CHARLES UNIVERSITY

Faculty of Science

Department of Demography and Geodemography

Doctoral thesis

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The demographic revolution in developing countries with special regards to Africa and Zimbabwe

Doctoral thesis

Collet Muza

Prague 2019 Supervisor: Professor Zdeněk Pavlík

Declaration

I declare that this Thesis is my own work and that I cited all the used sources of information or literature. This Thesis or its substantial part has not been submitted to obtain another or equivalent academic degree.

Prohlášení

Prohlašuji, že jsem závěrečnou práci zpracovala samostatně a že jsem uvedla všechny použité informační zdroje a literaturu. Tato práce ani její podstatná část nebyla předložena k získání jiného nebo stejného akademického titulu.

In Prague. 22. 08. 2017

Collet Muza

Dedication

This goes to my beloved family and friends.

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The demographic revolution in developing countries and Africa with special regards to Zimbabwe

Abstract

This dissertation aimed to examine the demographic revolution in developing countries, Africa and Zimbabwe. The decline of mortality and fertility everywhere in the world demonstrates the importance of the demographic revolution as a global process. While this universality was central to classic revolution theory, for many decades, it was questioned by demographers because fertility and mortality in Africa did not seem to follow the expected pathway. In sub–Saharan Africa the demographic revolution has been characterised by lagging, discontinuation and is occurring at a faster pace against low levels of socioeconomic development than observed in Europe, which has consequences for population dynamics. Questions have emerged if Africa is indeed different and a homogenous continent regarding demographic processes? However, empirical studies that have explored the unique demographic revolution starting from developing countries, Africa and Zimbabwe are lacking.

The first part of the thesis on developing countries showed variations in the reaction of fertility to mortality decrease with historically small gaps and extended gaps in more recent revolutions, plus the much faster decrease in vital rates in many developing countries pose a major challenge to the explanation of the processes. The specific features of the latest revolutions have resulted in much longer periods of high population growth and to potentially give way to much faster population ageing. The second part of the study examined spatial differentiation in the levels and trends of (1) fertility from (1960-2015) and (2) population development in Africa from (2000-2030). A secondary data set was derived from World Population Prospects 2017. Non-hierarchical cluster analysis enabled the identification of countries in Africa with the same fertility and population development characteristics for three periods, respectively. The findings revealed three fertility clusters with high, medium and low fertility. The number of countries with low and medium fertility was increasing while the number of countries with high fertility was simultaneously decreasing. Three clusters with high, medium and low population development were revealed. Additionally, countries reduced their fertility and mortality, while simultaneously increasing their percentages of the elderly in the population. Northern and Southern African countries constantly formed a relatively homogeneous spatial unit with the highest ageing. The clusters suggest that countries are at different stages of demographic revolution and consequently population development. Each cluster forms a spatial unit in which appropriate demographic policy measures can be implemented. Thus, this would allow those regions with the homogeneity in fertility and population development levels to share their knowledge and experiences as outlined in the Agenda 2030 for Sustainable Goal Development (SDG).

The third part of the thesis investigated the proximate determinants of fertility in Zimbabwe using 6 consecutive Zimbabwe Demographic and Health Surveys (ZDHS) from 1988, 1994, 1999, 2005, 2010 and 2015. The results revealed that fertility (TFR) declined from 5.4 (1988) to 3.8 (1999) and then stalled at about 4.0 until 2015. Contraceptive was the most significant proximate determinant of fertility level decline and its effect increases with time, while breastfeeding and marriage decreased with time. Therefore in order to foster further fertility decline to replacement level, policies should promote further contraceptive adoption and use extended breastfeeding periods and delay entry into marriages. Furthermore, women empowerment, especially the promotion of female education to higher education and female employment, could be useful tools to further fertility decline. Lastly, the thesis examined at the predictors of under–five mortality in Zimbabwe. Previous studies have used Zimbabwe Demographic and Health Survey none have used census data. Thus, this study utilises the 2012 Census data. Descriptive statistics and binary logistic regression analyses were used to test the hypotheses. The results revealed that all of the following: provincial location, mother's education level, mother's age at birth, marital status of the mother, and sanitation variables were significant predictors of under–five mortality. Public health interventions on under–five mortality should ideally include improvements in maternal education and sanitation.

Keywords: demographic transition, demographic revolution, Africa, Zimbabwe, fertility, mortality, determinants, regional differentiation

Demografická revoluce v rozvojových zemích se zvláštním zaměření na Afriku a Zimbabwe

Abstrakt

Cílem této disertační práce bylo popsat a analyzovat proces demografického přechodu v rozvojových zemích, Africe a v Zimbabwe. Na důležitost demografické revoluce jakožto globálního procesu ukazuje výrazný celosvětový pokles intensity úmrtnosti a plodnosti. Zatímco tato univerzalita byla ústředním bodem klasické revoluční teorie, demografové ji po mnoho desetiletí zpochybňovali, protože se zdálo, že vývoj plodnosti a úmrtnosti v Africe nejde předpokládanou cestou.

V sub-saharské Africe se demografická revoluce vyznačuje zaostáváním a diskontinuitou vývoje. Navzdory nízké úrovni socioekonomického vývoje však sám proces změn v celém regionu probíhá rychlejším tempem, než tomu bylo původně v Evropě, což výrazně ovlivňuje jeho výslednou populační dynamiku. Vyvstává tudíž otázka, zda Afrika je s ohledem na demografický vývoj opravdu jiná a zda se z hlediska demografického přechodu opravdu jedná o

homogenní kontinent? Nicméně empirické studie, které zkoumají tento jedinečný proces probíhající aktuálně ve většině zemí Afriky a Zimbabwe, chybí.

První část práce věnovaná sledovanému procesu v rozvojových zemích ukázala na rozdíly v reakcích plodnosti na pokles úmrtnost. Charakteristickým rysem později započatých přechodů je zejména nárůst prodlevy nástupu poklesu plodnosti a současně mnohem rychlejší průběh poklesu intenzit obou reprodukčních procesů. Vysvětlení tohoto jevu je však problematické. Specifické rysy pozdějších přechodů vedou k významně delším obdobím vysokého populačního růstu a otevírají tak cestu k mnohem rychlejšímu stárnutí populace v budoucnosti.

Druhá část studie se zabývá prostorovou diferenciací vývoje plodnosti v letech 1960-2015 a populačního vývoje v Africe z letech 2000-2030. Použit byl přitom soubor druhotných dat převzatý z databáze OSN "World Population Prospects 2017". Nehierarchická shluková analýza umožnila identifikaci afrických zemí se srovnatelnou úrovní plodností a obdobnými charakteristikami populačního vývoje v průběhu tří období. S její pomocí byly identifikovány tři shluky zemí vyznačujících se vysokou, střední a nízkou plodností. Obdobně se vydělily tři shluky zemí také v případě populační dynamiky. Počet zemí s nízkou a střední plodností ve sledovaném období rostl, zatímco počet zemí s vysokou plodností logicky klesal. Současně země severní a jižní Afriky představovaly relativně homogenní a svojí sestavou stabilní soubor zemí charakteristických nejintenzivnějším stárnutím. Výsledné shluky dokládají, že země Afriky se ve stejných časových horizontech nacházejí v různých stádiích demografického přechodu, a tudíž i populačního vývoje. Každý shluk tvoří zároveň prostorovou entitu, ve které lze aplikovat obdobná opatření populační politiky. To umožňuje, aby regiony s obdobnou plodností a populačním rozvojem sdílely své znalosti a zkušenosti v souladu s Agendou 2030 a cíli trvale udržitelného rozvoje.

Ve třetí část práce je hlavní pozornost věnována biologickým a behaviorálním faktorů, jejichž prostřednictvím nepřímé determinanty představované sociálními, ekonomickými, psychologickými a environmentálními proměnnými ovlivňují plodnost, a roli, kterou uvedené faktory hrají při jejím poklesu v podmínkách Zimbabwe. V tomto případě se informačním východiskem stalo šest po sobě jdoucích zimbabwských DHS – demografických a zdravotních šetření – z let 1988, 1994, 2005, 2010 a 2015. Výsledky ukázaly, že ve sledovaném období poklesla úhrnná míra plodnosti z 5,4 (1998) na 3,8 (1999) a poté až do roku 2015 oscilovala na úrovni přibližně 4,0 živě narozených dětí připadajících na jednu ženu. Rozhodujícím faktorem pozorovaného poklesu přitom bylo rozšíření antikoncepce. Role metod plánování rodičovství v procesu snižování plodnosti se přitom s časem narůstá, a to především na úkor faktoru kojení a sňatkového chování reprezentovaného věkem vstupu do manželství. S ohledem na existující rezervy proto bude k dalšímu postupnému snižování plodnosti směrem k hranici prosté reprodukce nezbytná pokračující podpora používání antikoncepce, prodlužování doby kojení a oddalování vstupu žen do manželství prostřednictvím veřejných politik. Dalším vhodným nástrojem snižování plodnosti by mohlo být posílení postavení žen, zejména s důrazem jejich další vzdělávání a vyšší zaměstnanost.

