching hospitals, reducing the generalizability. Peterson (2008) also noted that a number of the procedures accessed in the study were performed at the period when the skills for laparoscopic sterilization was growing, which may have accounted for the high failure rates.

Similarly, Trussell et al. (2003) assessed the 10-year cumulative failure rate of FPC in Canada. The study was a retrospective analysis of data from women who had FPC from 1980 to 1994, obtained from the Quebec provincial health insurance database. Among the 311,960 women included in the analysis, Trussell and colleagues reported a FPC failure rate of 0.84% within 10 years post procedure (Trussell et al., 2003). Compared with the 1.85% failure rate in CREST, the authors attributed their lower finding to the predominant use of Filshie clip; a more effective occlusion agent than Hulk Clip that was used in 15% of the cohort in CREST (Trussell et al., 2003).

Reporting on a shorter follow-up period, a systematic review of 19 RCT involving 13,209 women who had FPC with methods including tubal rings, clips, partial salpingectomy, or electrocoagulation found failure rates to be low (< 5/1,000) for all

methods after one year (Lawrie et al., 2016). According to the review, failure rates at one year after the procedure were not different for partial salpingectomy and clips, tubal rings and clips, and partial salpingectomy and electrocoagulation (Lawrie et al., 2016).

Retrospective analyses of clinical records in SSA have also found low failure rates of permanent contraception among women (Aisien & Oronsaye, 2007; Fasubaa et al., 2001; Swende & Hwande, 2010). In a review of literature published between 1979 and 1994 on FPC by minilaparotomy in Kenya, Ruminjo and Lynam (1997) reported the crude failure rate in the first year and second year as 0.4% and 0.1%, respectively. After adjusting for luteal phase pregnancy, they reported the failure rates as 0.2% and 0.1% in the first and second year, respectively (Ruminjo & Lynam, 1997). Kidan et al. (2001) evaluated safety and satisfaction of FPC by minilaparotomy among 82 women who had the procedure from April 1993 to May 1995 in Ethiopia, and reported that there was no failure after one-year follow up period.

Pregnancy conceived before FPC procedure but identified after the procedure (luteal phase pregnancy) is one of the leading causes of failure of FPC (EngenderHealth, 2002). In their 15-year review of FPC among women in Kenya, Ruminjo and Lynam (1997) found that luteal phase pregnancy was responsible for almost half of the failures. To prevent failure due to luteal phase pregnancy, it is recommended that interval procedure should be performed within the first 10 days of the beginning of a menstrual cycle (EngenderHealth, 2002). Other causes of failure include erroneous blocking of structures closely located to the fallopian tubes, incomplete occlusion, dislodgement of mechanical device (EngenderHealth, 2003), and tubal recanalization from tubo-peritoneal fistula formation or spontaneous tubal

reanastomosis (Aisien et al., 2002; Awonuga et al., 2009; Soderstrom, 1985; Varma & Gupta, 2004). Date et al. (2014) retrospectively evaluated failure of FPC from 2002 to 2012 in India, and among 120 women evaluated for the cause of failure, improper surgical procedure accounted for 22%, while 33% and 45% were due to spontaneous recanalization and tuboperioteoneal fistula, respectively.

Effects of Female Permanent Contraception

Complications of FPC procedures. FPC, like any other surgical procedure, if poorly performed carries some risks. Complications can arise from the procedure itself or anesthesia used during the procedure (Aisien et al., 2001; Peterson et al., 1983; Rochat et al., 1986; Strauss et al., 1984). These complications are, however, usually minor, and major complications or mortality rarely occur (Alton & Jensen, 2018; Escobedo et al., 1989; Jamieson et al., 2000; WHO/RHR et al., 2018). Examples of minor complications that may occur include wound infection and hematoma, while major complications include uterine perforation and injuries to the bowel or bladder (EngenderHealth, 2002). A systematic review of 19 RCTs involving 13,209 women found no mortality reported with FPC done by electrocoagulation, partial salpingectomy, or using clips or rings (Lawrie et al., 2016). In addition, the review reported that major morbidities from the methods were rare (Lawrie, et al., 2016). From a retrospective analysis of complications following FPC performed via minilaparotomy in a tertiary hospital in Nigeria between January 1985 and December 1999, Aisien et al. (2002) concluded that FPC procedure was associated with minimal major surgical and minor complications. Of the 2,986 women, 0.9% had major surgical complications, while 4.2%

had minor complications (Aisien et al., 2002). In a review of literature on FPC through minilaparatomy in Kenya, Ruminjo and Lynam (1997) reported that only 4.1% out of about 12,000 clients had complications at six weeks, with major complication accounting for 0.7%, while minor complications occurred in 3.4%.

Ectopic pregnancy. This refers to a pregnancy in which the fertilized egg attaches somewhere outside the uterus, and it is a leading cause of maternal mortality (Bronson, 2018; Kassebaum et al., 2016). FPC does not increase the risk of ectopic pregnancy (Li et al., 2014; Mol et al., 1995), but pregnancy occurring after FPC has a higher probability of being ectopic (Li et al., 2014). For all methods tubal occlusion in the CREST study, the 10-year cumulative rate of ectopic pregnancy was 7.3 per 1,000 procedures (Peterson et al., 1997). It ranged from 1.5 per 1,000 procedures with postpartum partial salpingectomy to 17.1 per 1,000 procedures with bipolar coagulation (Peterson et al., 1997). Age, race/ethnicity, and previous pelvic inflammatory disease before the procedure were significantly associated with the risk of developing ectopic pregnancy (Peterson et al., 1997). Lower rates of ectopic pregnancy were reported in a retrospective study among 44,829 women who had procedures for FPC between 1990 and 2010 at Western Australia hospitals (Malacova et al., 2014). For all methods of FPC, the 10-year cumulative probability was 2.4 per 1,000 procedures; ranging from 0 in electrodestruction of fallopian tubes, salpingectomy and Essure procedure to 21.5 per 1,000 procedures in partial salpingectomy (Malacova et al., 2014). In the study, the risk of ectopic pregnancy in women who had the procedure before the age of 28 years was three times those who had it after the age of 33 years (Malacova et al., 2014).

Post-tubal sterilization syndrome. Some women who undergo procedures for FPC report menstrual abnormalities such as dysmenorrhea (painful bleeding), menorrhagia (prolonged or heavy bleeding), and intermenstrual bleeding (bleeding at irregular intervals) (Shobeiri & AtashKhoii, 2005; Wilcox et al., 1992). These menstrual irregularities attributable to FPC were first described in 1951 by Williams and colleagues (Williams et al., 1951) and have been termed "post-tubal sterilization syndrome" (Lethbridge, 1992). However, more recent studies have refuted the claims that FPC is associated with menstrual cycle irregularities (Gentile, Kaufman, & Helbig, 1998; Peterson et al., 2000; Shobeiri & AtashKhoii, 2005). Indeed, Williams et al. (1951) remarked that:

> "It seems most likely that the predisposition to abnormal bleeding is related to the underlying disease or condition for which the sterilization is performed rather than to any mechanical interference with ovarian or uterine function resulting from the operative procedure" (p. 425).

In a review of literature on menstrual and hormonal changes in women who had FPC, Gentile and colleagues concluded that FPC in women 30 years and older was not associated with increased risk of menstrual dysfunction, dysmenorrhea, or premenstrual distress (Gentile et al., 1998). However, their findings suggested that women 20-29 years old who have histories of menstrual dysfunction may be at higher risk (Gentile et al., 1998). Using data from the CREST study, Petersen et al. (2000) concluded that women who had FPC did not have higher likelihood of reporting changes in their menstrual cycles compared with those who had not undergone FPC. In their study, women who used FPC were likely to have a reduction in the length and volume of

bleeding, and menstrual pain, but increase in cycle irregularity (Petersen et al., 2000). A survey of 453 women who had FPC between 1984 and 1986 in Zaire (now Democratic Republic of Congo), reported that about 57.6%, 58.3%, and 52.8% indicated no changes in the duration between menstrual cycles, number of days of bleeding, and menstrual flow, respectively (Bertrand et al., 1991). The direction of the change (increase or decrease) were nearly equal in those who reported changes in their menstrual cycles (Bertrand et al., 1991).

Sexual dysfunction. Sexual problems after FPC have also been investigated, and findings have been mixed. While some studies, particularly from developing countries have suggested increased risk (Gulum et al., 2010; Kunkeri et al., 2017; Sadatmahalleh et al., 2015; Yildiz et al., 2016), others have reported otherwise (Costello et al., 2002; Li et al., 2004; Shain et al., 1991; Smith et al., 2010). A population-based survey in Australia that explored sexual changes among women in heterosexual relationship who had FPC observed that the method was not associated with any specific sexual problem, including physical pain during sex or an inability to reach orgasm (Smith et al., 2010). After adjusting for sociodemographic factors, compared with non-sterilized women, women who had FPC had increased odds of having sexual pleasure, sexual satisfaction, and relationship satisfaction (Smith et al., 2010). A five-year longitudinal study in the U.S. that assessed marital sexuality among 152 women who had FPC, 106 wives of men who had vasectomy, and 83 women who did not have FPC, although reported decrease in sexual satisfaction, desire, and frequency in all the three groups, it did not find any differences in sexual dysfunction among the groups (Shain et al., 1991). In a cross-sectional survey of 453 women who had FPC in Zaire

(now Democratic Republic of Congo), 75% reported no change in satisfaction with sex, while 21% and 10% reported greater and less satisfaction with sex, respectively (Bertrand et al., 1991). The remaining 4% did not know if there was any change (Bertrand et al., 1991).

However, using Female Sexual Function Index (FSFI) questionnaire, a retrospective cohort study in Iran that compared 150 women who had FPC with 150 women who had used barrier method (condom) reported the prevalence of sexual dysfunction in the FPC group women as 44% and 20% in the condom group (Sadatmahalleh et al., 2015). In the study, mean values in all the domains of the FSFI, including lubrication, desire, satisfaction arousal, pain, and orgasm were significantly lower in the FPC group (Sadatmahalleh et al., 2015). Similarly, in India, Kunkeri et al. (2017) investigated sixty married women before and six months after FPC procedure, and found that the prevalence of sexual dysfunction increased from 37% before the procedure to 72% after the procedure.

Regret following Female Permanent Contraception

Prevalence. Life circumstances such as divorce, marriage, or death of a child may make women who use FPC regret undergoing the procedure and want to seek reversal. The prevalence of regret varies considerably in literature, largely as a result of the different measures used (EngenderHealth, 2002). Apart from direct question of regret, which may even be difficult to interpret by respondents (Loaiza, 1995), some studies have used reversal of FPC, request for information on reversal, request for reversal, or request for in-vitro fertilization (IVF) procedures as proxies for assessing

regret (Curtis et al., 2006). In the CREST study, the 14-year cumulative probability of regret after FPC was reported as 12.7% (95%CI=11.2-14.3) (Hillis et al., 1999). In the study, where regret was assessed by asking participants “Do you still think tubal sterilization as a permanent method of birth control was a good choice for you?” (Hillis et al., 1999. p 890), women aged 30 years and younger were nearly two times as likely to report regret as those over 30 years. In the same cohort, Schmidt et al. (2000) reported that the 14-year cumulative probability of requesting reversal information was 14.3%. Among women who were not up to 24 years at the time of the procedure, the cumulative probability was 40.4% (95% CI=31.6-49.2) (Schmidt et al., 2000). The likelihood of women younger than 24 years requesting reversal information was almost four times that of women 30 years or older (Schmidt et al., 2000). In Canada, a retrospective analysis of data obtained from the Quebec provincial health insurance database reported that 1.8% of the 321,929 women who had FPC from 1980 to 1994 obtained a reversal procedure (Trussell et al., 2003). From the Indian National Family Health Survey conducted in 2015–2016, a study that evaluated regret among 194,429 women who had FPC reported that 6.9% indicated regretting having the procedure (Singh, 2018). In a follow-up study, conducted in 1987-1988 among 453 women who had FPC in Zaire (now Democratic Republic of Congo), 14% reported they had some regret when directly asked if they had any regret over the procedure (Bertrand et al., 1991).

Risk factors. Age at procedure has been identified as one of the factors associated with regret after FPC among women. In a systematic review by Curtis et al. (2006) that assessed the relationship between age at procedure and regret after FPC

using studies published between 1983 and 2003, women who had the procedure at 30 years or younger were found to have twice the odds of regretting undergoing the procedure as compared to those who were older than 30 years. Furthermore, the study reported that those aged 30 years or younger were eight times as likely to have a reversal procedure or be evaluated for IVF (Curtis et al., 2006). In addition to age, other factors have been closely linked to regret after FPC. In a case-control study in Brazil, Ludermir et al. (2009) compared women who had a FPC procedure and had requested or undergone a tubal reversal (n=301) with women who had a FPC procedure but had not undergone tubal reversal or had requested to do so (n=276). The study results showed that FPC at a young age, decision to undergo the procedure not made by self, procedure carried out up to the 45th day after childbirth and acquisition of knowledge about contraceptive methods after the procedure, deceased child, or change of partner after the procedure were associated with the request for or submission to FPC reversal (Ludermir et al., 2009). In India, Singh et al. (2012) reported that women who had FPC at 30 years or older, those who had only daughters, those who had not experienced child loss were less likely to express FPC regret. Among women who had FPC in Zaire (now Democratic Republic of Congo), regret was associated with fewer than six children, decision made by someone else, and belief that their husband got involved with another women for children (Bertrand et al., 1991). Similar findings have also been reported in developed countries. A case control study in New South Wales which compared patients presenting for IVF treatment (n=97) with women who had undergone FPC without reporting regret or desire to regain sterility (n=101) between 1986–1996 reported that change in marital status as well as the desire of having children with a new

spouse were the main reasons why women requested for IVF (Kariminia et al., 2002). In the study, women younger than 30 years old (vs 30 to 34 years) at the time of the procedure and a concurrent caesarean section (vs interval procedure) were more likely to request for IVF treatment, while those with at least three children (vs childless) had lower likelihood of requesting for IVF (Kariminia et al., 2002). Based on research findings, the numerous risk factors for regret after FPC have been categorized into three groups (EngenderHealth, 2002):

I. Circumstance surrounding decision: Decision made by someone else or partner/husband, partner opposition to sterilization, sterilization for medical reasons
II. Clients Characteristics at time of procedure: Young age, too many children of one sex, less information about the procedure, poor contraceptive knowledge, did not pay for FPC procedure, previous contraceptive failure, low parity, death of a child, low year of marriage (less than 5 years)
III. Change of characteristics after procedure: Divorce and/or remarriage, desire for more children, behavior change of partner, death of a child,

Prevention and management. Regret following FPC can be minimized by adequate counseling of all women seeking the procedure, especially those at increased risk of regret (Chi & Jones, 1994). Health care providers should allow the decisions to undergo the procedure to be made by the women/couples (Chi & Jones, 1994). It has also been recommended that for those at increased risk of regret, the procedure should not be performed immediately after delivery or simultaneously with other procedures (Chi & Jones, 1994).

Treatment options such as tubal reanastomosis or (tubal reversal) and IVF are available to sterilized women who desire to have children. But the accessibility to these procedures remains low in SSA (Botha et al., 2018; EngenderHealth, 2002; Ombelet & Onofre, 2019). Tubal implantation was previously tried, but it was abandoned due to low success rate and risk of corneal rupture in pregnancy (Practice Committee of the American Society for Reproductive Medicine, 2015).

Tubal reanastomosis or reversal. This is a surgical procedure which involves rejoining the cut ends of the tubes or removal of the occluding material. It can be performed using laparotomic microsurgical procedures or laparoscopic approach including robot-assisted laparoscopic tubal reanastomosis (Caillet et al., 2010; Goldberg & Falcone, 2003; Rodgers et al., 2007; van Seeters et al., 2017). In a systematic review of studies published through July 2016 on fertility outcomes after reversal of FPC by different methods (laparotomy [microscopic], laparoscopy or robotic), van Seeters et al. (2017) estimated the pooled pregnancy rate from the included 37 studies (n=10,689 women) as 42–69%. The study concluded that the method used for reanastomosis did not impact on the success rate (van Seeters et al., 2017). The results showed that laparoscopic reversal was associated with shorter hospital stay in comparison with laparotomy approach, and it was less costly than robotic approach (van Seeters et al., 2017). The findings of the review corroborated earlier meta-analyses which have reported that both laparotomy and laparoscopy have comparable success rates (Deffieux et al., 2011; la Grange et al., 2012).

Research findings have suggested that the success rate of tubal reversal may depend on the type of the sterilizing procedure (Gordts et al., 2009; Jayakrishnan &

Baheti, 2011), age at time reversal (Godin et al., 2019; Gordts et al., 2009; Hanafi, 2003; Moon et al., 2012), body mass index (Hanafi, 2003), duration of sterilization (Hanafi, 2003), length of tube after recanalization (Jayakrishnan & Baheti, 2011), and site of anastomosis (Gordts et al., 2009; Moon et al., 2012). Deffieux et al. (2011) conducted a systematic review of 13 case series published through June 2009 and identified young age (less than 35 years), type of ligature (rings), duration of ligature (less than eight years), length of remaining tube (greater than seven cm) and site of anastomosis (in the middle of the tube) as the factors that may determine successful tubal reversal. However, van Seeters et al. (2017), after evaluating factors such as age, duration and method of FPC, and body mass index, concluded that age was the only prognostic factor influencing the possibility of conception after tubal reversal. Male factor also plays a role in conception after tubal reversal. Gordts et al. (2009) found that with fertile sperm, pregnancy rate after reversal was 80%, but with subfertile semen the rate was reduced to 50%.

Most pregnancies are estimated to occur within two years of reversal (Deffieux et al., 2011). Nevertheless, not all pregnancies after tubal reversal end in delivery, as there may be cases of ectopic pregnancy and spontaneous abortion (Bissonnette et al., 1999; Hanafi, 2003; Karayalcin et al., 2017; Moon et al., 2012). van Seeters et al. (2017) estimated the proportion of ectopic pregnancy after tubal reversal as 4-8%. Subsequent FPC procedure after reversal have also been reported among some women. In Canada, a retrospective analysis of data on women who had FPC from 1980 to 1994, obtained from the Quebec provincial health insurance database, reported that 23% (of 4,677) had

a subsequent sterilization after reversal (Trussell et al., 2003). However, there is dearth of evidence on the effectiveness of subsequent FPC performed after reversal.

In-vitro fertilization (IVF). This is a type of assisted reproductive technology that involves retrieving mature eggs from the ovaries and fertilizing them by sperm in a laboratory, which are then transferred to the uterus (Bing & Ouellette, 2009).

Comparing the results of tubal anastomosis and IVF may be challenging given the different measures that are used for the procedures (pregnancy rate per patient for tubal reversal and success rate are per cycle in IVF) (Practice Committee of the American Society for Reproductive Medicine, 2015). However, based on a review of literature on the options for restoring tubal patency, the Practice Committee of the American Society for Reproductive Medicine noted that cumulative pregnancy rate is significantly higher with tubal reanastomosis and it is also more cost effective than IVF (2015). But it is important to note that there has not been a RCT comparing the effectiveness of tubal reversal with IVF (van Seeters et al., 2017).

Although IVF is less surgically invasive, one of its drawbacks is cost. Using a decision tree model, Messinger et al. (2015) estimated that the cost per ongoing pregnancy for women in the U.S. as follows: younger than 35 years ($16,446 for tubal reanastomosis and $32,814 for IVF), 35-40 years ($23,914 for tubal reanastomosis and $45,839 for IVF) and older than 40 years ($218,742 for tubal reanastomosis and $111,445 for IVF). The authors concluded that IVF was more cost-effective for women aged 41 years and older, while tubal reanastomosis was more cost-effective for those younger than 41 years old (Messinger et al., 2015). In contrast, a similar study by Hirshfeld-Cytron and Winter (2013) concluded that laparoscopic tubal reversal,

irrespective of the occlusion method, was more cost-effective than IVF for all the age categories. They suggested that the difference in their findings may be due to inclusion of delivery cost in the analysis they conducted (Hirshfeld-Cytron & Winter, 2013).

In addition to cost, there is also the risk of multiple pregnancy (Reynolds et al., 2003) and ovarian hyperstimulation syndrome (Aboulghar & Mansour, 2003; Toftager et al., 2016) with IVF. These drawbacks can be avoided with tubal reanastomosis, but it also bears its own risks such as complication from the procedures and ectopic pregnancy (Boeckxstaens et al., 2007; Hanafi, 2003; Moon et al., 2012).

Given the pros and cons of the two methods, the Practice Committee of the American Society for Reproductive Medicine (2015) recommended that the following should be considered when deciding on what method to use between IVF and tubal reversal:

- Patient preference
- Age of the woman and ovarian reserve
- Number and quality of sperm in the ejaculate
- Number of children desired
- Site and extent of tubal disease
- Presence of other infertility factors
- Risk of ectopic pregnancy and other complications
- Experience of the surgeon
- Success rates of the IVF program
- Cost

According to their recommendation “ideal patient candidate for tubal surgery is young, has no other significant infertility factors, and has tubal anatomy that is amenable to repair” (Practice Committee of the American Society for Reproductive Medicine, 2015, p.e38).

Advantages of Female Permanent Contraception

Usability and permanency. Most medical conditions do not affect a woman’s eligibility for FPC (WHO, 2015). However, certain conditions and circumstances may require some precautions to be taken (WHO, 2015). FPC is not user dependent, thus it does not require behavior such as adherence or correct use for it to be effective (Trussell & Wynn, 2008). The absence of hormones and the possible side effects also makes it a good option for women who are seeking to stop childbearing. Concerns about feeling of foreign objects in the body that limit the uptake of other types of effective methods such as IUD and implants (Ferguson et al., 2015; Hall et al., 2016) are eliminated with FPC. It is also a convenient method, because it is a one-off procedure, requiring no recurrent visit to healthcare providers (Borrero et al., 2009; The RESPOND Project, 2014). In their study which explored the views of women in the U.S. regarding their choice of LARC and permanent contraception, Kane et al. (2009) reported that women use FPC to avoid the side effects from hormones and constant decision making with regards to childbearing. In a mixed methods study on FPC among women in India by Brault et al. (2016), some women described their experience with FPC as empowering, because of the control they have over their fertility and sexuality. In the study, many of the women reported better sexual relationships, because they

were no longer worried about having unwanted pregnancies (Brault et al., 2016). Studies in SSA Africa have also reported satisfaction among women who use FPC and willingness of the majority of them to recommend to a friend (Gordon-Maclean et al., 2014; Nuccio et al., 2016).

While other types of contraceptive methods such as implant, IUD, and injectables are also effective, they are not permanent and can be easily discontinued. High discontinuation rates not due to the desire to get pregnant have been documented among women using reversible methods (Blanc et al., 2002). Ali et al. (2012) investigated the pattern of contraceptive use using DHS from 2002 to 2009 in 19 countries and reported that about 38% and 64% of women discontinued using reversible methods at the 12^{th} and 36^{th} month, respectively. The discontinuation rate within the first 12 months of use ranged from 13% for IUD to 50% for condoms (Ali et al., 2012). According to their findings, method-related reasons which included side-effects, health concerns, problems of access and availability, desire to switch to a more effective method, spouse's objection, inconvenience of use, and cost were the most cited reasons for discontinuation for all methods except periodic abstinence and withdrawal (Ali et al., 2012). The results showed that injectable users had the highest likelihood of discontinuation due to method-related reasons, with nearly 35% discontinuing by the end of first year (Ali et al., 2012). The researchers, however, did not include implants in their analysis (Ali et al., 2012).

Barden-O'Fallon et al. (2018) conducted a secondary data analysis to assess the reasons for discontinuation as well as method switching following discontinuation among 6,297 women of reproductive age group in Senegal, and the 12-month

discontinuation rate for all methods was found to be 34.7% (Barden-O'Fallon et al., 2018). Implants and IUD had the lowest one-year discontinuation rates with 6.3% and 18.4%, respectively. Higher rates were reported for condoms (62.9%), pills (38%), and injectables (32.7%) (Barden-O'Fallon et al., 2018). Although reduced need was the most common reason for discontinuation (45.6%), Barden-O'Fallon et al. (2018) reported that 30.1% discontinued as result of method-related problems which included fear of side effects/health concerns, inconvenience of use, no privacy for use, weight gain, menstrual problems, lack of sexual satisfaction, and the desire for more effective method.

There is high risk of unintended pregnancy after contraception discontinuation mostly because some women switch to less effective methods or do not continue with another method (Ali et al., 2014; Barden-O'Fallon et al., 2018). Jain and Winfrey (2017) investigated unintended pregnancies as a result of contraceptive discontinuation in 36 developing countries and observed that approximately 35% of unintended recent pregnancies were attributable to contraceptive discontinuation. A study that used six DHS conducted between 1999 and 2003 in Bangladesh, the Philippines, Kazakhstan, the Dominican Republic, Kenya, and Zimbabwe, reported that unintended pregnancy after discontinuation for other reasons apart from desire for pregnancy ranged from 48.6% in Kazakhstan to 63.2% in Kenya (Curtis et al., 2011).

Cost effectiveness. The cost effectiveness of a contraceptive method is determined by key elements such as the cost of the method, cost of method failure, cost of side effects, and timeframe (Barbieri, 2010). Based on these factors, FPC has been estimated as one of the most cost-effective contraceptive methods. Trussell et al.

(2009) used a Markov model to determine the cost effectiveness of 16 contraceptive methods over a 5-year period from a payer's perspective and reported copper-T intrauterine device, vasectomy, and the LNG-20 intrauterine device as the most cost-effective methods in the U.S. However, with a longer timeframe beyond five years, the study concluded that copper-T intrauterine device, vasectomy, and FPC were more cost effective, because of the prolonged duration of protection at no added cost (Trussell et al., 2009). Using a decision-analytic model, a related study that investigated the cost effectiveness of LARC, combined oral contraceptives, and FPC from the British National Health Service (NHS) perspective, reported LARC as the most cost-effective contraceptive methods (Mavranezouli, 2008). However, beyond five years of contraceptive protection, FPC dominated LARC (Mavranezouli, 2008). From a societal perspective, Sonnenberg et al. (2004) compared 13 contraceptive methods to nonuse of contraception using a Markov model and concluded that methods such as FPC that require less action by the user are more cost effective.

Although there is dearth of research on the cost effectiveness of FPC in Africa, the permanent nature of the method may likely reduce the direct medical and nonmedical costs such as cost of side effects, recurrent cost of contraceptive, and health care provider's time.

Service providers. Some FPC procedures, e.g., minilaparatomy, may not require a specialist physician. The WHO has recommended that associated clinicians and non-specialist doctors can be involved in provision of FPC (WHO, 2012). This is quite important for Africa where there is shortage of surgical physicians (Holmer et al., 2015). Studies in developing countries have suggested that FPC provided by non-

physicians are effective, safe, and acceptable (Gordon-Maclean et al., 2014; Nuccio et al., 2016). However, a systematic review that assessed the safety, efficacy, or acceptability of FPC performed by mid-level providers from studies published through January 2013 in developing countries concluded that there was limited body of evidence, and the available studies were of fair to poor quality (Rodriguez & Gordon-Maclean, 2014). In filling the gap in quality and strength of evidence in SSA, a recent RCT in Tanzania compared the safety of minilaparatomy procedure performed by trained clinical officer (non-physician providers that have received a standard 3-year training program) and assistant medical officers (those with additional three years of clinical work experience and two more years of training) (Barone et al., 2018). The open-label noninferiority trial, conducted between December 2016 and June 2017, randomly allocated 1,970 participants (984 to clinical officer group and 986 to assistant medical officer) (Barone et al., 2018). The results indicated that no participants had a major adverse effect in the clinical officer group, but one person had (0.1%) in the assistant medical officer group (Barone et al., 2018). Further, there were no differences in provider self-efficacy as well as client satisfaction between the two groups. Notwithstanding the short duration of follow up, the study concluded that minilaparotomy performed by trained low-cadre officer for FPC is safe and acceptable to women desiring to limit childbearing (Barone et al., 2018).

Non-contraceptive benefits. In addition to preventing unintended pregnancies, empirical evidence suggests that FPC reduces the risk of certain cancers, particularly ovarian cancer. In an assessment of the association between FPC and 26 site-specific cancers in a cohort of 1,278,783 recruited between 1996 and 2001 and followed up for

13.8 years, Gaitskell et al. (2016) reported that there was a significant reduction in the risk of ovarian (RR=0.80, 95% CI= 0.76–0.85), peritoneal (RR=0.81, 95%CI=0.66–0.98), and tubal (RR=0.60, 95%CI=0.37–0.96) cancer. They did not find significant associations with breast, cervical, and endometrial cancers, whereas they reported an increased risk of anal cancer (RR=1.34, 95%CI=1.11–1.63) (Gaitskell et al., 2016). According to the authors, the increased risk of anal cancer among those who have FPC may be confounded by sexual behavior and exposure to human papilloma virus which causes anal cancer. The association between anal cancer and FPC has been limitedly reported in literature.

Ovarian cancer is one of the most common gynecologic cancers and leading causes of cancer mortality among women (Coburn et al., 2017; Momenimovahed et al., 2019). Pooled analyses have shown consistent finding of the reduced risk of ovarian cancer among women who use FPC (Cibula et al., 2011; Rice et al., 2012; Sieh et al., 2013). For example, a meta-analysis study that investigated the association between ovarian cancer and FPC (tubal ligation) as well as other gynecologic surgeries from studies published between 1969 through March 2011, estimated from the 30 included studies that woman who had FPC were 30% less likely to develop ovarian cancer compared with women who did not (RR=0.70, 95%CI: 0.64, 0.75) (Rice et al., 2012). The protective effects of FPC on ovarian cancer risk have also been found to vary by subtype. Using 13 population-based case-control studies, pooled analysis by Sieh et al. (2013) showed that ovarian cancer risk reduction by FPC was significantly higher for invasive endometrioid and clear cell compared with serous cancer.

