MULTILEVEL DETERMINANTS OF FERTILITY BEHAVIOUR IN ESWATINI

By

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DECLARATION

I, Garikayi Bernard Chemhaka, declare that this thesis is my own original work. It is being submitted for the degree of Doctor of Philosophy in Demography and Population Studies, Schools of Social Sciences and Public Health, Faculty of Humanities of the University of the Witwatersrand, Johannesburg. It has not been submitted before in part or in full for any degree or examination at this or any other University.

Signed:

Dated: **31** day of **October, 2018**

DEDICATION

To Sinikiwe, Prince and Prudence

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ABBREVIATIONS AND ACRONYMS

AIDS	Acquired immunodeficiency syndrome
AIRR	Adjusted incident rate ratio
AOR	Adjusted odds ratio
AR	Abortion rate
ASFR(s)	Age-specific fertility rate(s)
CEB	Children ever born
CI	Confidence interval
CPFR(s)	Cohort period fertility rate(s)
CPR	Contraceptive prevalence rate
CSO	Central Statistics Office
DHS(s)	Demographic and Health Survey(s)
DOS	Disk Operating System
DPS	Demography and Population Studies
DTT	Demographic transition theory
EA	Enumeration area
EASWESPOP	East-West Population
FHS	Family Health Survey
GBV	Gender based violence
HIV	Human immunodeficiency virus
ICC	Intra-cluster/community correlation coefficient
ICPD	International Conference on Population and Development
IEC	Information, Education and Communication
IRR	Incidence rate ratio
IUD	Intrauterine device
IUSSP	International Union for the Scientific Study of Population
LAM	Lactational amenorrhea method
LDCs	Less developed countries
MDCs	More developed countries
MDGs	Millennium Development Goals
MEPD	Ministry of Economic Planning and Development
MICS	Multiple Indicator Cluster Survey
MIRR	Median incidence rate ratio
MOR	Median odds ratio
MSCYA	Ministry of Sports, Culture and Youth Affairs
NDS	National Development Strategy
OBM	Original Bongaarts Model
OR	Odds ratio
P.A	Periodic abstinence
PASEX	Population Analysis Spreadsheets for Excel
PCA	Principal component analysis
PD	Proximate determinants
PHC	Population and Health Census
P/F	Lifetime (parity) to current fertility ratio
PSU	Primary sampling unit
RJB	Revised John Bongaarts [model]
RJS	Revised John Stover [model]
SD	Standard deviation
SDGs	Sustainable Development Goals
SE	Standard error

SNL	Swazi National Land
SRB	Sex ratio at birth
SSA	Sub-Saharan Africa
STIs	Sexually transmitted infections
TAR	Total abortion rate
TFR	Total fertility rate
UN	United Nations
UNICEF	United Nations Children's Fund
UNFPA	United Nations Population Fund
UNPD	United Nations Population Division
UOR	Unadjusted odds ratio
US	United States of America
VIF	Variance inflation factor
VRS	Vital registration system
WFS	World Fertility Survey

DISSEMINATION PLAN: SPECIFIC MANUSCRIPTS AND CONFERENCES

1. Conferences

Abstract accepted and oral presentation: *Social context, social position in the proximate determinants of fertility behaviour in Swaziland*, 2015 Young Scientists' conference, "Inspiring change post-2015: The role of science, technology and innovation in empowering women in Africa", Birchwood Hotel & OR Tambo Conference Centre, Johannesburg, South Africa, 16-18 September 2015

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5. Odimegwu C. and G.B Chemhaka. Contraceptive use in Eswatini: Do contextual influences matter? *BMC Women's Health*

ABSTRACT

The study re-examines the levels, trends and determinants of fertility in Eswatini. The overall objective of the study is to understand fertility behaviour of Swati women. Fertility behaviour is explained by actual (current and lifetime) fertility and proximate determinants of fertility measures. The following variables were considered as regression dependent variables: i) lifetime fertility (children ever born), ii) current use of contraception.

The study used data from four population censuses (1976, 1986, 1997 and 2007) and 2007 Eswatini Demographic and Health Survey (DHS). The study employed direct and indirect estimation methods (P/F ratio methods-Brass, Trussell, Arriaga, Feeney; Relational Gompertz model and regression based methods-Rele's, Palmore's, Gunasekaran and Palmore methods), to estimate the level and trends of fertility in Eswatini. The impact of the proximate determinants of fertility on the level of fertility was assessed using the Bongaarts model and its modifications. Bivariate and multivariate (or multilevel) Poisson and logistic regressions analyses were used to examine the correlates of fertility and contraceptive use in Eswatini.

The study found that between 1966 and 1976, fertility remained constant and thereafter fertility declined from 7.0 in 1976 to 4.6 children per woman in 2007. Contraceptive use among sexually active women is 46.1% of which 1.9% used traditional methods and 44.2% used modern contraceptives. Among the individual-level factors influencing fertility were child mortality, women's empowerment, ideal number of children, employment, marriage, female education, wealth, age at first sex and age at first birth. At community-level, rural-urban residence played a significant role in shaping fertility in Eswatini. On the one hand, fertility was positively associated with child mortality, women's empowerment, ideal number of children, employment, marriage and rural residence. On the other hand, fertility was negatively associated with female education, wealth, age at first sex, age at first birth, but not associated with mass media exposure and contraceptive use.

The analyses of the proximate determinants of fertility revealed that contraception had the greatest impact on fertility reduction, then postpartum infecundability, sexual activity and induced abortion. In terms of contraceptive use, the study indicated that the following individual-level variables are significantly associated with contraceptive use in Eswatini: occupation, wealth, education, exposure to mass media, women's empowerment, marital/union status, age, parity and age at first birth.

The study recommends, among other things, improving female education, delaying age at first birth and sexual debut, and reducing poverty, child mortality and desired number of children as measures that can be adopted to accelerate fertility decline in the country. In addition, the study recommends more studies on aspects such as women's empowerment, employment, marriage patterns, and rural-urban divide disadvantages which could provide additional insights into fertility behaviour. Efficient and effective fertility reducing programmes and interventions should be directed towards individual-level differences as well as considering the urban-rural community contexts in Eswatini.

Key words: children ever born, contraceptive use, community, fertility behaviour, multilevel logistic regression, multilevel Poisson regression, Eswatini

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Evidence indicates that fertility tends to vary between and within populations due to differences in cultural and socioeconomic conditions (Jain and Ross, 2012, Solanke, 2015, Van Lith et al., 2013, Ejembi et al., 2015, Wang et al., 2013, Elfstrom and Stephenson, 2012, Sear et al., 2016, Stephenson et al., 2007). Less developed countries (LDCs), particularly those in the sub-Saharan Africa (SSA) region, are observed to have higher levels of fertility (above replacement level fertility of 2.1 children per woman) than more developed countries (MDCs). Relative to the latter, LDCs tend to have higher population growth and lag behind in fertility decline (Garenne and Joseph, 2002, Van Lith et al., 2013, Bongaarts and Casterline, 2013).

Contraception is a key tool for starting, stopping, spacing or postponing a birth that has been widely invoked by proponents of small family size for individuals or couples in accelerating the pace of fertility transition in SSA region. Despite investment in family planning and adoption of implicit population policies, fertility in Africa in general and Eswatini in particular, remains high. The shift from family planning to reproductive health, the emergence of HIV epidemic and the recent global focus on demographic dividend, underscores the importance of population planning and a well-managed demographic transition. As such, the understanding of the factors responsible for continued high fertility and contraceptive use remain interesting fields of study among demographers (Garenne, 2008, Warren et al., 2013, Van Lith et al., 2013, Bongaarts and Casterline, 2013, Bloom et al., 2009).

Eswatini is amongst the SSA countries with high fertility and population growth rates. The population has doubled in three decades, between 1976 and 2007, from 494,534 to 1,018,449. In this period, the level of fertility (or total fertility rate) has declined over time from an average of 6 to 4 children per woman in Eswatini (CSO, 2010a, CSO, 2010b, CSO, 2008). Of recent, the path of fertility decline continues on a downscale whilst contraceptive use has tremendously increased as anticipated, including for many LDCs (Johnson et al., 2011, Majumder and Ram, 2015, United Nations, 2015c, UNFPA, 2016, Bongaarts and Casterline, 2013).

Contraceptive prevalence in Eswatini was estimated at 4.0% in the early 1980s rising to 16.6% and 37.9% between 1988 and 2007, respectively (CSO, 2008, Ministry of Health, 1990) and recently to 66.1% in 2015 (CSO, 2015a). As in most SSA countries, family planning programmes since inception in the early 1970s, have however, not yielded replacement level fertility or the desired low fertility results in more than three decades. In the case of Eswatini, challenges that have been identified include; unintended births, especially among HIV-positive or younger women, mistimed births among HIV-negative women (Warren et al., 2013) and exceeding ideal number of children among women wanting to limit their births (Van Lith et al., 2013).

Preceding the recent alertness to increased awareness and uptake of contraception among women, breastfeeding was the main driver of fertility decline as found earlier in SSA studies and reports (Letamo and Letamo, 2001, Stover, 1998, Onuoha, 1992, Odimegwu and Zerai, 1996, Warren et al., 1992). Among the key four proximate determinants of fertility (contraception, abortion, postpartum infecundability and marriage) proposed by Bongaarts (1978), contraception has been quite amenable to policy and programme efforts to reduce levels of fertility. It is important, though, to understand the relative importance of proximate fertility determinants to fertility level over time and in different contexts or settings. Fertility behaviour has not only demographic importance, but has significant social and economic policy relevance for women's reproductive health and rights as highlighted in 1994 International Conference on Population and Development (ICPD) Programme of Action (PoA).

The ICPD framework sets out key principles for gender equity and empowering of women, *inter alia,* control of family size, when to marry or get pregnant and equity in health (United Nations, 2014). Within this framework, an environment conducive for women to be free from abuse or coercion, is propagated. Post the 1994 ICPD strategies, anti-poverty developmental goals have been laid out by the United Nations (United Nations, 2015a, United Nations, 2015b), in which indicators of development are interconnected with fertility behaviour.

For SSA, high fertility in women has profound repercussions for their social standing, well-being, health, families, communities and socioeconomic development at local community area or national level. Since 2000, most countries in SSA had been engaged in a 15-year cycle of monitoring the past eight Millennium Development Goals (MDGs) and currently they are committed to the seventeen Sustainable Development Goals (SDGs) set out as the 2030 agenda. Linked to these development goals is the National Development Strategy (NDS) vision 2022 of Eswatini, which seeks to improve the quality of life for Swati people to equal that of MDCs or at least be comparable (MEPD, 2012).

In-depth study on fertility in Eswatini is outdated and limited. For example, unpublished scholarly work by Wallender (1978) found the significance of ecological factors in influencing fertility decision-making. Another micro fertility study by Dlamini (1995), using standard single-level multivariate regression, found that education, child mortality and age at first marriage, were significant factors influencing cumulative or lifetime fertility (children ever born). Warren et al. (1992) examined the impact of proximate fertility determinants on fertility level and found in their order of importance; breastfeeding, marriage, contraception and involuntary fertility at aggregate level. This research seeks to further these prior studies methodologically by examining the influence of micro or individual- and community-level determinants on fertility behaviour in a holistic manner using a multilevel structure.

Few studies, for example the one conducted by Wallender (1978), highlight the significance of spatial communities and socioeconomic contexts spheres for fertility variation and hence, the need for further insights into the subject matter under study in Eswatini. This gap is addressed by paying attention to small local area fertility variation regarding communities at clusters or enumeration areas

(EAs). An in-depth analysis, at community-level, the research might unmask clusters of fertility that guarantee programme or policy attention.

1.2 The problem statement

Research on fertility levels, trends and determinants of fertility is of deep interest to demographers in both LDCs and MDCs settings which are set at different stages of fertility transition. The concern is of low fertility in MDCs, whereas for LDCs, high fertility and its consequences is an issue worth noting, especially in SSA countries (Caldwell, 1976, Cohen, 1998, Colleran, 2016, Garenne, 2008, Hirschman, 1994, Kravdal, 2010, Shapiro and Gebreselassie, 2008, Skirbekk, 2008, Stulp and Barrett, 2016, Testa, 2014, Kirk and Pillet, 1998, United Nations, 2015d, Tabutin and Schoumaker, 2004, Mberu and Reed, 2014, Bongaarts and Casterline, 2013). Furthermore, a significant decline in fertility is one of the necessary conditions for the demographic dividend, noteworthy for achieving faster human development and fostering economic growth.

The consequences for high fertility are dire for African countries, precipitating poverty amongst other population and development matters (Aassve et al., 2006). High fertility associated with high rates of population growth tends to stifle socioeconomic development or progress at individual family and community level due to competition for access to limited resources (Kirk, 1996, Tabutin and Schoumaker, 2004, Casterline, 2010). The concern of high fertility and its consequences in SSA should also be illustrated by the gap between current and desired fertility, the former being generally higher than the latter, particularly among the poor, resulting in a high and unmet need for contraception.

Low uptake or acceptance of contraceptives, combined with low social status among women, has impeded fertility decline in Africa (Andi et al., 2014, Bamiwuye et al., 2013, Barnett et al., 1999, Bongaarts et al., 1984, Cleland and Ali, 2004, DeRose and Ezeh, 2010, Ejembi et al., 2015, Elfstrom and Stephenson, 2012, Hindin, 2000, Kaufman, 1998, Letamo and Letamo, 2001, Odimegwu and Adedini, 2014, Stephenson et al., 2007, Van Lith et al., 2013). Contraceptive use, which is perceived as the most dynamic proximate fertility determinant (Garenne and Joseph, 2002), alongside other determinants of fertility, has been examined mostly in the context of marriage - a prerogative of childbearing in the African setting. This however, neglects the gap of emerging or increasing patterns of new contraceptives and childbearing among the sexually exposed never married single women, especially in Eswatini (Russell, 1993, Adepoju, 1991, Lule, 1991, CSO, 2008, Sonubi and Nkombua, 2015).

In Eswatini, there exists a gap in understanding of fertility behaviour with regards to levels, proximate and distal determinants of fertility. Overall, fertility - measured by total fertility rate (TFR) - has remained above replacement level, estimated at 3.95 children per woman in 2007 and has been projected to reach 3.12 and 2.9 in 2022 and 2030, respectively (CSO, 2007). In Southern Africa (inclusive of Botswana, Lesotho, Namibia and South Africa), Eswatini has the highest fertility (United Nations, 2015d). Paralleling the high fertility rates are decennial population growth rates which ranged between 2.8% and 3.2% from 1966 to 1997 then declined to 0.9% in 2007 (CSO, 2010a). The population of Eswatini is anticipated to increase to 1,210,939 in 2022 and 1,303,090 in 2030, a rise of 1.2% and 1.6%, respectively from 1,018,449 estimate in 2007 (CSO, 2007). The aforesaid projections of fertility estimates are within the margins of population policy targets of Eswatini (MEPD, 2002), but farthest above those of MDCs which have below replacement level fertility.

Besides Eswatini having high fertility levels far above replacement fertility level, inconsistency in the estimates of fertility, is worth mentioning. For example, for the same reference year of 1988, Cleland et al. (1994) and Ministry of Health (1990) reported a significant different TFR of 6.5 and 5 children per woman, respectively. The latter lower TFR has been accepted while contested by others (Blacker, 1994). Blacker estimated TFR at 6.6 children per woman in the previous 1986 census and found that the reported births were seriously underreported. Given this background, reassessment of fertility levels to generate reasonable and accurate fertility estimates, becomes of utmost interest to demographers and policymakers.

According to CSO (2010b) report, Eswatini has been reliant on one technique to estimate fertility levels: the Brass P/F ratio method or its revisions known as Arriaga and Trussell variants. This study seeks to account for these variations in levels of fertility empirically. Corroborating the Brass 'type' methods use of multiple data sources (censuses and surveys- see section 3.3) and other robust indirect demographic methods (see section 3.7.2), is of utmost importance in the assessment of fertility levels. In statistically underdeveloped countries such as Eswatini, there is a need to apply as many demographic procedures as possible in order to have a clear picture of the demographic situation.

Fertility behaviour is not simple to determine or predict since it depends on a number of objective and subjective dynamics in the population. Fertility behaviour involves at least two individuals and may have intended or unintended influences of family, kinship, social networks and/or community. Individual and household (micro) factors are thought to influence fertility indirectly through proximate (immediate or direct) fertility factors- contraceptive use, marriage (or sexual exposure), breastfeeding and abortion- do not only vary with contexts but are also multidimensional (Bongaarts, 1982, Cleland et al., 1984, Cohen, 1998, Colleran and Mace, 2015, Easterlin and Crimmins, 1985, Hindin, 2000, Hirschman, 1994, Mason, 1997, Testa, 2014, Degraff et al., 1997, Grady et al., 1993, Kravdal, 2001).

The individual factors affecting fertility behaviour in Eswatini have been examined in detail as prior mentioned. These include the proximate fertility factors namely education, employment, place of residence, child death, polygyny, and socioeconomic status (Warren et al., 1992, Dlamini, 1995, Lule, 1991, Wallender, 1978). The proximate fertility determinants framework of Bongaarts (1978, 1982) as applied by Warren et al. (1992) in Eswatini, is limited to macro level fertility analysis and hence, intuitively the theory is not correct for explaining micro level fertility behaviour at woman's individual level since this leads to bias. The proximate factors of fertility are, however, vital in micro fertility analysis.

Excluding the study by Wallender (1978) and a recent multicounty study by Elfstrom and Stephenson (2012) on contraceptive use, previous fertility behaviour studies in Eswatini have only focused on woman's individual factors which are not enough to explain the emerging pattern of fertility. This micro-level approach posits that a woman can make her own fertility choices independent of her social realms or external environments (McNicoll, 1998, Amin et al., 2002, Carter, 2001, Cleland and Wilson, 1987, Hirschman and Young, 2000). Individualism or couples' independent decision-making outside societal influence in Eswatini might not be a reality as customs and beliefs are highly regarded.

In this light, macro-level fertility behaviour is pinned down to the social contexts where social intercourse and structures are deemed to influence individual fertility decisions (Angeles et al., 2001, Hank, 2002, Dev et al., 2002, Kravdal, 2002, Kravdal, 2012, Benefo, 2006, Tienda, 1984). However, extant literature on contextual or community influences leans more towards mortality and public health concerns than fertility behaviour (Montgomery and Hewett, 2005). Maintaining this argument, a recent look at 503 published studies on community influences by Entwisle (2007), found that fertility and contraceptive outcomes fell amongst the least researched in comparison to mortality and health-related subjects. Further, van de Kaa (1996) argues that there is a paucity of literature on importance of community effects on fertility behaviour compared to vast existing literature on micro fertility studies.

Scant research on determinants of fertility or contraceptive use (Sonubi and Nkombua, 2015, Mhele, 2015) has been undertaken in Eswatini, especially to understand the role of community as a function of fertility variation. A knowledge gap exists on the role which local clusters or community-level factors play in influencing fertility behaviour.

The suitability of Eswatini as a context of study warrants attention. A recent study has found that Eswatini has a moderate social setting (measured by life expectancy, literacy and income) with however, a poor or weak family planning programme effort (Jain and Ross, 2012). At community-level, political and administrative structures- legal system, public funded programmes and social and economic affairs- have been set under chieftainship which indirectly or directly affect the social well-being of both men and women and thereby fertility behaviour. The Swati patriarchal society structure permits men to have much authority and autonomy in unions or marital relationships (Gule, 1994, Whiteside et al., 2003, Russell, 1993). Eswatini generates interest as a case study for patriarchal societies with high prevalence of polygyny practices and for its strong cultural values or traditional adhering. Polygyny is deemed desirable and was estimated at 19.4% in 1978 (Lule, 1991) and 18.3% in 2007 (CSO, 2008). Although the country appears to have a monolithic culture, the social fabric is not uniform.

This study examines a range of individual-community variables and gives special attention to the role of community in fertility behaviour. The motivation for the chosen community variables in the study is explained later in section 1.7. These have been grouped into three overlapping categories i) gender equity and women's empowerment/autonomy, ii) fertility norms and marital practices and iii) socioeconomic structure or development. The omission of community variables in fertility analysis has created a gap in knowledge that leads to limited understanding of contextual factors underlying fertility behaviour in Eswatini.

1.3 Research questions

The main question of the study is given as:

What is the fertility behaviour of women in terms of actual fertility (levels of fertility), lifetime fertility (children ever born) and use of fertility control (contraceptive use) in Eswatini?

This question has been expanded as follows:

i. What are the levels and variation of fertility in Eswatini based on direct and indirect methods of fertility estimation? Are there data quality problems which need to be addressed?
ii. What is the influence of proximate determinants of fertility (contraceptive use, postpartum infecundability, abortion and sexual activity) in explaining levels in fertility (TFR) in Eswatini?
iii. What is the role of individual and community characteristics in use of fertility control (contraceptive use)?

iv. Beyond individual characteristics, what is the contribution of community characteristics in determining disparities of lifetime or cumulative fertility?

v. How does fertility behaviour (contraceptive use and/or lifetime fertility) vary between communities or clusters?

1.4 Research objectives

1.4.1 General objective

The ultimate aim of this study is to understand the role of individual and community factors in fertility behaviour of Swati women.

1.4.2 Specific objectives

i. To estimate fertility levels using direct and indirect methods of fertility estimation;

ii. To assess the impact of proximate fertility determinants on level of fertility based on the Bongaarts model and its modifications;

iii. To examine the association between individual- and community-level factors and contraceptive use using a multilevel binary model;

iv. To examine associations of individual- and community-level factors with lifetime fertility in Eswatini through the use of multilevel count models; and

v. To assess whether or not there was a significant community variation of contraceptive use or lifetime fertility using multilevel or random intercept regression methods.

1.5 Definitions of terms

1.5.1 Community

A community refers to a macro-level structure with reference to 'neighbourhoods' of both non-spatial (e.g. community education, social position, polygyny level) and geographical/spatial environments - village, district, urban-rural or region residence status (Bongaarts and Watkins, 1996, Entwisle, 2007). Communities have manifold uniformities of behaviour patterns (McNicoll, 1983: 3), and incorporate collectivities of persons whose interactions are marked by communion and mutuality (Carter, 2001: 154) although variation across communities is permissible (Smith, 1989, Degraff et al., 1997). The impact of community on fertility is accounted for when community-level variables are specified (Smith, 1989) in a non-prescriptive way, representing key institutional features in the communities (Hermalin, 1986). This study employs the clusters (or enumeration areas) to represent communities.

1.5.2 Community-level factor

A community-level factor is defined as any set of characteristics common to all the persons living in the community (Syamala, 2004: 119).

1.5.3 Cluster

A cluster is the smallest unit, also known as the primary sampling unit (PSU), obtained from a nationally representative, multistage stratified clustered sampling designed DHS survey. The PSU represents neighbourhoods capturing the geopolitical environment of the community as shown in many studies (Weeks et al., 2010, Janevic et al., 2012, Kravdal, 2006, Kaggwa et al., 2008, Kravdal, 2003, Stephenson et al., 2007, Kamal et al., 1999).

1.5.4 Period total fertility rate

The period or current total fertility rate (TFR) is an aggregate measure of current fertility. It is defined as the average number of children born to a woman in her reproductive lifespan if she has to experience the prevailing age-specific fertility rates. The TFR captures aggregate fertility behaviour of women in a country and at subnational or subpopulation level.

1.5.5 Fertility behaviour

Defining and measuring fertility behaviour is of sheer significance to demographers. Fertility behaviour is a sequential decision-making process which may or not reduce reproduction or fertility and thereby prevent them from achieving their potential maximum (Schmid, 1989, Degraff et al., 1997, Ezeh, 1997). Fertility behaviour constitutes one or more fertility outcomes representing desired or actual fertility and acts of fertility control/preventing reproduction.

Actual fertility (reproductive performance) is often measured using number of children born, either recently born (Agyei-Mensah and Owoo, 2015) or ever born per individual woman (Moeeni et al., 2014, Grace and Carr, 2009, Etukudo and Effiong, 2016) and fertility rates (age-specific and total fertility rates) for all women combined (Siddiqui, 1996, Nahmias, 2004). Thus, cumulative/lifetime fertility is represented by total number of children ever born and level of fertility/current fertility is measured by the total fertility rate.

Desired fertility captures the rationale process of decision-making on the number of children a woman prefers or intends to bear in her reproductive lifespan (Testa and Grilli, 2006).

Fertility control is an act of reducing reproductive performance or refraining procreation through adoption of family planning practices, including contraception (Easterlin, 1975, Schmid, 1989).

Fertility behaviour in a holistic manner is represented using two or more fertility outcomes (Solanke, 2015, Ezeh, 1997, Hindin, 2000, Wusu and Amoo, 2016). In particular for this study, fertility behaviour of women is measured in terms of use of contraceptives and children ever born adopting Easterlin's theoretical framework for fertility determination (Degraff et al., 1997, Ferrone, 2014). Therefore, fertility behaviour of women using a broad lens can be defined as a sequential process that reflects their actual reproductive performance (levels of fertility, lifetime fertility) and fertility regulation (use of contraception).

1.5.6 Women's empowerment

Women's empowerment is rather an elusive term (Ibrahim and Alkire, 2007). The concept of empowerment is often synonymous with gender equality, status or autonomy. Therefore, literature conceptualises or measures women's empowerment by encompassing various social, economic, cultural, psychological and economic components (Do and Kurimoto, 2012, Upadhyay et al., 2014, Upadhyay and Karasek, 2012, Mills, 2010, Balk, 1994, Mahmud, 1994).

The work of the World Bank and Kabeer as cited in Do and Kurimoto (2012) defines women's empowerment as 'the expansion of freedom of choice and action to shape one's life' (World Bank, 2002) and 'a process by which those who have been denied the ability to make strategic life choices acquire such an ability' (Kabeer, 1999, Kabeer, 2005). Women's empowerment is conceptualised here as a multidimensional composite index with several components related to women's i) experience of gender based violence (GBV), ii) household decision making, and iii) sexual negotiation or control.

1.5.7 Sustainable development

Sustainable development is a multidimensional phenomenon. Its commonest definition is 'development that meets the needs of the present, without compromising the ability of future generations to meet their own needs' (Sustainable Development Commission, 2011). Sustainable development is therefore determined as a continuous process.

1.5.8 Development

Development in a broad sense is cross-cutting, bringing to the fore a desirable and irreversible change meant to improve various facets of life for an individual or community (Bellù, 2011).

1.5.9 Socioeconomic development

Socioeconomic development has been adopted well by social science research and is much more specific, combining social and economic aspects or conditions. Socioeconomic development pertains to progress in terms of social (and economic) values and ecological values - nature or territory (Chojnicki, 2010).

Social and economic values are evaluated in terms of education, wealth/poverty and employment as suggested by Brewster (Brewster et al., 1993) and access to media or knowledge of family planning. To include the dimension of lack of resources or poverty, this dimension has been named a 'socioeconomic disadvantage' as highlighted in literature (Whiteman, 2014, Scutella et al., 2009, Thornton et al., 2016, Majumder and Ram, 2015).

Ecological values pertain to physical space of locational/spatial contexts or environments regarded in this study as an 'area disadvantage', commonly measured in literature using region and place as residence variables (Bentley et al., 2009, Clements et al., 2004, Basten et al., 2011, Entwisle, 2007, Kamal et al., 1999, Kulu et al., 2007, Weeks et al., 2010).

1.5.10 Lifetime fertility

Lifetime fertility is the total number of children ever born alive during the whole reproductive lifespan of the woman.

1.5.11 Proximate determinants of fertility

The proximate determinants of fertility refer to the biological and behavioural factors through which the remote or indirect determinants – cultural, socioeconomic, psychological and ecological variables, affect fertility. Key proximate determinants of fertility, which include marriage or sexual exposure, contraception, postpartum infecundability and abortion, have a direct or immediate influence on fertility and hence alone or in combination cause fertility variation among populations.

1.6 Significance of the study

This section justifies the importance of study on fertility behaviour based on literature, programmes and policy grounds. It is important to note that fertility, its magnitude (levels), determinants and consequences, as well as the reasons behind fertility, changes, and serves as a basis for policy planning and formulation for many aspects of the population. The formulation of those policies mediates indirectly or directly on fertility.

Fertility is one of the most important components of population change. Among other things, fertility change is associated with the changing age-sex structure of the population which is believed to lead to a “demographic dividend”, assuming relevant and appropriate policies are in place. The subject of demographic dividend in Africa is becoming another interesting topic of research in certain circles.

Continued high fertility and the resultant rapid population growth, are linked with a number of challenges that are common in developing countries: poverty, unemployment, hunger, malnutrition, etc. These issues are of global concern and require further investigation in the African context. Understanding these aspects (fertility and their determinants), are critical in alleviating poverty and addressing sustainable development goals (Aassve and Altankhuyag, 2002, Agadjanian and Prata, 2002, Lindstrom and Berhanu, 1999, Montgomery and Hewett, 2005). Hitherto, accurate assessment of fertility levels is not only vital for policy strategy but of demographic importance to generate reliable and accurate estimates from data which often are incomplete or scanty in SSA.

The need to examine or reassess data to estimate fertility levels using several methods and data sources becomes imperative to corroborate estimates. In addition to direct fertility estimates, which usually do not account for misreporting of births, indirect estimation techniques (such as P/F ratio and regression-based methods), are useful for validation and estimation of fertility levels. Alternative and recent formal technique formulations of the P/F ratio method such as the Feeney and relational Gompertz methods, have proved robust and dependable in generating fertility estimates (Moultrie and Dorrington, 2008, Moultrie et al., 2013). More importantly, utilisation of multiple datasets is useful for consistency checking of fertility levels and thereby establishing trends of fertility. As prior noted, only a few or dated studies have been conducted on fertility in Eswatini, especially at subnational or community level.

The SSA region, unlike Latin American and Asian developing regions, is conceived as having pronatalist attitudes to children, characterised as a pre-transition fertility regime with TFR nearing 5 children per woman between 1950-2010 (Bongaarts and Watkins, 1996, Bongaarts and Casterline, 2013). This high fertility pattern is projected into the future for SSA (Odimegwu and Adedini, 2014). The lagging behind of fertility decline has motivated policymakers to have a keen interest in fertility transition in LDCs at any given moment and of recent in MDCs, issues of low fertility are of prime concern (Kravdal, 2010). High fertility and slow paced fertility decline lead to high population growth, which has consequences for a range of population aspects (Bongaarts and Casterline, 2013). For example, Kirk (1996) argues that high population growth disadvantages women's socioeconomic position, progress or empowerment and hence, is incompatible with or competes with their gainful activities of employment and education.

High fertility levels in SSA including Eswatini, calls for small local area understanding of the effect of fertility behaviour on community factors that might perpetuate high fertility regimes. The local community based overall strategy of promoting small size fertility norms and sustained contraceptive use, becomes vital for family planning programmers to effectively monitor and evaluate fertility behaviour in Eswatini (MEPD, 2002). This study examines the role of community in fertility behaviour in SSA by examining Eswatini as a case study. Further, this study is an exception for Eswatini, because it presents an in-depth look at the micro-macro level relationships of fertility behaviour outcomes.

A dated study by Warren et al. (1992) of Eswatini can be singled out as a comprehensive study on the proximate determinants of fertility, but does not capture the micro- and macro-level link structure of the determinants of fertility. Fertility declines may not be uniform across spatial contexts and among subpopulation groups (Agyei-Mensah and Owoo, 2015). Apparent fertility behaviour disparities have been observed such as in urban-rural, poor-rich and illiterate-literate populations. Targeted programmes or resources focussing on interventions can therefore be made. The implementation is variable according to the insights of the underlying determinants of fertility outcomes.

Although insufficient research on factors associated with fertility variation has been done in Eswatini, numerous authors have demonstrated the theoretical and empirical (based on regression-methods) importance of individual and household (micro) variables influences on fertility outcomes. The determinants of fertility behaviour are not only a wide array but also multi-dimensional, qualifying or quantifying cultural, socioeconomic and other factors representing women's fertility decision-making process. The micro- and macro-level determinants, which probably do not have the same bearing on fertility, make this study comprehensive, extending the realm that fertility considerations are taken at personal or couple level and beyond at community or societal level.

However, the realm in which individuals live in a community and whose effect may shape their childbearing, is acknowledged in literature or theories but not properly accounted for in analyses. Micro fertility studies have ignored the effective methodological approach to deal with these community effects, especially with hierarchical structured data. This methodological gap is addressed in this study, by applying a quantitative multilevel framework (using data from 2007 Eswatini DHS survey), which serves as a basis for understanding the 'unexplained variation', usually expressed as a 'random error' bias, which is often wide in standard or single-level regression models. The latter models overlook differences in communities with regard to women's fertility behaviour. Hence, multilevel models have been put forth to address these concerns. Multilevel Poisson regression models have been applied to analyse count fertility outcomes such as children ever born (Amin et al., 2002, Colleran et al., 2014, Ezeh, 1997, Colleran et al., 2015) whereas multilevel logistic models are meant for binary outcomes, such as whether or not to use contraceptives (Degraff et al., 1997, Moursund and Kravdal, 2003, Janevic et al., 2012, Stephenson et al., 2008, Muhwava, 2003, Elfstrom and Stephenson, 2012, Wang et al., 2013, Ejembi et al., 2015, Benefo, 2010). The importance of a multilevel framework has been detailed in section 2.4.

Besides considering why communities may be important, this study adds to the body of knowledge, including community variables which may be of influence in the case of Eswatini. Different to individual factors which are well established, the community-level variables affecting fertility behaviour are far beyond being exhausted and understood in demographic research. The study adopted a holistic approach to community variables to examine fertility behaviour as inspired by Stephenson et al. (2007), amongst others.

Community variables relevant to study of fertility behaviour have been identified in literature. The three contextual dimensions that merit research in the context of Eswatini are identified as i) socioeconomic development, subdivided into area disadvantage and social position disadvantage, ii) fertility norms and marital practices and iii) gender equity and women autonomy/empowerment. These were derived and inspired by studies by Bentley and colleagues (Bentley et al., 2009), Wang and colleagues (Wang et al., 2013) and Elfstrom and Stephenson (Elfstrom and Stephenson, 2012) which examined contextual influences on contraceptive use.

This study has been extended to assess lifetime fertility as measured by number of children ever born. The uniqueness of the factors of women's status and community aspects chosen for this study is that they represents the traditional and patriarchal structure of the Swati marital practices and customs which have a bearing on fertility or contraceptive use. In addition, the variables are varied or interlinked, covering the cultural and socioeconomic characteristics of a society.

Importance of fertility norms, marital customs and practices

As already highlighted, Swati people have a strong tradition and culture. Marriage values precipitated by tradition or religion in the form of customs, values or norms, have a strong link with fertility behaviour. Where these norms tend to be widespread, they seem to sanction childbearing or contraceptive use.

Whereupon the community is bounded by traditions, the fertility behaviour of individuals or couples would closely resemble the fertility norms of the community. Attitudes towards fertility, common in the community, may permit childbearing by generating the desirable number of children which a woman should have. In some communities, women's status is upheld by bearing as many children as possible, especially in rural areas. On the contrary, the elite women in urban areas tend to have fewer children. The imprint which society makes on childbearing and marriage patterns exerts pressure on women in a way that they are obliged to follow societal norms. Similarly, fertility control methods adopted may be those commonly acceptable or available in the community (Caldwell and Caldwell, 1987, Cleland and Wilson, 1987, Colleran, 2016, MEPD, 2012, Ezeh, 1997, Ezeh and Dodoo, 2001, Ferraro, 1991, Lule, 1991, Garenne, 2004, Preston-Whyte, 1988). In the case of Eswatini, for instance, injectables seemingly appear to have been popularised among women (CSO, 2008) and hence their greater uptake.

The study adopts two community variables namely, community polygyny and community ideal fertility norm (the number of children women would desire to have). The former has not been examined in the case of Eswatini while the latter has been found to be a significant factor influencing contraceptive use (Elfstrom and Stephenson, 2012), however, it remains to be seen what its influence is on lifetime fertility.

Gender equity and women's autonomy or empowerment

In social settings where men and women have unequal relations, women may be bound to the fertility and contraceptive demands of the 'masculinity' community. Therefore, women with low autonomy (probably more economic dependency), are more likely to have many children and inclined to have limited control over spacing and postponing births (Mason and Smith, 2000, Do and Kurimoto, 2012, Hindin, 2000, Mills, 2010, Moursund and Kravdal, 2003, Solanke, 2015, Upadhyay et al., 2014, Wang et al., 2013). Most studies of fertility or contraceptive use have looked at women's personal decision-making process with undue attention on ecological spheres of life that shape their fertility behaviour.

Gender stratification and women autonomy or empowerment components tend to be similar; literature on fertility behaviour has looked at these as separate components (Solanke, 2015) or one component with several dimensions- including economic, physical, decision-making autonomy (Moursund and Kravdal, 2003, Mason and Smith, 2000, Odimegwu and Adedini, 2014, Upadhyay and Karasek, 2012, Wang et al., 2013) and in the case of Eswatini (Elfstrom and Stephenson, 2012).

This study fills two gaps in literature on women's empowerment by providing a unitary measure or an overall index that can be vital for comparison purposes (Bamiwuye et al., 2013, Do and Kurimoto, 2012, Fanchette, 1974). Second, women's empowerment measures have been applied mostly for married women, neglecting the never married women. Rather than focussing on actual women's experiences, attitudes towards violence or sexual negotiation dynamics for the never married, can be incorporated (Do and Kurimoto, 2012, Upadhyay et al., 2014) thereby increasing sample size for all sexually exposed women when examining fertility behaviour.

Socioeconomic development

The paths of community development, according to Lobao and Brown (1998: 821), can filter down to fertility behaviour. The authors argue that this occurs through social structure, character of patriarchy, unequal relations with respect to age and gender and through state influence on social reproduction. The importance of political and administrative structures of governments for fertility has generated interest among population scientists and has socioeconomic developmental implications (McNicoll, 1980, McNicoll, 1983, McNicoll, 1996, McNicoll, 2001, Demeny, 1975, Potter et al., 2002). Both micro and macro factors play a major role in fashioning community/geographical disparities in fertility behaviour (Basten et al., 2011, Stephenson et al., 2007, Hank, 2002, Kulu et al., 2007). Both local spatial and social contexts (Entwisle, 2007), as engines of socioeconomic development, are of interest in this study.

a) *Area disadvantage*

Area development or disadvantage is proxied by place and region of residence in most studies as aforementioned in section 1.5.8. Including these variables in micro fertility studies with multilevel data structure, has led to random error bias as noted earlier, however, this can be corrected in a micro-macro multilevel level framework, utilised in this study. Overall, there is a greater chance that children are more likely to be born in regions and/or places with poor economic conditions in LDCs. In the case of Eswatini, although all regions are predominantly agricultural and rural, there are disparities in the built environment. Lubombo and Shiselweni are characterised as poor resource rural settings whereas Manzini and Hhohho have better resources and are more urbanised, industrialised and modernised areas.

b) *Socioeconomic disadvantage*

Women's status or socioeconomic disadvantage is viewed differently to women's empowerment which incorporates gender relations and decision control (Mahmud, 1994, Hindin, 2000). Women's socioeconomic disadvantage parallels poverty. Variables such as education, wealth index (in DHS), employment and/or occupation have been invoked to assess women's social position. Similar to empowerment measures, composite or factor variables have been used in research to measure socioeconomic disadvantage, for example, occupation and employment (Burgard and Lee-Rife, 2008, Colleran and Mace, 2015), education-wealth-occupation- employment (Thornton et al., 2016), education-wealth-occupation (Brewster et al., 1993). The latter composite index has been adopted in this study. In addition, access or exposure to mass media is also an important socioeconomic opportunity measure that may influence fertility behaviour (Ejembi et al., 2015, Wang et al., 2013).

The research is expected to give insight into the possible influence of community variables of women's empowerment, socioeconomic development and fertility norms domains on fertility behaviour (lifetime fertility or contraceptive use) in Eswatini. To assess the relative importance of individual and community-level variables on fertility behaviour, an array of demographic and socioeconomic factors in statistical models, has been adopted in this study.

Eswatini is a member of United Nations (UN) and therefore, subscribes to its resolutions, policies and strategies which are adaptable among countries. The UN agenda on population issues is astounding, especially since the 1994 ICPD 20-year Programme of Action (PoA). The PoA progressed by a cascade of developmental goals ushered in as eight MDGs from 2000 and have since been extended post-2015 as a set of seventeen SDGs whose themes are summarised in Appendix B (United Nations, 2014, United Nations, 2015a, United Nations, 2015b).

The developmental goals aforementioned have been confirmed or prioritised in the population policy of Eswatini set out in 2002. The policy points out a number of objectives which are key to this study. These include promoting fertility level decline, gender equity and women empowerment, use of population data, a legal framework responsive to population needs, research for policy and planning, understanding of the role of cultural practices in population, availability of information, education and communication (IEC) materials on population, the well-being of the population and integrating population issues in plans for development (MEPD, 2002). In line with vision 2022, fertility levels have been set to reduce to 3.0 children per woman from 4.5 estimated in 1997 and contraceptive prevalence rate (CPR) set to increase to 65% from 34% as estimated in 1998.

The vision of Eswatini to attain first world status by 2022 makes it sensible to take a closer look at fertility behaviour of women. Currently, MDCs have low fertility levels which are commensurate with higher economic development compared to LDCs. The understanding of the factors that influence fertility behaviour is vital for appropriate adoption, strengthening and implementation of population policy or programmes.

1.7 Organisation of the study

The study is divided into ten chapters. The first chapter gives an overview of the study by setting out the background, objectives, research questions, and justification of the study. In the second chapter, literature on fertility-related behaviour including fertility transition and variation, is reviewed. Various theoretical perspectives or conceptual frameworks are set out and gaps in literature identified. Fertility levels, trends, patterns and/or determinants, are also reviewed or outlined in their contexts at global level and in Africa. The levels of fertility for Eswatini are also highlighted.

Chapter 3 describes the profile of the study population in order to understand the context of the study and presents data sources, instruments, variables and methods used in the study. The possible linkages (or hypotheses) between fertility and community-level variables are then discussed. In the following chapter, Chapter 4, descriptive analyses of fertility behaviour and the background characteristics at individual- and community-level for the survey data used, are examined.

Chapter 5 examines quality of data (especially on reporting of births) and the methods which are used to study the fertility levels and determinants of fertility variation (differentials) in Eswatini. Both multilevel regression methods and indirect techniques of fertility estimation are then presented. The subsequent chapter, Chapter 6, assesses the contribution of the proximate determinants of fertility to total fertility rate using the Bongaarts' model and its modifications. Chapter 7 uses a combination of direct and indirect approaches to estimate levels, trends and differentials of fertility in Eswatini. The subsequent two chapters examine the data to assess the individual and community-level determinants of fertility behaviour outcomes (contraceptive use in Chapter 8 and lifetime fertility in Chapter 9) with respect to the research objectives or hypotheses using multilevel regression techniques. The final chapter summarises the research findings and suggests how fertility is related to development goals as a policy perspective in Eswatini.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter reviews related literature on fertility behaviour with set objectives which are presented in four major parts. The first part (sections 2.1-2.3), looks at the levels of fertility from a global, regional and contextual view. Also presented in this segment is a review of major studies of quality of fertility data and different formal demography measures of fertility levels. The following segment (sections 2.4-2.6), presents a review of determinants of fertility and an overview of the statistical measures of fertility behaviour. The major theoretical underpinnings of fertility behaviour are reviewed in section 2.7 and a conceptual framework formulated in section 2.8. The last section presents research hypotheses of the study.

2.1 Empirical findings: Levels of fertility at global, regional and contextual level

This section presents an overview of past and projected global and African fertility levels in the period 1970-2030. A glimpse of fertility levels for southern African neighbouring countries of Eswatini is shown.

2.1.1 Global and Sub-Saharan Africa overview of fertility levels

In overview, since 1970, the status of fertility transition worldwide has been on the downward scale. Fundamentally, once fertility has started to decline by a 10% margin, the momentum of decline continues (van de Kaa, 1996). Exceptions have been noted for moments of stalling of fertility in some examples of African countries (Ezeh et al., 2009, Opiyo and Levin, 2008, Garenne, 2011). The falling in quantum of fertility has notably been slower and above the replacement level fertility (2.1 children per woman) in Africa compared to the rest (United Nations, 2015d).

Table 2.1, in addition to fertility levels varying over time, depicts fertility differences observable across regions, sub regions and countries. In particular, recent fertility for the period 2010-2015 and projected fertility for the period 2025-2030, suggests low fertility in more developed countries (MDCs) including Europe and Northern America closely followed by Asia and Latin

America and the Caribbean. Africa and most of its regions maintains high fertility and a slowed pace of fertility decline. Southern African countries neighbouring Eswatini-the context of study- maintain the status quo of fertility transition that is above replacement level fertility (United Nations, 2015d).

Table 2.1: Overview of fertility levels worldwide and major regions or countries, 1970-2030

	Total fertility rate: children per woman			
Region/major area/*country*	1970-1975	1990-1995	2010-2015	2025-2030
World	4.5	3.0	2.5	2.4
[1]More developed regions	2.2	1.7	1.7	1.8
[2]Less developed regions	5.4	3.4	2.6	2.5
Northern America	2.0	2.0	1.9	1.9
Oceania	3.2	2.5	2.4	2.2
Latin America and the Caribbean	5.0	3.0	2.2	1.9
Europe	2.2	1.6	1.6	1.7
Asia	5.1	3.0	2.2	2.0
Africa	6.7	5.7	4.7	3.9
Sub-Saharan Africa	6.8	6.2	5.1	4.1
Eastern Africa	7.1	6.4	4.9	3.9
Middle Africa	6.5	6.8	5.8	4.6
Northern Africa	6.4	4.2	3.3	2.8
Western Africa	6.8	6.4	5.5	4.6
Southern Africa	5.6	3.5	2.5	2.2
Botswana	6.5	4.3	2.9	2.3
Lesotho	5.8	4.7	3.3	2.6
Namibia	6.6	4.9	3.6	2.9
South Africa	5.5	3.3	2.4	2.1
Eswatini	6.9	5.3	3.4	2.6

Source: United Nations (2015d)

In support of this view, Bongaarts and colleagues examining fertility in the period 1950-2010, observed a pre-transitional fertility regime, due to pronatalist attitudes, in Sub-Saharan Africa (Bongaarts and Watkins, 1996, Caldwell et al., 1992, Bongaarts and Casterline, 2013). Odimegwu and Adedini (2014) opined that this high fertility regime would persist for Sub-Saharan Africa (SSA) for a considerable time in the future. In contrast, low fertility below replacement level that depicts MDCs does not mask portions of high fertility at subnational or subpopulation level observable in part due to contextual influences (Basten et al., 2011). Contrary to MDCs where data quality on fertility is

[1] In this study more developed regions are referred to as more developed countries (MDCs).
[2] In this study less developed regions are referred to as less developed countries (LDCs).

good, interest has been generated in estimating and reconstructing fertility levels with defective and scarce data for SSA countries (Arnaldo, 2004, Cohen, 1993, Garenne, 2012, Machiyama, 2010, Mhloyi, 1992, Muhwava, 2002, Odimegwu, 1998, Palamuleni, 2013, Moultrie and Timæus, 2003). Fertility levels have vital policy implications for various regions, contexts and countries including Eswatini. In resource poor settings, high fertility most often stifles socio-economic progress, especially for women.

In overview, fertility behaviour is a significant indicator of development (Jain and Ross, 2012), including women's social standing. It should be noted that populations in the fertility transition process may reflect a different or varying pace of fertility change (decline, stagnation or rise). Therefore, identifying a typology or unique fertility pattern for SSA not only remains a challenge, but a difficult task due to different changes or modifications in the social and economic environments. The following section presents a perspective of fertility levels for Eswatini as the context of this study

2.1.2 The fertility estimates in the context of Eswatini

An overview of fertility from the United Nations database presented in the previous section indicates that Eswatini is a high fertility country with above replacement level fertility as is common in Africa (see Table 2.1). Great strides have been made in deriving and re-examining fertility estimates in various African countries (Kirk and Pillet, 1998, Garenne and Joseph, 2002, Cohen, 1993, Garenne, 2008) and specific countries such as South Africa (Moultrie and Timæus, 2003, Udjo, 2003, Palamuleni, 2013), Kenya (Ezeh et al., 2009, Blacker et al., 2005, Opiyo and Levin, 2008) and Zimbabwe (Mhloyi, 1992, Muhwava, 2002), to mention a few. In the case of Eswatini, little academic progress has been made in Eswatini documenting fertility estimates. Dated extant literature on fertility levels for Eswatini (Cohen, 1993, Warren et al., 1992) requires further updates with recent information and methods of measurements.

Although fertility decline is underway in Eswatini (see Table 2.2), the implied levels shown by direct fertility estimates, between 1966 and 2007, signify underreporting of children. In the four decades, a reduction of 1 birth - a decline of TFR from 5.2 to 3.8 children per woman, suggests rather a snail-paced fertility decline. Also, this is indicative of poor quality of reported fertility data. The case of defective data is confirmed when indirect fertility estimates, which often are relied on, are higher than direct estimates. When data are not defective and accurate, the variation between indirect and direct estimates of fertility, is minimal.

Table 2.2: Total fertility rate by data source and method of measurement, Eswatini

Data Source	TFR reported	Method applied	Source/reference
PHC 1966	5.2[d] [6.9[+]]	[d] direct; [+] method not stated	CSO (1979); Cohen (1993)
PHC 1976	5.7[d] [7.1[b]; 6.8[m]]	[d] direct; [b] (original) P/F ratio-Brass, [m] model not stated, but based on 'best fit' on Coale and Trussell parameters	CSO (1979)
PHC 1986	4.3[d][6.8[b];6.7[a,t]; 6.6/6.5[g];6.4[i]]	[d] direct; [b] P/F ratio-Brass; [a] P/F ratio-Arriaga variant; [t] P/F ratio-Trussell variant; [g](original) Brass relational Gompertz model; [i] Arriaga intercensal cohort method	CSO (1991)
FHS 1988	5.0	Direct/observed	Ministry of Health (1990)
DHS* 1991	5.6	Direct/observed	CSO (1998)
PHC 1997	4.3[d][4.5[a];5.3[t]]	[d] direct (own calculation); [a] P/F ratio-Arriaga variant; [t] P/F ratio-Trussell variant	CSO (1998)
PHC 2007	4.0[d][4.7[t]]	[d] direct; [t] P/F ratio-Trussell variant	CSO (2010a)
DHS 2007	3.8	Direct	CSO (2008)
MICS 2011	3.7	Direct	CSO and UNICEF (2011)
MICS 2014	3.3	Direct	CSO and UNICEF (2016)

Notes: DHS=Demographic and Health Survey; DHS*=Demographic and Housing Survey; PHC=Population and Housing Census; MICS=Multiple Indicator and Cluster Survey; FHS=Family Health Survey. Direct method estimate involves computing TFR directly from reported births in the census data or full birth histories in survey data.

2.2 Quality issues or reviews on fertility data in estimating fertility levels

Demographic data collection is not a completely scientific exercise in that the data are collected by individuals on individuals and therefore errors are unavoidable (Moultrie, 2009b). In the same view, Hill (1990: 134) posits that all datasets are defective, and most are deficient-always requiring evaluation, often requiring adjustment. Further, the National Research Council (2004) and Schoumaker (2014) highlight that errors in census data are inescapable, but focus should be on knowing their existence and potential sources, quantifying their effects, measurement of errors and minimising errors. These authors recognise that evaluating the quality of data is not piecemeal but a tenacious exercise requiring various techniques and researchers' knowledge on fertility subject matter.

In brief, the concern to demographers is the accuracy of fertility estimates and quality of fertility data, both from censuses and surveys collected in developing countries, including Africa. Poor quality, defective and inadequate data with regard to censuses and surveys, is worth noting, especially in earlier decades of data collection in SSA. Hence, underreporting or misspecification of births was commonly observable (Cleland, 1996, Cohen, 1998). In the case of Eswatini, Cohen (1998) observed that the 1966, 1976 and 1986 censuses were of poor quality of data. Some concerns around the quality of fertility estimates in earlier estimates point to the underreporting of births and a significant number of births being reported as 'not-stated' (Warren et al., 1992). Illiteracy of the African populace hampered the collection of reputable data for most countries.

Whilst the position on quality of demographic data in censuses and surveys has been contested and investigated using various demographic and statistical tools for some Southern African countries such as South Africa (Phillips, 1999, Moultrie and Timæus, 2003), Zimbabwe and Botswana (Blanc and Rutstein, 1994, Thomas and Muvandi, 1994), such scientific enquiry is missing for Eswatini in spite of regular census enumerations done. Thus, fertility data remains under-examined for Eswatini. Further, the in-depth analysis of Eswatini census data has been limited due to paucity of data as well as inadequate demographers and their lack of interest or capacity, especially within the country.

As a preliminary step, census data are evaluated on accuracy and quality of age reporting errors, using classic demographic tools such as age ratios, sex ratios and Myers', Whipple' and joint score indices on pinpointing irregularities in age-sex composition (Brass, 1996, Shryock et al., 1976, Spoorenberg, 2007). Fertility data errors on children ever born (lifetime fertility/parities-P) and recent births (current fertility-F) due to underreporting or underenumeration, have been observed in data. Appraisal of the data has required the diagnostic tools of the P/F ratios inherent for most indirect estimation techniques (see section 2.3) and the el-Badry technique, to correct for distorted parity data. The multiple census data sources allow for consistency checks on age-sex distributions, age pattern of fertility and comparisons of fertility data over time (Joyner et al., 2012, Moultrie et al., 2013, United Nations, 2004, United Nations, 1983). A distorted age-sex structure through bias and errors in age-sex data has implications for fertility estimates and their projections (Spoorenberg, 2014) and also affects input data to development planning.

Efforts since 2000 in evaluating and monitoring Millennium Development Goals (MDGs) has been crucial for most African countries towards achieving set targets. The post-MDGs era of Sustainable Development Goals (SDGs) now entails the realisation of the need for reliable data on performance assessment of developmental activities and the necessary programme interventions. Whereas less flawed demographic data has been collected for developed countries, the contrary has happened in African countries in the past four decades where data has been rendered as either defective or inadequate due to its poor quality (Cleland, 1996, Cohen, 1993, Cohen, 1998, Brass, 1996, Moultrie et al., 2013, United Nations, 1983, Potter, 1977, Hill, 1990). Due to an incomplete vital registration system (VRS) in most developing countries, the censuses and surveys remain as dependable sources of fertility data (United Nations, 2004).

The types, causes and effects of errors on estimates of fertility that occur in census or survey data are highlighted in demographic literature (National Research Council, 2004, Schoumaker, 2014, Vergauwen et al., 2015, Potter, 1977, Brass, 1996, Joyner et al., 2012, Cleland, 1996, Spoorenberg, 2014, Phillips, 1999, United Nations, 2004, United Nations, 1983, Hill, 1990, Moultrie et al., 2013). This literature highlights common quality issues around age-sex and fertility data which relate to omission, duplication, misreporting, mistiming or misplacement of birth events or age, selection bias and non-responsiveness or response irregularities due to memory lapse or recall problems and/or negligence as well as other motives in reporting/recording.

Although errors and bias can be classified in somewhat different ways, the tabular format excerpt from Schoumaker (2014: 3-4), comprehensively describes the data quality issues in developing countries regarding the measurement of fertility as depicted in Table 2.3. Overall, such errors may occur in a survey or when a census aims to compile a complete enumeration of population statistics on fertility data for the whole country using a short census form and/or a long census form for sampled data.

Table 2.3: Description of main data quality problems affecting fertility estimates

Type of problem	Possible causes and mechanisms	Impact on fertility
Misreporting of date of birth		
Heaping	Heaping of year of birth or age (e.g., final digit 0 or 5). More likely in contexts where exact date of birth/death is not known by respondent.	Irregular fertility trends; underestimation of recent fertility if heaping implies displacement of births outside the window of eligibility for computation of rates.
Displacement of recent births before the cutoff date	Displacement of births by interviewer or respondent in order to avoid additional questions to complete the child health section in the DHS questionnaire.	Irregular fertility trends; underestimation of recent fertility if births are displaced outside the window of eligibility for computation of rates.
Potter effect	Tendency to report distant births as closer to the survey than actually occurred. More likely when birth histories are collected starting with first birth.	Underestimation of fertility in earlier periods and overestimation in intermediate periods ([inverted] U-shape trend in fertility); apparent decrease in median age at first birth.
Underreporting of births		
Omission of distant births	Involuntary omission of early births, especially by older respondents and for deceased children.	Underestimation of fertility in earlier periods; apparent decrease in median age at first birth.
Omission of recent births	Omission of births by interviewers or respondents in order to avoid additional questions to complete the child health section in the DHS questionnaire. Omission of deceased children in order to avoid sensitive questions.	Underestimation of recent fertility.
Selection bias		
Mortality	Only surviving women are interviewed about their past fertility.	Slight underestimation of recent fertility if fertility and mortality are positively correlated. Fertility at young ages among older women may be underestimated if high fertility women experience higher mortality rates.
Other factors		
Misreporting of women's age	Heaping on year of birth or age (e.g., final digit 0 or 5). Women may also be reported as younger or older than they actually are, to avoid being interviewed.	Possible impact on fertility rates if misreporting of age is related to fertility.

Source: Excerpt of Table 1 from Schoumaker (2014: 3-4)

In overview, it is difficult to uncover, distinguish or correct all errors in data and hence, the focus is on reducing and knowing their bias or overall effect (National Research Council, 2004, Schoumaker, 2014). For instance, the United Nations (1983) notes that the effect of age misreporting on fertility is complex, but the overall effect tends to be small.

Errors (of different types) which may have occurred on a simultaneous basis could lead to a similar effect on fertility (Schoumaker, 2014) or an offset (National Research Council, 2004, Shryock et al., 1976). Further, possible effects of errors or bias, in magnitude or direction, which Brass (1996) cautions their difficulty in proving, can be compensated by adjustments using appropriate methods of applications and assumptions of fertility estimation (Hill, 1990, Moultrie et al., 2013). Thus, United Nations (2004) and Moultrie et al.(2013) posit that though data may portray errors in some aspects, it may be possible to come up with robust levels and trends of fertility.

2.3 Estimating fertility levels: Milestones in technical methods

Fertility estimates are derived from two types of fertility measures, namely the direct and indirect measures. Examples of the former include age-specific fertility rates and total fertility rates which are computed using demographic data sources of surveys, vital registration system, population registers, demographic surveillances system and censuses. Direct measures are dependable when data sources are of reputable good quality, but this is at variance with most data generated in less developed countries as discussed in detail in the previous section. The indirect estimation fertility as an alternative method became a viable option for LDCs as early as in the 1960s and 1970s. This recourse has yielded multiple indirect methods, which have depended chiefly on census data.

The work of William Brass has been much more elaborate in providing detailed mechanical computations of the techniques of estimating fertility, packaged in the Manual X of UN (United Nations, 1983) and of recent in a manual by Moultrie and others (Moultrie et al., 2013). The Brass P/F ratio (lifetime/cohort fertility (P) to current/period fertility (F)) method, originally developed in the 1960s (Brass and Coale, 1968), has been applied extensively when data are flawed and limited.

Using the conventional P/F ratio approach, improvements to the original work have been done yielding several variants of the Brass-type method by Arriaga (1983) and Feeney (1998). The modifications take into account the situation of declining fertility occurring in most developing countries, a condition not depicted in the Brass P/F ratio method, which assumes constant fertility in the recent past. A type of the P/F ratio method known as the relational Gompertz model conceived by Brass (1978), has been reformulated by Zaba (1981) and much more recently improved by Moultrie and colleagues (Moultrie et al., 2013). With DHS survey data, cohort-period fertility rates (CPFRs) suggested by Hobcraft and associates (Hobcraft et al., 1982), are derived from the computation of P/F ratios which allow for assessment of data quality and estimation of fertility rates in two successive five-year periods prior to the survey.

Besides the P/F ratio correction technique used for fertility data, regression based method approaches have been formulated to estimate fertility levels. Regression based methods use age-sex distribution data of the population and these include Rele's method (Rele, 1967), Palmore's regression method (Palmore, 1978) and the Gunasekaran-Palmore method (Gunasekaran and Palmore, 1984).

Reverse survival techniques such as the own children method suggested by Cho (Cho, 1973, Cho et al., 1986) and Feeney (1975), rely on matching children to their mothers using household censuses or survey data. A reverse survival technique has the advantage of giving a time trend of fertility estimates 15 years prior to the survey or census and therefore, can be used to check the reasonableness of the other fertility estimates. Revisions or improvements on the reverse survival methods are ongoing (Moultrie et al., 2013, Avery et al., 2013). With the recent IPUMS International[3] effort of bringing harmonised census data, variants of the reversal survival method such as through the work of Michel Garenne (Garenne et al., 2015, Garenne, 2008), have emerged. Multiple data sources and databases have been utilised to validate fertility estimates using the various indirect technical methods. Methods which utilise two or more censuses data such as the parity increments method, Arriaga's two or three census methods of P/F ratio and the relational Gompertz model,

[3] See https://international.ipums.org

have also been developed. These methods have permitted fertility estimates in-between periods to be generated.

With this background, it is important to note the limitation and use of these methods which depend on availability of data, assumptions taken into account, age misreporting errors, age distribution reliability and other data quality issues mentioned earlier in detail (section 2.2). When accuracy is lacking, the estimates of fertility cannot be relied upon (Moultrie et al., 2013). Reliability of these technical methods results when estimates derived are reasonably consistent.

In the case of Eswatini, fertility levels are commonly presented in census reports (CSO, 1991, CSO, 1998, CSO, 2010b) based on the P/F ratio method. Moultrie and Dorrington (2008) note that alternative indirect methods of fertility estimation are rarely used in SSA countries. In addition to problems of incomplete and scarcity of data aforementioned, technical methods such as the relational Gompertz model, requires one to have great tact, demographic knowledge and skills in their applications. To cover the gap of relying more on one type of fertility estimation, several indirect techniques have been applied in Eswatini as part of this study (Chemhaka et al., 2016a).

The actual computations involved in applying several of these indirect methods have been meticulously explained in two manuals; one of the UN (United Nations, 1983) and the other of IUSSP (Moultrie et al., 2013). The latter has provided tailor made Microsoft Excel based spreadsheet templates based on the methods whereas the former one had to follow the mechanical computation procedure explanations of the demographic methods. Computer based application of the indirect estimation techniques using tailor-made spreadsheets such as PASEX files methods of the US Census Bureau developed by Arriaga and colleagues (Arriaga et al., 1994b, U. S. Bureau of the Census, 1997), software applications such as the DOS-based EASWESPOP-fertility program (East-West Center, 1992) and windows based MortPak (United Nations Population Division, 2013), have eased the preparing of fertility estimates. Direct measures of fertility can be estimated on survey data using programs such as tfr2 (Schoumaker, 2013) developed for use in Stata.

The proximate fertility determinants framework or the model by Bongaarts (Bongaarts, 1978, Bongaarts, 1982, Bongaarts, 2015) and Stover (Stover, 1998), has been used as a secondary objective to estimate or predict total fertility rate (TFR). The model has been widely applied, as its primary objective, in estimating the impact of the main four proximate determinants (PDs) of fertility (marriage, abortion, contraception and postpartum infecundability), on the level of fertility in many studies (Odimegwu and Zerai, 1996, Majumder and Ram, 2015, Letamo and Letamo, 2001, Palamuleni, 2017, Nasir et al., 2015, Chola and Michelo, 2016, Onuoha, 1992, Madhavan, 2014, Jain et al., 2014). The aggregate fertility model framework proposed by Bongaarts (1978) expresses the TFR as the product of the fertility inhibiting effects of the four indices of PDs on total fecundity; measuring natural fertility. Bongaarts and colleagues (Bongaarts et al., 1984) and Stover (1998) added a fifth PD, infecundity/sterility to the multiplicative model. If accurately measured and modelled, the proximate determinants [of fertility] should explain 100% variation in fertility (Bongaarts, 2015: 536). Data quality issues in survey data due to retrospective inquiry, as reported in section 2.2, have often led to bias in estimating TFR as result of under- or over-estimation in the measures of PDs and other factors that may influence fertility (Bongaarts, 2015, Stover, 1998, Thomson et al., 2012, Majumder and Ram, 2015, Jain et al., 2014).

Despite a wide range of demographic tools that can be used to prepare fertility estimates, a great deal of effort in collecting and processing data to meet standard or good quality, is needed. Direct measures can be applied to data of reasonable quality; MDCs have made progress in collecting data in contrast to LDCs where greater efforts are required to generate complete and less flawed data.

2.4 The micro and macro linkages in fertility behaviour analysis

The micro (individual and household/compositional) and macro (community) divide of fertility behaviour analysis has led to bias or errors interpreted in literature as ecological/aggregation fallacy and atomistic/individualistic fallacy. The former explains the relationship between fertility behaviour and population characteristics at community-level is attributed as occurring to individuals whereas actually does not exist at the individual level. In the latter, individual-level variables are used together with community characteristics attributed to individuals in a standard regression model. This results in the assigned characteristic being identical for each individual within a cluster or community, leading to atomistic fallacy (Diez-Roux, 2002, Hank, 2002, Courgeau, 2003, Diez-Roux, 2003, DiPrete and Forristal, 1994, Greenland, 2000, Merlo et al., 2005, Teachman and Crowder, 2002).

Two decades ago, Billy and Moore (1992) noted that little was done to combine the two approaches (i.e. micro and macro) in fertility behaviour studies. However, recent literature, as shall be explained in the next section, has given focus to the need for multilevel methods when individual- and community-level variables interact to examine individual-level differences of demographic behaviour.

2.5 Why multilevel analysis?

Extant literature (Bentley et al., 2009, Kravdal, 2006, Elfstrom and Stephenson, 2012, Mason and Smith, 2000, Kazembe, 2009, Rabe-Hesketh and Skrondal, 2012, Greenland, 2000, Diez-Roux, 2002, Hank, 2002, Carle, 2009, Kamal et al., 1999), demonstrates the importance and use of multilevel methods to examine individual-level outcome variables, usually behaviours (Blalock, 1984). In determining fertility behaviour, multilevel modelling is required when:

i. Data are nested or hierarchical such as that of DHS where data are collected in multistage sample design and therefore, individual women are nested in PSU or clusters/communities.
ii. Data in each cluster is correlated or dependent. Fertility behaviour of women in a cluster tends to be the same or common. That is, individual women within a community tend to have a similar number of children or contraceptive choices and use.
iii. Modelling heterogeneity or model variances, assuming that fertility behaviour varies across the clusters. That is, contraceptive use or children ever born varies from one community to another.
iv. Modelling micro-macro linkages/relations of fertility behaviour. That is, when the simultaneous examination of individual and community variations of individual fertility behaviour is required.

This evades atomistic and ecological fallacies. In addition, corrects standard errors bias found in classical or standard regression models.

The need for empirical tests of the influence of community factors on demographic outcomes in developing countries and in particular, Africa is reiterated by many researchers. Of particular mention is Adedini et al. (2015) and Boco (2010) who, amongst others, have echoed the same sentiment in their study of child mortality in SSA. Adedini et al. (2015) found substantial ecological influence on child mortality in Nigeria. Further, in a number of SSA countries, community-level factors have been found to decrease child mortality (Boco, 2010) which has an important bearing on fertility behaviour. The micro and macro determinants of fertility are viewed in section 2.5.

Further, a multilevel framework (see section 2.6.2) synchronises theory (section 2.6.1) and empirical analysis (section 2.5). Theoretical explanations on macro-fertility behaviour can be used wrongly at different micro-levels to explain micro-fertility behaviour. That is, the level of unit observation is different to the one on which the theory is based. For instance, according to the demographic transition theory, socioeconomic development, when conceptualised as a contextual variable, cannot be measured at the individual unit of analysis, leading to an anomaly between theory and empirical analysis. This aggregation bias can be weakened through multilevel models.

Modelling binary fertility behaviour outcomes (such as contraceptive use/non-use) leads to the default of multilevel (random intercept) logistic regression procedure (McNay et al., 2003, Moursund and Kravdal, 2003, Kaggwa et al., 2008, Muhwava, 2003, Elfstrom and Stephenson, 2012, Wang et al., 2013, Colleran and Mace, 2015, Ejembi et al., 2015, Aremu, 2013, Giusti and Vignoli, 2006).

With cumulative fertility count outcomes (e.g. children ever born or number of births), a number of multilevel models have been adopted to account for overdispersion in the data. While multilevel Poisson regressions have been commonly adopted for count data (Agyei-Mensah and Owoo, 2015, Ezeh, 1997, Kazembe, 2009, Moeeni et al., 2014, Nguyen-Dinh, 1997, Solanke, 2015, Amara, 2015, Alvergne and Lummaa, 2014, Snopkowski et al., 2016, Colleran et al., 2015), other models which have been less widely applied include multilevel negative binomial (Amara, 2015) and multilevel zero-inflated Poisson (Lee and Wang, 2006).

The latter models usually apply when there are excess zeros in count data and overdispersion (variance is greater than the mean) in the data cannot be accounted for using multilevel Poisson regressions. Likewise, for single-level statistical models, overdispersion in the number of births can be handled by negative binomial regression, zero-inflated Poisson and zero-inflated negative binomial models. The latter two models perform better in low fertility populations where many women opt not have children or are childless (Poston and McKibben, 2003).