V závěrečné části se předložená práce zabývá prediktory úmrtnosti dětí do věku pěti let v Zimbabwe. Předcházející studie snažící se o jejich identifikaci vycházely z dat demografického a zdravotního průzkumu Zimbabwe, žádná však nevyužila údaje ze sčítání lidu. Proto naše studie vychází z výsledků sčítání lidu v roce 2012. K testování hypotéz byly použity metody popisné statistiky a binární logistické regresní analýzy. Výsledky ukázaly, že všechny následující faktory: geografická poloha, úroveň vzdělání matky, věk matky při narození, rodinný stav matky a hygiena jsou významnými prediktory úmrtnosti ve věku do pěti let. Intervence zaměřené na snížení úmrtnosti do pěti let věku by měly směřovat především do veřejného zdravotnictví a také se zaměřit na zvýšení vzdělanosti budoucích matek a všeobecné zlepšení hygienických podmínek života obyvatel.

Klíčová slova: demografický přechod, demografická revoluce, Afrika, Zimbabwe, plodnost, úmrtnost, determinanty, regionální diferenciace.

CONTENTS

LIST OF ABBREVIATIONS

CBR	Crude birth rate
CDR	Crude death rate
CSO	Central Statistical Office
DD	Demographic dividend
DHS	Demographic and Health Survey
IMR	Infant mortality rate
LE	Life expectancy
MDG	Millennium Development Goals
MOHCC	Ministry of Health and Child Care Zimbabwe
NCD	Non-Communicable Diseases
SDG	Sustainable Development Goals
TFR	Total fertility rate
UN	United Nations
WHO	World Health Organisations
WWII	Second World War
ZDHS	Zimbabwe Demographic Healthy Surveys
ZIMSTAT	Zimbabwe National Statistical Agency

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Chapter 1
Introduction to the study

Currently, the world is demographically divided. At one end, we have populations from developing countries that are rapidly growing, which threatens their natural resource base. At the other end, we have populations from developed countries that are shrinking on the demographic trajectory course. According to the World Population Prospects (UN 2017), the world population exponentially grew from 2.5 to 7.7 billion between 1950 and 2017. Precisely developed and developing countries grew from 0.8 and 1.3 billion to 1.7 and 6.3 billion for the above mentioned periods, respectively (UN 2017). This means that, since 1950, much of the world population growth has happened in developing countries

Two–thirds of the world population is now approaching or is below the fertility replacement level. Dyson (2013) defines fertility replacement rate as "*the level at which a population exactly replaces itself from one generation to the next, usually measured by total fertility rate (TFR) of 2.1*". Precisely, developed countries are below fertility replacement rate (TFR 2.1). Many countries in Latin America and Asia are approaching replacement rate or below fertility replacement rate. In fact, in 2010–2015, the world's least fertility rates are found in Eastern Asia. It is only in Africa and a few Asian countries, including Afghanistan, that have high rates of childbearing between 4 and 7 births per woman (Machiyama et al., 2015). Even if the TFR for developing countries with high fertility rates is to fall very soon, they will still experience growth because of population momentum.

This is very important because currently, although population projections should be treated with caution, the UN (2017) medium population projections variants show that the world population will reach about 10.5 billion by 2050 and then probably stabilise at11.5 billion 2100. It is projected using the United Nations medium variant of population projections that the African population will grow from 1.3 billion currently to 2.5 billion in 2050 and about 4.5 billion by the end of 21st Century. However, if childbearing does not decrease at a fast pace in Africa, then it will increase to 15 billion by the end of the century (Dyson 2013, Harper 2016). The world population would have, therefore hit the 22 billion mark by the end of the century (Harper 2016) that will have huge implications on resources.

The difference between the developed and the developing countries are enormous. The developed countries have a higher standard of living than developing countries as measured by many socio–economic indicators including Human Development Index (HDI), GDP, high life expectancy, low infant and child mortality rates, and maternal rates, literacy (Harper 2016). Meanwhile, an increasing number of developing countries especially in Sub–Saharan Africa have a double burden of both infectious diseases including HIV and AIDS and an increasing rate of non–communicable diseases. This is worrisome considering that Sub–Saharan Africa constitutes 33/48 of the least developed countries in the world (UN 2017). To understand the current population issues not only in terms of their absolute numbers but also in terms of their distribution, density, sex and age structure, it is crucial to understand the demographic revolution process.

The demographic revolution is defined as a movement from high to low mortality and fertility regimes as a result of improvement in the standard of living (Harper 2016, Coale 1973, Notestein 1945, 1953). Mortality and fertility are processes. They cannot grow or anything similar (e g increase). Only their intensity or levels can increase or decrease. The demographic transition is perhaps the most prominent event to occur in human affairs during the last 250 years, since the time of the Enlightenment (Dyson 2013). It started in the countries of north–western Europe and was completed by the mid–20th century in developed countries. In pre–transitional and post– transitional Europe, population homeostasis was maintained by high natality and mortality and low natality and mortality, respectively (Coale 1973). In other words, there was an improvement in the reproductive system. On the one hand, the lagged decline of fertility to mortality causes rapid population growth, and the population becomes younger (Coale 1973). On the other hand, the decline of fertility causes the population ageing (Harper 2016). Therefore, the transitional period is made up of two phases of mortality and fertility decline, respectively. However, most people know little about it, although it has gone on to affect the rest of the world at different times.

Although some processes emanating from the Enlightenment period, e.g. development of modern economic growth (Kuznets 1966), have gone on to receive more considerable attention, the demographic revolution is not well known. Several studies have argued that the demographic revolution has a mutual relationship with socio–economic development (Pavlik 1980, Dyson 2013). The demographic revolution is central/part of the "*global revolution of modern times''* which includes a combination of specific revolutions, e.g. agricultural, industrial and gender revolutions (Pavlik 1980). Although the revolutions occurred closely with the demographic revolution, their importance can be classified according to their direct relationship to the socio– economic conditions. Dyson (2013), noted that synergistic processes of cumulative causation are often involved. However, many processes that constitute the global revolution of modern times vary under different circumstances. Consequently, the demographic revolution has gone to occur under different conditions.

The variation in the time of onset, levels, pace, pathways and specific causes of the demographic revolution can be used in the formulation of different typologies of the demographic revolution to enhance our understanding of its processes. Pavlik (1980) has outlined three basic typologies, namely the French and English for developed countries and the Japanese–Mexican model for developing countries.

The French model is the oldest, longest and happened in the USA and France. Natality and mortality declined gradually concurrently without modernisation. Therefore population growth was minimal. English model was experienced by the rest of the developed countries and happened with industrialisation and urbanisation. It follows a pathway of mortality decline – population increase – fertility decline – population ageing. Therefore, it had higher population growth than the French model. Finally, the Mexican Japanese model was experienced by all developing countries in the mid–20th century. The onset of mortality decline after WWII, the Mexican Japanese model, marked the demographic revolution as a global process (Reher 2004). As the name suggests, Japan was the first country to experience it in the group. It followed the pathway of the English model but was happening at a faster pace and lower levels of socioeconomic development than in the other two models. However, Africa is lagging within this group.

Unlike the French and English models in which causes of the demographic revolution were born out of gradual and autonomous processes that grew from within the societies themselves, in the Japanese–Mexican model the principal cause was the diffusion of science and knowledge from developed countries through processes of colonisation, globalisation and local governments. In the late 18th and 19th centuries, under–five child mortality declined the most in the developed countries as a result of maternal education. In contrast, in the Japanese–Mexican model, the onset of under–five child mortality decline, in the mid–20th century as a result of government sponsored public health initiatives such as immunisation programmes.

Fertility declined in the developed countries was a result of the use natural methods, supposedly withdrawal methods of family planning, whereas, in the Japanese–Mexican model, cheap modern methods of contraception were used. This probably explains why natality and mortality declined at fast speed against low levels of socio–economic development in the Japanese Mexican model than in the other two above mentioned models. The decline of fertility was delayed because the socioeconomic conditions were not yet favourable. It can be observed that prior mortality decline, especially infant and child mortality is central to natality decline. The conditions for natality and mortality decline are related but asymmetrical.

In the Mexican Japanese model, the gap between the onset of mortality and natality decline is longer than the English model. Reher (2004) noted a gap of 5–10 years in most European countries, whereas, in African countries where natality decline started in 2000, the gap between mortality and fertility decline was effectively 50 years. This probably means, the overall duration of the transition in African countries that reach replacement level in 2050, will last for about 100 years. However, once natality decline has started, it proceeds at a faster pace as women are using modern methods of contraception.