The mechanism by which FPC lowers the risk of ovarian cancer is not well understood, but a few theories have been proposed. One of them is the screening-effect, in which it is posited that providers are likely to assess abnormalities in the ovaries during procedures for FPC and remove pre-malignant lesions (Rice et al., 2012). It has also been suggested that FPC protects the ovaries from retrograde transport of carcinogens and inflammatory agents from the vagina and perineum (Cibula et al., 2011; Rice et al., 2012). After FPC procedure, some studies have also found decrease in blood flow to the ovaries, resulting in reduced production of estrogen (Narod et al., 2001; Rice et al., 2012). Evidence also indicates that ovarian cancer arises from the fallopian tubes (Cibula et al., 2011; George et al., 2016; Kurman & Shih, 2011) and procedures such as salpingectomy remove the cancer precursor lesions. However, it has not been rigorously assessed if tubal ligation or occlusion like salpingectomy affect cancer precursor lesions (Erickson et al., 2013).

Limiters and their Use of Female Permanent Contraception in Africa

Birth limiting behaviors have significant impact on fertility rates (Van Lith et al., 2013; Westoff, 1990). As clearly noted by Van Lith et al. “If a spacer has a birth earlier than planned, that birth presumably was still desired, although perhaps mistimed, and would have occurred regardless, whereas an unintended pregnancy for a limiter directly adds to the fertility rate overall” (2013, p.98). The low demand for contraception to limit childbearing in Africa has been attributed to the slow economic development and social and cultural reasons for high fertility (Bongaarts, 2017a; Caldwell & Caldwell, 1987, 1990). However, financial reasons, health benefits, and having too many children are

increasingly becoming motivating factors for limiting birth in Africa (Bertrand et al., 1991; Bertrand et al., 1989; Dwyer & Haws, 1990; Machiyama et al., 2019; Oguanuo & Ikechebelu, 1999). Nonetheless, women who want to limit birth in Africa have received little attention and are underserved (Van Lith et al., 2013).

Evidence suggests increasing demand for limiting childbearing in SSA. Using data from nationally representative surveys conducted between mid-1970s and the late 1990s in 41 developing countries, including 18 from SSA, Westoff and Bankole (2000) reported that the proportion of married women desiring to limit birth had increased steadily since 1970s. They described the increase in SSA as slow but steady; rising up to 20-40% in many countries (Westoff & Bankole, 2000).

Westoff (2012) examined unmet need of modern contraceptive methods among currently married women aged 15-49 years using DHS conducted between 2001 and 2011 in 52 developing countries (Westoff, 2012). Trends were also assessed using 39 countries with at least one previous survey and a sub-analysis was conducted by region. In eastern and southern Africa (ESA), from 13 countries in the subregion, the total demand for modern contraceptive methods as 65% (33% for limiting and 32% for spacing) (Westoff, 2012). In six countries (Kenya, Lesotho, Malawi, Namibia, Rwanda, and Swaziland) the demand for limiting childbearing exceeded the demand for spacing. In western and middle Africa (WMA), from the 14 countries included from the subregion, the total demand for modern contraceptive methods was 41% (13% for limiting and 29% for spacing) (Westoff, 2012). The demand for limiting childbearing did not exceed demand for spacing in any of the countries. Although the time intervals between the surveys differed considerably, the demand for limiting childbearing showed an increase

of at least one percentage point from the base survey year compared to the final survey year in 7 out of 10 countries in WMA (Westoff, 2012). For example, in Cameroon, the demand for limiting increased from 10% in 1991 to 15% in 2004. While in ESA there was an increase in 11 out of the 12 countries (Westoff, 2012). For example, in Malawi, the demand for modern methods of contraception to limit birth increased from 18% in 1992 to 40% in 2010 (Westoff, 2012).

Van Lith et al. (2013) investigated the characteristics of women of reproductive age intending to limit birth in 18 SSA countries using DHS conducted between 2004 and 2010. According to their findings, the demand for limiting was 14%, while the demand for spacing was 25% (Van Lith et al., 2013). However, among married women, the difference between the demand for limiting (26%) and spacing (31%) was smaller (Van Lith et al., 2013). In one-third (6/18) of the countries in the study, the demand for limiting exceeded the demand for spacing. The study reported that the average ages for limiters and spacers were 37 and 27 years, respectively (Van Lith et al., 2013). The mean age at which demand for limiting starts to exceed demand for spacing was 33 years, ranging from 23 years in Swaziland to 38 years in the Democratic Republic of Congo and Senegal (Van Lith et al., 2013). The study also showed that the demand for limiting is not exclusive to older women, but also exists among young women (Van Lith et al., 2013). For instance, 44%, 35%, and 39% of women aged 25–29 years in Swaziland, Lesotho, and Namibia had a demand for limiting, respectively (Van Lith et al., 2013). The study also revealed that many limiters exceeded their ideal parity (i.e., their desired number of own children) (Van Lith et al., 2013). On average, the study reported that

30% had exceeded their ideal parity. In countries like Rwanda and Swaziland, 54% and 52%, respectively had exceeded their ideal parity (Van Lith et al., 2013).

The proportion of demand for limiting satisfied with modern contraceptive methods is also steadily increasing in SSA, particularly in ESA where it is more than 60% in some countries (Westoff, 2012). Despite the increasing proportion, the use of FPC among women who want to limit childbearing in SSA is low (Van Lith et al., 2013). Rutenberg and Landry (1993) compared the use and demand for FPC among currently married women (15-49 years) in 26 developing countries, and their findings showed that approximately 20% or less of the demand for limiting childbearing was satisfied with FPC in each of the four included African countries (Botswana, Egypt, Kenya and Morrocco) (Rutenberg & Landry, 1993). However, this critical indicator (demand for limiting childbearing satisfied with FPC) has been sparsely reported in literature on limiting behavior or the use of FPC. The majority of the studies have focused on contraceptive prevalence of FPC or method mix (Darroch & Singh, 2013; EngenderHealth, 2002; Ewerling et al., 2018; Van Lith et al., 2013). Demand satisfied is an important indicator for monitoring and assessing progress of family planning programs in meeting reproductive health needs and rights (Bongaarts & Hardee, 2017; Fabic et al., 2015; Kali, 2016). Unlike other family planning indicators, it is a measure that indicates voluntarism and informed choice (Fabic et al., 2015). This indicator, according to Fabic et al. (2015), “it neither sets contraceptive prevalence nor fertility targets, but rather emphasizes the imperative to satisfy individuals’ and couples’ own choices regarding number and timing of children” (p.1929). Furthermore, Fabic et al. (2015) noted that the indicator can be disaggregated by different equity factors such as

age, education, wealth, and residence. On FPC, Rutenberg and Landry (1993) remarked that: “Another indicator of the degree to which a society has adopted sterilization is the proportion of the demand for limiting childbearing that is met by sterilization” (p.8).

Findings by Van Lith et al. (2013) indicated that limiters using contraceptives in SSA are more likely to use less effective methods such as short-acting or traditional methods than permanent or long-acting contraceptive methods. In the study, which utilized DHS conducted between 2004 and 2010 in 18 countries in SSA, on average, 80% of limiters used a short-acting or traditional method (Van Lith et al., 2013). In 83% of the countries studied, more than 50% of women using contraception for limiting relied on short-acting methods (Van Lith et al., 2013). However, a few countries had permanent contraception prevalence of more than 20% among limiters (Van Lith et al., 2013). For example in Malawi and Tanzania, 38% and 23% of limiters use permanent methods, respectively (Van Lith et al., 2013).

Indeed, evidence suggests a decline in the trend of FPC in many countries, and this has been attributed to the increase in the availability and uptake of LARC (Chan & Westhoff, 2010; Patil & Jensen, 2016). Darroch and Singh (2013) investigated trends in the use and unmet need for modern contraceptive methods among married and unmarried women aged 15-49 years in developing countries using national surveys from three reference years; 2003, 2008, and 2012. Compared to IUD, injectable or implants, oral contraceptives, and barrier methods, they reported that permanent contraception (with FPC representing 91%) accounted for the highest percentage of the modern contraceptive methods used by women (or their partners) across the three

points (47% in 2003, 42% in 2008, and 38% in 2012) (Darroch & Singh, 2013). But the percentage of those using permanent contraception showed a steady decline across the years. Compared with other regions, Africa had the lowest percentage point decline in permanent contraception, decreasing from 9% in 2003 to 8% in 2012 (Darroch & Singh, 2013). Within Africa, middle Africa had the highest percentage decline from 13% in 2003 to 5% in 2012. Based on these findings, Darroch and Singh (2013) recommended the need to pay more attention to the increasing shift away from permanent contraception toward less effective methods.

Reviews of clinical records in SSA have also shown decline in the uptake of FPC. Mutihir and Nyango (2011) assessed trend in FPC between January 1985 and December 2009 in a tertiary institution in Nigeria. In their retrospective analysis of clinical records, annual FPC procedures increased from less than 100 in 1985, peaking at about 400 in 1991, with a decline starting in 2001 to less than150 procedures in 2009 (Mutihir & Nyango, 2011). Similarly, Abiodun et al. (2012) reviewed trends in FPC over a 10-year period in a teaching hospital in northcentral, Nigeria and reported that the percentage of total contraceptive acceptors who chose FPC declined from 1.1% in 1994 to 0.2% in 2003.

However, decline in FPC is not pervasive across Africa. According to the trend study by Darroch and Singh (2013), in both 2003 and 2012, the percentage of women using permanent contraception did not change in southern and northern Africa, but both subregions showed 1% point increase between 2008 and 2012 (Darroch & Singh, 2013). In a six-year prospective study in a rural setting in Uganda, Lutalo et al. (2015) found an increasing desire for FPC among limiters. After adjusting for age and number

of living children, the desire for FPC increased from 54% in 2002 to 63% in 2008. Based on their results, they recommended the need to improve availability of FPC services for women who desire to limit childbearing. Although the study may not be representative and the reported desire to use may not translate to actual use when the services are available, it adds to the evidence base that the desire to limit childbearing with FPC may be increasing in some areas in SSA.

Factors Affecting the Use of Female Permanent Contraception in Africa

In a review article by Gaym (2012), factors such as misconceptions, lack of information, and weak health systems for surgical services were identified as the major barriers affecting the increase in the use and availability of permanent contraception in Africa. Gaym (2012) further stated that provider-related factors such as lack of knowledge and motivation may constitute important barriers to voluntary permanent contraception. Given these findings, Gaym (2012) concluded that providing information on the safety and effectiveness of permanent contraception to potential clients and service providers, and task shifting of the service provision can improve the availability and uptake of permanent contraception. However, permanent contraception in the review applied to both vasectomy (male) and tubal sterilization (female).

A more recent review by Olakunde et al. (2019) was specific to barriers and facilitators of permanent contraception among women in SSA. Using the socioecological model, the review which included quantitative, qualitative, and mixed methods studies published between January 1, 2000 and October 30, 2017 reported that barriers as well as facilitators of uptake of FPC operate at many levels including individual,

interpersonal, and organizational. Some of the barriers identified in the study included poor knowledge, fear of surgery, irreversibility of procedure, male partner disapproval, limited access, and provider bias (Table 4). While concluding that factors affecting utilization of FPC are multifaceted, Olakunde et al. (2019) recommended the need for more quantitative studies to further understand the magnitude of the relationships between these factors and utilization of FPC.

Table 4: *Barriers of uptake of female permanent contraception in SSA*

Level	Barriers
Individual	Low-level knowledge Not aware of where to access service Myths and misconception Fear of perceived side effect Irreversibility of procedure Surgical nature of procedure Against religious belief
Interpersonal	Partners' disapproval Knowing other women with failed procedure/regrets
Organizational	Healthcare workers' personal reservation Long waiting time Lack of expertise Lack of equipment Limited knowledge by healthcare provider Not offered/recommended/provided by healthcare provider High cost of the procedure

Source: Olakunde et al. (2019).

There is a dearth of evidence on the factors associated with the use of FPC in SSA. A number of quantitative studies that have assessed the use of FPC in SSA conflated FPC with other long-acting reversible methods (see Appendix 1). Thus, findings reported in these available studies are not specific to FPC. Furthermore, these studies only considered individual-level determinants, with none of them assessing possible contextual factors, which may also influence the uptake of FPC (Ghosh & Siddiqui, 2017; Stephenson, 2006). Finally, the majority of the studies focused on a single country, and their findings are not generalizable to the entire SSA region.

Evidence from other regions suggests that the use of FPC is influenced by both individual and contextual factors. On individual-level determinants, studies from both developed and developing countries have found women's age, parity, and number of living children to be positively associated with FPC (Anderson et al., 2012; Bass, 2013; Borrero et al., 2007; de Oliveira et al., 2014; Lunde et al., 2013; Perpetuo & Wajnman, 2003; Thind, 2005; White et al., 2015). Studies have also shown that level of education also influences the use of FPC. In developing and developed countries, women with less education are more likely to use FPC (Anderson et al., 2012; Borrero et al., 2007; Bumpass et al., 2000; Chan & Westhoff, 2010; Dereuddre et al., 2016; Godecker et al., 2001; Hoq et al., 2019; Lunde et al., 2013; Perpetuo & Wajnman, 2003; Stephenson, 2006; White et al., 2015). Rural residence has also been found to be negatively associated with FPC in developing countries (de Oliveira et al., 2014; Perpetuo & Wajnman, 2003; Stephenson, 2006), while the relationship is opposite in developed countries like the U.S. (Bass, 2013; Lunde et al., 2013). Effect of religion has also been reported in literature (Bass, 2013; Bumpass et al., 2000; de Oliveira et al., 2014;

Godecker et al., 2001; Hoq et al., 2019; Thind, 2005). For example, among American women, a study reported that the odds of Protestants using FPC was 1.5 times that of Catholics (Bass, 2013). In India, Muslims are less likely to use FPC compared with Hindus (de Oliveira et al., 2014; Stephenson, 2006; Thind, 2005). Research in both developed and developing countries have found increased odds of using FPC with higher income level (Edmeades et al., 2011; Hoq et al., 2019; Lunde et al., 2013; Perpetuo & Wajnman, 2003). In some studies in the U.S., higher likelihood of using FPC has been reported among women with public insurance compared with private insurance (Borrero et al., 2007; White et al., 2015). In India, media exposure to family planning messages has been found to be negatively associated with the use of FPC among married or ever-married women (de Oliveira et al., 2014; Thind, 2005). It is possible that the messages promote other methods of contraception.

On contextual factors, a study assessing its effect on the use of permanent method (FPC and male permanent contraception) in India found decrease in the odds of women using permanent method with the degree of remoteness of the community, while the degree of availability of medical/grassroots-level community health workers increased the odds of using permanent method compared with other reversible methods (Ghosh & Siddiqui, 2017). Mean asset score and mean number of years of female education at the district level have be found to have negative relationships with the use of FPC (Stephenson, 2006).

Spatial Analysis of the Use of Female Permanent Contraception in Africa

Understanding spatial variations in healthcare risks, burden of diseases, or geographic access to healthcare has increasingly become an important part of epidemiological research, health planning, and decision-making (Boyda et al., 2019; McLafferty, 2003; Nykiforuk & Flaman, 2011). Identifying spatial clusters or disease hotspots and gaining insights into shared cultural, demographic, behavioral, economic, or environmental factors by contiguous area can inform effective policy and program interventions (Banerjee, 2016; Robin et al., 2019; Schmitz et al., 2019; Sudhof et al., 2013). Furthermore, Anselin and colleagues argued that finding interesting patterns of unusual values in relation to neighboring areas presents opportunities for learning from nearby areas (Anselin et al., 2007). Despite the increasing number of studies examining spatial dimension with respect to maternal health, a few studies have examined spatial patterns in contraceptive use in SSA (Ebener et al., 2015; Makanga et al., 2016). A paper that analyzed the spatial distribution of maternal and child health indicators, including prevalence of modern contraceptive methods across 27 countries in SSA, found no significant spatial clustering at the regional level (within countries) (Burgert-Brucker et al., 2015). A literature search for the present study revealed a lack of spatial analysis with focus on FPC in SSA.

Research Questions and Hypotheses

Based on the identified gaps in literature, the study aims to answer the following questions:

1. What proportion of demand for limiting childbearing is satisfied with FPC among married or in-union women aged 15-49 years in SSA?
2. What proportion of demand for limiting childbearing is satisfied with FPC among married or in-union women aged 15-49 years in SSA by sociodemographic characteristics (age, living children, education, household wealth, and area of residence)?
3. Is there spatial clustering in the:
    i. proportion of demand for limiting childbearing among married or in-union women aged 15-49 years in SSA?
    ii. proportion of demand for limiting childbearing satisfied with modern contraceptive methods among married or in-union women aged 15-49 years in SSA?
    iii. proportion of demand for limiting childbearing satisfied with FPC among married or in-union women aged 15-49 years in SSA?

Hypotheses (i-iii)

H_0: There is no spatial autocorrelation in the: (i) proportion of demand for limiting childbearing; (ii) proportion of demand for limiting childbearing satisfied with modern contraceptive methods; and (iii) proportion of demand for limiting childbearing satisfied with FPC among married or in-union women aged 15-49 years across the countries.

H_A: There is spatial autocorrelation in the: (i) proportion of demand for limiting childbearing; (ii) proportion of demand for limiting childbearing satisfied with modern methods; and (iii) proportion of demand for limiting childbearing

satisfied with FPC among married or in-union women aged 15-49 years across the countries.

4. Are there individual- and country-level factors that influence the use of FPC among married or in-union women aged 15-49 years using modern contraceptive methods to limiting childbearing in SSA?

   Hypothesis

   $H_{0:}$ There are no individual- or country-level factors associated with the use of FPC compared with other modern contraceptive methods.

   $H_{A:}$ There is at least one individual- or country-level factor associated with the use of FPC compared with other modern contraceptive methods.

CHAPTER 3: METHODS

This chapter provides an overview of the conceptual framework that underpinned this study. It includes a discussion about the study design, data source, variables, and the study setting. The data analytical approach is also described in this chapter.

Conceptual Framework

The conceptual framework underpinning the selection of variables included in this study draws upon the supply-demand framework for the determinant of fertility and contraceptive use (Easterlin et al., 1988) and the behavioral model of health services use (Andersen, 1995; Andersen, 1968) (Figure 3). The selected variables are factors that have been empirically found to influence the use of contraception or are theoretically plausible.

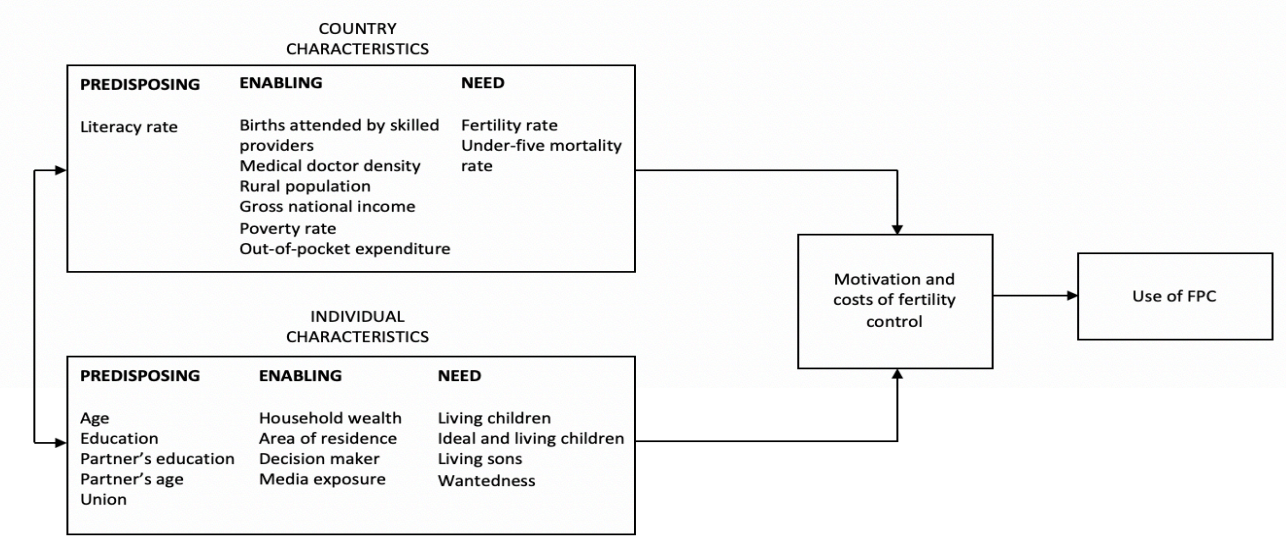

Figure 3: Conceptual framework.

The supply-demand framework for the determinants of fertility and contraceptive use. Building on earlier economic theory of fertility behavior by Harvey Leibenstein and Gary S. Becker in the late 1950s and early 1960s, respectively, Richard Easterlin, in the 1970s, developed a framework for fertility analysis (Easterlin, 1975). According to the framework, the determinants of fertility are a function of the demand for children, the potential output (supply) of children and the costs of fertility regulation (Easterlin, 1975; Easterlin et al., 1988; Easterlin & Crimmins, 1982). Easterlin defined demand for children (desired family size) as "the number of surviving children parents would want if fertility regulation were costless" (Easterlin et al., 1988, p.258). (Easterlin, 1975). Easterlin explained that this will depend on income, prices, and taste (Easterlin, 1975). Easterlin (1975) remarked that "the demand for children is seen as depending on the household's balancing of its subjective tastes for goods and children against externally determined constraints of price and income in a way that maximizes its satisfaction" (p. 55). Easterlin emphasized surviving children rather that number of births as the principal dependent variable. In achieving the desired number of surviving children, all other things being equal, the number of births may be high where there is high infant and child mortality (Easterlin, 1975).

The supply of children is "the number of surviving children parents would have if they did not deliberately limit fertility" (Easterlin et al., 1988, p.258). According to Easterlin, this will depend on natural fertility and the rates of survival of children to adulthood (Easterlin, 1975). Natural fertility which can be affected by physiological or biological factors, and cultural practices may prevent a couple from achieving their

desires (Easterlin, 1975; Easterlin et al., 1988). An increase in survival rate of newborns would increase the potential supply of children (Easterlin, 1975; Easterlin et al., 1988).

According to the framework, the motivation or incentive for fertility regulation is influenced by both the demand for and supply of children (Easterlin, 1975; Easterlin et al., 1988). If supply is lower than demand, there would not be a desire to limit fertility (Easterlin, 1975; Easterlin et al., 1988). Conversely, if potential is higher than demand (excess supply), there would be a motivation to limit fertility (Easterlin, 1975; Easterlin et al., 1988). However, the framework holds that the use for fertility control when there is excess supply would depend on the costs of fertility control relative to motivation to limit fertility (Easterlin, 1975; Easterlin et al., 1988). The costs include subjective (psyhic) and objective (time and money) costs of obtaining and using a contraceptive method (Easterlin, 1975; Easterlin et al., 1988). According to Easterlin and colleagues, “the higher the costs (the less, for example, the accessibility of family planning services), the less the likelihood of adoption” (Easterlin et al., 1988, p. 259). Easterlin’s framework has been used in literature to analyze determinants of contraceptive use (Ahmed, 1987; Casterline et al., 2001; DeGraff, 1991; Jayne & Guilkey, 1998; Lapham & Mauldin, 1985; Schutjer et al., 1986).

The behavioral model of health services use. The model, also known as the Andersen model, was initially developed in the 1960s to better understand why people use health services, assist in defining and measuring equitable access, and development of policies to reduce inequitable access to care (Andersen, 1995). It posits that “people's use of health services is a function of their predisposition to use services, factors which enable or impede use, and their need for care” (Andersen, 1995, p.1). The

model, described as the most common framework for understanding individual's access to health care (Derose et al., 2011), has been widely used to examine multiple dimensions of health care utilization (Babitsch et al., 2012), including contraceptive uptake among women (Andi et al., 2014; Gu et al., 2018; Sileo et al., 2015; Upadhya et al., 2015).

Over the years, the key components of the model and the interrelationships have expanded to reflect emerging issues and new developments in health policy, health service delivery, research, and medical sociology (Andersen, 2008). Recognizing the significance of community, structure, and process of service delivery, in the 2000s, the fifth version of the model added contextual characteristics as important determinants of health behaviors (Andersen, 2008). According to Andersen (2008), "understanding of utilization of health services can be best achieved by focusing on contextual and individual determinants" (p.652). Contextual factors can affect individual characteristics, which will in turn influence health behaviors and outcome, or they can directly influence health behaviors and outcome (Figure 3). The components of contextual characteristics are similar to individual characteristics (predisposing, enabling, and need factors), but they are measured at aggregate level (e.g., community or country) rather than individual (Andersen, 2008). The addition of contextual factors to the model has been described as one of its strengths; making it appropriate for multilevel models to assess predictors of health care utilization (von Lengerke et al., 2014).

Predisposing characteristics (Individual and Contextual). Predisposing characteristics include demographic, genetic, social, and health beliefs. At the individual level, Andersen et al. (2014) described demographic factors such as age and sex as

biological imperatives influencing the likelihood of an individual needing health services. Genetic susceptibility, a recent addition to the model, is also an important predisposing factor that may influence the need for health services (Andersen et al., 2014). Social factors refer to the status of an individual, such as education, occupation, and ethnicity that influence their ability to deal or cope with health issues or to raise resources to manage health issues (Andersen et al., 2014). Andersen et al. (2014) describes health beliefs as peoples' attitudes or knowledge about health and health services that may affect the perceived need for and utilization of health services. At the contextual level, demographic factors refer to age or gender composition of the community that can predispose it to the utilization of health services (Andersen et al., 2014). The social characteristics may refer to educational level, employment level, or ethnic composition of the community, and how these in turn affect health and utilization of healthcare (Andersen et al., 2014). Beliefs at the contextual level refer to the values and cultural norms of the community or political views relating to how health services should be structured and accessible to the people (Andersen et al., 2014).

Enabling factors (Individual and Contextual). These include financing and organizational factors which may facilitate or hinder utilization of health services (Andersen et al., 2014). Financing factors at the individual level refers to resources (e.g., income, wealth, or health insurance) available to an individual for payment of health services (Andersen et al., 2014). They may also include social support available to an individual. The organizational factors entail how health services are structured to facilitate utilization (Andersen et al., 2014). Examples include type of providers, nature of the providers, waiting time, and distance to health care facilities (Andersen et al.,

2014). Contextual enabling factors include public or health policies which influence utilization of health services (Andersen et al., 2014). They also include financing characteristics, which refer to available resources within the community such as the rate of health insurance coverage, per capita expenditures, or per community income for health services that can facilitate the utilization of health services (Andersen et al., 2014). At the contextual level, organization refers to the distribution of health services and providers, and how they are organized. This may include the ratio of physicians to population, provider mix, and location of services (Andersen et al., 2014).

Need (Individual and Contextual). According to Andersen et al. (2014), the need for health care can be perceived and evaluated. Perceived need refers to how people view their health and functional status. This may influence the decision to or not to utilize health services. Evaluated need refers to an expert and objective measurement or assessment of individual health and functional status, and the need for medical care (Andersen et al., 2014). At the contextual level, the need characteristics may refer to health-related condition of the physical environment. It also refers to population health indices of the area such as death rate or injury rate (Andersen et al., 2014).

Evidence has shown that individual- or contextual-level predisposing, enabling, or need factors can influence motivation and the financial, psychological, social, and medical costs of obtaining and using contraception.

At the individual level, age is an important predisposing characteristics associated with the uptake of contraception in developing countries (Njotang et al., 2017; Okigbo et al., 2017; Palamuleni, 2013; Stephenson et al., 2007). Women's level

of education also plays a key role in contraceptive use in developing countries, with the majority of previous studies suggesting lower uptake among less educated women (Ainsworth et al., 1996; Bakibinga et al., 2019; Bbaale & Mpuga, 2011; Blackstone & Iwelunmor, 2017; de Oliveira et al., 2014; Mochache et al., 2018; Palamuleni, 2013; Stephenson et al., 2007; Tekelab et al., 2015). Similar to women's educational attainment, higher husband/partner's educational level has been reported in some studies to be positively associated with the use of contraception (Balogun et al., 2016; Bbaale & Mpuga, 2011; Bietsch, 2015). Some studies have also reported association between partner's age and contraceptive use (Habyarimana & Ramroop, 2018; Hoq et al., 2019; Makola et al., 2019). While currently married women have lower contraceptive prevalence in SSA, the use of contraception among married women varies with type of union. Compared with women in monogamous union, those in polygynous have been reported to have lower odds of contraceptive use (Wang et al., 2017). Contextual predisposing characteristic such as community-level education (Elfstrom & Stephenson, 2012; Mutumba et al., 2018; Ngome & Odimegwu, 2014) has been found to influence uptake of contraception in developing countries.