2.6 Empirical findings: Micro and macro determinants of fertility behaviour

A multitude of demographic, cultural, and socioeconomic factors influencing fertility behaviour are noted in literature. The role that these factors play in determining fertility has been of keen interest to demographers for several decades, both in MDCs and LDCs (Kravdal, 2010, Nguyen-Dinh, 1997, Mberu and Reed, 2014). Unabated similar and sometimes different impact in time and contexts, have been established, therefore, perpetuating the debate on the determinants of fertility behaviour.

The refocus of the determinants of fertility behaviour beyond the individual behaviour (that is inclusive of contextual factors) in recent years, has proven vital in improving demographic literature. However, as previously mentioned, fertility studies seem to be lagging in this quest of knowledge in comparison with mortality (Entwisle, 2007, Montgomery and Hewett, 2005). The role of community or community factors in the variation in childbearing (or contraceptive use), is highlighted in literature. An overview of fertility behaviour studies on multilevel analysis is presented in Appendix D. This study sought to understand variability in fertility behaviour by population subgroups or small units of the populations among women in Eswatini. The case of Eswatini generates interest in important or unique aspects of fertility. Moreover, there has been little research on fertility behaviour in the context.

Brief empirical literature on individual (micro) and community (macro) determinants of fertility behaviour is expounded in the following sections. Though the determinants may be explained individually, in reality there are interactions among variables in determining fertility behaviour. The ensuing literature discussion has considered the influence of each factor when all other factors are taken into consideration in multivariate regressions. In other words, the overall net effect of combined independent variables on fertility behaviour is considered more important than the separate effect of the respective individual independent variables.

2.6.1 Socioeconomic development

It has been generic to understand socioeconomic development as a precursor to fertility decline. This dominant view, positioned in the demographic transition theory (DTT), asserts that socioeconomic conditions including modernity, and urbanisation may impede higher demand for children and facilitates increased uptake of contraceptives. Therefore, lack or retardation of socioeconomic progress is an issue of concern that may warrant reversals in fertility decline.

Socioeconomic development in this study is looked at as a multidimensional concept (at individual- and community-level) that can have an important impact on women's fertility behaviour. The 'living conditions of individuals' termed 'local opportunity structure' (Basten et al., 2011:575), define socioeconomic development variables inclusive of factors namely; built environment (urbanisation), labour market conditions, socioeconomic iniquities, cultural factors and social connectedness, either motivating for or against high fertility. A brief discussion on selected factors for the study is given below.

2.6.1.1 Area disadvantage

Literature highlights variations in fertility patterns according to geographical locations where women reside. Hence, spatial context can have an important effect on fertility behaviour.

Place and region of residence

Urban-rural residence of women is fundamental in understanding fertility behaviour. Urbanisation has brought for many developing countries many social and economic aspects of modern life (e.g. high costs of raising children) that militates against having many children and therefore, facilitating increased use of contraceptives. Evidence supports that urban women tend to have lower fertility and higher contraceptive use than their rural counterparts (Alvergne and Lummaa, 2014, Dev et al., 2002, Ezeh, 1997, Nguyen-Dinh, 1997, Agyei-Mensah and Owoo, 2015, Kamal and Pervaiz, 2011, Hindin, 2000, Ferede, 2013, Kravdal, 2001). Controlling for all variables, however, no significant relationship has been observed between urban population and lifetime fertility in Iran (Moeeni et al., 2014) and Nigeria (Akpa and Ikpotokin, 2012).

For the latter country, Nigeria, striking research findings have been observed in a recent study important for policy. Aremu (2013) found that women living in rural areas had greater propensity than those in urban to seek out private providers of contraceptives. It is explained that lack of healthcare facilities or services saw a proliferation in private and unlicensed healthcare providers offering family planning services. The decreased use of public or government as a provider for modern contraceptives in rural *vis-à -vis* informal channels, was attributed to the introduction of user fees to the rural dwellers who are mostly poor, and hence, they resorted to consulting nonprofessional healthcare providers.

In the same view of area or spatial effects, regional variability has significant and important implications for fertility behaviour. Regional fertility differences have been observed in a number of countries including South Africa (Palamuleni, 2013, Moultrie and Timæus, 2003), Ethiopia (Ethiopian Society of Population Studies, 2008), Malawi (Kazembe, 2009), Ghana (Agyei-Mensah and Owoo, 2015), Tunisia (Amara, 2015), Iran (Moeeni et al., 2014) and Pakistan (Kamal and Pervaiz, 2011).

Regional variability in contraceptive behaviour has also been found to differ significantly across several countries, for example, Egypt (Giusti and Vignoli, 2006), Ethiopia (Ferede, 2013) and Nepal (Wang et al., 2013). However, recently no significant variation was observed in Rwanda (Wang et al., 2013) and Nigeria (Ejembi et al., 2015). Multiple country studies also reveal mixed results on the effects of regions on contraceptive use (Stephenson et al., 2007).

In many LDCs, regions or provinces vary in population characteristics and socioeconomic development. Remote and impoverished regions tend to have higher fertility compared to the well-off regions. In well-resourced regions and urban areas women tend to have ease of access to family planning services, information and facilities and therefore lower fertility. For example, a recent study in Nigeria found that women from a better off area had greater likelihood of using both private and public healthcare providers for modern contraceptives instead of informal channels than those from a poorer neighbourhood (Aremu, 2013). The role of amenities in urban areas and economic advantage for fertility has also been confirmed outside of Africa (Lerch, 2013). The typology of residence (place or region) emphasises the socioeconomic and cultural stratification in a given society or context (Giusti and Vignoli, 2006).

Eswatini, though, has a seemingly homogeneous culture, social and economic diversity can be found among the four regions and in the urban-rural areas, which may affect fertility behaviour. This uneven area and socioeconomic disparities may emphasise the differences observed for fertility behaviour.

2.6.1.2 Socioeconomic status/disadvantage

Women's status is a key determinant of fertility and an important policy variable for manipulating fertility. The literature suggests women's socioeconomic status is linked to various factors, namely education, labour force participation/occupation, wealth/resources or income deprivation, to name a few (Shenk et al., 2016, Alvergne and Lummaa, 2014, Stulp and Barrett, 2016, Balk, 1994, Mahmud, 1994). However, composite variables (including wealth in DHS surveys), which determine socioeconomic status, have also been put forth (Jain and Ross, 2012, Janevic et al., 2012, Kaggwa et al., 2008, Colleran et al., 2015, Dev et al., 2002, Giusti and Vignoli, 2006). Literature highlights the concept of women's status as static or varied, and fluid and not conclusive regarding its dimensions.

Fertility is expected to decrease as women's positions, either at the aggregate or individual level, improve, and as development takes a modern, and for some, capitalist, trajectory (Lobao and Brown, 1998:840). It has been also noted that contraceptive use tends to increase as women's social position/status improves (Bentley et al., 2009). Overall positive aggregate/community effects of socioeconomic status on contraceptive use were observed in several countries including Bangladesh

(Kamal et al., 1999), United States (Grady et al., 1993) and United Kingdom (Bentley et al., 2009).

Explanations emphasise that individual women or communities with high socioeconomic status, have norms or mechanisms that values or invests in quality education and well-being of children. Such norms deemphasise childbearing as this competes with social aspirations or mobility. Thus, norms that promote use of fertility/birth control may spread in communities in order to limit fertility or enhance opportunities in education, employment, and wealth, to mention a few (Grady et al., 1993).

Education

An inverse relationship between maternal education and fertility is firmly established in many studies, for both LDCs and MDCs (Snopkowski et al., 2016, Dev et al., 2002, Lobao and Brown, 1998, Akpa and Ikpotokin, 2012, Nguyen-Dinh, 1997, Agyei-Mensah and Owoo, 2015, Jain and Ross, 2012, Poston and McKibben, 2003, Balk, 1994, Grace and Carr, 2009, Amara, 2015, Hindin, 2000, Degraff et al., 1997, Kaufman, 1998, Elfstrom and Stephenson, 2012, Eyasu, 2015, Testa, 2014). In Tanzania, the sharpest fertility-inhibiting effect of completing primary education was observed for first order births only (Kravdal, 2001). The author notes that the strong effect of primary education occurs in egalitarian societies or where women have relatively high status.

Formal education, specifically higher maternal education beyond primary level, shapes fertility behaviour through its mediating effect on, amongst others, delaying the age at marriage (or first birth), the likelihood of being employed, the attitudes toward childbearing and childrearing as well as on the efficiency and consistency in use of contraceptives. Thus, through education, the horizon of opportunities for women is broadened through knowledge and ability or potential to make fertility-related decisions (Kravdal, 2000, Snopkowski et al., 2016, Colleran, 2016, Kravdal, 2001).

Evidence indicates that better educated women are more likely to adopt and use contraceptives in several developing countries (Hindin, 2000, Kamal et al., 1999, Ezeh, 1997, Wang et al., 2013, Degraff et al., 1997, Kaufman, 1998, Ejembi et al., 2015, Stephenson et al., 2007, Yeatman and Trinitapoli, 2008) and developed countries (Bentley et al., 2009, Grady et al., 1993). Positive effects of secondary or higher education on contraceptive use have also been observed at community-level in Nigeria (Ejembi et al., 2015). However, in Ethiopia, primary education was found to be significant and more important than secondary or higher education in increasing modern contraceptive usage (Ferede, 2013).

Community-level influence of at least primary education has also been observed in some countries, such as Niger and Namibia (Elfstrom and Stephenson, 2012) and Bangladesh (Kamal et al., 1999). Conversely, community-level education has been found to have no influence on contraceptive use beyond that of individual-level education in Zimbabwe (Kravdal, 2000) and in other several Eastern, Northern, Middle, Southern and Western African countries (Elfstrom and Stephenson, 2012, Stephenson et al., 2007).

In brief, education challenges social norms promoting high fertility behaviour and lack of it may have the opposite effect. Education influences other pathways that have an impact on fertility. For example, in Poland, it was found that education delayed age at first birth and lowered childhood mortality, a precondition for fertility decline, and thereby lowering fertility (Snopkowski et al., 2016).

Women with secondary education and above had 19% lower lifetime fertility than illiterate women in Ethiopia (Ethiopian Society of Population Studies, 2008). A recent study reveals the great impact of higher education (Eyasu, 2015). Similarly, in Malawi, higher education significantly reduced the number of children born (Kazembe, 2009) as was also found in Zimbabwe (Hindin, 2000). These findings are supported in other developing countries elsewhere (Dev et al., 2002). However, no relationship was found between women's education and fertility in Kenya (Ezeh, 1997) and in Pakistan (Kamal and Pervaiz, 2011).

Community-level education has been shown to have larger (1.3 times) fertility-reducing effect than individual-level education in high-fertility communities in Poland. Further, least educated women were shown to imitate lower fertility of tertiary educated women in their communities (Colleran et al., 2014). Other studies have shown the importance of husband's/partner's education (Amara, 2015, Hindin, 2000) or education capital (Colleran et al., 2015) as an aid in reducing fertility among women. However, the effect of husband education on fertility behaviour was shown to be insignificant in some instances (Degraff et al., 1997).

Employment/ occupation

Unemployed women tend to have more children (greater than two children) than those employed or currently working (Kamal and Pervaiz, 2011, Solanke, 2015). Moreover, unemployed women are less likely than those employed to use contraceptives (Hindin, 2000, Wang et al., 2013, Aremu, 2013). The opportunities of women who are employed conflicts or competes with childrearing or childbearing and therefore, as a consequence, employed women desire fewer children (Kravdal, 2000, Ethiopian Society of Population Studies, 2008). In Vietnam, unemployed women had highest fertility, yet women employed in agriculture had more children compared to those working in non-agricultural occupations (Nguyen-Dinh, 1997) as may be anticipated. This negative relationship between women employment and fertility, however, cannot be generalised.

There was no relationship between an individual woman's employment status and the number of children she has had in Malawi (Kazembe, 2009) and Iran (Moeeni et al., 2014). This finding was also observed in a multi-country study of Bangladesh, Bolivia and Bangladesh (Snopkowski et al., 2016), but a positive association was found in rural Poland for women who had ever worked. Similarly, in developed countries such as Sweden, a positive effect of labour force participation on fertility was observed in the early 1990s as a result of generous employment benefits offered to parents (Stulp and Barrett, 2016).

Informal work, such as in agriculture, may increase fertility, especially if children are viewed and valued as economic contributors as found in Ecuador (Lobao and Brown, 1998). A recent study in Ghana, revealed a similar finding where women employed in agricultural occupations had higher fertility compared to those in the non-agricultural sector, possibly, for provision of farm labour (Agyei-Mensah and Owoo, 2015). Similar evidence in Pakistan (Kamal and Pervaiz, 2011) and Zimbabwe (Hindin, 2000) indicates women in informal sectors were more likely to have a bigger family than those in the formal sector. However, recent evidence in Ethiopia (Eyasu, 2015), reveals that employment positively increased number of children and women in non-agricultural occupations had significantly higher likelihood of childbearing than those in agricultural sector when compared to those not employed. Other measures such as market integration, measured as access to informal and formal employment opportunities, reflects a negative association with lifetime fertility as found in rural Poland (Colleran et al., 2015).

Women's working status was not significantly associated with contraceptive use in Ethiopia (Ferede, 2013). However, being employed increased the odds of contraceptive use in Rwanda and Nepal (Wang et al., 2013). Agricultural/manual occupations significantly increased contraceptive use in Rwanda, while in Nepal, sales and service as well as agricultural/manual occupations, had a significant influence on contraceptive use. Professional occupations had positive, but insignificant influences on contraceptive use in both countries.

At community-level, contraceptive use tends to increase with average community earnings for women in the labour market, possibly reflecting their greater propensity to be assertive or independent (Degraff et al., 1997). However, striking literature findings highlight that high community levels of unemployment rates significantly increased contraceptive use or effectiveness (Grady et al., 1993). For example in the US, it was explained that uncertainty about the future brought about greater unexpected costs of unplanned pregnancy and therefore, women were more likely to use effective means of contraceptives to avert births.

Wealth or poverty

Overall, wealth status is negatively (or positively) associated with lifetime fertility (or contraceptive use). In terms of fertility, the low levels found in post-demographic transition societies appear to be maladaptive, occurring as they do alongside radical increases in material wealth, nutrition and modern healthcare, which should allow parents to raise larger families (Shenk et al., 2016:10).

Evidence suggests that there is greater likelihood of children to be born in contexts where economic conditions are not favourable or in poor-resource settings of wealth (Snopkowski et al., 2016, Stulp and Barrett, 2016, Shenk et al., 2016, Dev et al., 2002, Akpa and Ikpotokin, 2012, Solanke, 2015). It has been noted that poverty might increase the risk of having more children in a number of developing countries at both at micro- and macro-level (Jain and Ross, 2012, Poston and McKibben, 2003). On the other hand, material wealth significantly reduces higher order births (Kravdal, 2001). However, in Tunisia, an inverse-j relationship between wealth and number of children was observed, implying low fertility at both low- and high-wealth status (Amara, 2015).

In Mongolia, however, lifetime fertility was found higher among the wealthiest women in both rural and urban areas (Alvergne and Lummaa, 2014). The positive association between fertility and wealth has been established in traditional fertility regimes or pre-industrial populations where status, along with resource availability for men, generates high fertility. In postmodern society, however, the extremely wealthy have been observed to have a reproductive advantage of having slightly more children than the average wealthy (Stulp and Barrett, 2016). Some instances show no association between lifetime fertility and wealth as was found in Ethiopia (Ethiopian Society of Population Studies, 2008) and in Pakistan (Kamal and Pervaiz, 2011).

The relation between wealth and fertility has been seen to change over time; changing from positive in traditional societies to negative in modern wage economies (Sear et al., 2016). Other measures of wealth, farming wealth (ownership of land, cows or tractor) or non-farming wealth (car, computer, internet, income, etc.), were found to be positively associated with fertility as measured by number of live births (Colleran et al., 2015). This highlights the significance of meaning or measurement of wealth in various contexts, which has implications for fertility.

In both urban and remote rural areas of Mongolia, the poor women were less likely to use contraceptives (both traditional and modern) before giving birth in their first three parities (Alvergne and Lummaa, 2014). On the other end, women within top tier wealth status had higher likelihood of being current users of contraceptives in Zimbabwe (Hindin, 2000) and Malawi (Yeatman and Trinitapoli, 2008). Studies have firmly established a positive association between contraceptive use and household wealth (Wang et al., 2013, Ejembi et al., 2015, Elfstrom and Stephenson, 2012, Stephenson et al., 2007) as well as community wealth status (Kamal et al., 1999, Grady et al., 1993, Kravdal, 2001, Elfstrom and Stephenson, 2012, Giusti and Vignoli, 2006).

Elsewhere, in Central Asia, Caucasus and Eastern Europe countries, the influence of wealth at individual – or community-level on contraceptive use was varied (Janevic et al., 2012). The effect of improved wealth on contraceptive use possibly indicates ease of access to family planning services and methods for women with adequate resources and this has important policy considerations.

Exposure to media

Access to family planning messages through the media is an important determining factor of fertility behaviour. Women frequently exposed to mass media or family planning messages in media are observed to have reduced propensity of childbearing (Dev et al., 2002, Ethiopian Society of Population Studies, 2008, Solanke, 2015) and higher odds of contraceptive uptake (Ejembi et al., 2015, Colleran and Mace, 2015, Stephenson et al., 2007). Owning a television, associated with media access, was positively associated with fertility in Guatemala (Grace and Carr, 2009). In Ethiopia, access to radio significantly increased modern contraceptive use. Such patterns were observed with television and newspaper exposure although the findings were not statistically significant (Ferede, 2013). Some studies in Eswatini attest to the fact that the media positively influences use of contraception (Sonubi and Nkombua, 2015).

Studies across multiple countries showed that the correlation between media exposure and contraceptive use differed at community-level. For example, in Madagascar and Democratic Republic of Congo, women from 'communities with higher mean community media exposure index score' were more likely to use contraceptives, whereas in Ghana, those with higher score had lower odds of currently using contraceptives (Elfstrom and Stephenson, 2012).

2.6.2 Gender equity and women autonomy/empowerment

Women's autonomy is synonymous with empowerment or gender equity as prior mentioned in section 1.5.5. Historically, women's empowerment measure tends to be varied or has dimensions which make comparisons of its effect on fertility behaviour, difficult. Despite these dimensions or complexities, women's empowerment remains an important variable that has implications for fertility behaviour. The concept of women empowerment has a gendered context with various socioeconomic and cultural dimensions including decision making, access or control of economic resources (Mahmud, 1994).

Gendered inequality explains much of the variation in childbearing and contraceptive use as noted for patriarchal societies (Lerch, 2013, Mason and Smith, 2000). In such cases, husbands' fertility preferences tend to be much stronger. Mason and Smith (2000) however, argue, that there could be some traces of evidence that women may be in agreement with their partners on fertility preferences. Such views might not be out of context in Eswatini or any other African country as women would want to enhance their status consciously or involuntarily through childbearing and thus fulfilling societal expectations and values (Ziyane and Ehlers, 2006).

Overall, in an environment where unequal power relations exist between women and men as well as where access to resources or employment is unequal, women tend to be reliant on their male partners or husbands for upkeep of themselves and their children. The socioeconomic and cultural stratification for disadvantaged women, has many repercussions. Women tend to be bound in marriages or unions for survival strategy and not necessarily for their wellbeing as their choices or decisions would be restricted according to male partners' demands. In general, past studies have linked empowered women to having lower demand for many children (Hindin, 2000, Upadhyay and Karasek, 2012) and higher levels of contraceptive use (Kravdal, 2001, Do and Kurimoto, 2012, Giusti and Vignoli, 2006), including at community-level in Rwanda (Wang et al., 2013, Ejembi et al., 2015).

However, the reverse is true. In several African countries, it has been demonstrated that women who are dormant in decision making with regards to number of children or family planning, and who have their own earnings, amongst other things, tend to use contraception less frequently and at least, desire a large family (Kravdal, 2001, Stephenson et al., 2007). Domestic violence has also been linked to precipitating higher childbearing for women in some African countries (Odimegwu et al., 2015). Women's decision-making autonomy was not significantly related to lifetime fertility in Ethiopia (Ethiopian Society of Population Studies, 2008) and contraceptive use in Zimbabwe (Hindin, 2000).

In cross-country studies, the association of contraceptive use and women's empowerment is varied at community-level. The latter variable represents social inequalities for women as noted previously. Women residing in communities with higher mean decision-making autonomy (e.g. in Madagascar), and where violence was greater than average justified (e.g. Niger and Zimbabwe), had greater propensity to use contraceptives (Elfstrom and Stephenson, 2012). The converse was also observed in the same study for several countries.

2.6.3 Fertility norms, marital practices and customs

In overview, the 'cultural' *milieu* focuses on how or whether individual women learn or incorporate fertility/reproductive behaviours and ideas from others or in their communities.

2.6.3.1 Marital/union status

Both sanctioned and unsanctioned sexual unions have important implications for fertility behaviour. In conservative contexts or countries it is expected that children are more likely to be born in formal marriages than in other forms of informal or cohabiting relationships.

Marital status, age at marriage or sexual union and proportion of married women are influential determinants of fertility, as they determine exposure to intercourse. As a rule of thumb, the higher (or lower) the age at marriage, the lower (higher) is fertility. The higher the proportion of single women, the lower is fertility. Most women in LDCs prefer to be married to enhance their status. In Nigeria, married women had more children than those cohabiting (Akpa and Ikpotokin, 2012). In Africa, marriage positively influences fertility (Agyei-Mensah and Owoo, 2015), possibly due to bride wealth payments which obligates women to bear children, thus enhancing fertility.

In overview, the use of contraceptives is a displeasure for non-married women, specifically among girls before marriage. A previous study in Eswatini found more than half of the respondents (56%) had not used contraception at first sex (Sonubi and Nkombua, 2015). A study for six African countries, however, found never married women had higher probability of using contraceptives compared with married or in union women (Stephenson et al., 2007). Evidence has established that married women tend to have high propensity of using any contraceptive method (Colleran and Mace, 2015).

The age at first marriage is an important determinant of fertility, which determines the number of children a woman would have. Age at marriage is highly correlated with age at first birth, as women would want to give birth as soon as they marry. Delaying marriage consequently reduces fertility, by reducing the time exposed to the risk of pregnancy (Ethiopian Society of Population Studies, 2008, Winkelmann and Zimmermann, 1994). Early onset of childbearing at a young age was found to be strongly associated with high fertility in Ethiopia (Eyasu, 2015), Nigeria (Akpa and Ikpotokin, 2012, Solanke, 2015) and Tunisia (Amara, 2015). An earlier study in Eswatini reveals that early first births occurred among women who had less than some secondary education, began early sexual debut before age 15, who began using contraceptives after birth and came from large households of seven and above members (Mhele, 2015). Early marriage or childbearing tend to produce large families and promote poor contraception (Ziyane and Ehlers, 2006). Further, women who marry young tend to have less bargaining power in reproductive behaviour (Mason, 1987). This viewpoint shall be expanded later for Eswatini.

Evidence has found that the higher the age at marriage, and consequent age at first birth, the lower the contraceptive use at community-level (Wang et al., 2013). Secondary education is associated with thrusting the age at first birth higher (Kravdal, 2001). At community-level, the correlation between mean age marriage, age at first intercourse or mean age at first birth and contraceptive use has produced mixed, both positive and negative, results across the study of several African countries (Elfstrom and Stephenson, 2012). In six African countries, age at marriage measured at community-level had no significant influence on contraceptive use (Stephenson et al., 2007).

Non-multivariate research on Eswatini (Warren et al., 1992, Ziyane and Ehlers, 2006, Ferraro, 1991, Russell, 1993, Van Lith et al., 2013, Warren et al., 2013, Gule, 1994) emphasises that cultural and marital customs have important bearing on fertility behaviour and therefore, impinge on several determinants of fertility and contraceptive use. Childlessness among women is stigmatised or rare as adolescent girls are expected or tend to prove childbearing at an early age before marriage. Women thus appear to have unintended pregnancies or births. In this patriarchal society men have control over sexuality or fertility and hence, are ultimate decision makers. Women, deemed as minors, tend to conform to pressure from in-laws to bear more children to expand the clan name and thus their contraceptive use may be not solely for stopping having births. This is necessitated by cultural practices such as levirate '*kungenwa*' and paying of bride wealth '*lobola*', which are meant to value children, perpetuate the family name, and hence increase fertility. On the other hand it reduces contraception. Cultural constraints in uptake of contraceptives have also been reported, such as contraceptives causing subfertility, delaying childbearing, amongst others. The practice of polygyny relationships in Eswatini society is wide, sometimes thought of as ideal and therefore, has some influence on fertility behaviour- as men would want to prove their virility.

2.6.3.2 Polygyny

The overall relationship between polygyny and fertility is expected to be positive as women would use children to provide help in the household, to secure child support from their husbands as well as for insurance in old age (Akpa and Ikpotokin, 2012, Randall and LeGrand, 2003). In Nigeria, women in polygynous relationships had more children compared to those in a monogamous relationship (Akpa and Ikpotokin, 2012). In contrary, evidence supporting the reverse was found in Pakistan (Kamal and Pervaiz, 2011) and Zimbabwe (Hindin, 2000). Alvergne and Lummaa (2014) reported that monogamy sanctioned through cultural norms permits long-term fertility in developing countries, especially amongst the wealthy.

At micro-level polygyny was not associated with fertility (births in the last five years) in Kenya (Ezeh, 1997). In Iran, it has been shown that community (provincial) polygyny was positively associated with higher fertility (Moeeni et al., 2014). In Kenya, women living in high polygyny areas had higher fertility and lower contraceptive use than those living in low polygynous areas (Ezeh, 1997). Similarly, at community-level, in Nigeria, women from communities with higher proportions of polygyny had a lower likelihood of use of modern contraceptives (Ejembi et al., 2015). In Zimbabwe, women in polygynous relationships reported lower odds of current users of contraceptives compared to those in monogamy unions at micro-level (Hindin, 2000).

2.6.3.3 Fertility preferences

Fertility preferences or desires tend to shape actual fertility or the use of fertility control. The measurement of preferences can take many forms; in DHS the approach is a direct measurement of desired number of children. Sex preference also explains fertility behaviour. It influences the likelihood that additional children may be born.

Ideal number of children

Fertility preferences or desires are a strong determinant of fertility. Higher fertility ideals are associated with higher fertility (Kamal and Pervaiz, 2011). Ideal number of children is thought to be a ceiling of actual fertility, and to explain or reflect the normative context in which the woman resides (Testa and Grilli, 2006). The limitation of fertility preferences or ideals is that the tastes may change over time, depending on the socioeconomic context or just personal choice, and hence, may either overestimate or underestimate actual fertility (Testa and Grilli, 2006, Kamal and Pervaiz, 2011). Women who do not want children soon tend to use contraceptives more often (Kravdal, 2001).

The fertility desires for women can be subjugated by their partners creating a barrier to birth control and ultimately the number of children born. There is some evidence that husband's desire for children also influences fertility positively (Kamal and Pervaiz, 2011, Upadhyay and Karasek, 2012). Couples involved in joint fertility decision making tended to have fewer children - below replacement level fertility of 2.1 children per woman (Kamal and Pervaiz, 2011). At community-level, women with high ideal number of children showed significantly reduced contraceptive use in Rwanda and Nepal (Wang et al., 2013). This pattern of observation is supported for married or cohabiting women in a multiple country study for several African countries which includes Eswatini (Elfstrom and Stephenson, 2012). However, in the same study the association was not significant in all countries.

Sex preferences

Ideal number of children may change, depending on parity (Kamal and Pervaiz, 2011). Over time, couples may produce more children in desiring a male child who either guarantees as an heir from the men's perspective or from the women's viewpoint may act as insurance against abandonment or eviction from land. In traditional societies, boys are preferred to girls for provision of labour and as a source of financial security in old age (Grace and Carr, 2009, Kamal and Pervaiz, 2011, Kravdal, 2001). In fulfilling fertility desires or norms, whether for sons or daughters, the more likely is fertility to increase and this may act as an impediment to accelerated levels of contraceptive use.

Also, fertility ideals are related to other factors which impact on fertility. In Kenya, desired family size was positively associated with polygyny levels. Women in high polygyny areas had high fertility ideals and consequently fertility (Ezeh, 1997). A qualitative study in Senegal by Randall and LeGrand (2003) highlights that women consciously or unconsciously control their fertility behaviour. In their study, childbearing has been linked to having an ideal number of children to counter child mortality, provide labour or help, perpetuate lineage, and provide security in old age or isolation. On the other hand, the ideal number of children that a couple could propagate is believed to entirely depend on what God desires. The study has also pointed the impreciseness of the variable which measures ideal family size, as women negotiated the meaning and sometimes changed the preferred number in the interview process.

In Eswatini, evidence from a qualitative study indicates that there is some expectation that although women might have their own fertility desires - often small family size ideals - they are expected to comply with family norms requiring them to have many children; six being the required minimum in traditional marriages. Women tend to want to bear male children to please their husbands (Ziyane and Ehlers, 2006).

2.6.3.4 Number of living children and child mortality

Couples have fertility goals or relational decision making, hence they decide on an overall number of living children and respond to child mortality whenever a loss is incurred. Response mechanisms of child replacement, hoarding or insurance strategy have been observed when mortality is high or anticipated in future. Women who had an experience of child loss were found more likely to increase their fertility (Sandberg, 2006, Snopkowski et al., 2016, Dev et al., 2002, Agyei-Mensah and Owoo, 2015, Jain and Ross, 2012, Kamal and Pervaiz, 2011, Grace and Carr, 2009, Amara, 2015, Randall and LeGrand, 2003). Consequently, women who have experience of child mortality tend to have lower likelihoods of using contraceptives to conceive. This observation was found in Poland, however the relationship was not significant (Colleran and Mace, 2015).

In Ethiopia, women with one child loss and at least two children death experience were 1.25 and 1.45 times, respectively more likely to increase lifetime fertility than those with no child loss (Ethiopian Society of Population Studies, 2008). Later in Ethiopia, it was reflected that women who had at least one child death were 8.6 times more likely to have more children (Eyasu, 2015). In India, Syamala (2004) observed that the impact of child loss experience on fertility was high in areas where mortality was high compared to low mortality areas. Women's social networks which had higher infant mortality tended to have higher fertility experience (Sandberg, 2006). Infant and child mortality levels are key health indicators and may influence the context in which reproductive decisions are made. Social norms of maintaining high fertility, such as early marriages, may be precipitated by societal experience of high child mortality.

Evidence has shown that the number of surviving children, parity, is positively correlated with both fertility and contraceptive use in Kenya (Ezeh, 1997), the latter in Malawi (Yeatman and Trinitapoli, 2008), Ethiopia (Ferede, 2013), Rwanda (Wang et al., 2013) and Bangladesh (Kamal et al., 1999). On the other hand, a significant negative association between parity and contraceptive use was observed in several African countries at individual level (Elfstrom and Stephenson, 2012). However, parity was not associated with current use of modern contraceptives in Zimbabwe (Hindin, 2000).

2.6.3.5 Religion

Religious norms or institutions play a significant role in fertility behaviour (Agadjanian and Yabiku, 2014, Grady et al., 1993, Yeatman and Trinitapoli, 2008). However, Stephenson et al. (2007) argue that correlation between contraceptive use and religion is weak. Although religion, overall, idealises pronatalist ideology, certain religious affiliations or denominations tend to either promote or downplay childbearing and/or use of contraceptives. Muslims tended to have positive effects on fertility (and lower odds of contraceptive use) than other religions, including at community or societal level (Dev et al., 2002, Balk, 1994, Ferede, 2013, Wang et al., 2013, Ejembi et al., 2015, Westoff and Bietsch, 2015). However, in Ethiopia, Catholics and Protestants had higher propensity to childbearing than Muslims (Eyasu, 2015). Apostolic churches had higher completed fertility than Catholics or any other religions- such as the Zionist and Protestant religions (Agadjanian and Yabiku, 2014). In the United States, Catholic women had lower propensity not to have children than women with no religion (Poston and McKibben, 2003).

Agadjanian and Yabiku (2014) noted that 'spirit-type' or 'African initiated' religions such as Apostolic and Zionists are viewed to be of persistently high fertility regimes. Catholics officially oppose birth control technologies, but in practice, variability in their use of contraceptives has been observed (Grady et al., 1993, Agadjanian and Yabiku, 2014, Colleran and Mace, 2015, Yeatman and Trinitapoli, 2008).

Fertility or contraception differences in religion comparisons (e.g. Catholics versus Protestants), have not been consistent. Explanations point to religious ideals being modified by the normative or institutional setting such as patriarchy, social cohesiveness, dominant religion and developmental setting (Westoff and Bietsch, 2015, Agadjanian and Yabiku, 2014). While religion affiliation has been extracted in DHS datasets, religious involvement or engagement is thought to be a meaningful measure of religion than simply membership (Agadjanian and Yabiku, 2014, Yeatman and Trinitapoli, 2008). Thus, religiosity tends to lower the likelihood of contraceptive use (Colleran and Mace, 2015) thereby increasing fertility. However, such data beyond denominational affiliation is rarely collected.

Traditional culture ascribes to the importance of children, especially boys, so as to maintain the family name. Elsewhere, however, studies have found no significant association between religion and fertility (Akpa and Ikpotokin, 2012) or contraceptive use (Stephenson et al., 2007, Yeatman and Trinitapoli, 2008) taking into account all other factors.

Eswatini is predominantly a Christian country, however, fertility variation according to religiosity, has been observed. For instance, in a prior study in 1988, the Zionists were found to have higher fertility than Catholics and Protestants (TFR=5.7 versus 4.4 and 4.3, respectively) (Ministry of Health, 1990). In several African countries, however, little fertility disparities have been observed (Westoff and Bietsch, 2015).

The extent of influence of religion on fertility behaviour has important implications. Religion sanctions against abortion practice, and therefore, according to Grady et al. (1993) living in prevalently religious communities, may accelerate the use of contraceptives through exposure to anti-abortion messages in church services. However, in Muslim societies women do not have the right to limit the number of children, although they can use contraceptives for spacing births or due to health concerns (Randall and LeGrand, 2003). That said, for the Muslims, there is no universal formal opposition to family planning (Westoff and Bietsch, 2015: 20).

2.6.3.6 Contraception

Use of contraceptives -whether traditional or modern- has proved in historical and current populations to be an imperative for deliberate fertility control. Contraception has been a key proximate fertility reducing determinant since inception of family planning programmes in most developing countries. Therefore, there is correlation between programme variables (contraception and family planning services) and fertility.

Evidence in SSA suggests contraceptive use is the prominent depressant of fertility in most populations (Garenne, 2012, Akpa and Ikpotokin, 2012, Alene and Worku, 2009, Bongaarts, 2015, Chola and Michelo, 2016, Palamuleni, 2017, Rutaremwa et al., 2015, Stover, 1998). However, inconsistent uptake of contraception has led to fertility variation among subpopulation groups, which is an issue of concern amongst researchers and policymakers. It is important to note that the drivers of contraceptive use in demographic literature are the same as those regarding actual fertility.

Colleran (2016) noted contraceptive users appear to have higher fertility than non-users in SSA. Similarly, in Bolivia and Bangladesh (Snopkowski et al., 2016), Pakistan (Kamal and Pervaiz, 2011), India and Bangladesh (Dev et al., 2002), and Tunisia (Amara, 2015) it was found that women who used contraceptives had more births. However, there was no association in rural Poland (Snopkowski et al., 2016). The authors explain that the higher use of contraceptives among women with higher parity would be to prevent further births, probably after having reached the desired family size.

2.6.3.7 Age of the mother

Maternal age is one of the biological determinants of fertility which is very important; it describes the fertility behaviour of the individual participant. Age is interrelated with most variables influencing fertility hence, its crucial role in assessing fertility behaviour. The number of children a woman has had depends on her exposure to the risk of pregnancy; age at sexual debut or marriage, the length of her marriage (Nguyen-Dinh, 1997) and ultimately her age (Kamal and Pervaiz, 2011, Winkelmann and Zimmermann, 1994, Amara, 2015, Grace and Carr, 2009, Ethiopian Society of Population Studies, 2008, Hindin, 2000).

Evidence has firmly established that the current age of a woman determines her parity. Older women aged above 40 tend to have the highest number of children ever born (Grace and Carr, 2009, Amara, 2015). According to Winkelmann and Zimmermann (1994:215) the positive effect of age on lifetime fertility can be understood as a taste shifting mechanism, measuring unavailable determinants of long-run fertility decline. However, it should be noted that the intensity of childbearing decreases with age hence, observing a non-linear relationship (Agyei-Mensah and Owoo, 2015). Thus, the risk of childbearing is not linear but has a threshold effect producing a curvilinear (inverted j-shaped or inverted U-shaped curve); younger women up to middle age of 30-34 tend to have positive risk and thereafter a decreasing risk (Kamal et al., 1999).

Use of contraceptives is associated with women's age. Grace and Carr (2009) noted that both older women and younger women are more likely to use contraception. In this nonlinear relationship, older women tend to have achieved their fertility goals and therefore, contraception is mainly for limiting births while for younger women it is about exploring new methods of contraception (Grace and Carr, 2009). Contraceptive use was found to increase for each unit increase in age in Kenya (Ezeh, 1997) and Zimbabwe (Hindin, 2000). In a similar view for Egypt, older women had higher probability of contraceptive use than younger women, implying a positive association (Giusti and Vignoli, 2006). Conversely, an overall negative significant association between maternal age and contraceptive use was found in Ethiopia (Ferede, 2013) and Rwanda (Wang et al., 2013), several African countries (Elfstrom and Stephenson, 2012) and elsewhere (Degraff et al., 1997, Grady et al., 1993).

Other studies reveal a positive and negative relationship with contraceptive use at younger age and older age, respectively. For example, older women (age 40-49) had significant lower odds of using contraceptives compared with younger women (aged 15-19) in Bangladesh, whereas the middle aged group had the highest propensity for contraceptive use (Kamal et al., 1999). An inverse j-shaped pattern was found in Ivory Coast, Tanzania and Malawi (Stephenson et al., 2007, Yeatman and Trinitapoli, 2008). In their study, Stephenson et al. (2007), revealed a conflicting pattern of the effect of age on contraceptive use, although it was overarching that older women aged 40-49 had the lowest likelihood of being current users.

The selection of variables in this study chiefly draws from the integrated socioeconomic characteristics of Easterlin's hypothesis, expanded in subsequent sections. The factors chosen are considered to be relevant to the context of Eswatini society.

2.7 Theoretical frameworks

This section presents an overview of theoretical perspectives on fertility behaviour that lead to the analytical frame that will be used later in this study. Fertility behaviour can be assessed from different viewpoints as expounded in literature (Caldwell, 1976, Carter, 2001, Cleland and Wilson, 1987, Hirschman, 1994, van de Kaa, 1996, Kirk, 1996, Mason, 1997, Easterlin, 1975, Colleran, 2016, Mberu and Reed, 2014). In brief, various theories explain fertility behaviour as a process of change over time (fertility transition), or at a given moment of time (point in time) in explaining differentials or disparities through population characteristics.

Some theories focus on explaining aggregate fertility behaviour at group, community or societal level (macro-level theories) while others are oriented towards explaining the fertility of individuals, couples or household (constituting the micro-level aspects). Given these realities, the theories of fertility have fallen short in one or more aspects in predicting or explaining human fertility behaviour. Although no single theory is all-encompassing, an incorporative approach of integrating theories has been adopted since they are not completely mutually exclusive. Various theories emphasise the role of demographic, biological, social, cultural and economic characteristics in fertility, both at individual (micro) -level and/or community (macro)-level.

A brief, though not exhaustive, outline of the major fertility theories or models discussed includes; the demographic transition theory (DTT), intervening or proximate determinants of fertility framework, ideation-diffusion theories, social learning theory and social influence hypothesis, multilevel or contextual frameworks- local opportunity structure hypothesis, Bronfenbrenner's social-ecological theory and microeconomic theory on new household economics theory and Easterlin's hypothesis.

The classical DTT formulated in 1953 by Notestein has a macro view because the key outcomes (mortality and fertility) and concepts (socioeconomic development), are abstracted at a large scale (country level). The DTT is characterised by a set of generalised statements that describes the process of transition (in phases) of mortality and fertility to low levels in the modern society of industrialised countries. In the pre-modern era, both mortality and fertility existed at high levels. The dynamics of mortality and fertility change are thought to be interconnected with socioeconomic development, urbanisation, industrialisation and modernisation. These processes cast the central argument of the theory. In this process of transition, fertility decline is mediated by the falling of mortality first. Urban lifestyle is noted to mitigate against accumulation of many children due to high child rearing costs, amongst other factors (Kirk, 1996, Bongaarts and Watkins, 1996, Cleland and Wilson, 1987). Since the DTT provides a broad picture in explaining fertility change, it is not best suited to micro analysis of fertility. The theory, however, provides the basis for examining fertility as well as for improving or modifying theory.

The decision on the number of children one could have has commonly been assumed to occur at personal, couple or household level. This micro approach neglects the possibility that individual decisions may be shaped by the contexts or environments in which the individuals interact with or reside. Therefore, the debate on the complete picture of fertility behaviour can only be understood when individual and community levels are integrated.

Van de Kaa (1996) argues that high fertility is maintained by community customs, marital customs and moral codes, specifically in the traditional or subsistence economy. In reorganisation of the family unit towards smaller families, the institutions or group social goals are abandoned in favour of individualistic rationale goals of development. The market economy has contributed to such breaking down of social norms and family network support structures of childbearing and childrearing (van de Kaa, 1996, Hirschman, 1994, Kirk, 1996, Kirk and Pillet, 1998, Sear et al., 2016). This parallels the notion expounded by the DTT that the social setting or changes have an influence on the fertility decision-making process, *albeit*, at macro level.

In 1956, Davis and Blake proposed a set of eleven proximate determinants of fertility that affect a woman's fertility through her exposure to sexual intercourse, conception and pregnancy (Davis and Blake, 1956). Later, Bongaarts and colleagues (Bongaarts et al., 1984, Bongaarts, 1978, Bongaarts, 1982) eventually articulated the four principal proximate fertility variables as contraception, marriage, abortion and postpartum infecundability. These biological and behavioural proximate variables are deemed important and through which background socioeconomic factors tend to influence fertility.

The ensuing debate on fertility explanation encompasses social and economic theory. Social and cultural narratives of fertility behaviour such as ideation and diffusion theories have been proposed. The ideational theory of fertility is propounded by several theorists (Colleran, 2016, Carter, 2001). The theory focuses on changes in the systems of societies which give meaning to life (van de Kaa, 1996: 423). Fertility behaviour of individuals conforms to those views or opinions of marriage, contraception and value of children, held collectively or legitimised at macro-level. Cultural beliefs or traditional values are therefore esteemed in communities. In traditional societies, children are highly valued and the costs of raising children are shared or reduced in the kinship networks (Caldwell, 1976, Hirschman, 1994, van de Kaa, 1996, Cleland and Wilson, 1987, Mason, 1997, Colleran and Mace, 2015, Stulp and Barrett, 2016, Sear et al., 2016) and Eswatini is not an exception (Ferraro, 1983, Ferraro, 1991, Lule, 1991, MEPD, 2009).

Diffusion theory promulgates ideals, norms, ideologies and innovative birth control technologies or practices (family planning) that have prompted fertility change through communication (language or mass media) and observational (from parental and nonparental) channels, both at individual- and community-level. By and large, acceptance or receiving of family planning methods or services may reflect wider societal norms reception and social exposure or contagion (Kirk, 1996, van de Kaa, 1996, Snopkowski et al., 2016, Colleran, 2016, Zhang et al., 2013). Moreover, ideational diffusion may drive low fertility norms, especially with modern contraceptive uptake (Colleran and Mace, 2015). The concept of diffusion can occur irrespective of socioeconomic development or geographic location (Hirschman, 1994, van de Kaa, 1996).

A similar line of argument by Bongaarts and Watkins (1996) and Montgomery and Casterline (1998) points to the fact that social learning and interaction/influence are crucial avenues through which fertility decisions can be made. This viewpoint is shared by many researchers. Women may observe, or imitate fertility behaviour of peers (especially the reference/prestige group), social networks and neighbours or could conform to societal authority or pressure determining fertility behaviour (Colleran and Mace, 2015, Stulp and Barrett, 2016, Sear et al., 2016). The society, therefore, sanctions acceptable fertility behaviour and consequently its bounds where an individual fits in or complies. Being close to an urban area or ease of access to media are examples that may negatively influence the fertility decision-making process.

According to Carter (2001) social processes as a function of fertility transition has propelled studies on the role of contextual or community-level effects on fertility behaviour. For instance, the 'local opportunity structure' hypothesis (Basten et al., 2011) provides variables on local conditions – place, economic, cultural and social embeddedness aspects- that promote or discourage childbearing or contraception. In agreement to this phenomenon, Bronfenbrenner's social-ecological theory (Bronfenbrenner, 1977, Bronfenbrenner, 1986, Bronfenbrenner, 2005) has shown external or environment influences, both subjective and objective, shape human behaviour through experience, interactive processes, to name a few, facilitating continuity or change.

Van de Kaa (1996) argues, however, that although highly esteemed values systems may correlate with fertility changes, societies may shift from dominant value systems to being autonomous or individualist in fertility decision making. Mason (1997) further notes that there is complexity of mix of institutional, cultural, environmental and family conditions that motivates or sanctions birth control and fertility. Bongaarts and Watkins (1996) argue that approval, rejection and modification of ideas and information could possibly pattern fertility preferences and family planning in communities.

Micro economic theory has gained much ground in assessing fertility behaviour than social theory due to its more easily quantifiable or testable empirical variables. With regards to fertility as measured by total number of children ever born, earlier formulations in 1960 by Becker and 1981 by Schultz cited in literature (Cleland and Wilson, 1987, Hirschman, 1994) are key explanations to what is known as the new home economics theory approach. The said theory argues that optimum number of children is reached upon considering the economic resources constraints. Therefore, parents' fertility choices depend on the quantity of children they have (children surviving), the quality of those children and the quantity of other goods they consume. Fertility is presumed to increase with income. The relationship, however, is reversed due to preference of quality children to quantity children as a result of modernisation factors including prices, tastes and aspirations that compete with childbearing. The theory shows the social standing or status of a woman is negatively associated with fertility. Nonetheless, biological and social factors are not controlled for in classical microeconomic theory.

Easterlin's micro-economic theory (Easterlin, 1975, Easterlin and Crimmins, 1985) has been elaborated from the new home economics theory. Economic development or factors thereof cannot fully explain the complete fertility behaviour change. As aforementioned, fertility decline has occurred irrespective of lack of progressive economic development or little opportunities of industrialisation in some countries. The Easterlin's framework or 'hypothesis' ascribes fertility behaviour not as an economic entity only, but a fusion with sociological, cultural and biological variables (Hirschman, 1994, van de Kaa, 1996). The multiplicity of these micro- and macro-level variables, models fertility (children ever born) through three aspects of demand for children, supply of children and fertility regulation costs factors (Easterlin, 1975) yielding an integrated approach of understanding fertility behaviour of women. Consistent with Bronfenbrenner's argument women are therefore modelled 'both as individuals and as groups' (Bronfenbrenner, 2005: 3). Other researchers (Mberu and Reed, 2014) have attempted to use the integrated approach of theoretical models to explain fertility levels, patterns and differentials in various populations.

The Easterlin's 'synthesis' framework/hypothesis is adopted for the study. This theoretical procedure seeks to combine simultaneously both community- and individual-level characteristics explanations on fertility behaviour. The mechanics of this theory is furthered in the next section contributing to the body of knowledge on micro- and macro-linkage literature on fertility behaviour.

2.8 Conceptual framework

The conceptual framework, as illustrated in Figure 2.1, was developed leaning heavily on Easterlin's supply-demand model framework (Easterlin, 1975, Easterlin and Crimmins, 1985) for fertility analysis. The underlying assumption of the framework is that fertility behaviour is influenced by both exogenous (indirect) and endogenous (direct) factors. The latter consists of two variables that explain fertility behaviour in the framework, namely contraceptive use and children ever born. The two fertility outcomes describe a sequential process of fertility behaviour, of which the Easterlin framework is more appropriate to apply (Degraff et al., 1997). Notably, Easterlin's framework inherently incorporates the (direct) proximate determinants of fertility suggested in literature – contraception, abortion, postpartum infecundability and marriage/sexual exposure (Bongaarts et al., 1984, Bongaarts, 1978, Bongaarts, 1982, Davis and Blake, 1956, Stover, 1998). The Easterlin model also consists of three proximate factors of demand for children, supply of children and regulation costs of fertility as essential aspects of fertility control (Easterlin, 1975, Easterlin and Crimmins, 1985). Following previous studies (Degraff et al., 1997, Ferrone, 2014), the current study adopts the Easterlin framework as a two-stage model.

According to Degraff et al. (1997), the two stages match the short-run and lifetime periods of fertility control or planning. In the short-run, current use of contraceptives is deemed to determine the number of children as the decision to bear a child is evaluated periodically in response to whether or not one has given previously birth, and external forces, tastes and preferences regarding potential births. Second, lifetime period represents cumulative fertility (number of children) based on a chain of decisions made in the past in a woman's reproductive lifespan.

In the first stage, the determinants of contraceptive use are analysed while in the second stage the determinants of lifetime fertility (children ever born) are assessed, using multilevel regressions as shall be explained later. In the ultimate model for second stage analysis, it should be noted that use of fertility control (contraceptive use) is treated as an indirect (explanatory) variable together with other proximate factors and remote/background variables. Therefore, Easterlin's synthesis framework on fertility behaviour views contraceptive use both as a dependent and independent variable, but in a two-stage design of separate analysis.

The indirect variables are separated into individual- and community-level factors and hence, the study adopted a multilevel framework on analyses (see sections 2.4.1 and 3.7.4). The multilevel approach in the context of Easterlin's framework has been used previously in research (Amara, 2015, Degraff et al., 1997). In Figure 2.1 the micro (individual/compositional) variables are represented for remote and proximate factors. As previous stated, community effects on fertility behaviour have been largely ignored in examining fertility behaviour in most studies (where focus is on individual-level factors), except when assessing levels of fertility at aggregate level - a social outcome (objective i in the study). Similarly, the influence of community factors, whether in the spatial or social sphere, on fertility behaviour, has received little attention in research for Eswatini. The proximate factors are integral to the Easterlin framework and are deemed key variables that influence fertility (objective ii).

The dominant view, being tested by this study (objective v including iii and iv), is that the community structure provides the basis of encouraging or discouraging personal fertility choices and childbearing 'contextual effects'. Although not the basis of this present study, it should be noted, as argued by Basten et al. (2011), that these personal considerations over time can shape community behaviour ('compositional effects'). The latter, stated differently, imply that different communities or neighbourhoods are distributed differently with regard to individual level characteristics related to fertility behaviour, such as educational attainment or socio-economic status (Basten et al., 2011: 575), hence, the two way community-individual direction indicated in Figure 2.1. The community-individual independent variables influence lifetime fertility in two ways, either directly (less common approach) or indirectly (widely held view) through proximate fertility variables.

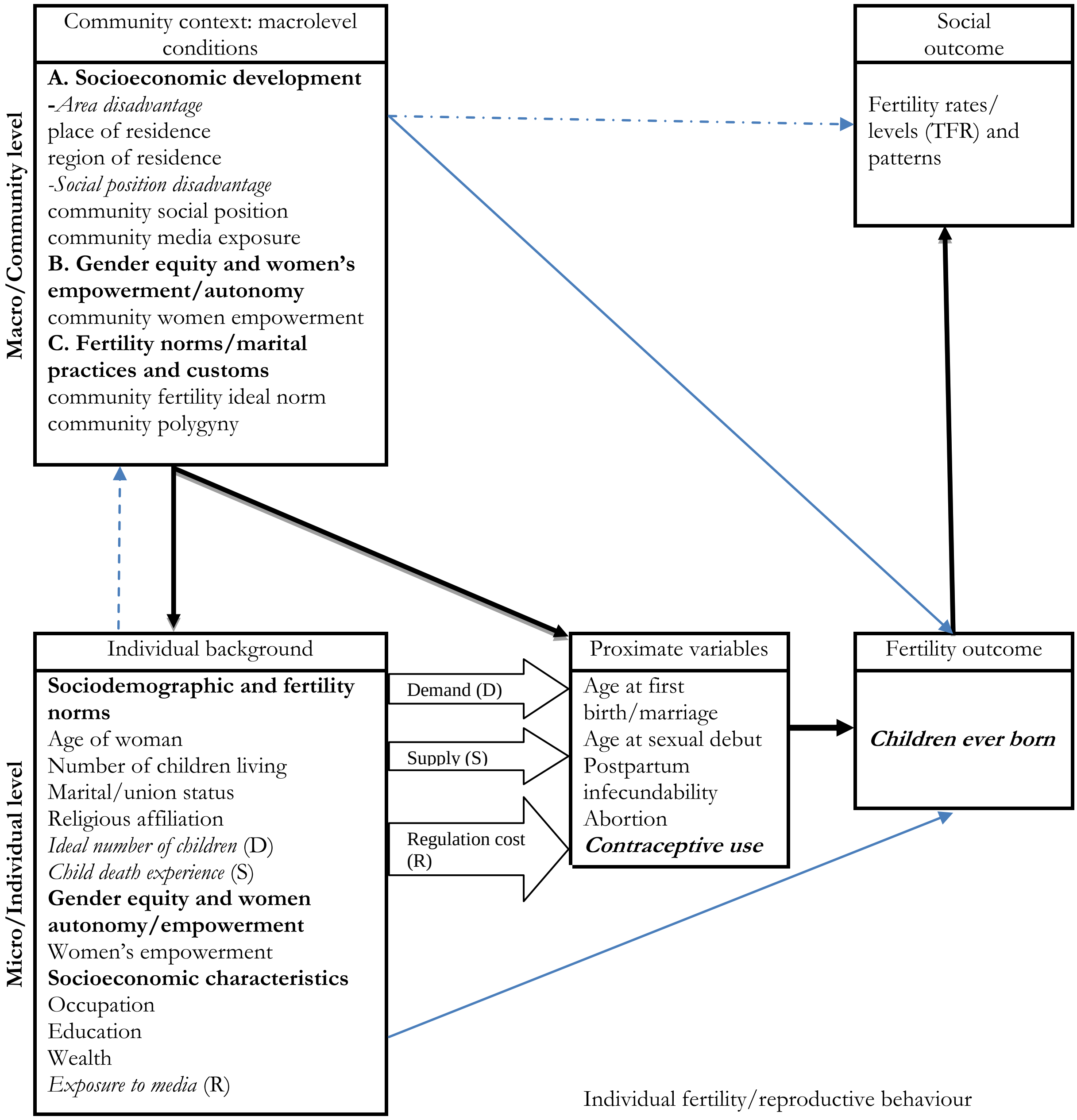

Figure 2.1: Conceptual framework of the individual- and community-level variables effects on fertility behaviour
Source: Adapted from Testa et al. (2011); Hirschman and Young (2000); Easterlin and Crimmins (1985).

The key premise of Easterlin's model is that it allows for determinants of contraceptive use to be analysed (objective iii) and explained through three proximate or mediating variables, namely a) 'demand for children', b) 'supply of children' and c) 'regulation of fertility cost'. These factors which motivate fertility control, according to Easterlin (1975: 55) are defined as follows:

a. the demand for children- the number of surviving children that parents [or couples] would want if fertility regulation were costless [measures fertility preferences-ideal number of children];
b. the supply of children- the number of surviving children that parents would have if they did not deliberately limit fertility [captures the reproductive capacity or fecundity often related to child mortality]; and
c. the costs of fertility regulation, including both subjective (psychic) costs and objective costs, the time and money required to learn about and use specific [family planning] techniques [aspects promoting or inhibiting practice of fertility control e.g. exposure to media and/or family planning messages].

The second stage of analysis examines lifetime fertility (objective iv) with respect to a 'full' or broader framework of individual-level and community-level determinants. The adapted Easterlin 'synthesis' analytical framework took rather a synergistic linkage of demographic, biological, cultural and socioeconomic determinants to explain fertility behaviour in the context of Eswatini. This holistic approach captures several domains with special attention to community realms of a) socioeconomic development, b) fertility norms and practices, and c) gender equity and women's empowerment or autonomy as explained previously. Failing to include other theoretically relevant contextual variables severely limits our understanding of the ways in which context influences the fertility regulation process (Grady et al., 1993: 5).

Overall, socioeconomic characteristics (wealth, occupation/employment, education, urbanisation, women empowerment, socioeconomic status, media exposure and contraception) tend to depress fertility. On the contrary, sociocultural and fertility norms variables (e.g. marriage/polygyny, child mortality and religiosity), tend to increase fertility. Demographic factors such as age and parity tend to influence fertility positively. Literature suggests that the direction of influence on fertility of socioeconomic variables is mixed and may depend on the context, however, the theoretical expected direction of influence of each independent variable on lifetime fertility is indicated in Tables 3.1 and 3.2 in the next chapter. The directions of influence on contraceptive use tend to be opposite to that of lifetime fertility. The choice of variables used in the study was guided by the reviewed literature and theoretical frameworks aforementioned.

In sum, the puritan views opined by researchers on the determinants of fertility fall short of expectation of the overall understanding of fertility behaviour. The two views, on the one hand capture individualism in regards to fertility decisions and on the other hand, emphasise community structure which shapes fertility. This study will inform the usefulness of the individual-community dimension factors that have a bearing on fertility.

2.9 Research hypotheses

The overall research presents research hypotheses at the individual (micro) level and macro (community) level. The main hypotheses of the study in the form of null hypothesis (H_0) versus alternative hypothesis (H_a) are as follows:

Research hypothesis 1

H_0: There is no association between individual characteristics and fertility behaviour: number of children ever born or contraceptive use.

H_a: There is an association between individual characteristics and fertility behaviour.

Research hypothesis 2

H_0: There is no association between community characteristics and fertility behaviour.

H_a: There is an association between community characteristics and fertility behaviour.

Research hypothesis 3

H_0: There is no variation between communities in fertility behaviour.

H_a: There is significant variation between communities in fertility behaviour.

CHAPTER THREE

METHODOLOGY

The objectives of this chapter are set out in three sections. The first section describes the study setting and design; the second describes the data sources, the instruments and the variables used in the study of fertility behaviour and the third discusses the technical and statistical method approaches used to examine the quality of data, analyse data and address the research objectives.

3.1 Study setting

This section situates the study context covering in brief the geography, economy, and the political and administrative structure of Eswatini.

The Kingdom of Eswatini is positioned in the Southern African region. The country is mountainous and landlocked, covering 17,363 square kilometres and hence, has the smallest land area in the region. It is sandwiched between South Africa and Mozambique; the latter covers the most part of the eastern border stretching to the Indian Ocean. Eswatini's economy is lower middle-income and is heavily reliant on agricultural activities. Service industry is a major driver of the economy supported by the manufacturing sector (CSO, 2008, CSO, 2010b, MEPD, 2012).

Eswatini is administratively divided into four regions, namely Hhohho, Manzini, Lubombo, and Shiselweni. Hhohho and Manzini are more urbanised, commercialised and industrialised with the former housing the capital city - Mbabane. On the other side, Lubombo and Shiselweni are more rural and impoverished. The four regions are currently subdivided into fifty-five *tinkhundla* or constituencies (see Figure 3.1) which serve as focal points for administrative roles, service delivery and implementation of community development policies or programmes at grass roots (local community centres or councils). In rural areas, most people have access to land known as Swazi National Land (SNL) where communities are closely-knit social groups. There are also twelve local municipality authorities in the urban areas (MEPD, 2012).

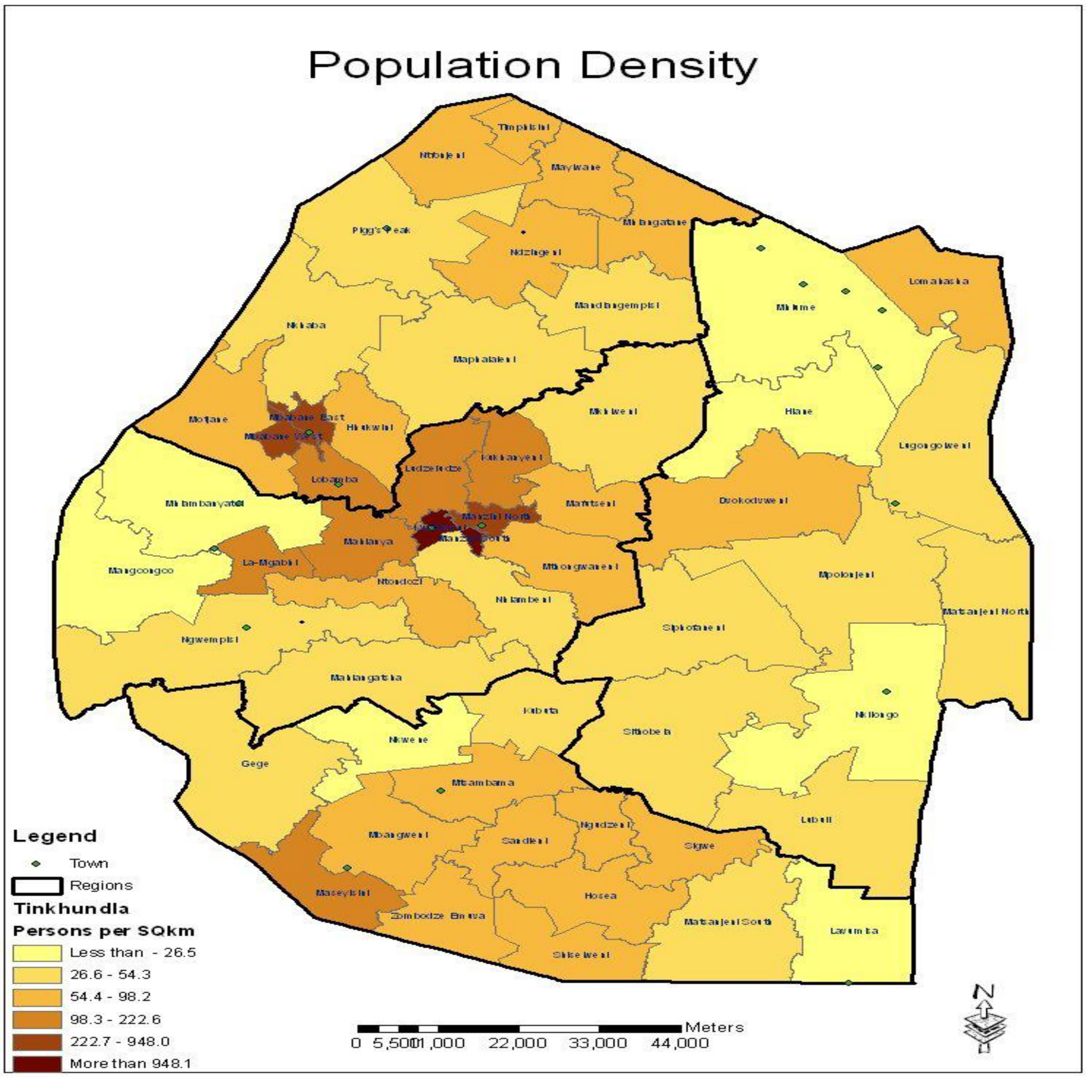

Figure 3.1: A map showing Eswatini Tinkhundla boundaries by population density
Source: CSO (2010b: 15)

The country attained its independence in 1968 and henceforth, a monarchical structure was set up with dualistic modern (Westminister) and traditional government systems. This has been characterised as a homebred *Tinkhundla* system of governance. The customs, norms and values of the Swati indigenous culture are preserved and perpetuated, especially thorough traditional councils and structures of which chiefs are the overseers (Adepoju, 1991, MEPD, 2002). In the 2013 speech by King Mswati III, the *Tinkhundla* system of governance was declared a monarchical democracy, whereas in 2018 the King renamed the colonial country name of Swaziland, calling it Eswatini. In the complex governance system, Western or modern values tend to be promulgated. The intricate 'Swati culture' permeates marriage or relationships, family building, the economy and the government

(Russell, 1993, Ferraro, 1991, Ferraro, 1983, Lule, 1991, MEPD, 2012). Therefore, this has important implications for fertility behaviour at community level or in local contexts and other social/society spheres where fertility variation need further insight. Elsewhere, extant literature (Janevic et al., 2012, Kaufman, 1998, Kazembe, 2009, Kravdal, 2002, Kravdal, 2012, Kulu and Boyle, 2008, McNay et al., 2003, McNicoll, 2001, Stephenson et al., 2007, Wang et al., 2013) suggests community aspects of socioeconomic development, fertility norms and marital practices, gender equity and women empowerment, have a bearing on fertility behaviour.

The kingdom of Eswatini's modern government permits legislation and controls public administration and has the responsibility of socioeconomic development implemented through various strategies, policies and five year plans. Post-independence fertility-related efforts and concerns of the government of the kingdom of Eswatini have been focussing on limiting population growth. Date back to the 1970s, a family planning programme was launched in 1973 (Gule, 1994) and the Third National Development Plan for 1978/79 to 1982/83 report on family planning education and services were offered at various public health facilities (Government of Swaziland, 1978). The population policy was launched in 2002 (MEPD, 2002) and prior to this Wear and Katsande (1989) note that family planning programmes were nested in the National Health Strategy to promote the use of contraceptives in arresting the burgeoning population growth rate.

Cascading efforts have been coordinated and implemented through various policy strategies meant to curb childbearing and population growth. To mention a few, the 2005 Poverty Reduction Strategy Action Plan (PRSAP) report (MEPD, 2006), the National Condom Strategy (NCS) 2010-2015 report (Ministry of Health and Social Welfare, 2010), and the National Health Policy (Ministry of Health, 2013) are part of the continued efforts of the government to achieve its mandate of socioeconomic development in line with the national vision 2022 formulated in 1999 (MEPD, 2012).

Women empowerment is historical and government envisioned since the 1970s (Government of Swaziland, 1978). Although the government has taken initiatives of women emancipation, they are yet to be fully realised. Gender inequality, gender based violence, unemployment, poverty, and low decision-making autonomy, amongst others, are rife in society, disadvantaging women who are treated as minors and expected to be subservient. The Swati patriarchal society structure, at household, community or national level, permits power dynamics that shape marriage, family building or fertility behaviour to be more vested in men than women (Gule, 1994, MEPD, 2006, MEPD, 2009, MEPD, 2012, Whiteside et al., 2003, Adepoju, 1991). This synopsis of political economy underlines vital aspects of culture and contextual influences on fertility behaviour.

3.2 Study design

The research design incorporates a multimethod quantitative approach. Triangulation of multiple data sources (censuses and surveys) and methods was done to estimate fertility levels and cross validating the estimates, was made possible. Quantitative methods - both technical demographic (direct or indirect) measures and statistical techniques, were applied as outlined in section 3.7. A cross-sectional research design for survey data, was applied. The survey information was used to examine the determinants of fertility behaviour using a statistical approach that incorporates multilevel research design (combining individual- and community-level data see section 2.4 and 3.7.3). The data collection methods, variables and data analysis plan, are discussed in subsequent sections.

3.3 The population and sample

This section gives an overview of the study population and describes the survey and census data sources.

The population of Eswatini was estimated at 1,018, 449 in 2007 and has more than doubled in four decades from 374,697 in 1966. As at 2007, females were 52.7%, presenting a sex ratio of 90 males per 100 females. The population has a young age distribution. More than three quarters of the population live in rural areas. The urbanised population was 15.2%, 22.8%, 23.1% and 22.1% in the year 1976, 1986, 1997 and 2007, respectively. The populace is ethnic Swati while non-Swati consists of less than 3 per cent of the population (CSO 2008, 2010b). The majority of Swatis occupy the

‘Swazi National Land’ (SNL) where homesteads are sparsely clustered in various chiefdoms. The urban areas and surrounding areas have the highest population densities.

3.3.1 Census data

The mandate of a census is to enumerate the entire population in a country. Besides the current census scheduled for 2017, Eswatini has conducted four censuses in 1976, 1986, 1997 and 2007 post 1968 independence. The censuses enumerated 494,534; 681,059; 929,718 and 1,018,449 individuals in the respective censuses, showing a steady increase in the population over time (CSO, 2010a). The data on censuses were sought and provided by the Central Statistics Office (CSO) of Eswatini. Raw data were only available for the recent two censuses: full information for 1997 census and 20% sample for the 2007 census. For the earlier censuses, only official published data was availed. For the purpose of the study, published raw data on the population size by age and sex were sufficient to assess the quality of data. The study sought to re-examine or reconstruct fertility levels using the data from the four censuses. Therefore, aggregated fertility data tabulated in census reports (CSO, 1980, CSO, 1988a, CSO, 1988b, CSO, 1998, CSO, 2010b, CSO, 2010c) were used, targeting recent births and children ever born/parity variables. The raw data from the 2007 census sample had issues of missing ‘non-stated’ parities, vital for correcting parity distribution and was discarded. Therefore, for consistency sake, single year and aggregated data from the published census report, were deemed credible to meet the objective of the study.