The rapid mortality decline with sustained natality in developing countries meant that population growth rates reached peak levels of above 3.6% per annum in the 1970s (Dyson 2013). Currently, population growth rates in Africa remain high at 2.5% per annum. In developed countries, the population growth rates rarely exceeded 1.5% per annum in most countries, and their populations grew by growth multiples of about 2–4 times from the beginning to the end of the transition. In fact, in France, where fertility and mortality declined concurrently, growth rates averaged 0.7% and never reached 1% per annum. Consequently, France's population grew by

50% from the beginning to the end of the revolution, i.e. from 40million in the 1750s to about 60 million after WWII.

For several reasons, rapid population changes are problematic. The rapid population growth provides countries only limited time for preparation in terms of youth employment, education, and health provision. Thus rapid *"population explosion''* has been equated with poverty, rapid urbanisation and slums development. The rapid decline in fertility also causes rapid population ageing since fertility is more dominant in population ageing than mortality decline. The window of opportunity, in which, to benefit from demographic dividend (DD) is short.

The DD is a period of rapid and accelerated economic that emanates when there are more productive people than children and the elderly (Bloom et al. 2007). China, South Africa and Botswana are typical examples of countries enjoying the demographic dividend (Canning et al. 2015). The North Africa political uprisings popularly referred to as "*the Arab Spring''* is a typical example of a demographic disaster than can happen, when governments fail to meet the needs for ever–growing youth and achieve a demographic dividend. Finally, the increases in the elderly in poor developing countries are associated with increasing pensions non–communicable diseases (NCD). NCD are more chronic and expensive to manage. The standardised mortality rates show higher death rates from NCDs in developing countries than in developed countries.

As mentioned above, the mortality decline in developing countries started after WWII. However, other studies reveal that in Latin America mortality decline might have started earlier in the 1920s. (Dyson 2013). The United Nation's data (UN 2017) show that mortality levels represented by CDR were far below 30 per 1000 people in most developing countries in the 1950s, whereas the demographic revolution theory assumes CDR in developing countries was higher than 40 per 1000 people and higher than pre–transitional mortality in Europe. There were regional variations in pre–transitional mortality levels.

The mortality decline followed a pattern as in historical transition in which the most mortality decline was in infants and children followed by adults. The unacceptably high infant and child mortality in sub–Saharan Africa is an indication of the level of development. However, the specific causes of death across all ages (cardiovascular, cancer, diabetes) highlights that these countries are in the middle of mortality transition. Within this context, Africa was lagging in the mortality transition.

Observations have been made that between the 1980s and 2005 in sub–Saharan African countries such as all of Southern Africa and neighbouring countries, mortality decline, precisely life expectancy at birth gains discontinued and reversed by about 20 years due to the HIV pandemic (Richie and Roser 2019, Harper 2016). Although significant declines have been witnessed, HIV and AIDS is remains the leading cause of death in Southern Africa and neighbouring countries such as Zimbabwe, Mozambique, Malawi, etc., followed by cardiovascular, cancer diabetes, lower respiratory infections (Global Burden of Disease Collaborative Network 2018, Ritchie and Roser 2019). This means these countries are in the middle of a mortality transition with a double burden of both communicable and non–communicable diseases. Elsewhere in most sub–Saharan African countries HIV is usually in the top 5 leading causes of death. The reasons of a mortality decline are easier to explain; because all humans covet life and population policies are usually unidirectional in ensuring the survival of people. The mortality in developing countries has been caused by the introduction of tried and tested methods that were brought by diffusion through colonialism and globalisation. The increased roleof governments and missionaries are also noted in their efforts to decrease mortality. Nonetheless, mortality has declined as a result of improved public health initiatives, vaccinations, improved nutrition, and medicines.

Research has established that pre–transitional fertility in developing countries was higher than in Europe's pre–transitional fertility (Teitelbaum 1975, Caldwell 1976). In Africa, universal and early marriage rates maintained high fertility rates (Caldwell 2007). Postpartum abstinence and amenorrhea were used as a means of ensuring the survival of children and mothers, but not as a means of conscious methods of birth spacing (Caldwell 1976). Such fertility behaviour was inculcated by societal norms, values, culture and religious doctrine. Community sanctions were enforced against offenders (Notestein 1945). To the extent that such variables changed fertility also changed. For example, within the context of Zimbabwe, fertility declined between the 1970s and 1980 as a result of the postponement of marriage during the liberation war (Chemhaka 2009).

Another unique feature of pre–transitional fertility patterns was the increase in fertility levels before sustained decline in the Japanese–Mexican model (Mhloyi 1988). One can argue that to the extent that factors favouring high fertility increase due to modernisation without compensating adoption of contraceptives fertility will increase. For example, in Zimbabwe, Mhloyi (1988) has argued that during the period of colonization is from 1890 to 1964 and settler regime of Ian Smith from 1965 to 1979 demand for children increased as a result of men migrating to work so that they could pay colonial taxes. Thus, women compensated the missing labour from men by having more children (Mhloyi et al. 2013).

In traditional patriarchal societies like Africa and Asia, access to resources favoured male than females. In such context, marriage and childbearing offer women access to the husband's wealth. The higher the number of children born especially sons, the stronger the link between the woman, the husband and his family. Researchers have noted that women's infertility was looked down upon. Childless women were not accorded adult status (Mhloyi 1988, Caldwell 1976). Children contributed at an early age to the productive system of the family, i.e. net wealth flow was in the direction of parents (Caldwell 1976). Moreover, a high number of children, especially sons provided old age security as they would defend their mother (Mhloyi 1988, Caldwell 1976). Intergenerational marriages of younger women to older men were also typical.

Everywhere, the transition from non–parity related fertility (natural) to parity related fertility has always happened as a consequence of conscious adoption of contraception. Unlike the developed countries which used natural methods of fertility limitation and stopped childbearing behaviour at older ages usually (35 years), the developing countries fertility declined as a result of using efficient modern methods of fertility limitation across all age groups. This means younger and older women were practicing birth postponement and stopping, respectively (Reher 2004).

However, Zimbabwe, Botswana South Africa and Namibia were regarded as pioneers of fertility decline in the early 1980s in Sub–Saharan Africa. Analysis of nuptiality reveals that fertility decline in Zimbabwe starting in the 1970s to 1984 from 7.4 to 6.5 children per woman, respectively as a result of marriage postponement during the liberation war period and thereafter by contraceptive adoption (Chemhaka 2009). A similar phenomenon was witnessed in French fertility revolution where fertility decline due to marriage postponement was followed immediately after by adoption of contraception (Diebolt and Perrin 2017).

Women empowerment, particularly female education, female employment, urbanisation and access to reproductive health have been found to determine fertility and mortality decline. Moreover, the mortality decline is also central to fertility decline. There is nowhere in the developing countries where fertility has declined in the absence of lower mortality or prior mortality decline, especially infant and child mortality. These factors indirectly affect the proximate determinants of fertility. Thus fertility stalling has been noted; as a result, mortality stalling, educational stalling, SAPs, FP stalling as resulting of directing FP to other pressing issues such as HIV and AIDS (Lutz and Kebede 2017) However, fertility stalling has also been noted in the circumstances were overall FP prevalence was increasing.

Africa's demographic data were not available in literature until the late 1960s. However, prior attempts had been made by Kuczynski in 1948 and 1949 (Kuczynski 1948, 1949, Zanamwe 1989) and later estimates were made by Brass et al. 1968. However, the data were limited in scope and quality, but they provided the basis for later developments. Indeed, during the first African Population conference held in Ibadan University in Nigeria in 1966, Coale cited in Caldwell (1968) acknowledged the existence of variations in mortality and fertility within and between countries. It was widely accepted that mortality was declining, although it was lagging behind other regions (Caldwell 1968). However, TFR was high and variable ranging from 3.5 to 8.0 children per woman. Caldwell (1968) stated that mortality was falling and reported signs of rapid population growth by more than 3% per annum. However, the fertility trends over time were speculative, and it has been challenging to identify the onset of fertility decline without conducting an investigation of such trends it will be difficult to ascertain the stages in which African countries reached. Since previously, Page (1988) reiterated that African fertility at the time seemed stable because of the scarcity of reliable demographic data.