On individual-level enabling factors, evidence suggests household wealth is an important factor with individuals from poor households having lower uptake of contraception (Adebowale et al., 2014; Bakibinga et al., 2019; Creanga et al., 2011; Dias & de Oliveira, 2015; Okigbo et al., 2017; Ugaz et al., 2016). Area of residence has also be found to be associated with contraceptive use, with people living in the rural area having lower uptake compared with urban dwellers in some studies (Lakew et al., 2013; Mandiwa et al., 2018). Male partner is another important enabling factor that

enhances uptake of contraception in developing countries. Some studies have reported that women who make joint contraceptive decisions with their husbands/partners have higher likelihood of using contraceptives (DeRose & Ezeh, 2010; Eshete & Adissu, 2017; Feyisetan, 2000; Hameed et al., 2014; Mutombo & Bakibinga, 2014). In developing countries, electronic mass media are used to provide and disseminate information for improved knowledge and awareness about contraception. Research findings have indicated that individuals exposed to mass media messages about family planning on television, radio, or newspaper have a higher uptake of contraception (Ajaero et al., 2016; Babalola et al., 2017; Bajoga et al., 2015; Bakibinga et al., 2019; Retherford & Mishra, 1997; Stephenson et al., 2007; Ugboaja et al., 2018). At individual-level, having institutional delivery and births attended by skilled health providers have also been shown to be positively associated with contraceptive use (Hounton et al., 2015; Mengesha et al., 2015; Rutaremwa et al., 2015; Tessema et al., 2018). However, births attended by skilled health providers was considered as a contextual factor in this study because of availability of country-level data.

Contextual enabling factors such as community-level wealth index (Dias & de Oliveira, 2015; Elfstrom & Stephenson, 2012; Mutumba et al., 2018) and facility-level doctor staffing (Hamid & Stephenson, 2006; Stephenson et al., 2008) have been found to positively influence uptake of contraception in developing countries. High out-of-pocket expenditure for family planning is not uncommon in developing countries (Haghparast-Bidgoli et al., 2015; Radovich et al., 2019). However, its effect on the use of contraception varies and remains inclusive (Asaolu et al., 2019; Korachais et al., 2016). Conventional demographic transition theory suggests that as societies develop

socially and economically, the desire for smaller families would rise (Bongaarts & Watkins, 1996). This in turn would increase the demand for contraception and would eventual lead to decline in fertility (Bongaarts, 2017a). Although this theory has been a subject of longstanding debate (Bongaarts & Casterline, 2013), some of the socioeconomic variables that have been considered include gross national income, gross domestic product, and percent urban population (Bongaarts, 2017a; Bongaarts & Hardee, 2018). In an analysis of trends in contraceptive prevalence from 1990 to 2015 in 24 countries in SSA, Bongaarts and Hardee (2018) reported that gross national income per capita and percent urban were not statistically significant.

The perceived need to use contraception may arise from high parity or number of living children. Women with high parity or number of living children may receive evaluation by providers and counselled on the need for contraception. Studies have found that women with high parity or number of living children have highly likelihood of using contraception (Abate & Tareke, 2019; Anguzu et al., 2018; Apanga & Adam, 2015; de Oliveira et al., 2014; Islam, 2016; Okigbo et al., 2017). Having more living children than the desired number of children may positively influence the use of contraception (Shah et al., 1998). Gender preference affects fertility behavior (Adebowale & Palamuleni, 2015; Calhoun et al., 2013; Chaudhuri, 2012; Rai et al., 2014) and may influence the perceived need for contraception. Some studies in developing countries have found the number of living sons to be positively associated with the use of FPC (de Oliveira et al., 2014; Hoq et al., 2019; Thind, 2005). Community-level parity has also been reported as a contextual determinant that influences the uptake of contraception (Ngome & Odimegwu, 2014). Improved child

survival may lower the motivation for the family planning among couples, and consequently increase fertility (Olsen, 1980; Taylor et al., 1976). While positive association between infant mortality rate and fertility rate (Jain & Ross, 2012; Van Soest & Saha, 2018) as well as under-five mortality rate and desired family size (Bongaarts, 2011) has been reported in developing countries, Bongaarts and Hardee (2018) found no statistically significant relationship between under-five mortality rate and contraceptive prevalence in their analysis of trends in contraceptive prevalence from 1990 to 2015 in 24 countries in SSA. Some studies in SSA have suggested that previous unintended pregnancy influence the use of modern contraceptive methods (Bakibinga et al., 2016; Fotso et al., 2014). In the U.S., history of unintended pregnancy has been found to increase the odds of using FPC (Borrero et al., 2010; Lunde et al., 2013).

Study Design

This study was a secondary data analysis of available survey data on family planning among women in SSA. Secondary data analysis involves the analysis of existing data that has been collected by others for another primary purpose (Cheng & Phillips, 2014). It is an empirical research design that follows basic research principles as research that utilizes primary data (Johnston, 2017), and with appropriate and rigorous approaches, secondary data analysis can generate quality evidence (Trinh, 2018). It is a useful and cost-effective method of generating evidence from nationally representative datasets (Boo & Froelicher, 2013; Donnellan & Lucas, 2013).

Data Sources

Individual-level data. These were obtained from the DHS Program (https://dhsprogram.com/). DHS are globally conducted nationally-representative household surveys that gather data on a number of health-related topics such as family planning, maternal and child health, gender, HIV/AIDS, malaria, and nutrition in many developing countries (ICF, n.d.-b). The surveys have be an important source of data for health policy and planning, monitoring, and evaluation of population health indicators in developing countries (Corsi et al., 2012; Fabic et al., 2012).

The DHS program started in 1984 and over 400 surveys have been conducted in more than 90 countries (ICF, n.d.-b). The DHS program initially focused on fertility, contraception, maternal and child health, and nutrition before expanding to including other topics (Corsi et al., 2012; Fabic et al., 2012). It is conducted by institutions in the host country, usually the national statistics body (Fabic et al., 2012), with technical assistance from ICF who implements the program (ICF, n.d.-d). The level of technical assistance varies, depending on the capacities of the host countries (Fabic et al., 2012). The program is funded by USAID, with contributions from donors and participating countries (ICF, n.d.-d).

The DHS program utilizes standardized methodologies and procedures, making the surveys across different countries comparable. There are two main types of DHS: (i) Standard DHS with sample size ranging from 5,000 to 30,000 households, and usually conducted every five years and (ii) Interim DHS with smaller samples, shorter questionnaire, and are conducted in-between standard DHS (ICF, n.d.-b). The program uses standard model questionnaires which are usually adopted by the countries.

However, to reflect local context and need, countries can add or delete questions (ICF, n.d.-a).

The DHS program adopts a stratified two-stage probabilistic sampling design. The samples are drawn from an existing sampling frame, usually the latest census frame (Croft et al., 2018). With the goal of reducing sampling errors, the sampling frame is usually stratified by geographic region and by area of residence (urban and rural) within each region (Croft et al., 2018). The first stage involves the selection of the primary sampling units (PSU) (usually enumeration areas from population census files), with the probability of selecting a unit proportional to its size within each stratum (Croft et al., 2018). The PSU usually serves as the survey cluster. The second stage involves selecting a fixed number of households; about 25-30 households per cluster (Croft et al., 2018). Trained interviewers visit the selected households to complete the household interview and the individual interviews for eligible women and men. The surveys are usually conducted over a period of 18–20 months (ICF, n.d.-c).

The surveys use four types of core model questionnaires: household, woman, man, and biomarker (ICF, n.d.-a). Optional questionnaire modules are also available and can be used for additional or special information on additional topics not in the model questionnaire (ICF, n.d.-a). The woman's questionnaire contains information about a number of topics such as background characteristics; reproductive behavior and intentions; contraception; antenatal, delivery, and postnatal care; breastfeeding and nutrition; HIV and other sexually transmitted infections; children's health; and husband's background.

The advantages of DHS include it is high response rates, representatives, and the range of information collected (Corsi et al., 2012). The standardized data collection procedures makes the DHS suitable for cross-comparative analyses (Corsi et al., 2012). Furthermore, the multistage design of the surveys allows for multilevel analysis to differentiate between individual-level and contextual-level factors that may affect health utilization or outcomes.

Country-level data. These were obtained from global open data repositories including the World Bank (https://www.worldbank.org/), WHO (https://www.who.int/), and United Nations Educational, Scientific and Cultural Organization (UNESCO) (https://en.unesco.org/). The World Bank has collections of time series data on a variety of indicators including world development indicators, health- and population-related statistics gathered from a variety of international sources. The WHO has a collection of health-related statistics of its Member States, while the UNESCO database contains information on education and literacy. The most recent available data corresponding or closest to the DHS survey year for each of the country were used.

Description of Study Setting

Africa is the second most-populous continent in the world after Asia (United Nations, Department of Economic and Social Affairs, Population Division, 2019). With an estimated population of about 1.3 billion, it accounts for approximately 17% of the world's population (United Nations, Department of Economic and Social Affairs, Population Division, 2019). Africa is one of the poorest continent in the world (Le Goff & Singh, 2014). Geographically, it is subdivided into SSA and northern Africa (United

Nations, Department of Economic and Social Affairs, Statistics Division, 2020). SSA can be further divided into two subregions: western and central Africa (WCA) and eastern and southern Africa (ESA) (Figure 4).

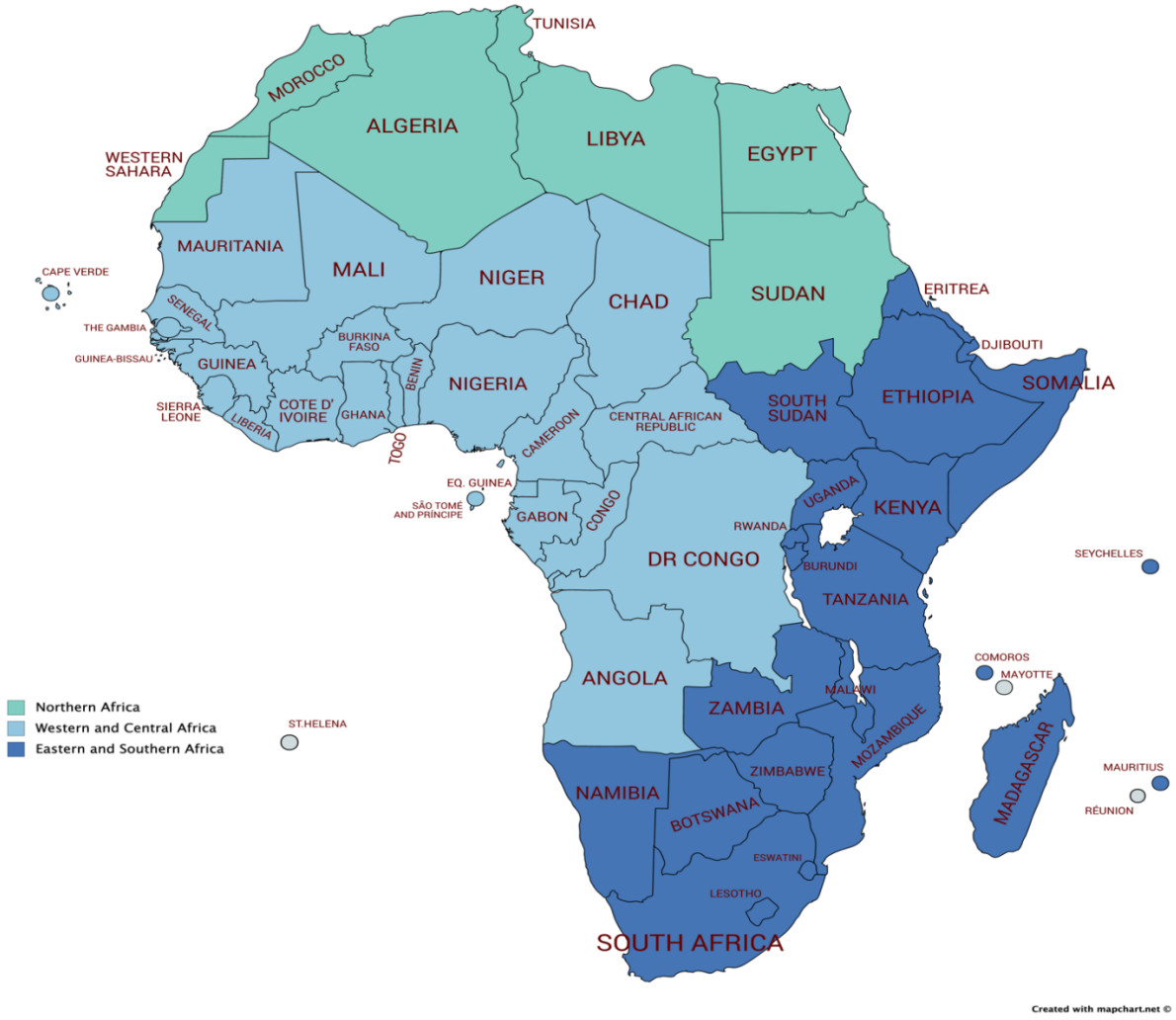

Figure 4: Map of Africa and subregions based on United Nations classification.

SSA has an estimated population of 1.1 billion, average total fertility (live births per women) of 4.6, under-five mortality rate of 74 per 1,000 live births, and life expectancy at birth is 61.1 years (United Nations, Department of Economic and Social Affairs, Population Division, 2019). There is a low density of health workers in Africa, with about 0.2 physicians and 1.2 nurses/midwives per 1,000 population estimated in 2013 (WHO, 2016). In 2015, the average current health expenditure (CHE) as percentage of gross domestic product in Africa was 6.18% (WHO, 2018).

The organization of health service provision varies across countries in SSA. Generally, it involves a range of providers in both the public (government-owned health facilities) and private (for-profit health facilities, non-governmental organizations and self-employed practitioners) sectors. The public sector is largely made up of formal providers, but the private sector usually includes informal providers such as traditional care providers or medicine vendors who have not received institutionalized formal training and qualifications (Bloom et al., 2011; Shah et al., 2011; Sudhinaraset et al., 2013). The private sector contributes significantly to the provision of health care services in many African countries; however, the public sector remains the main provider of maternal health services, including provision of modern contraceptive methods (Campbell et al., 2015; Grépin, 2016; Radovich et al., 2018). Nonetheless, studies have suggested that poor quality of services exist in both the public and private sector (Campbell et al., 2015; Radovich et al., 2018; Tessema et al., 2016).

Inclusion Criteria and Study Population

SSA countries with a Standard DHS conducted between 2010 and 2019 were considered for inclusion. Based on these, there were 33 countries (19 from WCA and 14 from ESA) included in this study (Table 5). The survey year ranged from 2010 to 2018. The study population were married or in-union (i.e., living with partners) women of reproductive age (15-49 years) with demand for limiting childbearing.

Table 5: *Included countries and survey year*

S/N	Subregion	Country	Survey Year
1	Western and Central	Angola	2015-16
2		Benin	2017-18
3		Burkina Faso	2010
4		Cameroun	2011
5		Chad	2014-15
6		Congo	2011-12
7		Cote d'Ivoire	2011-12
8		Democratic Republic of Congo	2013-14
9		Gabon	2012
10		Gambia	2013
11		Ghana	2014
12		Guinea	2018
13		Liberia	2013
14		Mali	2018
15		Niger	2012
16		Nigeria	2018
17		Senegal	2017
18		Sierra Leone	2013
19		Togo	2013-14
20	Eastern and Southern	Burundi	2016-17
21		Comoros	2012
22		Ethiopia	2016
23		Kenya	2014
24		Lesotho	2014
25		Malawi	2015-16
26		Mozambique	2011
27		Namibia	2013
28		Rwanda	2014-15
29		South Africa	2016
30		Uganda	2016
31		Tanzania	2015-16
32		Zambia	2013-14
33		Zimbabwe	2015

Measures

Aims 1 and 2. The variable analyzed was demand for limiting childbearing satisfied with FPC (see definitions of key terms on page 19). The sociodemographic variables considered in Aim 2 were:

I. Age: Age of the respondent in years at interview. It was categorized as: 15-29 / 30-39 / ≥40.

II. Living children: Number of living children at interview. It was categorized as: 0-2 / 3-4 / ≥5.

III. Education: Highest educational level attained by the respondent. It was categorized as: None / Primary / Secondary or higher.

IV. Household wealth: A composite measure of a household's cumulative living standard, estimated by the survey using household's ownership of selected assets, such as televisions and bicycles; materials used for housing. construction; and types of water access and sanitation facilities. It was grouped into five categories by DHS: Poorest, Poor, Middle, Rich and Richest. However, in this study it was re-categorized as: Poor (poor and poorest) / Middle / Rich (rich and richest).

V. Area of residence: Place of residence of the respondent. It was categorized as: Rural / Urban.

Aim 3. The variables analyzed included demand for limiting childbearing, demand for limiting childbearing satisfied with modern contraceptive methods, and demand for limiting childbearing satisfied with FPC (see definitions of key terms on page 19).

Aim 4. The dependent and explanatory variables are described below.

Dependent variable. A binary dependent variable was created from married or in-union women (15-49 years) with demand for limiting childbearing satisfied with modern contraceptive methods. Married or in-union women with demand for limiting childbearing who reported using FPC were coded '1'. Married or in-union women that reported using other modern contraceptive methods including pill, IUD, injections, diaphragm, condom, male sterilization, implants, lactational amenorrhea, female condom, foam and jelly, emergency contraception, and standard day method were coded '0'.

Explanatory variables. Using the Andersen Model, the explanatory variables were categorized into two levels: individual and country. Under each level, the variables were grouped into predisposing, enabling, and need. See Appendix 2 for the summary of the operational definitions, categorization of the variables, and hypotheses.

1. *Individual-level variables.*

A. Predisposing factors.

I. Age: Age of the respondent in years at interview.

II. Education: Highest educational level attained by the respondent. It was categorized as: None / Primary / Secondary or higher.

III. Husband/partner's education: Highest educational level attained by the respondent's husband/partner. It was categorized as: None / Primary / Secondary or higher.

IV. Husband/partner's age: Age of respondent's husband/partner in years at interview.

V. Union: Type of union between the respondent and husband/partner. It was categorized into: Monogynous / Polygynous.

B. Enabling factors.

I. Household wealth: A composite measure of a household's cumulative living standard, estimated by the survey using household's ownership of selected assets, such as televisions and bicycles; materials used for housing. construction; and types of water access and sanitation facilities. It was grouped into five categories by DHS: Poorest, Poor, Middle, Rich and Richest. However, in this study it was re-categorized as: Poor (poor and poorest) / Middle / Rich (rich and richest).

II. Decision maker: Decision maker for using contraception. It was categorized into: Joint decision / Mainly respondent / Mainly husband or partner and others.

III. Area of residence: Place of residence of the respondent at interview. It was categorized as: Rural / Urban.

IV. Media exposure: Hearing about family planning in the last few months from radio, television, newspapers, or magazines. It was categorized as: Yes / No.

C. Need factors.

I. Living children: Number of living children at time of interview.

II. Ideal and living children: Difference between number of living children and ideal number of children. It was categorized as: Living equal or greater than ideal / Living less than ideal.

III. Number of sons: Number of living sons at time of interview.

IV. Wantedness: Whether the last child born in the last five years was wanted at that time, later or not at all. It was categorized as: Wanted then / Wanted later / Wanted no more.

2. *Country-level variables.*

A. Predisposing factor.

I. Literacy rate: The percentage of female population aged 15 years and over who cannot both read and write with understanding a short simple statement on his/her everyday life (source: UNESCO).

B. Enabling factor.

I. Births attended by skilled health providers: The percentage of deliveries attended by personnel trained to provide basic care to women and their newborns during pregnancy, childbirth and the postpartum period (source: World Bank).

II. Density of medical doctors: Number of medical doctors per 10,000 population (source: WHO).

III. Rural population: Percentage of total population living in the rural area (source: World Bank).

IV. Gross national income (Atlas method): A measure of income of a nation’s residents and businesses, regardless of where it's earned (source: World Bank).

V. Poverty rate: Percentage of the population living on less than $1.90 a day at 2011 international prices (source: World Bank).

VI. Out-of-pocket expenditure: Percentage of total current health expenditure that is out-of-pocket payment (source: WHO).

C. Need factor.

I. Total fertility rate: The number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specified year (source: World Bank).

II. Under-five mortality rate: Number of deaths in children under five years of age per 1,000 live births (source: WHO).

Data Preparation and Analysis

For pooled analysis, the 33 datasets were appended into one dataset. The data preparation included recoding and computing of the individual-level variables and inputting of the country-level variables.

Descriptive statistics were performed to summarize the data. Unweighted frequencies and weighted percentages were reported. For each of the countries, the women's individual standard weights provided in the survey were used. However, for the pooled analyses across subregions or all countries, the weights were de-normalized using population of women of reproductive age group (15-49 years) obtained from United Nations Population Division (https://population.un.org/wpp/Download/Standard/Population/). To de-normalize the weights for each country, the women's individual standard weights were multiplied by the population of total women aged 15-49 years at the year of the survey and then divided by the number of women aged 15-49 years in the survey (Ren, n.d.).

Aims 1 and 2. The weighted proportion of demand for limiting childbearing satisfied with FPC, and by sociodemographic characteristics (age, living children,

education, household wealth, and place of residence) among married or in-union women was computed using the formula:

$$\frac{\text{Use of FPC for limiting childbearing}}{\text{Unmet need for limiting childbearing + Met need for limiting childbearing}} \quad (1)$$

For easier reporting and to be consistent with United Nations report on SDG indicator 3.7.1 (United Nations, 2019a; United Nations, Department of Economic and Social Affairs, Population Division, 2019a), the calculated proportions were multiplied by 100 and reported in percentages. The analysis was performed with SPSS version 25, using complex samples procedures to obtain the 95% confidence intervals (CIs).

Aim 3. Exploratory spatial data analysis (ESDA) techniques (Anselin, 1996) were used to determine and visualize patterns of spatial association in the proportion of demand for limiting childbearing, proportion of demand for limiting childbearing satisfied with modern contraceptive methods, and proportion of demand for limiting childbearing satisfied with FPC. The units of analysis were the countries. Global Moran's I statistic was first determined to assess the overall spatial autocorrelation among the countries using the following equation (Anselin, 2018b; Rajabi et al., 2018):

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})\,(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (2)$$

Where:

I= Global Moran's I statistic

x_i = the value of the variable (proportion of demand for limiting childbearing, proportion of demand for limiting childbearing satisfied with modern methods, or proportion of demand for limiting childbearing satisfied with FPC) for country i

$\bar{x}$ = the mean of the variable across all countries

$x_j =$ the value of the variable for country j

$w_{ij} =$ a spatial weight between countries i and j the represents proximity

n = the number of countries in the study

S_0 = the sum of all weights ($\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}$)

Global Moran's I statistic ranges from −1 to +1, where a value of zero indicates spatial randomness or no spatial autocorrelation (Chi & Zhu, 2008; Zhang & Lin, 2007). Positive global Moran's I statistic indicates spatial clustering of neighbors with similar values (Anselin, 2018b; Chi & Zhu, 2008; Zhang & Lin, 2007). This could be high or low values surrounded by neighboring high or low values, respectively. Negative Moran's I statistic indicates neighbors have dissimilar values or the presence of an outlier (Anselin, 2018b; Chi & Zhu, 2008; Zhang & Lin, 2007). This could be low values bordered by neighbors with high values or high values bordered by neighbors with low values. To make an inference for the Moran's I statistic, rather than analytical derivation, the software used in this study uses a random permutation procedure to calculate a pseudo p-value level (referred to as pseudo because it is dependent on the number of permutation) to test the null hypothesis of spatial randomness (Anselin, 2018b). Many values of Moran's I statistic are computed from randomly reshuffled datasets to create a reference distribution, which is then used to calculate the pseudo p-value (Anselin, 2018b). The global Moran's I statistic was assessed by using 999 permutations. The significance level was set at 0.05.

Although significant global Moran's I indicates spatial clustering, it does not show where the significant spatial clusters or outliers are located. Local indicator of spatial association (LISA) can be calculated and plotted on a map to identify the locations of the

spatial clusters or outliers (Anselin, 1995, 2019). Local Moran's I was calculated using the following equation (Anselin, 1995; Rajabi et al., 2018):

$$I_i = \frac{(x_i - \bar{x}) \sum_j w_{ij} (x_j - \bar{x})}{S^2} \quad (3)$$

Where:

I_i= Local Moran's I statistic

x_i = Value of the variable (proportion of demand for limiting childbearing, proportion of demand for limiting childbearing satisfied with modern methods, or proportion of demand for limiting childbearing satisfied with FPC) for country i

$\bar{x}$ = the mean value of the variable across all countries in the study

x_j = the value of the variable for country j

w_{ij} = a spatial weight between countries i and j

S = the standard deviation of the variable across all countries in the study

With significance level set at 0.05, LISA cluster maps presented the significant locations in four color-coded categories: high-high, low-low, low-high and high-low (Anselin, 2005). The terms high and low are defined relative to the overall mean (Anselin, 2005). High-high (hotspot) location signifies a country with high value of the variable surrounded by countries that have high values of the variable. Similarly, low-low (cold spot) location signifies a country with low value of the variable surrounded by countries that have low values of the variables. Low-high location signifies a country with low value of the variable surrounded by countries that have high values of the variable. High-low location signifies a country with high value of the variable surrounded by countries that have low values of the variables. The high-high and low-low locations (positive local spatial autocorrelation) are referred to as spatial clusters (Anselin, 2005). Low-high and

High-low locations (negative local spatial autocorrelation) are referred to as spatial outliers (Anselin, 2005).

Because of the variation in the base (number of married or in-union women and number of married or in-union women with demand for limiting childbearing), empirical Bayes standardization was performed to smooth the proportions (Anselin, 2005). On the shapefile (WGS84 geographic coordinate system), spatial weights matrix was generated using distance band method (based on geometric centroids) with the bandwidth set at 3000km (Anselin, 2018a). Connectivity histogram, maps, and graphs were used to assess and ensure even distribution of the neighbor cardinality and absence of isolates (Anselin, 2018a). The spatial data analysis was conducted using GeoDa v. 1.14.

Aim 4. Given the hierarchical nature of the appended datasets where individual women (Level 1) were nested within the countries (Level 2), a 2-level multilevel logistic regression analysis was performed using Stata Statistical Software: Release 15, College Station, TX, StataCorp LLC. Multilevel models (also known as mixed or hierarchical linear models) were developed for the purpose of analyzing hierarchical data where lower level units are nested within higher level units (Goldstein, 2010; Hox, 2010; Snijders & Bosker, 1999). When data have a hierarchical structure, there may be interdependence between subjects, as those nested within same clusters (countries) are more likely to be similar to each other than subjects from different countries. Consequently, for variables on subjects from the same countries, their average correlation may be greater than the correlation between variables on subjects from different countries, invalidating the assumption of independence (Hox, 2010; Rice & Leyland, 1996). Ignoring the nested structure in the data and the violation of the

independence assumption may bias the parameter estimates, standard error, and interpretation of the results (Guo & Zhao, 2000; Hox, 2010; Julian, 2001). With a multilevel model, the total variance in the outcome variable can be decomposed into portions attributable to each level (Austin & Merlo, 2017; Guo & Zhao, 2000; Rice & Leyland, 1996). A multilevel model allows for simultaneous analysis of how factors measured at lower level or higher level of a hierarchical data influence the outcome variable (Austin & Merlo, 2017; Guo & Zhao, 2000; Rice & Leyland, 1996). Thus it is useful in assessing the effect of context on individual level outcomes (Rice & Leyland, 1996).

Model specifications. Four models were built as follows:

Model 1: An empty model, containing no variable

$$\text{Logit}\ (\pi_{ij}) = \beta_0 + V_{0j} \quad (4)$$

Model 2: This contained the individual-level variables and survey year as control variable

$$\begin{aligned}\text{Logit}\ (\pi_{ij}) = {} & \beta_0 + \beta_1(\textit{Survey year}) + \beta_2(\textit{Age})_{ij} + \beta_3(\textit{Education})_{ij} \\ & + \beta_4(\textit{Household wealth})_{ij} + \beta_5(\textit{Number of living children})_{ij} \\ & + \beta_6(\textit{Number of sons})_{ij} + \beta_7(\textit{Residence})_{ij} + \beta_8(\textit{Decision maker})_{ij} \\ & + \beta_9(\textit{Ideal and living children})_{ij} + \beta_{10}(\textit{Union})_{ij} + \beta_{11}(\textit{Wantedness})_{ij} \\ & + \beta_{12}(\textit{Partner's education})_{ij} + \beta_{13}(\textit{Partner's age})_{ij} \\ & + \beta_{14}(\textit{Media exposure})_{ij} + V_{0j} \quad (5)\end{aligned}$$

Model 3: This contained the county-level variables and survey year as control variable

$$\begin{aligned}\text{Logit}\left(\pi_{ij}\right) = {} & \beta_0 + \beta_1(\textit{Survey year}) + \beta_{15}(\textit{Poverty rate})_j \\ & + \beta_{16}(\textit{Births attended by skilled health providers})_j + \beta_{17}(\textit{Literacy rate})_j \\ & + \beta_{18}(\textit{Medical doctor density})_j + \beta_{19}(\textit{Gross national income})_j \\ & + \beta_{20}(\textit{Total fertility rate})_j + \beta_{21}(\textit{Out-of-pocket expenditure})_j \\ & + \beta_{22}(\textit{Rural population})_j + \beta_{23}(\textit{Under-five mortality rate})_j \\ & + V_{0j} \qquad (6)\end{aligned}$$

Model 4: This contained the individual- and county-level variables, and survey year as control variable

$$\begin{aligned}\text{Logit}\left(\pi_{ij}\right) = {} & \beta_0 + \beta_1(\textit{Survey year}) + \beta_2(\textit{Age})_{ij} + \beta_3(\textit{Education})_{ij} \\ & + \beta_4(\textit{Household wealth})_{ij} + \beta_5(\textit{Number of living children})_{ij} \\ & + \beta_6(\textit{Number of sons})_{ij} + \beta_7(\textit{Residence})_{ij} + \beta_8(\textit{Decision maker})_{ij} \\ & + \beta_9(\textit{Ideal and living children})_{ij} + \beta_{10}(\textit{Union})_{ij} + \beta_{11}(\textit{Wantedness})_{ij} \\ & + \beta_{12}(\textit{Partner's education})_{ij} + \beta_{13}(\textit{Partner's age})_{ij} \\ & + \beta_{14}(\textit{Media exposure})_{ij} + \beta_{15}(\textit{Poverty rate})_j \\ & + \beta_{16}(\textit{Births attended by skilled health providers})_j + \beta_{17}(\textit{Literacy rate})_j \\ & + \beta_{18}(\textit{Medical doctor density})_j + \beta_{19}(\textit{Gross national income})_j \\ & + \beta_{20}(\textit{Total fertility rate})_j + \beta_{21}(\textit{Out-of-pocket expenditure})_j \\ & + \beta_{22}(\textit{Rural population})_j + \beta_{23}(\textit{Under-five mortality rate})_j \\ & + V_{0j} \qquad (7)\end{aligned}$$

Where

π_{ij} = the logit of the odds that a married or in-union woman i with demand for limiting childbearing satisfied with modern methods in country j use FPC

β_0 = the fixed intercept or the average log of odds of using FPC

β_1 = the slope corresponding to the control variable

β_{2-14} = the slope corresponding to the individual-level variables

β_{15-23} = the slope corresponding to the country-level variables

V_{0j} is the residual term at the country level, assumed to have normal distribution with mean zero and variances ($V_j \sim N(0, \sigma^2)$)

The models were random intercept models only. Random slopes were not estimated, i.e., the relationship between the dependent variable and Level 1 variables were not allowed to vary. Although estimating all random slope variance parameters can be used to improve the fit of the model, it may result in overparameterization or failure of convergence and uninterpretable findings (Barr et al., 2013; Bates et al., 2015). Multicollinearity among the explanatory variables was examined using the variance inflation factor (VIF), and a value exceeding 10 was used as the cut-off (Midi et al., 2010).