The 2017 census of Eswatini was set for enumeration from April 29 to 15 May 2017 and the population size was projected to reach 1,145,950: males 544,811 and females 601,159 (CSO, 2007). However, the preliminary published results of the actual count estimated population size at 1,093,238 (males 531,111 and females 562,127), representing an annual growth rate of 0.7% from 2007 (CSO, 2017). The 2017 census data, when it become available, will provide further insight into fertility transition in Eswatini.

3.3.2 Survey data

The data utilised in this study comes from the 2006-07 Eswatini Demographic and Health Survey (DHS) with the aim of examining the determinants of women's fertility using a multilevel approach. This survey is the only and first publicly available archived DHS for Eswatini, downloadable from the Measure DHS data repository website (https://dhsprogram.com/data). The survey collected a national representative sample using a two-staged cluster sampling design. First, the country was stratified into the four regions (Hhohho, Manzini, Shiselweni and Lubombo) and then urban and rural clusters or enumeration areas (EAs). A sample of EAs was drawn from the 1997 PHC sampling frame of 275 clusters consisting of 111 urban and 164 rural clusters. Second, households in the clusters were listed and a systematic sample was used to select 5,500 households. All individual women aged 15-49 in the households were eligible for interview, but only a target of 5,301 women was identified. A total of 4,987 women were successfully interviewed, yielding a 94 per cent response rate (CSO, 2008).

Sub-sample analysis of fertility behaviour in most African contexts has been limited to married women. Previous research postulated childbearing or contraceptive use to be sanctioned in marriage (Degraff et al., 1997, Ejembi et al., 2015, Elfstrom and Stephenson, 2012, Kaggwa et al., 2008, Wang et al., 2013, Amara, 2015). The held view ignored the single or never married whose exposure to sexual intercourse was thought to be insignificant or contributing little to fertility. In this case, Eswatini is an exception, since early teenage or out of wedlock births, are significant (CSO, 2008, CSO and UNICEF, 2011) and not frowned upon since they prove fecundity of women (Warren et al., 1992). That said, the sample for this study was limited to 4,112 sexually initiated, exposed or experienced women, that is, those who had ever had sex. Included in this sample were the single or never married women who often are missed in fertility studies and hence fill this gap.

Often, between old data and recent data, the latter are favoured for timeliness purposes. When the former is endowed with rich data as in the case of DHS surveys, and the information has not been exhausted in scrutiny on a subject matter, academic research is robbed of vital knowledge.

Further, without understanding or capturing nuances in information, traditional data may be overlooked, leading to resource wastage. Novel information has been obtained from old data: using the old data-new information principle. In fact, widely held notions have been challenged using old data. For example, Jensen et al. (2015) found in the Danish community that women aged 30 or more can bear several children (above replacement level fertility), quite contrary to common modern thinking that children become fewer.

As stated, DHS is the main source for data central to multilevel analyses for this study. While in several countries DHS surveys have been collected more than once, the exception is the case of Eswatini. Alternative to DHS data, the Multiple Indicator Cluster Survey (MICS) data have been recently collected in 2010 and 2014 (CSO and UNICEF, 2011, CSO and UNICEF, 2016). Like the DHS, MICS are nationally representative, self-weighted and information on women and household that is collected is vital for examining fertility behaviour. The information collected in MICS is similar or being harmonised with the DHS. On the other hand, there are differences in scope and hence, data collected between the two made the DHS best suited for this study.

First and foremost, the study took a holistic view on assessing fertility behaviour and therefore, a broad range of variables in line with the conceptual framework of the study, were chosen (see Figure 2.1 and Tables 3.1 and 3.2). Unlike DHS, the MICS has limited scope for the data variables collected and related to fertility behaviour in this study. Some key determinants of fertility behaviour from the MICS are not directly comparable to the DHS. For example, key input variables in regression and the theoretical framework of this study such as religion, occupation, ideal number of children and exposure to family planning messages in media, were not available or collected for MICS in Eswatini.

Also, the MICS has a narrower concept of women's empowerment and is different to the broader aspect applied for this study using DHS data, incorporating variables in women's participation in household decisions and gender based attitudes towards refusing sex. Given this background, this study utilised the 2007 Eswatini DHS data to examine birth histories and contraceptive use. Moreover, the study serves as a baseline for comparative future studies with respect to multilevel analysis of fertility behaviour in Eswatini, given a wider number of explanatory variables used.

In the same argument, some variables in MICS are not consistent with DHS, including live births. The latter surveys generate information on births in the 5 years preceding the interview while MICS truncates the births as it adopts a 2-year reference period. Truncation of births has its own implications for methods used for fertility analysis with respect to errors pertaining to sample sizes and reference period of indicators covered (Goldman and Hobcraft, 1982).

The effort to standardise indicators is an ongoing process that may harmonise questions and/or methods to make comparability easy, especially for the DHS and MICS surveys. The Eswatini MICS survey data, which is quite recent, was explored but not considered for the study as the data was collected on a limited range of demographic and socioeconomic variables in comparison to the DHS survey. For the current study, which required a holistic analysis of fertility behaviour, the DHS, rather than the MICS dataset, was appropriate for incorporating a broad overview of remote variables influencing fertility behaviour.

The data from surveys (based on sample enumeration) and censuses (based on full enumeration), are collected using different methods and hence the results are not exactly or directly comparable. However, the data are used for complementing and validating the results from the analyses.

3.4 The instruments

The study used data generated from recent surveys and censuses conducted in Eswatini. All survey instruments and census forms employed in the study were translated into the local language, SiSwati and pre-tested before being translated back into English. This procedure was done to check for ambiguities in wording, clarity, readability and understandability of questions in the translated questionnaires and to identify any irregularities that could arise administratively. Face to face interviews were conducted in the collection process, both for surveys and censuses.

3.4.1 The survey questionnaires

Data were gathered using an individual level and household questionnaire. The latter gathered information on each person in the household regarding their background characteristics such as age, sex, level of education, marital status, dwelling and household characteristics pertaining to, amongst others, water, sanitation, ownership of assets, goods and materials in the house. In addition, information on children born was collected, including the sex and survival status of child.

The individual questionnaire was used to draw information on women aged 15-49 in each household. Topical information on fertility or reproductive behaviour was extracted from various sections in the women's questionnaire. Information was collected on birth history, contraception or family planning, marriage, sexual behaviour, fertility preferences and woman's background characteristics including residence, social position or status and autonomy or empowerment.

The variables used in the study are indicated in Tables 3.1 and 3.2 in section 3.5. The DHS has specified four quantity based questions on fertility, collecting specific information on the number of children of a woman namely: (i) ever born (live births), (ii) living with her, (iii) living elsewhere and (iv) who are dead. These variables are vital to fertility measurement.

3.4.2 The census forms

The census questionnaires were used to gather background information on all household members on various characteristics; fertility, mortality, migration, educational, economic, demographic, household and social aspects. The 1976, 1986, 1997 and 2007 censuses collected fertility data in uniform with modern census questions on recent live births and children ever born and hence are similar in content. These questions are also similar to those asked in DHS surveys. The content on other background variables is, however, limited for censuses when compared to surveys which collect in-depth information on population.

The question on (recent) births a woman had in the last 12 months, required a reference period in the four censuses. In the 1966 census, this question had no specific reference period and hence data was amenable to dating errors. The question on children ever born was asked of women aged 12 years and older in the 1997 and 2007 censuses or 15 years and above in the 1976 and 1986 censuses. The latter two censuses ascertained fertility by looking at the date of last birth spanning the period of 26 August to 25 August in the respective years. In the 1997 and 2007 censuses, the reference period was changed to May/April and the census was undertaken from 28 May to 14 April in 1997 and 28 May to 17 April in 2007.

Alternative demographic data sources in Eswatini such as the Vital Registration System (VRS) are nonetheless incomplete and flawed as technical expertise is required to validate the vital statistics records on births, deaths, and marriages. The VRS requires universal enumeration of the population and continuous registration of vital events in a population; in many developing countries these expectations are often not met, including in Eswatini. The administration of VRS for Eswatini is much less adequate than for national censuses and surveys, while this current study relies on the latter for accurate measurement of representation of fertility and other demographic processes.

3.5 Variable identification: Definition and measurement

The variables have been chosen based on their theoretical underpinnings in the literature and with respect to their availability in the dataset in relation to the methods applied as well as the conceptual framework for the study. The variables outlined are based on the statistical regressions and have been described in the following two sections.

3.5.1 Dependent variables

As in previous studies, fertility behaviour is measured using two dependent variables (contraceptive use and children ever born) in the context of Easterlin's framework (Degraff et al., 1997, Ferrone, 2014) using a statistical multilevel regression relationship (Amara, 2015). The key dependent variable is the number of children ever born (CEB), which is the number of live births a woman has had. This is measured as a count variable.

The other variable utilised in the study is whether or not a woman is currently using contraception to determine the act of fertility control. The responses were given as binary - a yes or no answer. Use of contraception refers to taking any traditional contraceptives (withdrawal, periodic abstinence (P.A), rhythm, Lactational Amenorrhea Method (LAM) and folk) and modern contraceptives. The latter includes long-acting methods (female and male sterilisation, intrauterine device (IUD) and implants) and short-acting methods (pills, male and female condoms and injectables). The dependent variables are outlined in section 3.7.3. An alternative measure of ever use of contraceptives has been proposed in studies (Westoff and Bietsch, 2015), especially when contraceptive prevalence rate was low, but was not the case with this study.

3.5.2 Independent variables

The explanatory variables in fertility behaviour have been grouped into micro (individual and household) characteristics and macro (community) characteristics. The expected directions of influence of independent variables on fertility (*a priori* expectation) as hypothesised in section 2.7 are presented in Tables 3.1 and 3.2. A positive sign (+) indicates the variable is positively related to fertility and a negative sign (-) indicates a negative relationship between the variable and fertility.

3.5.2.1 Microlevel: individual and household (compositional) characteristics

The study identified 14 explanatory micro-level (level-1) variables compiled from the DHS guided by literature and theory. These included age at first birth, age at sexual debut, contraceptive use, age of woman, number of children living, marital/union status, religious affiliation, ideal number of children, child death experience, women's empowerment, occupation, education, wealth, and exposure to media as classified in the conceptual framework in Figure 2.1.

These micro-level variables are included to fit multivariate and multilevel statistical models on fertility behaviour outcomes as identified above (section 3.5.1) on the key outcome lifetime fertility (CEB) and contraceptive use. The latter is modelled first as specified in the Easterlin framework and the explanatory characteristics are the same for lifetime fertility, excluding the variable itself. This array of independent variables in demographic, cultural, social and economic characteristics presented (as well as defined or measured) in Table 3.1, was checked for multicollinearity which makes it difficult to separate the independent effects of interrelated variables.

Due to multicollinearity, important variables such as self-reported fecundity, the v623 DHS variable, fertility desire - 'wantedness' of a child -v605 (Stephenson et al., 2007) and age at marriage, were excluded in the study. With children ever born as the dependent variable in regression analysis, two variables (age of woman and number of children) with correlation coefficient greater than 0.6, were dropped in the analysis (see Table E1 in Appendix E).

Table 3.1: Micro/individual -level independent variables

Variable	Definition/Measurement	DHS variable/s	*a priori* sign
Age of woman	Age in years of the respondent: 15-19; 20-24; 25-29; 30-34; 35-39; 40-44; 45-49	v013	+
Number of living children	The number of living or surviving children a woman has had: 0-2; 3-4; 5+	v218	+
Age at first sex (sexual debut)	Age at which a woman had her first sexual encounter: <16;16-17;18-19;20+	v531	-
Age at first birth	Age at which a woman gave her first birth: <16;16-17;18-19;20+	v212	-
Union status	Marriage or union status of the woman: never married ; monogamous; polygynous; formerly married or in union	v502; v505	+
Ideal number of children	Ideal family size of children desired by a woman in her lifetime: 0-2; 3-4; 5+	v614	+
Religion	Religious affiliation: None/other-Traditional, Islam; Catholic; Pentecostal/Charismatic; Protestant; Apostolic/Zion	v130	+
Contraception	Current use of any (traditional or modern) contraceptives: yes; no	v313	-
Child death experience	A dichotomous variable indicating whether or not a woman has experienced any infant or child death of a daughter or son: yes; no	v206 v207	+
Occupation	Current occupation: unemployed; agricultural/manual; sales and services; professional/technical/managerial/clerical	v717	-
Education	Highest educational level of a woman completed: none/ no education; primary; secondary and higher	v106	-
Household wealth	A DHS household wealth quintile generated in the dataset using principal component analysis (PCA) by taking into account various household items, facilities and assets: poorest, poor, average, richer, richest.	v190	-
Exposure to media	An index combining frequency of access to media (newspapers, radio, and television) and whether respondent has been exposed to family planning messages in media: low; moderate; high	v157, v158 v159 v384a-c	-
Women's empowerment	Women's household and reproductive behaviour/gender equity or violence index: whether a respondent has a say in decision-making on household and family planning issues; her attitude towards wife beating or refusing sex being justified: low; moderate; high	v743a-d v632 v739 v744a-e v633a-d	-

The Easterlin framework realises lifetime fertility as determined by the three key proximate factors of demand for children, supply of children and fertility regulation cost. The first is proxied by fertility preference as measured by ideal number of children. The immediate determinants of demand for children are income, prices, tastes or aspirations proxied by the socioeconomic characteristics of occupation, education and wealth. The supply of children captures the chances of child survival (child death experience) and woman's natural fertility and hence her exposure to intercourse and fecundity. The latter is captured with proximate fertility variables of age at first sex (age at sexual debut) and age at first birth.

The cost of regulation is proxied by exposure to mass media, family planning messages (exposure to media) and current use of contraceptives. The latter is one of the proximate (biological or behavioural) determinants of fertility, whereby all other basic or background variables affect fertility through them as illustrated in the analytical framework (Figure 2.1). In the Easterlin framework, use of fertility control (contraception) regression model fitted separately, thereafter the CEB model is fitted sequentially. The basic determinants mediate on fertility behaviour and therefore are controlled for in the model.

Composite indices were constructed when two or more DHS variables were combined to measure women's empowerment, exposure to media and household wealth at individual level. The latter is already a principal component analysis (PCA) composite index measure determined in the DHS dataset with five quintiles: poorest, poor, average, richer and richest.

Exposure to mass media composite index was measured by capturing i) access to media which may influence fertility behaviour in general and also by considering ii) whether a woman has heard specific family planning messages through mass media. Therefore, a reliability coefficient (Cronbach alpha) test for the items making up the factors for the mass media index was estimated. Cronbach's alpha measures the internal validity of an index. A higher alpha coefficient of 0.7 or greater is deemed dependable or reliable (Smith, 2011). An external valid index has strong correlations with actual behaviours that logically follow from the meaning of the index (Smith, 2011: 99). For example, in the case of access to media index, women who report little or no access to media should also show lower exposure to family planning messages than those who have higher exposure to media.

The factors constituting mass media items were access to television, radio and newspapers. From the DHS questions on the three items, access to media and exposure to family planning messages in mass media indices, were estimated.

a. *Access to media*. Women were asked if they had access to three media items separately with the given responses as: almost every day, at least once a week, less than once a week and not at all. Dichotomous responses were generated separately for television, radio and newspapers by combining the first two item responses (almost every day, at least once a week), indicating moderate to high exposure to media and the latter items indicating little or no access to media. From the three factors, an alpha or kappa reliability coefficient of 0.47 was estimated.
b. *Exposure to family planning messages in mass media*. Women were asked whether or not they have heard of family planning on the radio, television and in newspapers. For each of the three media items, responses were given as a yes or no. From this set of three questions, a Cronbach alpha value of 0.64 was obtained for this index.

The overall 'exposure to media' composite index measure was estimated from the two dichotomous indices above, using Cronbach alpha and giving a dependable reliability coefficient value of 0.6776. Instead of generating five quintiles as in the case of household wealth, three quartiles responses (low, moderate, high) for exposure to media, were created from the index using alpha.

The women empowerment overall index was created at individual level following Upadhyay and Karasek (2012) from three indicators: decision-making autonomy, attitudes toward domestic violence and whether attitudes towards refusing sex for women is justified. The three dimensions of women's empowerment also constitute several items or variables and therefore, Cronbach's alpha coefficient was estimated. The number of variables for each dimension can vary by removing those that lower or negatively affect the reliability coefficient. In the same manner of constructing a unidimensional scale, variables of the same construct with a positive effect, can be added.

a. *Woman's household decision making*. Each woman's decision-making process was assessed based on six variables namely: final say on healthcare, major household purchases, spending own money, contraception, daily household purchases and visiting friends or relatives. In response to decision making, DHS questions were formulated in which the variables were categorised as: respondent; husband/partner, respondent and husband/partner or jointly, and someone else or other person. The answers were grouped into two categories; 1=respondent makes decisions either alone or jointly with another person and 0= other person or someone else makes decision. The reliability coefficient of the 6 items was 0.66.

b. *Women's attitudes toward gender based violence*. Five gender-related factors were used in the study namely: women being beaten for going out without permission, neglecting children, arguing with male partner, refusing sex, and burning food. The responses on whether or not a woman should be beaten were coded as binary; 1= yes and 0= no/ don't know. The Cronbach's alpha was 0.72 for the index.

c. *Women's attitudes regarding refusing sex*. The study utilised four questions which were asked of each woman. Two questions were on whether she agrees that a woman may refuse sexual activity if she has recently given birth or is tired or not in mood. The other two questions asked whether she refuses sex because the husband has a sexually transmitted disease or has sex with other women. The responses were coded as binary; 1= yes and 0= no/ don't know. A satisfactory alpha coefficient of 0.60 was estimated.

The overall women's empowerment index yielded alpha 0.6804 as the reliability coefficient. The responses were divided into tertiles indicating low, moderate or high women's empowerment at individual level. With the overall women's empowerment score, the views of all women were covered, including unmarried or single childbearing and sexually exposed women often excluded from fertility behaviour studies.

3.5.2.2 Macrolevel: community characteristics

The study considered a range of community variables capturing the three dimensions of socioeconomic development, women's empowerment and fertility norms to examine fertility behaviour. Although the study conceptually classified the three dimensions of the seven community variables identified from literature as mutually exclusive, they may overlap in measurement when introducing collinearity among the variables. The study found there was no multicollinearity among the community-level variables when added one at a time or simultaneously (see Table E2 in Appendix E).

The seven community (level-2) variables and their dimensions considered in this study include women's place of residence, region of residence, community social status, community media exposure, community empowerment, community fertility ideal norms and community polygyny level. With the exception of the first two, the rest of the community characteristics were derived by aggregating individual (level-1) variables from the primary sampling unit or DHS cluster (v021).

First, the individual variables were created or recoded as binary before they were aggregated to form community variables. The latter were also created as binary and therefore, measured as a means or per cent distribution of women with a particular community characteristic. Only community social status of women, community media exposure for women and community women empowerment, were created as composite macro variables. These community variables, which were derived as aggregated micro variables and measured as means or percentages as well as composite variables, are presented in Table 3.2.

***Social position disadvantage*:** It is common in most studies to measure social inequality in a community with individual social status variables such as educational level, wealth/poverty status, occupation or employment status. The aforementioned variables, instead of being used separately to measure community social status, a derived composite measure of social position of women in the community was created through aggregating wealth, education and occupation variables as suggested by several researchers (Brewster et al., 1993, Burgard and Lee-Rife, 2008, Colleran and Mace, 2015, Thornton et al., 2016, Mills, 2010).

Following such examples with a particular reference to Brewster et al. (1993)'s study, a community socioeconomic disadvantage index was derived by aggregating responses about education, poverty and occupation as binary and hence proportions or percentages.

a. Education was divided into two, comparing women's disadvantage in terms of formal knowledge (1= primary or no formal education and 0=secondary or higher education).
b. Poverty status of women in the household was measured as a dichotomy of the lowest two quintiles - poorest and poor (or households below 20% wealth index) versus the other.
c. Occupational disadvantage of women was measured by comparing those in agricultural and manual occupations or unemployed with those employed otherwise in professional, technical, clerical, sales and services jobs.

Table 3.2: Macro/community-level independent variables

Variable/**dimension**	Definition/Measurement	DHS variable/s	*a priori* sign
A. Socioeconomic development			
Area disadvantage			
Place of residence	A dichotomous variable indicating urban-rural residence of women: urban-yes	v102	-
Region of residence	Eswatini's four regions indicating the socioeconomic development in the country: Hhohho; Manzini; Lubombo; Shiselweni	v101	-/+
Socioeconomic disadvantage			
Community social position/status	Percentage of women in the community with greater social status - derived as a composite of wealth, education and occupation: low; high	v717, v190, v106	-
Community media exposure	Percentage of women exposed to family planning messages in the community: low; high	v384a-c	-
B. Women autonomy			
Community women empowerment	Percentage of women in the community who are highly empowered based on decision-making and opinions regarding gender violence or women's sexual activity control or negotiation with partner: low; high	v743a-d v632 v739 v744a-e v633a-d	-
C. Fertility norms			
Community fertility ideal norm	Percentage of women with a high fertility norm preference (an ideal number of children greater than 4): low; high	v614	+
Community polygyny	Percentage of women in polygynous unions in the community: low; high	v505	+

The overall social status index for disadvantaged women in the community was created as a dichotomy variable from those with primary or no education, poorer household wealth quintiles and low occupational positions (agricultural and manual) or unemployed, aggregated at the primary sampling unit. The proportion of women with low community social position was considered disadvantaged. Following the same principle, the percentage of women residing in communities with either low or high exposure to media exposure, was created. Lastly, the percentage of community women empowerment was classified as either low or high.

3.6 Steps in data analysis

The preliminary step in demographic analyses often requires data evaluation and adjustment of fertility estimates as outlined in detail in section 3.7.1. Data analysis was done based on the research objectives (section 1.5). Following the conceptual framework, the estimates of fertility levels were determined and subsequently, multilevel analyses were done of determinants of fertility behaviour.

Estimates of fertility levels were done using demographic and statistical approaches (section 3.7.2) to address the first objective. Multivariate and multilevel statistical regression models in section 3.7.3 were applied to assess the impact of individual and community (compositional) characteristics on fertility outcomes (Table 3.3) and hence addressing the second, third and fourth objectives of the study. In regressions, the unit of analysis is women aged 15-49 and analyses are carried out for all women and women who have had sexual intercourse, that is, those who had been sexually exposed or initiated.

Final model multilevel logistic and Poisson regression results and findings were used to explain; a) statistical significance - the certainty or degree of confidence that an independent variable is related to fertility behaviour in the specified direction, b) coefficients - per cent change in fertility behaviour associated with a change in the independent variable, and c) the underlying reason for an observed relationship. The EASWESPOP-fertility program (East-West Center, 1992), MS Excel and Stata 14 (StataCorp, 2015b) software, aided in demographic and statistical estimation and modelling. The EASWESPOP-fertility program is rarely applied DOS based computer software for fertility estimation using a number of indirect techniques as elaborated in section 3.7.2.

3.7 Methods of data analysis

The methods used to evaluate age-sex and fertility data, derive fertility estimates and examine fertility behaviour in Eswatini, are explained in the following three sections.

3.7.1 Data quality: Evaluation and adjustment

The first objective of the study was to estimate the levels and the trends of fertility thereof (as shall be explained in section 3.7.2). Therefore, there was a need for assessment of data quality as a preliminary step prior to the estimation of levels of fertility. It is worth appraising quality of data to determine bias, errors and their probable sources.

It is worth noting that even if baseline data is erroneous in some aspects, fertility estimates can be derived reasonably by adjustment. For example, el-Badry correction is used to adjust data on women's parities when those with no children are misclassified as not stated (United Nations, 1983). Estimates like TFR and age specific fertility rates (ASFRs) extracted from censuses and surveys and then compared, are also used for quality assessment. Depending on assumptions and available data, various indirect techniques of estimating fertility such the P/F ratio, reverse survival method and the relational Gompertz model, amongst others, can also be used to adjust and evaluate fertility estimates (Moultrie et al., 2013, United Nations, 1983).

It should be reasonable to note that estimates of TFR may vary due to different data sources or qualities, and methodological differences. However, a reasonable variation may be permitted. Data are checked preliminarily for accuracy, quality and consistency of fertility estimates.

3.7.1.1 Quality of age-sex data methods

The standard demographic tools of ratios and indices for detecting errors of misreporting, age heaping or digit preference for age and sex data, include the age ratio, sex ratio, UN age-sex accuracy index (joint score), Whipple's index and Myers' blended index (Shryock et al., 1976, Moultrie et al., 2013, Spoorenberg, 2007). The discussion of the aforementioned methods by these authors has been summarised in this study (Chemhaka et al., 2016b).

The UN joint score is a summary measure of the general accuracy or quality of age-sex data, which is applicable to 5-year age groups. A joint score is interpreted in three range values of less than 20 (low range), between 20 and 40 (cautious range) and over 40 (high range), suggesting population structure is accurate, inaccurate and highly inaccurate, respectively (Shryock et al., 1976). The

'AGESEX' file in the PASEX package was used to compute the UN age-sex accuracy index at national level for the 1976, 1986, 1997 and 2007 censuses. The UN joint scores were compared across the data from the four censuses.

The sex ratio is defined as the number of males per 100 females. This ratio is a common measure utilised in the study to evaluate age-sex data by observing in a graphical manner how the population size deviates from 100 at each age. The changes in the age distribution of the population are accounted for through the population dynamics of fertility, mortality and migration. The consistency of sex ratio was checked by comparing the sex ratio in a later census to the one it was (or the corresponding one) in the prior census. In general, when the sex ratio is above 100, it signifies more males than females. In most populations, the sex ratio at birth (SRB) is above 100 and usually assumed a value of 105 or sometimes lower at 103 in African populations. The sex ratio (SR) at single age x is given as:

$$SR = 100 \times \frac{P_x^m}{P_x^f}$$

Where;

P_x^m and P_x^f refer to the male and female population at age x, respectively.

Moultrie et al. (2013) opined that in the age range 0 to about 45 years, a typical sex ratio for developing countries declines gradually with increasing age, with the exception of excess net migration, especially among young adults. A steep decline occurs at older ages when male mortality is in excess of females.

The age ratio was obtained as a ratio of the population in a particular age group to the average population of the two adjacent age groups. The age ratio (AR) is represented mathematically as:

$$AR = \frac{{}_5P_x}{0.5 \times \left({}_5P_{x-5} + {}_5P_{x+5}\right)} \times 100$$

Where;

${}_5P_x$ refers to the population at age x to $x+5$, and

${}_5P_{x-5}$ and ${}_5P_{x+5}$ represent the preceding and successive age groups of a population, respectively.

Similar to the sex ratio, the deviation from 100 signifies net age misreporting for each age group. This captures selective underenumeration, overenumeration or misclassification of age. A small kink of an upward bias in the age ratio is often overlooked since it is inherently produced by the omission of the central age in the denominator.

Internal consistency (meeting typical patterns of age and or sex distribution) and external consistency (comparison of data across censuses from the same country) checks were also done in appraisal of the data. For both the age and sex ratios, an age range from birth to older ages were assessed with the expectation that the oldest 49 year old woman who was counted for the 1976 census would be around 80 years in the 2007 census.

Whipple's index is utilised for single year age data to show the extent of heaping on certain ages, usually 0 or 5 in the age range 23 to 62. Whipple's index (W) is expressed as:

$$W = \frac{5\sum_{x=25,5}^{60} P_x}{\sum_{x=23}^{62} P_x} \times 100$$

Where;

$\sum_{x=23}^{62} P_x$ refers to summation of population in single year completed ages x from 23 to 62, and

$\sum_{x=25,5}^{60} P_x$ stands for the summation of population completed single year ages x in multiples of 5 from 25 to 60, that is, for ages with digits ending with 0 and 5.

For Whipple's index, the normal range of 100 to 500, with a value of 100, indicates no heaping and with 500, massive heaping. A value which is lower than 100 suggests heaping on certain ages other than 0 and 5. Between the extreme values of 100 and 500, the quality of data is graded on a scale of accurate, approximate and rough representation.

The 23-62 age range for the Whipple's index was altered to 23-52 to represent women in the reproductive lifespan for each census' data under the same linearity assumptions. The digits 0 and 5 in the numerator are distributed evenly or linearly over 5 year age intervals in the denominator, with the exception of ages lower than 23 and older ages greater than 62 (Shryock et al., 1976, Spoorenberg, 2007) or 52 as in the case of this study. A woman aged 49 probably would be able to respond to an age of 50 in a census due to 0 digit preference. Whipple's index is meant to measure the extent of digit preference for terminal digits 0 and 5. At any age other than 0 or 5, age heaping can be detected using Myers' blended index, which can be applied to an age range of 10-89 for 0 to 9 terminal digits.

A shorter age range for women aged 15-49 was taken into account for the study and hence a Whipple type version of Myers' index was considered since it uses the same principles as Myers' index. Spoorenberg (2007), following the work proposed in 1992 by Noumbissi in modifying Whipple's index to detect age heaping at age 0 and 5 separately, extended the index to each terminal digit, i, for 0 to 9, to obtain a 'digit-specific modified' Whipple's index (W_i). The algebraic expressions of W_i were applied for an age range of 21-52, representing women in the reproductive lifespan for each census. The modification to Spoorenberg's equations on W_i for each terminal digit is expressed as follows:

$$W_0 = \frac{5(P_{30} + P_{40} + P_{50})}{({}_5P_{28} + {}_5P_{38} + {}_5P_{48})}$$

$$W_1 = \frac{5(P_{31} + P_{41})}{({}_5P_{29} + {}_5P_{39})}$$

$$W_2 = \frac{5(P_{32} + P_{42})}{({}_5P_{30} + {}_5P_{40})}$$

$$W_3 = \frac{5(P_{23} + P_{33} + P_{43})}{({}_5P_{21} + {}_5P_{31} + {}_5P_{41})}$$

$$W_4 = \frac{5(P_{24} + P_{34} + P_{44})}{({}_5P_{22} + {}_5P_{32} + {}_5P_{42})}$$

$$W_5 = \frac{5(P_{25} + P_{35} + P_{45})}{({}_5P_{23} + {}_5P_{33} + {}_5P_{43})}$$

$$W_6 = \frac{5(P_{26} + P_{36} + P_{46})}{({}_5P_{24} + {}_5P_{34} + {}_5P_{44})}$$

$$W_7 = \frac{5(P_{27}+P_{37}+P_{47})}{({}_5P_{25}+{}_5P_{35}+{}_5P_{45})}$$

$$W_8 = \frac{5(P_{28}+P_{38}+P_{48})}{({}_5P_{26}+{}_5P_{36}+{}_5P_{46})}$$

$$W_9 = \frac{5(P_{29}+P_{39}+P_{49})}{({}_5P_{27}+{}_5P_{37}+{}_5P_{47})}$$

Where;

P_x is the population in single year completed ages x, and

${}_5P_x$ the population age range from x to $x+4$.

A positive (or negative) deviation above (or below) 1 for W_i reflects digit preference (or aversion) for that respective terminal digit. A value of W_i =1 implies no age heaping.

The modifications of W_i are noted by Spoorenberg as not suitable for assessing external consistency or temporal comparison. Therefore, a 'total modified' Whipple's index (W_{tot}) was proposed as an overall summary index of age reporting as follows:

$$W_{tot} = \sum_{x=0}^{9} |W_i - 1|$$

The summary index indicates no heaping if a value of 0 is obtained and a maximum value of 16 suggests massive heaping or poor quality of age reporting.

3.7.1.2 Quality of fertility data methods

Recent births and parity data on children ever born for women aged 15-49 provide the basis for establishing a number of standard fertility measures and evaluating fertility data in censuses or surveys. Experience from African data on recent births suggests that although they are frequently underreported, the emerging age pattern of fertility is usually fairly accurate (United Nations, 2004).

According to United Nations (1983), symptoms of omission for parity data are average parities that fail to increase rapidly enough as age increases. In specific cases, average parities for women aged 40-44 and 45-49 may actually fall below that for women aged 35-39, even when there is no reason to suppose that fertility has been increasing. Literature suggests the shortcomings in the completeness of reporting of parities may be achieved by using the P/F ratio method of the relational Gompertz model, adjusting underreporting for births upwards, after correcting for defective parities using the el-Badry technique (United Nations, 1983, United Nations, 2004, Moultrie et al., 2013). The el-Badry correction was employed to detect and correct for distorted parities. This was done in cases where proportion of parity in the 'not stated' category is over 2 per cent for all women in the reproductive lifespan.

The relational Gompertz model, due to its robustness and the most improved P/F method for preparing fertility estimates, was considered and utilised as an effective way of evaluating the extent of age and birth misreporting errors in census data as well as correcting or adjusting the fertility schedule, accounting for errors. The spreadsheet templates 'FE_Relational Gompertz' and 'FE_elBadry_0' (Moultrie et al., 2013), were used to adjust age-specific fertility rates and parities.

A typical pattern for age-specific fertility rates of recent births from census data is characterised by a right-skewed concave shape showing lowest fertility rates for older ages nearing end of childbearing, and lower fertility at the beginning of the reproductive lifespan for the youngest age group 15-19. In-between, a peak of childbearing is observed, especially prior to the age of 30.

Using the spreadsheet by Moultrie et al.(2013) for the relational Gompertz model, and the el-Badry method, the input of reported age-specific fertility rates and suitably corrected average parities, were used to generate a corrected fertility schedule which conforms to expected alpha (α) and beta (β) parameter ranges. The relational Gompertz models apply to the range $-0.3 < \alpha < 0.3$ and $0.8 < \beta < 1.25$. The α and β parameters measure age location and spread of fertility schedule, respectively.

The fitting of α and β were done in such a way that accurate reporting is observed when a corresponding set of F-value and P-value points match linearly on the same line. This also signifies a constant fertility when P/F ratio equals 1 (or is very close to unity in real data). Possible irregularities in data occur if the P/F value diverges from constant fertility. Alternatively, this implies a declining or increasing trend in fertility.

The consistency checks of fertility data with regard to age-sex distribution, average parities and age-specific fertility rate plausibility or expected fertility patterns, were employed to assess the quality of fertility data in census data.

3.7.2 Indirect techniques of fertility estimation

Indirect demographic estimation techniques usually complement direct demographic methods of estimating age-specific fertility rates and total fertility rates in LDCs. In Eswatini, there is limited use of indirect methods in deriving fertility estimates in census reports as prior mentioned. Therefore, the study invoked several indirect methods with multiple data sources (as highlighted in section 3.1) to avail a number of comparable fertility estimates (and therefore, meeting the first objective of the study).

The study sought to utilise i) P/F ratio based methods which include: the relational Gompertz model, and the Brass P/F ratio variants (Trussell, Arriaga, and Feeney), using census data and cohort-period fertility rates using DHS survey data, and ii) regression based or population structure (age-sex distribution) techniques including Rele's and the Gunasekaran and Palmore methods. The latter methods are quite useful but have been rarely applied for Southern Africa compared to the former, which are widely applied or published in deriving fertility estimates. The input data to these indirect methods were first verified as explained in the previous section, 3.7.1: distorted parities were corrected using the el-Badry method and age-specific fertility rates were adjusted from the P/F ratios with respective methods used.

The use of software or fertility programs aided in preparing fertility estimates for this study. The EASWESPOP fertility estimate program (East-West Center, 1992) constituting the P/F ratio method (Trussell variant), Rele's method, Gunasekaran and Palmore method, Palmore's method, own children method and the parity increment method, were used to prepare a number of fertility estimates for comparisons. Due to scarcity of data, only estimates at national level were prepared using published data as a means of re-examining the levels of fertility. The limitation of using reported published data along with the problems of incomplete or unavailable raw census data, rendered methods such as the own children method and Palmore method, unusable.

The parity increment method, which uses multiple (two) census data sources simultaneously, was not utilised in this study due to its variableness in data quality completeness. Moultrie and Dorrington (2008) caution that spurious trends in fertility estimates may result when fertility data differs significantly across two censuses. Therefore, potential bias and errors that occur in estimating total fertility rate may require calibration or smoothing to reduce measurement error using methods such as linear regression (Alkema et al., 2012).

Also because of limited (published) data, such uncertainty in the assessment using statistical regression techniques, could not be done for Eswatini censuses data. Regressions relationships, however, are also affected by data quality problems (Moultrie, 2010). For these reasons, multiple census methods were not deemed dependable and were not presented for this study. Thus, such methods of estimating fertility in the MortPak program (United Nations Population Division, 2013) and PASEX package (U. S. Bureau of the Census, 1997) such as the Arriaga two and three census methods (ARFE-2 and ARFE-3), were excluded.

The Trussell variant P/F ratio method is applied when fertility is assumed to have been constant in the recent past. Therefore, alternatives of this method accounting for changing (declining) fertility, were also applied to the four Eswatini censuses (1976, 1986, 1997, and 2007) in the study. These include the P/F ratio method (Arriaga variant) presented as 'FERTPF' in MortPak (Arriaga et al., 1994b, United Nations Population Division, 2013) and the Feeney variant (Feeney, 1998), allowing for a time trend in fertility to be generated. A template spreadsheet for this method was produced by Moultrie (2009a).

A refined type of the P/F ratio method, the relational Gompertz model, was invoked in the study. This robust method is best suited for medium to high fertility countries (Moultrie et al., 2013) such as Eswatini. The method is based on a combination of lifetime fertility (P) and current fertility

(F) data points chosen or fitted to determine the level and shape of fertility for estimating the total fertility rate.

In addition, fertility data can be corrected for the distortions in the fertility schedule and therefore, the method can be used to evaluate errors in age reporting and underreporting of births. A 'flexible' spreadsheet, 'FE_Relational Gompertz', designed by Moultrie et al. (2013), that requires expert knowledge (in eliminating distorted P-points and/ F-points in fitting a straight line), was used. For consistent checks, the Arriaga version of the relational Gompertz model 'REL-GMPZ' in the PASEX package, was also applied. This method type is based on 2 F-points and 2 P-points (or 3 F-points and 3 P-points) and is not as flexible as the Moultrie variant since erratic points are normally not eliminated, especially those that occur due to misreported parities by older women.

Besides using census data techniques, the cohort-period fertility rates (CPFRs) method suggested by Hobcraft et al. (1982), was applied using detailed (full) birth history data from the 2007 Eswatini Demographic Health Survey. This method also applies the P/F ratio procedure and was employed to obtain two estimates of fertility as well as evaluate the quality of data. Thus, the nature of fertility transition in Eswatini was assessed using several indirect measures and data sources.

These technical methods were carefully selected for the study, based on assessment of data quality (age-sex, parity and births), availability of data and assumptions of fertility in Eswatini. A comparison of the robustness and consistency of the methods in preparing fertility estimates, was done. It should be noted that demographic software has reduced computational errors but has not replaced the much needed skills of demographic knowledge, tact and skills in producing demographic estimates. Details on actual mechanical computational procedures of the employed methods in deriving fertility estimates, are dealt with in many publications (Arriaga et al., 1994a, Moultrie et al., 2013, United Nations, 1983) and applied in this study (Chemhaka et al., 2016a).

Formal demographic methods, however, tend to analyse aggregate fertility behaviour and therefore, are limited in control for other possible influential variables in fertility as is the case with multivariate regressions. Multilevel regressions become appropriate to explain the synergistic relationship between micro- and macro-level variables in this study.

3.7.3 Proximate fertility determinants estimation

The second objective of the study was to assess the impact of proximate determinants (PDs) of fertility on fertility level as initially proposed by Bongaarts (1978), using a simple model, hereafter referred to as the original Bongaarts model (OBM). The OBM has been modified and the alternative model widely accepted has been the revision by Stover (1998), which the study refers to with the abbreviation (RJS). Recently, Bongaarts (2015) revised the original PDs framework to improve its measurement precision. The newly revised Bongaarts model (RJB), RJS implementation and improvements to the OBM proximate fertility determinants framework, are discussed in the subsequent sections. The derived indices and estimates are displayed in Appendix G.

3.7.3.1 The original Bongaarts model (OBM)

The Bongaarts framework explains why fertility cannot reach its potential full maximum through the four principal proximate factors namely; contraception, marriage, induced abortion and postpartum infecundability (Bongaarts et al., 1984). These combined factors are used to determine the proximate factors which have a significant effect on total fertility rate (*TFR*) and explain 96 per cent of the variation in fertility levels (Bongaarts, 1982). The Bongaarts model (Bongaarts, 1982, Bongaarts, 1978) expresses *TFR* as a multiplicative function of proximate variables as follows:

$$TFR = C_m \times C_c \times C_a \times C_i \times TF$$

Where;

TF = total fecundity rate (natural reproductive capacity of women),

C_m = index of proportion married or in union,

C_c =index of contraception use and effectiveness,

C_a =index of abortion,

C_i =the index of postpartum infecundability (due to amenorrhea or abstinence).

The indices' values range between 0 and 1. A zero represents the fact that the determinant is completely effective in inhibiting or reducing fertility and a value of 1 indicates no influence on fertility. Since *TFR* values of women were known beforehand as calculated in Stata using the 'tfr2' method (Schoumaker, 2013), the *TF* values were computed by rearranging the OBM formula as given below:

$$TF = \frac{TFR}{C_m \times C_c \times C_a \times C_i}$$

The OBM value of *TF* is assumed to be 15.3 births per woman since it differs marginally across all populations (Bongaarts, 1978). This model assumption of average total fecundity rate understated the *TFR* values for the model. Therefore, the average *TF* value (TF_{ave}) of 20.94, ignoring abortion as implemented by Bongaarts (2015), was adopted for the study which derived high values of TF (see Table G3 Appendix G). The average *TF* of 20.94 matches the value of 21 revised and estimated by Stover (1998) for potential fertility. Thus, the predicted or model estimate of total fertility rate, TFR_e, (Bongaarts, 2015) is expressed as:

$$TFR_e = C_m \times C_c \times C_i \times TF_{ave}$$

Estimation of the indices

There are various ways of estimating the indices of the PDs framework. They are commonly computed directed from the parameters of the PDs. The estimation of the impact of each variable index in the equation of TFR on fertility level for the OBM was computed as follows:

Index of marriage or sexual union: C_m

The risk of conceiving for women occurs in marriage or sexual unions and thus timing or duration in unions is a function of proportion of women who are sexually exposed and their age pattern:

$$C_m = \frac{\sum f(a)}{\sum \frac{f(a)}{m(a)}}$$

Where;

$m(a)$ = the proportion of currently married or in consensual union for females at each age a, and

$f(a)$ = the age-specific fertility rates as observed in the data.

For the age group 15-19, the value of the age-specific marital fertility rate, $g(a) = f(a)/m(a)$ is computed as $0.75 \times g(20-24)$, since the estimate $g(15-19) = f(15-19)/m(15-19)$ computed directly tends to be unstable or unreliable (Bongaarts, 1982).

The intended use of this index was to measure sexual exposure, but due to limited data, the variable was restricted for marriage/cohabitation. The estimation of C_m can be improved, as originally intended, with improvements in data collection on sexual exposure (Stover, 1998).

In Eswatini, conception often precedes marriage - a rather fluid concept defined as customary, civil or as a non-single event. Early sexual activity before marriage is high (CSO, 2008) and is not atypical in the society as this proves women's fertility. Fertility is meant to decline when a significant proportion of women do not marry (due to celibacy) or are not sexually active in their entire childbearing years (Stover, 1998). Alternatively, equation C_m above is expressed simply as:

$$C_m = TFR/TMFR$$

Where the observed *TFR* is based on all women aged 15-49 and births occurring three years preceding the survey and *TMFR* is the total marital fertility rate for women of childbearing ages. The term marital simply refers to women married or in union/cohabiting.

Index of contraceptive use: C_c

This index is a function of prevalence of contraception use and the effectiveness of methods used.

$$C_c = 1 - 1.08 \times u \times e$$

Where;

u = the proportion of currently married or in union women using contraception,

1.08= the correction factor for sterility, meant to exclude sterile/infecund women who normally do not use contraception, and

e = the average use-effectiveness of contraception.

The average use-effectiveness of contraception by method is expressed as:

$$e = \frac{\sum u_m e_m}{\sum u_m} \equiv \frac{\sum u_m e_m}{u}$$

Where;

u_m =proportion of currently married/in union women using contraceptive method m , and

e_m = average use-effectiveness of contraceptive method m .

The use effectiveness rates applied are taken from Trussell (2011a) as follows: female and male sterilisation (0.99), pill (0.91), intrauterine device (0.99), injectables (0.94), implants (0.99), male condom (0.82), female condom (0.79), rhythm/periodic abstinence (0.76), withdrawal (0.78) and others(0.412), lactational amenorrhea (LAM) and folk method (Liu et al., 2008).

Index of postpartum infecundability: C_i

The index represents the ratio of average birth interval when postpartum abstinence and lactational amenorrhea are not practised to average birth interval in the presence of postpartum abstinence and lactational amenorrhea. In the absence of postpartum abstinence and lactation, the average of 20 months is estimated as a sum of four components: 1.5 months infecundable period after birth, 7.5 months waiting time to conception, 2 months added due to spontaneous intrauterine mortality and 9 months full term gestation (Bongaarts, 1978). The index is estimated as:

$$C_i = \frac{20}{18.5 + i}$$

Where i is the average number of months of postpartum infecundability (due to postpartum amenorrhea or abstinence, whichever is longer). In this study, i was estimated as the median duration of postpartum infecundability compiled from StatCompiler for Eswatini 2006-07 DHS data (STATcompiler, 2015).

Index of induced abortion: C_a

The index of abortion can be estimated, first as a residual by rearranging the equation of TFR as given below:

$$C_a = \frac{TFR}{TF \times C_m \times C_c \times C_i}$$

Second, the index is computed as preferred and applied in this study as follows:

$$C_a = \frac{TFR}{TFR + b \times TAR}$$

Where;

$b = 0.4 \times (1 + u)$, representing averted births per induced abortion and

TAR =total abortion rate.

Data on abortion rates are incomplete and difficult to get and therefore, Johnston and Westoff (2010) developed a regression model for computing *TAR* as expressed below:

$$TAR = 3.63 - 0.33(MOD) + 0.009(TRAD) - 0.333(TFR)$$

Where MOD and $TRAD$ are the percentages of currently married/in union women using a modern contraceptive and traditional contraceptive, respectively. The TAR can be expressed as a rate per 1000 women which is an average abortion rate (*AR*) computed as (Johnston and Westoff, 2010):

$$AR = 1000 \times TAR/35$$

TAR is divided by 35 (an estimate average value of the reproductive years per woman). Abortion rates are scarce for Eswatini and the current study fills that gap by indirectly estimating those estimates using the proximate determinants modelling approach.

3.7.3.2 The revisions of the Bongaarts model

This section looks at the improvements to the OBM framework using the widely accepted Stover (1998) model – RJS, and the recent update of the OBM (Bongaarts, 2015) denoted RJB. A tabulation of formulae of the three models is shown in Table G1 in Appendix G.

Stover's revision model (RJS)

Due to improved questioning techniques in data collection, the aggregate of the original Bongaarts model has been improved in quantifying the proximate determinants by Stover (1998). The major modifications suggested (Stover, 1998: 255) are;

1) the use of sexual activity rather than marriage to indicate exposure to pregnancy;
2) a revision of the sterility index to measure infecundity due to all causes;
3) a revised index of contraception that accounts for the fact that users of sterilisation may become infecund before age 49; and
4) a revised definition and estimate of total fecundity.

The multiplicative aggregate model is expressed as follows:

$$TFR = C_x \times C_i \times C_a \times C_u \times C_f \times PF$$

Where;

PF =potential fertility,

C_x = index of proportion of women sexually active in the reproductive lifespan,

C_i = index of postpartum infecundability,

C_a = index of induced abortion,

C_u = index of contraception use and effectiveness, and

C_f = index of infecundity.

Also, the indices range between 0 and 1. An index value of the proximate determinant close to zero (one) indicates more (less) influence on fertility (Stover, 1998). Again, since actual fertility (*TFR*) is known beforehand, *PF* can be estimated by rearranging Stover's aggregate proximate determinants model.

$$PF = \frac{TFR}{C_x \times C_i \times C_a \times C_u \times C_f}$$

The Stover model assumption average value for potential *PF* is estimated at 21. Therefore with this value the predicted fertility, TFR_e, from the revised Stover model, denoted as RJS, is expressed as follows:

$$TFR_e = C_x \times C_i \times C_a \times C_u \times C_f \times PF_{ave}$$

Revised Bongaarts Model (RJB)

Bongaarts revised his original model (Bongaarts, 1978, Bongaarts, 1982) recently (Bongaarts, 2015) in line with revisions by Stover's revisions (Stover, 1998). In recent revisions, countries with two or three DHS were used and an interpolation procedure was used to compute average values. The interpolation procedure was not applied in this study since there is only one DHS which has been conducted in the country. The average value of *TF* of 15.4, however, for the countries used by Bongaarts (2015), was applied for the study. The revised aggregate Bongaarts model (RJB) with asterisks (*) for revised measures or indices of proximate determinants analysis on fertility, is given as:

$$TFR = \sum C_m^*(a) \times C_c^*(a) \times C_i^*(a) \times C_a^*(a) \times f_f^*(a)$$

$$TFR = C_m^* \times C_c^* \times C_i^* \times C_a^* \times TF^*$$

Where;

TF^* = revised total fecundity rate,

$f_f^*(a)$ =revised fecundity rate at age (*a*).

The revisions of the estimation of the indices of the proximate determinants framework by Stover (1998) and Bongaarts (2015) are elaborated on in the subsequent subsections. Bongaarts (2015) has succinctly summarised the three PDs model framework-OBM, RJS and RJS. From this recent study, the comparisons of the two revisions of the OBM are mostly derived.

Sexual activity index, C_x -RJS

According to Stover (1998), using sexual activity to define the index rather than marriage will increase the index to the extent that some unmarried women are sexually active and will decrease it to the extent that some married women are not sexually active (Stover, 1998: 256). To differentiate the index from the index of marriage (C_m) of OBM, the index of sexual activity is denoted as C_x in the RJS framework. The index of sexual activity is expressed by Stover (1998) as follows:

$$C_x = s$$

Where;

s = the proportion of sexually active among all women aged 15-49.

According to Bongaarts (2015: 542), the implementation of these revisions differs slightly. [R]JS calculates the sexual activity index from the proportion of all women who have had sex in the last month or are pregnant or abstaining postpartum, but excludes married women who don't meet these criteria. In contrast, [R]JB assumes that all women who are married or in a union are exposed to the risk of pregnancy, and includes all women (regardless of their marital status), who have had sex in the last month, are pregnant, are abstaining postpartum or are contraceptive users. As hereby defined above, the RJB expresses the index as follows:

Index of marriage/union/sexual exposure, C_m^* -RJB

$$C_m^* = \sum C_m^*(a) \times w_m(a)$$

$$w_m(a) = \frac{f_m^*(a)}{\sum f_m^*(a)}$$

$$f_m^*(a) = C_c^*(a) \times C_i^*(a) \times C_a^*(a) \times f_f^*(a)$$

Where;

$f_m^*(a)$ =fertility rate among sexually exposed women,

$w_m(a)$ =weighted age-specific fertility rates.

Postpartum infecundability index: C_i -RJS

No adjustments were required for this model, which is expressed by Stover (1998) as:

$$C_i = \frac{20}{18.5 + i}$$

Where;

i = the median number of months of postpartum infecundability.

[R]JS and [R]JB [models] are in agreement, except that the latter takes into account the average 27-month delay between a change in postpartum infecundability and its impact on fertility (Bongaarts, 2015: 543).

Index of postpartum infecundability, C_m^* -RJB

No revisions were required for the index for the postpartum index except for the inherent model adjustments (Bongaarts, 2015). The index is given as:

$$C_i^* = \sum C_i^*(a) \times w_i(a) \approx C_i$$

No interpolation or weighting was applied for the study which uses one survey dataset whereas in the Bongaarts (2015) study, two or three datasets were used for weighting and hence C_i^* was approximated to C_i which is also applied in the same study.

Contraceptive prevalence index, C_u -RJS

Stover (1998) notes there could be a considerable proportion of women who are infecund (e.g. due to sterilisation), as well as the overlap of postpartum amenorrhoea (breastfeeding) with contraceptive use who should be excluded in determining the fertility suppressive effect of contraception. The index of contraception, therefore, is represented as follows:

$$C_u = 1 - u \times e$$

Where;

u = the contraceptive use prevalence rate among sexually active women that does not overlap with experiencing postpartum amenorrhea, and

e = the average use-effectiveness of contraception.

According to Bongaarts (2015: 542), the two sets of revisions [RJS and RJB] agree on the need to address the overlap between postpartum amenorrhea and contraceptive use, but the implementation of these revisions also differs slightly. [R]JS excludes overlap between contraceptive use and postpartum amenorrhea. [R]JB excludes overlap between contraceptive use and postpartum infecundability, which may be due to either breastfeeding or abstinence. The formulae for the revision of the index of contraception by Bongaarts (2015) are given below.

Index of contraception, C_c^* -RJB

$$C_c^* = \sum C_c^*(a) \times w_c(a)$$

$$w_c(a) = \frac{f_n^*(a)}{\sum f_n^*(a)} \approx \frac{f_f^*(a)}{\sum f_f^*(a)}$$

$$f_n(a) = C_i^*(a) \times C_a^*(a) \times f_f^*(a)$$

Where;

$f_n^*(a)$ =naturally exposed fertility.

The aggregate formula of the contraception index is further expanded by Bongaarts (2015) as follows:

$$C_c^*(a) = 1 - r^*(a)[u^*(a) - o(a)]e^*(a)$$

Where;

$u^*(a)$ =contraceptive prevalence for sexually exposed women,

$o(a)$ =overlap with postpartum infecundability,

$e^*(a)$ =average contraceptive effectiveness, and

$r^*(a)$ =fecundity adjustment.

The estimates of the fecundity adjustment factor $r^*(a)$ and $\bar{f}_f(a)$ which represent the average of fecundity rates $f_n^*(a)$ estimated for a number of countries are displayed in Table 3.3.

Table 3.3: Fecundity rate and fecundity adjustment factor by age group

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
$\bar{f}_f(a)$	678.5	631.0	587.6	514.2	379.9	191.6	59.8
$r^*(a)$	0.62	0.81	0.99	1.08	1.14	1.26	1.62

Source: Bongaarts (2015)

The implementation of the RJB formulae to calculate the index of contraception is shown in Appendix G, Table G10.

Induced abortion index, C_a -RJS

As noted above, [R]JS proposes a slight revision to the original equation for *Ca* to take into account contraceptive effectiveness (Bongaarts, 2015: 542). The index of contraception is expressed as:

$$C_a = \frac{TFR}{TFR + b \times TAR}$$

$$b = 0.4 \times (1 + u \times e)$$

$$TAR = 3.63 - 0.33(MOD) + 0.009(TRAD) - 0.333(TFR)$$

Where;

MOD=modern method contraceptive prevalence among all women age 15-49 and who are sexually active,

TRAD= traditional method contraceptive prevalence among all women age 15-49 and who are sexually active,

b =the averted births per induced abortion, and

TAR = the total abortion rate.

Index of abortion: C_a -RJB

In contrast, the [R]JB revision of *Ca* relies on the analysis of the impact of abortion by Bongaarts and Westoff (2000), which was published after Stover published his revisions in 1998 (Bongaarts, 2015: 542). The index is given as:

$$C_a^* = \sum C_a^*(a) \times w_a(a) \approx \frac{TFR}{TFR + b^* \times TAR}$$

$$b^* = \frac{14}{18.5 + i(a)}$$

Where;

14= average reproductive time associated with an abortion,

$18.5 + i(a)$ =average reproductive time associated with a live birth, and

$i(a)$ = average postpartum infecundability interval (Bongaarts, 2015: 557).

In this study, the TAR was computed using the method of Johnston and Westoff (2010) as shown in the previous section, 3.7.3.1. This procedure, based on a regression approach, is simple to implement and requires fewer (three) parameters than the one used by Bongaarts and Westoff (2000) which takes into account seven factors. The computation of TAR is sensitive to the variations in the direct measures such as contraceptive prevalence rate and TFR (Bongaarts and Westoff, 2000).

It should, however, be noted that estimates of TAR in Bongaarts (2015) paper were computed using the formula $TAR = 30 \times AR/1000$ where abortion rates (AR) were assumed for world sub-region estimates by Sedgh et al., (2012). For Southern Africa, where Eswatini is located, the authors estimated an abortion rate of 15 abortions per 1000 women for 2008. Adopting the regression approach by Johnston and Westoff (2010), the study estimated AR as 18.9 in 2007 for Eswatini (see Table G11, Appendix G) which was in close agreement to that found by Sedgh et al. (2012). Further, to compute abortion rates by selected background factors and allowing variation, the method by Johnston and Westoff (2010) was used for the study.

Infertility/infecundity index: C_f -RJS

[R]JS introduces a revised index of sterility C_f which is calculated as 1.0 minus the proportion of sexually active women estimated to be infecund. A woman is considered infecund at the time of a survey if she is not menopausal, postpartum amenorrheic, or pregnant; has not given birth in the last five years; has not used a contraceptive and has been in a union during that period. Women who declare themselves to be infecund are also included. This is the approach used by the DHS (Bongaarts, 2015: 543). The index is given as:

$$C_f = 1 - f$$

Where;

f = proportion of infecund among sexually active women aged 15-49.

In contrast, [R]JB does not discuss the sterility index because there appears to be no need for it in contemporary populations. ...Beginning in the 1990s, however, the role of sterility variations appears to have become small enough to be ignored. This conclusion is based on the lack of variation in the proportion of childlessness reported by women aged 40-49 in recent DHS surveys. (Bongaarts, 2015: 543).

3.7.3.3 Decomposition of proximate determinants

The total fertility reducing effect of each proximate variable is obtained as a ratio of the natural logarithm of each index to the total sum of the natural logarithm of all indices. This prioritises or ranks the fertility inhibiting effect of proximate variables in rank order of importance. For the Bongaarts model, as an example, the fertility reducing impact of contraception is expressed as follows (Odimegwu and Zerai, 1996):

$$\frac{100 \times \ln(C_c)}{\ln(C_m) + \ln(C_c) + \ln(C_a) + \ln(C_i)}$$

The rest of the factors are similarly prorated to measure their fertility inhibiting effects. The relative contribution of each proximate factor to the level of fertility for the Stover model, RJS, was done in a similar way for the five indices.

3.7.4 Statistical analyses

Stata 14 (StataCorp, 2015b) was used for statistical analyses at three levels: univariate, bivariate and multivariate levels. The statistical methods employed at these three levels are described in the subsequent sections.

3.7.4.1 Descriptive analyses

Univariate and bivariate descriptive statistics (frequencies, percentages, means, medians, standard deviations, and confidence intervals), were conducted to describe the characteristics (individual and community factors) of the respondents. For bivariate analyses, differences in proportions or percentages of respondent characteristic effects on fertility behaviour (contraceptive use or children ever born), were assessed by chi-square analysis using cross tabulations, bivariate logistic regression (contraceptive use) and bivariate Poisson regression (children ever born). The odds ratios for logistic model and incidence rate ratios for the Poisson model were computed to estimate each of the associations between the independent variable and the fertility behaviour outcome.

Prior to performing regression analysis, a test of multicollinearity among independent variables was done using a correlation matrix. A correlation coefficient above 0.6 was considered high (as highlighted in Table E1 of Appendix E) and a collinear variable removed after a further test on the model using variance inflation factors, are explained later. To reduce multicollinearity of community (level-2) variables, indices were constructed, combining separate variables, to obtain reliability coefficients using Cronbach alpha, also known as the kappa reliability coefficient consistent with past studies (Balk, 1994). Hence, all level-2 factors were retained.

All analyses were weighted to cater for the multistage sampling design (or correct sample design or oversampling) and non-response. All reported *p*-values are two-sided and *p*-values <0.05 are considered significant in the bivariate relationships as well as in the multivariate analyses considered next.

3.7.4.2 Multilevel statistical modelling approach

In order to examine the separate and combined effects of independent variables (demographic, cultural, environmental, biological and socioeconomic factors) on fertility behaviour outcomes (contraceptive use and total children ever born), a multivariate multilevel (or random effects) regression approach was adopted as shown in Table 3.4. To explain variation in fertility behaviour, random intercept models (intercepts of independent variables varying by community), were fitted, inclusion of random slopes did not improve the good of fit on models and there was no justification in using a complicated modeling strategy. According to Overmars and Verburg in 2006 cited by Amara (2015), it may be possible that random effects may not be precisely estimated at higher level.

Since a broad range of independent variables was required, the approach used in this study following Colleran and Mace (2015: 4), was to understand the multilevel predictors of different outcome parametrisations, rather than finding the most parsimonious variables to explain each fertility behaviour outcome. A two-level multilevel analysis was employed: individual women aged 15-49 at level-1 nested within clusters (or communities) and at level-2.

Table 3.4: Dependent variables and multilevel estimation technique for fertility behaviour outcomes

Dependent variable	Type of dependent variable	Multilevel method estimation/*Stata command*	Study objective
Contraceptive use	Binary (0, 1)	Logistic-*melogit*	Objective (ii, iv)
Children ever born	Discrete (0, 1… 16.)	Poisson-*mepoisson*	Objective (iii, iv)

As a recap, multilevel models take into account factors that affect a woman's fertility behaviour beyond individual characteristics. These factors are considered as aggregate (that is, group, community or contextual) behaviour that sanction a woman's individual fertility in any specific context or ecological sphere. For DHS surveys, community data are not collected, hence community-level variables were derived by calculating proportions or a mean of the individual characteristics aggregated at the cluster (primary sampling unit) level, except for a few cases of woman's residence status variables.

The primary sampling unit (PSU) represents the women's community. Also, considering the hierarchical data structure of DHS surveys (women nested in clusters), multilevel (random intercepts) models were considered indispensable for analysing contextual influences on fertility behaviour for nested variables since there are many clusters. In addition, the within and between cluster/community variance can be estimated (Diez-Roux, 2002, Hank, 2002).

To determine the variation in fertility behaviour due to differences at community-level, and in characteristics for individual women, multilevel regression techniques were applied to the 2007 Eswatini DHS data. The employed random intercept approach allows the intercept of an outcome to vary randomly by cluster/community (Kaggwa et al., 2008). The multilevel analytical procedure conducted in the study, is explained hereinafter.

The multilevel analytical strategy

The multilevel step-approach adopted for the study follows Boco (2010), Wang et al. (2013) and Merlo et al.'s (2016) analytical strategies of first fitting a standard multivariate regression model and then multilevel (random intercept) models in a sequential manner. Four steps of multilevel models were fitted to describe the fixed part of the model in a comprehensive manner as exemplified in certain studies (Ejembi et al., 2015, Ngome and Odimegwu, 2014, McNay et al., 2003). Hence, a five-step analytical approach for logistic, Poisson and negative binomial regression models was employed in the study and is summarised as follows:

- First, a conventional or standard single-level multivariate model was fitted (Model 1);
  - **Model 1**: The individual effects model for the standard single-level logistic, Poisson and negative binomial multivariate regressions for individual-level independent variables, were fitted. Only individual-level variables were included.

Multilevel (or two-level random intercept) regression models with two-level (individual, community) random intercepts, were now considered. The models assume fixed effects of the independent variables do not vary in clusters, save for the random effects.

- Second, a null/empty model was considered (Model 2);
  - **Model 2**: This model has no independent variables and decomposes total variance into two individual and community parts. This examines whether there is a significant variation between communities in the number of children ever born or use of contraceptives.
- Third, a model with only individual-level (level-1 variables) was added (Model 3);
  - **Model 3**: The individual-level independent variables are the same with Model 1, but the model is converted from a standard single-level multivariate regression to a multilevel regression model. The community-level factors are completely ignored.
- Fourth, a model with level-2 (community-level) variables was considered, excluding the level-1 factors (Model 4);
  - **Model 4**: This model considered the separate effect of community-level variables on fertility behaviour, independent of individual-level factors.

- Fifth, the full model included all individual-level and community-level variables considered in the study (Model 5);
    - **Model 5**: This model examined the combined effects of individual-level variables and community-level variables with the dimensions of area disadvantage (urban-rural residence and region of residence), socioeconomic disadvantage (social position and media exposure), women's autonomy or empowerment and fertility norms or (ideal number of children and polygyny).

The assessment of the community effect controlling for level-1 variables can be done separately for each of the three dimensions of community variables and the final model includes all the level-1 and level-2 variables. This did not yield different results from the full model where all community sphere variables were added simultaneously. Therefore, the results of the full model were presented in the study.

The fertility behaviour outcomes incorporating this multilevel framework were modelled in a two-stage Easterlin framework (Easterlin and Crimmins, 1985) type, whereby the effects on current contraceptive use were estimated first, then those on children ever born were estimated at the second stage as follows:

Stage 1 of Easterlin's model

Modelling the determinants of use of fertility control/contraception was done using a logistic regression model since the outcome is binary with categories 0 and 1 for nonuser and users of contraceptives currently, respectively.

Model fit and specification: Contraceptive use

Single-level logistic regression

Let $y_i = 1$ if woman i is using a contraceptive and $y_i = 0$ otherwise, $x_i = (1, x_{i1}, x_{i2}, ..., x_{ip})'$ a vector of individual characteristics of woman i and the link function is logit. Then the single-level logistic model used for analysis of contraceptive use/non-use is represented as follows:

$$E(y_i \mid x_i) = \Pr(y_i = 1 \mid x_i) = \pi_i \,;$$

$$\operatorname{logit}(\pi_i) = \ln\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_p x_{ip} = \beta_0 + \beta_i x_i \,;$$

$$\operatorname{Odds}(y_i = 1 \mid x_i) = \exp(\beta_0 + \beta_i x_i) \equiv \frac{\exp(\beta_0 + \beta_i x_i)}{1 + \exp(\beta_0 + \beta_i x_i)} \,;$$

Where;

π_i = proportion of women who are currently using a contraceptive method,

β_0 =intercept coefficient,

β_i =the coefficient of individual explanatory factor x_i ,

$\exp(\beta_0)$=odds of getting a response of 1 when x_i =0, and

$\exp(\beta_i)$=odds ratio (OR) computed 'considering a 1-unit change in x_i from some value a to $a+1$'. For example, '$\exp(\beta_2)$ is interpreted as the odds ratio comparing $x_{i2} = a+1$ with $x_{i2} = a$ for given x_{i3} (controlling for x_{i3})' (Rabe-Hesketh and Skrondal, 2012: 503-504).

Two-level random intercept logistic model

A multilevel (random intercept) logistic regression to estimate the impact of individual (level-1) and community (level-2) factors on contraceptive use, was considered. The model with p level-1 covariates and q level-2 covariates employed is given as:

Let y_{ij} = contraceptive use for woman i in community j , $x_{1ij} = (x_{1ij1}, x_{1ij2}, \ldots, x_{1ijp})'$ denotes an array of individual-level characteristics of woman i in community j , $x_{2j} = (x_{2j1}, x_{2j2}, \ldots, x_{2jq})'$ a vector with community-level characteristics for community j . Then the random intercept logistic regression model is of the form (Rabe-Hesketh and Skrondal, 2012, Grilli and Rampichini, 2006, Hank, 2002):

$$\operatorname{logit}(\Pr(y_{ij} = 1 \mid \mathbf{x}_{\mathrm{ij}}, \zeta_j)) = \operatorname{logit}\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2j} + \zeta_j$$

In reduced form the equation is given as follows:

$$\pi_{ij} = \Pr\left(y_{ij} \mid \mathbf{x}_{ij}, \zeta_j\right), \ \text{logit}\left(\pi_{ij}\right) = \beta_0 + \beta_i \mathbf{x}_{ij} + \zeta_j$$

and

$$y_{ij} \mid \pi_{ij} \sim Binomial\left(1, \pi_{ij}\right),$$

$$\zeta_j \sim \text{Normal}(0, \psi), \text{ shortened as } \zeta_j \sim \text{N}(0, \psi)$$

Where;

π_{ij} = proportion of women who are currently using a contraceptive method,

The subscript $j = 1, \ldots, M$ clusters (level 2 units), with cluster i consisting of $i = 1, \ldots, n_j$ observations (level 1 units) for individual women,

ζ_j = the community-level error term (random intercept) with mean 0 and variance ψ,

β_0 = the intercept,

β = the vector of regression fixed coefficients ($\beta_1, \beta_2, \ldots \beta_q$) of the individual- and community-level factors, and

$\mathbf{x}_{ij} = \left(x_{1ij}, x_{2j}\right)'$ is a vector of fixed effects consisting of both individual-level and community-level variables/covariates.

Stage 2 of Easterlin's model

In the Easterlin framework, contraception, together with other proximate determinants, influences lifetime fertility measured as children ever born (CEB). This second endogenous variable is also influenced by background (individual and community) variables including the demand, supply and regulation costs factors (see Figure 2.1). Whilst Easterlin and Crimmins (1985) employed an ordinary least squares regression (OLS) on modelling CEB, this study applied a random intercept Poisson regression method. Inferences based on conventional OLS have been shown to produce downward bias of the estimated standard errors which could be corrected when using multilevel models (Moeeni et al., 2014, Zhang et al., 2013).

Model fit and specification: Children ever born

Poisson regression modelling is used to assess associations and confounders between count variables. Assuming non-independence of the count variable, children ever born, single-level Poisson regression method was the basic model of choice used. This model is normally applied when there is no dispersion in the count data for CEB, that is when the mean is equal to the variance (Kazembe, 2009, Winkelmann and Zimmermann, 1994, Austin et al., 2017).