The introduction of the World Fertility Surveys (WFS) between 1974 and 1982 and later the Demographic Health Surveys (DHS) with nationally representative and internationally comparable quality data was a milestone in gathering demographic data (Machiyama 2010, Tabutin et al. 2004). The surveys collected information on fertility, reproductive health, including maternal mortality and child health. The surveys guided in relevant policy formulations. The findings of the WFS indicated that fertility was declining almost in every country in Latin America, Caribbean, Pacific, Asia and North Africa, except in South Asia and Sub Saharan Africa (Machiyama 2010, Tabutin et al. 2004). Sub Saharan Africa was found with average TFR of 7.0 per woman (Tabutin et al. 2004). Fertility has decline earlier in Southern and North African than West and Central Africa countries. Since then, in sub–Saharan Africa, Botswana, South Africa, Namibia and Zimbabwe have been regarded as the pioneers of fertility decline with the onset of fertility decline in the early 1980s. In order to more fully understand whether these countries still cluster together in the same region, it is important to view the problem in the demographic revolution theory lens. In the remaining countries, the onset of fertility decline has been in the 1990s and 2000s, but the pace of the decline has been reported slower than in other developing countries (Machiyama and Cleland 2017, Casterline 2017).

1.3 Statement of the Problem

There is a dearth of information that looks at the demographic situation in Africa and places it within the context of the demographic revolution as a global process, i.e. within the context of developing and developed countries. There is a clear need to look at the demographic revolution similarities and differences between and within developed, developing countries, Africa and Zimbabwe. After periods of neglect of African demography, coupled with lagging of population development (Bongaarts 2017, Dyson 2013) the population issue should receive more attention due to growing concerns about sustained high infant and life expectancy at birth reversals (Tabutin et al. 2004, Pillay and Maharaj 2013), sustained high fertility, and fertility stalling (Casterline 2017, Goujon et al 2015). It is therefore essential to provide up to date scientific information on recent population trends and determinants to policymakers and programme implementers in Africa.

A significant number of countries in Africa are either the early stages of fertility decline (TFR above 5) or are experiencing fertility stalling midway fertility transition (about TFR 4) (Machiyama 2010, Goujon et al. 2015, Casterline 2017, Bongaarts 2006, 2013). Without investigation of this new phenomena, population control will be a challenge in Africa. For instance, it is postulated that such high fertility rates contribute to high population growths usually above 2.5% per annum and population doubling rates of about 22–28 years (Dyson 2013, Coale 1973). The determinants propelling such high fertility levels remain unexplored. Accordingly, the World Population Prospects 2015 revision (WPP 2015) population projection using medium variant for the period 2015 to 2100, the world's next 4 billion people will come from developing countries. Africa, with the majority of the least developed countries (33/48 countries) and second largest continent by population will grow rapidly from 1.2 to 4.5 billion, while Asia and Latin America including the Caribbean will grow by smaller margins from 4.4 and 0.6 billion to 4.8 and 0.7 billion respectively from 2015 –2100 (UN 2017).

Mortality improvement is not only an undeniable human right but also an indicator of development. Yet, Africa has remained with the highest rates of under–five mortality and low life expectancies in the world (UN 2017). Although Under–five mortality has declined, but most African countries failed to reduce under–five mortality by 2/3 in the period 2000–2015 as recommended by the Millennium Development Goals (MDGs) (Black et al. 2015). Precisely, in sub–Saharan Africa, the under–five mortality had significantly declined by 49% from 183 in 1990 to 93 per 1000 children in 2015. This is still unacceptably high as 1 in 11 children aged below five years still dies every year compared with 1 in 147 on developed countries (UN 2017). Furthermore, life expectancy at birth, reversed by an unprecedented 20 years in Southern Africa and neighbouring countries due to HIV–AIDS mortality (Pillay and Maharaj 2013, Tabutin et al. 2004).

Although, Africa is the last region to experience demographic revolution, its growth of both the youth and elderly is at a faster pace and magnitude in comparison to other world regions (Maharaj 2013). It is clear that the number of elderly is increasing in Africa, yet the magnitude, extent, and differentiation of this phenomenon remained unexplored. Few fragmented studies in Africa have looked on different aspects of population development and ageing, mainly at country levels or sub–regions e.g. Sub–Saharan Africa (Suntoo 2012, Cohen and Menken 2006, Apt 2002, Kinsella 1992, Nair 2014, Aboderin et al 2015, Kyobutungi et al. 2009, Ferreira and Kowal 2006, Dhemba and Dhemba 2015). Such high rates of population change give countries little time to prepare for population changes.

Very often, studies have looked at components of the demographic revolution separately, as mortality and fertility, yet studies have highlighted the cumulative causation of mortality on fertility or vice versa. While a common problem with studies of mortality and fertility processes in developing countries is related to the scarcity of data. Waltisperger (1988), cited in Tabutin and Akoto (1992:32) argues that scientific research on African mortality is also hindered by the insufficient use of the information available, however imperfect or indirect it may be. This statement appropriately describes the situation in several African countries, including Zimbabwe, where data from several surveys and Censuses are available, yet research on is still basic and unsystematic. For example in Zimbabwe, the estimation and analysis of levels and trends of infant and child mortality have not proceeded much beyond the basic application of indirect estimation methods (ZIMSTAT 2012, ZIMSTAT 2015) while the examination of differentials and determinants is either lacking or methodologically insufficient (ZIMSTAT 2012). There is lack of studies addressing causes of under–five child mortality utilising census data. In addition (Chitiyo 2011, Kembo and Ginnekem 2009, Kembo 2011, Marindo and Hill 1997, Bah 1997), previous studies have failed to apply the demographic revolution theory.

To fill this gap in knowledge and meet the needs stated above, this thesis assesses the demographic revolution in developing countries, particularly in Africa and Zimbabwe. The use of large international comparable data sets allows capturing the similarities and differences in the populations/countries experiencing a different rate of fertility and mortality decline. Moreover, the use of national datasets as the case of Zimbabwe allows capturing detailed country information that might not be available at the international level.

1.4 Rationale of the study

This study will not only provide a scientific contribution to our existing knowledge on the demographic literature in developing countries but more specifically to the debate on recent population changes in Africa. It will also contribute to the understanding of mortality, fertility and ageing levels trends and their spatial differentiation (distribution) in Africa. Thus, findings will be helpful to policymakers, providing them with current information on levels and trends, which might help in monitoring and evaluation of progress on mortality, fertility and ageing in Africa.

1.5 Goal of the study

The overall goal or general objective is to examine the demographic revolution in developing countries with particular regards to Africa and Zimbabwe.

1.5.1 Specific objectives

The general objective was met by addressing the following specific objectives which were to:

1. examine fertility levels, trends and spatial differentials in Africa
2. examine population development with special regards to ageing in Africa
3. examine determinants of under–fives mortality in Zimbabwe, and
4. identify and examine the proximate determinants of fertility decline in Zimbabwe.

1.5.2 Research questions and hypothesis

The following research questions were asked to guide this study:

1. What are the fertility levels and trends and differentials in Africa?
2. What are the population development levels and trends and differentials in Africa?
3. What are the levels and determinants of under–five mortality in Zimbabwe?
4. What are the main proximate determinants of fertility in Zimbabwe?

Based on the above objectives and research questions the following hypothesis were formulated and tested for this study:

1. The levels and trends of fertility in are Africa vary between countries or regions. .
2. African countries are at different stages of fertility revolution.
3. The population development levels and trends are different in Africa.
4. African countries are at different stages of demographic revolution
5. The determinants of under–five mortality differs with demographic–cultural and socioeconomic differences in Zimbabwe
6. Fertility in Zimbabwe is a function of main proximate determinants of fertility

1.6 Data and methodological notes

1.6.1 Definition of basic concepts and terminology

The definitions of basic concepts and terminology listed below have been adopted for this study.

Demographic revolution/demographic transition – the terms can be used interchangeably. Nonetheless, this study will adopt the demographic revolution phrase as refereeing to the permanent movement of population from regimes of high fertility and mortality to regimes of low fertility and mortality.

Developed countries– Refers to Europe, North America, Australia and New Zealand. Sometimes Europe and offshoots or Europe and countries settled mainly by people of European origin.

Developing regions/countries– taken here to comprise Africa, Asia, Latin America and the Caribbean. The name is sometimes used interchangeably with less developed regions.

Fertility– the reproductive performance of an individual, couple or population. Births as a component of population change. A common measure of fertility is CDR and TFR.

Crude birth rate – Number of births over a given period divided by the person–years lived by the population over that period. It is expressed as a number of births per 1,000 population

Total fertility rate– The average number of live births a hypothetical cohort of women would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality. It is expressed as live births per woman.

Age–specific fertility rates – Number of births to women in a particular age group, divided by the number of women in that age group. The age groups used are 15–19, 20–24, ..., 45–49. The data refer to five–year periods running from 1 July to 30 June of the initial and final years.

Net reproduction rate – The average number of daughters that female members of a birth cohort would bear during their reproductive life span if they were subject throughout their lives to the observed age–specific fertility and mortality rates of the given period. It is expressed as the number of daughters per woman

Proximate determinants of fertility – intermediate behavioural and biological factors through which distant socioeconomic, cultural, and environmental factors affect fertility

Contraception– deliberate effort to avoid falling pregnant. The contraceptives include condoms, pills, intrauterine devices, pills, injectable, implants, sterilisation, and rhythm and withdrawal method.