Fixed effects (measures of association). These were reported as odds ratios (ORs), with their 95%CIs. P-value of less than 0.05 was considered statistically significant.

Random effects (measures of variation). The country-level effects were measured by the intra-cluster (intra-country in this study) correlation coefficient (ICC), proportional change in variance (PCV), and median odds ratio (MOR).

ICC shows the proportion of observed total variation in the outcome that can be attributed to the between-cluster variation (Austin & Merlo, 2017). It quantifies the level of homogeneity of the outcome within the clusters (Sommet & Morselli, 2017). It may range from 0 to 1 (Sommet & Morselli, 2017). When ICC = 0, it means perfect independence of residuals, indicating there is no between-cluster variation and the observations are independent of cluster membership (Sommet & Morselli, 2017).

Whereas when ICC = 1, it means there is perfect interdependence of residuals, indicating that the variation in the observations only exits between clusters (Sommet & Morselli, 2017). The ICC was used to examine the proportion of the total variance in the odds of using FPC attributable to the countries. Using the latent variable method (Merlo et al., 2006), the equation for calculating the ICC for the two-level model was as follows:

$$\text{ICC} = \frac{\sigma^2}{\sigma^2 + 3.29} \quad (8)$$

Where: σ^2 = the variance at country level.

PCV was used to estimate the proportion of the country variance that was attributable to the individual- and/or country-level variables in the models (Merlo et al., 2005). PCV was calculated using the following equation (Merlo et al., 2005):

$$\text{PCV} = \frac{\sigma_A^2 + \sigma_B^2}{\sigma_A^2} \text{ x } 100 \quad (9)$$

Where:

σ_A^2 = the country-level variance in the empty model

σ_B^2= the country-level variance in the model with more terms

MOR quantifies the variation between the countries by comparing two women from two randomly chosen different countries (Larsen et al., 2000; Larsen & Merlo, 2005). It represents the median value of the odds ratio between the country at highest propensity and country at lowest propensity of FPC use when two countries are randomly selected (Larsen et al., 2000; Larsen & Merlo, 2005; Merlo et al., 2006). It can be conceptualized as the increased odds (in median) of using FPC if a woman moves to a country with a higher probability of FPC use (Larsen & Merlo, 2005; Merlo et al.,

2006). MOR is usually greater or equal to 1. MOR of 1 indicates there is no variation between the countries (Larsen & Merlo, 2005). MOR was calculated using the following equation (Merlo et al., 2006):

$$\text{MOR} = \exp\left(0.95\sqrt{\sigma^2}\right) \quad (10)$$

Where:

σ^2 = the variance at country level.

Ethical Consideration

This study was a secondary analysis of publicly available de-identified data. DHS program obtains ethical clearance from appropriate National Ethics Committees in the respective countries before conducting the surveys. Access and permission to use the datasets was granted by ICF (Appendix 3). Given the nature of the study, an exempt was granted by the University of Nevada, Las Vegas Institutional Review Board (Appendix 4).

CHAPTER 4: RESULTS

The results of the analyses are presented in this chapter. The chapter begins with a description of the surveys and summary statistics of selected characteristics of the women and countries included in the study. The calculated proportions of demand for limiting childbearing satisfied with FPC are presented in this chapter. Findings of the exploratory spatial data analyses as well as the multilevel logistic regression modelling are also reported in this chapter.

Summary of Included DHS

Table 6 shows the summary of the study population in the included DHS by subregion and country. The total number of women in the reproductive age group (unweighted) in the 33 countries was 478,447. The number ranged from 5,329 in Comoros to 41,821 in Nigeria. There were 306,080 married or in-union women out of which 56,720 had demand for limiting childbearing. Overall, the weighted percentage of married or in-union women with demand for limiting childbearing was 19.7. This percentage ranged from 5.4 in Chad to 47.5 in Lesotho.

Table 6: *Study population by subregion and country, DHS, 2010-2018*

Subregion and Country	Number of women of reproductive age group*	Number of married or in-union women* (%)**	Number of married or in-union women with demand for limiting childbearing* (%)**
Western and Central Africa	274834	187524 (67.7)	23986 (13.7)
Angola	14379	8033 (55.3)	1154 (16.8)
Benin	15928	11170 (70.1)	1720 (15.1)
Burkina Faso	17087	13392 (79.4)	1654 (12.1)
Cameroun	15426	9805 (63.5)	1664 (16.8)
Chad	17719	13439 (74.8)	636 (5.4)
Congo	10819	6750 (58.1)	904 (13.4)
Cote d'Ivoire	10060	6453 (62.7)	765 (12.0)
Democratic Republic of Congo	18827	12448 (64.2)	1596 (13.7)
Gabon	8422	4749 (89.3)	782 (16.1)
Gambia	10233	6905 (66.4)	504 (7.6)
Ghana	9396	5456 (56.6)	1235 (24.2)
Guinea	10874	7812 (71.1)	711 (9.0)
Liberia	9239	5875 (58.3)	1016 (16.2)
Mali	10519	8332 (81.4)	912 (11.6)
Niger	11160	9509 (88.5)	460 (4.3)
Nigeria	41821	28888 (69.6)	4045 (13.8)
Senegal	16787	11394 (64.9)	1458 (14.0)
Sierra Leone	16658	10754 (65.5)	1519 (14.4)
Togo	9480	6360 (66.3)	1251 (20.5)
Eastern and Southern Africa	203613	118556 (58.0)	32734 (28.5)
Burundi	17269	9559 (56.6)	2640 (27.8)
Comoros	5329	3291 (61.2)	462 (13.5)
Ethiopia	15683	9824 (65.2)	1849 (23.7)
Kenya	31079	19036 (59.7)	3439 (41.0)
Lesotho	6621	3609 (54.6)	1707 (47.5)
Malawi	24562	15952 (65.7)	6399 (40.6)
Mozambique	13745	8956 (67.9)	1492 (14.2)
Namibia	9176	3366 (34.0)	1454 (41.1)
Rwanda	13497	6890 (51.7)	2473 (35.8)
South Africa	8514	2841 (35.8)	1331 (45.5)
Uganda	18506	11379 (60.6)	3106 (27.4)
Tanzania	13266	8189 (61.9)	1643 (21.6)

Subregion and Country	Number of women of reproductive age group*	Number of married or in-union women* (%)**	Number of married or in-union women with demand for limiting childbearing* (%)**
Zambia	16411	9649 (60.1)	2568 (26.9)
Zimbabwe	9955	6015 (61.8)	2171 (34.8)
All countries	478447	306080(63.3)	56720 (19.7)

*Unweighted frequency. ** Weighted proportion.

Characteristics of Married or In-union Women with Demand for Limiting Childbearing

The characteristics of the pooled sample of married or in-union women with demand for limiting childbearing are shown in Table 7. The mean age was 36.8 years. About one-third had at least a secondary education. Approximately 47% of the respondents were from rich households. Over 60% of the respondents resided in rural areas. The mean number of living children was 4.8, while the mean ideal number of children was 4.7. The number of living children was equal or greater than the ideal number of children in about 65% of the women. The mean number of living sons was 2.4. Forty-eight percent reported media exposure to family planning messages, while 63% of those using contraceptives reported joint contraceptive decision making with their husband or partner. The mean husband/partner's age was 44.7 years. Over 44% of the respondents reported that their husbands /partners had at least secondary education. The majority of the women were in a monogynous union (80%). Among those whose last child was born in the last five years, about 58% reported that the child was wanted at that time. Approximately 53% of the women were using modern contraceptive methods.

Table 7: *Selected characteristics of married or in-union women with demand for limiting childbearing in 33 countries in SSA, DHS, 2010-2018*

Variable	Frequency (N)	Weighted percentage
Age		
Mean ± SD		36.8 ± 6.7
≤30 years	8610	14.7
30-39 years	26087	46.5
≥40 years	22023	38.8
Education (N=56717)		
None	17505	30.8
Primary	23225	35.6
Secondary or higher	15987	33.6
Household wealth		
Poor	20700	33.1
Middle	11301	20.0
Rich	24719	46.9
Area of residence		
Urban	20589	40.2
Rural	36131	59.8
Living children		
Mean ± SD		4.8 ± 2.1
0-2	6775	13.3
3-4	19166	34.0
≥5	30779	52.7
Ideal number of children (N=54281)		
Mean ± SD		4.7 ± 2.5
0-2	7966	15.7
3-4	22061	39.6
≥5	24254	44.7
Ideal and living children (N=52481)		
Living equal of greater than ideal	35918	64.5
Living less than ideal	18363	35.5
Number of living sons		
Mean ± SD		2.4 ± 1.5
0-2	31398	56.3
3-4	19946	34.5
≥5	5376	9.2
Media exposure (N=56708)		
Yes	27502	47.7
No	29206	52.3
Decision maker (N=33621) *		
Joint decision	21638	62.9
Mainly respondent	8646	27.9
‡Mainly husband/partner	3009	8.4

Variable	Frequency (N)	Weighted percentage
‡Others	328	0.8
Husband/Partner's age (N=56415)		
Mean ± SD		44.7 ± 9.9
15-29	2915	4.5
30-39	14300	24.6
40-49	22997	41.3
50 and above	16203	29.6
Husband/Partner's education (N=55349)		
None	13404	22.2
Primary	20056	33.8
Secondary or higher	55349	44.0
Union (N=55403)		
Monogynous	43152	80.2
Polygynous	12251	19.8
Wantedness (N=39917) **		
Wanted then	22656	57.6
Wanted later	6701	15.8
Wanted no more	10560	26.6
Contraceptive method		
None	22947	39.7
Traditional***	3996	7.8
Modern	29777	52.6

N= 56720 expect where stated. SD=Standard deviation. *Women using contraception. **Women who gave birth to a child in the last five years. ***Includes folkloric methods. ‡The two categories were combined in the multilevel logistic regression.

Characteristics of Included Countries

The summary of the selected characteristics of the 33 countries are shown in Table 8 (See Appendix 5 for the characteristics by country). The mean poverty rate was 40.5%, ranging from 3.4% in Gabon to 76.6% in Democratic Republic of Congo. The mean literacy rate was 53.6%. It ranged from 14% in Chad to 88% in Namibia and Zimbabwe. The mean births attended by skilled health providers was 66.2%; ranging from 20% in Chad to 97% in South Africa. The mean density of medical doctors was 1.4 per 10,000 population. It ranged from 0.2 in Malawi to 8.0 in South Africa. The mean gross national income was $1617; ranging from $270 in Burundi to $9080 in Gabon.

The mean rural population was 61%; ranging from 13% in Gabon to 88% in Burundi. The mean total fertility rate was 4.9. It ranged from 2.5 in South Africa to 7.4 in Niger. The mean out-of-pocket expenditure was 37%. It ranged from 8% in South Africa and Rwanda to 78% in Comoros. The mean under-five mortality rate was 79.8 per 1,000 live births; ranging from 36.6 in South Africa to 136.7 in Sierra Leone.

Table 8: *Summary of country characteristics*

Variable	Mean (SD)	Range
Poverty rate (%)	40.5 (19.0)	3.4-76.6
Literacy rate (%)	53.6 (23.0)	14-88
Births attended by skilled health providers (%)	66.2 (19.3)	20-97
Density of medical doctors (per 10,000 population)	1.4 (1.5)	0.2-8.0
Gross national income ($)	1617 (1919)	270-9080
Rural population (%)	60.8 (17.2)	13-88
Total fertility rate	4.9 (1.0)	2.5-7.4
Out-of-pocket expenditure (%)	37.2 (19.9)	8-78
Under-five mortality rate	79.8 (27.4)	36.6-136.7

SD=Standard deviation.

Demand for Limiting Childbearing Satisfied with FPC among Married or In-union Women

The proportion of demand for limiting childbearing satisfied with FPC among married or in-union women in the 33 countries was 6.7% (95%CI=6.2-7.1%) (Figure 5, Appendix 6). The proportion of demand for limiting satisfied with FPC was 9.4%(95%CI=8.7-10.1%) in ESA, while it was 2.8% (95%CI=2.5-3.3%) in WCA (Figure

5, Appendix 6). The proportion of demand for limiting satisfied with FPC ranged from 0.3% (95%CI=0.1-0.8%) in Angola to 27% (95%CI=25.3-28.7%) in Malawi. In about 27% (9/33) of the countries, the proportion of demand for limiting satisfied with FPC was higher than the pooled regional value (6.7%). In 15% (5/33) of the countries, the proportion of demand for limiting satisfied with FPC was 10% or higher.

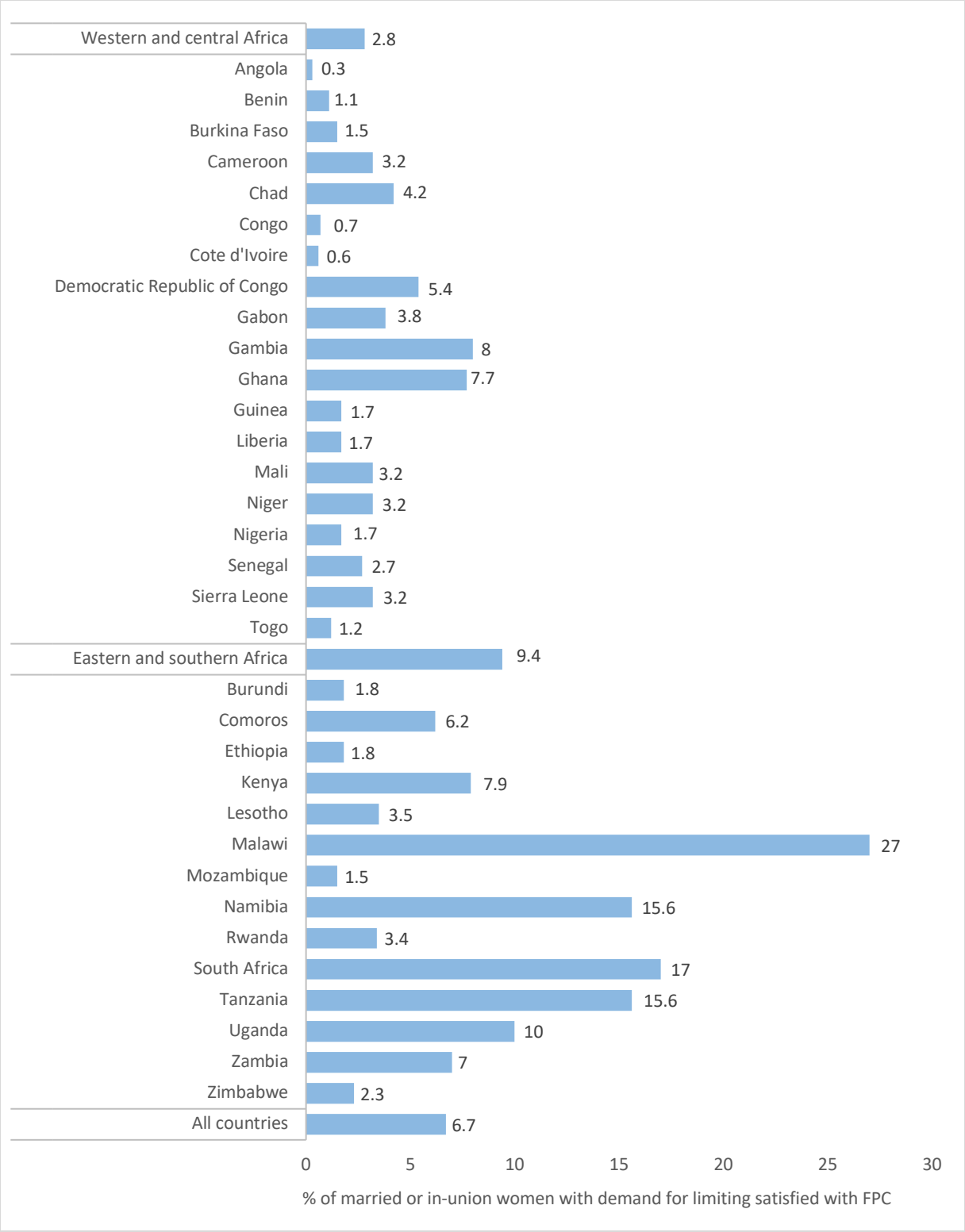

Figure 5: Proportion of demand for limiting childbearing satisfied with FPC among married or in-union women.

Demand for Limiting Childbearing Satisfied with FPC among Married or In-Union Women by Sociodemographic Characteristics

Age. Across the 33 countries, the proportion of demand for limiting childbearing satisfied with FPC was highest among women 40 years and older (10.4%, 95%CI=9.7-11.3%) compared with those aged 30-39 years (5.1%, 95%CI=4.6-5.7%), and 15-29 years (1.5%, 95%CI=1.1=2.0%) (Figure 6, Appendix 7). In both WCA and ESA, women 40 years and older had the highest proportion (Figure 6, Appendix 7). In 27 out of the 33 countries (81%), women 40 years and older had the highest proportion, although marginally (less than 0.5 percent point margin) in one country (Burkina Faso) (Figure 6, Appendix 7).

Living children. The proportion of demand for limiting childbearing satisfied with FPC was highest among women with 3-4 children in all countries (7.8%, 95%CI=7.0-8.7%), compared with women with 0-2 (6.4%, 95%CI=5.0-8.0%) and ≥5 (6.0%, 95%CI=5.5-6.5%) living children (Figure 7, Appendix 8). A similar pattern was seen in ESA with women who had 3-4 living children having the highest proportion (Figure 7, Appendix 8). However, in WCA women with 0-2 living children had the highest proportion of demand for limiting childbearing satisfied with FPC (Figure 7, Appendix 8). In 36% of the countries (12/33), women with 3-4 living children had the highest proportion of demand for limiting childbearing satisfied with FPC (although with less than 0.5 percent point margin in Congo and Ghana). In 33% of the countries (11/33), women ≥5 living children had the highest proportion (although marginally in Angola and Rwanda). In 30% of the countries (10/33), those with 0-2 living children had the highest proportion (although marginally in Nigeria) (Figure 7, Appendix 8).

Education. The proportion of demand for limiting childbearing satisfied with FPC was lowest among uneducated women (4.1%, 95%CI=3.6-4.7%) compared with those with primary (7.7%, 95%CI=7.1-8.3%) or at least secondary education (7.9%, 95%CI=7.0-9.0%) (Figure 8, Appendix 9). ESA showed a similar pattern with women who had no education (5.1%, 95%CI=4.3-6.0%) having the lowest proportion compared with those with primary (10.0%, 95%CI=9.2-10.8%) or at least secondary education (12.4%, 95%CI=10.8-14.1%) (Figure 8, Appendix 9). In WCA, the proportion of demand for limiting childbearing satisfied with FPC was lowest among those with primary education (2.5%, 95%CI=1.9-3.1%), but marginally higher among those with no education (3.1%, 95%CI=2.5-3.8%) compared with those with secondary or higher education (2.9%, 95%CI=2.3-3.5%) (Figure 8, Appendix 9). In 24 out of the 33 countries (73%), the proportion was highest among those with primary or secondary or higher education (Figure 8, Appendix 9).

Household wealth. Across the 33 countries, the proportion of demand for limiting childbearing satisfied with FPC was highest among those from rich households (8%, 95%CI=7.2-8.8%) compared with those from middle (6.2%, 95%CI=5.4-7.0%) or poor (5.1%, 95%CI=4.6-5.6%) households (Figure 9, Appendix 10). In both WCA and ESA, women from rich households had the highest proportion of demand for limiting childbearing satisfied with FPC (Figure 9, Appendix 10). In 23 out of the 33 countries (70%), women from rich households had the highest proportion, although marginally (less than 0.5 percent point margin) in five countries (Benin, Burkina Faso, Congo, Cote d'Ivoire, and Nigeria) (Figure 9, Appendix 10).

Area of residence. Overall, among married or in-union women, the proportion of demand for limiting childbearing satisfied with FPC was higher among urban dwellers (7.2%, 95%CI=6.4-8.1%) compared with rural dwellers (6.3%, 95%CI=5.8-6.8%) (Figure 10, Appendix 11). The proportion of demand for limiting childbearing satisfied with FPC was also higher among those residing in urban areas (12.2%, 95%CI=10.7-13.9%) compared with rural areas (8.0%, 95%CI=7.3-8.7%) in ESA (Figure 10, Appendix 11). However, in WCA, women living in rural areas (3.2%, 95%CI=2.6-3.8%) had higher proportion of demand for limiting childbearing satisfied with FPC compared with urban dwellers (2.5%, 95%CI=2.0-3.0%) (Figure 10, Appendix 11). In 21 countries out of the 33 countries (64%), the proportion of demand for limiting childbearing satisfied with FPC was higher among urban dwellers, although marginally (less than 0.5 percent point margin) in five countries (Burkina Faso, Cameroon, Ghana, Ethiopia, and Togo) (Figure 10, Appendix 11).

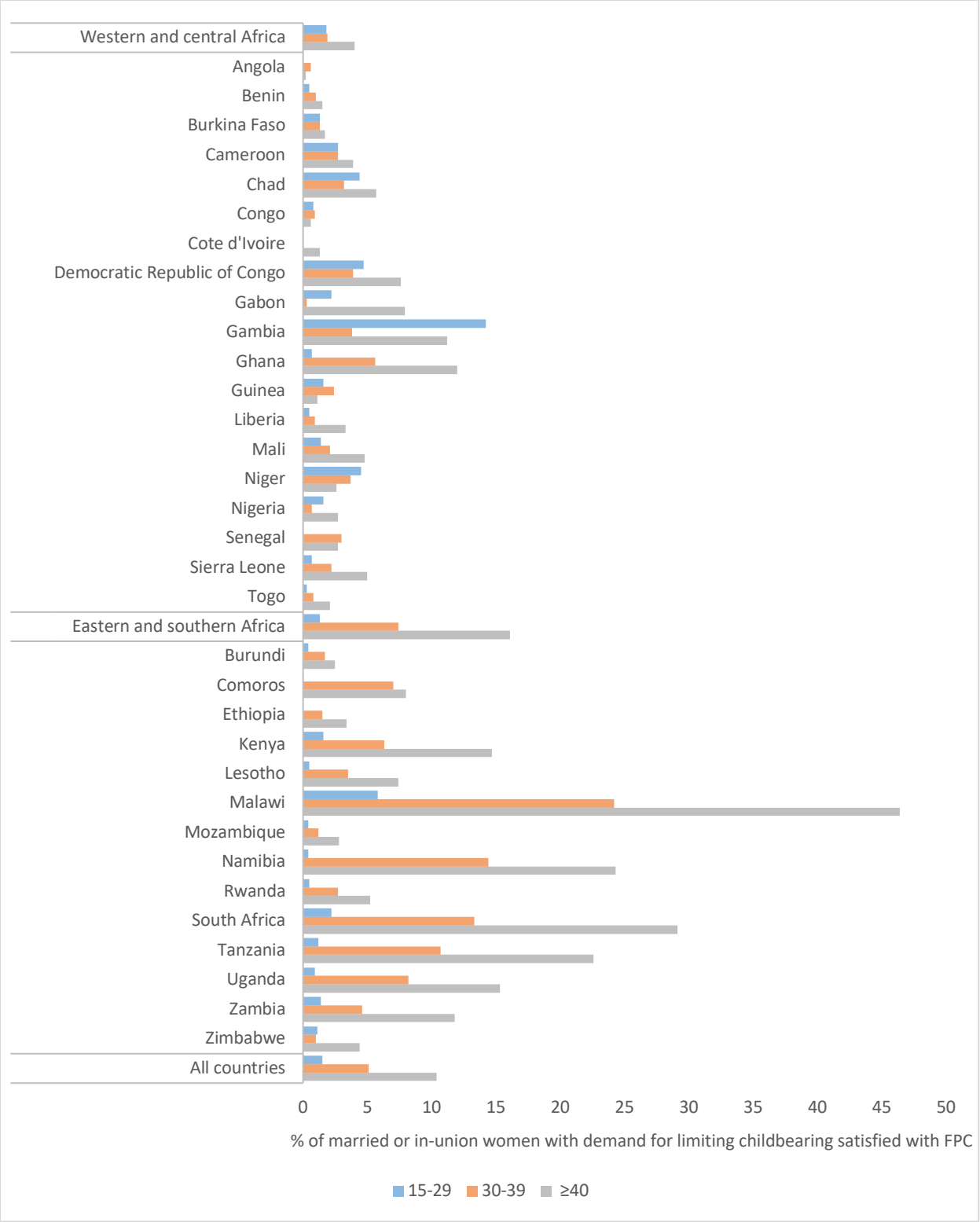

Figure 6: Proportion of demand for limiting childbearing satisfied with FPC among married or in-union women by age.

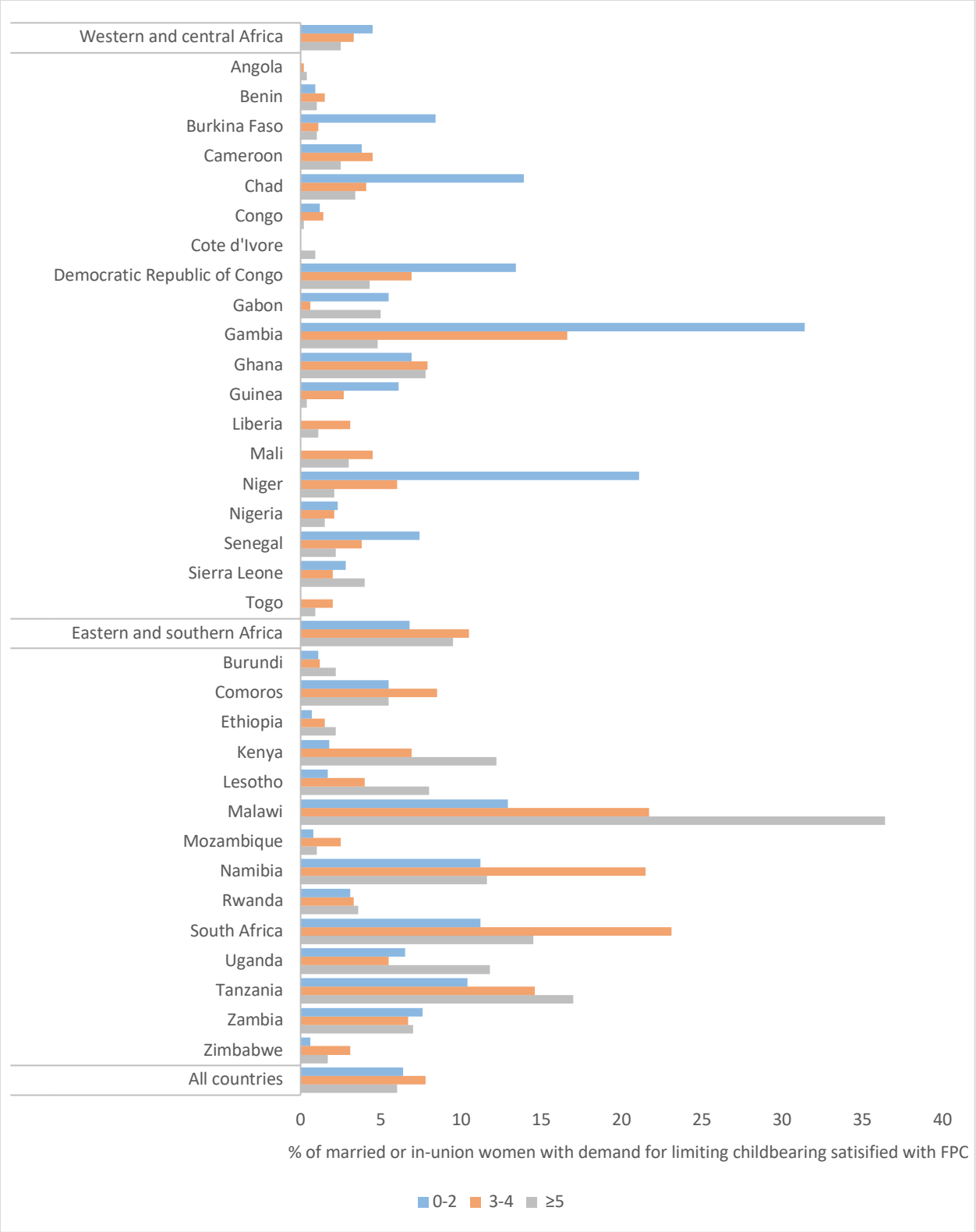

Figure 7: Proportion of demand for limiting childbearing satisfied with FPC among married or in-union women by living children.