Single-level Poisson regression

The total number of children ever born per woman is assumed to follow a Poisson regression denoted as follows (Rabe-Hesketh and Skrondal, 2012, Moeeni et al., 2014, Winkelmann and Zimmermann, 1994);

$$\Pr(y = y_i \mid x_i) = \frac{e^{-u_i} u_i^{\,y_i}}{y_i!} \equiv \frac{\exp(-\mu_i) u_i^{\,y_i}}{y_i!}, \; y = 0, 1, 2, \ldots, 16$$

and

$$\ln(\mu_i) = \beta_0 + \beta_i x_i$$

$$u_i = E(y_i \mid x_i) = \exp(\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_{ip} x_{ip}) \equiv \exp(\beta_0 + \beta_i x_i)$$

Where;

μ_i =the expected number of children per woman i.

There was overdispersion for the dependent variable, CEB, using a single-level Poisson model and therefore, will give downward biased standard errors or overstated significance levels or small *p*-values (Winkelmann and Zimmermann, 1994, Poston and McKibben, 2003). That is, the variance of CEB was higher than the mean of CEB (6.14 >2.28). This overdispersion can be handled by a single-level negative binomial regression model in analysis. Considering the hierarchical structure of the DHS data, the study deemed it appropriate to apply the two-level random effects models (that is, the multilevel Poisson and multilevel negative binomial regression models) that account for overdispersion (Kazembe, 2009, Moeeni et al., 2014, Amara, 2015, Austin et al., 2017). The two-level random effects models were further tested for their appropriateness using the likelihood-ratio test as shall be explained later.

Two-level random intercept Poisson regression

Let y_{ij} =the number of children ever born to a woman i in cluster j, mean= μ_{ij}, and ζ_{1j} is the random effect for the cluster or community. Then the distribution for a two-level multilevel Poisson model is specified as follows (Rabe-Hesketh and Skrondal, 2012, Moeeni et al., 2014):

$$y_{ij} \sim Poisson(\mu_{ij}) \qquad \Pr(y_{ij} = y \mid \mathbf{x}_{\mathrm{ij}}, u_j) = \frac{e^{-u_{ij}} u_{ij}^{y}}{y!}, \; y_{\mathrm{ij}} = 0, 1, \ldots, 16$$

and

$$\ln(\mu_{ij}) = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2j} + \zeta_{1j}$$

$$\ln(\mu_{ij}) = \beta_0 + \beta_i \mathbf{x}_{ij} + \zeta_{1j}$$

The expectation is expressed as:

$$u_{ij} = E(y_{ij} \mid \mathbf{x}_{ij}, \zeta_{1j}) = \exp(\beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2j} + \zeta_{1j})$$

$$u_{ij} = \exp(\beta_0 + \beta_i \mathbf{x}_{ij} + \zeta_{1j})$$

The random effects distribution is given as:

$$\zeta_{1j} \mid \mathbf{x}_{ij} \sim \mathrm{N}(0, \psi_{11})$$

$$\mathrm{var}(\zeta_{1j} \mid \mathbf{x}_{ij}) = \psi_{11}$$

The exponent of β, $\exp(\beta)$, is called the incidence rate ratio (IRR) for the Poisson regression model. This captures the proportionate change in the mean number of children ever born for specific change in the explanatory variable, *ceteris paribus* (i.e. when all other categorical variables are held constant).

When the random intercept Poisson model cannot handle overdispersed count data, the random intercept negative binomial regression can also be fitted (Amara, 2015).

Multilevel negative binomial regression

The multilevel negative binomial model is similar to the multilevel Poisson model, but has a greater variance that allows for overdispersion as shown below. The multilevel negative binomial model is given as (Rabe-Hesketh and Skrondal, 2012, Amara, 2015):

$$\Pr\left(y_{ij} = y \mid \mathbf{x}_{\mathrm{ij}}, u_{ij}\right) = \frac{\Gamma\left(y+v\right)v^{v}u_{ij}^{y}}{y!\,\Gamma\left(v\right)\left(v+\mu_{ij}\right)^{v+y_{ij}}}\ ,\ y_{\mathrm{ij}} = 0, 1, \ldots, 16$$

$$\mu_{ij}^{M} \equiv E\left(y_{ij} \mid \mathbf{x}_{ij}, \zeta_{1j}^{(1)}\right) = \exp\left(\beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2j} + \zeta_{1j}^{(1)}\right)$$

$$\mathrm{var}\left(y_{ij} \mid \mathbf{x}_{\mathrm{ij}}\right) = \mu_{ij}^{M} + \left(\mu_{ij}^{M}\right)^{2}\alpha$$

$$\alpha = \exp\left(\psi^{(1)}\right) - 1$$

Thus, in the expanded form, the mean or marginal dispersion for a two-level random intercept negative binomial model is given as:

$$\mathrm{var}\left(y_{ij} \mid \mathbf{x}_{\mathrm{ij}}\right) = \left[1 + \left\{\exp\left(\psi^{(1)}\right)\left(1+\alpha\right) - 1\right\}E\left(y_{ij}\right)\right]E\left(y_{ij}\right)$$

Where;

$v = \alpha^{-1} = 1/\alpha$ is a shape parameter, α a scale parameter

The mean dispersion $\exp\left(\zeta_{1j}^{(1)}\right)$ follows a gamma distribution, $\Gamma\left(v\right)$, with mean=1 and variance= α , rather than a normal distribution as in the case of the Poisson model.

When α =0 then the dispersion equates to that of a two-level random intercept Poisson regression (StataCorp, 2015a), which allows for overdispersion (Rabe-Hesketh and Skrondal, 2012). The second scenario is when variance =0 then the dispersion of the two-level negative binomial regression equals that of the standard or single-level negative binomial regression (StataCorp, 2015a). For the present study, as argued in the previous section 2.4.1, multilevel models were considered for modelling micro-macro linkages of fertility behaviour using hierarchical DHS data. Further tests were made, however, comparing the standard and multilevel models using the likelihood-ratio test as illustrated later.

Fixed effects (measures of association)

The fixed estimates were measured by odds ratios (OR) with 95% confidence interval (CI) for the binary dependent variable, current contraceptive use. The incidence rate ratios (IRR), with their 95% CI were used for the count response outcome, total children ever born. The estimates for all five models (Model 1 to Model 5), were presented in tabular format.

Random effects (measures of variation)

The estimated between-community variance quantified the variability in unobserved influences on fertility behaviour of women living in the same cluster/community. Boco (2010: 11) explains the higher the estimated variance, the higher is the level of inequality between groups.

Also measures of random effects were assessed using the intra-cluster correlation coefficient (ICC), median odds ratio (MOR) for logistic regression (on contraceptive use) and median incidence rate ratio (MIRR) for count models (on CEB). These measures used to assess the heterogeneity between areas or communities, are explained in the following sections (Merlo et al., 2016, Rabe-Hesketh and Skrondal, 2012).

Intra-cluster correlation coefficient

The variances can be interpreted in terms of intra-class correlations in a latent variable, reflecting the unobserved factors (Boco, 2010: 10) shared in the same community among women. The intra-class/cluster correlation coefficient (ICC) used to measure the dependence among the binary responses (logistic regression) in the same cluster or the between cluster heterogeneity, is expressed as:

$$ICC = correlation\left(\zeta_{ij}, \zeta_{i'j}\right) = \frac{\psi}{\psi + 3.29}$$

The variance, ψ , controls the conditional within-cluster correlation. The proportion of the residual variability (unexplained by covariates) in the latent response (propensity to use contraceptives) explained by between-community variations/variance, is more relevant when the ICC is much higher (Merlo et al., 2016).

The median odds ratio (MOR) method was applied as an alternative way of interpreting the magnitude of the [community] variance (Merlo et al., 2016: 7) for binary response (contraceptive use). For count response (CEB), the equivalent median incidence rate ratio (MIRR) to MOR was used (Rabe-Hesketh and Skrondal, 2012).

Median odds ratio

Median odds ratio (MOR) for random intercept logistic regression is computed as:

$$MOR = \exp\left\{\sqrt{2\psi} \times \Phi^{-1}(0.75)\right\}$$

Where;

$\Phi^{-1}(0.75)$ = 0.6745 represents the 75th percentile of the cumulative distribution function of the standard normal distribution, with mean 0 and variance 1.

Therefore, the MOR equation can be reduced to the formula:

$$MOR = \exp\left\{\sqrt{2\psi} \times 0.6745\right\} \equiv \exp\left(0.95\sqrt{\psi}\right)$$

Median incidence rate ratio

Following the derivation of MOR for binary response, the same procedure can be applied for count model (random intercept Poisson/negative binomial regression) to compute the median incidence rate ratio (MIRR) given as:

$$MIRR = \exp\left\{\sqrt{2\psi_{11}} \times \Phi^{-1}(0.75)\right\} \equiv \exp\left\{\sqrt{2\psi_{11}} \times 0.6745\right\} \equiv \exp\left(0.95\sqrt{\psi_{11}}\right)$$

A MOR or MIRR close to 1 reflects little variation or differences between communities or clusters. The higher the MOR/MIRR, the greater is the between community variation (Aremu, 2013, Merlo et al., 2016). All the sequential multilevel models (Models 2-5), both for contraceptive use and children ever born, were found to have MOR and MIRR values, respectively significantly different from 1, suggesting that multilevel models were appropriate.

Model fit

The covariates selected for the study were further tested for multicollinearity in fitted models. To quantify collinearity between correlates, variance inflation factors (VIFs) were used in a fitted full model. The collinear variable was removed when the VIF was higher than 10 - reflecting severe multicollinearity (Uthman, 2010, Aremu, 2013). The results of Table E3 in Appendix E show that the study variables, both in binary and count models, were not collinear as reflected with VIFs less than 10.

The Wald test criterion was used to determine statistical significance of covariates, that is, the overall goodness fit of the model. The log likelihood was used to assess the improvements in fit. A lower value reflects a better fit (Elfstrom and Stephenson, 2012, Rabe-Hesketh and Skrondal, 2012, Smith, 2011, Uthman, 2010). The Wald test and likelihood-ratio test are equivalent to each other but may produce different conclusions in small samples (Rabe-Hesketh and Skrondal, 2012: 138). Therefore, the likelihood-ratio test was done using the 'lrtest' Stata command and was obtained from the last line of the output of the fitted model.

Likelihood-ratio test

The likelihood-ratio test (lrtest) compares the 'log likelihood' of two models and tests whether they are significantly different. Hence, the test was used to compare a fitted random intercept model to the fitted model without the random intercept using the following likelihood-ratio test statistic:

$$L = 2(l_1 - l_0)$$

Where;

l_1 = variance-components (empty multilevel) model (Model 2) maximised log likelihood,

l_0 = without random intercept model maximised log likelihood.

The null hypothesis is that there is no significant difference between the two models. The hypothesis for the likelihood-ratio test for Model 2 is expressed as:

Null hypothesis $H_0: \psi = 0$ there is no random intercept in the model (variance is equal to zero).

Alternative hypothesis $H_a: \psi > 0$ there is a random intercept in the model.

A *p*-value less than 0.05, $p<0.05$, was significant and it was considered that there is a statistically significant difference between the two models. The rejecting of the null hypothesis concluded that the random effects model provided a better fit (it has the lowest log likelihood). Otherwise, if the null hypothesis is true (not rejected), then the standard single-level regression can be used rather than the multilevel model.

The present study found that the likelihood-ratio test for the empty model (Model 2) for multilevel logistic, Poisson and negative binomial regressions, was statistically significant, further justifying the use of multilevel models instead of standard regression models. In a similar way, models 3 to 5 were compared to the standard regression model using the likelihood-ratio test. Comparing Model 3 (individual model) with Model 5 (full model) served to examine whether or not the added community variables were significant. Also the study on modelling children ever born considered multilevel negative binomial results by comparing them with those obtained from multilevel Poisson regression using the likelihood-ratio test and comparing the parameters obtained (see Appendix H). The multilevel Poisson regression was considered a better fit to data than the multilevel negative binomial model. For the latter, the likelihood-ratio test proved the parameter alpha was not different from zero (i.e. $\alpha=0$), implying there was no significant difference between the two count multilevel models.

3.8 Addressing research objectives

3.8.1 Addressing the first objective:

To estimate fertility levels using direct and indirect methods of fertility estimation.

To come up with credible fertility estimates, there is a need to utilise as many methods as possible to gain a clear overview of the demographic situation of Eswatini. Levels of fertility, and consequently trends and differentials, can be estimated for survey and census data using direct estimation. Direct estimation is often affected by underreporting of children ever born or births in the recent period prior to the survey or census. The indirect estimation method approach aids in validating the direct fertility estimates. Further, it has the advantage of evaluating errors in the data and correcting or adjusting for the underreporting of fertility to estimate reasonable and accurate fertility estimates.

In addition, indirect estimation often requires minimum data. Multiple data sources for several years indicated in section 3.3 were employed to check for consistency in the estimates and in evaluating the quality of data. Besides, several indirect estimation techniques highlighted in section 3.7.2 were employed. Accordingly, estimation was done using Excel spread sheets and East-West Center fertility programs. The East-West Center software gives a range of choice of five programs of estimating fertility.

3.8.2 Addressing the second objective:

To assess the impact of proximate fertility determinants (contraceptive use, postpartum infecundability, abortion and sexual activity) on level of fertility based on the Bongaarts model and its modifications.

This study investigates the role of various proximate determinants of fertility on fertility level in Eswatini by socio-economic context of women, using the Bongaarts framework and 2006-07 Eswatini Demographic and Health Survey data. To improve the model by examining women who are sexually active, rather than only married, adjustments to the Bongaarts were made based on the propositions by Stover (1998) and recent modifications of the original Bongaarts model (Bongaarts, 2015).

3.8.3 Addressing the third objective:

To examine the association between individual- and community-level factors and contraceptive use using a multilevel binary model.

The effects of individual and community determinants on contraceptive use were assessed using a five-step multilevel approach (see section 3.7.4). Before multilevel statistical modelling, cross tabulations were done between binary contraceptive use and each independent individual and community variable. In this bivariate analysis, a chi-square test was conducted to determine the association between the independent variable and contraceptive use. Second, multivariate analyses were done using logistic regression analysis at individual- and/or community-level. The odds ratios were employed as measures of associations (fixed effects).

3.8.4 Addressing the fourth objective:

To examine associations of individual- and community-level factors with lifetime fertility in Eswatini through the use of multilevel count models.

This objective is addressed as the third objective in the same manner using a five-step multilevel approach. Since the outcome of children ever born is a count variable, the mean parities for each individual and community variable were computed. Second, Poisson regression models were employed to examine the role of community-level and individual-level factors in influencing lifetime or cumulative fertility in Eswatini. The incidence rate ratios were employed as measures of associations.

3.8.5 Addressing the fifth objective:

To assess whether or not there was a significant community variation in contraceptive use or lifetime fertility in Eswatini using multilevel or random intercept regression methods.

To address this objective, special interest has been given to contextual influences on fertility behaviour. The bulk of the study comprises various multilevel regression models used for the fertility outcomes being measured in the second and third objectives (see Table 3.3 in section 3.7.4). To assess the extent to which communities explain variation in contraceptive use or lifetime fertility in Eswatini, measures of variations (random effects) were employed.

3.9 Ethical considerations

The study is derived from existing survey and census data collected by the Central Statistical Office- a statistical agency body in Eswatini. The CSO and allied partners follow national and international ethical procedures and protocols in collecting data on humans. The objectives of the surveys and censuses were explained to the study participants. Likewise, the assurance of anonymity of participants and confidentiality of their results, was guaranteed. Participation in the data collection process was voluntary and the information leading to the identification of individuals was removed.

3.10 Study limitations

The main source of data for the study is cross-sectional in nature and therefore, associated with a number of common challenges. First, cross-sectional data show temporal changes and are suited for showing relationships between fertility behaviour and various explanatory variables. The measures of association are subject to misinterpretation due to causality of the relationship being unknown; meaning whether or not contraceptive use (or number of children ever born) preceded the associated explanatory factors. Since time precedence or sequence of key events cannot be determined, analysis of cross-sectional data was limited to associations rather than causal relationships.

Second, cross-sectional data cannot adequately be used to assess change of demographic behaviour over time. The explanatory or independent variables are mostly current status variables measured at the time of the survey and are therefore not time-varying. Thus, lifecycle changes, such as dynamics of fertility outcomes and/or correlates might not be adequately captured in assessing fertility behaviour. For instance, by the time of the interview, most women would not have completed their fertility. The timing of a birth occurrence (in the last 12 months) might not match the 'current status' variables. For example, a women might report that she is currently residing in an urban area but could report on the birth of a child she had when residing in a rural area prior to migration.

Similarly, explanatory variables in fertility preferences or desires such as ideal number of children are also variable to change when individuals or couples modify their intentions. The assumption that women make rational fertility choices about the number of children in their lifetime, may be less perfect. Regarding contraceptive use, the study does not tell us whether the use of contraceptives is for stopping, postponing or spacing births or to prevent STIs, including HIV and AIDS.

Thirdly, the community contextual variables obtained by aggregating individual characteristics from DHS survey data may lead to false ecological inference or an aggregation bias problem - the bias is introduced when women with the same attributes are grouped into the same aggregate units.

According to Boco (2010), potential bias related to aggregated community variables hinges on multicollinearity and atomistic fallacy. First, it could result in multicollinearity, since the same variables used to derive the "contextual" variables are also included as individual variables. Second, the approach is subject to atomistic fallacy, or the problem of making inferences at a higher level based on data collected at a lower level (Boco, 2010: 57). While aggregation of micro units is theoretically and methodologically not wrong, caution should be exercised in making conclusions about the relationships at micro-level (Kravdal, 2006, Kuate-Defo, 2005).

Primary data collection from a community as a whole is thought to overcome some of these concerns. The Eswatini DHS survey did not collect integral community variables, but elsewhere these were collected in what was known as the special service availability module (Muhwava, 2002). Some studies (Entwisle, 2007, Kravdal, 2002) have combined DHS survey and census data where in the latter, integral variables could be extracted. This procedure was sought in this study by merging the 2007 DHS and 2007 census data using clusters or EAs/ PSUs by seeking permission from CSO.

However, matching the EAs in the DHS to those of the census, was not achieved. The PSUs are anonymous and cannot be identified or linked to the census data for ethical reasons. Nonetheless, aggregated data best approximates community data which is rarely collected for developing countries. The use of PSUs as proxies for communities has been widely adopted in literature.

Using census data, only existing published data was used in the study since raw data were either unavailable or incomplete. Although raw data could have achieved much more in-depth analysis, the available reported data in census reports was sufficient to derive and construct fertility estimates using indirect measures.

3.11 Summary of the chapter

The chapter looked at the methodology used in the study. In overview, the study setting, design, population, sampling procedure, variables and methods used, are described. A multiple methods approach using demographic and statistical applications to determine fertility behaviour is applied in the study. In reassessing fertility levels, direct methods and several indirect methods to check consistency are adopted for the study. Primarily due to the hierarchical structure of DHS survey data, multilevel statistical models are invoked for statistical modelling of fertility behaviour outcomes; lifetime/cumulative fertility and current contraceptive use. The former proxy actual fertility measured using total number of children ever born, while the latter determines the use of fertility control among sexual exposed or initiated women.

CHAPTER 4

CHARACTERISTICS OF THE RESPONDENTS

The chapter presents the profile of the respondents for the main survey data employed for the study. Univariate and bivariate analyses of the survey data findings are presented on the fertility behaviour outcomes of the study namely: a) contraceptive use and b) fertility-children ever born. This study makes a departure and improves analyses by estimating the effect of fertility behaviour on both the full sample (all women respondents) and the sub-sample (sexually exposed women). The tables presented in this chapter show the effect of magnitude, direction of relationship and statistical significance of the covariates, on fertility behaviour. The overview picture or overall pattern of the association between the covariates and fertility behaviour was sought in both samples. The difference of ± 5% or more in univariate analysis was considered substantial, showing large variation in the subcategory variables.

4.1 Characteristics of the study population

Background characteristics of respondents are presented at individual/compositional (micro) level (section 4.1.1) and cluster/community (macro) level (section 4.1.2).

4.1.1 Micro level characteristics

The sample characteristics of all respondents and the sexually initiated or exposed subsample of women are shown in Table 4.1 as per cent distribution of women and means with standard deviation. A tenth of the respondents were employed in agricultural or manual labour while one-third was employed in non-agricultural/manual labour (a quarter in sales and services, 8.2% in a professional occupation), and 56.4% were unemployed. A third of respondents were from poor households while 47.6% were well-off (22.3% richer and 25.3% richest). One-third of women had primary education and almost 3 in 5 had at least some secondary education. Slightly more than half (55.9%) of respondents had moderate to high exposure to media - 25.2% and 30.7%, respectively. A third of women had low autonomy/empowerment while two-thirds had moderate or higher empowerment (36.2% and 30.5%, respectively).

Table 4.1 further showed that almost 3 in 5 women (58.6%) preferred or had an ideal number of children, less than three, while one-third considered 3 to 4 children as an ideal number to have. Half of the women were never married. Among the married or in union women; one-third and 7.6% were monogamous and polygynous, respectively. The mean age of all respondents was 27.8 $\pm$ 9.8SD years; a quarter of the respondents were adolescents, and the percent distribution of women in the age range 15-49 decreased with age. Two-thirds of respondents had low parity (0-2 number of living children) while 15% had high parity (5 or more number of living children). About 4 out of 5 women had no child loss experience. Most of the women (44.1%) were of Apostolic or Zion religious affiliation. Almost 2 in 5 women were using a contraceptive method (Table 4.1).

Compared with all women respondents, 4 in 5 women who had ever had sexual intercourse were less likely to be unemployed (56.4% vs 49.3%) or to have never been married (39%). Similarly, sexually exposed or initiated women who were aged 15-19 years (12.9%) had low parity (60.2%). On the contrary, a higher proportion of sexually exposed women reported current use of contraception (46.1%) and were employed in non-agricultural/manual labour (38.2%). Meanwhile, the mean age at first birth was 18.7 $\pm$ 3.3SD years, while the mean age at sexual debut and first marriage were 17.1 $\pm$ 2.6SD and 21.1 $\pm$ 5.0SD years, respectively. Of the sexually initiated females, 85% had their first sexual intercourse as adolescents (aged 19 years or less), while two-thirds had their first birth as adolescents. Forty-five per cent had their first marriage as adolescents.

Table 4.1: Selected individual characteristics of women aged 15-49 by sexual activity, Eswatini, 2007

	All women		Sexually initiated	
Individual characteristics	%	N	%	N
Occupation		**4969**		**4105**
Not working	56.4	2749	49.3	1979
Agricultural or manual	10.6	536	12.5	522
Sales and services	24.7	1249	28.6	1186
Professional	8.2	435	9.6	418
Wealth		**4987**		**4112**
Poorest	15.7	778	16.1	651
Poorer	17.3	857	17.7	720
Middle	19.4	934	19.4	769
Richer	22.3	1059	21.5	846
Richest	25.3	1359	25.3	1126
Education		**4987**		**4112**
None	8.1	413	9.6	401
Primary	32.7	1636	32.9	1363
Secondary/higher	59.3	2938	57.6	2348
Exposure to media		**4987**		**4112**
Low	44.1	2218	44.8	1861
Moderate	25.2	1244	24.1	978
High	30.7	1525	31.1	1273
Women's empowerment		**4987**		**4112**
Low	33.3	1663	31.8	1304
Moderate	36.2	1795	37.2	1518
High	30.5	1529	31.1	1290
Ideal number of children	[2.5 mean, 1.5SD]	**4952**	[2.5 mean,1.6SD]	**4079**
<3	58.6	2900	57.8	2357
3-4	34.9	1724	34.8	1417
5+	6.6	328	7.4	305
Union status		**4983**		**4108**
Never married	49.9	2486	39.1	1612
Monogamous	33.7	1685	41.0	1685
Polygynous	7.6	380	9.2	379
Formerly married	8.8	432	10.7	432
Age	[27.8 mean, 9.8SD]	**4987**	[30.0 mean, 9.3 SD]	**4112**
15-19	25.5	1265	12.9	528
20-24	21.0	1027	22.9	922
25-29	14.6	732	17.3	714
30-34	12.4	630	14.9	622
35-39	10.1	508	12.2	506
40-44	8.8	442	10.6	440
45-49	7.7	383	9.2	380
Number of living children		**4987**		**4112**
<3	67.3	3362	60.2	2488
3-4	17.8	881	21.6	880
5+	14.9	744	18.2	744
Child death experience		**4987**		**4112**
No	83.7	4158	80.2	3285
Yes	16.3	829	19.8	827

Table 4.1 continued

Religion		**4984**		**4110**
None/other-traditional/Islamic	5.5	280	6.0	250
Catholic	4.7	244	4.6	201
Pentecostal/Charismatic	21.6	1093	20.2	845
Protestant	24.1	1191	23.1	930
Apostolic/Zion	44.1	2176	46.2	1884
Contraceptive use		**4987**		**4112**
No	62.1	3066	54.0	2191
Yes (*Any method*)	37.9	1921	46.1	1921
Traditional method	*1.6*	*77*	*1.9*	*77*
Modern method	*36.3*	*1844*	*44.2*	*1844*
Age at first birth			[18.7 mean, 3.3SD]	**3484**
<16			12.2	429
16-17			27.0	938
18-19			28.1	982
20+			32.7	1135
Age at sexual debut			[17.1 mean, 2.6SD]	**3762**
<16			27.0	1028
16-17			33.8	1248
18-19			24.4	917
20+			14.9	569
Age at first marriage			[21.1 mean, 5.0SD]	**2500**
<16			9.0	225
16-17			15.2	384
18-19			20.4	495
20+			55.4	1396

Notes: SD=standard deviation; N=sample observations
Data do not add up to 4,987 for the full sample or 4,112 for the sexually exposed women sample due to missing cases.
Source: Author's calculations

4.1.2 Macro/Community level characteristics

Table 4.2 shows the per cent distribution of the study sample by community-level characteristics. Slightly more than 7 in 10 women lived in rural areas, while according to region, a third lived in Manzini, followed by about a quarter in Hhohho, then about one-fifth in either Shiselweni or Lubombo. The latter two regions in Eswatini are depicted as largely rural and remote and therefore, disadvantaged in terms of infrastructure, amenities and services in contrast with Manzini and Hhohho which are more urbanised or industrialised. Community-level variables were considered in the realm of socioeconomic disadvantage, women's autonomy/empowerment and fertility norms/marital practices as indicated in Table 4.2.

The results show that the study sample was fairly homogeneous or similar between women with a low or high proportion residing in communities of media exposure, social position, women empowerment, ideal fertility size norm and polygyny. Respondents who were sexually initiated had a similar distribution comparable to the full sample.

Table 4.2: Selected community characteristics of women aged 15-49 by sexual activity, Eswatini, 2007

	All women		Sexually initiated	
Community characteristics	%	N	%	N
Area disadvantage				
Residence				
Urban	26.7	1544	27.9	1330
Rural	73.3	3443	72.1	2782
Region				
Hhohho	26.9	1263	27.1	1049
Manzini	33.0	1475	33.1	1214
Shiselweni	20.7	1083	19.8	862
Lubombo	19.4	1166	20.0	987
Socioeconomic disadvantage				
Community media exposure				
Low	48.9	2500	48.6	2052
High	51.1	2487	51.5	2060
Community social position				
Low	52.1	2506	51.1	2017
High	47.9	2481	48.9	2095
Women's autonomy				
Community women empowerment				
Low	50.9	2510	51.6	2098
High	49.1	2477	48.4	2014
Fertility norms				
Community ideal fertility norm				
Low	50.9	2511	51.0	2065
High	49.1	2476	49.0	2047
Community polygyny				
Low	51.5	2519	50.8	2052
High	48.5	2468	49.2	2060
Total	**100**	**4987**	**100**	**4112**

Source: Author's calculations

4.2 Contraceptive use

From Table 4.1, we can observe that the level of contraceptive use among the sexually exposed can be broken down by type of contraceptive method as revealed in Table 4.1 and Figure 4.1. Of the 46.1% women using any of the contraceptives, 1.9% used traditional methods and 44.2% used modern contraceptives (Table 4.1). The majority of sexually initiated women tend to use the male condom (16.5%), followed by injectables (14.6%) then the pill (7.1%) and female sterilisation at 3.5%. The use of any other methods was very low or negligible.

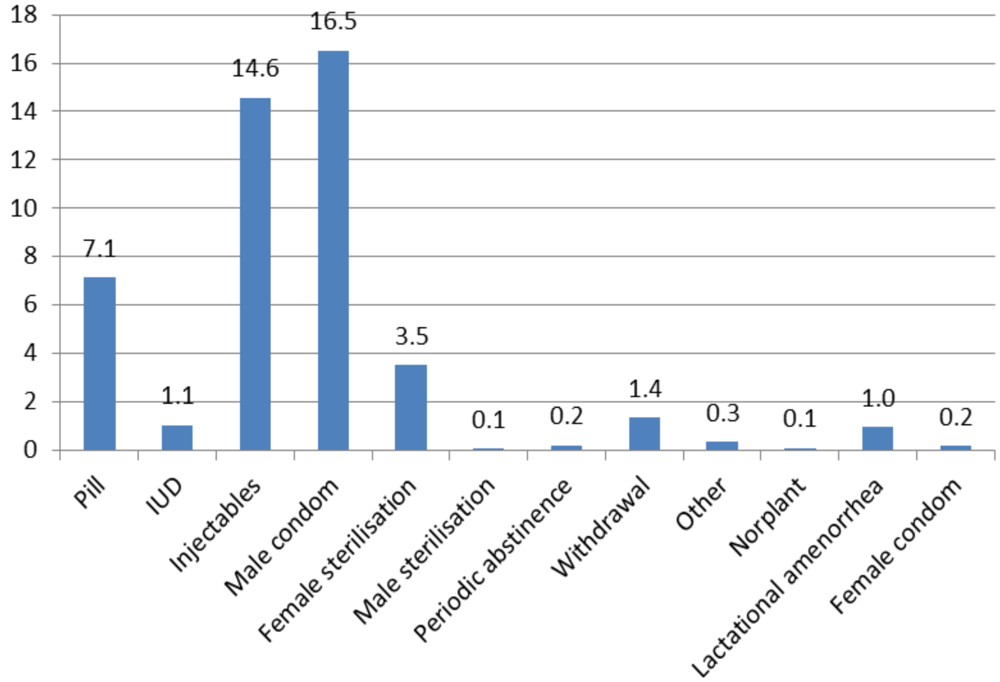

Figure 4.1: Per cent distribution of contraceptive type used by women, Eswatini, 2007 DHS
Source: Author's calculations

Table 4.3 shows the relationship between individual-level characteristics and contraceptive use - a proxy measure of fertility behaviour. The prevalence of contraceptive use (CPR) is shown among sexually exposed women (sub-sample). The association between contraceptive use (denoted CPR in table) and selected individual-level characteristics, was tested using chi-square (χ^2) tests and crude/unadjusted odds ratios of the bivariate logistic regression.

Overall, there was variation in contraceptive use by individual-level variables. Contraceptive use significantly increased with household wealth, educational level, media exposure, women's empowerment and age at sexual debut. The relationship between age at first birth and contraceptive use was less linear; indicating an inverted j-shaped curve with women aged 15 or less having the lowest odds of contraceptive use. Teenagers aged 16-17 had the highest probability of current use. Contraceptive use was higher among non-adolescent women (aged 20+ years), at age at first birth and sexual debut compared with girls aged less than 16 years.

Also, contraceptive use increased with being employed. Women who were not employed had the least use of contraceptives (42.9%) compared to their working counterparts of respective occupations (Table 4.3). Women in a professional occupation had the highest levels of contraceptive use (62.6%). Child death experience was strongly negatively associated with contraceptive use among sexually exposed women ($p<0.001$). As women's ideal number of children increased, use of contraception significantly decreased.

Married women had a high use of contraceptives (monogamous 52.0% and polygynous 45.1%). Similarly, the never married women, but who have previously been exposed to sexual activity, had higher contraceptive use (45.7%). Formerly married women had the least use of contraceptives (25.8%). An inverted-U strong significant relationship between contraceptive use and age, was observed. The teenagers or adolescents aged 15-19 years in the early reproductive cycle were more likely to use contraceptives compared with older women aged 45-49 years in the later reproductive cycle (37.0% vs. 27.1%).

In sum, occupation, wealth, education, exposure to media, women's empowerment, ideal number of children, union status, age, number of living children, child death experience, religion, age at first birth and age at sexual debut, were strongly associated with contraceptive use among sexually exposed women ($p<0.001$). The prevalence of contraceptive use was highest among sexually exposed women who were professional, richest, highly educated, highly exposed to media, highly empowered, had a small fertility norm (ideal number of children of less than three), married in monogamy, aged 30-34 years, had 3 or 4 surviving children, had no child death, Catholic, non-adolescents (aged 20+ years) age at first birth and sexual debut.

Contraceptive use varied by community-level variables (Table 4.4). Among sexually exposed women, place of residence, community media exposure, community social position and community ideal fertility norm, were strongly associated with contraceptive use ($p<0.001$). With the latter, community women empowerment was weakly associated ($p<0.05$). Region of residence and community polygyny level were found not statistically significant with contraceptive use.

Table 4.3: Per cent distribution of women currently using contraceptives according to individual characteristics and sexual activity, Eswatini, 2007

Individual characteristics	Contraceptive use Yes %	N	Chi-square test χ^2	UOR	95% CI
Contraceptive prevalence (overall)	46.1	4112			
Occupation		4105	62.8***		
Not working	42.9	1979		1	
Agricultural or manual	44.6	522		1.07	0.88 - 1.31
Sales and services	46.5	1186		1.16	0.98 - 1.36
Professional	62.6	418		2.22***	1.78 - 2.78
Wealth		4112	133.7***		
Poorest	32.0	651		1	
Poorer	38.8	720		1.35*	1.05 - 1.73
Middle	49.9	769		2.12***	1.66 - 2.71
Richer	48.3	846		1.99***	1.55 - 2.55
Richest	55.3	1126		2.63***	2.08 - 3.32
Education		4112	140.4***		
None	28.0	401		1	
Primary	39.7	1363		1.69***	1.33 - 2.14
Secondary/higher	52.7	2348		2.86***	2.31 - 3.55
Exposure to media		4112	130.0***		
Low	37.3	1861		1	
Moderate	50.6	978		1.72***	1.43 - 2.07
High	55.1	1273		2.06***	1.77 - 2.4
Women's empowerment		4112	59.8***		
Low	38.9	1304		1	
Moderate	46.7	1518		1.37***	1.17 - 1.61
High	52.6	1290		1.74***	1.49 - 2.05
Ideal number of children		4079	56.3***		
<3	50.2	2357		1	
3-4	41.9	1417		0.71***	0.62 - 0.83
5+	33.3	305		0.49***	0.37 - 0.67
Union status		4108	116.9***		
Never married	45.7	1612		1	
Monogamous	52.0	1685		1.29**	1.11 - 1.49
Polygynous	45.1	379		0.98	0.77 - 1.25
Formerly married	25.8	432		0.41***	0.32 - 0.54
Age		4112	166.3***		
15-19	37.0	528		1	
20-24	47.8	922		1.55***	1.24 - 1.95
25-29	53.9	714		1.99***	1.58 - 2.5
30-34	58.0	622		2.34***	1.83 - 3.01
35-39	47.8	506		1.56**	1.21 - 2.01
40-44	38.3	440		1.06	0.79 - 1.41
45-49	27.1	380		0.63**	0.45 - 0.88
Number of living children		4112	36.4***		
<3	44.8	2488		1	
3-4	53.8	880		1.43***	1.24 - 1.66
5+	41.2	744		0.86	0.72 - 1.03
Child death experience		4112	15.5***		
No	47.4	3285		1	
Yes	40.5	827		0.75***	0.64 - 0.88

Table 4.3 continued

Religion		4110	47.5***		
None/other-traditional/Islamic	42.2	250		1	
Catholic	57.8	201		1.87**	1.23 - 2.85
Pentecostal/Charismatic	50.6	845		1.40*	1.05 - 1.88
Protestant	49.7	930		1.35*	1.02 - 1.79
Apostolic/Zion	41.6	1884		0.97	0.74 - 1.28
Age at first birth		3484	52.9***		
<16	34.2	429		1	
16-17	51.4	938		2.04***	1.60 - 2.59
18-19	49.0	982		1.85***	1.47 - 2.33
20+	51.5	1135		2.05***	1.59 - 2.64
Age at sexual debut		3762	45.5***		
<16	38.8	1028		1	
16-17	47.2	1248		1.41***	1.18 - 1.69
18-19	48.7	917		1.50***	1.26 - 1.78
20+	53.4	569		1.81***	1.45 - 2.25

***P<0.001, **P<0.01, *P<0.05

Notes: CPR=percentage of contraceptive use; UOR=unadjusted (crude) odds ratio; CI =confidence interval; χ^2 =chi-square value

Source: Author's calculations

Area disadvantage in contraceptive use was observed; rural women were less likely to use contraceptives compared to their urban counterparts (43.5% vs. 52.7%). Although region was not statistically significant with contraceptive use, it was observed that the prevalence of contraceptive use was higher in Hhohho and Manzini (non-resource poor) regions than in Shiselweni and Lubombo (remote) regions. Contraceptive use was least in Shiselweni (43.2%). Women living in communities with higher levels of media exposure were more likely to use contraceptives compared to women in communities with lower levels of media exposure (49.8% vs. 42.1%). The prevalence of contraceptive use was higher in communities with higher levels of female social position than those with lower levels of female social position (50.6% vs. 41.7%).

The rate of contraceptive use was lower in communities with higher proportions of women empowered (43.4%) compared to those in communities with lower levels of women empowerment (48.5%). This finding contradicts the finding at individual-level, where empowered women had more contraceptive use than those less empowered. Beyond individual women's empowerment, at community-level, it is expected that the use of contraceptives should be high among empowered women which is contrary to the findings of this study. It is probable that at community-level there could be social norms and values upheld that condone use of contraceptives in Eswatini. Women's empowerment seems to operate differently at individual- and community-level and therefore this might need further investigation.

There were slight, but not significant, differences in contraceptive use between communities with higher levels of polygyny and those wither lower levels of polygyny. Contraceptive use appears to be higher for women in communities with low polygyny than those in communities with high polygyny levels, although difference was not statistically significant.

Table 4.4: Per cent distribution of women currently using contraceptives according to community characteristics and sexual activity, Eswatini, 2007

	Contraceptive use		Chi-square test		
Community characteristics	Yes %	N	χ^2	**UOR**	**95% CI**
Area disadvantage					
Residence		4112	33.9***		
Urban	52.7	1330		1	
Rural	43.5	2782		0.69***	0.58 - 0.82
Region		4112	7.2		
Hhohho	47.4	1049		1	
Manzini	47.7	1214		1.01	0.82 - 1.24
Shiselweni	43.2	862		0.85	0.68 - 1.05
Lubombo	44.3	987		0.88	0.73 - 1.06
Socioeconomic disadvantage					
Community media exposure		4112	30.3***		
Low	42.1	2052		1	
High	49.8	2060		1.37***	1.17 - 1.6
Community social position		4112	40.4***		
Low	41.7	2017		1	
High	50.6	2095		1.44***	1.23 - 1.68
Women's autonomy					
Community women empowerment		4112	12.8*		
Low	48.5	2098		1	
High	43.4	2014		0.82*	0.70 - 0.95
Fertility norms					
Community ideal fertility norm		4112	35.4***		
Low	50.2	2065		1	
High	41.8	2047		0.71***	0.61 - 0.83
Community polygyny		4112	2.1		
Low	47.1	2052		1	
High	45.0	2060		0.92	0.78 - 1.08

***P<0.001, **P<0.01, *P<0.05
Source: Author's calculations

In general, the bivariate results revealed that not all individual-level variables were consistent with study hypotheses. Socioeconomic variables had influence on contraceptive use in the expected directions. In general, all demographic variables were consistent with hypotheses except for age and parity. All community variables were consistent with hypotheses, except women's empowerment. All individual-level variables were statistically significantly associated with current contraceptive use at 5% level of significance for sexually exposed women. All seven community-level variables were statistically significant, except for region and community polygyny.

4.3 Fertility: children ever born

Table 4.5 presents the means, standard deviations and the unadjusted incidence rate ratios of the total number of children ever born (CEB) for selected individual-level characteristics among all respondents and sexually exposed women. Overall mean number of children ever born was 2.3 children per woman among all respondents and 2.8 children among sexually exposed women. The median was two children in both samples. The results based on medians showed little or no variation in fertility behaviour and therefore are not shown.

Since the variance of the number of children born in both samples was 6, which is greater than its mean, the dependent variable has an over-dispersion: multilevel count data models are considered in Chapter 8 to deal with this aspect of analysis. It is noteworthy to understand that the estimates of mean CEB are not corrected for misreporting (meant for section 5.1 and 5.2). This section focuses more on the significance and type of relationship between the individual covariates and CEB.

Overall, the number of children ever born significantly increased with women being ever married and having had an experience of a child death. Also, CEB significantly increased as age, ideal number of children, and number of surviving/living children increase among women. The number of children ever born significantly reduced with household wealth quintiles, educational attainment, exposure to media, age at first birth, age at sexual debut and age at first marriage. Although among all respondents CEB decreased with women's empowerment, the relationship was not significant. Among all respondents, CEB also significantly increased with contraceptive use and employment. Overall, being in polygynous unions was associated with a higher probability of having larger families than monogamous relationships. Religion was also significantly associated with CEB (Table 4.5).

Table 4.5: Mean number of children ever born by selected individual characteristics and sexual activity, Eswatini, 2007

Individual characteristics	mean	SD	N	UIRR	95% CI
Children ever born (overall)	2.8	2.5	4112		
Occupation					
Not working	2.51	2.48	1979	1	
Agricultural or manual	3.25	2.58	522	1.29***	1.18 - 1.42
Sales and services	3.14	2.54	1186	1.25***	1.16 - 1.34
Professional	2.39	1.74	418	0.95	0.87 - 1.04
Wealth					
Poorest	3.56	2.89	651	1	
Poorer	3.21	2.73	720	0.90*	0.83 - 0.98
Middle	2.89	2.53	769	0.81***	0.75 - 0.88
Richer	2.50	2.26	846	0.70***	0.64 - 0.76
Richest	2.11	1.83	1126	0.59***	0.54 - 0.64
Education					
None	4.47	3.20	401	1	
Primary	3.26	2.68	1363	0.73***	0.67 - 0.79
Secondary/higher	2.21	1.97	2348	0.49***	0.45 - 0.54
Exposure to media					
Low	3.27	2.77	1861	1	
Moderate	2.46	2.27	978	0.75***	0.7 - 0.81
High	2.29	1.98	1273	0.70***	0.66 - 0.75
Women's empowerment					
Low	2.95	2.67	1304	1	
Moderate	2.79	2.45	1518	0.95	0.88 - 1.02
High	2.58	2.26	1290	0.87***	0.81 - 0.94
Ideal number of children					
<3	2.41	2.20	2357	1	
3-4	2.99	2.65	1417	1.24***	1.16 - 1.32
5+	4.37	2.75	305	1.81***	1.67 - 1.97
Union status					
Never married	1.36	1.47	1612	1	
Monogamous	3.38	2.44	1685	2.48***	2.31 - 2.67
Polygynous	4.46	2.78	379	3.27***	2.99 - 3.58
Formerly married	4.15	2.62	432	3.05***	2.79 - 3.32
Age					
15-19	0.51	0.61	528	1	
20-24	1.20	0.89	922	2.37***	2.10 - 2.66
25-29	2.20	1.34	714	4.33***	3.87 - 4.83
30-34	3.20	1.72	622	6.30***	5.62 - 7.06
35-39	4.18	2.27	506	8.24***	7.32 - 9.28
40-44	5.21	2.71	440	10.27***	9.12 - 11.55
45-49	5.54	3.00	380	10.91***	9.71 - 12.27
Number of living children					
<3	1.19	0.96	2488	1	
3-4	3.70	0.88	880	3.11***	2.99 - 3.23
5+	6.91	1.80	744	5.80***	5.58 - 6.04
Child death experience					
No	2.28	2.12	3285	1	
Yes	4.77	2.78	827	2.09***	1.99 - 2.20

Table 4.5 continued

Religion					
None/other-traditional/Islamic	3.03	2.74	250	1	
Catholic	2.61	2.24	201	0.86	0.72 - 1.02
Pentecostal/Charismatic	2.48	2.22	845	0.82**	0.72 - 0.93
Protestant	2.39	2.22	930	0.79***	0.70 - 0.89
Apostolic/Zion	3.07	2.64	1884	1.01	0.90 - 1.13
Contraceptive use					
No	2.79	2.68	2191	1	
Yes	2.75	2.21	1921	0.99	0.93 - 1.05
Age at first birth					
<16	4.36	2.92	429	1	
16-17	3.53	2.55	938	0.81***	0.74 - 0.88
18-19	3.21	2.20	982	0.74***	0.68 - 0.8
20+	2.68	1.88	1135	0.62***	0.57 - 0.67
Age at sexual debut					
<16	3.46	2.93	1028	1	
16-17	2.59	2.34	1248	0.75***	0.69 - 0.81
18-19	2.29	2.11	917	0.66***	0.61 - 0.72
20+	1.98	1.77	569	0.57***	0.52 - 0.63

***P<0.001, **P<0.01, *P<0.05
Notes: UIRR=unadjusted incidence rate ratio; CI=confidence interval; SD=standard deviation, N=sample observations
Source: Author's calculations

Table 4.6 shows the relationship between contextual community-level factors and lifetime fertility- children ever born. There were wide and significant differences in lifetime fertility by community-level variables. As expected, the number of children born was higher in rural than urban areas. To live in the Lubombo region is associated with the highest probability of having a large family size.

Communities with lower media exposure and lower social position for women at community-level were associated with higher probability of having large families.

Women living in communities with a higher proportion of empowered women were more likely to have more children compared with women in communities with lower levels of women empowerment. Again, contrary to expectation, with the community women empowerment variable there could be bias in its measurement or meaning at aggregate level and thus cautionary conclusions should be made. The incident rates of children ever born were higher in communities with a higher proportion of women in polygyny and with high ideal fertility norm preferences.

Table 4.6: Mean number of children ever born by selected community characteristics and sexual activity, Eswatini, 2007

Community characteristics	mean	SD	N	UIRR	95% CI
Area disadvantage					
Residence					
Urban	2.18	1.90	1330	1.00	
Rural	3.00	2.62	2782	1.38***	1.29 - 1.47
Region					
Hhohho	2.75	2.45	1049	1	
Manzini	2.60	2.39	1214	0.94	0.87 - 1.03
Shiselweni	2.82	2.42	862	1.03	0.95 - 1.11
Lubombo	3.04	2.66	987	1.11*	1.01 - 1.21
Socioeconomic disadvantage					
Community media exposure					
Low	3.11	2.68	2052	1	
High	2.45	2.21	2060	0.79***	0.74 - 0.84
Community social position					
Low	3.05	2.64	2017	1	
High	2.49	2.25	2095	0.82***	0.76 - 0.87
Women's autonomy					
Community women empowerment					
Low	2.50	2.20	2098	1	
High	3.06	2.70	2014	1.22***	1.15 - 1.3
Fertility norms					
Community ideal fertility norm					
Low	2.45	2.23	2065	1	
High	3.11	2.66	2047	1.27***	1.2 - 1.35
Community polygyny					
Low	2.58	2.29	2052	1	
High	2.97	2.63	2060	1.15***	1.07 - 1.23

***P<0.001, **P<0.01, *P<0.05
Notes: UIRR=unadjusted incidence rate ratio; CI=confidence interval; SD=standard deviation; N=sample observations
Source: Author's calculations

4.4 Summary of the chapter

The individual- and community-level correlates of fertility behaviour, lifetime fertility or current contraceptive use considered in this study are shown in Tables 4.1 to 4.5, together with their descriptive statistics: frequencies, means, standard deviations, chi-square significance tests, bivariate logistic odds ratios and Poisson incidence rate ratios.

Chi-square tests showed that all individual-level predictors were strongly associated with contraceptive use ($p<0.001$). Except for religion and community level of polygyny, all community-level variables showed significantly weak ($p<0.05$) to strong ($p<0.001$) variation with contraceptive use. All individual- and community-level correlates of lifetime fertility (number of children born) were all significant at 5% level of significance. However, contraceptive use was not significantly correlated with lifetime fertility, at individual-level.

CHAPTER 5

THE QUALITY STATUS OF DATA ON FERTILITY IN ESWATINI

The chapter mainly focuses on examining the quality of census data used to analyse the data. The findings in this study, a by-product of this study, have been published in the article by Chemhaka et al. (2016b). The study aimed at appraisal of age-sex and fertility data as components of census data, used for deriving reasonable fertility estimates.

5.1 Data quality assessment

This section splits the assessment of quality of data into two by looking at age-sex data and fertility data- recent births and number of children ever born.

5.1.1 Quality of age-sex data

Table 5.1 shows the UN age-sex accuracy index (joint score) values for the 1976, 1986, 1987 and 2007 Population and Housing Censuses (PHC) in Eswatini. The estimated UN joint score at national level in all the four censuses fell between 20 and 40 (cautious range) as discussed in section 3.7.1.1. The results in all censuses suggest some anomalies in the general accuracy of age-sex data, which can be concluded to be 'inaccurate'. The caution in age distribution data irregularities could have been an anomaly in the population structure and not necessarily in age reporting. It should also be noted that the joint score is estimated from 5-year age data and thus the age distribution pattern becomes smooth due to this grouping, which reduces fluctuations of single year age data.

The joint score changed from 36.9 in 1976 to 27.1 in 2007, suggesting an overall improvement in age-sex data quality over time. The joint score is determined through a combination of the sex ratio and age ratio scores. For the former, the sex ratio score has decreased between 1976 and 2007 by 17.1 per cent, which is mainly due to the decline in the joint score. The age ratio score for females were less than males in all censuses, except for 2007, suggesting the age pattern of females was smoother. Over time, between 1976 and 2007, the age ratio score for males decreased by 56.0 per cent while the age ratio score for females also declined, however with a rise in 2007. This increase could be attributable not only to age misreporting of females but also can occur as a result of population dynamics – namely factors of fertility, mortality and migration. This requires further enquiry at specific or certain age groups.

Table 5.1: UN age-sex accuracy index (joint score), Eswatini 1976-2007 PHC

Census Year	Sex ratio score	Age ratio score		UN age-sex accuracy index
		Male	Female	
1976	7.0	10.0	5.9	36.9
1986	6.6	6.2	4.7	30.9
1997	6.3	5.1	4.1	28.0
2007	5.8	4.4	5.3	27.1

Source: Author's calculations

The age distribution base population for females in the age range of 0 to 80 is depicted in Figure 5.1 for the four Eswatini censuses. The displayed patterns in Figure 5.1 provide a starting point for assessing errors in census data. In all four censuses, the results show a non-smooth irregular pattern of age distribution. This reflects occurrence of age misreporting or age heaping for women aged 15-49, specifically at ages 0 and 5, as well other digits as indicated by the spikes in each respective census.

A cohort effect on age misreporting can be observed to have taken place over time. For instance, taking a look at one cohort, aged say 10 in 1976, then 20 in 1986, 31 in 1997 and 41 in 2007, suggests the same pattern of age heaping. This observation for other cohorts has been made for individuals or cohorts of women of childbearing ages suggesting that they had the same propensity of misreporting in subsequent censuses. Moultrie et al. (2013) describe a typical pattern of age distribution, depicting a developing country as one which reveals a gradual decline in slope as age increases. Overall, the results of this study are consistent with this observation. Further, all census results, except for the 1976 census, reveal that fertility transition is underway in Eswatini as the population size of those aged 0 is lower than those slightly older.

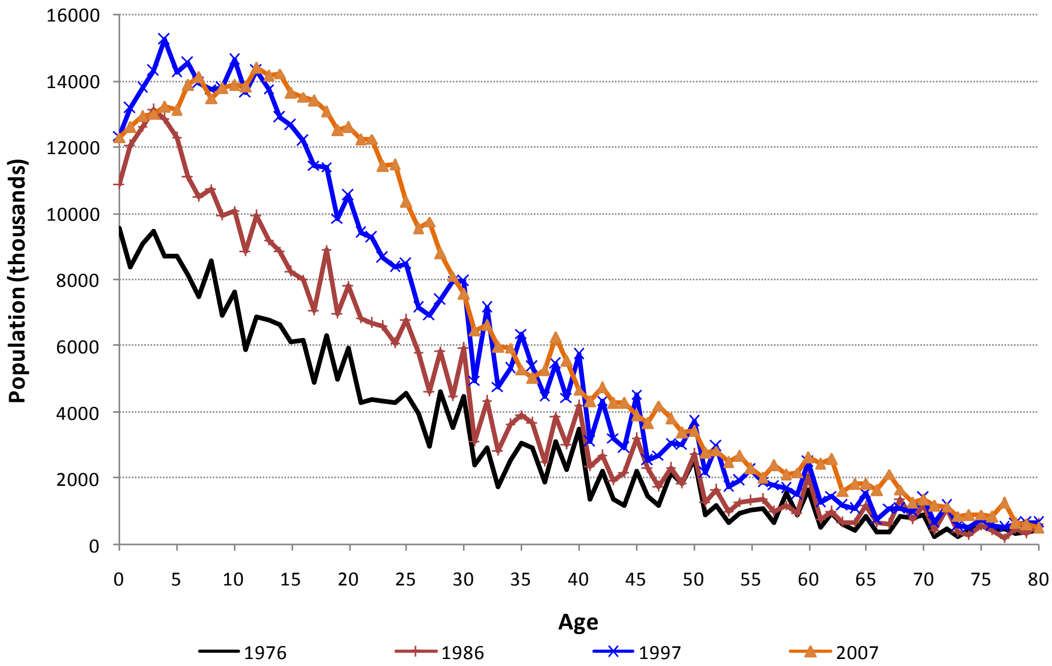

Figure 5.1: Age distribution of females aged 0-80, Eswatini, 1976-2007 PHC
Source: Author's calculations

In further determining the extent of age misreporting in the data from the four censuses, the Whipple's index (W) and the total modified Whipple's index (W_{tot}), were applied. The summary values of these two indices for women in the reproductive lifespan or childbearing ages are shown in Table 5.2. The findings indicate improvement in age reporting over time for women aged 15-49 as the two summary Whipple's indices values decrease in succeeding census. In 1976, the Whipple's index (W) value was 129.3, which suggests that the age data reported were of rough quality (i.e. in the range 125-174.9). In the following censuses of 1986 and 1997, the values were 124.7 and 118.4, respectively implying age data were approximately accurate (in the range 110-124.9). In 2007, the Whipple's index improved to 98, indicate age reporting was highly accurate (less than 105).

Similar results were observed using the total modified Whipple's index (W_{tot}) - a summary index, which suggests the lower the values are closer to zero, the less the extent of digit preference in age reporting. Therefore, W_{tot} estimate of 0.7 in the 2007 census data suggests marginal or no age digit preference. In the previous censuses, some age heaping was observed which was highest in the earliest 1976 census and decreased thereafter in the 1986 and 1997 censuses. Therefore, reasonable accuracy in all census data on age for childbearing women in Eswatini, seems to be well-established. The findings could reflect an improvement in the reporting and handling of census information in the country.

Table 5.2: The Whipple's index (W) for women aged 23-52, and Total modified Whipple's index (W_{tot}) for women aged 21-52, Eswatini 1976-2007 PHC

Census Year	W	W_{tot}
1976	129.3	1.62
1986	124.7	1.31
1997	118.4	1.19
2007	98.0	0.37

Source: Author's calculations

The pattern of digit preference (or aversion) for each terminal digit 0 to 9 is depicted using the digit-specific modified Whipple's indices (W_i) as shown in Figure 5.2 for women in the reproductive lifespan.

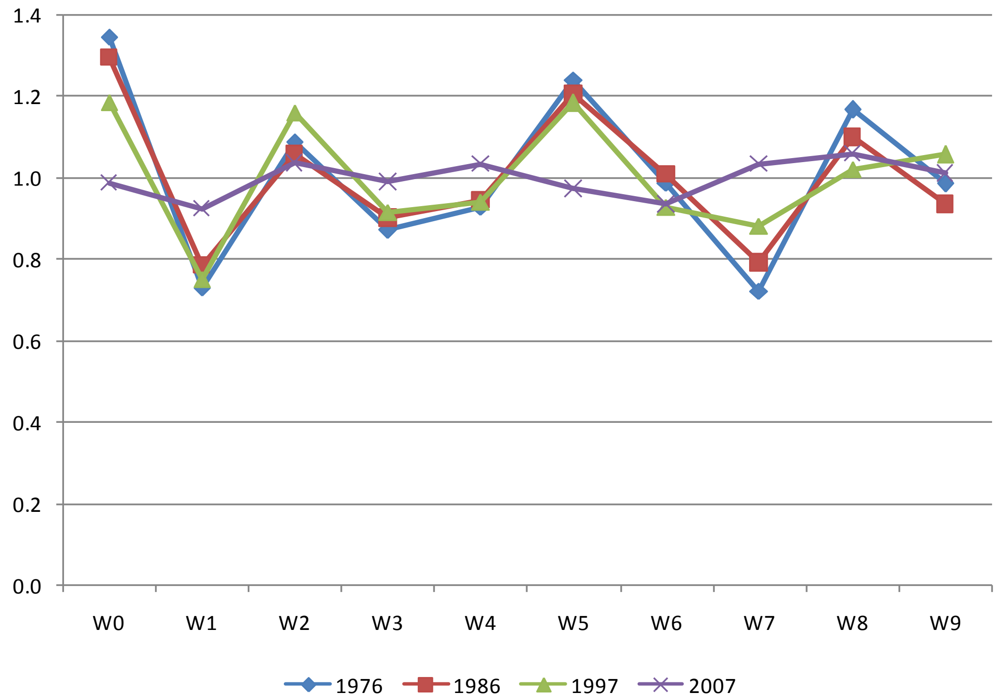

Figure 5.2: Digit-specific modified Whipple's indices (W_i) for women aged 21-52, Eswatini, 1976-2007 PHC
Source: Author's calculations

The findings show marked digit preferences for ages ending with a 0, 5 or 8 in all the censuses, excluding the 2007 census. In the same view, an age misreporting pattern can be significantly noticed for age ending with either digits 1 or 7. This indicates that these ages were least reported or just avoided in reporting. The results, as may be expected, clearly show age heaping at ages ending with digits 0 or 5 as commonly noticed in many populations.

Adding to the summary measures noted above, demographic ratios are tools often employed to evaluate census data. Figure 5.3 shows the sex ratios while Figure 5.4 displays the age ratios. Both Figures 5.3 and 5.4 show irregular patterns which suggest age misreporting, undercounting or overcounting errors which could be observable in the census data as already highlighted through the summary measures of Whipple's index.

Specifically, for the sex ratio, it is anticipated that males have little or higher excess mortality to that of females. The results in Figure 5.3 for Eswatini conform to this expectation. Further, the findings show that the sex ratio at birth (SRB) for all the censuses slightly falls below 100. This could be attributable to underreporting of births or ages. The SRB were estimated as 95.7, 93.3, 97.5 and 98.0 for the 1976, 1986, 1997 and 2007 censuses, respectively. Interestingly, the general sex ratios for young adults and the middle aged, in the age range 20-35, were exaggeratedly below 100. This finding could in part reflect higher male deaths, probably as a result of HIV/AIDS, higher emigration of males to seek employment, a lower SRB or a combination of these factors.

With regard to age ratios, Figure 5.4 exhibits an irregular pattern of age ratios for women aged 30-49 in all four censuses. This finding could indicate errors of age misclassification of these women in the middle and the older reproductive lifespan was undercounted.

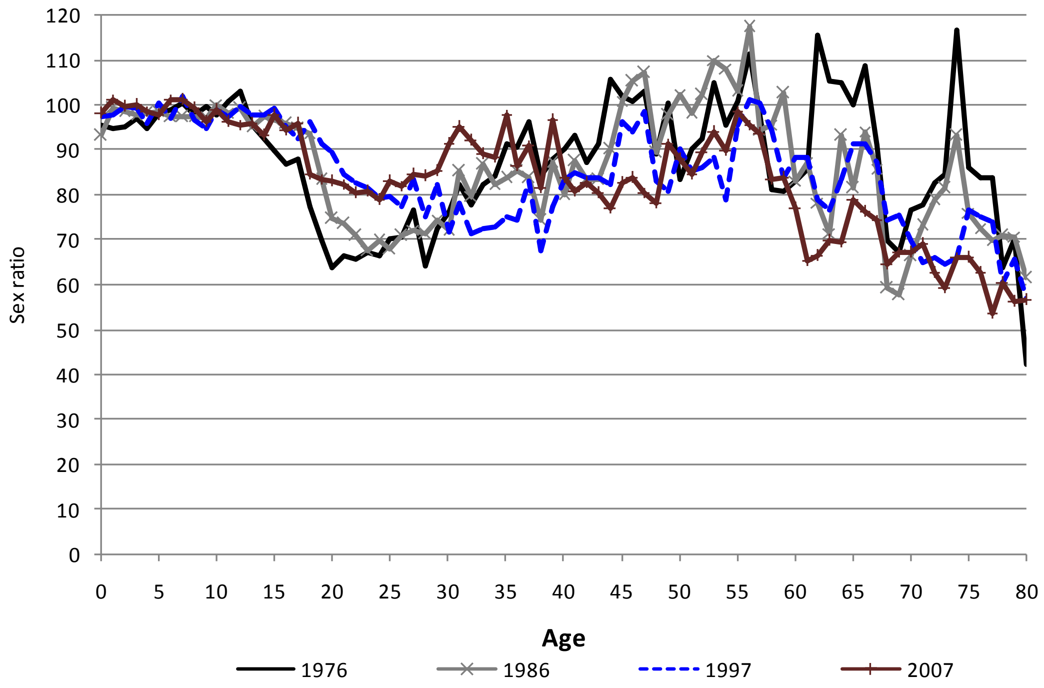

Figure 5.3: Sex ratios of the population aged 0-80, Eswatini, 1976-2007 PHC
Source: Author's calculations

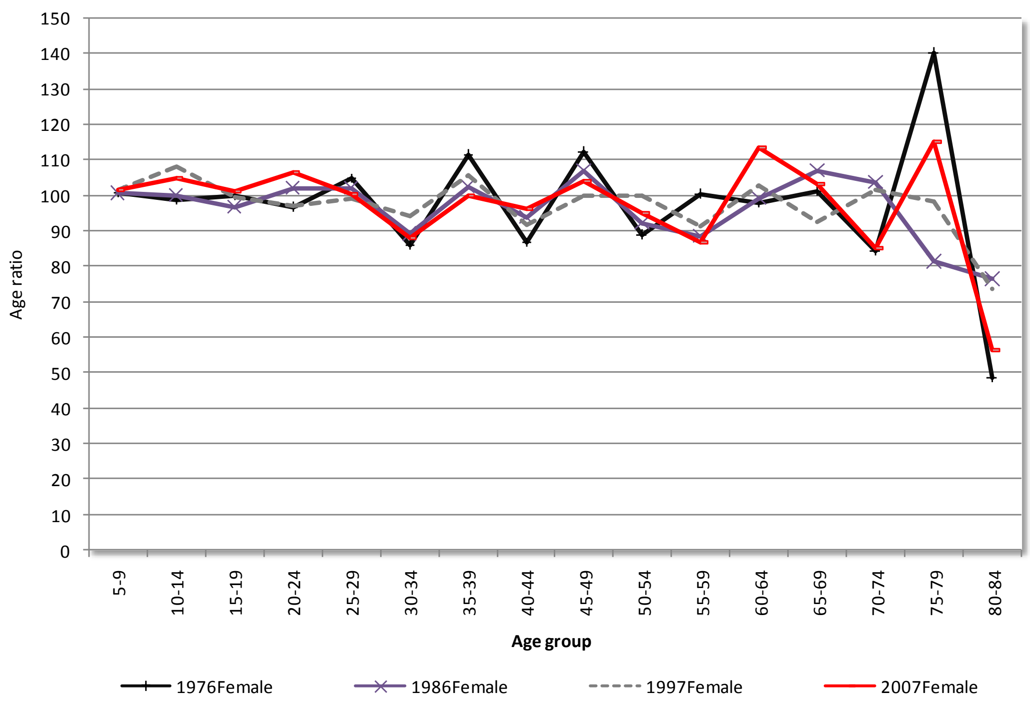

Figure 5.4: Age ratio of females for 5 years age groups, Eswatini, 1976-2007 PHC
Source: Author's calculations

5.1.2 Quality of fertility data

The evaluation of current and lifetime fertility was done using number of births in the last five years and number of children ever born (parity) data, respectively. Pertaining current fertility, age-specific fertility rates (ASFRs) were computed for women aged 15-49 using reported data from the relational Gompertz model to show pattern of fertility at national level in all four censuses. In Figure 5.5, the reported and relational Gompertz model adjusted ASFRs are shown and hence used to detect any possible anomalies in pattern of current fertility and change thereof.

The findings show that the levels of reported fertility rates in all censuses were lower than those adjusted, except for older women aged 45-49. These results are indicative of underreporting of fertility or age misreporting, especially by older women. The pattern of fertility, however, remains the same, considering both reported and adjusted data in all four censuses. From 1976 to 2007, the levels of ASFRs are declining, with each successive census implying fertility has been declining for Eswatini over these three decades. This finding conforms to observations in Figure 5.1.

Further, the results reveal that the peak of childbearing among women occurred at ages 20-29 in 1976, 1986 and 1997 censuses. This similar pattern observed is characteristic for most African countries. Later, in 2007, a somewhat different shape of fertility pattern was observed, depicting an almost flattened and peaked fertility distribution pattern at ages 20-39. At these ages, fertility behaviour appears to be similar, different to what has been observed previously, and therefore may require further explanation. It may be possible that among women in the supposed peaked childbearing ages, births could have been possibly underreported. Alternatively, it could be explained that older women have just increased or delayed their childbearing.

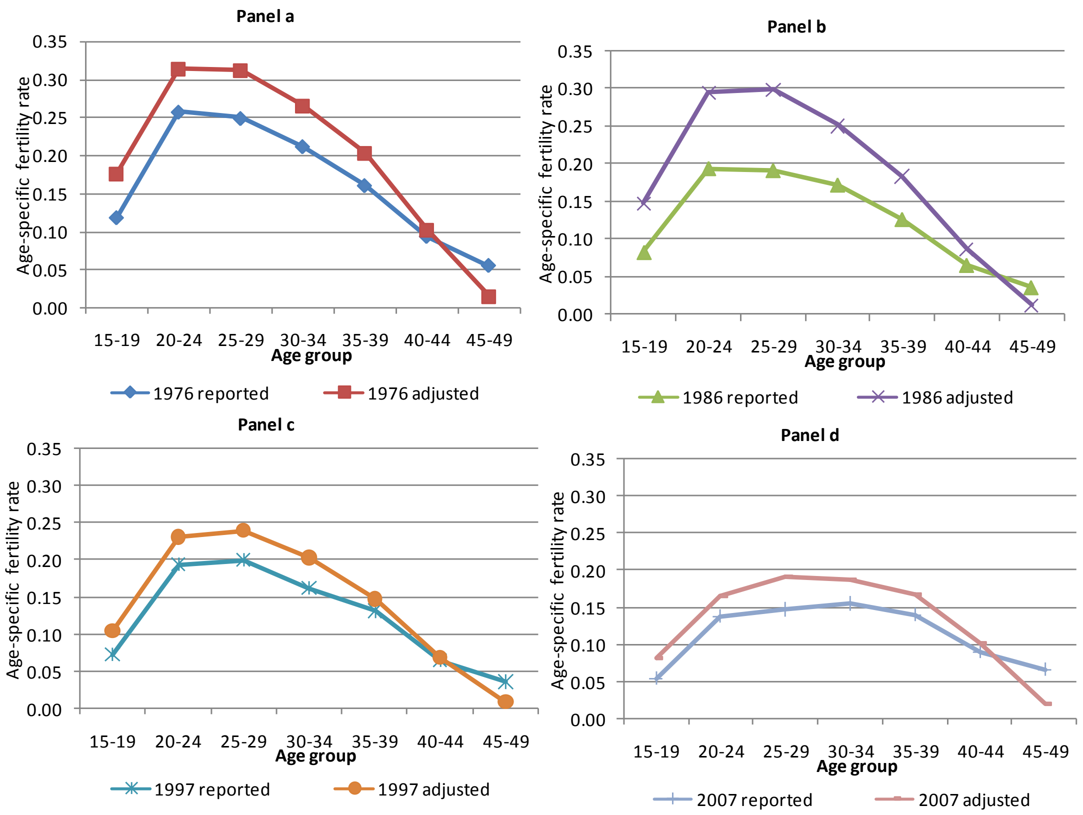

Figure 5.5: Reported and adjusted age-specific fertility rates for women aged 15-49, Eswatini, 1976-2007 PHC
Notes: Panel (a) 1976, Panel (b) 1986, Panel (c) 1997, Panel (d) 2007.
Source: Author's calculations

Figure 5.6 shows average parities for reported data and those adjusted using the el-Badry correction technique. The reported parities, if distorted, that is, had unknown parities recorded more than 2%, were corrected or adjusted in the dataset as was set in the 1986 and 1997 censuses. As anticipated, the results show that average parities (lifetime fertility) increased with age of women in the age range 15-49 in each census. Over time, from 1976 to 2007, the average parities decreased in levels suggesting fertility decline for almost all ages for childbearing women. In the earlier census for 1976, the asymptotic 'S' shaped pattern observed could reflect that fertility was rising or rather underreporting of parities by older women.