Mortality– refers to death as a component of population change. The level of mortality is usually represented by crude death rate, infant mortality and life expectancy.

Crude death rate – Number of deaths over a given period divided by the person–years lived by the population over that period. It is expressed as a number of deaths per 1,000

Infant mortality– Probability of dying between birth and exact age 1. It is expressed as deaths per 1,000 live births.

Population growth rate – Average exponential rate of growth of the population over a given period. It is calculated as ln $(P_t/P_0)/t$ where t is the length of the period. It is expressed as a percentage.

Rate of natural increase – Crude birth rate minus the crude death rate. Represents the portion of population growth (or decline) determined exclusively by births and deaths.

Population growth multiple –refers to the ratio of the size of a population at the end of the demographic revolution to its size at the beginning. It is used as an approximate at best.

Population ageing– refers to the increases in the average age of the population**.**

1.6.2 Methods

The main analytical methods used in this research include descriptive methods (demographic rates, probabilities, proportions, frequencies, mean, median, percentages, ratios, cross tabulations). Various indexes were used to measure fertility, mortality, population age and sex structure, and their changes and spatial distribution. Within the framework of the demographic revolution method specific methods were applied: K–means clustering method, logistical regression, Mosley and Chen's framework for child mortality and Bongaarts' framework for proximate determinants of fertility.

Defining the onset, duration and completion of demographic revolution is a very complex issue.

1. In this study I have chosen to adopt Chesnais (1992) definition of the beginning of the demographic transition (Tα) – the apparent starting point of a continuous decline in mortality, a fall which is not followed by a return to higher rates;
2. the end of the demographic transition (Tω) – the point of lasting return (at least five years) to an average rate of natural increase which equals, or is less than the one before the beginning of the demographic transition.
3. Duration of demographic transition = Tα– Tω. Two cases then present themselves:
   Firstly, mortality is not yet very low, which enables us to discount subsequent improvements and to recognize that the equilibrium at a given level is only provisional (as in certain European countries at the time of the 1930s depression) (Chesnais 1992), and as in "*Central infertility belt"* in Africa in the 1950–80s where rate of natural increase decreased to almost equilibrium level e.g. RNI of 2.6 per 1000 population in Gabon in the 1950s as result of sexually transmitted infections (STI) which caused infertility accompanied by high level of mortality (Collet et al. 1988, Inhorn 1994, Larsen 2003).
   Secondly, mortality is very low, less than the level just cited; only then do we have the point at which the previous trend has been overcome.
   Given these two conventions, one can assign a duration D = Tω – Tα on the revolution period and analyse the basic the basic parameters of change in a population fertility mortality and growth during the period. In addition to the general characterization of the demographic revolution, partial revolutions maybe defined for each of the components of demographic change i.e. a "health or mortality or epidemiologic revolution", a "reproductive or fertility revolution" a "migratory revolution" and an "age structural revolution". However migration is considered to be within countries and insignificant in this study
4. The onset of fertility decline is determined by a 10% continuous CBR decline. Using of Chesnais' (1992) characterization of continuous CBR decline to below 35 per 1000 live births is difficult because of the wide variations in pretransitional levels. Some developing countries in Africa had CBR as high as almost 48 per 1000 live births in a population (Tabutin et al. 2004). Moreover, using 10% of CBR continuous decline is also compatible with definition of fertility stalling by Bongaarts (2006).

1.6.3 Analysis strategy

After literature review and identification of research gaps, in this study using comparable international data, I focused on examining the fertility and population development levels, trends and spatial distribution in Africa, which are critical in the identification of the stages of the demographic revolution. The third part of the study using national data sets aimed to explore the demographic revolution in Zimbabwe. Under–five child mortality was specifically chosen because of its importance as a proxy of overall development and child mortality's overall role in fertility decline. Frequency tables, cross–tabulations were performed to show the levels and relationships in Zimbabwe, binary regression was applied to show the risk of factors on under– five mortality in Zimbabwe.

Lastly, the Bongaarts (1978, 1982) framework on proximate determinants was applied to explore trends and changes of fertility in Zimbabwe. The main proxies used were the proportion of married women, the median duration of postpartum insusceptibility, marital contraceptive prevalence, infertility and abortion.

The specific analytical methods applied will be discussed in the relevant sections, chapters 4, 5, 7 and 8.

1.7 Structure of the thesis

This thesis aims to investigate the demographic revolution in developing countries and Africa with particular regards to Zimbabwe. The introduction (Chapter 1) just presented above briefly introduced the subject matter, the background of the study, objectives, rationale of the study and brief methodological notes. Chapter 2 presents a literature review of the demographic revolution in developed countries and chapter 3 presents the demographic revolution in developing countries. Building from the previous chapter, Chapter 4 uses cluster analysis on fertility levels, trends and differentials in Africa. Similarly Chapter 5 like preceding chapter uses cluster analysis on population development with special regards to ageing in Africa. Building on from previous chapters on Africa, chapter 6 presents demographic revolution in Zimbabwe. Chapter 7 applies the Bongaarts' proximate determinants model to fertility decline in Zimbabwe. Chapter 8 using binary logistical regression investigates determinants of under–five mortality in Zimbabwe. Lastly, Chapter 9, is a synthesis of the study, stating conclusions and recommendations and finally, the implications of findings for demographic revolution.

Chapter 2
The demographic revolution in developed countries

In about the mid–18th century, North–Western countries started a world demographic revolution characterised by the secular decline of fertility and mortality, population increase and changes in population age structure from young to mature society. As defined above, the demographic revolution is defined as a movement from high to low births, and deaths as societies modernise from traditional societies (Harper 2016, Coale 1973, Notestein 1945, Notestein 1953). Before the mid–18th, population homeostasis was maintained by high fertility and mortality levels. In contrast, at the end of the revolution (in the mid–20th century), population homeostasis was maintained by low fertility and mortality. Population homeostasis is an equal balance between births and death, which maintained a relative population equilibrium. Thus according to Pavlik (1980), the demographic revolution is the transformation from inherently extensive to intensive forms of procreation in which few children are born, and they practically all survive.

The demographic revolution theory has credited improvements in the standard of living as the underlying cause in the demographic system improvements. Most importantly, science and technology are the impetus to modernisation and improvement in the standard of living (Notestein 1953). The demographic revolution effects are much more extensive than declines in fertility, mortality and age structural changes but also include gender role differentiation, decline in extended families and a corresponding increase in nuclear families, increase in vertical intergenerational relationships at the expense of horizontal relationships, urbanisation, and democratization of society etc. (Dyson 2013a).

In traditional society, life expectancy was on average below 35 years, and women would have, on average 4–7 children in Europe. The societies were young, with the percentage of children below 15 years ranging between 35–45 per cent of the population, and the median age was below 20 years. Indeed, after the transition, women would have a couple of children and who would almost all practically survive to old age. Life expectancy was generally above 50 years. Therefore, the societies become mature as the median age generally is above 30 years, and children below 15 years consist of less than 20 per cent of the total population (Coale 1973).

Moreover, traditional societies were predominantly rural in their settlement characteristics as less than 10% of the population lived in the urban centre' centres. Therefore, migration tended to be rural to rural, that when people migrated to get married and to work in farms. (Ibid).

Most people led lives similar to the lives of their family or extended family, e.g. in agriculture and fishing. Dyson (2013) notes that it was typical for less than 20% of the labour force to be engaged in other forms of employment. Formal educated was almost non–existent. Social status was overwhelmingly ascribed at birth. Gender roles were very distinct. Systems of governments lay in the hands of the few, usually a ruler of some kind (Wilson and Dyson 2017, Dyson 2013).

In contrast, in modern societies, population predominantly lives in urban areas, that is, typically, over 70% of the population lives in urban areas (Dyson 2013). Therefore, migration of people also tends to be mainly urban to urban. Moreover, even populations that reside in rural areas have similar socioeconomic characteristics to those who live in urban areas (modernisation). In these circumstances of modernisation, it is typical to find less than 5% of the population involved in agriculture because most people are now employed in the industry and service sectors of the economy. Status is acquired by achievement. Formal education becomes a requirement, and it can significantly determine the wellbeing of a person. Also, gender roles become less distinct as women can do jobs previously reserved for men, in education, industry, commerce etc., (Dyson 2013).