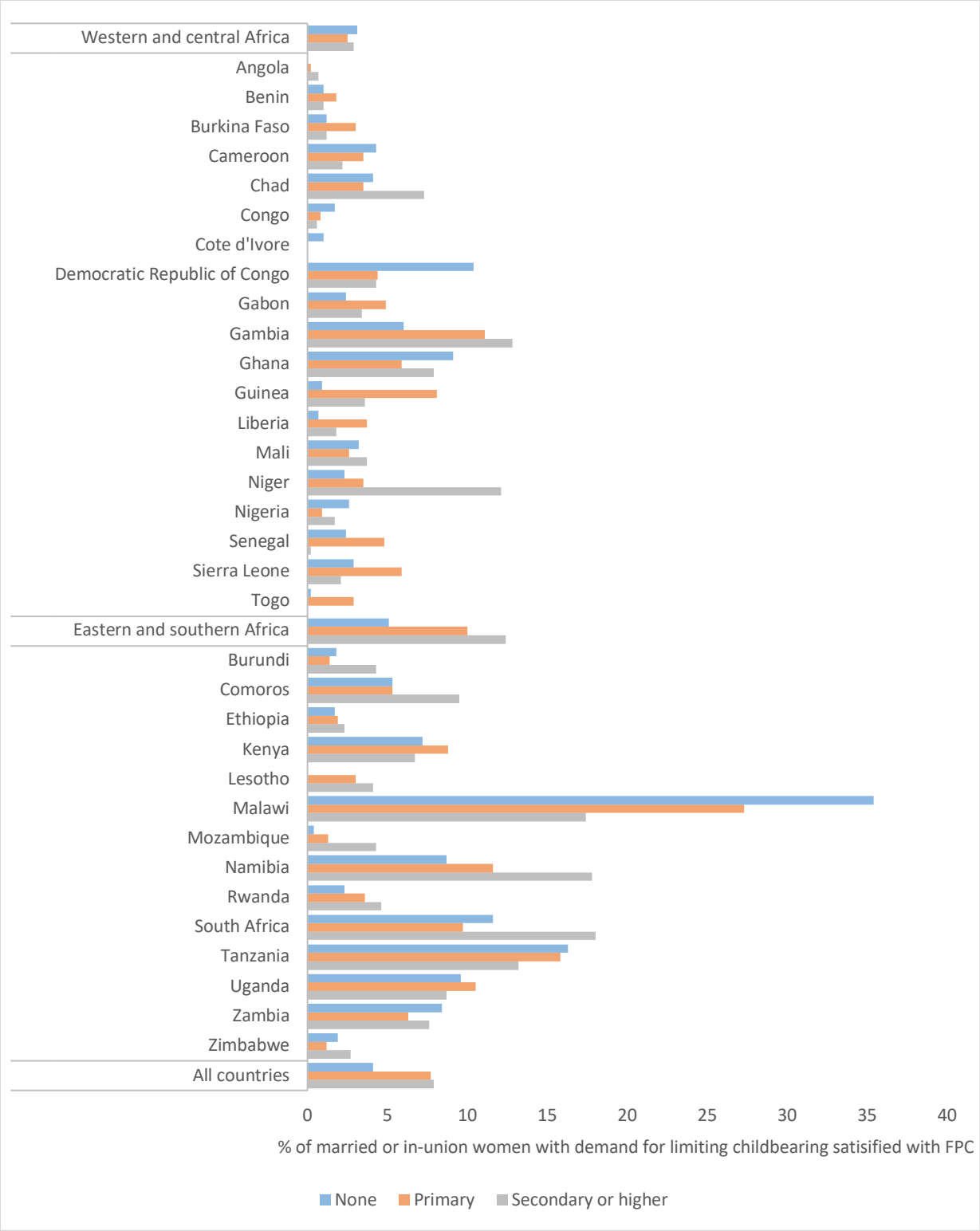

Figure 8: Proportion of demand for limiting childbearing satisfied with FPC among married or in-union women by education.

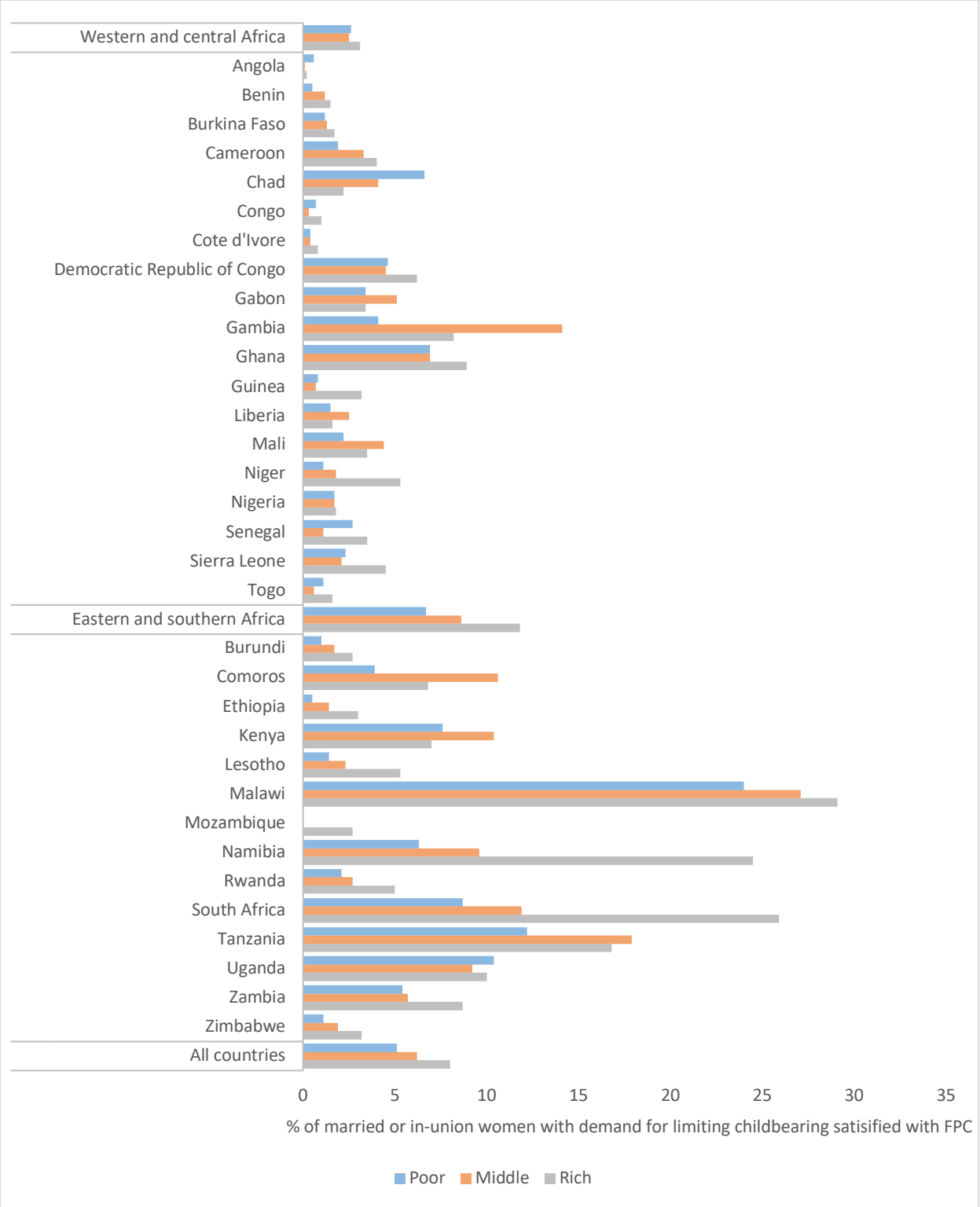

Figure 9: Proportion of demand for limiting childbearing satisfied with FPC among married or in-union women by household wealth.

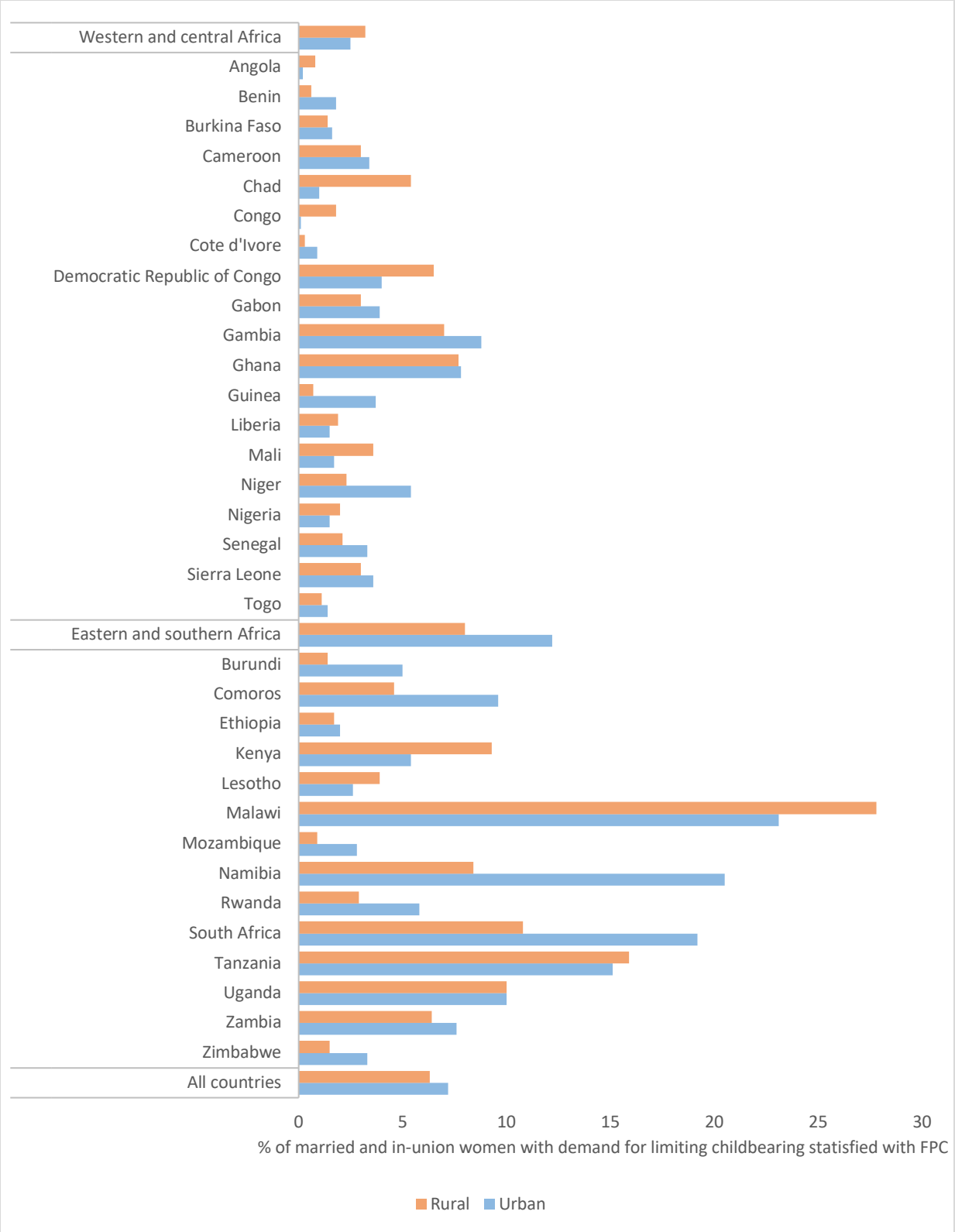

Figure 10: Proportion of demand for limiting childbearing satisfied with FPC among married or in-union women by area of residence.

Exploratory Spatial Data Analyses

The summary statistics of the three variables considered in the exploratory spatial data analyses are shown in Table 9.

Table 9: *Summary statistics by all countries and subregion.*

Variable	N	Mean (SD)	P-value*
Proportion of demand for limiting childbearing among married or in-union women (%)			
All countries	33	21.2 (12.0)	
WCA	19	3.5 (4.8)	<0.001
ESA	14	31.5 (11.0)	
Proportion of demand for limiting childbearing among married or in-union women satisfied with modern contraceptive methods (%)			
All countries	33	46.4 (19.7)	
WCA	19	33.9 (7.8)	<0.001
ESA	14	63.4 (18.2)	
Proportion of demand for limiting childbearing among married or in-union women satisfied with modern FPC (%)			
All countries	33	5.3 (5.9)	
WCA	19	2.9 (2.2)	0.016
ESA	14	8.6 (7.6)	

N= Number of countries. SD= Standard deviation. *Independent t-test for difference between means (WCA and ESA).

Proportion of demand for limiting childbearing among married or in-union women. There was a significant positive global spatial autocorrelation (global Moran's I=0.3, p=0.001), indicating significant clustering of similar values in the proportion of demand for limiting childbearing among married or in-union women. The LISA cluster map shows that cold spots were concentrated in WCA (Figure 11). These spatial clusters of low proportion of demand for limiting childbearing among married or in-union women were made up of 11 neighboring countries (Benin, Burkina Faso, Cote d'Ivoire,

Gambia, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, and Sierra Lone) with (Figure 11). However, there were two spatial outliers of high-low (Ghana and Togo) contiguous with the cold spots in WCA. Hot spots were found in ESA. These high-high clusters included seven neighboring countries (Lesotho, Malawi, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe) with values higher than the mean (Figure 11). Bordering the hot spots were three outliers (Angola, Comoros and Mozambique), with lower proportion of demand for limiting childbearing compared with their neighbors (Figure 11).

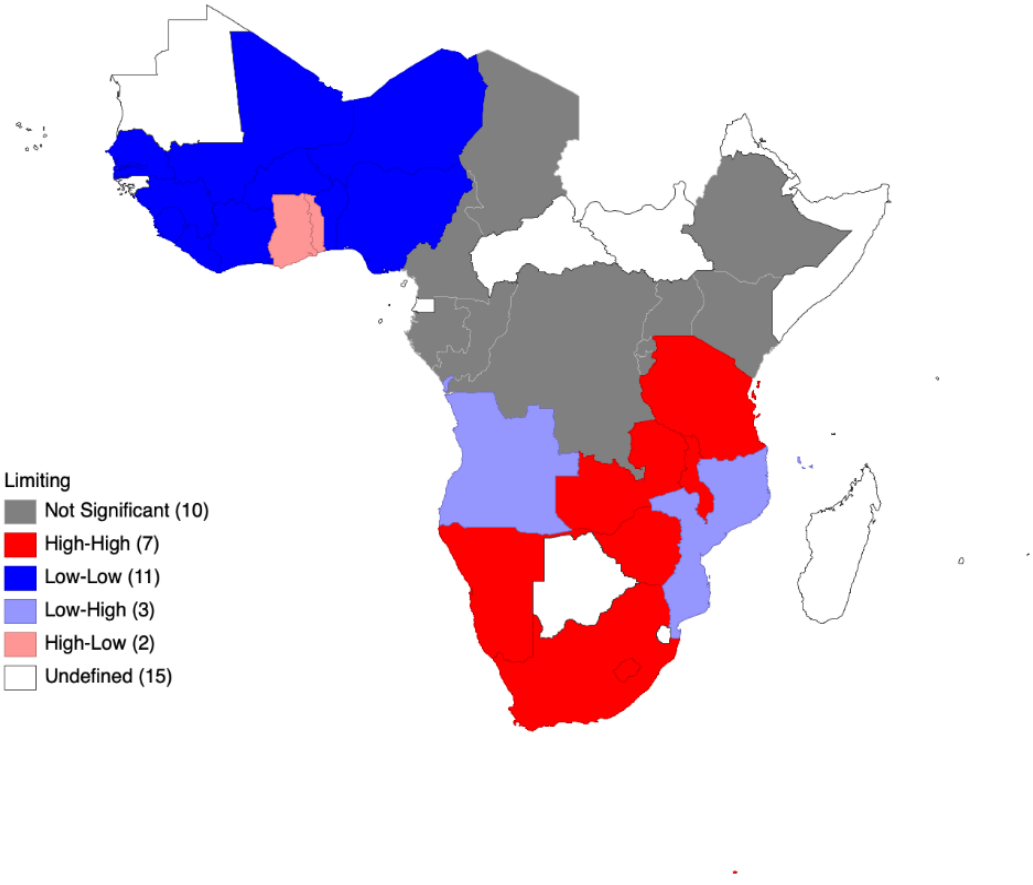

Figure 11: LISA cluster map of proportion of demand for limiting childbearing among married or in-union women.

Proportion of demand for limiting childbearing satisfied with modern contraceptive methods among married or in-union women. There was a significant positive global spatial autocorrelation (global Moran's I=0.2, p=0.004), indicating significant clustering of similar values in the proportion of demand for limiting childbearing satisfied with modern contraceptive methods across the countries. Spatial clusters with low proportion of demand for limiting childbearing satisfied with modern contraceptive methods were concentrated in WCA (Figure 12). These cold spots included 11 neighboring countries (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea, Liberia, Mali, Niger, Nigeria, Sierra Lone, and Togo) (Figure 12). However, there was one outlier of high-low (Senegal) contiguous with the cold spots in WCA (Figure 12). In ESA, Malawi was a hotspot (Figure 12). Mozambique and Comoros were two outliers in ESA, with lower proportion of demand for limiting childbearing satisfied with modern contraceptive methods compared with their neighboring countries (Figure 12).

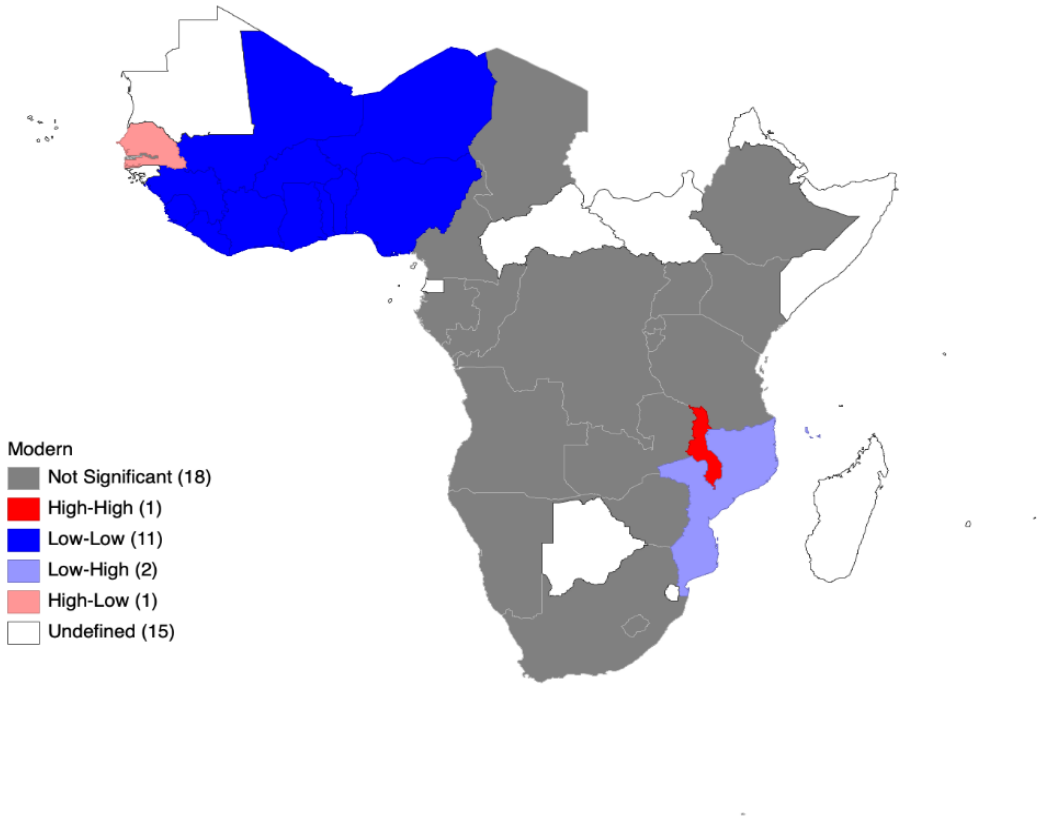

Figure 12: LISA cluster map of proportion of demand for limiting childbearing satisfied with modern contraceptive methods among married or in-union women.

Proportion of Demand for limiting childbearing satisfied with FPC among married or in-union women. The global Moran's I statistic was positive and significant for spatial distribution of the proportion of demand for limiting childbearing satisfied with FPC among married or in-union women (global Moran's I=0.1, p=0.008), indicating significant clustering of similar values across the countries. The LISA cluster map shows concentration of cold spots in WCA (Figure 13). These spatial clusters of low proportion of demand for limiting childbearing satisfied with FPC relative to the mean were made up of 10 neighboring countries (Benin, Burkina Faso, Cote d'Ivoire, Guinea, Liberia, Mali, Niger, Nigeria, Sierra Lone, and Togo) (Figure 13). There were two outliers

(Ghana and Gambia) with high proportion of demand for limiting childbearing satisfied with FPC contiguous to countries with low proportion of demand for limiting childbearing satisfied with FPC (Figure 13).

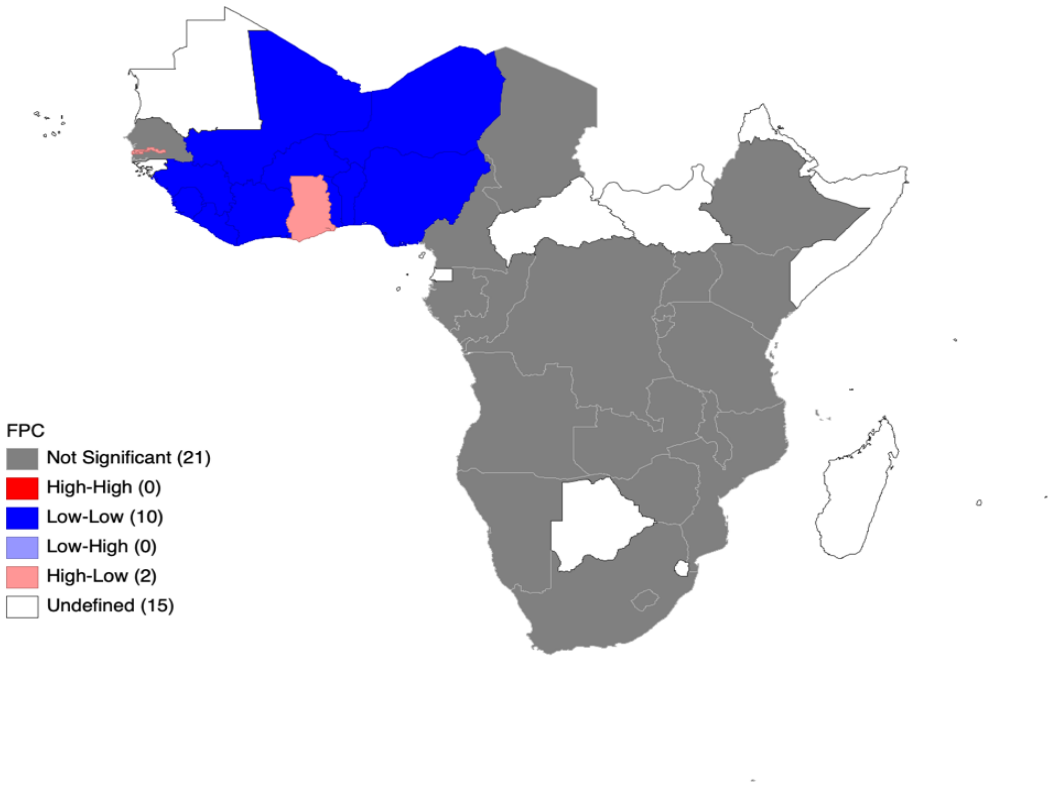

Figure 13: LISA cluster map of proportion of demand for limiting childbearing satisfied with FPC among married or in-union women.

Multilevel Logistic Regression Analyses

Measures of variations (random effects). From the fixed intercept of the empty model, the odds of using FPC in a typical country was 0.087(not shown). However, the odds of using FPC varies considerably across the countries. As shown in Model 1

(empty model), there was a significant variation in the odds of using FPC across the 33 countries (σ^2 =0.815, 95%CI=0.488-1.362) (Table 10). The ICC was 19.9% (Table 10). This indicates that approximately 20% of the variance in the odds of using FPC to limit childbearing was accounted for by the countries in the study, while 80% of the variance was accounted for by the individual or other unknown factors. The MOR of 2.36 in the empty model also indicated considerable heterogeneity between the countries (Table 10). If a woman moved to another country with a higher probability of FPC use, their odds of using FPC would (in median) increase 2.36 times.

After adjusting for the individual-level factors and survey year in Model 2, the variation in the odds of using FPC across the countries remained significant (σ^2= 0.669, 95%CI=0.367-1.219) (Table 10). The ICC decreased to 16.9% and the unexplained heterogeneity between the countries was reduced to an MOR of 2.17 (Table 10). The proportional change in variance in the odds of using FPC compared with the empty model showed that 18% of the variance in the odds of using FPC was explained by the individual-level factors in the study (Table 10).

In Model 3, after adjusting for the country-level factors and survey year, the variation in the odds of using FPC across the countries remained significant (σ^2= 0.428, 95%CI=0.252-0.752) (Table 10). The ICC was 11.5% and the unexplained heterogeneity between the countries was reduced to an MOR of 1.86 (Table 10). The proportional change in variance in the odds of using FPC showed that 48% of the variance in the odds of using FPC in the empty model was explained by the country-level factors in the study (Table 10).

In the full model (Model 4), after adjusting for the individual- and country-level factors and survey year, the variation in the odds of using FPC across the countries remained significant (σ^2= 0.417, 95%CI=0.229-0.761). The ICC slightly decreased to 11.3% and there was a marginal reduction in MOR to 1.85 (Table 10). The full model showed that 49% of the variance in the odds of FPC in the empty model was attributable to the individual- and country-level factors considered in this study (Table 10).

Measures of associations (fixed effects). The results of Model 2 which included the individual-level factors after adjusting for the survey year are shown in Table 10. Age, living children, household wealth, area of residence, decision maker, and ideal and living children were statistically significant. For every one unit increase in age, the odds of using FPC increased by 1.101 (95%CI=1.084-1.118). Similarly, for every one unit increase in the number of living children, the odds of using FPC increased by 1.097 (95%CI=1.041-1.155). Compared with women from poor households those from rich households had higher odds of using FPC (OR=1.380, 95%CI=1.171-1.626). Women residing in rural areas had lower odds of using FPC compared with those who resided in urban areas (OR=0.828, 95% CI=0.709-0.968). Women whose partners or others made contraceptive decision (OR=2.452, 95%=1.962-3.065) or who made joint contraceptive decision with their partners (OR=1.683, 95%=1.426-1.986) had higher odds of using FPC compared with women who made the decision by themselves. The odds of using FPC was significantly higher among women whose number of living children was less than their ideal number of children (OR=1.391, 95%CI=1.203-1.609).

The results of Model 3 which contained the country-level variables are shown in Table 10. After adjusting for survey year, births attended by skilled health providers and total fertility rate were the only significant factors. For every one unit increase in the births attended by skilled health providers, the odd of using FPC increased by 1.025 (95%CI=1.005-1.046). Similarly, for every one unit increase in total fertility rate, the odds of using FPC increased by 1.714 (95%CI=1.105-2.659).

In the full model (Model 4) that included all the individual- and country-level factors, after adjusting for survey year, all the individual-level factors that were significant in Model 2 (age, living children, household wealth, area of residence, decision maker, and ideal and living children) remained statistically significant. While for country-level factors, births attended by skilled health providers remained significant as in Model 3, but total fertility rate was no longer statistically significant. However, density of medical doctors which was not significant in Model 3 became significant in the full model. The results of Model 4 are shown in Table 10. For every one unit increase in age, the odds of using FPC increased by 1.100 (95%CI=1.083-1.118). Also, for every one unit increase in the number of living children, the odds of using FPC increased by 1.110 (95%CI=1.044-1.159). Compared with women from poor households those from rich households had higher odds of using FPC (OR=1.391, 95%CI=1.180-1.640). Women residing in rural areas had lower odds of using FPC compared with those who resided in urbans areas (OR=0.828, 95% CI=0.709-0.968). Women whose partners or others made contraceptive decision (OR=2.457, 95%=1.966-3.072) or who made joint contraceptive decision with their partners (OR=1.683, 95%=1.426-1.986) had higher odds of using FPC compared with women wo made the decision by themselves. The

odds of using FPC was significantly higher among women whose number of living children was less than their ideal number of children (OR=1.400, 95%CI=1.210-1.619). For every one unit increase in the births attended by skilled health providers, the odd of using FPC increased by 1.025 (95%CI=1.003-1.047). Similarly, for every one unit increase in the density of medical doctors, the odd of using FPC increased by 1.369 (95%CI=1.014-1.847).