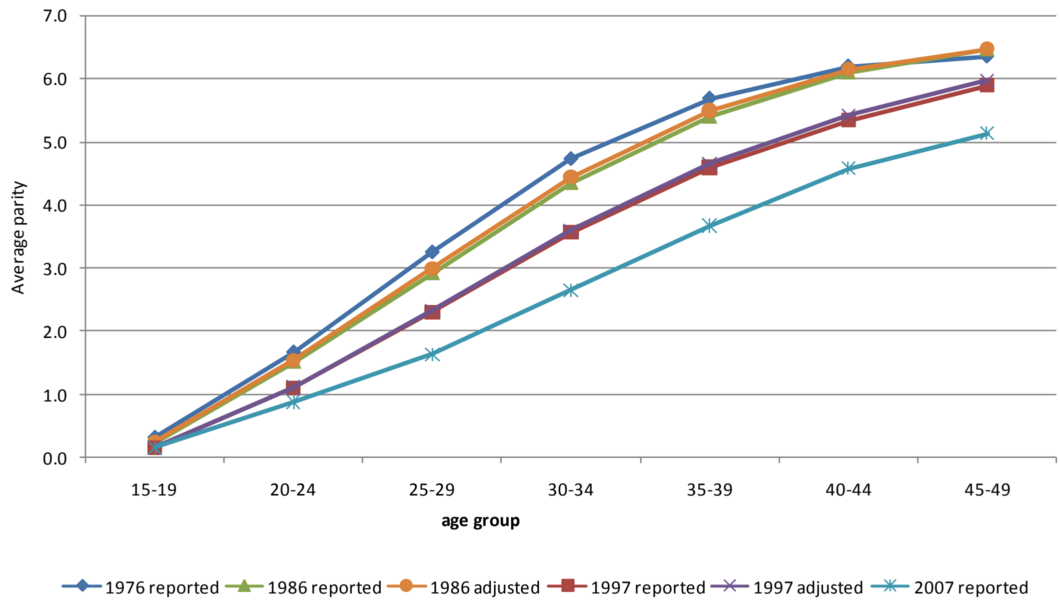

Figure 5.6: Average reported and adjusted parity for women aged 15-49, Eswatini, 1976-2007 PHC
Source: Author's calculations

5.2 Summary of the chapter

This chapter looked at the status of quality of census data for deriving fertility estimates for the four censuses. The appraisal of age-sex and fertility data was done on multiple census data to ascertain the level of consistency in estimates or patterns. Changes in the pattern of fertility were observed and evaluated on the basis of typical patterns observed in African settings. A number of demographic tools or measures were useful in the evaluation. These include Myer's index, Whipple's index, age ratios, sex ratios and the UN age-sex accuracy index. The data has been shown to be less flawed in terms of age reporting in the four censuses when evaluated using several methods. Therefore, estimates of fertility of reasonable accuracy can be derived using robust assumptions and applicable methods. When age-sex structure and fertility data are defective and incomplete, their usefulness becomes questionable.

CHAPTER 6

PROXIMATE DETERMINANTS OF FERTILITY IN ESWATINI

This chapter looks at the contribution of the key four proximate determinants (PD) of fertility (contraceptive use, postpartum infecundability, abortion and marriage/sexual activity) on fertility level (*TFR*) in Eswatini. The analysis of the impact of the four proximate fertility determinants on level of fertility is based on the formulations proposed by Bongaarts in late 1970s and early 1980s (Bongaarts, 1978, Bongaarts, 1982, Bongaarts et al., 1984) hereby referred to as the original Bongaarts model (OBM) and the recent revision by Bongaarts (2015) of the proximate determinants framework referred to as the revised John Bongaarts model (RJB). In addition to the set of four PDs, a fifth PD, infecundity, is provided for analysis using the modification by Stover (1998), referred to as the revised John Stover model (RJS).

The Bongaarts model was applied earlier to the 1988 survey data for Eswatini by Warren et al. (1992) and it was found that breastfeeding was most influential in suppressing fertility. This study extends the modification of variables for analysis in the Bongaarts model using an international comparable DHS dataset and improved concepts by Stover (1998) and Johnston and Westoff (2010) on sexual activity and abortion, respectively. The methodology on the computation of proximate fertility determinants is outlined in the previous section 3.7.3, and the comparison of the three PD models' formulae is shown in Table G1 of Appendix G. The three model estimates of OBM, RJS and RJB provide an opportunity to examine their performance in understanding the relative importance of key drivers influencing fertility levels. Bongaarts (2015: 549) highlighted that the three models provide quite similar estimates for *Ci* [postpartum infecundability index] and *Ca* [abortion index], but differences are substantial for *Cm* [marriage index] and *Cc* [contraception index].

In Appendix G, Tables G2 to G5, Tables G6 to G9 and Tables G10 to G12 present the input values and estimates results of the proximate determinants of fertility analysis for the OBM, RJS and

RJB models, respectively. The proximate determinants were compared across subpopulations to offer insight into background variables of social setting (place and region of residence) and social status (educational level and wealth status) that determine fertility differentials or patterns of influence. The impact of the indices of abortion, contraceptive use, postpartum infecundability, marriage/sexual exposure and infecundity on fertility, are presented in Figures 6.1 to 6.5. The higher the value of the index, the lower is the impact (per cent reduction) on fertility level. A ± 5% or more difference on population subgroups of impact of PDs on fertility level is considered fairly large.

6.1 Marriage/union/sexual exposure

Table 6.1 presents the descriptive results of the means and the standard deviations of age at first marriage and age at first sex (sexual debut). Table 6.1 also reports the medians of these variables. The gap between age at first marriage, age at sexual debut and the length of premarital sexual exposure, is also highlighted. Overall, the findings suggest that in Eswatini, sexual intercourse practised by women, begins early before marriage. This was consistent across social contexts (place and region) and social status (wealth and education) subpopulations. The means of age at first sexual intercourse were lower than for age at first marriage, implying early sexual engagement before marriage. Overall, the length of premarital sexual exposure for women aged 15-59 was estimated at 3 to 4 years on average. This gap showed some variation in place and region of residence, wealth status and level of education for women (Table 6.1).

The mean age at first marriage for urban women was higher than for rural women (22.4 ± 5.2SD vs. 21.1 ± 5.1SD years). Similarly, mean age at first sex was higher for urban women (17.7 ± 2.7SD years) compared to their rural counterparts (16.9 ± 2.5SD years). Age at first marriage was lower in the Lubombo region (20.2 ± 4.6SD years) compared to other regions - Hhohho (21 ± 5.3SD years), Shiselweni (21.5 ± 5.0SD years) and Manzini (21.6 ± 5.1SD years). The mean age at first sex ranged from the lowest in Lubombo (16.9 ± 2.5SD years) to the highest in Manzini (17.4 ± 2.6SD years).

Overall, the mean age at first marriage indicates that the rich or non-poor (richer and richest wealth quintiles) were married at a later age (21.7 ± 5.2SD and 22.7 ± 5.0SD years, respectively) compared to the average (20.1 ± 4.4SD years) and poor (poorest: 19.8 ± 4.6SD years and poorer: 20.5 ± 5.2SD years) women. The mean age at first sex increased with women's household wealth quintiles. Sexual intercourse began earlier among the poorest (16.4 ± 2.2SD years), followed by the poorest (16.6 ± 2.2SD years), average (16.8 ± 2.3SD years), then richer (17.1 ± 2.5SD years) and later for the richest (18.1 ± 3.0SD years). Overall, the poorest were more likely than the richest to engage in early marriage (19.8 vs. 22.7 years) and early sexual encounters (16.4 vs. 18.1 years) (Table 6.1).

Table 6.1: Means of age at first marriage and age at first sex (sexual debut) by selected variables, Eswatini 2007 DHS

	Age at sexual debut				Age at marriage				Length of premarital sexual exposure	
	median	mean	SD	N	median	mean	SD	N	median	mean
Total	17	17.1	2.57	3762	20	21.1	5.05	2501	3	4.0
Residence										
Urban	17	17.7	2.71	1226	22	22.4	5.24	757	5	4.7
Rural	17	16.9	2.48	2536	20	20.7	4.90	1744	3	3.8
Region										
Hhohho	17	17.1	2.61	950	20	21.0	5.26	685	3	3.9
Manzini	17	17.4	2.56	1116	21	21.6	5.11	702	4	4.2
Shiselweni	17	17.1	2.51	805	21	21.5	5.01	469	4	4.4
Lubombo	16	16.7	2.53	891	19	20.2	4.57	645	3	3.5
Wealth										
Poorest	16	16.4	2.16	587	19	19.8	4.64	447	3	3.4
Poorer	16	16.6	2.24	661	19	20.5	5.22	454	3	3.9
Middle	17	16.8	2.26	692	19	20.1	4.39	453	2	3.3
Richer	17	17.2	2.48	781	21	21.7	5.20	476	4	4.6
Richest	18	18.1	2.97	1041	22	22.7	5.05	671	4	4.6
Education										
None	15	15.6	2.62	347	18	19.6	5.58	320	3	4.0
Primary	16	16.2	1.98	1249	19	20.0	4.87	894	3	3.8
Secondary+	18	17.9	2.58	2166	22	22.3	4.76	1287	4	4.4

Notes: SD=standard deviation; N= sample size; Age at first sexual intercourse computed from DHS variable v531; Age at first marriage computed from DHS variable v511.
Source: Author's calculations

A positive relationship between the level of education and age at first marriage as well as age at first sexual intercourse, was observed. Educated women with secondary or higher education were more likely to marry later (22.3 ± 4.8SD years) compared to those with no education (19.6 ± 5.6SD years). The educated were also more likely to engage in sexual intercourse later in life than those with no formal schooling (17.9 ± 2.6SD vs. 15.6 ± 2.6SD years). Overall, similar patterns of variation in median values of age at marriage and age at sexual debut by residence, region, wealth and education variables, were observed (Table 6.1).

Sexual exposure captures the risk of pregnancy for married, cohabitating and unmarried women. The estimated values of the index of marriage (*Cm*) and sexual exposure index (*Cx*) show wide variation for the three (OBM, RJS and RJB) proximate determinant models. The OBM takes consideration of sexual activity in marriage/cohabitation. According to Bongaarts (2015), the RJS and RJB models account for extramarital sexual exposure. The implementation of the three sexual activity indices gives quite substantial differences in estimates as found in the study (Figure 6.1, Panels a to d).

At national level, the OBM and RJS models indicate that marriage/sexual activity has the highest fertility reducing effect, however according to the RJB model, the net effect of sexual activity is less than that of contraception on fertility (see Tables G4, G9 and G12 in Appendix G). The OBM had the least value of the marriage index at 0.42, while, the index of sexual activity was estimated at 0.52 and 0.66 for RJS and RJB models, respectively. To recap, the lower the value of the index for each PD, the higher the impact of the respective PD on fertility. Therefore, based on the three PD models, the impact of non-marriage or non-sexual activity on fertility varies widely from as low as 34% to as high as 58%. In the case of Eswatini, as aforementioned in Chapter 3, extramarital or cohabiting relationships are prevalent and therefore OBM marriage index values may be underestimated and less reliable. The values of the marriage index based on the OBM model are lowest across women's socioeconomic characteristics (place and region of residence, education and wealth) for the three PD models utilised in the study. The RJB depicted higher values for the sexuality index, which are feasible for Eswatini as prior mentioned. Thus it is reasonable to say 66% of fecund women age 15-49 were sexually active (*Cm*=0.66) at country level.

The impact of sexual activity by women's socioeconomic characteristics, showed some variation within subpopulation categories. Also differences in the three PDs model indices of marriage (OBM) or sexual activity (RJS and RJB) were quite large at national level and subgroup population levels. Between the urban-rural divide, the effect of sexual activity was similar for each PD model. The less variation observed in the RJS model was within the ± 5% difference across the urban-rural categories (see Table G9, Panel b in Appendix G). In this model, non-sexuality activity reduced fertility by 49.1% in rural and 44.8% in urban areas. According to this index, this slight variation is indicative of out-migration or shortage of men in rural areas. The regional differences in sexual activity are less conclusive among the indices. Based on the RJB model, the sexual activity index was better for non-poor resource regions (Hhohho and Manzini) relative to resource poor regions - Shiselweni and Lubombo. The index of sexual activity using the RJB model was least in Hhohho and highest in Lubombo region. However, the observable pattern was not consistent with findings from the RJS model and therefore not conclusive (Figure 6.1, Panel b).

Overall, the findings in Figure 6.1, Panel c show an inverse relationship between level of education and the values of the index of marriage/sexual activity. The index of marriage/sexual activity was highest among women with no formal education and lowest among women with secondary and above education. Wealth index also shows a negative relationship between the wealth quintile and the value of the sexual activity index. The fertility inhibition effect of sexual activity was lower for poor women (poorest and poorer) compared to non-poor women (middle/richer/richest).

In overview, the fertility reducing effect of non-sexual activity is higher among educated and well-off/rich women compared to uneducated and poor women. The fertility suppressive effect of the index of sexual activity is influenced by educational attainment and wealth. Educated and better-off women were prone to postpone or delay onset of marriage or sexual activity (Table 6.1). More so, the proportion of married or sexually active was low for women with higher social status (see Tables G5, G8 and G12 in Appendix G).

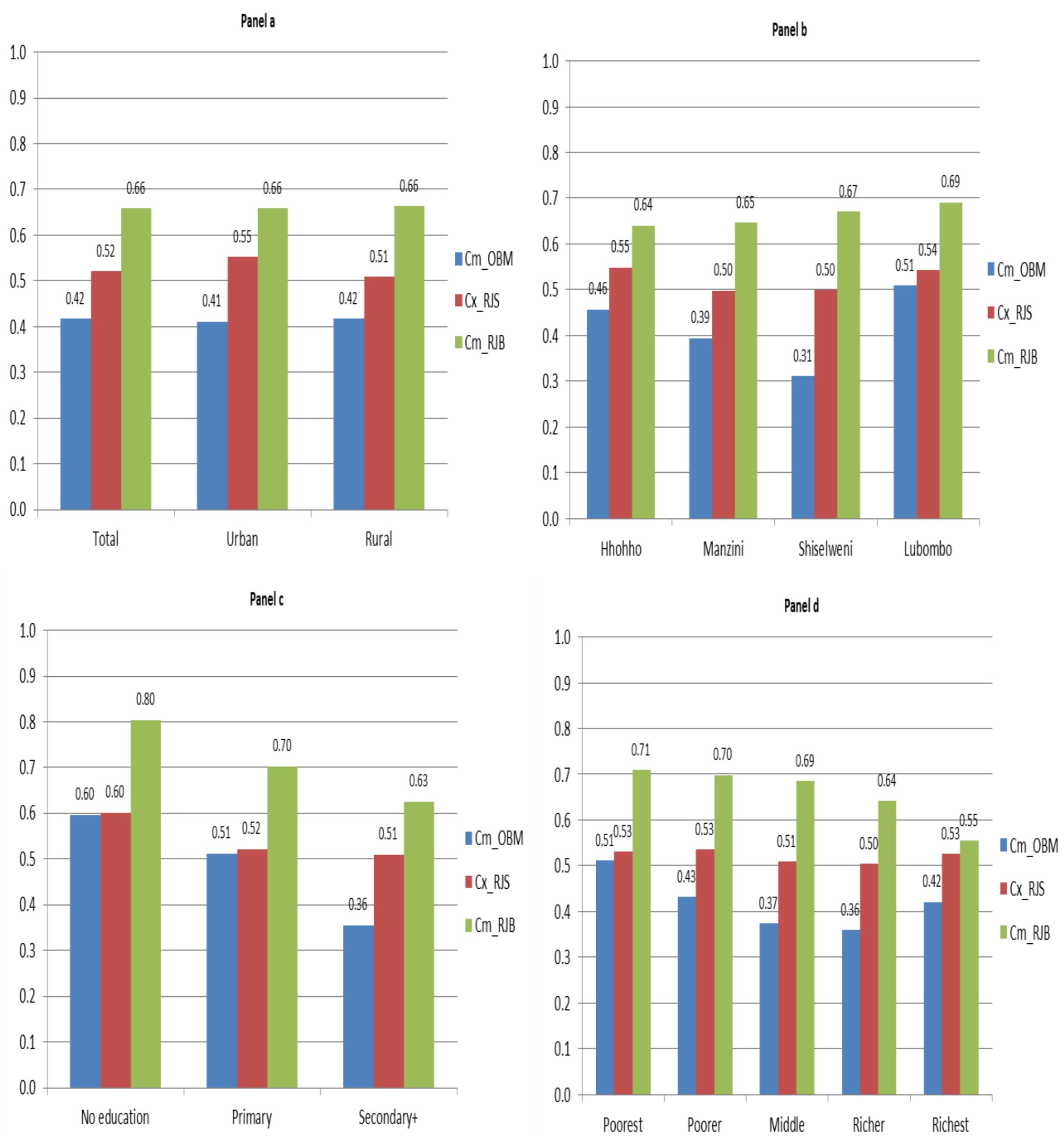

Figure 6.1: Indices for marriage or union (*Cm*)/sexual exposure (*Cx*) by residence, region, wealth and education, Eswatini 2007 DHS
Source: Author's calculations

6.2 Contraception

At national level, the results in Figure 6.2 and Tables G4, G9 and G12 in Appendix G show that contraceptive use had the second most net reduction effect on fertility as expressed by two models OBM (*Cc*=0.50), and RJS (*Cu*=0.64). However, the third model, RJB, suggests that contraception had the greatest fertility reducing effect on fertility, followed by sexual activity (*Cc*=0.61 vs *Cm*=0.66).

As explained for the marriage/sexual activity index, the variation of the three models in contraception, is more definitional. The OBM model, which has a narrow definition of sexual exposure in marriage/cohabiting, yielded the lowest *Cc* values in overall and across population subgroups. The other two models, RJS and RJB, with a broad and much broader/inclusive, respectively definition of sexual activity, had similar values to the contraceptive use index. The variation was within the ± 0.05 difference in the index values across subpopulations (Figure 6.2, Panels a to d).

The effect of contraception on fertility varied by place and region of residence, educational levels and wealth status subgroups. The effect of contraception on fertility varied significantly by place of residence. The fertility suppressive effect of contraception was greater in urban than rural areas (Figure 6.2, Panel a). The regional distribution shows that the contraceptive use index had higher impact of fertility in non-poor resource regions (Hhohho and Manzini) compared to resource poor regions (Shiselweni and Lubombo). Overall, Panels c and d in Figure 6.2 depicts an inverse relationship between values of contraceptive use index and level of education as well as wealth status of women. The estimated values of contraception index (*Cc*/*Cu*) were highest for uneducated and poorest women and lowest for women in the richest wealth quintile and with secondary or higher education. Thus a positive reducing effect of contraceptive use on fertility at both wealth status and educational level, was observed (see also Panels a and b of Tables G4, G9 and G12 in Appendix G).

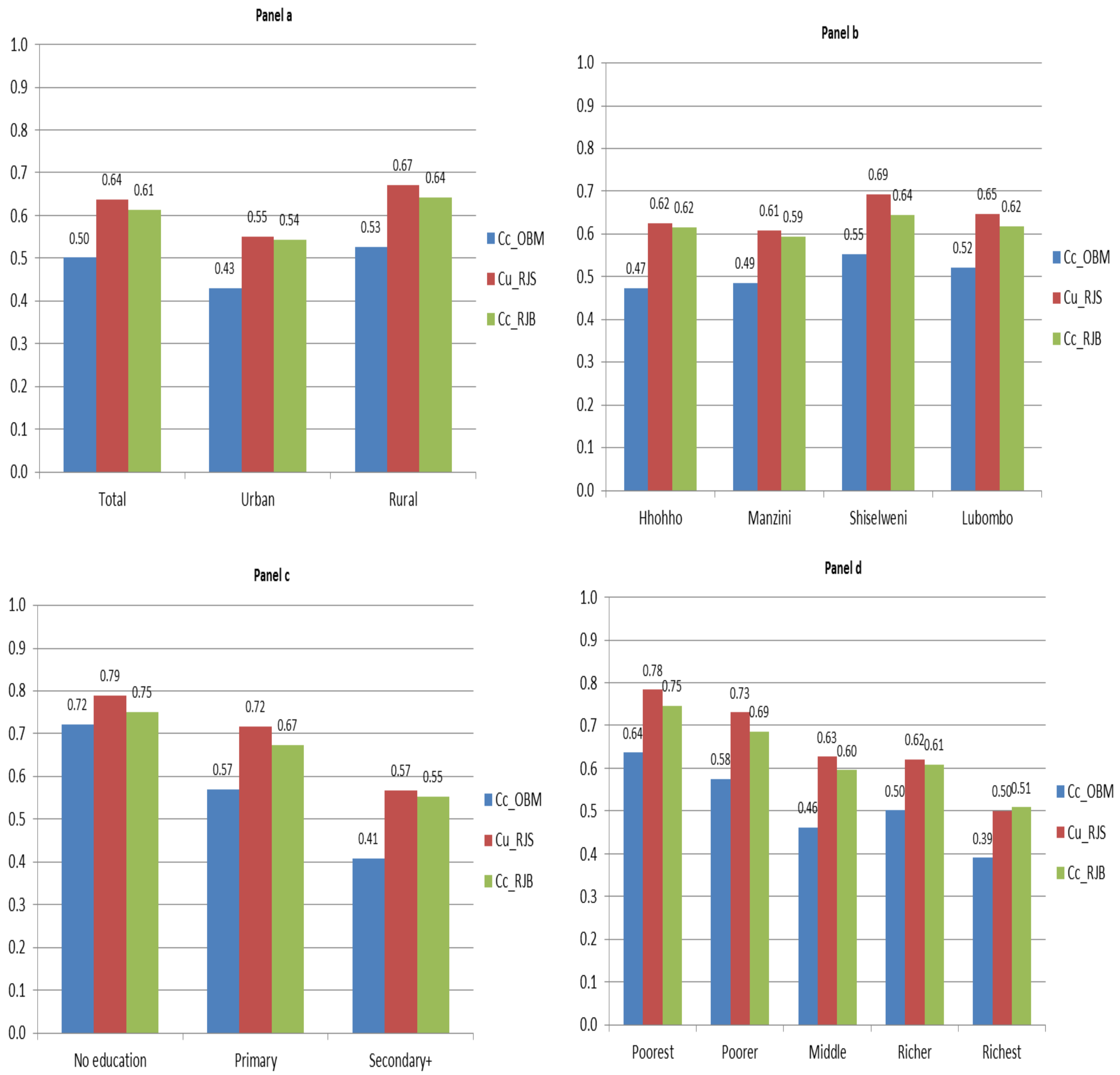

Figure 6.2: Indices for contraception (*Cc/Cu*) by residence, region, wealth and education, Eswatini 2007 DHS

Source: Author's calculations

The results for the three PD models in Tables G2, G6 and G10 of Appendix G show that contraceptive prevalence rate (u) in Eswatini was moderately high in the range 50.6-55.6%. The contraceptive prevalence rate (CPR=u) results in Tables G2 and G6 for marriage (OBM) and sexual activity (RJS), respectively, were in close agreement and yet the estimates from the two models varied less (within ± 5% variation) with those from the RJB model across most subpopulation groups in Table G10. The overall CPR for Eswatini among women aged 15-49 years was estimated at 50.2%

for those married or in union (an input to OBM model, refer to Table G2), and for those sexually active it was 50.6% (RJS input, Table G6) and 55.6% (RJB input, Table G10, Panel a).

Based on the three PDs of fertility models, the prevalence of contraceptive use was much higher in urban (58.1-63.5%) than in rural areas (46.9-52.5%). Contraceptive use was higher in non-poor resource regions - Manzini and Hhohho (52.5-58.1%) than in resource poor regions - Shiselweni and Lubombo (44.8-52.9%). Contraceptive use increased with wealth quintiles. The CPR was lowest among poorest women (33.2-39.4%) and highest among the wealthiest/richest women (62.2-66.4%). Similarly, a positive relationship of CPR with educational level was observed. The range for CPR for uneducated women (28.9-34.7%) is lower than for educated women (58.2-63.6%). The patterns of observed results are parallel to those found in section 4.2 for ever sexually exposed or sexually initiated women. The overall average effectiveness of contraceptive use (e) was estimated at 0.90.

In terms of contraceptive mix, the results in Tables G2 and G6 reveal a low (less than 5%) traditional method contraceptive prevalence rate in Eswatini. The majority of women chose to use more effective modern methods over traditional methods. Of the modern contraceptives, short-acting methods (pills, male and female condoms and injectables), were preferred to long-acting methods (female and male sterilisation, intrauterine device (IUD) and implants). Short-acting methods, in particular injectables, male condoms and pills, were mostly used among women and these could have contributed to the higher suppressive effect on fertility for the index of contraception. Female sterilisation, a long-acting method, was the fourth important contraceptive inhibiting fertility.

Overall, contraception has a stronger fertility inhibiting impact on urban than rural women, rich than poor women, better educated than uneducated/less educated women and among women in non-poor resource regions than resource poor/less urbanised regions. The observed pattern matches that of contraceptive prevalence rate across the selected socioeconomic characteristics (see Tables G2, G6 and G10 in Appendix G).

6.3 Postpartum infecundability

Postpartum infecundability (due to breastfeeding and postpartum sexual abstinence), is the third most important fertility inhibiting factor at national level based on all the three PDs frameworks. In these three models, the index of postpartum infecundability was measured in the same way and hence no variation in the index values among the models (refer to equations in Table G1, Appendix G). The results in Figure 6.3 reveal that the impact of postpartum infecundability was estimated at 31.5% at national level (Ci=0.68). The corresponding values for urban and rural areas are 34.6% and 30.1%, respectively. The greater fertility inhibiting effect of postpartum infecundability for urban women may probably be due to ease of access to information on benefits of breastfeeding. Regional variations in the (Ci) were observed, the inhibiting effect was lowest in Lubombo (23.4%) and highest in Manzini (36.9%). No clear pattern was observed contrasting poor versus non-poor resource regions.

The results in Figure 6.3 show a positive relationship between the level of education of women and the index of postpartum infecundability. Women with secondary and higher level of educational attainment had a lower impact on fertility (Ci=0.71) than those with no education (Ci=0.62). The results in Panel d depict clear differences in the value of Ci for the various wealth index categories, except for the richest wealth quintiles which had an equivalent value to the poorer of 0.63. This exception may require further enquiry to determine the motivation for long duration of breastfeeding or abstinence of contrasting groups - poorest versus richest women (see Table G3, Appendix G). The poorer and richest wealth quintiles exhibit the highest impact on fertility reduction due to postpartum infecundability. Excluding the richest wealth quintile, the findings suggest that postpartum infecundability has a stronger reduction impact on poor women (poorest and poorer) relative to non-poor women (middle and richer). In general, postpartum infecundability has a higher inhibiting effect on fertility among urban women, illiterate than educated women and poor than rich women.

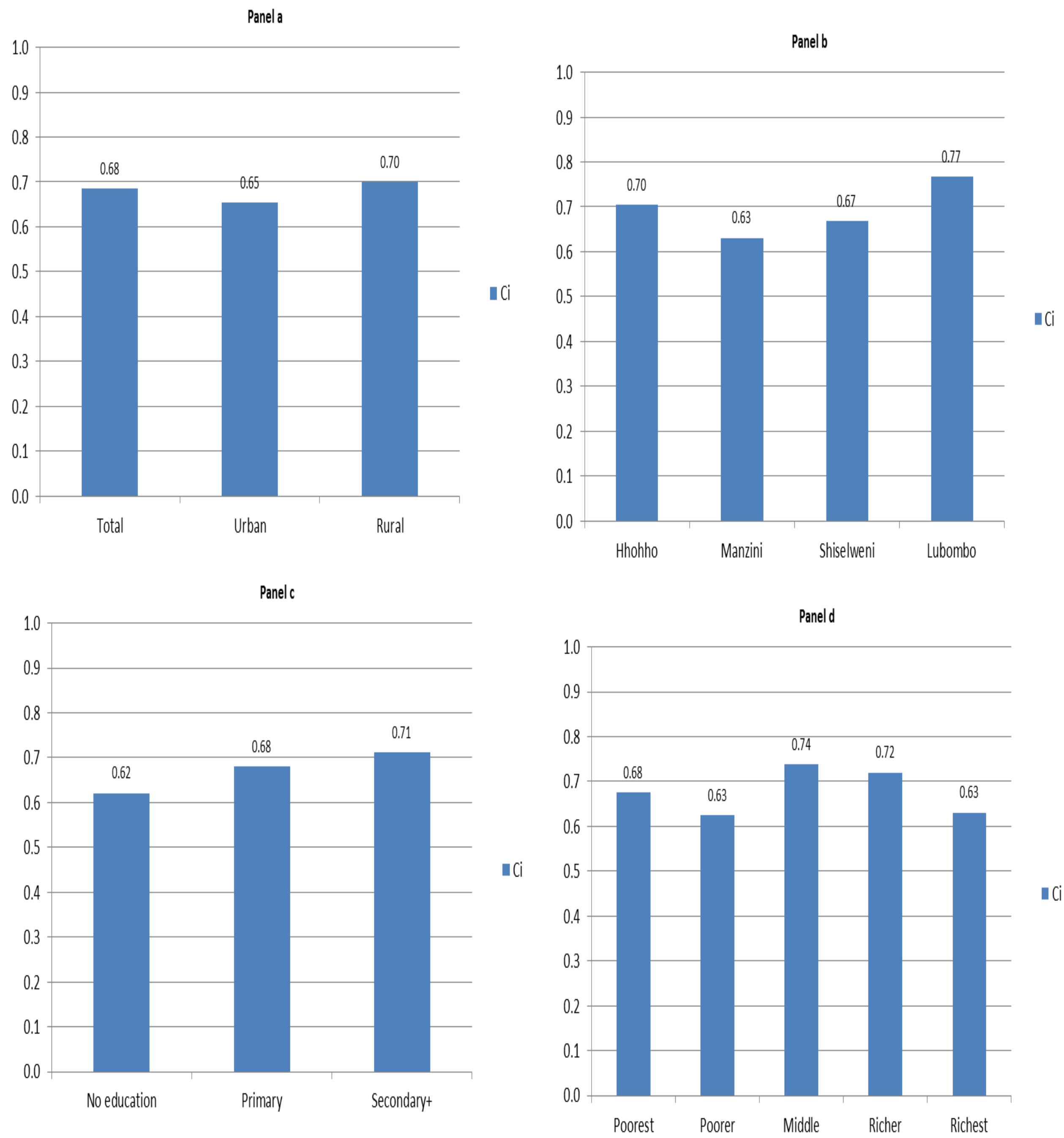

Figure 6.3: Indices for postpartum infecundability (*Ci*) by residence, region, wealth and education, Eswatini 2007 DHS
Source: Author's calculations

6.4 Induced abortion

Relative to the other three PDs (contraception, postpartum infecundability and marriage/sexual activity), abortion was the least important fertility reducing factor at national level. The results in Figure 6.4 indicate that the estimated indices of induced abortion (*Ca*) were similar for the three PD models: OBM (*Ca*=0.88), RJS (*Ca*=0.89) and RJB (*Ca*=0.92). The marginal difference of *Ca* figures between OBM and RJS models was also observed across subpopulations of urban-rural residence (Panel a), region (Panel b), educational level (Panel c) and wealth quintiles (Panel d). The *Ca* values for the RJB model were slightly higher compared to the other two, but mostly within ± 5% or ± 0.05 difference, except for the wealthiest quintile (Figure 6.4, Panel d).

The results show that urban-rural differences in the value of the index of abortion were minimal. Based on the three PD models, urban areas had slightly lower values of *Ca* compared to rural areas. Regional differences in the *Ca* figures were quite small (Figure 6.4, Panel b). Similarly, there was less variation in the impact of induced abortion with respect to level of educational attainment (Figure 6.4, Panel c). The results generally show that there was an inverse relationship between induced abortion and wealth quintile. The poor wealth quintiles (poorest and poorer) had higher values of *Ca* compared to the non-poor wealth quintiles. Women in the richest wealth quintile depicted lower figures of *Ca* compared to those in the poorest wealth category (Figure 6.4, Panel d).

Overall, the impact of abortion on fertility was rather similar across regions and levels of education. Abortion was lowest amongst the poorest and highest amongst the richest. Abortion has a slightly (within ± 5% variation) higher impact on fertility reduction among urban than rural women.

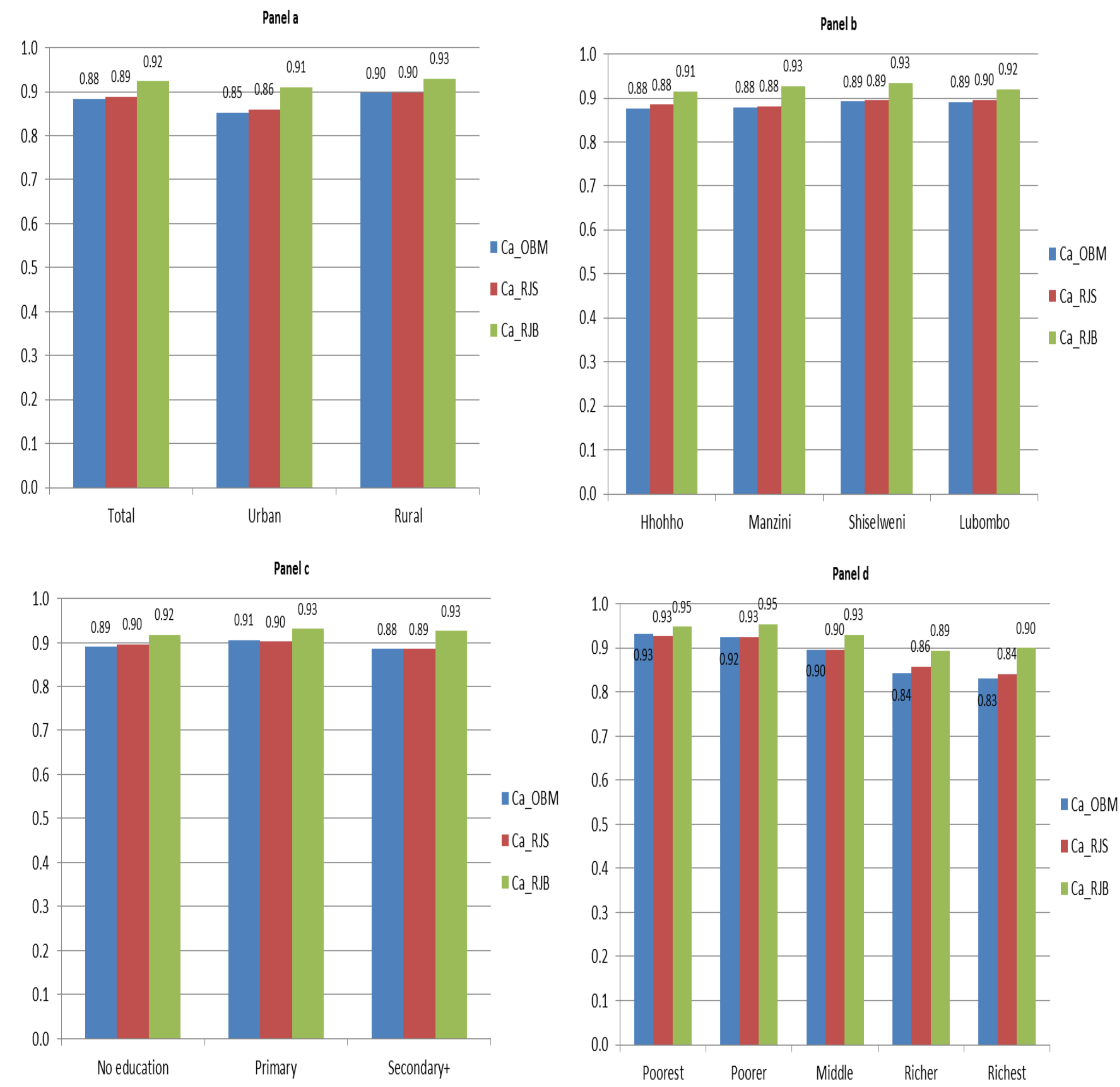

Figure 6.4: Indices for induced abortion (*Ca*) by residence, region, wealth and education, Eswatini 2007 DHS
Source: Author's calculations

In addition to analyses of the fertility reduction effects of induced abortion, estimates of total abortion rates (*TARs*) were modelled as prescribed by Johnston and Westoff (2010) and translated into abortion rates (*AR*) as depicted in Table 6.2. It should be noted that, the total abortion rate (*TAR*), like the total fertility rate (*TFR*), is a hypothetical estimate to derive the average number of induced abortions per woman in her reproductive lifespan. The abortion rates (*AR*) represent the number of abortions for every 1000 women aged 15-49. The estimation of abortion rates is incomplete and less common in most SSA countries. This is because abortion is deemed illegal and highly restricted in most circumstances and therefore misreported among women. This study contributes to the estimation of abortion of incidence in Eswatini and the Southern African region at large.

Table 6.2 depicts results on *TARs* (number of abortions per woman in her lifetime) and *ARs* (number of abortions for every 1000 women) for the three PD models - OBM, RJS and RJB. The comparison of the three models shows that abortion incidences were similar, especially for the OBM and RJS models. The abortion incidences were relatively lower for the RJB model. The abortion rate in Eswatini was high and in the range (18.9-23.9) abortions per 1000 women.

The abortion rates for the subgroup population showed a similar pattern to that shown for the values of *Ca* as presented above. There was no difference between urban-rural abortion rates and the abortion incidences were similar to that at national level. Regional differences in *ARs* were not consistent among the three PD models and therefore less conclusive. In general, however, it can be observed that the *TARs* were similar (0.7) in all regions based on the RJB model and varied less widely in the OBM and RJS models in the range (0.8-0.9). The differences in abortion rates were not substantial among regions. Thus abortion rates were similar between the poor and non-poor regions.

Contrary to the observed pattern of minimal variation of the impact of *Ca* on *TFR* by level of education, the estimates of *AR* or *TAR* showed an inverse relationship with educational attainment. The range for abortion rates (*ARs*) for women with a secondary or higher level of education (15.4-20.6 abortions per 1000 women) was lower than for women with no education (28.9-34.0). The *TAR* was highest among uneducated women. A woman with no education would experience about 1.0-1.2 abortions in her lifetime.

Concerning the wealth quintiles, abortion rates (*ARs*) in the three PD models ranged (15.5-24.3) for poor (poorest/poorer) women and (19.1-29.0) for non-poor (richer/richest) women. Overall, abortion rates were much lower in the two lowest wealth quintiles and higher in the two well-off wealth quintiles. In sum, combining the *AR* and *Ca* values, induced abortion in Eswatini is quite high and varies relatively by wealth and education. Abortion was higher among rich than poor women and higher for uneducated than better educated women.

Table 6.2: Total abortion rates and abortion rates by selected variables, Eswatini 2007 DHS

	OBM		RJS		RJB	
	TAR	*AR*	*TAR*	*AR*	*TAR*	*AR*
Total	0.84	23.9	0.83	23.8	0.66	18.9
Residence						
Urban	0.82	23.5	0.81	23.0	0.65	18.6
Rural	0.82	23.5	0.83	23.8	0.65	18.6
Region						
Hhohho	0.83	23.7	0.79	22.7	0.68	19.5
Manzini	0.83	23.8	0.84	24.0	0.65	18.6
Shiselweni	0.89	25.5	0.90	25.8	0.65	18.6
Lubombo	0.83	23.6	0.81	23.1	0.65	18.6
Wealth						
Poorest	0.73	20.9	0.85	24.3	0.65	18.5
Poorer	0.71	20.3	0.73	20.8	0.54	15.5
Middle	0.73	21.0	0.78	22.2	0.57	16.2
Richer	1.01	29.0	0.91	26.1	0.77	22.0
Richest	0.84	24.0	0.80	23.0	0.67	19.1
Education						
None	1.19	34.0	1.12	31.9	1.01	28.9
Primary	0.82	23.6	0.89	25.5	0.71	20.2
Secondary+	0.69	19.7	0.72	20.6	0.54	15.4

Notes: *TAR*= total abortion rate; *AR*=abortion rate per 1000 women
Source: Author's calculations

6.5 Infecundity/sterility

The index of infecundity, *Cf*, is the fifth PD of fertility computed based on the Stover model (RJS) only. Figure 6.5 shows the values of the index for selected background variables. Overall, infecundity had the least overall fertility reducing effect on fertility relative to the four PDs already discussed, accounting for a fertility reduction effect of 9.6% (*Cf*=0.90) on total fertility rate (see Appendix G Table G9 Panels a and b). Infecundity reduced fertility from its potential by 10.7% for rural women and 6.7% for urban women (Figure 6.5, Panel a). The pattern is less clear between less urbanised regions (Shiselweni and Lubombo) and urbanised ones (Hhohho and Manzini). The findings in Panel b, Figure 6.5 show that the infecundity index (*Cf*) value was 0.92 for the Manzini and Shiselweni regions and slightly less influential than for Lubombo (*Cf*=0.89) and Hhohho (*Cf*=0.88).

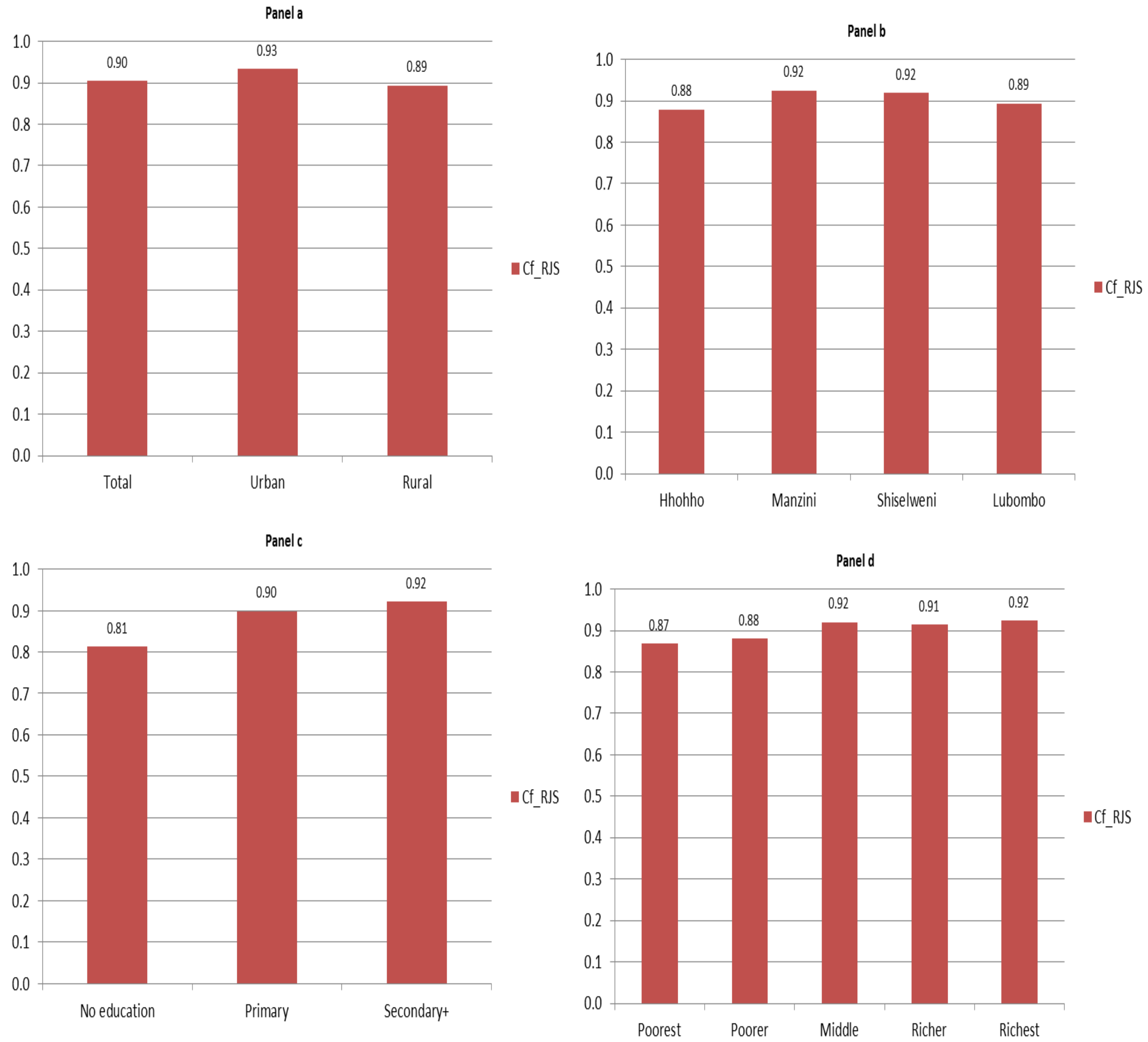

Figure 6.5: Indices of infecundity (*Cf*) by residence, region, wealth and education, Eswatini 2007 DHS
Source: Author's calculations

The results in panel c of Figure 6.5 reveal that the fertility inhibiting effect of infecundity was greater for women with no formal education than those with at least secondary education (18.7% vs. 7.8%). The differences in the value of *Cf* were clear by wealth quintiles. Women in the lowest wealth quintiles had lower values of *Cf* (poorest: *Cf*=0.87 and poorer: *Cf*=0.88) than those in the middle (*Cf*=0.92) and above average (richer: *Cf*=0.91 and richest: *Cf*=0.92) wealth quintiles (Panel d, Figure 6.5). The contribution of infecundity to fertility reduction was higher among poor women than among non-poor women. Overall, infecundity had a larger impact on reducing fertility among rural than urban women, poor than rich/well-off, and uneducated than educated women.

6.6 Decomposition of proximate determinants of fertility by background variables

The analysis of the PD framework can be extended further by examining the relative effects of the proximate determinants of fertility on total fertility rate. According to Odimegwu and Zerai (1996), a simple prorating decomposition analysis is applied to rank each PD with respect to order of its impact on or importance to fertility. The total combination of the respective indices sums up to 100. The results of decomposition analysis of the PDs by subpopulation categories of selected variables in the three PD models - OBM, RJS and RJB - are presented in Figures 6.6, 6.7 and 6.8. The corresponding values are also shown in Appendix G (Panel c, Tables G4, G9 and G12). This section gives emphasis to mostly determining the order of importance within the subcategories of the selected variables for each PD model. The pattern of influence of each PD by background variables has been examined in previous sections 6.1 to 6.5. It is noticeable that this pattern of influence on the impact on fertility matches that of the decomposition procedure (see Panel b versus Panel c, Tables G4, G9 and G12).

Based on the original Bongaarts model (OBM), the results in Figure 6.6 reveal at country level that relative contribution of PDs in order of greater influence was as follows: marriage (42.4%), contraceptive use (33.4%), postpartum infecundability (18.3%) and induced abortion (6.0%).

The order of importance at national level was observable at subpopulation by place and region of residence. The ranking order in general was the same with wealth index and level of education. However, among the richest women, the fertility suppressive effect ranking swopped between contraception and marriage (38.4% vs. 35.3%, respectively). The initial ranking of order of importance at national level was also switched for the second and third proximate determinants among women with no education. Postpartum infecundability due to combined effect of breastfeeding and sexual abstinence (33.1%) was found to be more important than contraception (22.7%). Women with no formal education were observed to have the highest median duration of postpartum infecundability (see Table G3, Appendix G). Overall, the impact of induced abortion is least important for fertility reduction. Sexual activity/marriage, contraception and postpartum infecundability (due to breastfeeding/sexual abstinence) constitute the three most influential determinants on fertility level.

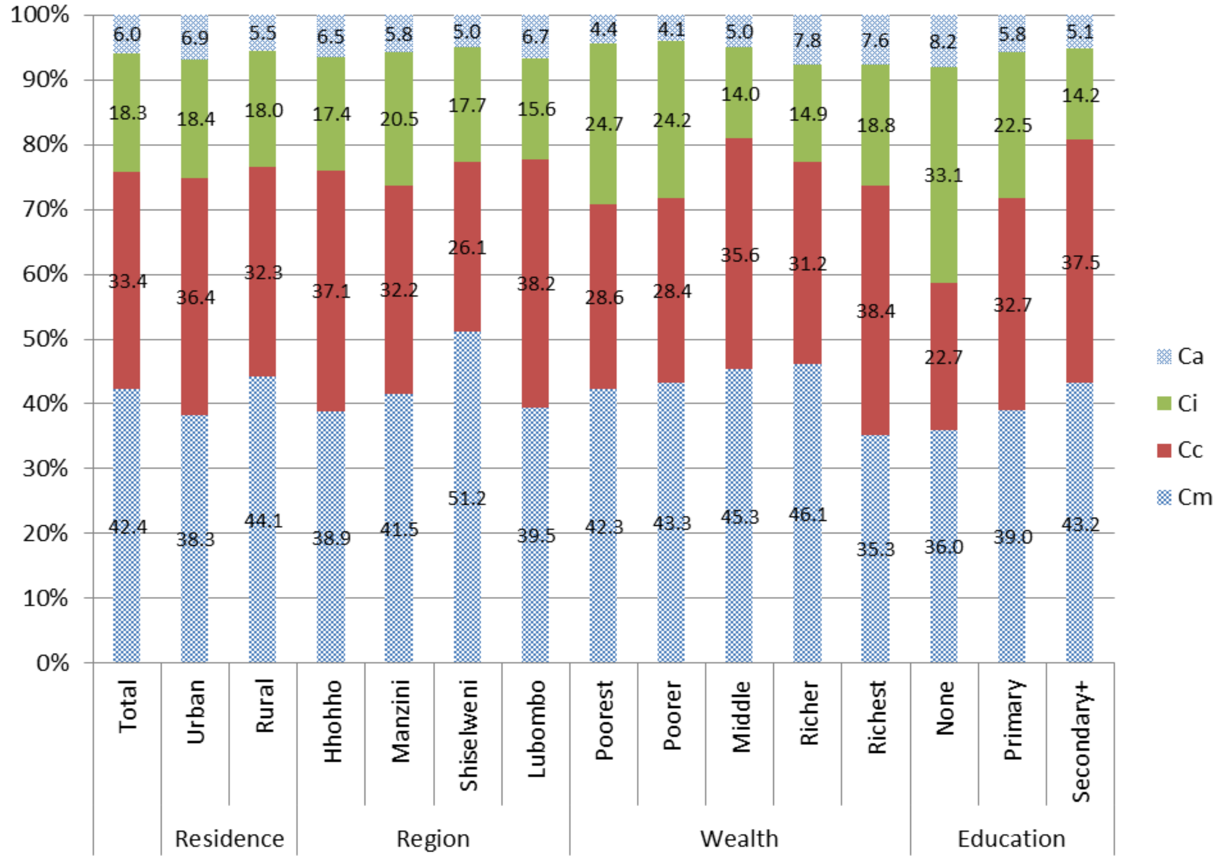

Figure 6.6: Relative contribution of proximate determinants of fertility by residence, region, wealth and education, OBM, Eswatini 2007 DHS
Notes: *Ca*=abortion index; *Ci*=postpartum infecundability index; *Cc* =contraception index; *Cm* =marriage index
Source: Author's calculations

Looking at the Stover PD framework (RJS) in Figure 6.7, the ranking of the relative effects of proximate determinants on total fertility rate corresponds to that of the OBM model, even when considering that a fifth PD of infecundity, *Cf,* had the least impact than the rest. At country level, the index of sexual activity, *Cx,* had the greatest reduction effect on fertility in Eswatini (38.4%) followed by contraception (26.5%), then postpartum infecundability (22.2%), abortion (7.0%) and infecundity (5.9%). Similar to the order of importance of PDs depicted through the OBM model, sexual activity, contraception and postpartum infecundability were the three most influential PDs on *TFR*. This rank order pattern of influence was observed for most subpopulation categories, especially by place and region of residence. The influence of sexual activity and contraception was similar for urban women.

In the Shiselweni region, postpartum infecundability was more important than contraception and both were less influential on inhibiting fertility than sexual activity. This pattern influence was observed among poor women (poorest and poorer) and among the uneducated and less educated women with primary education. Among the richest women, contraception had the strongest fertility inhibiting effect than non-sexual activity followed by breastfeeding/abstinence. Induced abortion and infecundity represent the least two impactful of the major PDs with their contribution ranging below 14% (see Table G9, Panel c).

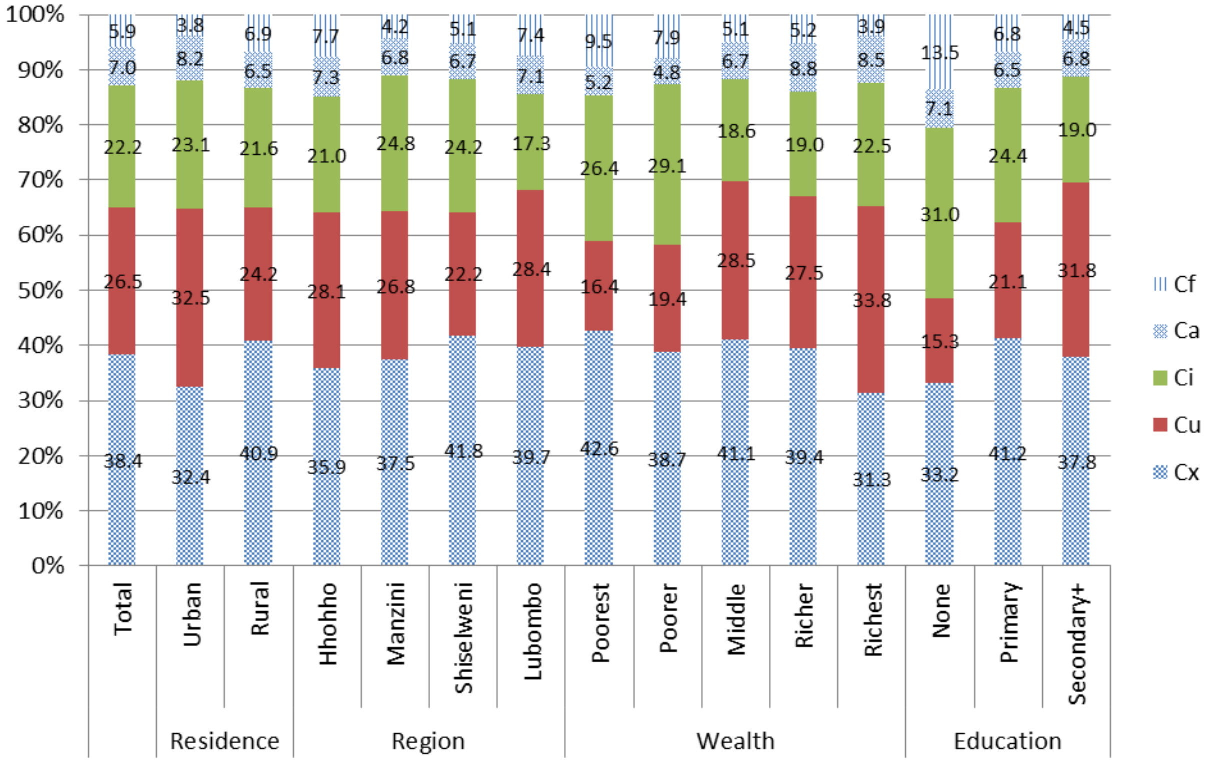

Figure 6.7: Relative contribution of proximate determinants of fertility by residence, region, wealth and education, RJS, Eswatini 2007 DHS

Notes: *Cf* =infecundity index; *Ca*=abortion index; *Ci*=postpartum infecundability index; *Cu*=contraception index; *Cx*= sexual activity index

Source: Author's calculations

The OBM was revised to the RJB framework by the same author, Bongaarts (2015) to account for sexual exposure outside formal unions. The results of the new framework are displayed in Figure 6.8. Abortion remains the least influential proximate determinant while the rest - sexual activity, contraception and postpartum infecundability, also have a substantial impact on reducing fertility. However, at national level, contraception had the more significant fertility suppressive effect than sexual activity, contradicting the finding of the OBM and RJS models as earlier observed. Postpartum infecundability remained the third most important fertility reducing factor. The RJB results presented by place and region of residence depict a similar pattern of influence. It should be noted, however, that the impact differences on fertility were minimal between sexual activity and postpartum infecundability in the urban, Manzini and Shiselweni population subgroups.

The ranking order of importance at country level was consistent with findings observed for wealth and education variables, especially with non-poor women (middle, richer and richest) and women with secondary and higher education. Among uneducated women and poor women (poorest and poorer), postpartum infecundability had the greatest effect on fertility relative to other PDs. Within these subcategories, the results show the very important contributions of contraceptive use and sexual activity to fertility in Eswatini.

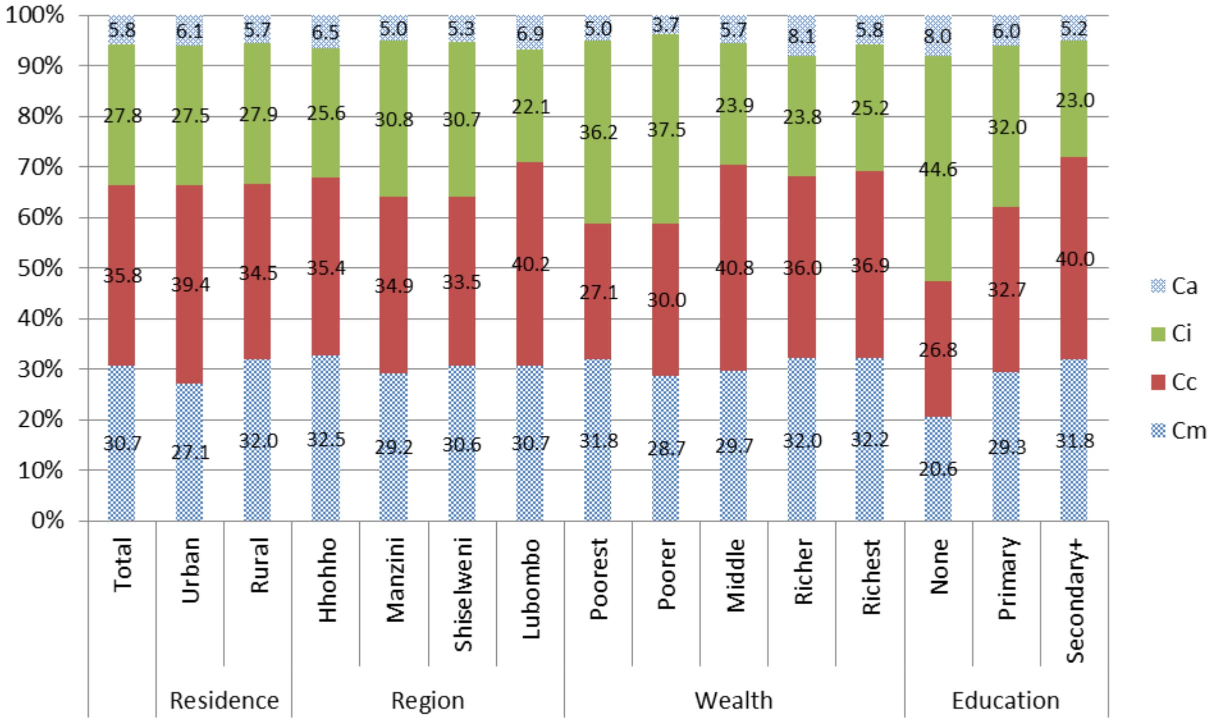

Figure 6.8: Relative contribution of proximate determinants of fertility by residence, region, wealth and education, RJB, Eswatini 2007 DHS

Notes: *Ca*=abortion index; *Ci*=postpartum infecundability index; *Cc* =contraception index; *Cm* =marriage index

Source: Author's calculations

The overarching impression of the results from Figures 6.6, 6.7 and 6.8 and matching values in Tables G4, G9 and G12 in Appendix G, is that sexual activity, contraceptive use and postpartum are the key drivers of fertility decline in Eswatini as predicted in the PDs frameworks. The relative effects of each of the three PDs vary by population subgroups. Abortion and infecundity contribute the least, although quite substantially, in reducing fertility. The role of abortion in reducing fertility has been obscured by lack of direct data measuring induced abortions. The impact of induced abortion, deemed illegal in normal circumstances in Eswatini and elsewhere in most countries in SSA, has been modelled or estimated in this study as presented in Table 6.2.

6.7 Comparison of the accuracy of the proximate determinants models

The indices of the PD framework, in particular *Cm* and *Ca*, are derived by utilising the observed total fertility rate (*TFR*). While one ultimate aim of PD models is to assess the contribution of each PD to *TFR*, the predicted *TFR* (*TFRe*) from the models provides an opportunity to examine the accuracy of the models. This is done by comparing the predicted *TFR* and observed *TFR* and computing the difference (*TFRe-TFR*) noted as error (Bongaarts, 2015). The estimates of *TFRe* and *TFR* of the three aggregate PDs of fertility models are presented in Table 6.3 by selected characteristics. The age-specific fertility rates to derive the actual *TFR* are displayed in Appendix G, Table G5. The age-specific fertility rates, generally, show a typical concave pattern as expected. It is noticeable that the fertility rates are higher for the age groups 20-24 and 25-29 and lower for the younger (15-19) and older (30-49) age groups of women.

Fertility level differences were apparent by place and region of residence, educational level and wealth status (Table 6.3). As expected, fertility decreased with increase in level of education and wealth status. Fertility was lower in urban than in rural areas. Fertility was higher in resource poor regions (Shiselweni and Lubombo) than in non-impoverished regions (Manzini and Hhohho). It is presumed that the reported *TFRs* may be underreported due to misreporting as highlighted in chapter 5 and therefore the examination of *TFR* is further extended in chapter 7 using appropriate adjustments methods.

The results of the comparison of observed *TFR* and model *TFRe* from the OBM, RJS and RJB models, are summarised in Table 6.3 and presented in Figure 6.9. When there is no bias, the error difference, *TFRe-TFR,* equals zero. Generally, the predicted *TFRe* estimates for the revised Bongaarts models of RJS and RJB are in very close agreement with the observed *TFR* values across subgroups of the selected variables. At country level, the two revised PD models had greater precision with (0.02-0.08) error bias than the original Bongaarts model (OBM) which had a bias of 0.86. The latter model shows a negative bias of approximately 1 birth per woman.

The small bias in fertility estimates for RJB model across the selected variables appears to suggest that the model is more accurate than the RJS model. This also indicates there is little fertility variation that is accounted for by other proximate variables (such as, coital frequency, intrauterine mortality) beside the key proximate factors accounted by the RJB and RJS proximate determinants of fertility models.

Table 6.3: Comparing estimates of level of fertility, Eswatini 2007 DHS

	OBM			RJS		RJB	
	TFR	*TFRe*	*error*	*TFRe*	*error*	*TFRe*	*error*
Total	3.85	2.99	-0.86	3.83	0.02	3.93	-0.08
Residence							
Urban	3.02	2.42	-0.60	3.34	-0.33	3.27	-0.25
Rural	4.21	3.22	-1.00	4.02	0.19	4.25	-0.04
Region							
Hhohho	3.62	3.19	-0.43	3.95	-0.33	3.90	-0.29
Manzini	3.67	2.53	-1.15	3.27	0.41	3.45	0.23
Shiselweni	4.28	2.41	-1.87	3.98	0.30	4.14	0.14
Lubombo	4.02	4.25	0.23	4.51	-0.49	4.62	-0.60
Wealth							
Poorest	5.55	4.60	-0.94	4.74	0.81	5.20	0.35
Poorer	4.95	3.24	-1.71	4.17	0.78	4.39	0.56
Middle	3.93	2.67	-1.26	4.08	-0.15	4.31	-0.38
Richer	3.27	2.72	-0.55	3.71	-0.45	3.86	-0.59
Richest	2.65	2.17	-0.48	2.71	-0.06	2.46	0.19
Education							
None	4.93	5.59	0.66	4.51	0.42	5.28	-0.35
Primary	4.54	4.16	-0.38	4.34	0.20	4.61	-0.07
Secondary+	3.39	2.16	-1.23	3.52	-0.13	3.51	-0.12

Notes: *TFR*= actual or observed total fertility rate; *TMFR*=total fertility rate for sexually active women; *TFRe*.= predicted or estimated total fertility rate from the Bongaarts and Stover models; error(*TFRe-TFR)*=the difference between the predicted and actual total fertility rate.
Source: Author's calculations

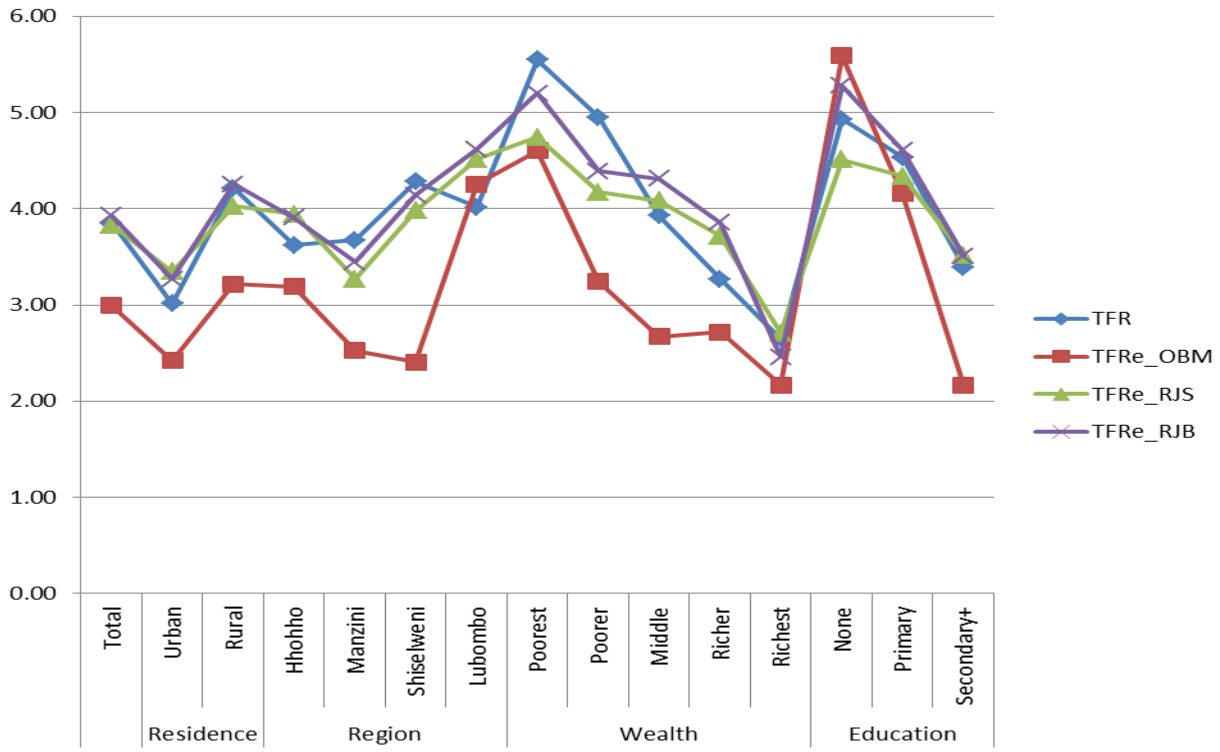

Figure 6.9: Reported and predicted fertility levels of PD models by residence, region, wealth and education, Eswatini 2007 DHS
Source: Author's calculations

6.8 Summary of the chapter

The chapter shows the decomposition of fertility using the proximate fertility determinants framework. The chapter summarises the overall contribution of each proximate determinant of fertility to observed fertility level. Since the proximate determinant framework is an aggregate model, it shows the overall contribution of each variable to fertility level for all women. This macro analysis of fertility may not be useful in programming fertility issues in small areas or with respect to individual women fertility preferences. A micro-perspective picture of the impact of proximate determinants of fertility on fertility level for each individual woman is shown through statistical modelling in the subsequent chapter, chapter 9. Due to possible impreciseness of the estimates of proximate fertility determinants in the sample, the PD model adequately captures the relative contribution of each PD to fertility.

CHAPTER 7

FERTILITY BEHAVIOUR IN ESWATINI: LEVELS AND TRENDS

This chapter presents estimates of fertility for Eswatini from multiple data sources and methods- both direct and indirect techniques. Age-specific fertility rates and the total fertility rate were computed using direct and indirect demographic estimation techniques to determine those that are best adapted to illustrate the levels and trends of fertility in Eswatini. In addition, the mean parity (children ever born) is also used in the analysis. Data on population structure (age-sex data, life expectancy) are useful in the calculation of total fertility rate, especially for methods requiring input based on population composition. The data are shown in Table F1 in Appendix F. The focus in this study is mostly on overall (national) level fertility estimates. Multiple methods and census data sources are utilised. The chapter findings -a by-product of this study- have been published elsewhere (Chemhaka et al., 2016a).