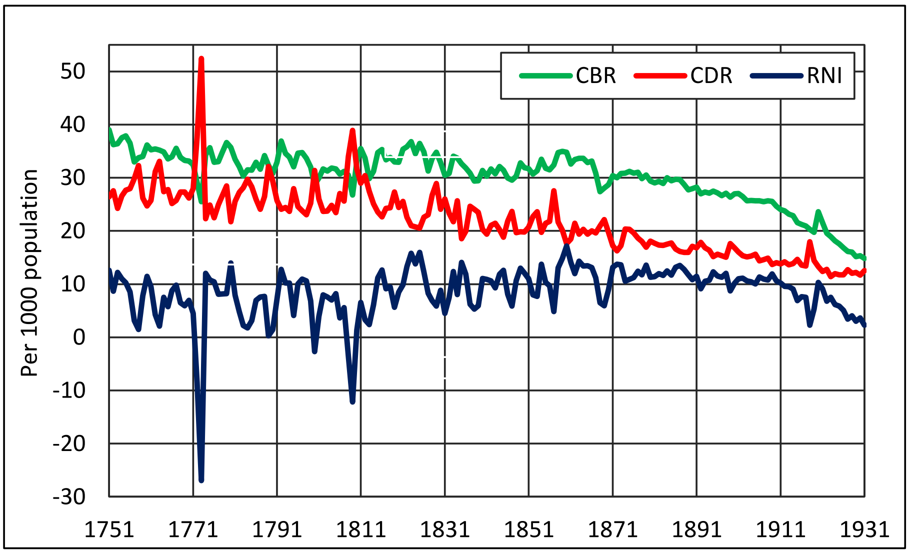
2.1 Stages of the demographic revolution

The period covering almost 200 years (1750–1950) can be considered as a transitional phase in which mortality declines first, then population increases and, lastly, fertility declines. The end of the revolution is the mid–20th century when the rate of natural increase stabilises as both natality and mortality establishes new equilibrium regimes at low levels (Coale 1973, Dyson 2013). Given, these processes (mortality decline, population increase, fertility decline and population ageing) were lagged one after the other; their effects were also lagged (Dyson 2013). For example, a decline in mortality, especially infant mortality, would lead to population increase, while later fertility decline would lead to population ageing.

Reher (2004) has called the transitional phase a disequilibrium period in which mortality and fertility are no longer at equilibrium. Furthermore, Dyson argues that fertility will respond by also declining to establish a new level of equilibrium at low birth and death levels. Notice that, before the transition, couples would need a high number of births to match deaths in order to maintain a specific household size, but after the transition, families would need a couple of births at replacement level of children that all practically survive to maintain the same level of household size. This replacement level fertility is achieved through a revolution from unplanned parenthood to planned parenthood through birth control (Pavlik 1980, Kirk 1996, 1963).

In order to illustrate the demographic revolution, I will present Sweden's demographic profile before, during and after the demographic revolution. Sweden is chosen because of historical data availability. Figure 1 presents Sweden crude death and birth rates and the rate of natural increase from 1751–1946. Figure 1 reveals that prior mid–17th century Sweden's high rates of natality and mortality ranged between 25 –35 and 30 – 40 per 1000 population respectively and declined to below 20 for both rates by the mid–20th century. Rate of natural increase was close to zero per cent at the beginning and end of the transition in the mid–18 and 20th centuries, respectively representing almost population equilibrium at both ends. Chesnais (1992) has classified crude birth and death rates above 35 as pre–transitional and rates below 30 transitional to modernity rates. Figure 1, also reveals that mortality declines before natality towards the end of the 18 and 19th centuries, respectively. Thus in 1800, Sweden's population numbered 2.3 million, and it increased dramatically to 7 million by 1950. It had a growth multiple of 3.04 (i.e. 3.04=7.0/2.3) or more if emigration is considered

Fig. 1 – Crude death rate (CDR), crude birth rate (CBR) and rate of natural increase (RNI), 1751– 1931, Sweden



Source of data: Human Mortality Database (2017)

Population structure changes in many significant ways. Equally important, population age structure changes from being young to a mature society. The percentage of children declined from about 30% to less than 20% from 1800 to 1950. The median population age increased from less than 20 years to over 34 years for the respective periods. Life expectancy almost doubled from 38.4 to 69.5 from 1751 to 1946, respectively. Lastly, the urban population grew from less than 10% to over 83 per cent by 1980 (Dyson 2013). Similarly, demographic transitions happened elsewhere in Europe and Europe overseas.

Based on the above description of Sweden and previous literature it can be concluded that the demographic revolution in developed countries is a historical event that happened roughly between 1750–1950, although a few isolated countries such as Albania, Ireland, Iceland began revolution late and had had not finished by 1950 (Pavlik 1980, Kirk 1996).

2.2 Types of demographic revolutions

However; there is a variation in the experience of the demographic revolution (Frejka 2016, Pavlík and Hampl 1975, Dyson 2013). Firstly, regions or countries that were forerunners, e.g (Northern and Western Europe) experienced more prolonged, gradual and fluctuating mortality, fertility declines and age structural changes than countries that followed later, i.e followers (Southern, Central and Eastern Europe). Moreover, followers had higher rates of population increase than forerunners. This because they probably benefited from the experience of the forerunners. Therefore, mortality declined rapidly while natality was sustained. Secondly, countries that were more homogenous in population characteristics took a shorter time than countries were not (Pavlik and Hampl 1975, Teitelbaum 1975). Thirdly, France and the USA were some of the exceptions in which fertility and mortality declined concurrently without modernisation. Nonetheless, based on the above points, it is possible to outline a typology of the revolution. Pavlik (1980), and Pavlik and Hampl (1975) outlined two basic typologies of demographic revolution, namely:

1.) French model – was experienced by the French and USA. It is the oldest model of the revolution in which fertility and mortality declined almost in tandem from the 1750s. It occurs without the industrial revolution. However, it was preceded by French and American revolutions, which were Enlightenment products. Its typical characteristics are; firstly, the long and gradual decline of natality and mortality. Secondly, low population growth multiples as natality and mortality decline almost concurrently (Diebolt and Perrin, 2017, Pavlik and Hampl 1975). France's growth rates never exceeded 1 per cent per annum, and its population did not even double from the start to the end of the transition (Dyson 2013, Chesnais 1992). Thirdly it occurred in a mostly rural setting, i.e. without modernisation.

2.) The English model is the typical demographic revolution model experienced by the majority of the developed countries except by France and the United States. Mortality decline precedes natality decline by decades allowing for unprecedented population growth to occur (Pavlik 1980). The growth multiples of an average of 4 were mainly experienced even though few countries like the Netherlands, England and Wales achieved relatively higher growth multiples of up to 6 if one factors migration (Dyson 2013). Also, Chesnais (1992), further classified the English model into Northern, Western, Southern and Eastern variants of English model. In a recent paper, Frejka (2016) using fertility cohort data came up with similar typology to Chesnais' classification of Western, Southern, Central and Eastern Europe. However, Frejka's classification grouped countries that experienced French model with Western Europe variants of English model. It occurred with modernisation. Please note the Mexican–Japanese model for developing countries which forms the core of this thesis will be discussed later on from section (2.2) of developing countries.

The discussion shows that there is no single form of the transition, but there is diversity in models. Nevertheless, based on this discussion, it is possible to formulate that, firstly modernisation is not a prerequisite for the demographic revolution as evidenced by France and the USA. Secondly, the duration of the demographic revolution is related to the geographical and cultural location to which a country belongs (regional clustering). Thirdly, countries that experienced the revolution earlier took a more extended period than countries that started later.

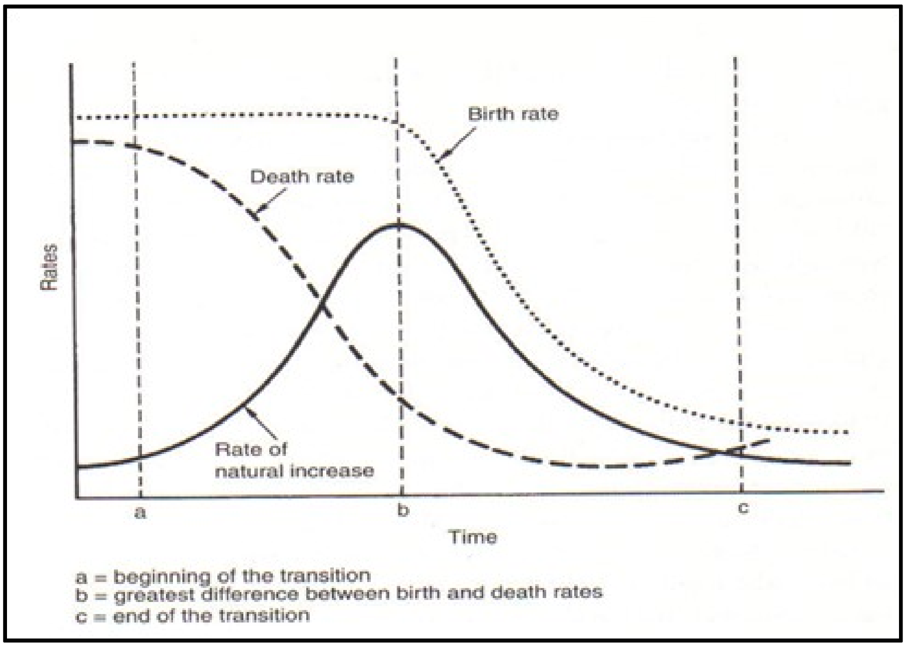
You can never exaggerate the importance of the demographic revolution to mankind. Imagine that, had it not occurred and people multiply according to available resources? This will not be possible for long time. The demographic revolution is also important for population projections. Indeed, literature has demonstrated that demographic revolution effects are much broader and multifaceted (Coale 1973, Dyson 2013, Pavlik 1980). To mention just a few, they include improvement in the quality of life as people live longer and much more secure life, which enables them to plan, invest, save and develop. Mortality decline also brings urbanisation, which is declared by Simon Kuznets (1966) as fundamental for modern economic growth. Also, most of the development innovations have emanated from urban areas. Most importantly, the modern nuclear family begin to dominate over the traditional extended family support system. Last but not least, gender differentiation is reduced as the societal roles of women become similar to the roles of men. After the revolution, childbearing and rearing are significantly reduced in women's much longer lives. (Dyson 2013, Pavlik 1980).