Table 10: *Results of multilevel logistic regression models comparing the use of FPC with other modern contraceptive methods among married or in-union with demand for limiting childbearing satisfied with modern contraceptive methods*

Variables	Model 1 OR (95% CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
Fixed effects				
Control variable				
Survey year				
2010		Reference	Reference	Reference
2011		1.825 (0.238-13.975)	2.165 (0.392-11.950)	2.030 (0.295-13.954)
2012		5.769 (0.718-46.335)	6.168 (0.967-39.326)	8.791 (1.137-67.932)
2013		3.749 (0.551-25.523)	5.370 (1.068-27.008)	3.965 (0.649-24.231)
2014		5.128 (0.720-36.504)	4.463 (0.803-24.817)	4.074 (0.546-30.386)
2015		4.637 (0.626-34.370)	4.634 (0.824-26.065)	3.914 (0.540-28.362)
2016		5.790 (0.795-42.142)	2.845 (0.467-17.336)	3.168 (0.423-23.752)
2017		1.946 (0.222-17.088)	2.159 (0.305-15.269)	2.474 (0.281-21.772)
2018		2.428 (0.306-19.298)	3.848 (0.638-23.221)	4.138 (0.558-30.705)
Individual-level factors				
Age (P)		1.101 (1.084-1.118)***		1.100 (1.083-1.118)***
Education (P)				
None		Reference		Reference
Primary		1.004 (0.837-1.203)		0.991 (0.827-1.187)
Secondary or higher		1.026 (0.812-1.295)		1.001 (0.792-1.265)
Husband/partner's age (P)		1.005 (0.995-1.014)		1.005 (0.995-1.014)
Husband/Partner's education (P)				
None		Reference		Reference
Primary		1.121 (0.909-1.382)		1.113 (0.902-1.372)
Secondary or higher		1.147 (0.910-1.445)		1.138 (0.903-1.436)
Union (P)				
Monogynous		Reference		Reference
Polygynous		0.927 (0.782-1.099)		0.933 (0.787-1.107)
Household wealth (E)				
Poor		Reference		Reference
Middle		0.971 (0.814-1.157)		0.974 (0.818-1.161)

Variables	Model 1 OR (95% CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
Rich		1.380 (1.171-1.626)***		1.391 (1.180-1.640)***
Area of residence (E)				
Urban		Reference		Reference
Rural		0.828 (0.709-0.968)*		0.828 (0.709-0.968)*
Decision maker (E)				
Mainly respondent		Reference		Reference
Joint decision		1.683 (1.426-1.986)***		1.683 (1.426-1.986)***
Mainly husband/partner or others		2.452 (1.962-3.065)***		2.457 (1.966-3.072)***
Media (E)				
No		Reference		Reference
Yes		0.998 (0.877-1.137)		1.002 (0.880-1.140)
Living children (N)		1.097 (1.041-1.155)**		1.110 (1.044-1.159)***
Number of sons (N)		1.025 (0.972-1.080)		1.025 (0.972-1.081)
Ideal and living children (N)				
Living equal or greater than ideal		Reference		Reference
Living less than ideal		1.391 (1.203-1.609)***		1.400 (1.210-1.619)***
Wantedness (N)				
Wanted then		Reference		Reference
Wanted later		0.969 (0.821-1.145)		0.968 (0.820-1.143)
Wanted no more		1.129 (0.977-1.306)		1.123 (0.971-1.299)
Country-level factors				
Literacy rate (P)			1.007 (0.986-1.029)	1.012 (0.988-1.035)
Poverty rate (E)			0.979 (0.955-1.003)	0.984 (0.958-1.110)
Births attended by skilled health providers (E)			1.025 (1.005-1.046)*	1.025 (1.003-1.047)*
Density of medical doctors (E)			1.298 (0.978-1.723)	1.369 (1.014-1.847)*
Gross national income (E)			1.000 (1.000-1.000)	1.000 (0.962-1.009)
Out-of-pocket expenditure (E)			0.989 (0.967-1.010)	0.985 (0.962-1.009)
Rural population (E)			1.012 (0.982-1.043)	1.007 (0.975-1.041)
Total fertility rate (N)			1.714 (1.105-2.659)*	1.317 (0.809-2.144)
Under-five mortality rate (N)			1.006 (0.986-1.026)	1.004 (0.983-1.025)
Random effects				
Country level				

Variables	Model 1 OR (95% CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
Variance (SE)‡ 95%CI	0.815 (0.213)*** (0.488-1.362)	0.669 (0.205)*** (0.367-1.219)	0.428 (0.115)*** (0.252-0.725)	0.417 (0.128)*** (0.229-0.761)
PCV (%)	Reference	17.9	47.5	48.8
ICC (%)	19.9 (12.9-29.3)	16.9 (10.0-27.0)	11.5 (7.1-18.1)	11.3 (6.5 -18.8)
MOR	2.36	2.17	1.86	1.85

P= Predisposing. E= Enabling. N= Need. OR = Odds ratio. CI = Confidence Interval. PCV= Proportional change in variance. ICC= Intra-country correlation coefficient. MOR = Median odds ratio. ***p <0.001; **p <0.01; *p<0.05; SE= Standard error. ‡ Standard error was used to calculate one-tail p-value for the variance.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

This chapter focusses on interpretation of the findings, their relevance, and how they compare with similar studies in other settings. The strength and limitations of this study are also highlighted in this chapter. This chapter concludes with recommendations for policy, practice, and future research.

Summary of Findings

This study adds to the sparse body of evidence on the use of FPC in SSA by providing insight into the uptake, geographical pattern, and determinants among married or in-union women. Using data from DHS (2010-2018) and other global data repositories, this study investigated the demand for limiting childbearing satisfied with FPC among married or in-union women aged 15-49 years in 33 countries in SSA. The study also examined the spatial patterns in the demand for limiting childbearing and demand for limiting childbearing satisfied with modern contraceptive methods as well as FPC using exploratory spatial data analysis techniques. Multilevel logistic regression models were fitted to determine the individual- and country-level predisposing, enabling, and need factors associated with the use of FPC among married or in-union women with demand for limiting childbearing satisfied with modern contraceptive methods.

The results showed that approximately 7% of the demand for limiting childbearing was satisfied with FPC among married and in-union women. The proportion of demand for limiting childbearing satisfied with FPC was highest among women: 40 years and older, with 3-4 living children, with formal education, from rich

households, and urban dwellers. There was a significant positive global spatial autocorrelation in the proportion of demand for limiting childbearing, the proportion of demand for limiting childbearing satisfied with modern methods, and the proportion of demand for limiting childbearing satisfied with FPC across the 33 countries, with low-low clusters concentrated in WCA. From the multilevel logistic regression, the odds of using FPC varied considerably across the 33 countries. In the full model, the individual-level factors associated with the use of FPC compared with other modern methods were age (predisposing), number of living children (need), difference between ideal and living children (need), household wealth (enabling), residence (enabling), decision maker (enabling), while the associated country-level factors were births attended by skilled health providers (enabling) and density of medical doctors (enabling).

Demand for Limiting Childbearing Satisfied with FPC among Married or In-Union Women

Despite its many positive attributes (The RESPOND Project, 2014), the results showed that the proportion of demand for limiting childbearing satisfied with FPC is low among married or in-union women in SSA. Regarding specific countries, these findings in this study were lower than an older study by Rutenberg and Landry (1993) that reported the proportion of demand for limiting childbearing among married women satisfied with FPC as 15% and 5% in Kenya and Zimbabwe, respectively. In the 80s, through funding provided to the International Program of the Association of Voluntary Sterilization (now EngenderHealth), some countries in SSA, including Kenya were supported for provision of voluntary surgical contraception (Frank, 1987). Zimbabwe

family planning program was also highly donor supported (Boohene & Dow, 1987). In other developing countries such as Dominican Republic, El-Salvador, Sri Lanka, and Thailand, Rutenberg and Landry (1993) reported that at least 50% of the demand for limiting childbearing among married women was satisfied by FPC.

Different barriers operating at multiple levels affect the use of FPC in SSA (Olakunde et al., 2019). Being a surgical procedure, access is one of the important factors inhibiting its use in SSA. Access to surgical care is very low in SSA, with more than 95% of the population not having access (based on four dimensions: surgical capacity, timeliness, safety, and affordability) (Alkire et al., 2015). In family planning, access has been defined as "the degree to which family planning services and supplies may be obtained at a level of effort and cost that is both acceptable to and within the means of a large majority of the population" (Bertrand et al., 1995, p.65).

Geographic and physical accessibility or the extent to which permanent contraception services are widely available or located, such that a large population of women who want to limit childbearing can reach them with at an acceptable level, may account for the low uptake of FPC services observed in this study (Ross & Hardee, 2013). In many countries in SSA, a significant proportion of health facilities that provide family planning services do not offer FPC services. From surveys that assessed availability (including readiness) to provide family planning services in 10 African countries between 2012 and 2015, the percentage providing family planning services out of the 82 to 1,555 health facilities assessed in the countries, ranged from 33% in Democratic Republic of Congo to 96% in Niger (Ali et al., 2018). However, the percentage providing FPC services ranged from 0% (out of 288 facilities) in Mauritania

to 15% (out of 209 facilities) in Uganda (Ali et al., 2018). FPC services are more likely to available in hospitals than smaller health facilities (Speizer et al., 2000).

Although availability is a necessary factor, it is not the only factor determining the use of FPC by women with demand for limiting childbearing. Even when available, economic accessibility—"the extent to which the costs of reaching service delivery or supply points and obtaining contraceptive services and supplies are within the economic means of a large majority of the target population" (Bertrand et al., 1995, p.65)— can also be a limiting factor to FPC in SSA. In Africa, cost remains a barrier to contraceptive use (Sedgh & Hussain, 2014). While surgical care in Africa may not be relatively high compared with other regions, it is majorly paid out-of-pocket. Paying out-of-pocket for surgical care can be catastrophic to the poor (Bijlmakers et al., 2019; Rajaguru et al., 2019; Shrime et al., 2015).

Provider bias in some of the countries studied may also have contributed to the low utilization of FPC among women with demand for limiting childbearing satisfied with modern methods (Solo & Festin, 2019). Tumlinson et al. (2015) studied the prevalence of service provider-imposed barriers to family planning in Kenya, and a sizeable proportion of providers who offered FPC reported restricting FPC based on age, parity, and marriage (Tumlinson et al., 2015). For example, of the 230 providers who offered FPC, 45.5% indicating that a woman must have at least three children (Tumlinson et al., 2015).

Low awareness and poor knowledge of FPC may also be affecting its uptake in SSA. A study that examined knowledge and attitude towards FPC among 383 women attending antenatal care in a tertiary hospital in Nigeria reported that about 53% had

never heard of FPC, while only 36% knew what it meant and 19.1% were aware of its level of effectiveness (Enyindah et al., 2018). Similar findings have been reported in other settings where only about 40-56% of the respondents had heard of FPC (Abajobir, 2014; Alemayehu et al., 2012; Takele et al., 2012). The surgical nature of FPC, myths and misconceptions about its safety, and issues that may arise following the procedure make it unappealing to some women in SSA (Akpor et al., 2016; Alemayehu et al., 2012; Babalola & John, 2012; Enyindah et al., 2018; Gebremariam & Addissie, 2014; Machiyama et al., 2018; Meskele & Mekonnen, 2014). The permanent nature of FPC can also be a barrier in SSA (Credé et al., 2012; Enyindah et al., 2018). For some women, having children may become necessary following life circumstances such as death of child or remarriage (Akpor et al., 2016; Babalola & John, 2012). Indeed, longitudinal studies have shown that women's preference for limiting change over time (Cleland et al., 2020). For example, in studies conducted in Malawi and Mozambique, 21% and 30% of women changed from not wanting any more children at baseline to wanting more children over a period of one and three years, respectively. (Cleland et al., 2020). These psychological, attitudinal, or social factors (psychosocial access) could have accounted for the low demand for limiting satisfied with FPC observed in this study.

Remarkably, low uptake of FPC was not pervasive across the 33 countries. Countries like Namibia, Malawi, South Africa, and Tanzania in the ESA subregion had more than 15% of demand for limiting satisfied with FPC, with Malawi having up to 27%. Malawi's unique success story, notwithstanding the health system constraints, has been documented in literature (Jacobstein, 2013). Unlike, other African countries where it is

poorly used, FPC is the second most commonly used contraceptive method in Malawi (Jacobstein, 2013). The prevalence of FPC increased from 5% in 2000 to 10% in 2010, matching the prevalence in some high-income countries (Jacobstein, 2013). Jacobstein (2013) attributed this significant change to demand-side factors such as increase in the proportion of women with some education as well as knowledge of FPC and the desire to stop childbearing. On the supply side, the factors included enabling environment (e.g. task shifting policy that allows lower cadres healthcare workers to perform FPC), public–private partnerships, mobile outreach services, and provision of free FPC services.

Demand for Limiting Childbearing Satisfied with FPC among Married or In-Union Women by Sociodemographic Characteristics

There were disparities in the use of FPC among the different subcategories in the five assessed characteristics across the countries. However, only age and household wealth had a consistent pattern across all countries (pooled) and the subregions.

As observed, the proportion of demand for limiting childbearing satisfied with FPC among married or in-union women was highest among those 40 years and older. While this is not the age at procedure, in this age bracket, many women are likely to have completed childbearing and may desire limiting permanently. In some countries like Gambia and Niger, it was interesting that the proportion of demand for limiting childbearing satisfied with FPC was highest among young married or in-union women (15-29 years). However, this finding should be interpreted with caution, as the observed high proportion among these young women is largely as result of the small population

base of those with demand for limiting childbearing. in WCA and ESA, the average age at first birth has been estimated as 20.9 years and 22.2 years, respectively (Bongaarts et al., 2017). Thus, early onset of childbearing may have accounted for early completion of desired family size, and in turn the use of FPC to limit childbearing among some young married or in-union women in this study. In Brazil, Vieira and Ford (1996), reported that women who began childbearing at young age and had culturally acceptable number of children were more likely to have undergone the FPC procedure before 30 years of age. The use of effective contraceptive methods such as FPC is important among young married woman with demand for limiting childbearing. The odds of pregnancy or birth (intended or unintended) have been found to be higher among younger women (15-29 years) compared with older women (30-49 years) who wanted to stop childbearing (Machiyama et al., 2015). While women who use FPC at early age enjoy a longer duration of protection and its other benefits, it is critical to adequately counsel younger women as they are at increased risk of regret (Curtis et al., 2006).

Overall, this analysis also suggests that the proportion of demand for limiting childbearing satisfied with FPC was highest among those 3-4 living children. However, the category with the highest proportion varied considerably across the countries, with women having 0-2 living children recording the highest proportion in many of the countries in WCA. Again, this may be as a result of the very small population base of this category of women with demand for limiting childbearing (see Appendix 8). Although, the proportion was lowest among those with five or more living children, in absolute terms they accounted for the majority of the women who use FPC. On average, women with at least five births in SSA would have achieved their desired

family size (Bongaarts, 2011), and thus may be more receptive to FPC than women with fewer children. Among women with fewer living children, health, and economic reasons may be their motivating factors for permanently limiting childbearing.

This study also found that women with formal education had higher proportion of demand for limiting satisfied with FPC, overall. The relationship between education and fertility control is complex and may vary with context (Prata et al., 2017; Psaki et al., 2019), but generally, educated women are more likely to be aware of contraceptive methods, inclined to using them for fertility control, or have higher decision-making power regarding contraceptive use (Gordon et al., 2011; Hameed et al., 2014). The pattern in WCA was however different with uneducated women having the highest proportion. A similar finding has been reported in Brazil (Perpetuo & Wajnman, 2003).

The results also showed that the proportion of demand for limiting childbearing satisfied FPC was highest among women from rich households. This was consistent in both WCA and ESA. Wealthier women may be able to afford the cost of the FPC services in settings where they are not provided for free of charge or subsidized. The findings also suggested that married or in-union women who reside in urban areas have higher proportion of demand for limiting childbearing satisfied with FPC. Urban women are likely to have better access to FPC. Interestingly, the proportion was higher among rural women in WCA. Mobile outreach services in some countries improve access and contribute to uptake of FPC in rural areas (Casey et al., 2013; High-Impact Practices in Family Planning, 2014; Jacobstein, 2013; Wickstrom et al., 2013). Some women residing in rural areas opt for permanent rather than temporary contraception to avoid the burden of periodic travel or visit to service delivery points (EngenderHealth, 2002).

Spatial Patterns in the Demand for Limiting Childbearing and Satisfied

The significant global spatial autocorrelation provided evidence of spatial clustering in the proportion of demand for limiting childbearing, proportion of demand for limiting childbearing satisfied with modern contraceptive methods, and proportion of demand for limiting childbearing satisfied with FPC in the 33 countries included in this study. On the proportion of demand for limiting childbearing, the LISA map showed that neighboring countries with low values relative to the overall of mean (low-low clusters or cold spots) were concentrated in WCA, while neighboring countries with high values relative to the overall of mean (high-high clusters or hot spots) were concentrated in ESA. On the proportion of demand for limiting childbearing satisfied with modern contraceptive methods, similar pattern, particularly with concentration of cold spots in WCA was observed. A linear relationship has been shown between the demand for contraception and demand satisfied in SSA (Bongaarts & Hardee, 2017; Bongaarts, 2010). The explanatory spatial data analysis also showed that cold spots in the proportion of demand for limiting childbearing satisfied with FPC were concentrated in WCA. However, they were two outliers in the proportion of demand for limiting childbearing satisfied with FPC. Gambia and Ghana had high value of 8.0% and 7.7%, respectively, compared with their neighbors that all had values below the mean (except Democratic Republic of Congo).

Although no further spatial regression analysis was performed to examine the possible factors responsible for the observed spatial patterns in this study, the concentration of cold spots in WCA may be attributable to health systems, socioeconomic, or cultural factors peculiar to the subregion. Compared with ESA, higher

proportion of women in WCA cite access as one of the reasons for not using contraceptive methods (Sedgh & Hussain, 2014). Evidence also suggests that access to surgical care is lower in WCA (Alkire et al., 2015) and this may affect the availability of FPC which remains largely a surgical procedure in SSA. The lower child survival rate in WCA (Chao et al., 2018; Wang et al., 2014) may also account for the lower demand for limiting and the use of FPC. In explaining the wide subregional divide between western and eastern Africa in the uptake of modern contraception in Africa, Cleland et al. (2011), highlighted education in eastern African as important factor in addition to better access. According to their estimates, the percentage of married women who had completed primary education or higher increased from 13% in 1991 to 16% in 2004 in western Africa, while in eastern Africa the percentage increased from 24% to 46% over the same period (Cleland et al., 2011). Finally, there seems to be more political will and commitment to family planning in ESA, as evidenced by increasing success stories of programs from some of the countries in the sub-region (African Institute for Development Policy, 2012; Cahill et al., 2018; Jacobstein, 2013; Jacobstein et al., 2013; Olson & Piller, 2013).

Individual- and Country-level Determinants

In this study, individual-level predisposing, enabling, and needs factors and country-level enabling factors were found to be associated with the use of FPC among married or in-union women using modern contraceptive methods to limit childbearing. There is a dearth of studies on uptake of FPC conducted at other regional level for

comparison. However, some of the findings in this study are consistent with similar studies at country level.

This study found higher odds of FPC use with increasing age. This corroborates findings from other developing and developed countries (Anderson et al., 2012; Bass, 2013; Borrero et al., 2007; de Oliveira et al., 2014; Lunde et al., 2013; Perpetuo & Wajnman, 2003; Stephenson, 2006; Thind, 2005; White et al., 2015). Being a permanent contraceptive method, FPC may be less appealing to younger women whose fertility preference may change overtime (Sennott & Yeatman, 2012). Provider bias towards younger women (Tumlinson, et al., 2015) may also account for their lower odds of using FPC to limit childbearing.

Similar to studies in India that reported positive association between number of living children and FPC (de Oliveira et al., 2014) or permanent contraception (female and male) (Ghosh & Siddiqui, 2017) when compared with modern methods, the results showed that the odds of using FPC increased with number of living children. Owing to the high demand for children in SSA, women with fewer living children may not been willing to permanently limit birth, as the need for children or more children may arise. Desire for large families is still high in Africa compared with other regions (Ezeh et al., 2012). The unique slow fertility transition in Africa has been attributed to the slow economic development and pronatalism rooted in social and cultural norms in many societies (Bongaarts, 2017a). Medical reason may also partially explain higher uptake of FPC among women with more living children. To prevent maternal-related complications that may arise from subsequent pregnancies, women who have had many births, particularly through cesarean section, are more likely to be offered

permanent contraception by physicians (Hyginus et al., 2012). Policy and laws may also require women to have a specified number of living children before they can have FPC (EngenderHealth, 2002). In addition to number of living children, some studies in other developing countries have found the number of living sons to be associated with the use of FPC (de Oliveira et al., 2014; Hoq et al., 2019; Thind, 2005). However, number of living sons was not statistically significant in this study. On gender preferences in developing countries, analyses by Fuse (2010) revealed that unlike southern Asia, western Asia, and northern Africa, son preference was not pervasive in SSA, prevailing in only 16 of the 28 countries examined.

Contrary to expectation of this study, the results showed that women who had lower number of living children than their ideal number of children were more likely to use FPC. This observation cannot be easily explained, and it needs to be further explored in future studies. Nonetheless, “unrealized fertility” is common in SSA (Casterline & Han, 2017; Channon & Sarah, 2019), and factors such as socioeconomic constraints, competing alternatives, or health issues may make women or couples opt for permanent contraception despite not having achieved their desired number of children (Casterline & Han, 2017). It is also possible that some of these women who have not achieved their desired number of children may have been coerced into having the procedure. In a study in Zaire (now Democratic Republic of Congo), having fewer children than they would have desired was cited as the most common reason for regret among women who had FPC (Bertrand et al., 1991). In the study, 14% (63/453) indicated that they felt pressured, with 56% reporting by their husband and 34% by the doctor. It is also important to note that the variable “ideal number of children” has been

reported to have two sources of bias: non-response and rationalization (Bongaarts, 1990; Bongaarts & Casterline, 2013a; Casterline & El-Zeini, 2007). In DHS, to obtain information on ideal number of children, respondents are asked "If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?". A number of respondents provide nonnumeric response such as “it is up to God” or “as many as possible” or no response to the question (Bongaarts, 1990). Although, this bias has declined over time (Bongaarts & Casterline, 2013a), a study that analyzed survey data from Costa Rica reported that women who had FPC were approximately 2.5 times as likely to provide a nonnumeric response as were non-sterilized women (Riley et al., 1993). Secondly, women also tend to inflate their ideal number of children to avoid reporting a number lower than their current number of living children (Bongaarts, 1990). How to handle the variable “ideal number of children” in literature remains unresolved. While some have limited the population to younger women who are less likely to inflate their ideal number of children (Bongaarts, 2010, 2011), some have included nonnumeric response in their analyses (Upadhyay & Karasek, 2012). In this present study nonnumeric responses (5%) were excluded, and may have constituted some bias (Olaleye, 1993).

In line with similar studies in developing countries that have a reported positive association between economic status as an enabling factor and the use of FPC (Edmeades et al., 2011; Hoq et al., 2019; Perpetuo & Wajnman, 2003), this study found higher odds of using FPC among married or in-union women from rich households. In settings where FPC requires a high out-of-pocket payment, women or couples with low income may not be able to afford it. Even in developing countries where FPC are

designed to be a free service, clients may still incur high out-of-pocket expenditure (Mohanty et al., 2020).

Compared with urban dwellers, there was lower uptake of FPC among women in rural areas. FPC services are less likely to be available and accessible in rural areas (Speizer et al., 2000). In India, Ghosh and Siddiqui (2017) found that the remoteness of a village (defined as distance to the nearest town), increased the likelihood of using reversible modern method rather than permanent method. Similar finding was also reported in Brazil (Perpetuo & Wajnman, 2003) and India (Stephenson, 2006). However, in developed countries like the U.S., rural women have been found to have higher odds of using FPC (Bass, 2013; Lunde et al., 2013). While the reason for the higher prevalence in rural areas are not clear, Lunde et al. (2013) opined that it might be due to less access to reversible methods.

These results also establish the influential role male partners play in decision making with regard to contraceptive use and choice in Africa (Daniele et al., 2018; Shattuck et al., 2011; Terefe & Larson, 1993). Power imbalances as result of traditional socio-cultural norms, economic differences, and age disparities allow male partners to influence reproductive health decision making in patriarchal societies that exist in many Africa countries (Blanc, 2001; Ezeh, 1993; Kriel et al., 2019). Women in SSA often cite partners opposition as one of the reasons why they do not use contraception (Balogun et al., 2016; Sedgh & Hussain, 2014), including FPC (Bertrand et al., 1989; Mbugua, 2013; Mota et al., 2015; Takele et al., 2012). Given the permanent nature of the procedure, married or in-union women may be reluctant to make the decision alone to avoid consequences such as intimate partner violence, separation, divorce, and

extramarital affairs (Alemayehu et al., 2012; Chibalonza et al., 1989; Lutala et al., 2011; Mbugua, 2013). Evidence has shown that joint fertility intention to stop childbearing (Bankole & Singh, 1998), in addition with interspousal communication, (Avogo & Agadjanian, 2008; Bawah, 2002; Coomson & Manu, 2019; Okigbo et al., 2017; Sileo et al., 2015; Tilahun et al., 2015) improves uptake of contraceptive use, and may have accounted for the inreased odds of FPC use among those who jointly made descision with their male partners.

Unlike other studies in developing countries that found association between the use of FPC and education (Hoq et al., 2019; Perpetuo & Wajnman, 2003; Stephenson, 2006), exposure to family planning messages (de Oliveira et al., 2014; Thind, 2005), number of sons (de Oliveira et al., 2014; Hoq et al., 2019; Thind, 2005), and husband/partner's age (Hoq et al., 2019), there was no enough evidence to suggest such associations in this study. Perhaps the different population or the focus on a region rather the individual country may account for these differences.

On the country-level factors, the odds of using FPC among married or in-union women with demand for limiting childbearing satisfied with modern contraceptive methods were significantly higher in countries with a higher proportion of births attended by skilled health providers. Although the cadres of personnel that constitute skilled birth attendants differ by country (Adegoke et al., 2012), positive relationship between births attended by skilled health providers and contraceptive use have been previously reported in studies conducted at the individual level (Mengesha et al., 2015; Rutaremwa et al., 2015). As a contextual enabling factor in this study, this finding may reflect access to FPC services in the countries assessed. For example, when a delivery is assisted by

an obstetrician, it may increase the chances of performing post-partum FPC, immediately after vaginal or abdominal birth for women who desire it. Also, given the positive correlation between antenatal care visits (particularly at least four visits) and births attended by skilled health providers in SSA (Baatiema et al., 2019; Jacobs et al., 2017; Nyongesa et al., 2018), it is possible that in countries where high proportion of births are assisted by skilled health providers, women may have received counselling about FPC as an effective contraceptive option for limiting during antenatal care, increasing their preference for it (Balogun et al., 2017). In Brazil, the use of prenatal care was found to be positively associated with the use of FPC (Rodrigues & Moji, 1995).

The higher of odds of using FPC in countries with more doctors also illustrates the importance of access to the procedure. Although task sharing to non-doctors such as clinical officers and other mid-level providers as recommended by the WHO (WHO, 2012b) is increasing, particularly in countries in ESA (Gordon-Maclean et al., 2014; Jacobstein, 2013; Nuccio et al., 2016), there are still restrictions on health care cadres that can perform FPC in many countries with shortages of doctors (The RESPOND Project, 2014). Thus, not having enough doctors that can provide the services may impact on availability. Further, evidence indicates that postpartum FPC is more likely to be performed with a cesarean delivery (Amaral, 2019; Moniz et al., 2017; Swende & Hwande, 2010). Countries with more skilled doctors may have higher rates of cesarean sections (Briand et al., 2012; Pearson & Shoo, 2005), and consequently FPC procedures.

Strengths and Limitations

The strength of this study lies in the use of pooled data from 33 countries to provide evidence on demand for limiting childbearing satisfied with FPC in SSA. To the best of the author's knowledge, this would be the first study to report on demand for limiting childbearing satisfied with FPC from such a high number of countries in Africa. Beyond choropleth mapping of geographical distribution of uptake of FPC among married or in-union women, the study used exploratory spatial data analysis techniques to show evidence of clustering in the use of FPC. In addition to individual-level factors, the use of multilevel model analyses also allowed for the examination of the contextual (country-level) factors that affect the uptake of FPC. With over 30 countries, the estimates of the country effects in this study are likely to be reliable (Bryan & Jenkins, 2016). Nonetheless, despite the strengths of this study, there are a few limitations. Considering the cross-sectional nature of the survey, causality cannot be inferred from the findings. There is also possibility of underreporting of FPC among some of the women due to its sensitivity (Choi et al., 2019). The surveys included in the study were conducted at different time points. However, this limitation was minimized by controlling for the year of survey in the regression models. Also, for some of the country-level variables, the most recent available data used did not correspond with the DHS survey year. Although, initially included as some of the important individual-level factors to be explored, religion and insurance coverage were eventually excluded from the analysis because they were not reported in all the countries. Other variables of interest at individual level such as presence of chronic health conditions (e.g., HIV infection or hypertension) could also not be included because they were not available in DHS.

These findings are also not generalizable to all women. The study was restricted to married or in-union women because of the assumption that they are at increased the risk of pregnancy, and may be more willing to limit childbearing compared with unmarried women. Cultural sensitivity in some African settings may also result in reporting bias on contraceptive use among unmarried women (Fabic & Jadhav, 2019).

Conclusions

Women with demand for limiting childbearing constitute an important population requiring effective contraceptive methods to prevent unwanted pregnancies. For these increasing proportion of women in SSA, FPC offers a safe, beneficial, and cost-effective option to permanently stop childbearing. However, the uptake remains low, as shown by the low demand for limiting childbearing satisfied with FPC in many of the 33 countries included in this study, particularly countries in the WCA subregion. Differences in the proportion of demand for limiting childbearing satisfied with FPC by sociodemographic characteristics suggest disparities in the use of FPC. Exploratory spatial analysis of the proportion of demand for limiting childbearing satisfied with FPC shows concentration of cold spots (low-low clusters) in WCA. The results of the study also indicate that both individual- and country-level determinants account for the variation in the use of FPC among married or in-union with demand for limiting childbearing satisfied with modern contraceptive methods in SSA. These findings have implications for policy, practice, and future research.