7.1 Reference period of fertility levels

The reference period or point to which fertility estimates refer to is usually ignored in most studies. More often the estimates refer to the year of survey or census and/or with no specific reference point.

The census night is declared 25 May 1966 (1966.40 in decimal faction), 25-26 August 1976 (1976.65), 25-26 August 1986, 11-12 May 1997 (1997.36) and 13/14 May 2007 (2007.36) for the 1966, 1976, 1986, 1997 and 2007 censuses, respectively. The data collection for the 2007 Eswatini DHS started in July 2006 ending in February 2007. The reference date for the 2007 Eswatini DHS estimated as 2006.88 (16 October 2006) was obtained using the mean of the century month code variable (v008) in dataset. Thus, decimal fraction of the enumeration reference date can be converted into day and month of the enumeration, and vice versa.

With regard to the direct estimates of fertility, the recording of births refers to the last 12 months before the census enumeration date. Therefore, the pattern of fertility was corrected by a one-half year lag before the survey to compensate for the fact that when women reported the births in the last year they were on average six months younger. For the DHS survey, the births collected refer to a 3-year period and hence there is a one and half year lag before the survey to which the fertility estimates refer.

With respect to indirect fertility estimates, the reference period for years and points are inherent in the assumptions of the indirect estimation techniques used as indicated in the respective tabulations. Overall, the fertility estimates from the P/F ratio methods (Arriaga, relational Gompertz model) refer to 12 months prior to the census reference date, while estimates from the P/F ratio-Trussell and Feeney variant, Gunasekaran-Palmore, Rele's method and CPFRs refer to 5-year period or multiples of 5-year periods before the census or survey reference date. The latter methods, therefore, allow a two and half-year lag to which fertility estimates refer.

7.2 Indirect estimates of fertility

The primary focus of this paper is to make a definitive set of fertility estimates for Eswatini through time. In doing so, the study seeks to present direct and indirect estimates of fertility obtained from various methods using the 1976, 1986, 1997 and 2007 censuses and 2006-07 Demographic and Health Survey (DHS) in Eswatini at national level. Multiple demographic methods of the P/F method ratio method, relational Gompertz model, Rele's method, Gunasekaran-Palmore method and cohort-period fertility rates (CPFRs) are employed to compare and validate the results. Thus, ultimately the fertility estimation method which performs better in the Eswatini context is set out.

7.2.1 The P/F ratio method

The commonly used P/F ratio method- Trussell variant was employed to all (1966, 1976, 1986, 1997 and 2007) censuses using the EASWESPOP-fertility software. As noted earlier, an adjustment factor (k) of P/F ratio for age group 20-24 (k1) is deemed more precise than that of average ratio of age groups 20-24 and 25-29 (k2) in determining the plausible TFR, but in this study both values of k are shown to indicate the sensitivity of this adjustment factor (Table 2). The results suggest that choosing the preferred k1 value for the age group 20-24 to that of the average k2 generates no difference in TFR, and the difference, if any, is only marginally higher. The differences, which may be due to data quality issues, especially for the 1966 census, should not be over interpreted.

The results are also compared to those of the Arriaga method which, unlike the Trussell variant, relaxes the assumption that fertility has been constant in the recent past, allowing for a changing or declining fertility pattern. Outstandingly, the fertility estimates are the same for both methods indicating fertility has fallen by two births in three decades (i.e. from seven to five children per women between 1976 and 2007). This trend of decline in fertility is similar to that depicted by the Feeney method (Table 7.1)

Table 7.1: Estimates of fertility based on P/F ratio method, Eswatini 1966-2007

Data Source	Enumeration reference date	TFR estimate	P/F Method: variant	Reference Period	Reference Point
PHC 1966	1966.40	7.9	Trussell (20-24)	1961 -1966	1963.90
		7.5	Trussell (20-29)	1961-1966	1963.90
		7.4	Arriaga[1] (20-24)	1965-1966	1965.90
		6.8	Arriaga[1] (25-29)	1965-1966	1965.90
		7.1	Arriaga[1] (30-34)	1965-1966	1965.90
PHC 1976	1976.65	7.1	Trussell (20-24)	1971-1976	1974.15
		7.1	Trussell (20-29)	1971-1976	1974.15
		7.0	Arriaga[1] (20-24)	1975-1976	1976.15
		7.1	Arriaga[1] (25-29)	1975-1976	1976.15
		7.1	Arriaga[1] (30-34)	1975-1976	1976.15
		7.1	Feeney		1976.65
PHC 1986	1986.65	6.9	Trussell (20-24)	1981-1986	1984.15
		6.7	Trussell (20-29)	1981-1986	1984.15
		6.5	Arriaga[1] (20-24)	1985-1986	1986.15
		6.5	Arriaga[1] (25-29)	1985-1986	1986.15
		6.5	Arriaga[1] (30-34)	1985-1986	1986.15
		6.7	Feeney		1986.65
PHC 1997	1997.36	5.2	Trussell (20-24)	1992-1997	1994.86
		5.2	Trussell (20-29)	1992-1997	1994.86
		5.2	Arriaga[1] (20-24)	1996-1997	1996.86
		5.3	Arriaga[1] (25-29)	1996-1997	1996.86
		5.2	Arriaga[1] (30-34)	1996-1997	1996.86
		5.3	Feeney		1997.36
PHC 2007	2007.36	5.1	Trussell (20-24)	2002-2007	2004.86
		4.8	Trussell (20-29)	2002-2007	2004.86
		4.8	Arriaga[1] (20-24)	2006-2007	2006.86
		4.7	Arriaga[1] (25-29)	2006-2007	2006.86
		4.7	Arriaga[1] (30-34)	2006-2007	2006.86
		4.8	Feeney		2007.36

Notes: Arriaga[1] implies Arriaga P/F ratio method based on one census data in the respective year; For the Feeney method the reference periods are shown in Figure 7.1.
Source: Author's calculations

For the Arriaga method, the most reliable adjustment factor for fertility rates is either for the age group 20-24, 25-29 or 30-34. Just like the Trussell variant, the (marginal) difference in fertility estimates for these adjustment factors is only noticeable in the 1966 census (Table 7.1). The P/F ratio-Arriaga variant fertility estimates adjusted for age group 25-29 were adopted for this study.

Moultrie and Dorrington (2008) found that for the Trussell variant, the P/F ratio for the age group 20-24 as an adjustment factor, is more preferable to the average scaling factor, k and is more accurate than the Feeney estimation method. This study in the context of Eswatini, however, finds that the Feeney method tends to be robust and accurate. The results in the period 1976-2007 show that the fertility estimates from the Feeney method and Trussell variant (adopting the average P/F ratio k2 scaling factors), are equivalent (Table 7.1).

The Feeney method generates a projected (backward/forward) TFR time trend as shown in Figure 7.1 for each census reference date. The fertility time trend gives an impression of an increase in TFR prior to 1975, which plateaus on, average at seven children per woman between 1975 and 1980. Onset of fertility transition (decline) is a recent occurrence in Eswatini, which could have started in the mid to late 1980s (Figure 7.1).

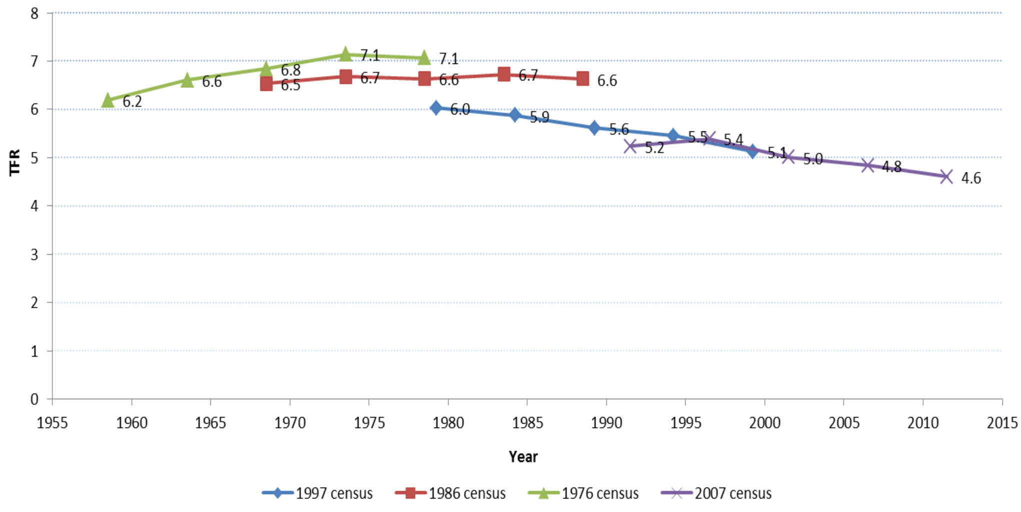

Figure 7.1: Fertility trends in Eswatini based on Feeney variant of the P/F ratio
Source: Author's calculations

The P/F ratios not only assess data quality and fertility levels, but also can be used to determine fertility trends as presented in Figure 7.2 and tabulated in Table F2 in Appendix F for the Arriaga and Trussell (equivalent to the Feeney method) variants. For both methods, the P/F ratios decrease with women's age for the 1966 and 1976 census data and hence, like the Feeney method (Figure 7.1), show fertility has been increasing between 1966 and 1976. The declining trend in P/F ratios in the two datasets may also be attributable to underreporting of children ever born.

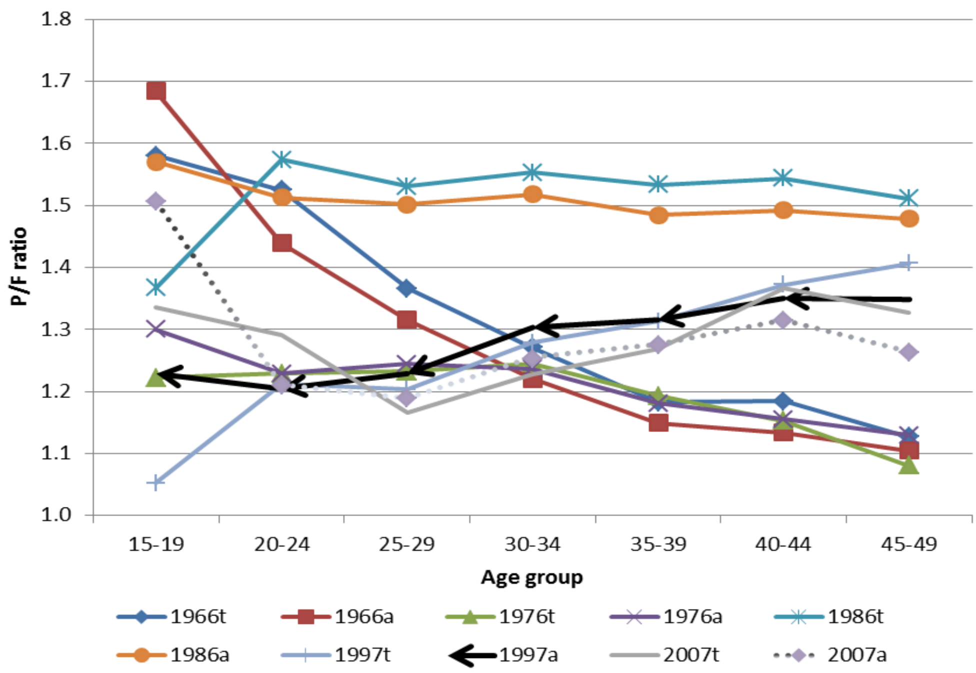

Figure 7.2: P/F ratios by age of women based on Trussell and Arriaga variants, Eswatini 1966-2007 censuses

Notes: t represents Trussell variant P/F ratios for age group 20-29 for k2 scale factor; a represents Arriaga's P/F ratios adjusting for age group 25-29

Source: Author's calculations

The rising trend of P/F ratios with age in the 1997 and 2007 datasets shows a true fertility decline affirming the Feeney method fertility trend. In 1986 census data, the P/F ratios follow a fairly uniform and constant pattern for all ages (age group 15-19, is always excluded for interpretation or treated with caution), implying a constant for fertility during the period as interpreted for the Feeney method. Alternatively, the constant misreporting of current fertility across all ages could be realistic.

The time trend of fertility estimates based on the Feeney method generated from the 1997 and 2007 census data seem to more consistent than from the 1976 and 1986 censuses, probably due to varying data quality issues in the censuses.

7.2.2 Cohort-period fertility rates

To further confirm the nature and onset of fertility transition in Eswatini implied by the P/F ratio method – the Arriaga, Trussell and Feeney variants and census data from an alternative type of data (2007 Eswatini DHS data) and the P/F ratio type method (cohort-period fertility rates), were applied. Unlike in the former methods where P/F ratios are computed from the respective model, the P/F ratios (in panel F) from the CPFRs are obtained directly as a ratio of rates in panel D to those in panel E for the corresponding ages (Table 7.2).

The P/F ratios referring to the 0-4, 5-9, 10-14 and 15-19 years before the survey are increasing with age of women in all the respective years. This indicates fertility has been declining in the matching years and hence the period 1987-2007 agrees with the results found earlier (see Figures 7.1 and 7.2). Although the pattern of fertility tends to be the same with the Feeney method, the level of fertility implied by CPFRs is lower by approximately one birth in the same periods. The CPFRs computed using the 2007 Eswatini DHS data in panel E of Table 7.2 estimates the TFR in 1997-2002 (mid-point 1999.38) and 2002-07 (2004.38) as 4.4 and 3.9 children per woman, respectively.

The onset of fertility decline using the P/F ratios (in panel F) is the average date between two periods when fertility was constant/unchanging (P/F ratios close to unity, i.e.1982-87) and fertility started to decline (P/F ratios increase with age, i.e. 1987-92). Therefore, onset of fertility transition in Eswatini is estimated as the average of 1984.38 and 1989.38, that is, 1986.88. This finding is important since it clearly gives a picture that onset of sustained fertility decline started in the period just after the mid-1980s. With the Feeney method, (Figure 7.1), fertility transition is approximated in the range of mid to late 1980s, consistent with the results from CPFRs.

Table 7.2: Cohort-period fertility rates and P/F ratios, Eswatini 2007 DHS

		Years prior to survey						
		2002-07	1997-02	1992-97	1987-92	1982-87	1977-82	1972-77
		0-4	5-9	10-14	15-19	20-24	25-29	30-34
Age group of cohort at survey								
A	No. Women in cohort	NUMBER OF BIRTHS						
15-19	1,273.5	263.2	4.4	0.0	0.0	0.0	0.0	0.0
20-24	1,046.1	864.5	266.2	0.7	0.0	0.0	0.0	0.0
25-29	728.8	687.5	661.3	202.5	7.7	0.0	0.0	0.0
30-34	615.8	502.5	639.4	611.2	188.8	7.4	0.0	0.0
35-39	502.6	334.7	470.6	547.5	551.6	185.8	6.4	0.0
40-44	437.6	148.7	332.6	470.6	535.8	567.8	202.6	15.1
45-49	382.6	27.9	153.4	326.6	402.6	538.9	470.7	175.4
B. COHORT PERIOD FERTILITY RATES								
15-19		0.041	0.001					
20-24		0.165	0.051	0.000				
25-29		0.189	0.181	0.056	0.002			
30-34		0.163	0.208	0.199	0.061	0.002		
35-39		0.133	0.187	0.218	0.220	0.074	0.003	
40-44		0.068	0.152	0.215	0.245	0.259	0.093	0.007
45-49		0.015	0.080	0.171	0.210	0.282	0.246	0.092
Age group of cohort at end of period								
C. COHORT PERIOD FERTILITY RATES								
15-19		0.041	0.051	0.056	0.061	0.074	0.093	0.092
20-24		0.165	0.181	0.199	0.220	0.259	0.246	
25-29		0.189	0.208	0.218	0.245	0.282		
30-34		0.163	0.187	0.215	0.210			
35-39		0.133	0.152	0.171				
40-44		0.068	0.080					
45-49		0.015	0.015					
D. CUMULATIVE FERTILITY OF COHORTS AT END OF PERIOD (P)								
15-19		0.207	0.254	0.278	0.307	0.370	0.463	0.458
20-24		1.081	1.185	1.299	1.467	1.760	1.689	
25-29		2.128	2.338	2.557	2.985	3.097		
30-34		3.154	3.493	4.060	4.149			
35-39		4.159	4.820	5.003				
40-44		5.160	5.404					
45-49		5.477						
E. CUMULATIVE FERTILITY WITHIN PERIODS (F)								
15-19		0.207	0.254	0.278	0.307	0.370	0.463	0.458
20-24		1.033	1.162	1.270	1.404	1.667	1.693	
25-29		1.976	2.200	2.360	2.629	3.076		
30-34		2.792	3.137	3.435	3.681			
35-39		3.458	3.897	4.289				
40-44		3.798	4.298					
45-49		3.871	4.370					
F. P / F RATIOS								
15-19		1.000	1.000	1.000	1.000	1.000	1.000	1.000
20-24		1.046	1.020	1.023	1.045	1.056	0.997	
25-29		1.077	1.062	1.083	1.135	1.007		
30-34		1.129	1.114	1.182	1.127			
35-39		1.203	1.237	1.167				
40-44		1.358	1.257					
45-49		1.415						

Source: Author's calculations

The CPFRs in panel C and D further indicates that fertility has been declining for all age cohorts of women. This is shown by looking from right to left in both panels for all the groups whereby the age-specific fertility rates are declining, indicating a fertility decline. Also, in both panels C and D, possible omission of births by older women in the period over 25 years before the survey, is noted. It is shown (reading up the diagonals for women aged 45-49), that the rates are lower than the adjacent cohort (40-44 age group) in the 1977-82 and 1972-77 periods. The underreporting of births by older women aged 45-49 by the P/F ratio is less than one for the same cohort in panel F for the period 1977-82.

7.2.3 The relational Gompertz model

As noted earlier, the relational Gompertz model is a more versatile and refined version of the Brass P/F ratio method. The model estimates of TFR using parity and fertility data in the form of P-points and F-points, respectively, which are related to a standard fertility schedule, are presented in Table 7.3.

Likewise, TFR declined by two births in four decades on average from 7 to 5 children per woman between 1966 and 2007 as shown with the P/F ratio method earlier. Although the total fertility rates between the relational Gompertz model variants are consistent, the similarity somewhat depends on choosing either the 2 F-points and 2 P-points or that of three points on the Arriaga's variant. The Arriaga's version gives little room for eliminating erratic points, especially for older women.

Table 7.3: Estimates of fertility based on relational Gompertz method, Eswatini 1966-2007

Data Source	Enumeration reference date	TFR estimate	Relational Gompertz method: variant	Reference Period	Reference point
PHC 1966	1966.40	7.0	Moultrie	1965-1966	1965.90
		6.5[6.8]	Arriaga	1965-1966	1965.90
PHC 1976	1976.65	6.9	Moultrie	1975-1976	1976.15
		6.6[7.0]	Arriaga	1975-1976	1976.15
PHC 1986	1986.65	6.4	Moultrie	1985-1986	1986.15
		6.3[6.6]	Arriaga	1985-1986	1986.15
PHC 1997	1997.36	5.0	Moultrie	1996-1997	1996.86
		5.2[5.4]	Arriaga	1996-1997	1996.86
PHC 2007	2007.36	4.6	Moultrie	2006-2007	2006.86
		4.7[5.0]	Arriaga	2006-2007	2006.86

Notes: the estimates in square brackets [] for Arriaga's version of the Brass Relational Gompertz model is based on 3 P-points and 3 F-points on both CEB and ASFR for 15-49 age group; the estimate not in bracket is that fitted using 2 P-points and 2 F-points 15-39.
Source: Author's calculations

The estimated fertility levels for the relational Gompertz model-Moultrie variant adopted for this study have been used to establish fertility trends and accuracy of fertility data as represented in Figure 7.3. The F-points (F-line) curve downwards in all the five censuses illustrating possible exaggeration of age or births by older women. The P-line (in pink) is above the F-line (in blue) and steeper, suggesting fertility was rising markedly, especially in 1966 and 1976. The fertility trend shown for 1986 indicates rather underreporting of current fertility by older women (aged 45-49 years), than possibly a fertility increase. This is similar to what was observed in Figure 7.2 for P/F ratios. The F-line is to the left of P-line, showing fertility decline in 1997. A fertility decline indicated in Figure 7.2 for 2007 is, however, not clear for panel e in Figure 7.3 since a similar pattern is shown, except for older women aged 45-49 whose deviation probably indicates their age exaggeration or exaggeration of births.

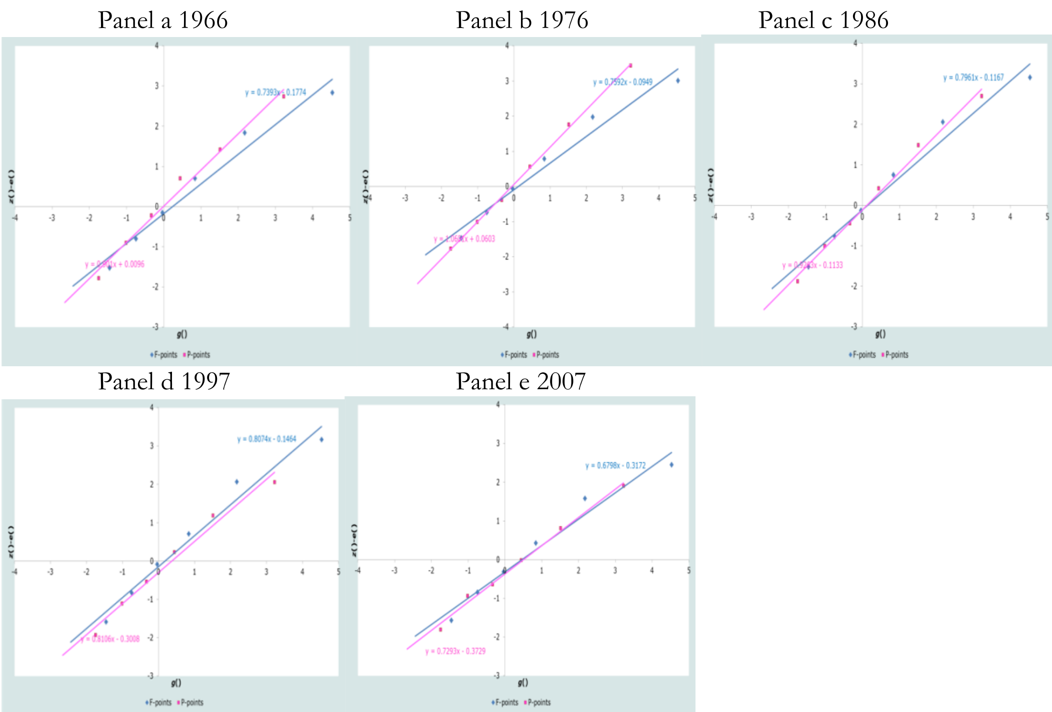

Figure 7.3: Relational Gompertz model diagnostic plots of fertility data for Eswatini censuses, 1966-2007
Source: Author's calculations

The next estimates of fertility are based on population structure or regression based indirect methods.

7.2.4 The regression based indirect methods of estimating fertility

The fertility estimates based on age-sex distribution are presented in Table 7.4 for the Rele's and Gunasekaran-Palmore regression based methods. The validity of fertility estimates from both these methods depends on the accuracy of the age-distribution, which is noted to be bad for 1976 and 1986 and moderate and good quality for 1997 and 2007 censuses. Two estimates of TFR were prepared for the Rele's method for the period 0-4 years and 5-9 years preceding the census enumeration.

The results in Table 7.4 illustrate that the fertility estimates referring to the recent period before the census are reasonably similar for the Rele's and Gunasekaran-Palmore methods. The results show a similar decline in fertility trend as shown with the P/F methods. However, the recent fertility estimates for the Rele's method and Gunasekaran-Palmore method are fairly lower, with a magnitude of a birth or slightly less, to those obtained from the P/F ratio method. The possible explanation is that age misreporting or under reporting of children could have led to an underestimation of fertility as the methods are very sensitive to errors in age data.

Table 7.4: Estimates of fertility based on Rele's and Gunasekaran-Palmore method - Eswatini 1976-2007

Data Source	Enumeration reference date	TFR estimate	Method	Reference Period	Reference Point
PHC 1976	1976.65	6.9	Rele[2]	1966-1971	1969.15
		6.1	Rele[1]	1971-1976	1974.15
		6.0	Gunasekaran-Palmore	1971-1976	1974.15
PHC 1986	1986.65	6.4	Rele[2]	1976-1981	1979.15
		5.7	Rele[1]	1981-1986	1984.15
		5.3	Gunasekaran-Palmore	1981-1986	1984.15
PHC 1997	1997.36	5.6	Rele[2]	1987-1992	1989.86
		4.4	Rele[1]	1992-1997	1994.86
		4.1	Gunasekaran-Palmore	1992-1997	1994.86
PHC 2007	2007.36	5.2	Rele[2]	1997-2002	1999.86
		3.8	Rele[1]	2002-2007	2004.86
		3.8	Gunasekaran-Palmore	2002-2007	2004.86

Notes: TFR estimates are based on EASWESPOP-fertility software; Rele[1] implies fertility rates computed for children aged 0-4 years to women age 15-49 years (i.e. CWR[0-4/15-49), and Rele[2] refers to CWR[5-9/20-54].
Source: Author's calculations

From a different data source and method (2007 Eswatini DHS data and CPFRs), the TFRs 4.4 and 3.8 for 1997 and 2007, respectively, are consistent with those obtained with Rele's method and the Gunasekaran method. Birth history data, from which CPFRs are obtained, are subject to errors in mistiming birth events or omissions, giving a false impression of fertility decline. The P/F ratios lower than the preceding adjacent cohort reading up the diagonal in panel F in Table A3 for older women aged 45-49, seem to suggest possible omission of births or age misstatement.

The TFR of 4.4 children per woman in 1997 from CPFRs was obtained assuming constant fertility 5-9 years before the survey. That said, fertility has been declining during the period and hence the TFR obtained could be an underestimate. A further examination of the accuracy of birth history data in determining TFR when miscounting of children occurs, is needed.

7.3 Overview on the estimates of fertility for Eswatini from direct and indirect methods

All the indirect methods are claimed to produce plausible estimates of fertility, especially with reasonably good quality data, irrespective of similar or different assumptions. It should be noted, however, that the quality of data impacts on the accuracy of estimates, depending on how each method corrects or adjusts for distortions in data. The estimates of fertility in Eswatini for comparable periods adopted from various methods as a summary, are tabulated in Table 7.5. The latter shows the direct and indirect estimation methods of fertility that can be best adapted or suited to explain level and trends of fertility in Eswatini. The summary of results reveal a reasonable degree of consistency of fertility estimates reported in census reports with those computed from this study using the same methods. Fertility decline of two births in four decades between 1966 and 2007 is, however, at a slower pace.

This study has prepared fertility estimates for each census data using the same method of estimation on all the methods undertaken for this study. Thus, re-estimating levels of fertility for Eswatini was done, where data was available, using various estimation techniques undertaken in the study using the five censuses of 1966, 1976, 1986, 1997 and 2007.

Table 7.5: Summary of fertility estimates for Eswatini using various methods

Method \Period	1965-66	1975-76	1985-86	1996-97	2006-07
Direct estimation	5.2	5.7	4.3	4.3	4.0
P/F Ratio-Trussell	7.5	7.1	6.7(6.7)	5.2 (5.3)	4.8(4.7)
P/F Ratio-Arriaga	7.1	7.1	6.5 (6.7)	5.1(4.5)	4.7
P/F Ratio-Feeney	----	7.1	6.7	5.3	4.8
RGM-Moultrie	7.0	6.9	6.4	5.0	4.6
RGM-Arriaga	6.5[6.8]	6.6[7.0]	6.3[6.6](6.6/6.5)	5.2[5.4]	4.7[5.0]
CPFR	----	----	----	4.4	3.9
Gunasekaran-Palmore	----	6.0	5.3	4.1	3.8
Rele's	----	6.1	5.7	4.4	3.8

Notes: CPFR implies cohort-period fertility rate; RGM implies relational Gompertz model; the estimates in bracket () are those derived from census reports on respective methods; for the RGM-Arriaga method estimates in square brackets [] are derived from 3 P-points and 3 F-points while those not in brackets are obtained from 2 P-points and 2 F-points.
Source: Author's calculations

The assumption of constant fertility in the Brass P/F ratio method-Trussell variant causes the method to slightly overestimate fertility. The Arriaga and Feeney methods, though, relaxes this assumption to allow fertility change; their estimates are almost identical to those of the Coale and Trussell variant. The estimates from these three methods match those obtained from the relational Gompertz models. The acceptable degree of correspondence between the relational Gompertz model variants suggests both models are dependable.

Due to the reasonable degree of freedom in eliminating the outlier P-points and F-points, the versatile and much improved version of the relational Gompertz model-Moultrie variant is preferable. The consistency in total fertility rates in these methods for all the periods is reassuring. The conclusion made by Moultrie and Dorrington (2008) that the Brass P/F ratio-Trussell method appears to be robust, even if its assumptions are violated, is corroborated in this study and hence cannot be overridden as a reliable method. The total fertility estimates obtained from this procedure are presumed to be upper bound fertility levels for the respective reference periods.

The Gunasekaran-Palmore and Rele's methods are in good agreement with direct estimation results although both estimates are more or less lower than the previous estimates from the P/F ratio methods. Equally, the CPFRs estimates correspond to the Gunasekaran-Palmore and Rele's methods. It is understood, however, that age distribution data and birth history data on which regression methods and CPFRs are based, suffer from errors of omission, undercount and age exaggeration, which need to be accounted or adjusted for in estimating fertility (Arriaga et al., 1994a; Cleland, 1996).

7.4 Summary of the chapter

The chapter has taken recourse in reassessing levels of fertility from around 1960 to 2007 using the available census data in Eswatini. Employed were a number of direct and indirect methods of estimating age-specific and total fertility rates. The empirical findings support that fertility transition is underway in Eswatini. Despite the fertility decline, fertility rates remained high in Eswatini. It remains to be interrogated using the latest 2017 census as to how fertility has progressed using the same data sources.

CHAPTER 8

DETERMINANTS OF CONTRACEPTIVE USE: A MULTILEVEL ANALYSIS

This chapter looks at the third objective of the study, to examine the associations of individual- and community-level factors with contraceptive use using statistical models. The chapter builds on bivariate analysis carried out in chapter 4 (section 4.2) to fit multivariate statistical models to study the impact of potential determinants of contraceptive use.

The study considered occupation, wealth, education, media exposure, women's empowerment, ideal number of children, union status, age, number of living children, child death experience, religion, contraceptive use, age at first birth and age at sexual debut correlates at micro or individual-level.

The macro (community-level) variables considered were those considered for modelling contraceptive use as follows: i) area disadvantage (place of residence, region of residence), ii) socioeconomic disadvantage (community social position, community media exposure), iii) women empowerment (community women's empowerment), and iv) fertility norms (community ideal fertility norm, community polygyny). Table 3.2 shows the definition or measurement of these macro variables. In brief, model building of a 2-level hierarchical logistic regression is explained in section 8.1 and section 8.2 deals with multilevel analysis of contraceptive use.

8.1 Model building for logistic regression analysis

A multilevel (or 2-level hierarchical) logistic regression with random intercept at the cluster (or community), level was constructed. The predictors of current use of contraceptives were chosen following their established theoretical importance in literature and in accordance with the study conceptual framework in section 2.3.2 and study hypotheses highlighted in section 2.4. Therefore, all women aged 15-49 who had ever had sex were the chosen sample. For these women, the study interchangeably used the terms sexually exposed, experienced or initiated. All the explanatory variables fitted showed dependence with contraceptive use in bivariate analysis (section 4.2).

A 5-step multilevel analytical strategy was used as suggested in section 3.7.4 and adjusted odds ratios were calculated to estimate associations between each explanatory measure variable with the binary response of contraceptive use. Single-level multiple (Model 1) and multilevel (Model 2-5) logistic regressions were constructed for comparison purposes of the methods. Multilevel models are a series of joined up analyses of empty, individual, community and individual-community variables. At individual-level, it should be noted that the findings from standard single-level logistic regression were very similar to those estimated using multilevel (random intercept) logistic regression as shown in Table 8.1.

Model interpretation of contraceptive use for sexually initiated women follows in section 8.2. Using multilevel models account for multilevel data structure of Demographic and Health Surveys which is not so with conventional single-level models based on population averages. Given Model 2 results for the empty model, indicate that the community variance of 0.1 though small, is statistically significant (standard error, 0.03) implying multilevel analysis should not be ignored in preference to single-level models. The latter are deemed not fit in dealing with hierarchical DHS data.

The statistically significant ($p<0.001$) Wald test indicates that individual (Model 3), community (Model 4) and full (Model 5) models fit the data well. Given the sample of women with high per cent users of current modern contraceptive users (47.7%) and insignificant traditional users (2.9%), statistical modelling is restricted to a subsample of all contraceptive users who are sexually exposed or experienced aged 15 to 49.

8.2 Multilevel logistic parameter estimates of contraceptive use among women

8.2.1 Individual- and community-level effects on contraceptive use

Table 8.1 shows the adjusted odds ratios (AOR) and 95% confidence interval (CI) for random-intercept logistic models of contraceptive use, among sexually experienced women by individual and community characteristics. The interpretation of results is based on full model (Model 5) which includes individual- and community-level variables and community random effects. Comparing Model 3 and Model 5 fixed effects coefficients, shows that the effects of the individual-level variables are relatively stable or consistent in the direction of influence. The level of significance is retained in all cases but two (age 35-39 and age at first birth 16-17 indicating weaker rather than moderate significant association) and in some cases, improved.

The results reveal variation in the individual-level effects on contraceptive use (Model 5). Each variable is interpreted such that all other factors are held constant or controlled for statistically. Table 8.1 reflects, overall, that women currently employed had a higher propensity of being current users of contraceptives than those who were unemployed. Taking into account the occupational type, women employed in professional occupations had significant higher odds of contraceptive use than those not employed (adjusted odds ratio (AOR) =1.51, 95% CI: 1.12-2.04). Being in agricultural or manual labour and sales and services occupations, increased use of contraceptives, although the association was not statistically significant.

Women in the poorest quintile of household wealth were less likely to use contraceptives than those in the richest quintile (AOR=1.52, 95% CI: 1.08-2.12). Relative to women from the poorest household wealth quintile, women in the poorer, middle, richer and richest were 19%, 78%, 40% and 52% more likely to use contraception, respectively; the association was not significant, only for poorer wealth status. Overall, women from a low level of wealth status were less likely to use contraception than their counterparts with middle or higher levels of wealth status.

As anticipated, the effect of education on contraceptive use was positive and statistically significant. Relative to women with no education, those with secondary or higher education were more likely to have reported use of contraceptives (AOR=1.87, 95% CI: 1.36-2.58). The odds of reporting contraceptive use significantly increased with increased exposure to media, with women having considerable access to media and moderate access to media 1.3 times and 1.4 times more likely to use contraceptives than women with low exposure to media, respectively. The likelihood of women using any contraceptives increased with improvement in the level of women's empowerment or autonomy. As compared to women with a low empowerment score, women with high empowerment were more likely to report current use of contraception (AOR=1.38, 95% CI: 1.12-1.69). The effect is still positive for moderate women's empowerment, but not statistically significant.

Compared with women who had less than two children (small fertility norm), women who had three to four children (intermediate fertility norm) and five or more children (high fertility norm), were 26% and 23% less likely to practise contraception. The odds of reporting current use of contraceptives declined among sexually experienced women who had intermediate or high fertility norms or ideals. However, the decline in contraceptive use was not significant for women with high ideal number of children.

Overall, being currently married or in a union seem to increase the probability of current use of contraceptives. On the other hand, as would be expected, the reverse is true for women who were formerly married. Relative to sexually exposed never married women, being married in monogamy increased the odds of contraceptive use (AOR=1.30, 95% CI: 1.08-1.58) while being married in polygyny was not significantly associated with increased use of contraceptives, and, having been formerly married, significantly reduced the odds of contraceptive use (AOR=0.49, 95% CI: 0.36-0.67).

In general, the odds of contraceptive use decreased with increase in maternal age. Compared to women aged 15-19 (teenage or adolescent years marking entry into marriage, sexual debut or first birth), older women (aged 35-49) had significantly reduced odds of contraceptive use (AOR between 0.3-0.6). Women aged 20-34 still had decreased odds of using contraceptives, although the difference was not significant. There was no difference observed between those aged 20-24 and those aged 25-29.

Number of living children (parity) was positively associated with contraceptive use. The odds of reporting current use increased from 1.7 for women with three to four children (medium family size) to 1.9 for those with five or more children (large family) compared with those who had none or not more than two children (small family). Age at first birth has a weak relationship with contraceptive use. Compared with women age less than 15 years at first birth, the odds of using contraceptives were significantly higher for women aged 16-17 at first birth (AOR=1.52, 95% CI: 1.10-2.11). No differences in use were observed for women aged 18 and above at first birth.

Child death, religion and age at sexual debut were not important or significant predictors of current contraceptive use among sexually exposed women. Although the differences were not significant, current use increased with increased age at sexual debut whereas having had an experience of child loss reduced the odds of current use.

In general, household wealth, education, exposure to media, women's empowerment, ideal number of children and number of living children, were found to be positively significantly associated with contraceptive use. Generally, the association between individual characteristics and contraceptive use remained similar in all the models. Controlling for community-level variables was of marginal difference in the association between individual-level variables and use of contraceptives.

The significant independent effects of community variables (Model 4) on contraceptive use were observed for urban-rural residence and community ideal fertility norm. Women living in rural communities were 17% less likely to use contraceptives than those in urban communities. Women had lower contraceptive use in communities with a higher proportion of women with high ideal fertility norms of four or more children (AOR=0.79, 95% CI: 0.68-0.92). Caution should be exercised, however, in interpreting these results (Model 4) since they aggregated individual-level variables likely causing atomistic fallacy. Net of all individual- and community-level variables for these independent effects in Model 5 becomes insignificant. Although the community-level variables effects are eliminated in the final/full model, the associations between current contraceptive use and individual-level variables (in Model 3 and Model 5), overall, remain consistently similar or stable.

The results indicate that none of the community-level variables considered in the study were significantly associated with current use of contraceptive among sexually experienced women, controlling for all individual- and community-level variables. Although there were no statistically significant differences in community influences on current use, notably women living in communities that had a higher number of ideal children (high fertility norm), reported lower odds of contraceptive use. Women from communities with high female empowerment had a higher likelihood of having reported current use of a contraceptive method. The lack of statistical significance of community-level variable, Model 5, reveals that individual-level characteristics have a stronger impact on individual contraceptive behaviour.

8.2.2 Unobserved heterogeneity at community level in contraceptive use

The intra-community correlation coefficient (ICC) and median odds ratio (MOR) were used to capture variability in current contraceptive use among women across communities. Table 8.1 shows the estimates of community-level variances, ICC and MOR. The ICC was used to explain the proportional differences in contraceptive use that are caused by intra-community variation. Model 3 includes individual-level variables in a multilevel model. This model accounted for 0.9% of the variation in contraceptive use and could be attributed to community-level. Model 5 indicates that intra-community correlation was 0.7%. The latter model implies that there are unobserved or unmeasured community factors not inclusive of those in the model that were causing clustering of contraceptive use. Unobserved heterogeneity explains very little (is not substantial) of the random variance in contraceptive use across communities.

Adding community factors (in Model 4) to the individual-level variables (Model 3) slightly reduced random intercept variance from 0.03 to 0.02 (Model 5). Therefore, the community-level factors explain very little of the differences in contraceptive use between clusters or communities. The addition of community variables reduced significantly, but slightly, community-level variability in contraceptive use. Therefore, it could be that the community variables included in the model were not better predictors of contraceptive use variability at enumeration area/community-level. Most variations between communities were explained by differences in their individual characteristics.

Table 8.1: Results of the multilevel logistic regression analysis of the predictors of contraceptive use among sexually exposed women aged 15-49 in Eswatini, 2007

FIXED EFFECTS	Model 1		Model 2		Model 3		Model 4		Model 5	
Individual characteristics	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**
Occupation										
Not working	1				1				1	
Agricultural or manual	1.12	0.88 - 1.42			1.15	0.90 - 1.47			1.13	0.89 - 1.45
Sales and services	1.18	0.97 - 1.44			1.12	0.93 - 1.35			1.09	0.90 - 1.32
Professional	1.66**	1.22 - 2.27			1.52**	1.12 - 2.04			1.51**	1.12 - 2.04
Wealth										
Poorest	1				1				1	
Poorer	1.15	0.87 - 1.51			1.19	0.91 - 1.56			1.19	0.91 - 1.56
Middle	1.75***	1.33 - 2.29			1.77***	1.36 - 2.32			1.78***	1.35 - 2.35
Richer	1.42*	1.05 - 1.91			1.41*	1.07 - 1.87			1.40*	1.04 - 1.89
Richest	1.48*	1.07 - 2.03			1.58**	1.18 - 2.12			1.52*	1.08 - 2.12
Education										
None	1				1				1	
Primary	1.35*	1.02 - 1.78			1.46*	1.08 - 1.97			1.49*	1.10 - 2.02
Secondary/higher	1.63**	1.21 - 2.20			1.81***	1.32 - 2.49			1.87***	1.36 - 2.58
Exposure to media										
Low	1				1				1	
Moderate	1.33*	1.04 - 1.70			1.29*	1.05 - 1.59			1.29*	1.05 - 1.59
High	1.42**	1.13 - 1.79			1.38**	1.11 - 1.71			1.38**	1.11 - 1.72
Women's empowerment										
Low	1				1				1	
Moderate	1.22	1.00 - 1.48			1.17	0.97 - 1.42			1.19	0.99 - 1.45
High	1.37**	1.12 - 1.68			1.35**	1.11 - 1.66			1.38**	1.12 - 1.69
Ideal number of children										
<3	1				1				1	
3-4	0.71***	0.60 - 0.85			0.73***	0.62 - 0.86			0.74***	0.62 - 0.87
5+	0.76	0.55 - 1.06			0.76	0.56 - 1.03			0.77	0.57 - 1.05
Union status										
Never married	1				1				1	
Monogamous	1.31**	1.07 - 1.6			1.32**	1.09 - 1.59			1.30**	1.08 - 1.58
Polygynous	1.12	0.83 - 1.51			1.19	0.89 - 1.59			1.16	0.86 - 1.56
Formerly married	0.46***	0.34 - 0.64			0.50***	0.37 - 0.68			0.49***	0.36 - 0.67
Age										
15-19	1				1				1	
20-24	0.83	0.56 - 1.21			0.88	0.63 - 1.22			0.89	0.64 - 1.24
25-29	0.80	0.53 - 1.19			0.88	0.61 - 1.25			0.89	0.62 - 1.27
30-34	0.85	0.55 - 1.30			0.96	0.65 - 1.41			0.98	0.66 - 1.44
35-39	0.55**	0.35 - 0.85			0.60*	0.40 - 0.92			0.61*	0.40 - 0.94
40-44	0.35***	0.21 - 0.56			0.42***	0.27 - 0.65			0.42***	0.27 - 0.66
45-49	0.25***	0.14 - 0.43			0.27***	0.17 - 0.44			0.28***	0.17 - 0.45
Number of living children										
<3	1				1				1	
3-4	1.66***	1.31 - 2.09			1.66***	1.33 - 2.07			1.65***	1.33 - 2.07
5+	2.02***	1.49 - 2.74			1.88***	1.41 - 2.51			1.88***	1.41 - 2.51
Child death experience										
No	1				1				1	
Yes	0.93	0.76 - 1.14			0.96	0.79 - 1.16			0.96	0.79 - 1.16

Table 8.1: continued

Characteristic	Model 1		Model 2		Model 3		Model 4		Model 5	
	AOR	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**
Religion										
None/other	1				1				1	
Catholic	1.44	0.84 - 2.47			1.44	0.90 - 2.28			1.40	0.88 - 2.24
Pentecostal/Charismatic	1.10	0.78 - 1.54			1.11	0.78 - 1.58			1.11	0.78 - 1.57
Protestant	1.05	0.74 - 1.50			1.12	0.79 - 1.59			1.13	0.79 - 1.60
Apostolic/Zion	1.01	0.74 - 1.39			1.03	0.74 - 1.43			1.03	0.74 - 1.43
Age at first birth										
<16	1				1				1	
16-17	1.61**	1.12 - 2.30			1.51*	1.09 - 2.09			1.52*	1.10 - 2.11
18-19	1.24	0.87 - 1.77			1.19	0.84 - 1.71			1.21	0.85 - 1.73
20+	1.25	0.84 - 1.85			1.17	0.79 - 1.72			1.19	0.81 - 1.75
Age at sexual debut										
<16	1				1				1	
16-17	1.14	0.90 - 1.44			1.13	0.90 - 1.42			1.13	0.90 - 1.41
18-19	1.26	0.97 - 1.64			1.23	0.93 - 1.63			1.23	0.93 - 1.63
20+	1.36	0.96 - 1.93			1.36	0.96 - 1.92			1.36	0.96 - 1.93
Community characteristics										
Area disadvantage										
Residence										
Urban							1		1	
Rural							0.83*	0.69 - 0.99	0.99	0.79 - 1.24
Region										
Hhohho							1		1	
Manzini							0.96	0.80 - 1.16	0.95	0.77 - 1.19
Shiselweni							0.98	0.80 - 1.21	0.92	0.72 - 1.16
Lubombo							1.00	0.82 - 1.21	1.12	0.89 - 1.42
Socioeconomic disadvantage										
Community social position										
Low							1		1	
High							1.19	0.99 - 1.42	1.04	0.84 - 1.30
Community media exposure										
Low							1		1	
High							1.09	0.91 - 1.3	1.01	0.82 - 1.24
Women's autonomy										
Community women empowerment										
Low							1		1	
High							1.01	0.86 - 1.19	1.09	0.90 - 1.33
Fertility norms										
Community ideal fertility norm										
Low							1		1	
High							0.79**	0.68 - 0.92	0.92	0.77 - 1.10
Community polygyny										
Low							1	0.84 - 1.12	1	
High							0.97	0.77 - 1.32	1.02	0.86 - 1.21
RANDOM EFFECTS			**Empty**		**Individual**		**Community**		**Full model**	
Community variance (SE)			0.1(0.03)	0.05 - 0.19	0.03(0.04)	0.00 - 0.33	0.04(0.03)	0.01 - 0.14	0.02(0.04)	0.00 - 0.48
Log-likelihood	-1950.7		-2833.9		-1955.6		-2809.5		-1952.9	
ICC (%)			2.9		0.9		1.3		0.7	
MOR			1.35***	1.22 - 1.48	1.18***	0.95 - 1.41	1.22***	1.08 - 1.37	1.16***	0.90 - 1.41
Wald Chi-square					307.9***		51.8***		312.6***	
Likelihood-ratio test			14.85***		0.75		3.64*		0.46	
N	3097		4112		3097		4112		3097	

***P<0.001, **P<0.01, *P<0.05,

Notes: AOR=adjusted odds ratio; SE=standard error; ICC=intra-cluster correlation coefficient; MOR=median odds ratio; N=sample observations.

Source: Authors' calculations

In Table 8.1, the substantial decline in the AIC from the empty model (5671.9, Model 2) to individual model (3989.3, Model 3), confirmed the latter model better fit to the data. However, when the community-level variables were added, the final model was less superior (4001.8, Model 5). Therefore, the results from community variance and AIC in the models further reveals that the differences in contraceptive use are mainly due to compositional differences rather than the influences of community context. Also, the MOR, measuring heterogeneity between communities, was 1.18 ($p<0.001$, Model 2) and 1.16 ($p<0.001$, Model 3), further signifying little difference between communities in the use of contraceptives. The likelihood-ratio test implies that there are no real community differences, but that the differences are due to compositional differences (Model 3 or 5).

8.3 Summary of the chapter

The full model (Model 5) of multilevel logistic regression is shown in Table 7.1 for all 4,112 sexually exposed women. A holistic approach based on Easterlin's microeconomic theory was used to enter all individual- and community-level independent variables presented in Tables 3.1 and 3.2. The study allowed intercepts of various socioeconomic and demographic variables to vary across communities.

The final model reveals that micro-level variables are significantly associated with contraceptive use, except for experience of child mortality, religious affiliation and age at first sexual intercourse. The fixed effects (Model 5) reveal that occupation (professional), wealth (middle-richest), education, exposure to media, women's empowerment (high), ideal number of children (three or four children), union status (monogamy, formerly married), age 35-49, parity, and age at first birth (16-17 years) were statistically significant variables influencing use of contraceptives in Eswatini.

All tests for the seven community variables found that they were not significant. The study findings demonstrate that community characteristics in this study do not affect the level of contraceptive use among sexually active women. The results, however, reflected that contraception differs slightly significantly between communities. Further tests implied that there are no real community differences but that the differences are due to compositional differences.

CHAPTER 9

DETERMINANTS OF LIFETIME FERTILITY: A MULTILEVEL ANALYSIS

This chapter presents the extent to which the selected determinants at individual- and community-level are associated with lifetime fertility (number of children) in Eswatini. Section 9.1 looks at the modelling of lifetime fertility using count models and sections 9.2 and 9.3 detail the specific statistical models utilised in the study.

At micro level, the study utilises the following variables: occupation, wealth, education, media exposure, women's empowerment, ideal number of children, union status, child death experience, religion, contraceptive use, age at first birth and age at sexual debut. Due to multicollinearity, age and number of living children, were dropped in the analysis.

As mentioned before, at macro level seven variables categorised into four dimensions or domains were identified as follows: i) area disadvantage (place of residence, region of residence), ii) socioeconomic disadvantage (community social position, community media exposure), iii) women empowerment (community women's empowerment), and iv) fertility norms (community ideal fertility norm, community polygyny).

9.1 Model building for count models

In this study, supply-demand and regulation cost variables were added to the models, determining number of children born as required for Easterlin's microeconomic theory. More so, various socioeconomic and demographic factors were deemed important for the study. Using data from the only 2007 Eswatini Demographic and Health Survey ever conducted in the country, the study applied multivariate and multilevel Poisson and negative binomial regressions to investigate potential determinants of total number of children ever born in a 5-step analytical strategy highlighted in section 3.7.4. Modelling count fertility data is complex and therefore, starting from a simpler but imperfect model, facilitates comparison of the impact of potential factors on fertility (Balk, 1994).

The single-level multiple Poisson regression is the basic or default in analysing count data, but due to overdispersion in data, a single-level multiple negative binomial regression was adopted. In this study, due to the multilevel nature of data, multilevel Poisson and negative binomial regressions with two levels -at individual and community - were applied. Results of the multilevel Poisson and negative binomial regression analysis of the predictors of lifetime fertility (children ever born), were restricted to a sample of sexually exposed women aged 15-49 in Eswatini. The likelihood-ratio test was subjected to the two count models and the multilevel Poisson regression was considered a better fit for modelling children ever born than the multilevel negative binomial regression model. The results of the latter model, in comparison with those of the multilevel Poisson regression, are shown in Appendix H, Table H1. The alpha parameter was equal to zero, implying there was no significant difference between this model and the multilevel Poisson model. This finding is consistent with previous studies by Grace and Carr (2009) and Amara (2015), who found that the multilevel Poisson model provided a better fit to data than the multilevel negative binomial model when modelling children ever born among women. The regression parameters for these two [generalised Poisson and negative binomial regression] models, are somewhat similar (Sadia, 2013: 561) in line with current study findings displayed in Table H1, Appendix H.

The likelihood-ratio test for Poisson regressions was significant for model 2 through 5, signifying that the single-level multiple Poisson regression is significantly different to the multilevel Poisson model. The latter model accounted for overdispersion in the data adequately and hence was adopted for this study (Table 9.1). Further, using the likelihood-ratio test, the negative binomial models fail to reject the null hypothesis that there is no significant difference between the standard multiple and multilevel regression compared to the multilevel Poisson models (Table 9.1). Therefore, attention has been restricted to the random intercept Poisson model. The results for the multilevel negative binomial results were thus excluded in this study. The results for the parameter estimates, however, are the same for the two models.

Unlike in the logistic regression with a dichotomous response, the ICC was not computed since there are no latent (unobserved) responses in the formulation of Poisson models from the assumption that the variance equals the mean, and its computation is quite complex (Rabe-Hesketh and Skrondal, 2012). However, the equivalent of the median odds ratio (MOR) called the median incidence rate ratio (MIRR) was computed to observe heterogeneity.

As explained earlier in section 8.1, results for Model 1 to Model 4 are provided for comparative reasons. At individual-level, the findings from Model 5 correspond well to those of Model 3. The directions of influence of the individual variables in both models are largely consistent or remain stable when community variables are added. Model 2 indicates a community variance of 0.06 (standard error, 0.01, Table 9.1). This significant random intercept variance justifies the application of multilevel models and that the between-community differences could be explained by either individual or community characteristics observed or other unobserved community variables.

9.2 Multilevel Poisson model parameter estimates of lifetime fertility

9.2.1 Individual- and community-level effects on children ever born

Table 9.1 presents fixed effects (micro and macro measures of association) and random effects (measures of variation) results with children ever born (CEB) as the outcome from multilevel Poisson analyses. To note, attention has been restricted to Model 5. As with the contraceptive use full model (Model 5), each factor coefficient is interpreted, controlling for all other variables.

At individual-level, findings contrary to what was expected, indicated that being employed for a woman strongly increases the likelihood of having more children compared to an unemployed woman (Table 9.1). When all other factors were held constant, the incident rate of children ever born for women employed in agricultural or manual labour was significantly greater than the incident rate of children ever born for unemployed women (adjusted incidence rate ratio (AIRR)=1.11, 95% CI: 1.04-1.18). Likewise, the propensity of children ever born for women in sales and services, and professional occupations was similar and highest (AIRR=1.13, $p<0.01$).

The likelihood of childbearing was equal between the lowest poorest wealth quintile and second poorer wealth quintile. Given that, the propensity to bear more children declined with wealth status; relative to worse-off (poor and poorest) women, and women from well-off (richer and richest) household wealth quintiles, were significantly less likely to have more number of children born. Being better educated (primary, secondary or higher educational level) was significantly associated with fewer children as compared to being illiterate or uneducated.

Although there was no significant difference in the incident rate of childbearing by exposure to mass media, women with moderate or high exposure to media had a slight lower incident of rate of children ever born than women with low media exposure (moderate: AIRR=0.99, 95% CI: 0.94-1.05; high: AIRR=0.97, 95% CI: 0.91-1.03). Thus, a negative association, but insignificant relationship was observed.

At individual-level, women's empowerment was a strong predictor of lifetime fertility. The inverse relationship with children ever born found earlier in the bivariate analysis (section 4.3) appears to have reversed in multivariate and multilevel analyses. There was no difference observed in incident rate of children ever born between women with moderate empowerment and those with high empowerment. Women with moderate levels of women's empowerment/autonomy were significantly more likely to have more children than those with low autonomy or empowerment.

The average number of children born was more likely to increase as the ideal number of children for women increased. Women whose ideal number was much higher (5 or more children) or moderately higher (3-4 children), were significantly more likely to report higher number of children born than those with small (less than 3) ideal number of children (AIRR=1.26, 95% CI: 1.18-1.35 and AIRR=1.12, 95% CI: 1.07-1.17, respectively).

The results indicate that union/marital status was strongly associated with lifetime fertility ($p<0.001$). Being formerly married (AIRR =1.89, 95% CI: 1.76-2.03) and currently married in monogamy (AIRR =1.73, 95% CI: 1.64-1.83) or polygyny (AIRR =2.09, 95% CI: 1.95-2.25) significantly increased the propensity to bear more children relative to being never married among sexually exposed women. Women who had child death experience had significantly more children on average than those who did not experience child loss (AIRR =1.41, 95% CI: 1.35-1.47).

Religion and contraceptive use were both not significantly related to children ever born at the 5% level of significance. Strikingly, contrary to what would be expected, the use of contraceptives did not have a declining but a positive effect on the number of children a woman would have.

As anticipated, the likelihood of bearing more children significantly decreased with increasing age at first birth. Relative to the incident rate of children ever born for women aged 15 years or less, the likelihood of having more children was significantly lower for teenage or adolescent women aged 16-19 (AIRR =0.91-0.93, $p<0.05$) and significantly much lower for women aged 20 years or more (AIRR =0.86, $p<0.001$). Women who had sexual intercourse post-teenage years (aged 20 or more) had 14% significantly fewer children while women aged 16-19 at first sex had 7-8% significantly lower fertility level compared with women who had sexual debut earlier, aged 15 or less. The results indicate that high fertility is strongly associated with early sexual debut and beginning childbearing at a young age.

Of all community variables, only place of residence (area disadvantage) had a significant effect on lifetime fertility. As expected, rural women had 1.09 more children on average as compared to their urban counterparts, when all individual- and community-level characteristics were controlled for. Although area disadvantage of lifetime disparities are reflected for women residing in urban-rural residence, the same cannot be concluded with region of residence. The regional differences in lifetime fertility were not statistically different.

At a glance, social position, women empowerment and ideal fertility norm at community-level, positively influenced lifetime fertility while media exposure and polygyny level at community-level decreased fertility level. However, the role of these indicators of socioeconomic disadvantage, women empowerment and fertility norms, was not statistically significant at community-level.

The independent effects of community variables (Model 4) were significant for rural residence, community exposure to media and community ideal fertility norm. Women in rural communities were predicted to have higher fertility than those in urban communities (AIRR =1.21, 95% CI: 1.12-1.30). Women living in communities with high exposure to mass media had fewer children than those with lower exposure to mass media (AIRR =0.91, 95% CI: 0.84-0.97). Women had higher fertility in communities with a higher proportion of women with high ideal fertility norms, i.e. considering four or more children. These independent effects disappeared, except for rural residence, when a range of individual- and community-level variables were both controlled for in Model 5.

9.2.2 Unobserved heterogeneity at community level in children ever born

There was significant variance in the number of children ever born across communities, although the models indicate a smaller variability which is unexplained ($p<0.001$). The community variance decreased from 0.06 (Model 2 or empty model in Table 9.1) to 0.01 (Model 1 or individual model) then to 0.00 (Model 5 or full model). Interestingly, in this latter model, however, residual community variance in the number of children ever born remained significant, even after adding community-level variables. This further justifies the use of a multilevel approach since the variance at community-level was always statistically significant. This implies individual and community variables had a huge effect in reducing variability of the final model. Specifically, the residuals converge closer to zero in Model 5 which indicates rural-urban residence accounted for variation between communities. The significant likelihood-ratio test results indicate that there are real community differences, although evidence is weak in the final/full model. It should be noted, however, that the MIRR remained significant and continued to show that the incidence of childbearing varied noticeably across clusters. The MIRR was low at 1.27 (Model 3) and 1.07 (Model 5) which suggests the communities (PSUs/EAs or clusters) do not seem to capture a relevant context that enhances understanding of individual fertility behaviour in determining family size or the number of children born (Table 9.1).

Table 9.1: Results of the multilevel Poisson regression analysis of the predictors of lifetime fertility among sexually exposed women aged 15-49 in Eswatini, 2007

FIXED EFFECTS	Model 1		Model 2		Model 3		Model 4		Model 5	
Individual characteristics	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**
Occupation										
Not working	1				1				1	
Agricultural or manual	1.08*	1.01 - 1.15			1.10**	1.03 - 1.17			1.11**	1.04 - 1.18
Sales and services	1.12***	1.06 - 1.18			1.12***	1.07 - 1.18			1.13***	1.07 - 1.18
Professional	1.13**	1.04 - 1.23			1.13**	1.04 - 1.23			1.13**	1.04 - 1.23
Wealth										
Poorest	1				1				1	
Poorer	1.01	0.94 - 1.08			1.00	0.94 - 1.07			1.00	0.94 - 1.07
Middle	0.97	0.90 - 1.04			0.94	0.88 - 1.00			0.95	0.89 - 1.02
Richer	0.88**	0.81 - 0.96			0.89**	0.83 - 0.96			0.92*	0.85 - 0.99
Richest	0.78***	0.71 - 0.86			0.80***	0.74 - 0.86			0.85***	0.78 - 0.93
Education										
None	1				1				1	
Primary	0.93	0.86 - 1.00			0.93*	0.87 - 0.99			0.92*	0.87 - 0.98
Secondary/higher	0.82***	0.75 - 0.90			0.81***	0.75 - 0.87			0.80***	0.75 - 0.86
Exposure to media										
Low	1				1				1	
Moderate	1.00	0.94 - 1.06			0.99	0.94 - 1.05			0.99	0.94 - 1.05
High	0.97	0.91 - 1.04			0.97	0.91 - 1.03			0.97	0.91 - 1.03
Women's empowerment										
Low	1				1				1	
Moderate	1.08**	1.02 - 1.13			1.08**	1.03 - 1.14			1.09**	1.03 - 1.14
High	1.09**	1.03 - 1.16			1.08**	1.02 - 1.14			1.09**	1.03 - 1.15
Ideal number of children										
<3	1				1				1	
3-4	1.11***	1.06 - 1.17			1.12***	1.07 - 1.17			1.12***	1.07 - 1.17
5+	1.27***	1.18 - 1.38			1.27***	1.18 - 1.35			1.26***	1.18 - 1.35
Union status										
Never married	1				1				1	
Monogamous	1.73***	1.62 - 1.84			1.74***	1.64 - 1.83			1.73***	1.64 - 1.83
Polygynous	2.09***	1.93 - 2.27			2.10***	1.96 - 2.26			2.09***	1.95 - 2.25
Formerly married	1.89***	1.75 - 2.04			1.88***	1.75 - 2.02			1.89***	1.76 - 2.03
Child death experience										
No	1				1				1	
Yes	1.42***	1.35 - 1.49			1.41***	1.35 - 1.47			1.41***	1.35 - 1.47
Religion										
None/other	1				1				1	
Catholic	1.00	0.88 - 1.14			0.96	0.85 - 1.08			0.95	0.84 - 1.08
Pentecostal/Charismatic	1.04	0.94 - 1.15			1.01	0.92 - 1.10			1.00	0.91 - 1.10
Protestant	1.02	0.92 - 1.13			1.01	0.93 - 1.11			1.00	0.92 - 1.10
Apostolic/Zion	0.99	0.90 - 1.09			0.98	0.90 - 1.06			0.97	0.89 - 1.05
Contraceptive use										
No	1				1				1	
Yes	1.04	0.99 - 1.08			1.03	0.99 - 1.08			1.04	0.99 - 1.08
Age at first birth										
<16	1				1				1	
16-17	0.93	0.85 - 1.01			0.93*	0.86 - 1.00			0.93*	0.86 - 1.00
18-19	0.93	0.84 - 1.02			0.92*	0.84 - 0.99			0.91*	0.84 - 0.99
20+	0.83***	0.75 - 0.91			0.83***	0.76 - 0.91			0.83***	0.76 - 0.91

Table 9.1: continued

Characteristic	Model 1		Model 2		Model 3		Model 4		Model 5	
	AIRR	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**
Age at sexual debut										
<16	1				1				1	
16-17	0.91**	0.85 - 0.97			0.92**	0.87 - 0.97			0.92**	0.87 - 0.97
18-19	0.92*	0.86 - 0.98			0.92*	0.86 - 0.99			0.93*	0.86 - 1.00
20+	0.87**	0.79 - 0.95			0.86**	0.78 - 0.95			0.86**	0.78 - 0.95
Community characteristics										
Area disadvantage										
Residence										
Urban							1		1	
Rural							1.21***	1.12 - 1.30	1.09*	1.02 - 1.16
Region										
Hhohho							1		1	
Manzini							1.01	0.93 - 1.08	1.06	0.99 - 1.13
Shiselweni							0.94	0.86 - 1.02	1.02	0.95 - 1.09
Lubombo							1.07	0.99 - 1.15	0.98	0.92 - 1.05
Socioeconomic disadvantage										
Community social position										
Low							1		1	
High							0.96	0.89 - 1.03	1.02	0.96 - 1.09
Community media exposure										
Low							1		1	
High							0.91**	0.84 - 0.97	0.96	0.91 - 1.02
Women's autonomy										
Community women empowerment										
Low							1		1	
High							1.02	0.95 - 1.08	1.03	0.97 - 1.08
Fertility norms										
Community ideal fertility norm										
Low							1		1	
High							1.16***	1.10 - 1.23	1.01	0.96 - 1.06
Community polygyny										
Low							1		1	
High							1.05	0.99 - 1.11	0.98	0.94 - 1.03
RANDOM EFFECTS			**Empty**		**Individual**		**Community**		**Full model**	
Community variance (SE)			0.06(0.01)	0.05 - 0.08	0.01(0)	0.00 - 0.01	0.02(0)	0.02 - 0.04	0(0)	0.00 - 0.01
Log-likelihood	-5832.1		-9407		-5838		-9331.8		-5830.1	
MIRR			1.27***	1.23 - 1.31	1.08***	1.1-1.16	1.16***	1.13 - 1.19	1.07***	1.03-1.10
Wald Chi-square					1728.8***		195.6***		1760.8***	
Likelihood-ratio test			322.44***		6.78***		82.02***		3.59*	
N	3097		4112		3097		4112		3097	

***P<0.001, **P<0.01, *P<0.05

Notes: AIRR=adjusted incidence rate ratio; SE=standard error; MIRR=median incidence rate ratio, N=sample observations.

Source: Author's calculations

9.3 Summary of the chapter

At individual-level, occupation, wealth, education, women's empowerment, ideal number of children, union status, child death experience, contraceptive use, age at first birth and age at sexual debut, were significantly associated with lifetime fertility (number of children ever born). However, only two variables, religion and exposure to media, were insignificant factors for lifetime fertility. The results, nonetheless, indicate that there was a declining effect with moderate and high access to media for women. Among the seven macro-level variables examined in the study, only place of residence played a significant role in influencing lifetime fertility. Region of residence, community social position, community media exposure, community women's empowerment, community ideal fertility norm and community polygyny were found to be insignificant in the context of Eswatini. While lifetime fertility variation decreased significantly from Model 2 to Model 5 across the communities after adjusting for women's individual and household (compositional) characteristics, it does not completely disappear, indicating that communities may have an impact on fertility. The next chapter discuss the results of the study.

CHAPTER 10

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

The main aim of this study was to understand the fertility behaviour of Swati women with respect to their contraceptive usage, total number of children ever born and ultimately fertility levels. The roles of proximate and individual determinants of fertility deemed important in fertility analysis, were investigated to inform policy. The study further sought to explain the importance of community and/or community-level determinants of fertility behaviour in Eswatini among sexually exposed women.

10.1 Discussion and conclusions

This section relates key findings to a) theory b) literature or c) discourse-issues on the subject. Policy and recommendations are set out in the study.

10.1.1 Levels of fertility

The first objective of this study was to estimate fertility levels in Eswatini using direct and indirect methods of fertility estimation. The study re-assessed or re-estimated fertility levels at national level to derive definitive estimates by incorporating a number of indirect estimation methods of fertility. The age distribution or regression based methods- Rele's and Gunasekaran-Palmore regression; P/F ratio based methods (Trussell, Arriaga and Feeney variants), and the relational Gompertz model, were utilised for the 1976, 1986, 1997 and 2007 censuses. Also, in direct estimation of fertility, cohort-period fertility rates (CPFRs) and total fertility rates (TFRs) were invoked for analysis.

Overall, between 1976 and 2007, fertility declined from 7.0 to slightly lower than 5.0 children per woman: a decline of more than a quarter, indicative of fertility transition in Eswatini. Sustained fertility transition appears to have started mid-1980s, in 1986 to be specific. Between 1986 and 2007, the pace of fertility decline was rapid. Over these 2 decades a reduction of 2 births has occurred, that is TFR fell from an average of 6.4 to 4.6 children per woman. Prior to mid-1980s, in the 1960s and

1970s, fertility appears to have risen and levelled off in the late 1970s and early 1980s as predicted with the Feeney method and P/F ratios in the respective periods.

Using published census data, this study finds that the computed unadjusted direct fertility estimates are equivalent to those of age distribution or regression based methods. However, both direct and regression based fertility rates are lower by a birth or very close than those computed from P/F ratio methods, in comparable periods. The estimates of fertility for the P/F ratio methods and the relational Gompertz model are matching in all the census years, likewise for the regression based methods.

Further, there is high degree of consistency of fertility estimates between those obtained from the census data for the Rele's and Gunasekaran-Palmore methods and from survey data using CPFRs for the 1996-1997 and 2006-2007 reference periods. Probably the fertility rates correspond as a result of the reputable good quality census data collected for 1997 and 2007. As a matter of caution, though the difference among direct estimation, CPFRs and regression based estimates is negligible, these methods are easily affected by inaccuracy of age reporting, misreporting of births or undercounting of children. These errors have been observed in the study and are likely to affect or understate fertility rates; hence probably their lower estimates when compared to the Arriaga, Trussell and Feeney variants of the P/F ratio method and the relational Gompertz model (Arriaga and Moultrie modifications). Also regression based methods such as Rele's and Gunasekaran-Palmore, have a weakness such that when the required input data are incorrect then the errors tend to be replicated in the resulting estimates (Moultrie, 2010).

Notwithstanding the above-mentioned limitations or other probable errors, techniques of indirect estimation prove unabatedly useful for deriving fertility estimates with defective data. Further they require little input data parameters such that with little or no access to raw data, for further adjustments to the data, reasonable fertility estimates may be derived. Thus, the P/F ratio methods which tend to account for these errors tend to be superior in generating fertility estimates if data are inaccurate.