2.3 Demographic revolution theory

Demographic revolution theory was based on the observations of population experiences of Europe from the mid–17th to the 20th century. It was a theory of its time. Previous attempts to describe population developments by mercantilist, e.g. Adam Smith (1776) and Malthus (1798), were relevant to their time. Mercantilist advocated for population growth because, during that period, mortality was very high. Malthus advocated for fertility control through positive or negative checks because at the end of 18th–century mortality had started to decline in Europe.

Several scholars noticed the demographic developments, notable amongst them were Thompson 1929, Laundry 1934 etc. However, it was Notestein (1945) who was able to describe the demographic processes in their entirety. He attributed the changes in the demographic revolution to the socioeconomic development factors such as urbanisation, modernisation, income, etc. The theory has since gone under further refinements by different scholars (Davis 1963, Coale 1973, Kirk 1996, Pavlik 1980, Dyson 2001, 2013).

Fig. 2 – Stylized model of the demographic revolution



Sources: Dyson (2013)

Figure 2, shows a stylized model of the demographic revolution with illustration of pre transitional, transitional and post transitional periods that characterised the demographic revolution. It can be seen that at the point before (a) which is the pre-transitional, both deaths and births were very high creating a slow rate of natural growth. At point (a) deaths began to decline and fertility remained the same, thus the rate of natural increase began to accelerate rapidly as a result of population growth that was being experienced. At point (b) fertility also began to drop and rate of natural increase began to fall gradually with further declines in fertility. Finally, point (c) marks the end of the transition characterised with low fertility and mortality. The model described represents the classical English model.

The description of decrease of mortality was easy and was widely accepted and needed no more in–depth theoretical explanations as it was connected to the improved hygiene and sanitation, medicine, nutrition, communication etc. (Machiyama 2010, Pavlik 1980), however, it was the description of fertility/natality which has proved difficult to fully explain. The explanation of fertility was complicated by authors limiting the analysis to specific situations, thereby confining themselves to one or the other phenomenon relations. Thus, originated the theory of social capillary by Dumont, urbanism etc. (Pavlik 1980). Several causes were given for the decline of fertility such as emancipation of women, the secularisation of religion and traditions, the curtailing of parental power, the decline of mortality rate, in particular, that of infants, obligatory school attendance, and changes in the economic importance of children in the family (Diebolt and Perrin 2017, Guinnane 2011, Coale 1973, Notestein 1953).

Pavlik and Hamp (1975) have argued that so powerful was the demographic revolution theory that scholars are forced to acknowledge it or criticise but still refer to it. In particular, all the other explanations, e.g. wealth flow theory by Caldwell (1976), economic theory by Becker (1960), ideation and cultural by Cleland and Wilson (1987), have several features in common they overate a particular phenomenal aspect of the process while neglecting or underrating others. They are incapable of extricating themselves from their dependence on the specific situation which the analysed population fined itself. The various reason was given overlap, and it is practically impossible to give a satisfactory enumeration of various factors affecting fertility decline in the course of the demographic revolution. Some authors mention ten factors (A Sauvy 1966) and some up to 21 factors. A partial explanation that relies on the phenomenality aspect of the researched facts can only help to discern correctly minor aspects of reality, limited in time and space, but the hierarchy significance of the relations ascertained and the essence of recognised regularities remain hidden (Pavlík 1980). To understand the process of the demographic revolution, the quantitative changes in the levels of mortality and fertility and the age structure requires the understanding of the development character of the demographic system.

2.4 The European fertility project

In 1963, Coale conducted a massive groundbreaking study in 700 administrative units across Europe, trying to explain the decline of fertility in Europe. Coale introduced an indirect method of measuring marital fertility (Ig) and non–marital fertility because of the scarcity of age–specific fertility rates. Their research highlighted that although pre–transitional natural fertility was the norm, there was also evidence of conscious fertility control among the upper classes. They also found out that timing of fertility decline was also clearly linked to cultural factors rather than socioeconomic factors, e.g. also followed major communication lines roads and railways. They also found out that in most cases, fertility decline was preceded by mortality decline, creating rapid population growth, although there were also cases in which fertility declined together with mortality. Moreover, that transition was happening faster in the followers (Eastern and Southern Europe) than the forerunners (Western Europe).

Perhaps the most critical finding is that fertility transition occurs under strikingly diverse socioeconomic settings. While a fertility transition often accompanied a high level of socioeconomic development. Transition is not a necessary condition for development. Thus Coale and Watkins (1986) summarised that fertility transition always happens when communities are ready, willing and able. Knodel and van de Walle (1979) summarised the historical European fertility experience as follows:

1. Secular fertility declines took place under a wide variety of socioeconomic and demographic experience.
2. The family limitation was not practised (and was probably unknown) among the broad sections of the population before the decline of fertility began, even though a substantial proportion of births may have been unwanted.
3. Increases in the practice of family planning and the decline of marital fertility were essentially irreversible processes once underway.
4. Cultural settings influence the onset and spread of fertility decline independently of socio–economic conditions.

Another important conclusion by Coale (1973, 1984) argued that pre–transitional fertility was not very high as per biological maximum observed among Hutterite women, but was moderate fertility. The moderate fertility was mediated through different natality patterns: later marriages, proportion married, celibacy across Europe (Hajnal 1965), and postpartum practices (Coale 1984 1986, Van de Kaa, 1987).

Below I cover a few of the theories as it is impossible to cover them exhaustively at this juncture. According to Van de Kaa (1987), theories of fertility decline can be broadly grouped into three categories namely those that emphasize on (1) mortality decline, (2) economic and socio–economic theories (Becker 1960, Easterlin 1975), and (3) diffusion/communication aspects (ideation, cultural aspects, language etc.)

2.5 Theoretical perspectives on fertility

There is significant literature that argues about the importance of mortality decline as the underlying process that causes all other processes, including fertility and urbanisation, to occur (Dyson 2013, Kirk 1996). The decline in mortality will cause the family to stop child hoarding and replacement behaviours. Moreover, the decline of mortality causes the population to be more secure, thereby think about the future, save and invest. Also, mortality decline causes urbanisation. In turn, urban areas have been instrumental in economic growth and fertility decline. Kuznets (1966) has argued that without mortality decline, it was impossible to archive modern economic growth. However, the challenge with mortality decline is that fertility in France and the USA decline without mortality decline and modernisation.

Mortality decline and modern economic growth are associated with women empowerment, rising income, women employment, and the secularisation of religion. So the decline of mortality decline is mediated through these aspects. Modernisation changes the economics of childbearing and makes it seem to be economically disadvantageous given changes in income prices, tastes for consumer choice and an affluent lifestyle. The theories, however, suffered their share of criticisms. First, is their consideration of babies as consumer goods? Kirk (1996) has argued the dominance of the economic and related socioeconomic theories have often tended to be more successful than for example cultural ideational theories is because they have better conceptual and mathematical precision to their models. Also, fertility in France, USA and some German villages declined mainly in rural areas without urbanisation (Kirk 1996, Dyson 2013).

Easterlin (1975), tried to include the social aspects into the economic theory. His framework postulates modernisation as influencing fertility through intervening variables of supply, demand and costs of controlling birth. Therefore, the framework does not assume priority or dominance among different economic, socioeconomic and cultural explanations. However, the theory has suffered from failing to acknowledge period perspective and assuming the number of desired children is fixed once in life and does not change. Also, Easterlin does not deal widely with natural fertility in pre–modern societies. The economic and socioeconomic theories are narrow in their view of the fertility decline. Their significant contribution is demonstrating that fertility goes through brief pre–decline raise before the secular decline, a phenomenon observed in most of Europe (Kirk 1996).