Implications for policy and practice. In line with SDG target 3.7, in addition to other reversible methods, countries with low uptake of FPC need to put in place

interventions that can improve geographic, economic, psychosocial, and cognitive access to the method. As suggested by some of the significant enabling factors in this study, availability and affordability may be limiting the use of FPC among women with demand for limiting childbearing in SSA. If readily accessible, women in SSA have expressed willingness to use the FPC when they complete childbearing (Abajobir, 2014; Enyindah et al., 2018; Lutalo et al., 2015; Makhathini et al., 2019). Evidence has shown that reduced cost of services, mobile outreach, and task shifting to lower cadre providers could improve uptake of FPC in SSA (Jacobstein, 2013; Nuccio et al., 2016; Rodriguez & Gordon-Maclean, 2014). As observed in this study, the willingness to limit birth and the use of FPC is not restricted to older women or those with high number of living children. Thus, policies are required to prevent provider bias, which can also be a limiting factor (Solo & Festin, 2019). As recommended by the International Federation of Gynecology and Obstetrics Committee for the Ethical Aspects of Human Reproduction and Women's Health, adult women who have freely made an informed choice to use FPC, should face minimum barriers in undergoing the procedure (Dickens, 2011). Some developing countries that operate laws or guidelines that restrict the provision of FPC to women who meet certain age, parity, or male partner consent requirement (EngenderHealth, 2002) may need to revisit their laws. The significance of having an adequate number of trained human health resources to provide surgical contraceptive services was also highlighted in this study. Indeed, Africa is underserved in terms of the density of obstetricians. (Choo et al., 2010; Holmer et al., 2015; Linden et al., 2012; Notrica et al., 2011). Policies are needed to address the diverse health workforce challenges in Africa, including brain-drain, poor compensation and working condition,

and mal-distribution (Anyangwe & Mtonga, 2007; Chen et al., 2004). Engaging male partners should be a critical component of interventions targeted at improving uptake of FPC in SSA. While a partner's consent should not be a requirement, interspousal communication or joint counselling should be encouraged in practice (Dickens, 2011). Finally, policies on the provision of FPC should guard against forced or coerced services, some of which have been reported, particularly among HIV-infected women in Africa (Bi & Klusty, 2015; Rowlands & Amy, 2018). In practice, intending clients should be given the required information to make an informed decision, and consent should be obtained before performing the procedure.

Implication for research. Although not many, this study has shown that some married or in-union women who desire to stop childbearing in SSA opt for FPC. Qualitative studies are needed to further understand the decision-making process among women and their male partners who choose to use FPC. The use of spatial regression analysis is recommended to investigate the factors accounting for the observed clustering in the study. Further investigation is needed to understand why the outliers (e.g., Ghana and Gabon) are different from their neighboring countries. The individual- and country-level factors associated with the use of FPC among married or in-union women with demand for limiting childbearing in this study are at regional level, and they may vary for specific countries. Thus, individual-level and other contextual factors specific to each country need to be further examined. As the results suggest, unavailability of skilled providers such as physicians that can provide FPC may be limiting the uptake of FPC in many SSA countries. Task sharing FPC procedure to non-physicians as recommended by the WHO can potentially address this barrier (WHO,

2012). While findings on safety, effectiveness, and acceptability from available studies in SSA are encouraging (Barone et al., 2018; Gordon-Maclean et al., 2014; Nuccio et al., 2016), the evidence on task sharing remains limited. Furthermore, research is needed for the development of safe and effective non-surgical FPC that can be easily performed by both physicians and non-physicians in low-resource settings. Non-surgical FPC may also be more appealing to women seeking to limit birth in SSA. Lastly, the majority of the evidence on failure and regret, particularly from longitudinal studies, and the cost-effectiveness of FPC has come from developed countries. Further studies are needed on these topics in SSA.

APPENDICES

Appendix 1: *Literature on Factors Associated with the Use of Female Permanent Contraception in SSA*

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
Getahun et al. (2018)	Ethiopia	To determine the prevalence and factors associated with long acting and permanent contraceptive methods (LAPM) among married reproductive age (15–49) females at Janamora district	Community-based cross sectional	730 married women of reproductive age group	Prevalence of LAPM was 12.9%. The prevalence of female sterilization was 0.3%, accounting for 2.1% of LAPM. Student (vs housewife), Government employed husband (vs merchant), good knowledge of long-acting and permanent contraceptive methods (vs poor knowledge) had higher odds of utilizing LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.
Bakibinga et al. (2019)	Zambia	To understand factors behind the current utilization of injectable, long acting and permanent methods (iLAPMs)	Secondary data analysis of the Zambia Demographic and Health Surveys (1992-2013/14)	Married women of reproductive age group 1992=(n=620) 1996 (n=1176) 2001/02 (n=1483) 2007 (n=1665) 2013/2014 (n=4394)	Desire for children (across all data point), Age (except in 2007) were associated with the utilization of iLAPMs. Education of the woman and partner, Number of living children, Heard about family planning in last 12 months, Ethnicity,	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception.

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
					Type of residence, Main decision maker on woman's health were associated with the utilization of iLAPMs in at least one or more data points.	Contextual factors were not investigated.
Abajobir (2014)	Ethiopia	To assess the intention and factors associated with LAPM among married women 15-49 years in Debremarkos	Community-based cross sectional	343 married women	45.9% intended to use long-acting and permanent family planning either to space or limit birth. 20.3 (23/113) intended to use female sterilization in future Age 30-44 years, educational status, discussion on family planning methods with husband, desire for live children, ever and current use of any modern contraceptive methods and shifting from one method to the other were factors associated with intention to use LAPM	The study assessed intention to use, which may not translate to actual use
Bulto et al. (2014)	Ethiopia	To assess demand for LAPM and associated factors among married women of	Community-based cross sectional	519 married women	The prevalence of LAPM was 19.5%. The prevalence of female sterilization was 0.2%;	The factors were not disaggregated by contraceptive methods Thus,

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
		reproductive age group in Debre Markos town			accounting for 0.5% of LAPM. Being in the older age group (40-44 years), having no desire for more child, desire to have a child after 2 years, not ever heard of modern, not ever using of modern family planning and having no spousal discussion in the last six month were significantly positively associated with demand for LAPM	may not be specific to permanent contraception. Contextual factors were not investigated.
Mota et al. (2015)	Ethiopia	To assess factors associated with unmet need of LAPM among women in the reproductive age group (15-49) using contraception in health facilities of Shashemene	Facility-based cross sectional	382 women of reproductive age group, using contraception	Prevalence of LAPM (among 366 married respondents) was 28.4%. The prevalence of female sterilization was 0.3%, accounting for 1% of LAPM). Education of women (< secondary level), lack of discussion between partners; lack of proper counseling for women; women's occupation (housewife) were	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
					significantly associated with unmet need of LAPM	
Alemayehu et al. (2012)	Ethiopia	To assess factors associated with utilization LAPM among married women of reproductive age group in Mekelle town.	Community-based mixed methods (Cross sectional and focus group discussion)	460 married women of reproductive age 8 married women of reproductive age group and married men for FGD	The prevalence of LAPM methods use was 12.3%. None of the women used tubal sterilization Women who had high knowledge of long-acting and permanent contraceptive methods (vs low knowledge); women who had two or more pregnancies (vs one pregnancy) had higher likelihood of using LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.
Mekonnen et al. (2014)	Ethiopia	To assess the prevalence and factors affecting LAPM	Community based mixed methods (Cross sectional and focus group discussion)	763 women of reproductive age group in cross sectional survey 32 women of reproductive age group for FGD	2.6% used female sterilization, representing 35.7% of LAPM (prevalence of LAPM was 28.4%) Women with knowledge on long acting and permanent methods, women ≥25 years were more likely to use LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception.

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
						Contextual factors were not investigated.
Zenebe et al. (2017)	Ethiopia	To assess prevalence of LAPM utilization and associated factors among women in reproductive age groups who have decided not to have more children in Gondar city	Facility-based cross-sectional study	317 women who have decided not to have more children	The prevalence of long acting and permanent contraceptive was 34.7% and the prevalence of female sterilization of female sterilization 0.6%. Women who had at least secondary school, women with history of previous utilization, and women with information about LAPM were significantly more likely to use LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.
Gelagay (2018)	Ethiopia	To assess LAPM utilization and its associated factors among HIV-infected women in Bahir Dar	Facility-based cross-sectional study	505 married women attending care at antiretroviral therapy (ART) clinics	Prevalence of LAPM was 27.5%. Prevalence of female sterilization was 0.2%, accounting for 0.7% of LAPM. Women who were getting pre- antiretroviral therapy (Pre-ART) services, women who had spousal	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception.

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
					discussion on family planning, women who had previous experience on long acting contraceptive methods, women who had no exposure to myths about long acting and permanent contraceptive methods, women who had no birth intention or who had birth intention after 2 years were factors significantly more likely to utilize LAPM	Contextual factors were not investigated. Results cannot be generalized. Population was limited to HIV-infected women.
Takele et al. (2012)	Ethiopia	To determine the utilization of LAPM and its associated factors among married women of Goba town	Community-based cross sectional	734 married women of reproductive age	The prevalence of long acting and permanent contraception was 8.7%. The prevalence of female sterilization was 0.7%, accounting for 7.8% of LAPM Women with previous use, women with longer number of times discussing contraceptive methods (more than twice), and main decider (joint) of using methods were more likely to use LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
Meskele et al. (2014)	Ethiopia	To explore the association between women's awareness, attitude and barriers with their intention to use LAPM among users of short-term methods, in Southern Ethiopia	Facility-based mixed methods (cross sectional survey and in-depth interview)	416 women who were using short term contraceptive methods were the study population. 12 family planning providers and women using short term methods	38% had the intention to use LAPM. Women who had a positive attitude to LAPM, Women who had no myths and misconceptions, women who attained secondary and higher level of education had higher intentions to use to LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.
Amo-Adjei et al.(2019)	Kenya	To explore the interaction of fertility intentions with LAPM in rural western Kenya	Secondary data analysis of routine service statistics	28 515 women	Prevalence of LAPM was 57% Women 40 years and above (vs 15-24 years), with at least primary education (vs none), women who want child within or after two year (vs wants no more children) were less likely to use LAPM, while those with at least 1 child (vs none) were more likely to use LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.

First author (Year)	Country of study	Objective	Study design	Study participants	Findings	Main gaps
Melka et al (2015)	Ethiopia	To understand the determinant factors of LAPM use among married women of reproductive age in Western Ethiopia.	Community-based cross sectional	1003 married women of reproductive age group	Prevalence of LAPM was 20%. Female sterilization accounted for 7.5% of LAPM Women who had secondary school education and above (vs none/primary education), women who were government employed (vs others occupation), women who had more than two children (vs ≤ 2 children), women who had joint discussion with their husband on fertility (vs those who had no joint discussion), women who had radio/TV (vs women who had no radio), Women who had discussion with health professionals (vs women who had no discussion) were more likely to use LAPM	The factors were not disaggregated by contraceptive methods Thus, may not be specific to permanent contraception. Contextual factors were not investigated.

Appendix 2: *Operational Definition, Types, and Categorization of Explanatory Variables*

Variable	Operational definition	Type of variable	Categories and coding	Hypothesis
Individual level				
Predisposing				
Age	Age of the respondent in years at interview	Continuous		Older women are more likely to use FPC
Education	Highest educational level attained by the respondent	Categorical	None (0) / Primary (1) / Secondary or higher (2)	More educate women are more likely to use FPC
Husband/Partner's education	Highest educational level attained by the respondent's husband/partner	Categorical	None (0) / Primary (1) / Secondary or higher (2)	Women in relationships with more educated husband/ partner are more likely to use FPC
Husband/Partner's age	Age of the respondent's husband/ partner in years at interview	Continuous		Women with older husband/partner are more likely to use FPC
Union	Type of union between the respondent and husband/partner	Categorial	Monogynous (0) / Polygynous (1)	Women in monogynous union are more likely to use FPC
Enabling				
Household wealth	A composite measure of a household's cumulative living standard, estimated by the survey using household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities. It was grouped into five categories by DHS: Poorest, Poor, Middle, Rich and Richest. However, in this	Categorical	Poor (0) / Middle (1) / Rich (2)	Women from wealthier households are more likely to use FPC

Variable	Operational definition	Type of variable	Categories and coding	Hypothesis
	study it was re-categorized into: Poor (poor and poorest) / Middle / Rich (rich and richest)			
Decision maker	Decision maker for using contraception	Categorical	Mainly respondent (0) / Joint decision (1) / Mainly husband or partner and Others (2)	Women who jointly make decision with their partners are more likely to use FPC
Area of residence	Place of residence of the respondent at interview	Categorical	Urban (0) / Rural (1)	Women in living in urban areas are more likely to FPC
Media exposure	Hearing about family planning in the last few months from radio or television, or newspapers or magazines	Categorical	Yes (0) / No (1)	Women exposed to family planning messages are more likely to use FPC
Need				
Living children	Number of living children at interview	Continuous		The likelihood of using FPC will increase with number of living children
Ideal and living children	Difference between number of living children and ideal number of children	Categorical	Living equal or greater than ideal (0) / Living less than ideal (1)	Women with number of living children equal or greater than ideal number of children are more likely to FPC
Number of sons	Number of living male children at interview	Continuous		The likelihood of using FPC will increase with number of sons
Wantedness	Whether the last child born in the last five years was wanted at that time, later or not at all	Categorical	Wanted then (0) / Wanted later (1) / Wanted no more (2)	Women who wanted no more are more likely to use FPC
Country level				
Predisposing				

Variable	Operational definition	Type of variable	Categories and coding	Hypothesis
Literacy rate	The percentage of female population aged 15 years and over who cannot both read and write with understanding a short simple statement on his/her everyday life	Continuous		The likelihood of using FPC will increase with literacy rate
Enabling				
Births attended by skilled health providers	The percentage of deliveries attended by personnel trained to provide basic care to women and their newborns during pregnancy, childbirth and the postpartum period	Continuous		The likelihood of using FPC will increase with country births attended by skilled health providers
Density of medical doctors	Number of medical doctors per 10,000 population	Continuous		The likelihood of using FPC will increase with density of medical doctors
Rural population	Percentage of total population living in the rural area	Continuous		The likelihood of using FPC will decrease with rural population
Gross national income	A measure of income of a nation's residents and businesses, regardless of where it's earned (Atlas method)	Continuous		The likelihood of using FPC will increase with gross national income
Poverty rate	Percentage of the population living on less than $1.90 a day at 2011 international prices	Continuous		The likelihood of using FPC will decrease with poverty level
Out-of-pocket expenditure	Percentage of total current health expenditure that is out-of-pocket payment	Continuous		The likelihood of using FPC will decrease with out-of-pocket expenditure
Need				

Variable	Operational definition	Type of variable	Categories and coding	Hypothesis
Total fertility rate	The number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specified year	Continuous		The likelihood of using FPC will increase with total fertility rate
Under-five mortality rate	Number of deaths in children under five years of age per 1,000 live births	Continuous		The likelihood of using FPC will decrease with under-five mortality rate

Appendix 3: *Letter of access to dataset*

Nov 15, 2019

Babayemi Olakunde
University of Nevada, Las Vegas
United States
Phone: 2408831582
Email: boolakunde@yahoo.com
Request Date: 11/15/2019

Dear Babayemi Olakunde:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Uptake of female permanent contraception in Africa":

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo Democratic Republic, Cote d'Ivoire, Egypt, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Nigeria (Ondo State), Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe

For restricted surveys, you must also request special permission from the Implementing Agencies. If approved, the restricted datasets will be provided to you by FTP.

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program

530 Gaither Road, Suite 500, Rockville, MD 20850 USA +1.301.407.6500 +1.301.407.6501 fax icf.com

Appendix 4: *UNLV IRB Exempt*

UNLV

UNLV Biomedical IRB - Administrative Review
Notice of Excluded Activity

DATE:	February 6, 2020
TO:	Jennifer Pharr
FROM:	UNLV Biomedical IRB
PROTOCOL TITLE:	[1537960-1] Utilization of female permanent contraception among women desiring to limit childbearing in sub-Saharan Africa: A mulitlevel analysis of the individual- and contextual-level determinants
SUBMISSION TYPE:	New Project
ACTION:	EXCLUDED - NOT HUMAN SUBJECTS RESEARCH
REVIEW DATE:	February 6, 2020
REVIEW TYPE:	Administrative Review

Thank you for your submission of New Project materials for this protocol. This memorandum is notification that the protocol referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46.

The UNLV Biomedical IRB has determined this protocol does not meet the definition of human subjects research under the purview of the IRB according to federal regulations. It is not in need of further review or approval by the IRB.

We will retain a copy of this correspondence with our records.

Any changes to the excluded activity may cause this protocol to require a different level of IRB review. Should any changes need to be made, please submit a Modification Form.

If you have questions, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 702-895-2794. Please include your protocol title and IRBNet ID in all correspondence.

Office of Research Integrity - Human Subjects
4505 Maryland Parkway . Box 451047 . Las Vegas, Nevada 89154-1047
(702) 895-2794 . FAX: (702) 895-0805 . IRB@unlv.edu

Appendix 5: *Characteristics of the included countries*

Country	Poverty rate (%)	Literacy rate (%)	Births attended by skilled health providers (%)	Density of medical doctors (per 10,000 population)	Gross national income ($)	Rural population (%)	Total fertility rate	Out of pocket expenditure as % of current health expenditure	Under-5 mortality rate
Angola	30.1	53	50	2.149	4520	37	5.8	33	88.1
Benin	49.5	31	78	1.572	800	53	4.9	45	95.5
Burkina Faso	55.3	22	64	0.457	570	75	5.9	30	114.4
Cameroun	23.8	72	65	0.898	1440	44	4.6	51	102.6
Chad	38.4	14	20	0.436	980	78	6.2	56	134.1
Congo	37	73	93	1.159	2120	36	4.7	41	60.7
Cote d'Ivoire	28.2	30	59	1.541	1120	52	5	39	104.2
Democratic Republic of Congo	76.6	63	80	0.9	410	58	6.4	59	103.7
Gabon	3.4	80	89	3.611	9080	13	4.1	28	58.1
Gambia	10.1	34	57	1.077	540	42	5.5	20	69.3
Ghana	13.3	74	71	1.686	1920	47	4.1	45	57.4
Guinea	35.3	22	63	0.788	830	64	4.8	57	100.8
Liberia	38.6	34	61	0.373	630	51	4.7	48	85.1
Mali	49.7	25	59	1.393	730	62	6.4	35	97.8
Niger	50.3	23	29	0.513	380	84	7.4	61	108.7
Nigeria	53.5	53	40	3.827	1960	50	5.5	77	119.9
Senegal	38	40	68	0.692	1280	53	4.7	52	45.6
Sierra Leone	52.2	25	60	0.25	660	60	4.8	63	136.7
Togo	49.2	51	45	0.487	620	61	4.7	65	81.8
Burundi	71.8	61	85	0.5	270	88	5.7	25	63.8
Comoros	12.8	43	82	1.699	1420	72	4.6	92	82.3

Country	Poverty rate (%)	Literacy rate (%)	Births attended by skilled health providers (%)	Density of medical doctors (per 10,000 population)	Gross national income ($)	Rural population (%)	Total fertility rate	Out of pocket expenditure as % of current health expenditure	Under-5 mortality rate
Ethiopia	30.8	44	28	1.000	660	80	4.5	36	60.4
Kenya	36.8	74	62	1.988	1240	75	3.9	29	48.2
Lesotho	59.7	85	78	0.676	1450	73	3.2	17	93.0
Malawi	70.3	55	90	0.157	350	84	4.5	11	59.2
Mozambique	62.4	36	54	0.508	500	68	5.3	9	99.5
Namibia	13.4	88	88	3.724	6020	55	3.6	10	46.6
Rwanda	56.8	66	91	1.204	720	83	4.2	8	44.1
South Africa	18.9	86	97	8.024	5470	35	2.5	8	36.6
Uganda	41.7	71	74	0.908	660	77	5.2	26	51.2
Tanzania	49.1	73	64	0.399	980	68	5.1	38	59.1
Zambia	57.5	78	63	1.632	1760	59	5.1	11	70.7
Zimbabwe	21.4	88	78	0.763	1280	68	3.9	26	54.3

Appendix 6: *Demand for limiting childbearing and the proportion satisfied with FPC among married or in-union women*

Subregion and country	N*	% (95%CI)**
Western and central Africa	23986	2.8 (2.5-3-3)
Angola	1154	0.3 (0.1-0.8)
Benin	1720	1.1 (0.7-1.8)
Burkina Faso	1654	1.5 (0.9-2.3)
Cameroon	1664	3.2 (2.4-4.4)
Chad	636	4.2 (2.0-8.7)
Congo	904	0.7 (0.3-1.9)
Cote d'Ivoire	765	0.6 (0.2-2.0)
Democratic Republic of Congo	1596	5.4 (3.8-7.6)
Gabon	782	3.8 (2.1-6.7)
Gambia	504	8.0 (5.3-12.0)
Ghana	1235	7.7 (6.0-9.9)
Guinea	711	1.7 (0.8-3.7)
Liberia	1016	1.7 (0.8-3.4)
Mali	912	3.2 (2.2-4.7)
Niger	460	3.2 (1.9-5.2)
Nigeria	4045	1.7 (1.3-3.3)
Senegal	1458	2.7 (1.7-4.3)
Sierra Leone	1519	3.2 (2.0-5.0)
Togo	1251	1.2 (0.7-2.3)
Eastern and southern Africa	32734	9.4 (8.7-10.1)
Burundi	2640	1.8 (1.3-2.5)
Comoros	462	6.2 (3.9-9.5)
Ethiopia	1849	1.8 (1.2-2.7)
Kenya	3439	7.9 (6.9-5.1)
Lesotho	1707	3.5 (2.5-4.9)
Malawi	6399	27.0 (25.3-28.7)

Subregion and country	N*	% (95%CI)**
Mozambique	1492	1.5 (1.0-2.2)
Namibia	1454	15.6 (13.5-18.0)
Rwanda	2473	3.4 (2.7-4.3)
South Africa	1331	17.0 (14.3-20.0)
Tanzania	1643	15.6 (13.4-18.1)
Uganda	3106	10.0 (8.7-11.4)
Zambia	2568	7.0 (5.8-8.4)
Zimbabwe	2171	2.3 (1.7-3.0)
All countries	56720	6.7 (6.2-7.1)

*Unweighted frequency of demand for limiting childbearing. **Weighted proportion of demand for limiting childbearing satisfied with FPC

Appendix 7: *Demand for limiting childbearing and the proportion satisfied with FPC among married or in-union women by age*

Subregion and country	15-29 years		30-39 years		≥40 years	
	N*	% (95%CI)**	N*	%(95%CI)**	N*	% (95%CI)**
Western and central Africa	2730	1.8 (1.1-3.1)	10716	1.9 (1.5-2.5)	10540	4.0 (3.4-4.7)
Angola	304	0.0 (0.0-0.0)	499	0.6 (0.2-1.7)	351	0.2 (0.1-0.9)
Benin	206	0.5 (0.1-3.5)	828	1.0 (0.5-2.0)	686	1.5 (0.8-3.1)
Burkina Faso	104	1.3 (0.2-8.7)	728	1.3(0.6-2.5)	822	1.7 (0.9-3.0)
Cameroon	244	2.7 (0.7-9.9)	738	2.7 (1.6-4.7)	682	3.9 (2.7-5.5)
Chad	106	4.4 (0.8-20.6)	306	3.2 (1.3-7.8)	224	5.5 (1.9-14.5)
Congo	100	0.8 (0.2-3.1)	349	0.9 (0.2-4.6)	455	0.6 (0.2-1.4)
Cote d'Ivoire	65	0.0 (0.0-0.0)	335	0.0 (0.0-0.0)	365	1.3 (0.4-4.4)
Democratic Republic of Congo	244	4.7 (2.0-10.9)	721	3.9 (2.0-7.3)	631	7.6 (5.3-10.7)
Gabon	133	2.2 (0.3-13.8)	291	0.3 (0.1-1.4)	358	7.9 (4.3-13.9)
Gambia	26	14.2 (4.6-36.0)	212	3.8 (1.5-9.1)	266	11.2 (7.0-17.5)
Ghana	116	0.7 (0.1-3.6)	568	5.6 (3.3-9.1)	551	12.0 (9.1-15.7)
Guinea	103	1.6 (0.2-10.2)	311	2.4 (0.9-5.9)	297	1.1 (0.4-2.8)
Liberia	164	0.5 (0.1-3.4)	489	0.9 (0.3-3.2)	363	3.3 (1.5-7.2)
Mali	107	1.4 (0.2-9.7)	437	2.1 (1.0-4.4)	368	4.8 (2.9-7.6)
Niger	28	4.5 (0.7-24.4)	182	3.7 (1.7-7.9)	250	2.6 (1.3-5.1)
Nigeria	299	1.6 (0.6-4.4)	1857	0.7 (0.4-1.2)	1889	2.7 (1.9-3.9)
Senegal	54	0.0 (0.0-0.0)	535	3.0 (1.3-6.5)	869	2.7 (1.7-4.3)
Sierra Leone	157	0.7 (0.1-5.0)	763	2.2 (1.4-3.5)	599	5.0 (2.6-9.2)
Togo	170	0.3 (0.0-2.4)	567	0.8 (0.3-2.2)	514	2.1 (1.0-4.5)
Eastern and southern Africa	5880	1.3 (0.9-1.9)	15371	7.4 (6.6-8.3)	11483	16.1 (14.8-17.5)
Burundi	326	0.4 (0.1-2.7)	1291	1.7 (1.0-2.9)	1023	2.5 (1.7-3.7)
Comoros	93	0.0 (0.0-0.0)	211	7.0 (3.7-12.8)	158	8.0 (4.1-15.1)
Ethiopia	392	0.0 (0.0-0.2)	897	1.5 (0.8-3.0)	560	3.4 (1.9-5.8)
Kenya	717	1.6 (0.8-3.0)	1585	6.3 (4.9-8.0)	1137	14.7 (12.3-17.5)
Lesotho	560	0.5 (0.1-0.9)	699	3.5 (2.1-5.8)	448	7.4 (5.0-10.8)

Subregion and country	15-29 years		30-39 years		≥40 years	
	N*	% (95%CI)**	N*	%(95%CI)**	N*	% (95%CI)**
Malawi	1332	5.8 (4.0-8.2)	3176	24.2 (22.0-26.5)	1891	46.4 (43.1-49.7)
Mozambique	355	0.4 (0.1-1.6)	693	1.2 (0.6-2.5)	444	2.8 (1.8-4.6)
Namibia	313	0.4 (0.1-1.7)	561	14.4 (11.2-18.2)	580	24.3 (20.6-28.4)
Rwanda	281	0.5 (0.1-2.1)	1253	2.7 (1.9-3.9)	939	5.2 (3.9-7.0)
South Africa	244	2.2 (0.7-6.5)	581	13.3 (9.8-17.8)	506	29.1 (24.4-34.3)
Tanzania	143	1.2 (0.3-5.6)	690	10.7(8.1-14.1)	810	22.6 (19.4-26.2)
Uganda	432	0.9 (0.4-2.2)	1477	8.2 (6.8-9.9)	1197	15.3 (13.1-17.9)
Zambia	338	1.4 (0.5-3.8)	1216	4.6 (3.4-6.20	1014	11.8 (9.6-14.5)
Zimbabwe	354	1.1 (0.3-4.1)	1041	1.0 (0.6-1.9)	776	4.4 (3.2-6.2)
All countries	8610	1.5 (1.1-2.0)	26087	5.1 (4.6-5.7)	22023	10.4 (9.7-11.3)

*Unweighted frequency of demand for limiting childbearing. **Weighted proportion of demand for limiting childbearing satisfied with FPC.