In sum, methods based on the P/F ratio (Trussell, Arriaga, Feeney and relational Gompertz model) have proved dependable in deriving fertility estimates for Eswatini. More importantly, the Relational Gompertz model as noted by Moultrie et al. (2013), is more versatile and dependable for deriving fertility estimates in all circumstances of fertility transition. The P/F ratio is a useful diagnostic tool that tends to be used to compensate for underreporting of births 'adequately', although this is not the case with population structure or regression based methods - Rele's and Gunasekaran-Palmore methods, and when data are unadjusted using the direct estimation method. This study, therefore, prefers fertility rates based on the P/F ratio methods, in particular the relational Gompertz model, to those based on age structure. Hence the total fertility rates for Eswatini for the 1965-66, 1975-76, 1985-86, 1996-1997 and 2006-07 periods are estimated at 7.0, 6.9, 6.4, 5.0 and 4.6 children per woman, respectively.

Based on 2006-07 Eswatini DHS data, the direct/reported total fertility rate in 2007 was estimated at 3.9 children per woman lower than the indirect estimate of 4.6 from the census in the same year. It is presumed that the reported TFRs may be underreported due to misreporting as sampling and non-sampling errors may cause estimates of total fertility rate to be biased (Bongaarts, 2015, Schoumaker, 2014). Exclusion of some factors that may have a bearing on fertility such as the influence of frequency of sexual intercourse, living apart of spouses due to migration and role of HIV, may cause fertility to be biased (Jain et al., 2014, Palamuleni, 2017).

Although direct estimates are low, the results reveal fertility variation at subnational level and among population subgroups. As expected, fertility decreased with increase in the level of education or household wealth status among women. Fertility was lower in urban than in rural areas. Fertility was higher in resource poor/remote regions (Shiselweni and Lubombo) than in non-impoverished regions (Manzini and Hhohho). Background factors including residence, region, wealth status and education, have an influence on fertility levels. These findings are consistent with fertility differentials found in other studies (Alene and Worku, 2009, Jain et al., 2014, Rutaremwa et al., 2015, Majumder and Ram, 2015, Udjo, 2003). It is crucial to reduce high fertility in rural and remote regions such as Shiselweni and Lubombo as well as among uneducated and poor women.

This study has contributed by illustrating the robustness or sensitivity of each indirect estimation method with varying data quality, even if with somewhat different or same assumptions and data requirements. An estimate of fertility emerges over time and consequently a trend is instructive to policy planning and developmental intervention programmes.

10.1.1 Impact of proximate fertility determinants on fertility level

Fertility behaviour has been examined quantitatively using the proximate determinants (PDs) of fertility proposed by Bongaarts (Bongaarts, 1978, Bongaarts, 1982) with some modifications by Stover (1998) and Bongaarts (2015) on sexual activity and Johnston and Westoff (2010) on abortion. In interpreting the results from the three PDs of fertility models (OBM, RJS and RJB), caution should be exercised since 'none of the models is perfect' (Bongaarts, 2015: 554). The author highlights that, bias may occur in the estimation models for the indices or due to errors in measuring the proximate fertility determinants. The PDs of fertility framework were applied to quantify the impact of each proximate determinant (contraception, postpartum infecundability, marriage/sexual activity, and abortion) on fertility at national and subpopulation level variation in terms of social context (urban-rural and region) and status (education and wealth).

The results from the three PD models confirm that the four proximate determinants had a significant effect on fertility at national level and showed some variation at subpopulation level in Eswatini. Overall, the fertility inhibiting effects of contraceptive use and sexual activity were the most influential, followed by postpartum infecundability. Abortion had the least suppressive effect on fertility.

An earlier study on Eswatini, by Warren et al. (1992), found that postpartum infecundability (Ci=0.66) had the most important reducing effect on fertility, then marriage (Cm=0.78), contraception (Cc=0.84) while abortion was considered to have had a negligible effect. Striking is the displacement of the importance of the role of postpartum infecundability with contraception in fertility reduction. While earlier in 1988, postpartum infecundability was strongest and contraception less important in suppressing fertility, almost two decades later in 2007, the importance role of the two proximate factors had reversed.

Published survey reports for Eswatini indicate contraceptive prevalence rate in the early 1980s was at 4.0%, although at country level. Between 1988 and 2007 contraceptive prevalence increased markedly from 16.6% to 37.9% among all women aged 15 to 49 (CSO, 2008, Ministry of Health, 1990). The results from the three PD models in the study reveal that the contraceptive prevalence rate was moderately high ranging between 50.2% for married/in union women to 55.6% for sexually active women. Consistent with previous studies (Johnson et al., 2011, Majumder and Ram, 2015, Van Lith et al., 2013) contraception, of recent, has increased tremendously and has become the most likely or anticipated method of choice to reduce fertility in many developing countries. Contrary, prior to this, in the 1970s and 1980s, contraception had a minimal impact on fertility reduction in SSA, although it was perceived as the most amenable policy variable with greatest potential for reducing fertility (Onuoha, 1992). In line with study findings, Eswatini is one country in sub-Saharan Africa with the highest demand to limit births and recently had the highest proportion of women contraceptors (Van Lith et al., 2013). Recent findings reveal that contraceptive use increased to 66.1% by 2015 (CSO, 2015b). Thus contraceptive use is the most important determinant for continued fertility decline in Eswatini.

The study reveals that short-acting methods, in particular injectables, male condoms and pills, were mostly used among women and these are considered to be highly effective contraception methods (Trussell, 2011b). These methods could have had a higher suppressive effect on the index of contraception. Overall, contraceptive use (and its impact on fertility), increased with the level of education and household wealth, and was higher in urban and non-poor resource regions (Hhohho and Manzini). This is consistent with study findings from several studies (Johnson et al., 2011, Majumder and Ram, 2015, Alene and Worku, 2009, Chola and Michelo, 2016), supporting high correlation of contraceptive use among women with better education and wealth and residing in non-disadvantaged areas (urban or well-resourced regions/provinces).

Contraception can greatly influence fertility. It is therefore imperative to promote contraceptive use among couples or women, especially those who are poor, uneducated and residing in rural and impoverished regions of Lubombo and Shiselweni. In sum, contraceptive use has an important role in fertility decline, and information and interventions around this issue should be invested and accelerated in the population.

Marriage (or sexual activity) competes with contraception as the most influential in limiting fertility at national level. The RJS (Cx=0.52) and OBM (Cm=0.42) model results suggest that marriage/sexual activity has the strongest fertility inhibiting effect while the RJB (Cx=0.66) model findings reveal that sexual activity had the greatest fertility reduction effect. The index of sexual activity from the RJS model is expected to be lower than from the RJB model consistent with the findings of Bongaarts (2015). The author explains that the difference is mainly due to the more inclusive definition of sexual activity in the RJB model, which assumes women who are in union or married are at risk of pregnancy. The RJS model, however, excludes married women who had no sex in the last month, were not pregnant or were not abstaining postpartum.

The OBM model considers exposure to sexual activity which occurs in a stable relationship, that is, formal marriage and consensual sexual union (Bongaarts, 1978). The study found that significant childbearing occurs within and without marriage in Eswatini, since fertility rates for sexually exposed women were high. Since non-marital childbearing is prevalent in Eswatini, it may be important to use sexual activity indices (RJS and RJB) instead of the marriage index (OBM). The OBM results for the index of marriage was much lower, implying non-marriage was high in Eswatini. Therefore, the OBM framework could have overestimated the impact of the index of marriage.

The descriptive results of the study indicated that women in rural areas married earlier compared to those in urban areas. Further, the average age at first sexual intercourse indicates women in rural areas began to engage in sexual intercourse earlier than those in urban areas. Early sexual experiences for women tended to occur in the impoverished Lubombo region, among the poor and among those with little or no education. Non-marriage due to delayed marriage or sexual activity contributed significantly to low fertility in urban areas, and among non-poor and educated women.

In line with descriptive results, variation of sexual activity/marriage index was observed at subnational level (urban-rural and region) and subpopulation level (wealth and education). As expected and consistent with previous studies (Alene and Worku, 2009, Chola and Michelo, 2016, Majumder and Ram, 2015, Mekonnen and Worku, 2011), the impact of non-sexual activity or non-marriage was high for non-poor and secondary or higher educated women. With regard to context, urban areas exerted a slightly higher influence than rural areas. Lubombo, a resource poor region, had the least influence. In Eswatini, out-migration or shortage of men in rural areas has been observed, which has been exacerbated by poverty (MEPD, 2002, MEPD, 2006). Awareness programmes to prevent adolescent childbearing among illiterate, poor and rural women, should be implemented.

Although less important than sexual activity and contraception at national level, postpartum infecundability has remained strong in limiting fertility in Eswatini, consistent with findings in SSA (Warren et al., 1992, Odimegwu and Zerai, 1996, Johnson et al., 2011, Chola and Michelo, 2016, Alene and Worku, 2009, Palamuleni, 2017, Onuoha, 1992). The impact of the index of postpartum infecundability on fertility reduction was strongest when contraception was low in Eswatini (Warren et al., 1992) and elsewhere in Africa, especially in the 1970s to 1990s (Odimegwu and Zerai, 1996, Chola and Michelo, 2016, Onuoha, 1992). The impact of postpartum infecundability may be weakened due to use of contraceptives during breastfeeding or not abstaining from sexual intercourse for a long duration after giving birth.

Variation of postpartum infecundability by women's social status and context has important implications. As expected, postpartum infecundability had a higher fertility reducing effect among poor than non-poor women. Postpartum infecundability had the strongest impact on fertility for uneducated women with respect to all proximate determinants. Among the educated women, this effect was probably compensated by their increased use of contraceptives. A striking result for Eswatini was that the impact of postpartum infecundability on fertility was lower in rural areas than urban areas, contrary to what was expected. Further, this lower impact was observed in the predominantly rural region of Lubombo, affirming the results of the study. The reasons for low breastfeeding duration in rural areas are apparently not clear. Urban women could have possibly acquired better knowledge on breastfeeding practices. Educated and non-poor women who may lack interest in breastfeeding, should be encouraged to breastfed their children and for women in rural areas, special attention should be given them to improve their breastfeeding practices. Breastfeeding should be promoted for its health benefits both to the infants and mothers (Heymann et al., 2013, Onuoha, 1992).

Abortion exerts the least influence on fertility amongst the proximate fertility determinants at national level. A prior study in Eswatini supposed that abortion was commonly practised in society (Warren et al., 1992), although quantitatively its impact was unknown and assumed to be negligible. Contrary, the study found that the abortion rate in Eswatini was quite high in the range (18.9-23.9) abortions per 1000 women. This finding was within the range of SSA countries in the same period (Johnston and Westoff, 2010, Westoff, 2008); the *TAR/AR* (0.8/22.9) for Eswatini was higher than for Zimbabwe (0.5/14.3) and lower than for Uganda (1.3/37.1) in the same 2006/2007 period. In 2008, abortion rate was estimated at 29 abortions per 100 women in Africa and the abortion rates ranged from 15 for Southern Africa (where Eswatini is situated) to 38 in Eastern Africa (Sedgh et al., 2012).

Although abortion rates were rather similar at regional level, they varied with urban-rural residence and with women's social status (wealth and education). Consistent with findings in SSA (Westoff, 2008), the urban and non-poor women had a high risk of inducing an abortion - both the abortion rates and the impact of abortion on fertility were high. With respect to education, the findings were contrary to Westoff (2008) findings for SSA. This previous study found that uneducated women had lower *AR* (34.3) than secondary educated women (45.7). The study found uneducated women had higher abortion rates in the range (28.9-34.0) than secondary educated women (15.4-20.6). In general abortion in Eswatini tends to be high, which, according to Majumder and Ram (2015), reflects difficulty in access to contraceptives for women or a high unmet need for family planning. In support of this view, the unmet need is high although it declined with educational level in Eswatini- 32.3%, 29.9% and 19.7% for none, primary and secondary/higher education, respectively (CSO, 2008). Thus constraints to access and use of contraceptives, should be addressed.

The estimation of abortion levels remains a methodological challenge due to moral, religious and legal issues and hence goes unnoticed if not quantified although abortion is a common practice in all societies. Unsafe abortion could be commonly practised in Eswatini, especially since abortion is illegal, unless in case of rape or incest, causing maternal health risk with severe implications for reproductive health or mortality. Restrictive abortion laws and high unmet needs for contraception are correlated with high abortion rates (Sedgh et al., 2012). Unsafe abortions are prevalent in developing regions including Africa, often leading to maternal morbidity and mortality in resource poor settings (Sedgh et al., 2013, Sedgh et al., 2012).

A fifth proximate determinant of fertility, infecundity, as provided by the Stover model, was also examined for its effect on fertility level. Infecundity had the weakest important fertility inhibiting effect on fertility than the four PDs observed above at national level. Bongaarts (2015) explains the effect of infecundity is the least important PD which does not significantly vary amongst contemporary populations. Therefore, the impact of infecundity has been without much emphasis and has remained largely ignored in fertility literature.

In conclusion, many studies reveal that the order of importance of the proximate determinants has been variable over time and context (Odimegwu and Zerai, 1996, Onuoha, 1992, Stover, 1998, Letamo and Letamo, 2001, Palamuleni, 2017, Chola and Michelo, 2016, Madhavan, 2014, Rutaremwa et al., 2015, Alene and Worku, 2009). It is noted in the present and previous studies that the proximate determinants of fertility play a central role in shaping fertility behaviour. Sexual exposure (including marriage), contraception and postpartum infecundability PDs have played a critical fertility inhibiting role to reduce fertility from its potential maximum. The PD aggregate fertility model framework provides an overall picture of the proximate factors' influence on fertility change levels and through which distal factors may provide a broader understanding of fertility behaviour.

The importance role of proximate determinants of fertility was also influenced by women's social context and social status. This study therefore maintains the position of Jain & Ross (2012) that social context has an influence on fertility behaviour. Area disadvantage and low social status are highly correlated with high fertility behaviour. Early marriage and low contraceptive prevalence maintain fertility at high levels, especially in rural areas, resource poor regions (Lubombo and Shiselweni), and among poor and uneducated women. It is important to continually address these disparities in the population for policy programming and human development. Therefore, empowering women's status, in particular through education and wealth creation initiatives, has huge negative implications for fertility and positive implications for reproductive choices such as contraception. Fertility decline in Eswatini is associated with high uptake of contraceptives.

There is still more potential for further reduction in fertility through adoption of improved and efficient modern contraceptives. The importance and large influence of contraception, in particular modern contraceptives, is a recent conclusion. Early family planning programme emphasis in Eswatini and elsewhere in Africa, had its major focus on breastfeeding (or postpartum) practices. Policies on fertility and family planning with regards to sexual activity/marriage, abortion, contraception and breastfeeding, need to account for nuanced subpopulation variations, especially giving greater attention to disadvantaged women and their contexts.

The proximate determinants of fertility account for much variation in fertility at aggregate (group) level, yet there is a need to observe fertility variation at woman's individual level. The next sections explore further fertility behaviour of individual woman at micro level, using appropriate multivariate regression techniques.

10.1.3 Impact of community on fertility behaviour

The study assessed whether communities in Eswatini have any significant importance variation in fertility behaviour as determined by lifetime fertility (children ever born-CEB) and use of fertility control (contraceptive use). The hypothesis tested was that there is significant variation between communities in fertility behaviour. For multilevel/hierarchical DHS data used in the present study, the results revealed that multilevel (random intercept) models for analysing binary and count data (i.e. logistic and Poisson /negative binomial models, respectively), performed better than the respective single-level multivariate regression models in line with previous research (Amara, 2015, Austin et al., 2017, Grace, 2010, Grace and Carr, 2009, Nguyen et al., 2017, Ejembi et al., 2015, Wang et al., 2013, Degraff et al., 1997). With respect to explaining overdispersion of count data on number of children ever born, the multilevel Poisson model was a better model fit than the multilevel negative binomial regression, although the estimates of the parameters were similar as observed in previous studies (Amara, 2015, Grace and Carr, 2009). Furthermore, these multilevel models, as noted in literature (Austin et al., 2017, Nguyen et al., 2017), allowed estimation at small area (cluster or community) to understand between-cluster variation fertility behaviour in Eswatini.

Using multilevel models, the study found the community variance was small but significantly different from zero, signifying that the intercepts varied slightly across communities in contraceptive use and children ever born. Therefore, one can conclude in line with a previous study (Kulu and Boyle, 2008) that there is some evidence that the differences in fertility behaviour, among sexually exposed or initiated women, could in part be explained by community effects.

The results indicate small, but significant, residual community effects on the likelihood of use of contraceptives or childbearing. One explanation is that, most clusters/communities in Eswatini have similar levels of contraceptive use or childbearing patterns, except in a few communities as explained in a previous study (Nguyen et al., 2017). These few areas, where contraceptive use is low and childbearing is high, need to be prioritised in fertility behaviour interventions.

Another explanation is that, the decline in random effects (measures of variation) - from the empty model to final model - reflects more compositional differences in fertility behaviour rather than the influence of community context. However, distinguishing between compositional and context influences may be difficult (Basten et al., 2011, Kulu and Boyle, 2008), especially to determine if behaviour is cumulated with cross-sectional DHS data. For example, variability in individual-level characteristics (compositional), say education, over time may become of less importance when related fertility behaviour is prevalently imitated among women. With social status of women, local opportunities benefiting all women in the community may decrease fertility status related differences.

Basten et al. (2011) point out that women with the same individual attributes, say education, may reside in the same area and therefore, the fertility behaviour differences in communities may be reflecting this compositional difference. This study however, does not disentangle between these community influences. Several studies have shown the importance of community to fertility behaviour (Amara, 2015, Amin et al., 2002, Balk, 1994, Ejembi et al., 2015, Entwisle, 2007, Janevic et al., 2012, Kravdal, 2001, Colleran et al., 2014).

Summing up, although substantial variation in fertility behaviour remains at individual-level there is significant unobserved or unmeasured variation at the community/cluster level. The standard deviation of the community random effects is small but significantly different from zero, implying that the intercepts vary slightly across the communities. This finding indicates the importance of communities. There is some evidence to develop contextual explanations in determining fertility behaviour variation in Eswatini. While this study emphasises the role of community may possibly explain fertility behaviour, caution should be exercised when making a firm conclusion as more fertility studies need to be done at macro-level in Eswatini. The results contribute to the improved understanding of community/contextual influences on fertility behaviour of individual women.

10.1.4 Impact of individual and community factors on fertility behaviour

This study used multilevel models to examine the association between individual- and community-level factors and contraceptive use in Eswatini on the one hand. On the other hand, the relationship between individual- and community-level factors and lifetime fertility, was determined. The overall hypotheses tested determined whether there is an association between individual characteristics and fertility behaviour (contraceptive use or lifetime fertility). Using multilevel logistic and Poisson models, the study examined whether fertility behaviour varied significantly across communities/clusters.

Although some community-level variables were associated with fertility behaviour, in the community-only model (Model 4), none were significant in the full model (Model 5) net of individual-level variables, except for place of residence only in the lifetime fertility (children ever born) model. Other studies have found this lack of relationship between contraceptive use and community variables in the final/full model, containing both individual and community factors (Kaggwa et al., 2008, Kravdal, 2000). The lack of direct association between contraceptive use and community variables in the full model in the case of Mali could be explained in part by the diffusion of innovations theory (Kaggwa et al., 2008: 86). Given the low contraceptive prevalence in Mali, one can argue that modern family planning methods are still an innovation, and that the small number of women using modern contraceptives may not yet be sufficient to influence the rest. However for Eswatini, where the prevalence of contraceptive is high, the non-significant relationship is not simple to explain and to some extent indicated that communities could have reached similar levels of contraceptive use, also due to innovation or diffusion of birth control measures or technology.

The importance of contextual conditions of socioeconomic development (area disadvantage and social position disadvantage), fertility norms and women autonomy for fertility behaviour in Eswatini may not require attention at cluster level, especially with contraceptive use. However, rural residence disadvantage was observed in terms of childbearing, and provided limited support to the hypothesis that area disadvantage is associated with increased number of children since region of residence was non-significant. Higher fertility characterises rural areas in Africa (Kazembe, 2009, Ezeh, 1997, Agyei-Mensah and Owoo, 2015).

In rural areas, mostly characteristically traditional communities, children are highly valued for many reasons, including for provision of labour (van de Kaa, 1996, Grace and Carr, 2009) whereas for urban areas, childrearing costs negatively affects childbearing (Hirschman, 1994). Exposure to family planning methods and services tend to be greater in urban settings than rural settings(Grace and Carr, 2009). In Eswatini, individuals living in rural areas own land, in the so called 'Swazi National Land' (SNL). There are studies which support land ownership calls for an additional number of children (Amara, 2015, Grace and Carr, 2009). Farming wealth (land, cows) tend to be positively associated with fertility (Colleran et al., 2015). Therefore, rural-urban residence is an important variable that should be addressed when determining observed fertility. The overall impact of residing in rural areas on fertility levels is great since as noted, a greater share (three quarters) of the population in Eswatini, live in these areas (CSO, 2010a).

Further, the estimates from the analysis show that lifetime fertility is jointly shaped by individual- and community-level characteristics as well as unmeasured micro (individual) and macro (community) effects. Although the empirical results of the study have limited or no support of the effects of selected community factors on fertility behaviour (lifetime fertility or contraceptive use), at individual-level, the expected relationships (hypotheses) on fertility behaviour were observed. Except for employment/occupation, women's empowerment, contraceptive use, religion, community social position, and community women's empowerment, were not in the expected directions. The first two variables were the only significant variables amongst those not influencing lifetime fertility in expected directions. The rest of the individual characteristics were significant. The specific thirteen hypotheses at individual-level, in line with answering the third and fourth objectives of the study, are expounded. Overall, the study findings demonstrate support for several hypothesis and most results were in the expected relationships observed in previous studies regarding fertility behaviour.

Hypothesis 1: The higher the woman's empowerment, the lower the number of children she will ever bear and the higher her probability of using contraceptives.

Fertility is expected to decline when women's autonomy or empowerment improves (Lobao and Brown, 1998). However, due to fluidity of the concept of women's empowerment/autonomy, a standard or cross-cutting measure is difficult to pin-point as reflected in many studies due to variation in cultural contexts (Upadhyay et al., 2014, Upadhyay and Karasek, 2012, Do and Kurimoto, 2012).

This study contributes to literature by using a composite indicator of women's empowerment and captures a variety of socioeconomic, cultural and interpersonal dimensions, including decision-making power in the household or in reproduction, attitudes with regards to sexual activity negotiation and attitudes on gender roles, violence and equity. In this study, a high level of women's empowerment is determined when a woman alone (or jointly with her partner) is empowered in decision making, does not condone violence and has control or positive attitudes to sexual activity. Researchers have demonstrated the need for further conceptualisation and understanding of women's empowerment (Upadhyay and Karasek, 2012). Therefore, caution should be exercised with interpretation of this variable.

Contrary to expectations, this study found that greater women's empowerment has positive impact on lifetime fertility. Specifically, moderate and high women's empowerment enabled individual women to have a higher number of children than those with low empowerment. This finding has a number of explanations, which could be attributed to the flaw in women's empowerment measure, 'an absent, nonparticipating partner' or 'that more empowered women fulfilled social expectations of high fertility' (Upadhyay and Karasek, 2012: 84).

Further analysis at macrolevel, however, showed that community women's empowerment was not significantly associated with fertility. This finding is parallel to evidence found in Zambia and

Namibia that empowered women had more children than they considered (Upadhyay and Karasek, 2012: 85). Moreso, this could reflect patriarchal power dynamics of men wanting more children and women conforming to husbands' demands or ideals. In Eswatini, childbearing among woman proves fecundity, especially before marriage.

Results from this study revealed a significant relationship between women's empowerment and a high level of contraceptive use. This was consistent with previous research efforts (Odimegwu et al., 2015, Do and Kurimoto, 2012, Giusti and Vignoli, 2006). To summarise, the variable of women's empowerment produced the anticipated result of increased contraceptive use, however, not expected as women's empowerment increased fertility also increased. It is important to know why sexually exposed women use contraceptives but not for limiting number of children; it could be because it may have sociocultural considerations for the norms of the Swati people.

Hypothesis 2: The women who are in agricultural or manual occupations should have more children ever born and a lower chance of using contraceptives than those who are not.

In contrast to other results (Dev et al., 2002, Nguyen-Dinh, 1997, Hindin, 2000, Solanke, 2015), the study found that employed women had more children than the unemployed. This is consistent with the finding by Snopkowski et al. (2016) in rural Poland. In Poland it was noted that working women live closely to their kinsfolk, hence there could be shared childrearing costs which facilitate childbearing. This situation could be possibly similar for Eswatini where about three-quarters of people reside in rural areas (CSO, 2008, CSO, 2010a). In rural places, traditional system structures of beliefs and norms, are preserved (MEPD, 2009). This is, however, unexpected in a modern or urban wage economy since childbearing competes with the woman's employment time, prospects and aspirations (Cohen, 1998, Kravdal, 2000). In Ethiopia, women employed in both agricultural and non-agricultural work, had lower lifetime fertility than those unemployed (Ethiopian Society of Population Studies, 2008) contrary to the findings of this study. However, in a recent study on Ethiopia by Eyasu (2015), the results are consistent with this study.

Further, in this study of employed women, contrary to what would be expected, women working in non-agricultural occupations had higher fertility than those in agricultural/manual occupation. The explanation of this deviation, from common observation, is derived from facilitation influences of societal and institutional factors, such as compatibility of childrearing and employment, and reduced domestic labour for women (Stulp and Barrett, 2016). Some contexts are observed as not supportive of employed women in reducing childbearing, as they would be less able to reap the rewards of being employed (Lobao and Brown, 1998). This can occur where there are fewer opportunities of gainful employment for educated wage labour. Higher fertility among women in agricultural occupations has been attributed to more children as a source of labour in farming activities (Agyei-Mensah and Owoo, 2015). In Eswatini, this attribution may not be foreign, especially in rural households.

As expected, the study showed that women who are employed were more likely to use contraceptives compared to women who are unemployed and women working in agriculture or manual sectors had lower odds of using contraceptives than those in professional sectors. These findings corroborate with other studies (Hindin, 2000, Aremu, 2013). Further, it was observed, as expected, that women working in agriculture were less likely to use contraceptives than those in a professional occupation. This finding contrasts with results in Rwanda and Nepal (Wang et al., 2013).

Hypothesis 3: The lower the woman's educational level, the higher the number of children she will ever bear and the lower her probability of using contraceptives.

The significant and negative relationship between education and lifetime fertility found in this study is not uncommon in sub-Saharan Africa (Ethiopian Society of Population Studies, 2008, Kravdal, 2000, Akpa and Ikpotokin, 2012, Agyei-Mensah and Owoo, 2015) and other developing countries (Alvergne and Lummaa, 2014, Kamal and Pervaiz, 2011). Women with secondary education are noted to have stronger low fertility ideals or preferences, wanting to invest in quality children than in quantity of children. Education tends to reduce fertility for women by increasing costs of childbearing and rearing as well as improving decision-making powers or awareness of reproductive choices, including contraceptives (Snopkowski et al., 2016).

Education, especially higher than primary level, influences many broad aspects of a woman's life choices that may reduce her fertility, such as her acquisition of skills, knowledge, and interaction with the environment. The benefits of individual or community/mass education on lowering fertility have been emphasised in many studies (Kravdal, 2012, Moursund and Kravdal, 2003, Snopkowski et al., 2016, Colleran, 2016, Dev et al., 2002, Amara, 2015), including increasing women's propensity to use contraceptives (Snopkowski et al., 2016, Ezeh, 1997, Bentley et al., 2009, Wang et al., 2013, Kravdal, 2001). The study finding of the positive effect of women's education on contraceptive use, is consistent with previous research efforts prior mentioned.

Hypothesis 4: The lower the woman's household wealth, the higher the number of children she will ever bear and the lower her probability of using contraceptives.

The study findings show that women with higher levels of wealth are likely to have fewer children and highly likely to use contraceptives. These findings are in line with literature findings (Moeeni et al., 2014, Colleran et al., 2015, Akpa and Ikpotokin, 2012, Amara, 2015, Hindin, 2000, Solanke, 2015). The wealthy (high status) individual women tend to quickly develop or adopt low-fertility strategies (Snopkowski et al., 2016). The wealthy forgo higher fertility to accumulate more wealth for their next generations or to better their social status or mobility (Stulp and Barrett, 2016, Alvergne and Lummaa, 2014). This study showed that women with low levels of wealth status had lower odds of using contraception than women with middle or higher levels of wealth status, as expected. The observed patterns matched previous research studies (Wang et al., 2013, Kravdal, 2001).

Hypothesis 5: The higher the woman is exposed to media, the lower the number of children she will ever bear and the higher her probability of using contraceptives.

Exposure to mass media was not associated with lifetime fertility, although the likelihood of bearing more children decreased for women with moderate and high mass media exposure compared to women with low exposure to media, consistent with an earlier study (Solanke, 2015). The study found that, improving exposure to mass media accelerates the use of contraceptives. This finding is supported by previous studies (Dev et al., 2002, Grace and Carr, 2009, Ejembi et al., 2015). This suggests the importance of diffusion of contraceptive knowledge, methods of adoption or uptake of contraceptives.

Hypothesis 6: Women who are in polygynous unions should have more children ever born and a lower probability of contraceptive use.

As would be expected, marital relationships expose women to the risk of bearing more children than being single but sexually exposed or experienced. This positive influence is consistent with other studies (Kazembe, 2009, Agyei-Mensah and Owoo, 2015). Thus, the risk of conception increases in marriage and consequently fertility levels. The study found that polygynous women had more children than those in monogamy. In a parallel study, there was no relationship between polygynous versus monogamy and fertility, measured by birth in last five years (Ezeh, 1997). Theoretical narrations highlight that women in polygyny are less likely to divorce, but more likely to remain in their unions (Ezeh, 1997), and are therefore exposed to a longer reproductive lifespan for childbearing.

The study showed that women in polygynous unions were less likely to use contraceptives that lower fertility than monogamy women. This is broadly consistent with past studies (Ezeh, 1997, Hindin, 2000).

Hypothesis 7: The greater the quantity of number of children preferred (or ideal family size) of a woman, the greater the number of children she will ever born and the lower her probability of using contraceptives.

Contrary to a two-child fertility norm prevalent in developed countries (Stulp and Barrett, 2016), this study found dominance of a high fertility norm (wanting 4 or more children). The results are parallel to the finding of Kamal and Pervaiz (2011) who found that women who wanted 2 or more children had higher fertility than those who wanted less. It is women who have achieved their preferred number of children who are more likely to use contraceptives to stop reproducing (Snopkowski et al., 2016). This is contrary to this study finding which finds an overall negative association between ideal number of children and contraceptive use, indicating the fertility drive of having larger family sizes. Interestingly, in a previous study in Eswatini at community-level (Elfstrom and Stephenson, 2012), it was found that women from communities with higher level of mean ideal number of children had significant reduced odds of using contraceptives, although it was not observed in this study. It is possible that the differences could in part explained by the fact that the previous studies were for currently married or cohabiting women while this study focused on sexually initiated/exposed women, including non-married women single or formerly married.

Hypothesis 8: Those who are religiously affiliated to the Zion or Apostolic churches should have more children ever born and a lower likelihood of using contraceptives than those not having this religious affiliation.

Religious differences in lifetime fertility have been observed in other countries (Ethiopian Society of Population Studies, 2008, Agyei-Mensah and Owoo, 2015). However, in this study, religion has no significant influence on the number of children or contraceptive use consistent with past studies (Akpa and Ikpotokin, 2012, Yeatman and Trinitapoli, 2008). In Eswatini, religious affiliation is mainly grounded on Christian ethos, and lack in denominational differences in fertility and contraceptive use could be in part from data limitations since religious affiliation tends to change over the life course of women (Agadjanian and Yabiku, 2014). The study found no evidence of religious fertility behaviour differences between Zionists or Apostolic members and other religions members.

Hypothesis 9: Women who have experienced child loss should have a greater number of children ever born and a lower probability of using contraceptives.

The results showed that women who had experienced child loss were more likely to have more children. The results are confirmed by previous studies in developing countries. In Ethiopia, women who had at least two child deaths were 1.45 times to increase their childbearing (Ethiopian Society of Population Studies, 2008). In India and Bangladesh the death of either a male or female child significantly increased fertility (Dev et al., 2002). In Pakistan, women who had a child loss were more likely to have had 2 or more children (Kamal and Pervaiz, 2011). This indicates women are more likely to replace any loss of a child. As would be expected, the study revealed that women who experienced a child loss had lower propensity to use any contraceptives. However, this result was not statistically significant. This result is in line with some an earlier study (Colleran and Mace, 2015).

Hypothesis 10: The younger the age at first birth of a woman, the greater the number of children she will ever bear and the lower her probability of using contraceptives.

This study confirms that delayed age at first birth lowers fertility in line with recent studies (Snopkowski et al., 2016, Alvergne and Lummaa, 2014, Akpa and Ikpotokin, 2012, Solanke, 2015). Later childbearing is associated with reducing fertility. The study has shown that younger women aged 15 or under had more children than those above and less likely to use contraceptives. The results are in line with an earlier study in Nigeria, which showed that adolescents aged 15 and below had higher fertility than those aged beyond age 15 (Akpa and Ikpotokin, 2012). Women beginning childbearing at age 20 and beyond had significantly reduced fertility, consistent with the study in Nigeria.

Hypothesis 11: The younger the age at sexual debut of a woman, the greater the number of children born and the lower her probability of using contraceptives.

As would be expected, the study shows that women who had first sexual encounter before the age of 16, the minimum age of consent, had more births (or lesser contraceptive use) than the rest who began later. The results are supported by previous studies (Akpa and Ikpotokin, 2012). The result, however, was not significant for the association between age at sexual debut and contraceptive use.

Hypothesis 12: The higher the woman's age, the greater the number of children ever born she will ever bear and the greater her likelihood of currently using contraceptives.

The study expected the number of children to increase with women's age. The study found age was highly correlated with children ever born. Age has been found to be included in multivariate regression to capture the effect of unmeasured or unavailable determinants of long-run fertility decline (Winkelmann and Zimmermann, 1994). This finding suggests these were incorporated in the model for children ever born, specifically variables such as age at first sex and first birth. Excluding age may result in a better fit as reported in other studies (Poston and McKibben, 2003).

It would be expected that older women have higher current contraceptive use to limit childbearing. The results are contrary, as older women (age 35-49) were significantly less likely to use contraceptives. This result is in line with earlier studies in Africa (Ferede, 2013, Wang et al., 2013). The negative effect on contraceptive use, especially by older women, could be possibly in part due to decline in fecundity or frequency of sex with age and reflect change in attitudes towards fertility control. Contraceptives may be avoided due to their negative consequences on women's health (Degraff et al., 1997, Grady et al., 1993).

Hypothesis 13: The higher the number of surviving/living children a woman has, the greater the number of children she will ever bear and the higher her probability of currently using contraceptives.

The study revealed that the number of living children was highly correlated with parity or number of children ever born. In statistical modelling involving parity, this variable was excluded. This study also showed that parity was strongly positively associated with contraceptive use. This result is in line with earlier studies in Africa and elsewhere (Ezeh, 1997, Ferede, 2013, Wang et al., 2013, Grady et al., 1993). According to Grady and colleagues, women who have more children tend to have achieved their desired family size, and therefore, choose to frequently use (effective) contraceptives to prevent unwanted pregnancies or births.

Interestingly, while parity has positive effects, age has negative effects on contraceptive use. These results apparently tend to disagree and may be due to younger women desiring the use of contraceptives for spacing or rather postponing births, but not stopping childbearing as big family size ideals/norms are prevalent among individual women. Older women have less risk of conception and thus, perception or norms about not using contraception may be common.

The study assessed fertility levels in Eswatini and examined the underlying factors explaining fertility differences observed. In sum, an overall fertility declined was observed in Eswatini since the mid-1960s. This study has shown significant differences in fertility levels between rural and urban residential contexts, and that individual-level demographic and socioeconomic characteristics did not explain all the variations in fertility behaviour. Swati women should have higher fertility due to their compositional characteristics. With respect to individual-level factors, women employed, currently or previously married, with moderate or high empowerment, with high fertility ideals wanting more than 2 children and who had experienced child loss, had higher fertility than their counterparts. However, women who delayed sexual debut or childbearing, who were better educated and non-poor/wealthy, had fewer children. The findings suggest that individual socioeconomic characteristics and place of residence are important determinants of lifetime fertility.

The study findings suggest various individual-level factors are responsible for lower contraceptive use in Eswatini. These include women who were unemployed, illiteracy, poor, older (aged 35 or more), previously married, had high fertility ideals/preferences, had fewer (2 or less) surviving children, had low gender equity/empowerment, had low exposure to media and had early child birth before age 16 years.

With respect to contraception, the study has shown that in Eswatini, contraceptive use is not associated with community fertility norms, women's empowerment and socioeconomic development or rather area and socioeconomic disadvantage. However, there are statistically significant associations between contraceptive use and individual-level characteristics. At individual-level, most results were in the expected direction and therefore not surprising. As noted earlier by Blalock (1984), it may be vital to understand that contextual influences are not always continuous, but that they may act intermittently.

The findings help build a conceptual/theoretical framework, explaining changes in fertility behaviour. The results show a strong association between demand-supply factors and one's fertility behaviour. Specifically, these findings contribute to existing theoretical fertility frameworks. They also lend support to the micro economic theory basic determinants of fertility as well as demographic or proximate determinants of fertility. While results are not consistent in some regards with theoretical expectations or hypothesis, the multivariate findings are found to broadly agree with the hypotheses of the study and theoretical statements in literature on fertility behaviour.

The study findings contribute to the existing fertility theories including Easterlin's microeconomic theory. The findings point out mechanisms underlying fertility decline at both individual- and community-level. For the latter, the role of urbanisation in providing contextual influences on fertility behaviour, has been overemphasised through many studies and theories. Aspects of geographical contiguity, whether rural or urban, that influence contraceptive use and consequently fertility, have been reported and are supported in this study.

At the individual-level, socioeconomic factors such as improved wealth status and educational attainment for women, are deemed as urbanisation or modernisation forces that depress fertility. Although the positive associations of fertility and employment or empowerment contend with microeconomic theory, it can be concluded that Easterlin's microeconomic theory is supported by study findings. There is evidence of opportunity-cost trade-off on fertility level through education and wealth. Women with better status of wealth or education forego having more children, as it suits their own aspirations and tastes.

The two proximate variables, age at first birth and sex, were significantly associated with fertility level. The findings conform to the Easterlin framework, emphasising that the supply of children is related to women's reproductive capability or fecundity, as well as chances of child survival. It is expected that when child survival chances are reduced through child death experience, women are likely to want more surviving children. The study found age of first birth was highly correlated with age at marriage. This suggests that increasing age at marriage has adverse effects on high fertility.

The study supports that the demand for children is an important aspect in determining fertility level as pronounced in Easterlin's micro-economic theory. The significant effects of fertility preferences on fertility are overwhelming, highlighting the fertility-inhibitive impact of small ideal number of children among women. However, lack of a direct effect of contraceptive may be appalling, but not unique, or at least in part could be explained, possibly by socioeconomic and geographical setting of the country. Other important variables, such as gender inequality/violence as new proximate determinants of fertility, are highlighted in literature (Odimegwu et al., 2015).

On the flip side, poverty and illiteracy reduce the momentum of fertility transition. This in particular, has implications for rural traditional settings where social norms that promote fertility, are maintained. This argument is supported by the study findings, as high fertility norms could be spread namely large family size ideals/desires, preferences of polygyny marriages and early sexual debut or first birth. These norms tend to prove fecundity or womanhood, hence they may be institutional.

Although aggregate level analyses did not show community differences on contraceptive use from a cultural perspective, there could be systemic transmission of cultural mores for the country as a whole. Alternatively, the insignificant effect of community variables on contraceptive use could be due to the way in some were created by aggregation of individual variables likely causing false ecological inference or the absence of relevant variables of the supply of family planning services. More aggregate or qualitative data is needed to test this assumption. However, from the study results, the diffusion of contraceptive use through media is seen at the individual-level rather than at community-level. Traditional cultural norms are at the vanguard of elders in the communities and it may be through individualism that they are challenged by new ideas.

In conclusion, the theoretical contributions of this study confirm that a 'synthesis' of factors is needed to have a holistic view of fertility behaviour and also that women's fertility cannot be abstracted from its community context. The empirical results support Easterlin's hypothesis as a reliable framework to explain fertility behaviour, which is viewed as a sequential decision-making process (Degraff et al., 1997). The theory demonstrates support for the proximate determinants of fertility as valuable and key drivers of fertility decline as opined by Bongaarts (1978, 2015). The results of the study establish the importance of applying Easterlin framework in a multilevel framework of analysis to allow women's individual fertility behaviour to be assessed for small areas at cluster/community-level. In doing so, the predictive value of both individual (compositional) and community characteristics for fertility outcomes can be established. Such multilevel models have been scarcely used for multilevel data such as DHS in the case of Eswatini. By reassessing the fertility levels using multiple methods and data sources, the study has made a contribution in understanding fertility transition and patterns in Eswatini as well as reassuring reliability of previous fertility estimates. The results confirm fertility levels varied widely due to unequal socioeconomic development and socioeconomic opportunities, and hence policy should focus on these vital determinants of fertility to achieve further fertility declines.

10.2 Limitations and strengths of the study

There are limitations to this study and therefore, caution should be exercised in interpreting the findings. First, all macro variables, except for place and region of residence, were aggregated micro variables at the cluster (PSU) level. That is, community variables are derived as averages of the individual-level outcome variables. Kravdal (2006: 3) notes that while the DHS sample average for a PSU may be the best variable available, its effect may still tell us little about the impact of the PSU population average that is theoretically more relevant. Other researchers have suggested use of censuses or community data collected through surveys (Kravdal, 2003, Elfstrom and Stephenson, 2012).

However, such data from community surveys are rarely collected, especially for the whole country. Further, linking community data from another source such as census to the individual file in the survey, is not permissible or possible for confidentiality reasons (Kravdal, 2000, Kravdal, 2006). The sample averaging could result in multicollinearity, since the same variables used to derive the 'contextual' variables are also included as individual variables (Boco, 2010: 57). However, such collinearity bias was not found or at least may require further assessment with methods other than those used in this study, such as structural model estimation, instrumental variable techniques or propensity score matching (Boco, 2010, Balk, 1994). These alternative methods to multilevel models also have their limits and are beyond the scope of this study.

Second, the cross-sectional study design of the Eswatini DHS survey limits inferences to associations between fertility behaviour outcomes and their correlates. Therefore, causal or temporal relationships cannot be ascertained with accuracy.

Finally, cross-sectional data poses various challenges with respect to depth or accuracy of analyses required. For instance, the current status variable problem (measured at the time of survey), may be presented in some models (Kravdal, 2006, Uthman, 2010). Community variables (e.g. residence, media exposure), often refer to the most recent period of the survey and may not correspond to the period to which the outcome event is being measured. In modelling lifetime fertility, current residence or media exposure, which may have changed or improved, might not reflect exposure at the time of childbearing, when the child was actually born. Besides knowing the exposure to risk of the event, there is also no knowledge on the cumulative effects of the event being measured on fertility behaviour. Another problem is that, the data are self-reported and therefore, may produce bias, including recall errors. Parity omissions or inclusions of births by older women, have been reported (Cleland, 1996, Moultrie et al., 2013, Potter, 1977, Warren et al., 1992). Although, the dichotomous contraceptive use outcome is a good proxy for the decision to control fertility (Colleran and Mace, 2015: 1), it does not measure efficiency and effectiveness of use among women. Further, the study's overall measure of contraceptive use does not distinguish between particular type of methods which may provide useful insights.

Despite these limitations, the data provide the only DHS survey data, a nationally representative sample of Eswatini, to inform literature on fertility behaviour and its underlying factors. The importance of DHS should not be less emphasised since the survey provides standardised interviews - a basis from which to compare the performance of the same variables in different countries as well as testing new indicators from a standard set of collected data variables. With a rich dataset such as DHS, an in-depth analysis of fertility behaviour variation would also be appropriately examined for within country specific local context variables. In Eswatini, DHS survey data was collected once and not continued in favour of MICS surveys. The latter, although recently collected, lack the same DHS variables used in the study, limiting analysis and therefore could not be compared.

The hierarchical nature of DHS data allowed for assessing the role of community-level (macro) variables in addition to the standard individual-level and household-level (micro) variables in shaping fertility behaviour. Except for place and region of residence, the study introduces community variables that have not been used or rarely applied in Eswatini for the study of fertility. Introducing composite macro variables such as community social position, and women's empowerment, instead of using multiple indicators, has the advantage of reducing collinearity and bringing parsimony in statistical modelling. This is important for policymakers to effectively design and implement interventions that target high-risk fertility behaviours. This study provides empirical evidence that place (area variation/disadvantage) matters in understanding fertility behaviour differences among women, specifically with regards to childbearing.

10.3 Implications and recommendations

This study has shown that a multilevel examination of fertility behaviour in Eswatini has policy and research implications. Understanding fertility differences is of paramount significance in terms of implementing policies that aim to reduce fertility and thereby decrease population growth. Reducing fertility levels has implications for quality of life and economic development in line with Eswatini National Development Strategy vision 2022 of reaching developmental status or the level of first world countries. The population policy of Eswatini set out in 2002 aimed at reducing fertility level to 3.0 in 2022 from 4.5 estimated in 1997. Hence, it is important to get an understanding of the drivers of high fertility in the country and explanations for community differences in fertility levels. This can enable effective interventions or policies to be strategised, designed and implemented.

Although fertility transition still persists in Eswatini, subpopulation and community fertility variation needs to be reduced. It is highlighted elsewhere that unequal communities propel fertility higher and cause it to be more varied (Colleran et al., 2015). The study highlights evidence of a possible community contextual phenomenon in the cluster/primary sampling unit (PSU) in Eswatini.

Demographic estimation of small areas can reflect fertility differences in communities and thereby facilitate targeted community-based interventions. The programmes on fertility could therefore be tailor-made to suit the factors or characteristics influencing communities. Community fertility differences are imperative to community specific policy with the ultimate goal of reducing fertility and consequently the rate of population growth. The influence of communities in the context of fertility variation needs to be explored in-depth using ethnographic studies as this might uncover influential cultural and socioeconomic factors vital for policy programming.

The study confirms significant urban-rural variation in fertility (number of children born) after controlling for individual and community characteristics. This suggests uneven development may shape area/geographical variations in women's fertility behaviour. This dualistic view of development between urban and rural may be not enough or there should be a shifted away from this view in explaining fertility behaviour. The extent to which locational differences may be explained is attributed to many aspects. There could be geographical or possibly normative dimensions to rural disadvantaged areas that drive high fertility among women living in rural places.

The study reveals geographical rural areas may be conducive for childrearing. It is important to also note that the demographic and socioeconomic profiles of women living in rural areas are different from those living in urban areas. The composition of these characteristics may exert local contextual norms and values about fertility choices on women through conscious or unconscious adaptation or imitation. Therefore, it is recommended to identify characteristics both in urban and rural areas that bring diffusion of information in order to understand the source of disparities in fertility behaviour. This facilitates implementation of customised policies for respective communities. The area disadvantage (urban-rural fertility differences) could be reflecting the role of amenities in shaping reproductive behaviour. Urban lifestyle may have constraints that limit fertility.

From a policy view, a number of micro-level findings from this study merit particular recognition in providing an effective way for increasing use of contraceptives and ultimately averting or limiting births among sexually exposed women.

Emancipation of women in reproductive choice has received policy attention for the past two decades since the Cairo population conference in 1994. Levels of gender inequality cause fertility behaviour variability. Patriarchal society has imprints on Swati culture. Although legal and statutory requirements or papers recognise women as equals to men, the predominance of males in reproductive decision making, is established in the society. The dominance of male partners leads to male desires of fertility to be perpetuated, such as requiring sons for lineage continuation. Women with more children are ascribed more rights and higher social status in a patriarchy. Thus, striving for women's empowerment is an important ingredient of the Sustainable Development Goals (SDGs)-goal number five.

In spite of provisions for gender equality and women empowerment, acts and policies such as the National Population Policy of 2002, fertility prospects of fertility reduction among empowered women, appear to be low. In a patriarchy, as in the case of Eswatini society, it could be that there are some factors that sustain high fertility, even for empowered women. Since women make their own or joint decisions with partners or husbands, this may reflect their subordination to men's demands of childbearing or simply empowered women requiring children for security, company and old age support in the absence of partners/husbands. This is shown by the fact the empowered women are most likely to use contraceptives. While women may negotiate for birth control, they may use secret-female methods such as the pill or injectables without a discussion with their partners. However, this perceived empowerment may not be guaranteed in their decision on number of children with their partners since the negotiation may be difficult. Sterilisation was one of the long-acting contraceptive methods fairly used and therefore couples who desire to limit children or prevent further pregnancies.

The findings of the study have implications for gendered empowerment programmes that are implemented or mainstreamed. Adequate attention should be given to curbing norms that perpetuate gender inequity in the country. Mass media and the education system can fill this gap which may be slow to address in conservative traditional structures.

It is important, however, to note that the concept of women empowerment is dynamic and elusive in its theoretical understanding and hence problematic in implementing. This is because the concept cascades into all socioeconomic, sociocultural and political spheres of life. The other point to note about the concept is that besides having an external power effect, its internal/within power 'self-worth' force shapes norms, norms, pathways and practices of fertility-related and development outcomes. A study in Eswatini by Ziyane and Ehlers (2006) found that women should empower themselves by becoming self-assertive in contraceptive use to avoid unprotected sexual intercourse.

The socioeconomic status of women, in terms of occupation, wealth or education, can have important effects on fertility behaviour. Combining work and family life is challenging. A positive association between labour force participation and lifetime fertility suggests societal norms which sanction childbearing and requires women to produce a large family size. This in turn may cushion household income, especially in traditional structures/rural areas where children provide labour in generating income/wealth such as in subsistence farming. The structure of labour can cause fertility variation and therefore, fertility can only decline when norms are challenged, improving working conditions or providing alternative financial security, especially in the agricultural sector. Working women are less financially dependent on partners and may have the ability to make their own fertility or reproductive decisions.

Less educated and worse-off status women are seen to have higher fertility and are less likely to practise innovative contraceptive behaviour. In general, the lower (educational, wealth) status amongst women reduces contraceptive uptake and consequently increases fertility. It can be conceived that couples would have fewer children than they possibly could have, considering if they had better wealth or education. These findings point to the need to develop programmes that focus on education enrolment, especially secondary or higher schooling and economic growth in the population, thus promoting upward mobility which favours lowering fertility. Economic constraints may not depress fertility, social inequalities or disadvantages (in wealth, education) but cause higher fertility differentials.

Secondary and above education is effective in increasing use of fertility/birth control measures and limiting fertility in Eswatini. The longer the duration of woman's education, the greater the possibility of fertility inhibition. Investment in women's education, beyond the current free public primary education, may influence fertility behaviour more markedly, and reap the benefits of the fertility-inhibitive effect. Post-compulsory education has been noted to be effective in reducing fertility, especially higher order births (Lerch, 2013). Maternal education widens women's horizons and should therefore be encouraged as a long term solution to reducing fertility ultimately harnessing the demographic dividend.

Low fertility levels could be achieved by promoting anti-natal policies or limiting social inequality within human or reproductive rights boundaries. With improvements in socioeconomic conditions, fertility is expected to decline. Evidence in Nigeria (Aremu, 2013), a country from which Eswatini could learn, indicates that when wealth increases there is a greater likelihood that women will seek family planning services from private healthcare providers, especially when the public health sector is weak or offers poor services.

The study does not support that lifetime fertility could be driven down by diffusion of knowledge (through mass media) or that birth control technology (contraceptive use) could shape fertility behaviour. Although there is lack of influence of contraceptive use on lifetime fertility, the contraceptive use model has shown variability in contraceptive behaviour in the population, indicating modern and natural methods of contraception remain critical for further fertility decline. Experience elsewhere indicates that introducing knowledge about contraceptives earlier in life is associated with earlier adoption of contraceptives (Snopkowski et al., 2016: 8). Sexual education, which has been introduced recently in the primary school curriculum, could reap such rewards.

Lessons from developing countries elsewhere, as in the case of Matlab, Bangladesh (Snopkowski et al., 2016) suggest that when family planning programmes are effective and all women have contraceptive knowledge, then this knowledge has little influence on fertility. The same reasoning applies with saturation of access to contraceptives. Fertility is then driven by individual reproductive strategies and choices.

At the same time, access to media or family planning messages on media has important policy implications. A variety of means may act as channels or means of communicating and reaching norms, values and beliefs on small family size, and empowering women, including male contraception as well benefits of contraception for women. Increasing access to contraceptives to specific target groups and areas should remain a priority. Evidence reflects that presence or visitation by family planning outreach workers would enhance contraceptive uptake by reducing costs of contraception, thereby reducing fertility through promotion of birth spacing and small family size norms (Degraff et al., 1997). Meeting the demands of family planning, including contraception, will enable the country to be on track in achieving Sustainable Development Goals, especially goal number three: good health and well-being.

Induced abortions occur in all societies (Sedgh et al., 2012: 22). The high abortion rates in Eswatini may cause maternal death and morbidity to increase and hence the need to reduce abortion levels which probably are unsafe due to restrictive laws. Improving access to family planning services, more effective methods of contraception and ensuring access to post-abortion care, are some measures to be taken to minimise cases of unwanted births or pregnancies and unsafe abortions (Sedgh et al., 2012). Since abortion levels are high irrespective of subnational areas or the subpopulation group where women belong, educational and investment programmes should be implemented and strengthened to reduce the adverse effects of induced abortion among all women and not excluding men from the initiatives. The abortion rates were high among uneducated women and therefore, it is imperative to focus attention and investments on them to prevent adverse effects that may be caused by unmet need for contraception or using less effective methods of contraception. Women should be encouraged to use more the modern contraceptive methods of high effectiveness.

Married status and desired fertility positively influence fertility. Individual fertility norms of high fertility preferences (family size greater than 4) marital practices of polygyny, and early marriages (proxied by age at first birth or sexual union,) drive the level of fertility high. There is a need to understand why fertility ideals are high among women, especially in various population subgroups or contexts, despite wide access to contraceptives.

Polygynous unions tend to promote high fertility and less contraception than monogamy unions. These findings suggest co-wives are more likely to forego contraception to enhance their capacity and chances of bearing children, especially to draw more resources from the husband. In order to limit fertility, women in polygynous relationships need to be discouraged from having high fertility ideals or at least have well planned ones in order to limit the number of children needed in the family structure. Within polygynous unions, the husband and women in the household should be cooperative in deciding their reproductive goals of total number of children.

It is likely that women who have reached their family size preferences are more likely to use contraceptives for stopping reproduction. The study findings suggest the existence of large family size norms among women. It is vital to understand why women continue to have high fertility norms or preferences in spite of increased availability of contraceptives and changing socioeconomic conditions. Fertility preferences have been noted to strongly predict actual fertility behaviour. Little recognised are the pronatalist tendencies of polygynous unions. Strategies to reduce fertility must therefore be targeted towards manipulation fertility norms of couples recognising their conscious choices. Using experience from Tanzania, Kravdal (2001: 127) set out that fertility desires are reduced by secondary education only when the woman has a saying in childbearing decisions, and higher-order birth rates are reduced only in areas with a high DHS-based status index.

Younger age at first birth (early childbearing) explains early sexual debut. Early sexual unions/engagements and childbearing observed in the study, positively affects number of children ever born, especially when consistent or effective contraception is not adopted. The Swati law has the provision that teens aged 15 or younger are deemed legally not to consent to sexual intercourse. Engaging in sexual activity with a minor may lead to prosecution for statutory rape. In spite of this, teenage pregnancy is high, and this has implications for fertility and women's reproductive health. Early childbearing has a number of consequences: infant and child deaths are frequently among teenage mothers due to negligence or lack of knowledge on nutrition and childrearing, amongst others. Infant and child mortality has been known to increase fertility for women wanting to replace the children they have lost or as a future strategy of hoarding or old age security; women are exposed to a longer risk of childbearing when they start early sexual intercourse, given the expectation of higher fertility.

Early marriages, therefore childbearing, before 18, are criminalised under the Children's Protection and Welfare Act of 2012, however, under Swati Law and Custom, parental authority may be sought to seek approval of child bride marriages. Early marriages have serious socioeconomic implications. Women's health may be compromised as giving birth early is life threatening. Human rights of girls and women are compromised as their socioeconomic success does not fully materialise due to incomplete education. Women may not realise their full potential of social mobility and economic productivity. Men should come on-board in curbing early marriages or childbearing. The policies already drafted or designed in the country should be supported or implemented by all stakeholders, including government, to achieve their set goals. Such mainstreaming could build cultural values that uphold women's dignity and empowerment and denigrate norms or practices that do not implore good cultural evolution.

The schooling system or laws have a pervasive impact in decreasing early childbearing. Educational costs are lowered, teenage fertility reduces and later, age at first marriage is achieved. Women should be retained in the schooling system beyond secondary level of education.

In an indirect way, age at marriage may be associated with other socioeconomic variables such as education. Age at marriage, which is correlated with age at first birth, is a variable amenable to programme or policy persuasion therefore manipulating fertility behaviour. Although the statutory law recognises age at marriage to be 18 years, the enactment of such legislature remains weak in the traditional customs where early marriages are tolerated or sometimes not forced.

There is a need to continue empowering girls and women as already established in the 2002 National Population Policy Framework for Eswatini. Although some of the objectives have been achieved in redressing gender iniquity, marriageable age to 18 years, to name a few, more focus should be put on socialisation of all stakeholders, both male and female, on the importance of equal opportunities and rights around reproductive health choices or goals. Among adolescents, the high propensity to engage in early first sexual activity, early childbearing and nonuse of contraception, have negative consequences. Past research indicates the supporting environment of the adolescent family structure needs to be strengthened, especially for those who grow up without parental care or guidance. Adolescents are prone to be risk takers in terms of sexual experimenting, and the tendency is thought to reach into adulthood (Grady et al., 1993).

The supply factors of children have important policy implications for childbearing. The strong positive effect of child mortality on fertility suggests that replacement strategies for women have implications for increasing family sizes. Interventions for improving child survival should be strengthened through immunisations, nutrition and prenatal care or rather better maternal and child healthcare. Maternal and healthcare programmes and interventions should be strengthened to improve or ensure child survival and well-being. This will reduce infant and child mortality and thereby fertility. It is advocated that women's health, both physical and mental, should be prioritised following the loss of a child (Randall and LeGrand, 2003).

The demographic variables of women appear to be important and should be factored in policy designs. In particular for this study, variability in fertility behaviour has been found to be affected by age and the number of children women had. Older women (aged above 34) tended to use contraceptives less whilst women with higher parity had a higher propensity to use them. The needs of women with different family sizes and by age should be taken into account in providing family planning.

In addition to findings from multivariate analysis, the study reveals at aggregate level that women's selected background factors of residence, region, wealth status and education have an influence on fertility levels and proximate determinants of fertility indices. The results suggest the need to combine a range of demographic, ecological, socioeconomic and cultural factors to account for fertility decline. A number of pathways for fertility transition may not act in one society despite being active in other societies. Informing policy messages requires an understanding of the incentives or disincentives for childbearing from area disadvantage, socioeconomic disadvantages and marital practices or fertility norms. The demand for and supply of children factors play an important role in explaining fertility variation in Eswatini.

Finally, policies that are more focused on improving female education, delaying age at first birth and sexual debut, and reducing poverty, child mortality and desired number of children, can be expected to simultaneously reduce fertility. Understanding women's empowerment, employment, and marriage patterns, could unearth important programme interventions for reducing fertility. Therefore, policy needs to account for a broad perspective on socioeconomic determinants of fertility behaviour for sexually exposed women. Programmes designed to promote awareness and use of contraceptives among all women in general, including girls in particular, could have multiple payoffs.

10.4 Scope for further research

This study's results on levels and determinants of fertility behaviour outcomes are based on a quantitative approach. Understanding these determinants is a vital step towards planning for further fertility reductions in the population and thereby limiting high population growth. This study therefore contributes to the scarce quantitative methods of how community (women empowerment, cultural customs and socioeconomic development) and individual variables, have an influence on fertility.

However, further research to fully understand fertility behaviour outcomes is needed using qualitative perspectives to capture nuances of perceptions, community customs and cultures that sanction childbearing and contraceptive use. These perceptions and belief systems about fertility and contraceptive use were not explored in this study and hence a potential source for rich data. Based on the results presented in this study, the reasons for low or none contraceptive uptake and high fertility among women, could be unearthed for policy and programme interventions.

Besides improving on the research design through triangulation, the quantitative methods used can be improved, especially the multilevel models adopted for the study. The multilevel (two) random intercept models permitted the disentanglement of individual and community variation in reported fertility behaviour among sexually initiated women. Areas of further research suggested pertain to cluster size, cluster levels as well as breadth and depth of cluster/community variables as follows:

- Further studies on community variables not too highly aggregated at the smallest political or administrative community level, is required. Other than the clusters (PSU) with small size affecting the power of the tests, bigger community such as constituencies (*Tinkhundla*) in Eswatini may provide a meaningful measurement of community. Such fertility behaviour data from *Tinkhundla* is required in Eswatini. On the other hand, even smaller than PSU levels such as family level have been used for some studies and therefore, there is a need to understand family/friends influence on fertility behaviour. Social capital or network of friends and family is a larger contributor to fertility behaviour than even a woman's own individual characteristics (Colleran and Mace, 2015).
- Given the information above, there is a need to understand variation in fertility behaviour at three levels (e.g. individual, family/friends, community) or rather any multiple (two or three) levels of influence of varying community sizes.
- Further research is needed on other unmeasured or unobserved community variables influencing fertility behaviour. In Eswatini, more community variables need to be explored since such

studies on community effects on fertility behaviour, are rare. For example, due to high HIV prevalence and a rich traditional culture in Eswatini, health-related indicators (including family planning) and sociocultural factors need to be further explored besides those already used such as child mortality and polygyny. Also, different definitions or measurement of unstandardised variables such as gender equity, women's status or empowerment as well as other composite scales, may be evaluated further. The constituents of the several aggregated women empowerment indicators may vary for international comparison. Indices may capture lesser or more dimensions depending also on the context where some indicators are valid or not significant. Community data (not from derived samples) may be also used when collected. Ethnographic data collection methods may be used to gather community perspectives on fertility behaviour, including those of men who are excluded in this study. Qualitative studies would collect more information on cultural issues sanctioning fertility behaviour in Eswatini.

Although, community aspects of fertility behaviour may be important, the findings indicate more work needs to be done in identifying the effects of individual factors. For instance, the meaning of women's empowerment in the context of Eswatini needs to be explored further and explain why employment has a positive influence on fertility whereas it is anticipated to depress fertility.

To sum, individual, family, and community variables not included in this study may be associated with fertility behaviour, and therefore, future research should explore these variables, including perceptions, beliefs and attitudes towards fertility-related behaviours not included in this study.

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APPENDIX A: PROOFREADER CERTIFICATION

25 October 2018

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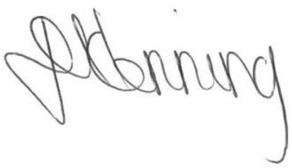
To Whom It May Concern

This is to certify that I have proofread the Ph.D thesis, “Multilevel Determinants of Fertility Behaviour in Eswatini”, by Garikayi Bernard Chemhaka. I checked the spelling, punctuation, grammar and sentence construction. I did not adjust the content in any way.

I hope this is in order.

Kind wishes



Diana Henning

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APPENDIX B: SUSTAINABLE DEVELOPMENT GOALS (SDGS): THE 2030 AGENDA THEMES

Source: http://sdgcompass.org/sdgs/

APPENDIX C: POLICY BRIEF

Thesis Topic: **Multilevel determinants of fertility behaviour in Eswatini**

By

Garikayi Bernard Chemhaka (766699)

Demography and Population Studies Programme, University of the Witwatersrand

POLICY BRIEF: Promoting fertility limitation among women in Eswatini

Policy Users: Ministry of Health; CSO; UNFPA; UNDP; FLAS; PSI

Introduction

Eswatini is a country where patriarchal ideals are endorsed and traditional social institutions or organisations are valued. For example, women's subordinate role, early marriage /marriage at younger ages or to gain social status for women, are informally promoted by older cohorts (Lule, 1991, MEPD, 2012). The sociocultural and economic structure of a society, where women actually live, has implications for fertility behaviour. Empirical evidence, not just theory alone, in Africa and elsewhere (Janevic et al., 2012, Kazembe, 2009, Kravdal, 2002, Stephenson et al., 2007, Wang et al., 2013), has shown that community aspects of development, fertility norms and marital practices amongst others, may shape fertility.

The total fertility rate for the country has gradually declined from a high of 7.1 children per woman in 1970 to 4.6 in 2007 (CSO, 1979, CSO, 2010b). However, this rate is noticeably much higher than the replacement level of fertility of 2.5, which is higher than most developed countries and which African countries have set as a benchmark. Earlier studies in Eswatini have found breastfeeding, contraceptive use, education, child mortality and age at marriage as important drivers of fertility rates or lifetime fertility (Dlamini, 1995, Warren et al., 1992). As noted in literature, factors affecting fertility rates or levels are many and requiring further scrutiny of important variables for policy formulation. The policy brief seeks to discuss fertility behaviour in Eswatini in terms of number of children born and its implications for population policy, using the 2007 Eswatini Demographic and Health Survey.

Policy context

A woman's fertility is part of her reproductive health and right which should be emancipated, as earlier envisaged in the 1994 International Convention on Population and Development (ICPD), to which Eswatini is a signatory. The government of Eswatini, since post-independence in 1968, has considered fertility concerns in its developmental planning in order to reduce population growth.

The family planning programme was introduced in 1973 and an explicit population policy with set targets for reducing fertility and increasing contraceptive use, was launched in 2002 (Government of Swaziland, 1978, Gule, 1994, MEPD, 2002, Wear and Katsande, 1989). Other economic and health policy strategies to complement population issues, such as the 2005 Poverty Reduction Strategy Action Plan (PRSAP), 2010, National Condom Strategy (NCS) and 2013 National Health Policy (MEPD, 2006, MEPD, 2012, Ministry of Health, 2013, Ministry of Health and Social Welfare, 2010), have buttressed fertility behaviour as a policy concern hinging on development of the country.

In spite of government interventions and programme efforts by various stakeholders to reduce fertility rate and increase contraceptive use, it remains a priority to meet small family size norms equivalent to the levels of developed countries.

Implications of findings and policy recommendations

The merits and demerits of each determinant of fertility should be weighed. For instance, factors that increase fertility such as polygyny, and child mortality should be discouraged and those that lower fertility promoted, such as improving women's status with respect to education and wealth. In a broad sense, both individual-level and community-levels factors affecting fertility behaviour should be examined. This provides a useful picture in that socioeconomic factors should not be considered in isolation when designing interventions or programmes that alter reproductive or fertility preferences.

In summary, key areas needing policy attention or redress on fertility reduction are as follows:

- Social milieu/mores on gender inequity/women's empowerment, patriarchy/polygyny and large fertility desires/preferences tend to support bigger family size structures.
- Cultural norms encouraging early marriages or onset of childbearing among teenagers tend to accelerate high fertility, especially in rural areas.
- Economic norms of poverty, and illiteracy tend to encourage high fertility in Eswatini.
- Infant and child mortality demotivates couples to limit number of children born.

Though current contraceptive use had insignificant impact on lifetime fertility, variability of contraceptive uptake was observed. There is a need to eliminate constraints in contraceptive use among Swazi women or couples. The following should be prioritised in policy strategy on contraception:

- Social milieu/mores on gender inequity/women's empowerment, patriarchy/polygyny and large fertility desires/preferences tend to support bigger family size structures.
- Cultural norms encouraging early marriages or onset of childbearing among teenagers tend to accelerate high fertility, especially in rural areas.
- Economic norms on poverty, and illiteracy tend encourage high fertility in Eswatini.
- Infant and child mortality demotivates couple to limit number of children born.

Policies on fertility and contraception should aim am improving women's empowerment and social standing in a number of ways. A variety of strategies could be implemented to promote family planning in Eswatini, specifically to increase contraceptive use and reduce fertility. One of the more important strategies could be promoting couples' discussion on family size ideals or preferences. Men are central to family planning and therefore should be involved in this decision-making process to curb false perceptions, myths, reservations and practices of family planning. Overall, women's empowerment relates to attitudes towards negotiation for sexual activity, gender based violence and decision making in various facets of a woman's life. Thus, it is important for woman to be equipped with strategies that improve their attitudes towards sexual negotiation by providing modern contraceptives that women can easily use, access, and meet their choice demands. Domestic violence not only impinges on the physical, mental or emotional health of the woman but also of the child and the entire productivity of the nation. Therefore, gender mainstreaming should promote equity and norms that value gender equity, should be aligned.

Programmes on improving women's status (as measured by wealth and education), should be encouraged, including women to make their own contributions to the household economy and not depend on men's economic power or earnings. Thus, income generating projects for women may be implemented or financed to improve their wealth status and contribution to household finances. In doing this, education is vital since better educated women tend to boost their self-efficacy in many aspects of life including employability, and reproduction control.