Appendix 8: *Demand for limiting childbearing and the proportion satisfied with FPC among married or in-union women by living children*

Subregion and country	0-2		3-4		≥5	
	N*	% (95%CI)**	N*	% (95%CI)**	N*	% (95%CI)**
Western and central Africa	1560	4.5 (3.2-6.3)	6726	3.3 (2.6-4.1)	15700	2.5 (2.0-3.0)
Angola	131	0.0 (0.0-0.0)	346	0.2 (0.0-1.7)	677	0.4 (0.1-1.2)
Benin	103	0.9 (0.1-6.0)	540	1.5 (0.7-3.0)	1077	1.0 (0.5-1.9)
Burkina Faso	88	8.4 (4.0-16.9)	443	1.1 (0.4-3.0)	1123	1.0 (0.5-1.9)
Cameroon	126	3.8 (1.3-10.5)	465	4.5 (2.7-7.6)	1073	2.5 (1.8-3.6)
Chad	46	13.9 (4.1-38.2)	99	4.1 (1.5-10.8)	491	3.4 (1.3-8.3)
Congo	48	1.2 (0.3-5.0)	232	1.4 (0.4-5.1)	624	0.2 (0.1-0.8)
Cote d'Ivoire	47	0.0 (0.0-0.0)	198	0.0 (0.0-0.0)	520	0.9 (0.2-3.0)
Democratic Republic of Congo	93	13.4 (6.9-24.4)	343	6.9 (4.1-11.2)	1160	4.3 (2.6-7.2)
Gabon	79	5.5 (1.7-16.6)	180	0.6 (0.2-1.9)	523	5.0 (2.5-9.6)
Gambia	23	31.4 (12.3-59.9)	91	16.6 (8.0-31.3)	390	4.8 (3.0-7.9)
Ghana	92	6.9 (2.8-16.2)	477	7.9 (5.3-11.5)	666	7.8 (5.5-10.8)
Guinea	81	6.1 (1.6-21.0)	208	2.7 (1.1-6.4)	422	0.4 (0.1-6.1)
Liberia	66	0.0 (0.0-0.0)	285	3.1 (1.3-7.0)	665	1.1 (0.4-3.0)
Mali	61	0.0 (0.0-0.1)	201	4.5 (2.2-8.9)	650	3.0 (1.9-4.8)
Niger	14	21.1 (6.5-50.9)	70	6.0 (2.2-15.4)	376	2.1 (1.0-4.1)
Nigeria	182	2.3 (0.9-5.8)	1287	2.1 (1.3-3.3)	2576	1.5 (1.1-2.2)
Senegal	40	7.4 (2.1-22.7)	279	3.8 (1.6-8.8)	1139	2.2 (1.3-3.7)
Sierra Leone	118	2.8 (0.7-10.2)	529	2.0 (1.0-3.6)	872	4.0 (2.2-7.1)
Togo	122	0.0 (0.0-0.0)	453	2.0 (1.0-4.0)	676	0.9 (0.3-2.4)
Eastern and southern Africa	5215	6.8 (5.2-8.9)	12440	10.5 (9.2-11.8)	15079	9.5 (8.7-10.4)
Burundi	125	1.1 (0.3-4.3)	839	1.2 (0.5-2.4)	1676	2.2 (1.5-3.2)
Comoros	44	5.5 (1.3-20.0)	106	8.5 (4.2-16.5)	312	5.5 (3.1-9.5)
Ethiopia	341	0.7 (0.1-4.4)	534	1.5 (0.6-3.7)	974	2.2 (1.3-3.5)
Kenya	549	1.8 (0.9-3.8)	1499	6.9 (5.5-8.7)	1391	12.2 (10.1-14.5)
Lesotho	750	1.7 (1.0-3.1)	714	4.0 (2.6-6.1)	243	8.0 (4.6-13.7)

Subregion and country	0-2		3-4		≥5	
	N*	% (95%CI)**	N*	% (95%CI)**	N*	% (95%CI)**
Malawi	908	12.9 (10.2-16.2)	2619	21.7 (19.3-24.5)	2872	36.4 (34.2-38.7)
Mozambique	230	0.8 (0.2-3.1)	597	2.5 (1.5-4.2)	665	1.0 (0.5-2.0)
Namibia	457	11.2 (7.9-15.6)	623	21.5 (17.9-25.6)	374	11.6 (8.0-16.4)
Rwanda	278	3.1 (1.6-6.1)	1111	3.3 (2.4-4.4)	1084	3.6 (2.6-5.1)
South Africa	571	11.2 (7.7-16.0)	616	23.1 (18.8-28.1)	144	14.5 (9.6-21.3)
Tanzania	105	10.4 (5.2-20.0)	549	14.6 (11.4-18.6)	989	17.0 (14.1-20.3)
Uganda	183	6.5 (3.5-11.8)	742	5.5 (4.0-7.5)	2181	11.8 (10.2-13.6)
Zambia	196	7.6 (4.5-12.5)	713	6.7 (4.9-9.2)	1659	7.0 (5.5-8.8)
Zimbabwe	478	0.6 (0.2-1.6)	1178	3.1 (2.2-4.4)	515	1.7 (1.0-3.1)
All countries	6775	6.4 (5.0-8.0)	19166	7.8 (7.0-8.7)	30779	6.0 (5.5-6.5)

*Unweighted frequency of demand for limiting childbearing. **Weighted proportion of demand for limiting childbearing satisfied with FPC

Appendix 9: *Demand for limiting childbearing and the proportion satisfied with FPC among married or in-union women by education*

Subregion and country	None		Primary		Secondary or higher	
	N*	% (95%CI)**	N*	% (95%CI)**	N*	% (95%CI)**
Western and central Africa	11232	3.1 (2.5-3.8)	6232	2.5 (1.9-3.1)	6521	2.9 (2.3-3.5)
Angola	372	0.0 (0.0-0.0)	457	0.2 (0.0-1.5)	325	0.7 (0.2-2.1)
Benin	1154	1.0 (0.5-1.8)	356	1.8 (0.7-4.5)	210	1.0 (0.3-3.2)
Burkina Faso	1303	1.3 (0.8-2.2)	202	3.0 (1.1-7.9)	149	1.2 (0.3-5.5)
Cameroon	276	4.3 (2.0-9.0)	777	3.5 (2.4-5.2)	611	2.2 (1.3-3.8)
Chad	421	4.1 (1.6-10.0)	156	3.5 (1.0-11.8)	59	7.3 (1.7-26.0)
Congo	96	1.7 (0.5-5.6)	309	0.8 (0.3-2.2)	499	0.6 (0.1-3.0)
Cote d'Ivoire	497	0.9 (0.2-3.3)	183	0.0 (0.0-0.0)	85	0.0 (0.0-0.0)
Democratic Republic of Congo	284	10.4 (6.5-16.4)	648	4.4 (2.6-7.3)	664	4.3 (2.7-6.7)
Gabon	53	2.4 (0.4-14.6)	353	4.9 (2.0-11.4)	376	3.4 (1.6-7.4)
Gambia	349	6.0 (3.6-10.0)	62	11.1 (4.1-26.7)	93	12.8 (6.5-23.7)
Ghana	396	9.1 (6.0-13.6)	268	5.9 (3.5-9.6)	571	7.9 (5.4-11.4)
Guinea	601	0.9 (0.4-2.2)	50	8.1 (1.7-30.7)	60	3.6 (0.9-13.8)
Liberia	573	0.7 (0.2-2.4)	292	3.7 (1.6-8.0)	151	1.8 (0.4-7.5)
Mali	717	3.2 (2.0-5.0)	102	2.6 (0.7-9.3)	93	3.7 (1.2-10.6)
Niger	355	2.3 (1.2-4.5)	51	3.5 (0.8-13.8)	53	12.1 (5.2-25.8)
Nigeria	1074	2.6 (1.6-4.2)	996	0.9 (0.4-1.7)	1975	1.7 (1.2-2.5)
Senegal	1026	2.4 (1.5-3.9)	313	4.8 (2.2-10.1)	119	0.2 (0.0-1.7)
Sierra Leone	1122	2.9 (1.8-4.8)	192	5.9 (2.7-12.3)	205	2.1 (0.7-6.2)
Togo	563	0.2 (0.1-0.9)	465	2.9 (1.5-5.6)	223	0.0 (0.0-0.0)
Eastern and southern Africa	6273	5.1 (4.3-6.0)	16993	10.0 (9.2-10.8)	9466	12.4 (10.8-14.1)
Burundi	1348	1.8 (1.1-2.7)	1029	1.4 (0.7-2.8)	263	4.3 (1.9-9.3)
Comoros	234	5.3 (3.0-9.4)	117	5.3 (1.8-14.5)	109	9.5 (4.4-19.2)
Ethiopia	1164	1.7 (1.0-2.9)	478	1.9 (0.9-4.0)	207	2.3 (0.4-12.6)
Kenya	242	7.2 (3.8-13.4)	2120	8.8 (7.4-10.3)	1077	6.6 (5.0-8.6)
Lesotho	27	0.0 (0.0-0.0)	858	3.0 (1.8-5.1)	822	4.1 (2.7-6.0)

Subregion and country	None		Primary		Secondary or higher	
	N*	% (95%CI)**	N*	% (95%CI)**	N*	% (95%CI)**
Malawi	1087	35.4 (32.1-38.8)	4088	27.3 (25.4-29.2)	1224	17.4 (14.0-21.5)
Mozambique	360	0.4 (0.1-1.4)	828	1.3 (0.7-2.2)	304	4.3 (2.4-7.6)
Namibia	124	8.7 (3.2-21.8)	382	11.6 (8.1-16.3)	948	17.8 (15.0-21.0)
Rwanda	504	2.3 (1.3-4.2)	1711	3.6 (2.7-4.7)	258	4.6 (2.3-9.2)
South Africa	41	11.6 (4.5-27.0)	174	9.7 (6.0-15.5)	1116	18.0 (15.0-21.4)
Tanzania	301	16.3 (11.9-21.9)	1117	15.8 (13.3-18.8)	225	13.3 (9.4-18.5)
Uganda	528	9.6 (7.2-12.8)	1987	10.5 (9.0-12.2)	591	8.7 (6.3-11.7)
Zambia	283	8.4 (5.6-12.4)	1512	6.3 (5.0-8.0)	773	7.6 (5.7-10.1)
Zimbabwe	30	1.9 (0.3-13.0)	592	1.2 (0.6-2.5)	1549	2.7 (2.0-3.7)
All countries	17505	4.1 (3.6-4.7)	23225	7.7 (7.1-8.3)	15987	7.9 (7.0-9.0)

*Unweighted frequency of demand for limiting childbearing. **Weighted proportion of demand for limiting childbearing satisfied with FPC

Appendix 10: *Demand for limiting childbearing and proportion satisfied with FPC among married or in-union women by household wealth*

Subregion and country	Poor		Middle		Rich	
	N*	% (95%CI)**	N*	% (95%CI)**	N*	% (95%CI)**
Western and central Africa	9413	2.6 (2.1-3.2)	4753	2.5 (1.8-3.6)	9820	3.1 (2.6-3.7)
Angola	458	0.6 (0.1-2.3)	276	0.1 (0.0-1.1)	420	0.2 (0.1-1.1)
Benin	569	0.5 (0.2-1.7)	321	1.2 (0.4-3.8)	830	1.5 (0.8-2.8)
Burkina Faso	524	1.2 (0.5-2.9)	286	1.3 (0.5-3.5)	844	1.7 (0.9-3.0)
Cameroon	511	1.9 (1.0-3.6)	374	3.3 (1.7-6.3)	779	4.0 (2.6-6.0)
Chad	216	6.6 (2.5-16.1)	123	4.1 (1.0-15.2)	297	2.2 (1.0-4.7)
Congo	631	0.7 (0.3-1.7)	116	0.3 (0.0-1.8)	157	1.0 (0.2-5.3)
Cote d'Ivoire	354	0.4 (0.1-2.9)	134	0.4 (0.1-2.8)	277	0.8 (0.1-5.4)
Democratic Republic of Congo	575	4.6 (2.8-7.5)	319	4.5 (1.3-14.1)	702	6.2 (4.3-8.9)
Gabon	503	3.4 (1.5-7.3)	114	5.1 (1.5-16.1)	165	3.4 (1.1-9.8)
Gambia	203	4.1 (2.0-8.6)	99	14.1 (7.2-25.7)	202	8.2 (4.3-15.2)
Ghana	591	6.9 (4.8-9.8)	250	6.9 (4.1-11.2)	394	8.9 (5.9-13.3)
Guinea	304	0.8 (0.3-2.6)	132	0.7 (0.1-5.0)	275	3.2 (1.2-8.2)
Liberia	618	1.5 (0.4-5.3)	207	2.5 (0.9-6.4)	191	1.6 (0.4-5.4)
Mali	328	2.2 (1.0-4.9)	177	4.4 (1.9-9.5)	407	3.5 (2.0-6.2)
Niger	126	1.1 (0.3-4.4)	74	1.8 (0.4-7.0)	260	5.3 (3.0-9.3)
Nigeria	1114	1.7 (1.0-2.8)	885	1.7 (0.9-3.0)	2046	1.8 (1.2-2.7)
Senegal	684	2.7 ((1.6-4.3)	341	1.1 (0.2-4.7)	433	3.5 (1.7-7.3)
Sierra Leone	552	2.3 (1.2-4.2)	312	2.1 (1.0-4.2)	655	4.5 (2.4-8.5)
Togo	552	1.1 (0.4-2.6)	213	0.6 (0.1-4.0)	486	1.6 (0.7-3.5)
Eastern and southern Africa	11287	6.7 (5.9-7.5)	6548	8.6 (7.5-9.9)	14899	11.8 (10.6-13.1)
Burundi	1005	1.0 (0.6-1.9)	487	1.7 (0.9-3.4)	1148	2.7 (1.7-4.2)
Comoros	233	3.9 (2.1-7.1)	76	10.6 (4.5-23.1)	153	6.8 (2.9-15.3)
Ethiopia	659	0.5 (0.2-1.6)	313	1.4 (0.5-3.8)	877	3.0 (1.8-5.0)
Kenya	1339	7.6 (6.1-9.4)	781	10.4 (8.1-13.2)	1319	7.0 (5.5-8.9)
Lesotho	624	1.4 (0.7-2.9)	339	2.3 (1.1-4.9)	744	5.3 (3.7-7.5)

Subregion and country	Poor		Middle		Rich	
	N*	% (95%CI)**	N*	% (95%CI)**	N*	% (95%CI)**
Malawi	2001	24.0 (21.5-26.6)	1287	27.1 (24.0-30.4)	3111	29.1 (26.5-31.8)
Mozambique	268	0.0 (0.0-0.0)	204	0.0 (0.0-0.0)	1020	2.7 (1.8-3.9)
Namibia	487	6.3 (4.2-9.4)	293	9.6 (6.2-14.5)	674	24.5 (20.7-28.7)
Rwanda	923	2.1 (1.3-3.3)	494	2.7 (1.5-4.7)	1056	5.0 (3.8-6.7)
South Africa	514	8.7 (6.4-11.7)	275	11.9 (7.9-17.6)	542	25.9 (21.2-31.2)
Tanzania	520	12.2 (9.5-15.5)	344	17.9 (12.9-24.4)	779	16.8 (13.9-20.0)
Uganda	1212	10.4 (8.4-12.8)	691	9.2 (7.2-11.7)	1203	10.0 (8.1-12.4)
Zambia	859	5.4 (3.9-7.4)	638	5.7 (4.0-8.1)	1071	8.7 (6.7-11.2)
Zimbabwe	643	1.1 (0.5-2.2)	326	1.9 (0.9-4.0)	1202	3.2 (2.2-4.5)
All countries	20700	5.1 (4.6-5.6)	11301	6.2 (5.4-7.0)	24719	8.0 (7.2-8.8)

*Unweighted frequency of demand for limiting childbearing. **Weighted proportion of demand for limiting childbearing satisfied with FPC

Appendix 11: *Demand for limiting childbearing and proportion satisfied with FPC among married or in-union women by area of residence*

Subregion and country	Urban		Rural	
	N*	% (95%CI)**	N*	% (95%CI)**
Western and central Africa	10272	2.5 (2.0-3.0)	13714	3.2 (2.6-3.8)
Angola	762	0.2 (0.0-0.7)	392	0.8 (0.2-2.6)
Benin	788	1.8 (1.0-3.2)	932	0.6 (0.3-1.4)
Burkina Faso	596	1.6 (0.7-3.3)	1058	1.4 (0.8-2.5)
Cameroon	849	3.4 (2.2-5.1)	815	3.0 (1.9-4.6)
Chad	178	1.0 (0.3-3.2)	458	5.4 (2.5-11.5)
Congo	251	0.1 (0.0-0.6)	653	1.8 (0.7-4.8)
Cote d'Ivoire	283	0.9 (0.2-4.6)	482	0.3 (0.0-2.1)
Democratic Republic of Congo	688	4.0 (2.6-6.0)	908	6.5 (4.0-10.3)
Gabon	465	3.9 (2.0-7.4)	317	3.0 (1.2-7.3)
Gambia	227	8.8 (4.9-15.2)	277	7.0 (4.1-11.8)
Ghana	542	7.8 (5.5-10.9)	693	7.7 (5.4-11.0)
Guinea	228	3.7 (1.4-9.8)	483	0.7 (0.3-2.0)
Liberia	316	1.5 (0.5-4.4)	700	1.9 (0.7-4.7)
Mali	273	1.7 (0.6-4.6)	639	3.6 (2.4-5.5)
Niger	199	5.4 (2.9-9.9)	261	2.3 (1.1-4.9)
Nigeria	1935	1.5 (0.9-2.4)	2110	2.0 (1.5-2.9)
Senegal	635	3.3 (1.7-6.5)	823	2.1 (1.2-3.6)
Sierra Leone	593	3.6 (1.4-8.6)	926	3.0 (1.9-4.6)
Togo	464	1.4 (0.6-3.3)	787	1.1 (0.5-2.6)
Eastern and southern Africa	10317	12.2 (10.7-13.9)	22417	8.0 (7.3-8.7)
Burundi	506	5.0 (2.7-9.2)	2134	1.4 (1.0-2.1)
Comoros	172	9.6 (5.4-16.6)	290	4.6 (2.4-8.6)
Ethiopia	466	2.0 (0.8-5.0)	1383	1.7 (1.1-2.8)
Kenya	1151	5.4 (3.9-7.4)	2288	9.3 (8.0-10.8)
Lesotho	494	2.6 (1.4-4.7)	1213	3.9 (2.6-5.8)

Subregion and country	Urban		Rural	
	N*	% (95%CI)**	N*	% (95%CI)**
Malawi	1326	23.1 (19.2-27.5)	5073	27.8 (26.0-29.7)
Mozambique	790	2.8 (1.9-4.2)	702	0.5 (0.2-1.3)
Namibia	806	20.5 (17.2-24.1)	648	8.4 (6.3-11.1)
Rwanda	534	5.8 (3.6-9.3)	1939	2.9 (2.3-3.8)
South Africa	829	19.2 (15.8-23.1)	502	10.8 (8.0-14.3)
Tanzania	490	15.1 (11.8-19.0)	1153	15.9 (13.1-19.1)
Uganda	607	10.0 (7.2-13.7)	2499	10.0 (8.7-11.5)
Zambia	1147	7.6 (5.7-10.2)	1421	6.4 (5.1-8.1)
Zimbabwe	999	3.3 (2.3-4.9)	1172	1.5 (1.0-2.4)
All countries	20589	7.2 (6.4-8.1)	36131	6.3 (5.8-6.8)

*Unweighted frequency of demand for limiting childbearing. **Weighted proportion of demand for limiting childbearing satisfied with FPC

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CURRICULUM VITAE

BABAYEMI OLUWASEUN OLAKUNDE

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EDUCATION

PhD in Public Health, University of Nevada, Las Vegas (UNLV), USA

Expected date of graduation: May, 2020

Master of Public Health (Distinction), University of Sheffield UK

August, 2010

Bachelor of Medicine and Surgery, Obafemi Awolowo University, Nigeria

February, 2007

PROFESSIONAL EXPERIENCE

Graduate Research Assistant, University of Nevada, Las Vegas, USA

August 2017 – To present

- Performed quantitative data analyses of large complex survey data using SPSS and SAS
- Prepared and submitted manuscripts such as HIV testing among men in Nigeria, people with sensory disabilities and pregnant women in the United States for publication
- Conducted literature and systematic reviews
- Participated in grant writing (R01 and R23)

Assistant Chief Programme Officer, National Agency for the Control of AIDS (NACA), Nigeria

January 2016 – August 2017

- Technical lead, HIV testing services (HTS) and prevention of mother-to-child transmission of HIV (PMTCT) service delivery areas under the NACA

Comprehensive AID Programme with States (NCAPS)—a $40-million-government-funded HIV/AIDS program in Nigeria

- Led the design of the implementation strategy of the HTS/PMTCT service delivery areas under NCAPS
- Prepared annual work plan, including annual budget for the implementation of HTS/PMTCT service delivery areas under NCAPS and monitored financial performance
- Prepared and presented periodic technical performance reports on HTS/PMTCT under NCAPS to NACA management, and other stakeholders
- Designed and developed tools for program monitoring and evaluation, supervisory visits, and conducted rapid service quality assessments to selected NCAPS sites
- Performed epidemiological analyses of HIV program data to inform robust and timely planning and decision making
- Engaged with political and community stakeholders on scaling up of HIV services, and advocated for improved HIV funding
- Conducted on-site training on HTS/PMTCT for healthcare providers
- Provided managerial supervision and mentorship to NCAPS junior staff and state programme officers
- Co-led the integration of PMTCT into maternal and child health week under the Global Fund HIV grant

Principal Programme Officer, National Agency for the Control of AIDS, Nigeria

December 2011 – December 2015

- Served as the alternate technical lead on the national PMTCT programme and PMTCT service delivery area under the Global Fund HIV grant to the government of Nigeria

- Co-led the development of technical strategies and provided guidance for the implementation of PMTCT for the national programme and Global Fund HIV grant
- Supervised the activities of five implementing partners (sub-recipients) of the Global Fund HIV grant
- Prepared periodic technical performance reports on PMTCT for Global Fund
- Contributed to the development/revision of national technical guidelines and standard operating procedures/job aids for HIV services in Nigeria such as National eMTCT Operational Plan 2014-2016, National Prevention Plan 2013-2015, Integrated National Guideline for HIV Prevention, Treatment and Care
- Represented NACA in PMTCT related stakeholders' meetings such as the National PMTCT Task Team and National HIV Prevention Working Group

Medical Officer, National Assembly Clinic, Nigeria

March 2008 – February 2009

- Clerked, examined, and managed outpatients and inpatients

House Officer, University College Hospital, Nigeria

March 2007 – February 2008

- Clerked, examined, investigated, and managed outpatients and inpatients
- Assisted in minor and major surgical procedures

PROFESSIONAL AFFLIATIONS/ASSOCIATIONS

Member, Nigerian Medical Association

Member, Delta Omega Society

Member, Association of Public Health Students, UNLV

Member, African Student Association

HONORS AND AWARDS

Summer Doctoral Research Fellowship, 2019

Patricia Sastaunik Scholarship, 2019

Stacy Darling Scholarship, 2019

Outstanding academic achievement from UNLV Alliance of Professionals of African Heritage, 2018 and 2019

RESEARCH INTEREST

HIV

Maternal and child health

Health financing, policy, and planning

Implementation science

PUBLICATIONS (Full list of research publications can be found **here**).

HIV prevention, treatment, and care

1. **Olakunde BO**, Pharr JR. Adeyinka DA. HIV testing among pregnant women with prenatal care in the United States: an analysis of the 2011– 2017 National Survey of Family Growth. Int J STD AIDS (Accepted).

2. **Olakunde BO**, Pharr JR. HIV-related risk behaviors and testing among people living with sensory disabilities in the United States. Int J STD AIDS (Accepted).

3. **Olakunde BO,** Pharr JR. Adeyinka DA, Danquah P. HIV-related risk behaviors and testing among adolescent gay and bisexual boys in the United States. *AIDS* 2019; 33(13):2107-2109. DOI: 10.1097/QAD.0000000000002333

4. **Olakunde BO,** Adeyinka DA, Olawepo JO, Pharr JR. HIV testing among men in Nigeria: a comparative analysis between young people and adults. *AIDS Care* 2019;32(2):155-162. DOI: 10.1080/09540121.2019.1622642

5. **Olakunde BO,** Adeyinka DA, Olawepo J, Pharr JR, Ozigbu CE, Wakdok S, Oladele T, Ezeanolue EE. Towards the elimination of mother-to-child transmission of HIV in Nigeria: a health system perspective of the achievements and challenges. *International Health* 2019;11(4):240-249. DOI: 10.1093/inthealth/ihz018

6. Sowale YO, **Olakunde BO,** Obi C, Itiola A, Erhunmwunse Y, Melvin SC. Risk factors for perinatal transmission of HIV among women attending prevention of mother-to-child transmission of HIV clinics in Northwest Nigeria. *AIDS Care* 2019; 31(3):326-332. DOI: 10.1080/09540121.2018.1524116

7. **Olakunde BO,** Adeyinka DA, Olakunde AO, Ozigbu CE, Ndukwe CD, Oladele T, Sabastine W, Udumezue S, Ezeanolue EE. Correlates of antiretroviral coverage for prevention of mother-to-child transmission of HIV in sub-Saharan Africa. *AIDS Care* 2019; 31(10):1255-1269. DOI: 10.1080/09540121.2019.1587364

8. **Olakunde BO,** Adeyinka DA, Ozigbu CE, Oladele T, Sabastine W. Quantification of the effect of terrorism on HIV response in Nigeria. *Lancet* 2018; 391:1257-1258. DOI: 10.1016/S0140-6736(18)30700-1

9. Adeyinka DA, **Olakunde BO,** Morka M, Oladimeji O, Agogo E. HIV treatment scale-up: a critical step to controlling HIV epidemic in a resource-limited country. *Public Health* 2018; 164:168-171. DOI: 10.1016/j.puhe.2018.07.016

10. **Olakunde BO,** Adeyinka DA, Oladele T, Ozigbu CE. HIV testing among male partners of pregnant women in Nigeria: a missing link in the elimination of mother-to-child transmission of HIV. *International Journal of STD & AIDS* 2018; 29(4):404-409. DOI:10.1177/0956462417739752

11. **Olakunde BO,** Wakdok S, Olaifa Y, Agbo F, Essen U, Ola M, Okeh M, Ibi S. Improving the coverage of prevention of mother-to-child transmission of HIV services in Nigeria: should traditional birth attendants be engaged? *International Journal of STD & AIDS* 2018; 29(7):687-690. DOI: 10.1177/0956462417745200.

Maternal and child health

12. Adeyinka DA, **Olakunde BO,** Muhajarine N. Evidence of health inequity in child survival: spatial and Bayesian network analyses of stillbirth rates in 194 countries. *Scientific Reports* 2019;9(1):19755 DOI: 10.1038/s41598-019-56326-w.

13. **Olakunde BO,** Sam-Agudu NA, Patel TY, Hunt AT, Buffington AM, Phebus TD, Onwasigwe E, Ezeanolue EE. Uptake of female sterilization in sub-Saharan: A literature review of the barriers and facilitators. *Contraception* 2019; 99(4):205-211. DOI: 10.1016/j.contraception.2018.12.007

14. Chinaeke E, Fan-Osuala C, Bathnna M, Ozigbu C, **Olakunde B,** Ramadhani HO, Ezeanolue EE, Sam-Agudu NA. Correlates of reported modern contraceptive use among postpartum women living HIV in rural Nigeria. *Reproductive Health* 2019; 16(2). https://doi.org/10.1186/s12978-018-0663-8

15. **Olakunde BO,** Adeyinka DA, Mavegam BO, Olakunde OA, Yahaya HB, AJiboye OA, Ogundipe T, Ezeanolue EE. Factors associated with skilled birth attendants at birth among married adolescents in Nigeria: evidence from the Multiple Indicator Cluster Survey, 2016/2017. *International Health* 2019; 11(6): 545-550. DOI: 10.1093/inthealth/ihz017

Health financing, planning, and policy

16. **Olakunde BO,** Adeyinka DA, Ozigbu CE, Olawepo J, Ogundipe T, Menson WN, Olakunde OA, Ezeanolue EE. Revisiting aid dependency for HIV programs in sub-Saharan Africa. *Public Health* 2019; 170:57-60. DOI: 10.1016/j.puhe.2019.02.016

17. Adeyinka DA, **Olakunde BO,** Olademiji O, Ezeanolue EE. HIV Indicator and Impact Survey: considerations for Nigeria. Lancet HIV 2019; 6(6): e348-e350

18. **Olakunde BO,** Adeyinka DA. Test-and-treat approach to ending HIV epidemic in Nigeria: current status and future prospects of domestic funding. *HIV and AIDS Review* 2017; 16(4): 205-211. https://doi.org/10.5114/hivar.2017.72013

19. **Olakunde BO,** Ndukwe CD. Non-adoption of option B+ for prevention of mother-to-child transmission of HIV in Nigeria: a look at the policy process. *Journal of Public Health Policy* 2017; 38(1):105-120. DOI: 10.1057/s41271-016-0048-6

20. **Olakunde BO,** Ndukwe CD. Improved domestic funding enhances sustainability of HIV/AIDS response in Nigeria. *Annals of Global Health* 2015; 81(5):684-688. DOI: 10.1016/j.aogh.2015.10.005

21. **Olakunde BO.** Public health care financing in Nigeria: which way forward?. *Annals of Nigeria Medicine* 2012; 6(1):4-10. DOI: 10.4103/0331-3131.100199

SELECTED CONFERENCES

1. **Olakunde BO,** Pharr J. HIV screening among pregnant women in the United States. Roundtable discussion at the American Public Health Association Annual Conference; 2-6 November 2019; Philadelphia, USA

2. **Olakunde BO,** Pharr J. HIV risk behavior and testing among people with sensory disabilities in the United States. Poster presentation at the 10th International AIDS Society Conference; 21-24 July 2019; Mexico City, Mexico

3. **Olakunde BO,** Adeyinka DA, Olakunde OA. Rethinking health financing in Africa: Impact of demographic-, governance-, and economic-related factors on government health expenditure. Oral presentation at the Africa Health Agenda International Conference; March 5-7, 2019; Kigali, Rwanda

4. Ozigbu CE, Adeyinka DA, **Olakunde BO,** Olatosi BA. Demographic variation of Hepatitis C virus prevalence in the US: Results from the national health and nutrition examination survey 2009 – 2016. Poster presentation at the 23rd International Society for Pharmacoeconomics and Outcomes Research; 19 - 23 May 2018; Baltimore, USA

5. Oladele T, **Olakunde B,** Ndukwe C, Ikpeazu A, Okojie S, Ajiboye A, Yahaya H. Lessons learnt on use of performance-based financing to engage private health sector for HIV testing services in Nigeria. Poster presentation at: National HIV Prevention Conference; 29 -30 November 2016; Abuja, Nigeria

6. **Olakunde B,** Oladele T, Alau K, Alagi M, Wakdok S, Mamadu I. Contribution of primary healthcare centres to PMTCT coverage in Nigeria. Oral presentation at: the 18th International Conference on AIDS and STIs in Africa; 29 November-4 December 2015; Harare, Zimbabwe