It is also important that the various subpopulation groupings of women should be taken into consideration in devising strategies for promoting contraception and small family sizes. The demographics of women include important factors, for example targets such as, married and unmarried/single, younger and older, and small parity and high parity, should be considered. Lifetime history events such as experiences of early birth, sexual engagement and loss of a child, may be vital in designing developmental programmes, interventions and strategies to ultimately limit fertility. Fertility has a bearing on many population and developmental programming aspects of life including fulfilling the recent SDGs, with which many countries including Eswatini are concomitant.

APPENDIX D: SELECTED REVIEWED LITERATURES ON STATISTICAL METHODS OF FERTILITY BEHAVIOUR

Table D1: Multivariate and multilevel statistical methodology papers on fertility behaviour

Title	Author/s	Journal	Independent Variables	Outcomes	Statistics Used	Gaps
Children Ever Born/ completed fertility						
Development Context, Regional Differences among Young Women, and Fertility: The Ecuadorean Amazon	Lobao and Brown (1998)	*Social Forces*	**Individual variables** Women's education, employment, ethnicity, and marriage **Controls** Migration status, age **Contextual variables** Family-based economy, Class structure, Gender inequality in schooling, Indigenous- non-Spanish speaking population, State sector presence in employment, Demographic regime, Migration context	Number of children ever born among women	Multilevel Multinomial logistic regression model ; Multilevel Proportional-odds model; Principal components analysis; Cronbach's alpha; Discriminant analysis	Data on national census does not provide information about proximate determinants of fertility: contraception
Modeling the Determinants of Fertility among Women of Childbearing Age in Nigeria: Analysis Using Generalized Linear Modeling Approach	Akpa and Ikpotokin (2012)	*International Journal of Humanities and Social Science*	**Proximate determinants:** current marital status; polygyny; age at first marriage; age at first sexual intercourse; recent sexual activity; postpartum amenorrhea, abstinence and insusceptibility; age at first birth; use of contraceptives **Sociodemographic variables**: Type of place of residence, Highest educational level, Religion, Ethnicity, Personal wealth index, Household wealth index, Husband lives	Total number of children ever born by women before age of 50 years	generalized linear model -Poisson regression	Multilevel modelling not applied to cater for the multistage stratified and cluster sampling design and hence the study assumes homogeneity of all clusters in the study sample

			in house			
Does Community Level Mortality Affect the Reproductive Performance of Women? Evidences from Goa, India	Syamala (2004)	*Anthropologist*	level of education of women, Religion, Age at marriage, Current age, Individual experience of child loss for woman	Number of children ever born to women	Multivariate linear regression analysis on two community level indexes of mortality; Analysis of variance (ANOVA)	Community level mortality impact on reproductive behaviour was tested separately for the high mortality region and low mortality area. The one dimensional index of mortality does not capture all the aspects of community mortality that has a bearing on fertility. Other socio-economic variables should have been included. The community mortality variable is not a direct measure of mortality but a proxy variable measure on number of women who experienced child loss, hence not a standardised measure.
Individual and Community Aspects of Women's Status and Fertility in Rural Bangladesh	Balk (1994)	*Population Studies*	**Individual variables** Age, Age Difference between Spouses, Age at First Marriage, Education, Size of the family's dwelling unit, Amount of landholding, Landlessness, Husband's employment, Wife works outside the home, Religion, Region, Women's status: mobility, leniency, Attitudes and authority **Village-level status Variables** Village-Adjusted Mean for wife's work, Village-adjusted mean for Mobility, Village-adjusted mean for Leniency, Village-adjusted mean for Authority, Village-adjusted mean for Attitudes	Total children ever born to women	ordinary least squares (OLS) regression; two-stage least squares (TSLS) regression; path analysis	Women's status is shown to be a multidimensional concept and thus cannot be adequately captured by proxy variables. Since there is no standardised measure of women status, its measure needs further exploration in various contexts.
Multiple fertility behaviour outcomes studies						
Community-Level Determinants of Contraceptive Use in	Degraff et al. (1997)	*Demography*	**Individual variables** age, education, husband's education, husband's	current use of contraception; Number of living	Generalized method of moments (GMM) instrumental variables	The study assumes an instrumental variable approach to solve for endogeneity. The study does not show how these instrumental variables

the Philippenes: A Structural Analysis			occupation, value of land owned by household, number of women other than mother aged 15 and above in household, Perceived travel time to the nearest Family Planning (FP) clinic, Respondent ever visited by a FP worker **Community variables** Distance, Roads, FP clinic, FP worker, Child wage, Female wage, Male wage, women's organization in community, FP clinic at marriage, FP worker at marriage, Health center at marriage, Irrigation at marriage.	children; Desire for an additional child	method (includes 2-stage least squares for linear regression models)	were chosen or which instrumental variables chosen through which the independent variables directly affect fertility outcomes.
Family planning promotion, contraceptive use and fertility decline in Ghana	Parr (2002)	*African Population Studies*	Age, Region, Education, Religion, Ethnicity, Number of Surviving Children, Number of Dead Children, Urban-rural residence **Contextual** Exposure to Family Planning (FP) Messages by Media	contraceptive use; giving birth in the 12 months before the interview (current fertility)	Multilevel logistic regression	Ghana DHS was collected from 400 enumeration areas (EAs). A disadvantage of a sample design involving smaller numbers of women being sampled per cluster is the reduced accuracy of measurements of variables at the cluster level, and the associated difficulties this creates for contextual analysis. For births coefficients of the analysis may be affected to some degree by reverse causality, because the response variable was measured over a period of time that precedes the point in time at which most of the explanatory variables were measured.
Causes of Fertility Decline in India and Bangladesh: Role of Community	Dev et al. (2002)	*Economic and Political Weekly*	**Individual (women) level variables** Modern contraceptive use, male and female children died, age, age square, education, religion, caste, media exposure, standard of living index, work status, residence, membership in a	number of children born to each of the ever-married women	Multilevel Regression	type of multilevel regression not stated, levels of interaction that exist at household level and at the community level are not tested empirically using interaction terms but the study assumes that the diffusion takes place through a social interactive framework

			self-help group. **Community-level (Village) variables** Distance to the nearest town from the village, existence of women's associations in the villages, the number of group meetings of family planning held.			
Women's Networks and the Social World of Fertility Behavior	Madhavan et al. (2003)	*International Family Planning Perspectives*	**Individual** Woman's age, Woman's age squared, Number of infant deaths, Education, Husband's age, Presence of a co-wife **Household** Size, Extended household, Asset score, Network function, Size of material support network, Size of practical support network, Membership in a tontine, Level of multiplexity in total network, **Contextual** Network composition: Presence of mother-in-law, Presence of husband, Presence of mother, Presence of nonfamilial older women, per cent of network who are natal kin, per cent of network who are conjugal kin, per cent of network who are nonkin, per cent of network who live outside village.	number of children a woman has ever borne; ever use of contraceptives	Ordinary least-squares(OLS) regression; Logistic regression	Possibility of reverse causality, the outcome children ever born is measured using current status variables and no controls of previous childbearing experience are used. The OLS regression assumes normality of children ever born in a population which might not be the case in the population. There is possibility of correlation between the regressors and/or the error term (endogeneity or reverse causality) and this has not been accounted for. Thus women's network indices may estimate inconsistent and biased estimates
Timing of fertility						
A Multilevel Analysis of Marital and Nonmarital Fertility in	Billy and Moore (1992)	*Social Forces*	**Individual** Demographic Characteristics (Age, Age at menarche,	Annual risk of a live birth (measured to a	parametric hazard rate models with time-dependent covariate	The role of couple or male in fertility decision is not incorporated in multilevel model.

the U.S			Previous childbearing/parity, Ethnicity); Family Background Characteristics (Mother's education, Mother's and father's occupation, Living arrangements); Present Socioeconomic Status (Family income, Woman' s education); Labor Force Participation (Woman' s occupation); Religion and Religiosity; Family Planning Service Use **Community** Socioeconomic Status (Housing values); Female Labor Force Participation; Social Disorganization (Marital dissolution); Local demography (Sex ratio, Race and ethnic composition, Age structure); Service Availability (Family planning services, Abortion providers); Fertility Level (Marital fertility, Nonmarital fertility)	maximum of 42 months prior to the interview date)		
Regional Social Contexts and Individual Fertility Decisions: A Multilevel Analysis of First and Second Births in Western Germany	Hank (2002)	*European Journal of Population*	**Individual level** Age, age squared, age at first birth, Education, marital status, foreigner, **Regional level** Urbanised area, agglomerations (≥ 300 inhabitants per sq. km), day-care provision (number of slots per 1000 children aged 3 to 6), labour market structure (share of employees in the tertiary sector, unemployment rate, female labour force participation rate)	Number of births (occurrence of a first birth and second birth, respectively within a one-year interval)	Multilevel discrete-time logistic model	The sample size diminishes once a specific birth order has occurred. This results in poor determination of individual level unobserved heterogeneity.

A search for aggregate-Level effects of education on fertility, using data from Zimbabwe	Kravdal (2000)	*Demographic Research*	Women's education, Age, religion, parity, education of women in the district currently resided, current place of residence, place of residence as a child, duration since previous birth, husband's education	Birth rate (birth order-first births and higher-order birth); Fertility desire (wanting another child within two years); Modern contraception use; Post-partum susceptibility	Multilevel discrete-time hazard models Multilevel logistic models	Education is controlled for by few variables, whereas other mediating variables could have added to get the net effects of education such as work status, or normative variables. However, the author state that a retrospective approach strongly restricts the number of variables to include in the model Many attitudes and characteristics at interview may be different from those earlier in the 5-year observation period.
High Fertility in City Suburbs: Compositional or Contextual Effects	Kulu and Boyle (2008)	*European Journal of Population*	**demographic controls** : marital/union duration, woman's age, the age of the youngest child, calendar time, marital or cohabiting status. **socio-economic controls** women's educational enrolment (not enrolled or enrolled), educational level (lower secondary, upper secondary, vocational, lower tertiary or upper tertiary) and annual earnings (none, low, medium, high or very high). **contextual** housing type (single-family houses, terraced houses and apartments) type of residential contexts capital city, other cities and towns, rural areas	hazard of first, second and third birth	multivariate event history analysis	The study focus its attention to suburban (cities) fertility in Europe may mask the extent of the fertility differentials between city centres and rural areas. In most developing countries the majority of women reside in rural areas.
Fertility-related attitudes						
The Influence of Childbearing Regional Contexts on Ideal Family Size in Europe	Testa and Grilli (2006)	*Population*	**Individual-level** age, gender, marital status, school enrolment, educational level (years of	Ideal number of children among individuals aged 20-39 years	the logit regression model-explaining the desire to have or not to have children;	A cluster of geographical region may be too large to proxy cultural behaviours which are fertility related, small units may be required.

			schooling), employment status, urbanization level, household size and household income, political opinion **Regional-level** the mean actual number of children ever born, percentage of childless people, the mean age at the birth of the first child; regional means of individual variables		the proportional odds regression model-for the ideal number of children for those desiring at least one child	
The community-level effects of women's education on reproductive behaviour in rural Ghana	Benefo (2006))	*Demographic Research*	**Individual-Level** Woman's exposure to family planning ads, ethnicity, religion, schooling, work, age at first marriage, age, family size **Community-Level** Aggregate women's education, Community transportation, Urbanization, Community infrastructure development	Contraceptive use; Interest in Fertility Regulation	Multinomial logit Regression using penalized quasi-likelihood methods in the software Hierarchical General Linear Model (HGLM)	Some clusters in DHS data were dropped in the analysis due to few numbers of women. Thus some potentially important variables such as village access to family planning services were dropped in the analysis due to small sample size.
The Role of Individual and Community Normative Factors: A Multilevel Analysis of Contraceptive Use Among Women in Union in Mali	Kaggwa, et al. (2008)	*International Family Planning Perspectives*	**Individual-level variables** *woman-specific variables* age, education, religion, urban or rural residence, region, ethnicity, work outside the home, socioeconomic status, approval of family planning, discussion of family planning with husband or partner, discussion of family planning with people other than the husband or partner and exposure to family planning messages.	current use of modern contraceptive	Generalized linear latent and mixed models procedures (GLLAMM) in Stata-Multilevel logistic regression	As a rule of thumb for multilevel analysis, cluster sample size of not less than 25 women was used for analysis. Other studies have used a cut-off point of a minimum of 10 women per cluster. Thus a many women (3,026 women or 173 of the 403 clusters) were excluded in the analysis reducing a sample size. There are many independent variables measuring normative environment and hence a possibility of multicollinearity and endogeneity, which is not corrected

			Partner-specific variables education and approval of family planning. **Community-level variables** proportions or means in the woman's cluster of residence: the proportion of women desiring a small family size of four or fewer children, mean number of births per woman in the woman's cluster of residence, proportion of women who were exposed to a family planning message in the past six months, proportion of women who approved of family planning and proportion of women with access to piped water			
Patterns of Contraceptive Use at the Edge of Fertility Transition in Zimbabwe	Muhwava (2002)	*African Population Studies*	**Individual and Household Characteristics** Age, marital status, children ever born, household consumption, Education, work status , female autonomy, Exposure to family planning messages, Stratum of Residence, Educational Opportunities, Transport System in Cluster, CBD in Cluster, IEC/Mobile Clinic in Cluster, Access to Family Planning Clinic, Availability of Pharmacy in Cluster, Availability of Private Doctor	current contraceptive use	multilevel logistic regression	All women sexually active included in the sample, thus exclusion criteria was not part of the study of those sterile, infecund, breastfeeding etc. Inclusion criteria not stated of the clusters used , all clusters were used and no knowledge is given on the number and size of the clusters

Table E1: Correlation matrix for micro-level DHS variables, Eswatini

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
A. Parity	1.00														
B. Contraceptive use	-0.08	1.00													
C. Occupation	0.01	0.08	1.00												
D. Wealth	-0.22	0.17	0.33	1.00											
E. Education	-0.31	0.20	0.17	0.38	1.00										
F. Exposure to media	-0.18	0.17	0.24	0.52	0.42	1.00									
G. Women's empowerment	-0.07	0.11	0.15	0.23	0.23	0.22	1.00								
H. Ideal number of children	0.24	-0.11	-0.03	-0.12	-0.19	-0.09	-0.08	1.00							
I. Union status	0.39	-0.13	0.07	-0.09	-0.17	-0.07	-0.05	0.16	1.00						
J. Age	0.66	-0.11	0.23	0.04	-0.14	0.02	0.07	0.24	0.46	1.00					
K. Number of living children	0.88	-0.05	0.02	-0.20	-0.26	-0.15	-0.04	0.23	0.36	0.63	1.00				
L. Child death experience	0.35	-0.09	0.01	-0.12	-0.20	-0.11	-0.07	0.10	0.19	0.23	0.15	1.00			
M. Religion	0.06	-0.05	-0.15	-0.20	-0.13	-0.15	-0.09	0.02	0.03	-0.05	0.06	0.06	1.00		
N. Age at first birth	-0.20	0.06	0.12	0.16	0.29	0.16	0.12	-0.06	-0.03	0.11	-0.17	-0.12	-0.11	1.00	
O. Age at sexual debut	-0.22	0.09	0.16	0.20	0.34	0.21	0.13	-0.07	-0.06	0.07	-0.19	-0.10	-0.09	0.72	1.00

Source: Author's calculations

Table E2: Correlation matrix for macro-level DHS variables, Eswatini

	P	Q	R	S	T	U	V
P. Place of residence	1.00						
Q. Region of residence	0.07	1.00					
R. Community social position	-0.53	-0.12	1.00				
S. Community media exposure	-0.44	-0.25	0.55	1.00			
T. Community women empowerment	0.44	0.11	-0.42	-0.39	1.00		
U. Community ideal fertility norm	0.30	0.10	-0.31	-0.32	0.26	1.00	
V. Community polygyny	0.28	0.08	-0.15	-0.20	0.30	0.15	1.00

Source: Author's calculations

Table E3: Test for multicollinearity for logistic and poisson models, DHS variables, Eswatini

	LOGISTIC MODEL			POISSON MODEL		
Variable	Model variable	VIF	1/VIF	Model variable	VIF	1/VIF
Occupation	occ			occ		
Agricultural or manual	1	1.38	0.7247	1	1.34	0.7466
Sales and services	2	1.90	0.5276	2	1.82	0.5496
Professional/technical/managerial/clerical	3	1.66	0.6020	3	1.61	0.6229
Wealth	v190			v190		
Poorer	2	2.10	0.4765	2	2.07	0.4839
Middle	3	2.36	0.4246	3	2.34	0.4268
Richer	4	2.99	0.3345	4	2.95	0.3387
Richest	5	4.92	0.2031	5	4.83	0.2072
Education	v106r			v106r		
Primary	1	4.36	0.2295	1	4.34	0.2305
Secondary/higher	2	8.86	0.1129	2	8.73	0.1145
Exposure to media	medialpha			medialpha		
Moderate	2	1.79	0.5592	2	1.79	0.5587
High	3	2.61	0.3832	3	2.61	0.3833
Women's empowerment	empowalpha			empowalpha		
Moderate	2	2.30	0.4339	2	2.27	0.4401
High	3	2.31	0.4328	3	2.26	0.4425
Ideal number of children	v614r2			v614r2		
3-4	1	1.72	0.5830	1	1.70	0.5893
5+	2	1.29	0.7760	2	1.24	0.8042
Union status	union			union		
Monogamous	1	2.91	0.3431	1	2.49	0.4020
Polygynous	2	1.63	0.6141	2	1.44	0.6944
Formerly married	3	1.68	0.5956	3	1.45	0.6915
Age	v013					
20-24	2	3.74	0.2676			
25-29	3	3.96	0.2527			
30-34	4	4.34	0.2306			
35-39	5	4.22	0.2371			
40-44	6	3.80	0.2631			
45-49	7	3.70	0.2706			

Table E3 continued

	Model variable		VIF	1/VIF	Model variable		VIF	1/VIF
Number of living children	v218r2							
3-4		1	2.07	0.4833				
5+		2	2.82	0.3543				
Infant/child death experience	1.u5cm		1.48	0.6759	1.u5cm		1.40	0.7125
Religion	v130r3				v130r3			
Catholic		1	1.73	0.5786		1	1.71	0.5857
Pentecostal/Charismatic		2	3.80	0.2635		2	3.72	0.2686
Protestant		3	3.97	0.2516		3	3.90	0.2564
Apostolic/Zion		4	6.88	0.1453		4	6.65	0.1503
Age at first birth	v212r				v212r			
16-17		2	4.18	0.2394		2	4.09	0.2444
18-19		3	5.83	0.1717		3	5.57	0.1796
20+		4	8.33	0.1200		4	7.69	0.1300
Age at sexual debut	v531r				v531r			
16-17		2	3.04	0.3288		2	3.03	0.3304
18-19		3	3.35	0.2989		3	3.34	0.2998
20+		4	3.02	0.3307		4	3.01	0.3324
Contraceptive use					1.dv313p		2.19	0.4573
Rural	2.v102		5.61	0.1783	2.v102		5.52	0.1813
Region	v101				v101			
Manzini		2	2.23	0.4489		2	2.21	0.4531
Shiselweni		3	1.97	0.5076		3	1.94	0.5149
Lubombo		4	1.97	0.5071		4	1.96	0.5115
Community social position	2.comm_poxn		3.93	0.2543	2.comm_poxn		3.92	0.2553
Community media exposure	2.comm_media		3.55	0.2814	2.comm_media		3.53	0.2833
Community women empowerment	2.comm_empow		2.95	0.3393	2.comm_empow		2.93	0.3407
Community ideal fertility norm	2.comm_chn		2.52	0.3972	2.comm_chn		2.50	0.4002
Community polygyny level	2.comm_poly		2.44	0.4103	2.comm_poly		2.43	0.4113
	Mean VIF		3.26		Mean VIF		3.09	

Source: Author's calculations

APPENDIX F: LEVELS OF FERTILITY ADDENDUM

Table F1: Average parity and age-specific fertility rates, Eswatini

Panel a	PHC 1966*		PHC 1976*		PHC 1986		PHC 1997		PHC 2007	
Age group	Parity	ASFR	Parity	ASFR	Parity+	ASFR	Parity+	ASFR	Parity	ASFR
15-19	0.3168	0.0904	0.3299	0.1184	0.2499	0.0825	0.1665	0.0728	0.1608	0.0541
20-24	1.6589	0.2166	1.6774	0.2574	1.5418	0.1931	1.1190	0.1929	0.8809	0.1383
25-29	3.0126	0.2206	3.2588	0.2490	2.9920	0.1905	2.3324	0.1989	1.6354	0.1469
30-34	4.1361	0.1995	4.7335	0.2119	4.4450	0.1714	3.6063	0.1622	2.6520	0.1545
35-39	4.8499	0.1523	5.6896	0.1606	5.4935	0.1260	4.6563	0.1305	3.6734	0.1400
40-44	5.4689	0.0953	6.1988	0.0937	6.1452	0.0655	5.4161	0.0645	4.5809	0.0900
45-49	5.7451	0.0591	6.3530	0.0555	6.4706	0.0361	5.9701	0.0354	5.1362	0.0656
Panel b										
LEbirth		---		46.2		56.3		60.0		43.0
LEfemale		---		49.5		59.9		62.6		43.1
Population size		---		49534		681059		929718		1018449

Notes: LEbirth implies life expectancy at birth; LEfemale refers to life expectancy for females and pop size refers to the defacto total population. * the parities and ASFRs for 1966 and 1976 refers to African women population. Parity+ indicates that the average parities that were corrected using the el-Badry technique,

Source: Author's calculations

Table F2: P/F ratios based on Trussell and Arriaga variants, Eswatini 1966-2007

Source	PHC 1966		PHC 1976		PHC 1986		PHC 1997		PHC 2007	
Reference date	1965.90		1976.65		1986.65		1997.36		2007.36	
Age\Method	Trussell	Arriaga	Trussell	Arriaga	Trussell	Arriaga	Trussell	Arriaga	Trussell	Arriaga
15-19	1.580	1.684	1.222	1.300	1.367	1.570	1.052	1.229	1.336	1.507
20-24	1.524	1.439	1.229	1.229	1.574	1.512	1.212	1.204	1.291	1.210
25-29	1.366	1.315	1.232	1.244	1.530	1.501	1.203	1.229	1.166	1.188
30-34	1.271	1.220	1.245	1.237	1.553	1.518	1.279	1.303	1.227	1.253
35-39	1.182	1.149	1.192	1.180	1.533	1.484	1.313	1.315	1.269	1.275
40-44	1.184	1.134	1.153	1.155	1.544	1.492	1.372	1.350	1.366	1.315
45-49	1.126	1.105	1.081	1.130	1.511	1.478	1.407	1.347	1.327	1.262

Source: Author's calculations

APPENDIX G: PROXIMATE DETERMINANTS OF FERTILITY ESTIMATION

Table G1: Summary of comparison of formulae for the Bongaarts and Stover models

Original aggregate Bongaarts Model by Bongaarts (1978, 1982)	Revised aggregate Bongaarts Model by Stover (1998)	Revised aggregate Bongaarts Model by Bongaarts (2015)
	Total Fertility Rate	
$TFR = C_m \times C_c \times C_i \times C_a \times TF$ TFR = total fertility rate TF = total fecundity rate C_m = the index of proportion married or in union C_c = the index of contraception use and effectiveness C_a = the index of abortion C_i = the index of postpartum infecundability (due to amenorrhea or abstinence)	$TFR = C_x \times C_i \times C_a \times C_u \times C_f \times PF$ PF = potential fertility C_x =the index of proportion of women sexually active (rather than marriage) in the reproductive lifespan C_i =the index of postpartum infecundability C_a = the index of abortion C_u = the index of contraception use and effectiveness C_f = the index of infecundity.	$TFR = \sum C_m^*(a) \times C_c^*(a) \times C_i^*(a) \times C_a^*(a) \times f_f^*(a)$ $TFR = C_m^* \times C_c^* \times C_i^* \times C_a^* \times TF^*$ *represents revised measures TF^* = revised total fecundity rate $f_f^*(a)$ =revised fecundity rate
Index of marriage/union	*Index of sexual exposure*	*Index of marriage/union/sexual exposure*
$C_m = \sum m(a) f_m(a) / \sum f_m(a)$ $m(a)$ =the proportion of currently married or in consensual sexual union females at each age a $f_m(a)$ =the age-specific marital fertility rates	$C_x = s$ s = the proportion of women sexually active	$C_m^* = \sum C_m^*(a) \times w_m(a)$ $w_m(a) = f_m^*(a) / \sum f_m^*(a)$ $f_m^*(a) = C_c^*(a) \times C_i^*(a) \times C_a^*(a) \times f_f^*(a)$ $f_m^*(a)$=fertility rate among sexually exposed women

Index of contraception		
$C_c = 1 - 1.08 \times u \times e$ u = the proportion of currently married/in union women using contraception e = the average use-effectiveness of contraception 1.08 = the correction factor on sterility (in that sterile/infecund women who normally do not use contraception are excluded)	$C_u = 1 - u \times e$ u = the proportion of sexually active, fecund women using contraception	$C_c^* = \sum C_c^*(a) \times w_c(a)$ $w_c(a) = f_n^*(a) / \sum f_n^*(a)$ $w_c(a) \approx f_f^*(a) / \sum f_f^*(a)$ $f_n(a) = C_i^*(a) \times C_a^*(a) \times f_f^*(a)$ $f_n^*(a)$ =naturally exposed fertility
Index of postpartum infecundability		
$C_i = 20/(18.5 + i)$ i =the average number of months of postpartum infecundability (due to postpartum amenorrhea or abstinence, whichever is longer) for women in union	$C_i = 20/(18.5 + i)$	$C_i^* = \sum C_i^*(a) \times w_i(a) \approx C_i$
Index of abortion		
$C_a = TFR/(TFR + b \times TAR)$ $b = 0.4 \times (1 + u)$ b = the averted births per induced abortion and TAR = the total abortion rate	$C_a = TFR/(TFR + b \times TAR)$ $b = 0.4 \times (1 + u \times e)$	$C_a^* = \sum C_a^*(a) \times w_a(a)$ $C_a^* \approx TFR/(TFR + b^* \times TAR)$ $b^* = 14/[18.5 + i(a)]$
	Index of sterility	
	$C_f = 1 - f$ f =the proportion of sexually active women who are infecund	

Original Bongaarts model parameter (OBM)

Input and estimates from Stata and DHS

Table G2: Contraceptive Prevalence, effectiveness, method mix for currently married and in union women, OBM Eswatini 2007

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Method mix															
Female sterilisation	5.8	8.2	4.9	5.2	5.2	5.5	7.5	2.3	4.1	7.1	4.5	9.2	5.8	4.5	6.5
Male sterilisation	0.2	0.5	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.3
IUD	1.4	1.9	1.2	1.4	1.9	0.9	1.1	0.0	1.1	0.4	1.9	2.8	0.6	0.8	2.0
Implants	0.2	0.6	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.3
Pill	9.9	10.6	9.6	10.9	10.4	7.2	9.8	5.5	9.0	12.1	10.1	11.6	6.1	7.5	12.2
Injectables	17.2	13.7	18.4	17.8	15.1	18.0	18.8	20.8	16.6	19.9	16.1	14.2	7.7	17.7	19.0
Male condom	12.2	19.8	9.4	13.0	15.7	9.4	8.0	4.4	8.4	9.7	14.4	19.7	4.7	9.6	15.5
Female condom	0.1	0.0	0.2	0.5	0.0	0.0	0.0	0.0	0.3	0.3	0.2	0.0	0.4	0.0	0.2
Rhythm/P.A	0.3	0.7	0.1	0.2	0.3	0.6	0.2	0.0	0.3	0.4	0.2	0.4	0.0	0.1	0.4
Withdrawal	2.2	1.7	2.4	2.4	2.9	2.3	1.0	0.9	2.0	2.9	2.8	2.3	1.5	2.1	2.5
LAM	0.9	0.4	1.1	1.1	0.6	1.1	1.0	2.8	1.2	0.8	0.0	0.2	1.3	0.7	0.9
Folk	0.5	0.0	0.6	0.5	0.1	0.7	0.7	0.6	0.0	0.6	0.5	0.6	0.9	0.3	0.5
Type of method															
Any method	50.6	58.1	48.0	53.7	52.5	45.6	48.0	37.2	42.9	54.2	50.7	62.2	28.9	43.3	60.3
Traditional	3.8	2.7	4.2	4.2	3.8	4.6	2.8	4.2	3.4	4.8	3.5	3.4	3.7	3.2	4.3
Modern	46.8	55.4	43.8	49.5	48.7	41.0	45.2	33.0	39.5	49.4	47.3	58.8	25.2	40.1	56.0
Long-acting	7.5	11.3	6.2	7.4	7.5	6.4	8.6	2.3	5.2	7.5	6.4	13.3	6.4	5.3	9.2
Short-acting	39.3	44.1	37.6	42.2	41.3	34.6	36.6	30.7	34.2	41.9	40.8	45.5	18.8	34.8	46.9
Not currently using	49.4	41.9	52.0	46.3	47.5	54.4	52.0	62.8	57.1	45.8	49.3	37.8	71.1	56.7	39.7
e	0.91	0.91	0.91	0.91	0.91	0.91	0.93	0.91	0.92	0.92	0.91	0.91	0.89	0.92	0.91
u	0.51	0.58	0.48	0.54	0.53	0.46	0.48	0.37	0.43	0.54	0.51	0.62	0.29	0.43	0.60

Notes: u refers to proportion of contraceptive use; e refers to average contraceptive effectiveness; P.A=periodic abstinence
Source: Author's calculations

Table G3: Estimates of selected reproductive parameters for estimating proximate determinants of fertility, OBM Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
amen	6.9	8.7	6.6	0.7	7.4	4.7	4.1	3.9	11.6	0.7	7.1	4.9	3.9	7.4	6.6
abst	4.6	4.1	4.8	4.4	3.9	6.2	4.3	4.9	3.5	6.3	5.1	3.7	4.5	4.4	4.8
i	10.7	12.1	10.1	9.9	13.2	11.4	7.6	11.1	13.5	8.6	9.3	13.2	13.7	10.9	9.6
TFR	3.85	3.02	4.21	3.62	3.67	4.28	4.02	5.55	4.95	3.93	3.27	2.65	4.93	4.54	3.39
b	0.60	0.63	0.59	0.61	0.61	0.58	0.59	0.55	0.57	0.62	0.60	0.65	0.52	0.57	0.64
TF	30.45	30.60	30.58	27.09	34.64	41.73	22.19	27.06	34.57	34.32	29.86	30.84	20.76	25.22	37.16
TFave	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94	20.94
TAR	0.84	0.82	0.82	0.83	0.83	0.89	0.83	0.73	0.71	0.73	1.01	0.84	1.19	0.82	0.69
AR	23.9	23.5	23.5	23.7	23.8	25.5	23.6	20.9	20.3	21.0	29.0	24.0	34.0	23.6	19.7
TFRe	2.99	2.42	3.22	3.19	2.53	2.41	4.25	4.60	3.24	2.67	2.72	2.17	5.59	4.16	2.16
TFRe-TFR	-0.86	-0.60	-1.00	-0.43	-1.15	-1.87	0.23	-0.94	-1.71	-1.26	-0.55	-0.48	0.66	-0.38	-1.23

Notes: *i* = median duration (months) of postpartum insusceptibility source: https://www.statcompiler.com/

amen= median duration (months) of postpartum amenorrhoea/breastfeeding source: https://www.statcompiler.com/

abst=median duration (months) of postpartum abstinence source: https://www.statcompiler.com/

b =births averted

TF= Total fecundity rate

TFave= average total fecundity rate source: Bongaarts (2015)

TAR= Total abortion rate-lifetime number per woman

AR= Abortion rate- number per 1000 women

TFR= observed total fertility rate

TFRe= predicted total fertility from model assumption (average TF=20.94)

TFRe-TFR is difference between observed and predicted total fertility rate (error/bias)

Source: Author's calculations

Table G4: OBM indices for proximate determinants of fertility by social context and status, Eswatini 2007 DHS

		Residence		**Region**				**Wealth**					**Education**		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Panel a	Estimated value of each proximate determinant														
Cm	0.42	0.41	0.42	0.46	0.39	0.31	0.51	0.51	0.43	0.37	0.36	0.42	0.60	0.51	0.36
Cc	0.50	0.43	0.53	0.47	0.49	0.55	0.52	0.64	0.58	0.46	0.50	0.39	0.72	0.57	0.41
Ci	0.68	0.65	0.70	0.70	0.63	0.67	0.77	0.68	0.63	0.74	0.72	0.63	0.62	0.68	0.71
Ca	0.88	0.85	0.90	0.88	0.88	0.89	0.89	0.93	0.92	0.90	0.84	0.83	0.89	0.91	0.88
Panel b	Impact on fertility reduction (%)														
Cm	58.4	58.9	58.3	54.3	60.6	68.8	49.1	48.8	56.9	62.6	64.0	57.9	40.4	48.8	64.4
Cc	49.9	57.0	47.3	52.7	51.4	44.8	48.0	36.4	42.5	53.8	49.9	61.0	27.9	43.0	59.3
Ci	31.5	34.6	30.1	29.6	36.9	33.1	23.4	32.4	37.5	26.2	28.1	36.9	37.9	32.0	28.8
Ca	11.6	14.7	10.3	12.3	12.2	10.8	10.8	6.8	7.6	10.3	15.8	17.0	11.1	9.4	11.6
Panel c	Per cent reduction by the operation of variables														
Cm	42.4	38.3	44.1	38.9	41.5	51.2	39.5	42.3	43.3	45.3	46.1	35.3	36.0	39.0	43.2
Cc	33.4	36.4	32.3	37.1	32.2	26.1	38.2	28.6	28.4	35.6	31.2	38.4	22.7	32.7	37.5
Ci	18.3	18.4	18.0	17.4	20.5	17.7	15.6	24.7	24.2	14.0	14.9	18.8	33.1	22.5	14.2
Ca	6.0	6.9	5.5	6.5	5.8	5.0	6.7	4.4	4.1	5.0	7.8	7.6	8.2	5.8	5.1
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Author's calculations

Table G5: Proportion of women married, age-specific fertility and marital rates, OBM Eswatini 2007

	Residence		Region				Wealth					Education		
Age	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Panel a	Proportion of women currently married or in union														
15-19	0.0692	0.0574	0.0721	0.0869	0.0626	0.0461	0.0864	0.1219	0.0808	0.0804	0.0544	0.0229	0.2089	0.1156	0.0322
20-24	0.3276	0.3510	0.3184	0.3858	0.3138	0.2179	0.3968	0.4305	0.3155	0.3070	0.2861	0.3224	0.5154	0.4110	0.2814
25-29	0.5330	0.4985	0.5490	0.5284	0.5125	0.4813	0.6411	0.6362	0.6439	0.4935	0.4868	0.4893	0.6908	0.5715	0.5027
30-34	0.6154	0.5225	0.6639	0.6488	0.5610	0.5686	0.7172	0.6230	0.6570	0.5955	0.5847	0.6268	0.7298	0.6502	0.5828
35-39	0.6653	0.6300	0.6796	0.6630	0.6523	0.6205	0.7374	0.6880	0.6416	0.5884	0.7160	0.6771	0.6777	0.6838	0.6505
40-44	0.6656	0.5720	0.6984	0.6481	0.6385	0.7146	0.6857	0.6324	0.6867	0.6825	0.6669	0.6566	0.6229	0.7202	0.6375
45-49	0.6222	0.4913	0.6606	0.6364	0.6339	0.6345	0.5754	0.5608	0.6414	0.6291	0.6176	0.6614	0.6417	0.5677	0.6668
Panel b	Age-specific fertility rate														
15-19	0.1108	0.0885	0.1172	0.1154	0.1013	0.1029	0.1307	0.1560	0.1345	0.1073	0.0932	0.0831	0.1970	0.1601	0.0810
20-24	0.2025	0.1634	0.2194	0.1967	0.1946	0.2228	0.2039	0.2711	0.2448	0.2250	0.1870	0.1322	0.2663	0.2205	0.1907
25-29	0.1646	0.1240	0.1845	0.1671	0.1637	0.1716	0.1544	0.2204	0.2116	0.1718	0.1617	0.1116	0.1996	0.1685	0.1589
30-34	0.1595	0.1134	0.1822	0.1417	0.1479	0.1902	0.1717	0.2535	0.2283	0.1632	0.1305	0.1026	0.1921	0.2089	0.1268
35-39	0.0990	0.0828	0.1048	0.0661	0.0885	0.1388	0.1186	0.1499	0.1409	0.0857	0.0644	0.0706	0.0933	0.1181	0.0880
40-44	0.0298	0.0308	0.0295	0.0317	0.0387	0.0247	0.0181	0.0471	0.0239	0.0328	0.0163	0.0297	0.0278	0.0278	0.0326
45-49	0.0037	0.0000	0.0047	0.0051	0.0000	0.0049	0.0062	0.0117	0.0060	0.0000	0.0000	0.0000	0.0100	0.0034	0.0000
TFR	3.85	3.02	4.21	3.62	3.67	4.28	4.02	5.55	4.95	3.93	3.27	2.65	4.93	4.54	3.39
Panel c	Age-specific marital /in union fertility rate														
15-19	0.4637	0.3492	0.5168	0.3824	0.4652	0.7669	0.3853	0.4723	0.5820	0.5495	0.4902	0.3075	0.3875	0.4024	0.5081
20-24	0.6182	0.4656	0.6891	0.5099	0.6202	1.0225	0.5138	0.6298	0.7760	0.7327	0.6536	0.4099	0.5167	0.5365	0.6775
25-29	0.3087	0.2488	0.3360	0.3162	0.3194	0.3565	0.2408	0.3464	0.3286	0.3480	0.3322	0.2281	0.2890	0.2949	0.3162
30-34	0.2592	0.2171	0.2745	0.2184	0.2636	0.3345	0.2394	0.4069	0.3474	0.2740	0.2232	0.1638	0.2632	0.3213	0.2176
35-39	0.1487	0.1315	0.1542	0.0996	0.1356	0.2237	0.1609	0.2178	0.2196	0.1457	0.0900	0.1043	0.1376	0.1726	0.1353
40-44	0.0448	0.0538	0.0423	0.0489	0.0606	0.0345	0.0264	0.0745	0.0348	0.0481	0.0244	0.0452	0.0446	0.0386	0.0512
45-49	0.0059	0.0000	0.0071	0.0080	0.0000	0.0078	0.0107	0.0209	0.0094	0.0000	0.0000	0.0000	0.0156	0.0060	0.0000
TMFR	9.25	7.33	10.10	7.92	9.32	13.73	7.89	10.84	11.49	10.49	9.07	6.29	8.27	8.86	9.53

Source: Author's calculations

Stover's revision model (RJS)

Table G6: Contraceptive Prevalence, effectiveness, method mix among sexually active women, RJS Eswatini 2007

		Residence		**Region**				**Wealth**					**Education**		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Method mix															
Female sterilisation	4.0	6.0	3.2	4.0	3.4	3.0	5.7	1.1	2.9	4.0	3.0	7.3	5.9	2.6	4.4
Male sterilisation	0.1	0.3	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.2
IUD	1.2	1.3	1.2	1.4	1.4	0.9	1.0	0.0	0.9	0.5	1.6	2.3	0.6	0.4	1.8
Implants	0.1	0.4	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.2
Pill	8.7	9.0	8.6	11.0	8.5	5.6	8.8	5.3	6.7	11.1	8.9	10.4	5.3	6.9	10.3
Injectables	16.6	13.8	17.7	16.8	14.3	18.3	18.4	18.7	16.2	19.4	15.6	14.4	9.1	16.0	18.2
Male condom	15.9	25.0	12.3	16.2	20.4	12.8	11.6	4.2	12.0	12.3	20.9	24.5	6.2	12.1	19.7
Female condom	0.2	0.1	0.2	0.4	0.3	0.0	0.0	0.0	0.2	0.6	0.2	0.0	0.4	0.2	0.1
Rhythm/P.A	0.2	0.5	0.1	0.0	0.2	0.6	0.2	0.0	0.0	0.3	0.2	0.4	0.0	0.0	0.4
Withdrawal	1.8	1.3	2.0	2.0	2.4	1.6	0.5	0.9	1.5	2.3	1.8	2.0	1.5	1.8	1.8
LAM	1.1	1.0	1.2	0.8	1.4	1.4	0.9	2.8	1.4	1.1	0.5	0.4	1.9	1.2	0.9
Folk	0.3	0.0	0.4	0.1	0.1	0.6	0.4	0.2	0.0	0.4	0.5	0.2	0.4	0.3	0.2
Type of method															
Any method	50.2	58.6	46.9	53.2	52.7	44.8	47.5	33.2	41.8	52.1	53.3	62.7	31.3	41.4	58.2
Traditional	3.4	2.7	3.6	3.0	4.1	4.2	2.0	3.9	3.0	4.2	3.1	3.0	3.8	3.3	3.3
Modern	46.8	55.9	43.3	50.2	48.6	40.6	45.5	29.3	38.8	47.9	50.2	59.7	27.5	38.1	54.9
Long-acting	5.4	8.0	4.4	5.9	5.1	3.8	6.7	1.1	3.8	4.5	4.6	10.5	6.5	3.0	6.6
Short-acting	41.4	47.9	38.9	44.4	43.5	36.7	38.8	28.2	35.0	43.4	45.6	49.2	21.0	35.1	48.3
Not currently using	49.8	41.4	53.1	46.8	47.3	55.2	52.5	66.8	58.2	47.9	46.7	37.3	68.7	58.6	41.8
e	0.90	0.89	0.91	0.91	0.89	0.90	0.92	0.90	0.90	0.91	0.89	0.90	0.89	0.90	0.90
u	0.50	0.59	0.47	0.53	0.53	0.45	0.47	0.33	0.42	0.52	0.53	0.63	0.31	0.41	0.58
u-overlap	0.40	0.50	0.36	0.41	0.44	0.34	0.39	0.24	0.30	0.41	0.42	0.56	0.24	0.31	0.48

Notes: *u-overlap* refers to contraceptive prevalence that excludes contraceptive use that with postpartum amenorrhea
Source: Author's calculations

Table G7: Estimates of selected reproductive parameters for estimating proximate determinants of fertility, RJS Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
TFR	3.85	3.02	4.21	3.62	3.67	4.28	4.02	5.55	4.95	3.93	3.27	2.65	4.93	4.54	3.39
b	0.58	0.61	0.57	0.59	0.59	0.56	0.57	0.52	0.55	0.59	0.59	0.63	0.51	0.55	0.61
PF	21.12	18.93	21.98	19.26	23.61	22.59	18.70	24.57	24.91	20.21	18.46	20.56	22.96	21.97	20.24
PFave	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
TAR	0.83	0.81	0.83	0.79	0.84	0.90	0.81	0.85	0.73	0.78	0.91	0.80	1.12	0.89	0.72
AR	23.8	23.0	23.8	22.7	24.0	25.8	23.1	24.3	20.8	22.2	26.1	23.0	31.9	25.5	20.6
TFRe	3.83	3.34	4.02	3.95	3.27	3.98	4.51	4.74	4.17	4.08	3.71	2.71	4.51	4.34	3.52
TFRe-TFR	-0.02	0.33	-0.19	0.33	-0.41	-0.30	0.49	-0.81	-0.78	0.15	0.45	0.06	-0.42	-0.20	0.13

Source: Author's calculations

Table G8: Proportion of currently sexually active women by age group, RJS Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
Age group	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
15-19	0.2207	0.1990	0.2259	0.2455	0.1987	0.2114	0.2378	0.3075	0.2494	0.2423	0.1918	0.1380	0.6002	0.2986	0.1531
20-24	0.5994	0.6349	0.5855	0.6139	0.5647	0.5788	0.6688	0.6219	0.6415	0.6129	0.5877	0.5557	0.7125	0.6776	0.5613
25-29	0.6869	0.6689	0.6952	0.6586	0.7007	0.6593	0.7462	0.6819	0.7339	0.6685	0.7413	0.6317	0.7098	0.6685	0.6911
30-34	0.6961	0.6714	0.7089	0.6977	0.6650	0.7385	0.7044	0.7424	0.7522	0.6576	0.6679	0.6945	0.7329	0.6958	0.6912
35-39	0.6627	0.6747	0.6579	0.7163	0.5826	0.6809	0.6999	0.7139	0.5665	0.6518	0.6136	0.7448	0.6028	0.6551	0.6799
40-44	0.5742	0.5956	0.5667	0.5754	0.5887	0.5492	0.5720	0.5144	0.5427	0.5807	0.5929	0.6107	0.5225	0.5693	0.5964
45-49	0.4543	0.4164	0.4654	0.5197	0.4248	0.4249	0.4421	0.3677	0.5244	0.3780	0.4495	0.5372	0.4418	0.4070	0.5102

Source: Author's calculations

Table G9: RJS indices for proximate determinants of fertility by social context and status, Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Panel a	Estimated value of each proximate determinant														
Cx	0.52	0.55	0.51	0.55	0.50	0.50	0.54	0.53	0.53	0.51	0.50	0.53	0.60	0.52	0.51
Cu	0.64	0.55	0.67	0.62	0.61	0.69	0.65	0.78	0.73	0.63	0.62	0.50	0.79	0.72	0.57
Ci	0.68	0.65	0.70	0.70	0.63	0.67	0.77	0.68	0.63	0.74	0.72	0.63	0.62	0.68	0.71
Ca	0.89	0.86	0.90	0.88	0.88	0.89	0.90	0.93	0.93	0.90	0.86	0.84	0.90	0.90	0.89
Cf	0.90	0.93	0.89	0.88	0.92	0.92	0.89	0.87	0.88	0.92	0.91	0.92	0.81	0.90	0.92
Panel b	Impact on fertility reduction (%)														
Cx	48.0	44.8	49.1	45.1	50.2	50.1	45.7	46.9	46.5	49.0	49.5	47.4	40.0	47.8	49.1
Cu	36.3	45.0	32.9	37.5	39.3	30.8	35.4	21.6	26.9	37.3	37.9	50.0	21.0	28.3	43.3
Ci	31.5	34.6	30.1	29.6	36.9	33.1	23.4	32.4	37.5	26.2	28.1	36.9	37.9	32.0	28.8
Ca	11.2	14.0	10.1	11.5	11.8	10.6	10.4	7.4	7.5	10.5	14.2	16.0	10.4	9.7	11.5
Cf	9.6	6.7	10.7	12.1	7.5	8.1	10.8	13.2	12.0	8.0	8.6	7.7	18.7	10.2	7.8
Panel c	Per cent reduction by the operation of variables														
Cx	38.4	32.4	40.9	35.9	37.5	41.8	39.7	42.6	38.7	41.1	39.4	31.3	33.2	41.2	37.8
Cu	26.5	32.5	24.2	28.1	26.8	22.2	28.4	16.4	19.4	28.5	27.5	33.8	15.3	21.1	31.8
Ci	22.2	23.1	21.6	21.0	24.8	24.2	17.3	26.4	29.1	18.6	19.0	22.5	31.0	24.4	19.0
Ca	7.0	8.2	6.5	7.3	6.8	6.7	7.1	5.2	4.8	6.7	8.8	8.5	7.1	6.5	6.8
Cf	5.9	3.8	6.9	7.7	4.2	5.1	7.4	9.5	7.9	5.1	5.2	3.9	13.5	6.8	4.5
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Author's calculations

Table G10: Current contraceptive status and method used among women aged 15–49 years, according to age at interview, RJB Eswatini 2006–2007

		Residence		Region				Wealth					Education		
Total	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Panel a	Contraceptive prevalence by age among married/in union/ sexually exposed women, *u*(a)*														
15-19	0.517	0.597	0.497	0.412	0.550	0.478	0.623	0.334	0.579	0.505	0.527	0.696	0.511	0.460	0.579
20-24	0.553	0.605	0.534	0.568	0.578	0.563	0.482	0.475	0.466	0.594	0.568	0.629	0.424	0.475	0.598
25-29	0.613	0.596	0.620	0.635	0.611	0.562	0.634	0.491	0.495	0.666	0.666	0.653	0.341	0.543	0.669
30-34	0.657	0.754	0.606	0.684	0.687	0.644	0.578	0.412	0.609	0.679	0.680	0.748	0.473	0.591	0.716
35-39	0.567	0.691	0.517	0.627	0.629	0.434	0.518	0.398	0.516	0.597	0.549	0.697	0.369	0.492	0.656
40-44	0.467	0.551	0.437	0.457	0.489	0.462	0.453	0.247	0.329	0.595	0.419	0.596	0.222	0.363	0.630
45-49	0.382	0.559	0.339	0.440	0.388	0.313	0.358	0.228	0.217	0.348	0.450	0.598	0.245	0.326	0.512
u	0.556	0.635	0.525	0.570	0.581	0.521	0.529	0.394	0.477	0.592	0.576	0.664	0.347	0.475	0.636
Panel b	*u*(a)-o(a)*														
15-19	0.438	0.523	0.417	0.325	0.457	0.427	0.543	0.275	0.499	0.399	0.483	0.576	0.298	0.392	0.502
20-24	0.432	0.498	0.407	0.450	0.473	0.422	0.348	0.327	0.329	0.481	0.447	0.532	0.347	0.352	0.474
25-29	0.474	0.492	0.465	0.454	0.476	0.449	0.530	0.388	0.347	0.537	0.470	0.542	0.239	0.467	0.502
30-34	0.545	0.658	0.486	0.582	0.578	0.494	0.490	0.275	0.466	0.539	0.571	0.678	0.344	0.440	0.627
35-39	0.453	0.608	0.389	0.492	0.503	0.383	0.388	0.304	0.355	0.435	0.426	0.636	0.346	0.331	0.556
40-44	0.409	0.531	0.364	0.391	0.471	0.335	0.398	0.178	0.224	0.508	0.387	0.572	0.206	0.296	0.566
45-49	0.378	0.559	0.334	0.440	0.376	0.313	0.358	0.228	0.196	0.348	0.450	0.598	0.227	0.326	0.512
u-overlap	0.454	0.551	0.417	0.457	0.485	0.418	0.435	0.296	0.355	0.479	0.468	0.588	0.280	0.376	0.527
Panel c	average use-effectiveness of contraception by age, *e*(a)*														
15-19	0.88	0.86	0.88	0.87	0.87	0.89	0.88	0.93	0.86	0.88	0.87	0.86	0.80	0.88	0.88
20-24	0.89	0.87	0.89	0.89	0.88	0.89	0.89	0.90	0.87	0.89	0.89	0.89	0.88	0.89	0.89
25-29	0.90	0.89	0.90	0.90	0.89	0.88	0.93	0.91	0.92	0.91	0.88	0.89	0.91	0.90	0.90
30-34	0.90	0.89	0.90	0.90	0.89	0.90	0.91	0.89	0.91	0.89	0.89	0.90	0.87	0.90	0.90
35-39	0.90	0.87	0.91	0.91	0.87	0.93	0.90	0.90	0.92	0.88	0.90	0.90	0.90	0.89	0.90
40-44	0.91	0.93	0.90	0.87	0.92	0.90	0.93	0.84	0.91	0.94	0.90	0.89	0.89	0.91	0.90
45-49	0.93	0.93	0.93	0.93	0.93	0.91	0.94	0.95	0.96	0.94	0.90	0.92	0.96	0.94	0.91
e	0.90	0.89	0.90	0.90	0.89	0.90	0.91	0.90	0.90	0.90	0.89	0.89	0.89	0.90	0.90

Table G10 continued

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Panel d	Contraceptive index by age, *1-r*(a)(u*(a)-o(a))e*(a)*														
15-19	0.384	0.450	0.368	0.283	0.396	0.380	0.481	0.255	0.430	0.351	0.422	0.496	0.238	0.345	0.443
20-24	0.383	0.435	0.363	0.401	0.417	0.375	0.310	0.293	0.287	0.427	0.398	0.472	0.304	0.312	0.420
25-29	0.426	0.438	0.420	0.411	0.421	0.396	0.494	0.355	0.319	0.489	0.414	0.484	0.217	0.422	0.450
30-34	0.489	0.582	0.439	0.523	0.512	0.445	0.446	0.246	0.422	0.482	0.510	0.609	0.299	0.396	0.563
35-39	0.406	0.528	0.355	0.445	0.439	0.357	0.349	0.272	0.327	0.381	0.382	0.570	0.311	0.294	0.501
40-44	0.371	0.492	0.327	0.342	0.432	0.300	0.370	0.150	0.205	0.476	0.350	0.512	0.183	0.270	0.512
45-49	0.350	0.521	0.309	0.411	0.348	0.284	0.336	0.217	0.189	0.328	0.405	0.549	0.219	0.305	0.467
Panel e	*(u*(a)-o(a))e*(a)*														
15-19	0.763	0.722	0.773	0.825	0.756	0.766	0.704	0.843	0.735	0.783	0.740	0.694	0.853	0.787	0.726
20-24	0.690	0.647	0.706	0.675	0.662	0.696	0.749	0.763	0.767	0.655	0.677	0.618	0.754	0.747	0.659
25-29	0.578	0.566	0.584	0.593	0.583	0.608	0.511	0.649	0.684	0.516	0.590	0.521	0.786	0.582	0.555
30-34	0.474	0.373	0.527	0.437	0.449	0.521	0.520	0.736	0.545	0.481	0.451	0.345	0.678	0.574	0.394
35-39	0.539	0.400	0.597	0.494	0.502	0.595	0.603	0.691	0.629	0.567	0.566	0.352	0.647	0.666	0.431
40-44	0.535	0.383	0.590	0.571	0.457	0.623	0.536	0.812	0.743	0.403	0.561	0.357	0.770	0.661	0.358
45-49	0.433	0.157	0.500	0.335	0.437	0.540	0.456	0.648	0.694	0.469	0.344	0.111	0.646	0.506	0.243

Source: Author's calculations

Table G11: Estimates of selected reproductive parameters for estimating proximate determinants of fertility, RJB Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
TFR	3.85	3.02	4.21	3.62	3.67	4.28	4.02	5.55	4.95	3.93	3.27	2.65	4.93	4.54	3.39
b	0.48	0.46	0.49	0.49	0.44	0.47	0.54	0.47	0.44	0.52	0.50	0.44	0.43	0.48	0.50
TF	15.04	14.17	15.21	14.23	16.37	15.87	13.37	16.39	17.32	14.00	13.00	16.53	14.34	15.12	14.84
TFave	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4
TAR	0.66	0.65	0.65	0.68	0.65	0.65	0.65	0.65	0.54	0.57	0.77	0.67	1.01	0.71	0.54
AR	18.9	18.6	18.6	19.5	18.6	18.6	18.6	18.5	15.5	16.2	22.0	19.1	28.9	20.2	15.4
TFRe	3.93	3.27	4.25	3.90	3.45	4.14	4.62	5.20	4.39	4.31	3.86	2.46	5.28	4.61	3.51
TFRe-TFR	0.08	0.25	0.04	0.29	-0.23	-0.14	0.60	-0.35	-0.56	0.38	0.59	-0.19	0.35	0.07	0.12

Source: Author's calculations

Table G12: Proportion of women married/in union/sexually exposed by age group, RJB Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
Age group	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
15-19	0.2967	0.3034	0.2950	0.3006	0.2766	0.2875	0.3357	0.3689	0.3369	0.3157	0.2791	0.2050	0.6858	0.3676	0.2336
20-24	0.7747	0.7686	0.7771	0.7864	0.7449	0.7664	0.8241	0.8007	0.8156	0.7937	0.7392	0.7457	0.8297	0.8465	0.7436
25-29	0.8563	0.8356	0.8659	0.8164	0.8739	0.8577	0.8977	0.8483	0.8517	0.9032	0.8674	0.8204	0.8740	0.8836	0.8446
30-34	0.8732	0.8738	0.8729	0.8581	0.8695	0.8707	0.9046	0.8786	0.9124	0.8461	0.8791	0.8640	0.8753	0.9070	0.8565
35-39	0.8404	0.8450	0.8386	0.8446	0.8297	0.8032	0.8916	0.8617	0.7842	0.8598	0.8366	0.8585	0.7704	0.8663	0.8375
40-44	0.8176	0.8506	0.8061	0.7742	0.8580	0.8021	0.8265	0.7385	0.7512	0.8286	0.9063	0.8338	0.7452	0.8397	0.8258
45-49	0.7026	0.6071	0.7306	0.7162	0.7031	0.7015	0.6855	0.6289	0.7015	0.7391	0.6650	0.7757	0.7225	0.6588	0.7360

Source: Author's calculations

Table G13: RJB indices for proximate determinants of fertility by social context and status, Eswatini 2007 DHS

		Residence		Region				Wealth					Education		
	Total	Urban	Rural	Hhohho	Manzini	Shiselweni	Lubombo	Poorest	Poorer	Middle	Richer	Richest	None	Primary	Secondary+
Panel a	Estimated value of each proximate determinant														
Cm	0.66	0.66	0.66	0.64	0.65	0.67	0.69	0.71	0.70	0.69	0.64	0.55	0.80	0.70	0.63
Cc	0.61	0.54	0.64	0.62	0.59	0.64	0.62	0.75	0.69	0.60	0.61	0.51	0.75	0.67	0.55
Ci	0.68	0.65	0.70	0.70	0.63	0.67	0.77	0.68	0.63	0.74	0.72	0.63	0.62	0.68	0.71
Ca	0.92	0.91	0.93	0.91	0.93	0.93	0.92	0.95	0.95	0.93	0.89	0.90	0.92	0.93	0.93
Panel b	Impact on fertility reduction (%)														
Cm	34.2	34.2	33.7	36.0	35.4	33.0	30.9	29.1	30.2	31.4	35.8	44.5	19.7	29.8	37.5
Cc	38.6	45.6	35.8	38.4	40.7	35.5	38.3	25.4	31.4	40.4	39.2	49.1	24.9	32.5	44.6
Ci	31.5	34.6	30.1	29.6	36.9	33.1	23.4	32.4	37.5	26.2	28.1	36.9	37.9	32.0	28.8
Ca	7.6	9.0	7.0	8.5	7.3	6.7	8.0	5.2	4.6	6.9	10.6	10.0	8.2	6.9	7.3
Panel c	Per cent reduction by the operation of variables														
Cm	30.7	27.1	32.0	32.5	29.2	30.6	30.7	31.8	28.7	29.7	32.0	32.2	20.6	29.3	31.8
Cc	35.8	39.4	34.5	35.4	34.9	33.5	40.2	27.1	30.0	40.8	36.0	36.9	26.8	32.7	40.0
Ci	27.8	27.5	27.9	25.6	30.8	30.7	22.1	36.2	37.5	23.9	23.8	25.2	44.6	32.0	23.0
Ca	5.8	6.1	5.7	6.5	5.0	5.3	6.9	5.0	3.7	5.7	8.1	5.8	8.0	6.0	5.2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Author's calculations

APPENDIX H: COMPARISON OF MULTILEVEL POISSON AND NEGATIVE BINOMIAL REGRESSION RESULTS

Table H1: **Results of the multilevel Poisson and multilevel negative binomial regression analysis of the predictors of lifetime fertility among sexually active women aged 15-49, Eswatini 2007 DHS**

	Multilevel Poisson model						Multilevel negative binomial model					
FIXED EFFECTS	Model 1		Model 3		Model 5		Model 1		Model 3		Model 5	
Individual characteristics	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**	**AIRR**	**95% CI**
Occupation												
Not working	1		1		1		1		1		1	
Agricultural or manual	1.08*	1.01 - 1.15	1.10**	1.03 - 1.17	1.11**	1.04 - 1.18	1.08*	1.02 - 1.16	1.10**	1.03 - 1.17	1.11**	1.04 - 1.18
Sales and services	1.12***	1.06 - 1.18	1.12***	1.07 - 1.18	1.13***	1.07 - 1.18	1.12***	1.06 - 1.18	1.12***	1.07 - 1.18	1.13***	1.07 - 1.19
Professional	1.13**	1.04 - 1.23	1.13**	1.04 - 1.23	1.13**	1.04 - 1.23	1.13**	1.04 - 1.23	1.13**	1.03 - 1.23	1.12**	1.03 - 1.23
Wealth												
Poorest	1		1		1		1		1		1	
Poorer	1.01	0.94 - 1.08	1.00	0.94 - 1.07	1.00	0.94 - 1.07	1.01	0.94 - 1.09	1.00	0.94 - 1.07	1.00	0.94 - 1.07
Middle	0.97	0.90 - 1.04	0.94	0.88 - 1.00	0.95	0.89 - 1.02	0.97	0.90 - 1.04	0.94	0.88 - 1.01	0.95	0.89 - 1.02
Richer	0.88**	0.81 - 0.96	0.89**	0.83 - 0.96	0.92*	0.85 - 0.99	0.89**	0.81 - 0.96	0.90**	0.83 - 0.96	0.92*	0.85 - 1.00
Richest	0.78***	0.71 - 0.86	0.80***	0.74 - 0.86	0.85***	0.78 - 0.93	0.78***	0.71 - 0.86	0.80***	0.74 - 0.86	0.85**	0.78 - 0.93
Education												
None	1		1		1		1		1		1	
Primary	0.93	0.86 - 1.00	0.93*	0.87 - 0.99	0.92*	0.87 - 0.98	0.93	0.85 - 1.00	0.93*	0.87 - 0.99	0.92*	0.86 - 0.99
Secondary/higher	0.82***	0.75 - 0.90	0.81***	0.75 - 0.87	0.80***	0.75 - 0.86	0.82***	0.75 - 0.90	0.81***	0.75 - 0.87	0.80***	0.74 - 0.87
Exposure to media												
Low	1		1		1		1		1		1	
Moderate	1.00	0.94 - 1.06	0.99	0.94 - 1.05	0.99	0.94 - 1.05	1.00	0.94 - 1.06	0.99	0.93 - 1.05	0.99	0.93 - 1.05
High	0.97	0.91 - 1.04	0.97	0.91 - 1.03	0.97	0.91 - 1.03	0.97	0.91 - 1.04	0.97	0.91 - 1.03	0.97	0.91 - 1.03
Women's empowerment												
Low	1		1		1		1		1		1	
Moderate	1.08**	1.02 - 1.13	1.08**	1.03 - 1.14	1.09**	1.03 - 1.14	1.08**	1.02 - 1.13	1.08**	1.03 - 1.14	1.09**	1.03 - 1.14
High	1.09**	1.03 - 1.16	1.08**	1.02 - 1.14	1.09**	1.03 - 1.15	1.10**	1.03 - 1.16	1.08**	1.02 - 1.14	1.09**	1.03 - 1.15

Table H1 continued

	Model 1		Model 3		Model 5		Model 1		Model 3		Model 5	
Ideal number of children												
<3	1		1		1		1		1		1	
3-4	1.11***	1.06 - 1.17	1.12***	1.07 - 1.17	1.12***	1.07 - 1.17	1.12***	1.06 - 1.17	1.12***	1.07 - 1.17	1.12***	1.07 - 1.17
5+	1.27***	1.18 - 1.38	1.27***	1.18 - 1.35	1.26***	1.18 - 1.35	1.28***	1.18 - 1.38	1.27***	1.19 - 1.36	1.27***	1.18 - 1.36
Union status												
Never married	1		1		1		1		1		1	
Monogamous	1.73***	1.62 - 1.84	1.74***	1.64 - 1.83	1.73***	1.64 - 1.83	1.73***	1.62 - 1.83	1.73***	1.64 - 1.83	1.73***	1.64 - 1.83
Polygynous	2.09***	1.93 - 2.27	2.10***	1.96 - 2.26	2.09***	1.95 - 2.25	2.09***	1.93 - 2.27	2.10***	1.95 - 2.26	2.09***	1.94 - 2.25
Formerly married	1.89***	1.75 - 2.04	1.88***	1.75 - 2.02	1.89***	1.76 - 2.03	1.89***	1.75 - 2.03	1.88***	1.74 - 2.02	1.88***	1.75 - 2.03
Child death experience												
No	1		1		1		1		1		1	
Yes	1.42***	1.35 - 1.49	1.41***	1.35 - 1.47	1.41***	1.35 - 1.47	1.42***	1.35 - 1.49	1.41***	1.35 - 1.48	1.41***	1.35 - 1.48
Religion												
None/other-traditional/Islamic	1		1		1		1		1		1	
Catholic	1.00	0.88 - 1.14	0.96	0.85 - 1.08	0.95	0.84 - 1.08	1.00	0.88 - 1.14	0.96	0.84 - 1.09	0.95	0.84 - 1.08
Pentecostal/Charismatic	1.04	0.94 - 1.15	1.01	0.92 - 1.10	1.00	0.91 - 1.10	1.04	0.94 - 1.15	1.00	0.91 - 1.10	1.00	0.91 - 1.10
Protestant	1.02	0.92 - 1.13	1.01	0.93 - 1.11	1.00	0.92 - 1.10	1.02	0.92 - 1.13	1.01	0.92 - 1.11	1.00	0.91 - 1.10
Apostolic/Zion	0.99	0.90 - 1.09	0.98	0.90 - 1.06	0.97	0.89 - 1.05	1.00	0.90 - 1.09	0.98	0.90 - 1.07	0.97	0.89 - 1.06
Contraceptive use												
No	1		1		1		1		1		1	
Yes	1.04	0.99 - 1.08	1.03	0.99 - 1.08	1.04	0.99 - 1.08	1.03	0.99 - 1.08	1.03	0.99 - 1.08	1.04	0.99 - 1.08
Age at first birth												
<16	1		1		1		1		1		1	
16-17	0.93	0.85 - 1.01	0.93*	0.86 - 1.00	0.93*	0.86 - 1.00	0.93	0.85 - 1.01	0.93	0.86 - 1.00	0.93	0.86 - 1.00
18-19	0.93	0.84 - 1.02	0.92*	0.84 - 0.99	0.91*	0.84 - 0.99	0.93	0.84 - 1.02	0.92*	0.84 - 1.00	0.91*	0.84 - 1.00
20+	0.83***	0.75 - 0.91	0.83***	0.76 - 0.91	0.83***	0.76 - 0.91	0.83***	0.75 - 0.92	0.83***	0.76 - 0.91	0.83***	0.76 - 0.92
Age at sexual debut												
<16	1		1		1		1		1		1	
16-17	0.91**	0.85 - 0.97	0.92**	0.87 - 0.97	0.92**	0.87 - 0.97	0.91**	0.85 - 0.97	0.92**	0.87 - 0.98	0.92**	0.87 - 0.98
18-19	0.92*	0.86 - 0.98	0.92*	0.86 - 0.99	0.93*	0.86 - 1.00	0.92*	0.86 - 0.98	0.92*	0.85 - 0.99	0.92*	0.86 - 1.00
20+	0.87**	0.79 - 0.95	0.86**	0.78 - 0.95	0.86**	0.78 - 0.95	0.87**	0.79 - 0.95	0.86**	0.78 - 0.95	0.86**	0.78 - 0.95

Table H1 continued

	Model 1		Model 3		Model 5		Model 1		Model 3		Model 5	
MACRO LEVEL												
Area disadvantage												
Residence												
Urban					1						1	
Rural					1.09*	1.02 - 1.16					1.08*	1.01 - 1.16
Region												
Hhohho					1						1	
Manzini					1.06	0.99 - 1.13					1.06	1.00 - 1.13
Shiselweni					1.02	0.95 - 1.09					1.02	0.95 - 1.09
Lubombo					0.98	0.92 - 1.05					0.99	0.93 - 1.05
Socioeconomic disadvantage												
Community social position												
Low					1						1	
High					1.02	0.96 - 1.09					1.02	0.96 - 1.09
Community media exposure												
Low					1						1	
High					0.96	0.91 - 1.02					0.96	0.91 - 1.02
Women's autonomy												
Community women empowerment												
Low					1						1	
High					1.03	0.97 - 1.08					1.03	0.97 - 1.08
Fertility norms												
Community ideal fertility norm												
Low					1						1	
High					1.01	0.96 - 1.06					1.01	0.96 - 1.06
Community polygamy												
Low					1						1	
High					0.98	0.94 - 1.03					0.99	0.94 - 1.03

Table H1 continued

	Model 1	Model 3		Model 5		Model 1	Model 3		Model 5	
Random effects										
Community variance (SE)		0.01(0)	0.00 - 0.01	0(0)	0.00 - 0.01		0(0)	0 - 0.02	0(0)	0.00 - 0.02
Log-likelihood	-5832.1	-5838		-5830.1		-5826.3	-5833.6		-5825.9	
MIRR		1.08***	1.1-1.16	1.07***	1.03-1.10		1.06***	1.02 - 1.11	1.05***	0.99 - 1.10
Wald Chi-square		1728.8***		1760.8***			1619.2***		1653.1***	
lnalpha							-3.82	-4.52-(-3.12)	-3.85	-4.57-(-3.13)
alpha							0.02	0.01-0.04	0.02	0.01-0.04
Likelihood-ratio test		6.78***		3.59*			2.2		0.75	
N	3097	3097		3097		3097	3097		3097	

***P<0.001, **P<0.01, *P<0.05

AIRR=adjusted incidence rate ratio; SE=standard error; MIRR=median incidence rate ratio; N=sample observations.

Source: Author's calculations