Caldwell is identified with the wealth flow theory in which he argues that all fertility behaviours are always rational even in the pre–transitional period. He argues that the direction of the intergenerational wealth flow determines the rational behaviour of several children being born. In traditional societies, the intergenerational flow is from children to parents, and in modern societies, it is vice versa. He makes a further distinction between westernisation and modernisation. Modernisation, include ideas of progress, secularisation, mass education and mastery over the environment (Caldwell 1976). This idea can historically be supported by fertility decline that has happened in low levels of modernisation as in France.

Cleland and Wilson, (1987), the article have emphasised the importance of diffusion of new ideas on fertility limitation than modernisation effects. They argued that in traditional societies, the absence of fertility control does not necessarily mean demand for a high number of children. To them, the timing of the transition was linked with linguistic and cultural boundaries and less strongly by modernisation factors, e.g. women's education income. (Cleland and Wilson 1987). Similar findings have also been found by, (Lesthaeghe 1980, Leasure 1963, Teitelbaum 1975, 1977). The homogeneity of societies determines fertility decline. Hence, societies that are more homogeneous experience fertility decline faster than societies that are less homogeneous (Teitelbaum 1975).

2.6 The mortality revolution

The previous discussion demonstrated how the demographic revolution could offer useful insights into the trends, patterns and causes of population change in Europe and Europe overseas. The essence of the revolution is that fertility and mortality are inextricably and systematically linked. Indeed, together, they explain the demographic revolution. However, these two natural processes of fertility and mortality are very different from each other, not only in their patterns and timing and rates of decline but also in their causes and implications for development in a broader sense (Gould 2015, Chesnais 1992). Therefore, they require separate analysis and discussions on their own merit. The following section 2.2 discusses mortality, and the subsequent section 2.3 discusses fertility with a focus on measuring mortality trends, causes, and how they are affected by socio–economic development and also how they affect each other.

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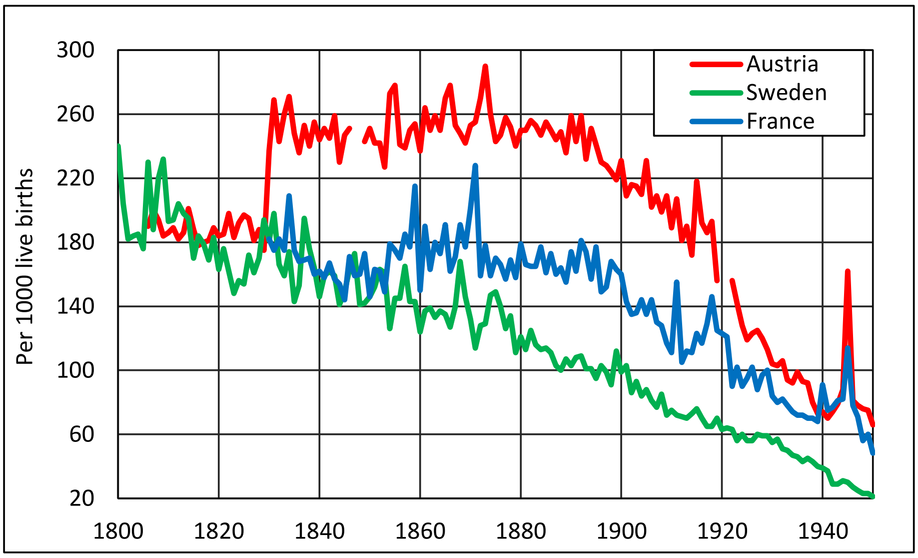
2.6.1 Infant mortality rate

Infant mortality rate (IMR) is widely used as an indicator of the health of a population (Coale 1973, Caldwell 2007). Moreover, studies have found that IMR decline is the most significant contributor to the general mortality decline (Chesnais 1992, Omran 2005). Hence a discussion on mortality decline without a focus on infant mortality decline is incomplete.

Fig. 3 – Infant mortality rate, selected European countries, 1800 – 1950



Source of data: Mitchells (1998)

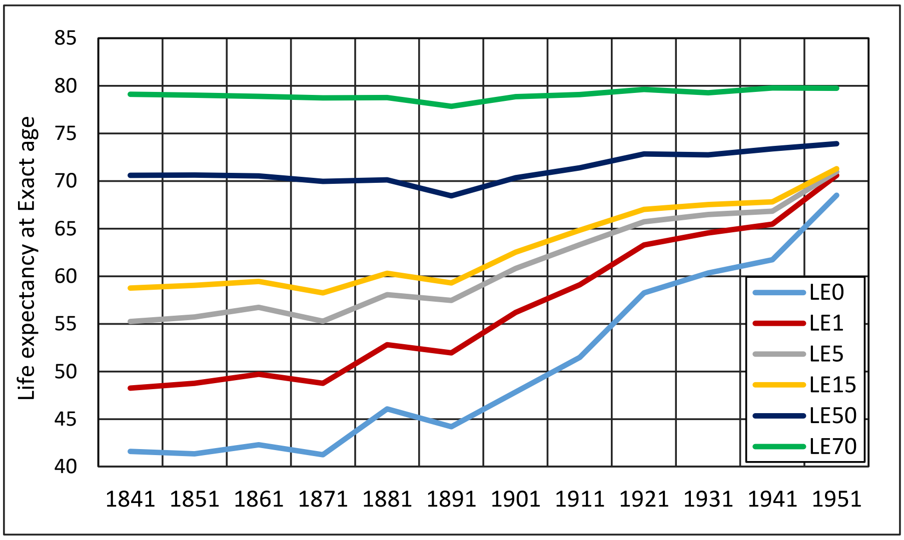
Figure 3, shows the evolution of IMR between 1800 and 1950 for Sweden, Austria and France. The graph reveals that in the year, 1800, Swedish IMR declined significantly from 250 to 20 per 1000 inhabitants by 1950. Figure 3 also shows country variations, in that, France and Austria had different and higher IMR and finished the decline at a higher level than Sweden. Despite the fluctuations, especially in the 18th century, the pattern was continuous in its overall decline for both countries. Similarly, the same infant mortality pattern in terms of continuous decline and regional variations were also experienced across Europe (Cutler et al. 2006, Diebolt and Perrin 2017, Chesnais 1992).

2.6.2 Life Expectancy at birth

Mortality varies with age. Most of the historical decline in mortality happened at the younger ages, especially for children (Omran 1971, Schofield and Wrigley 1979). Figure 4, shows the life expectancy at different ages (LE) in England and Wales between 1841 and 1951. The graph reveals that life expectancy at birth (LE0) increased significantly from a fluctuating levels of 35 years in 1841 to almost 70 years by 1951. In essence, it almost doubled. Whereas, for infants and five years old, it rose from almost 50 years and 55 years and converged at almost 70 years by 1950. Life expectancy at older ages, 60 and 70 years, increased marginally from almost 75 to just above 75 years from 1841 to 1951. Figure 4 also shows exceptionally high mortality during a period of the flu epidemic in 1918. Life expectancy was affected more for younger people than the older people, presumably because older people had stronger immunity and disease resistance from the previous Russian flu pandemic of 1889–90 (Roser 2016). Life expectancy also varied by sex with females always having higher life expectancy than males (Harper 2016).

The decline in infectious diseases explains the decline in mortality pattern (Omran 1971). According to Cutler et al. (2006), in 1848, about 60 per cent of deaths in England were from infectious diseases. Between 1848 and 1971, infectious disease mortality declined by a remarkable 95% (Cutler et al. 2006, Deaton 2015). Therefore, since infants and children are the most affected by infectious diseases, curbing infectious diseases affects them more than adults. The causes of the decline in infectious diseases have been widely investigated and debated in the literature.

Fig. 4 – Life expectancy at exact ages, 1841–1951, both sexes, England and Wales



Source of Data: Human Mortality Database (2017)

The demographic revolution model assumes that mortality declines as societies move from traditional to modern societies. The decline in mortality is brought about by technological changes and socioeconomic progress, e.g. industrialisation and rising incomes. (Notestein 1953, Kirk 1996, Dyson 2013a). Empirical evidence shows that in England and Wales, the mortality decline started around the middle of the 18th century and increased with about 6 years to 41 years by 1820. However, a paradox remains in the fact that between 1820 and 1870 period, which England experienced the highest industrialisation, life expectancy remained stable at about

41 years (Cutler et al., 2006). After that, in 1870, mortality declined at a faster pace than the first phase of the mortality decline to reach 50 years by the beginning of the 20th century. This means other factors besides socioeconomic progress were also operating.

According to Omran (1971, 2005), Epidemiological Transition Theory (ETT) mortality declines as a country modernises. Mortality shifts from long periods of infections and parasitic diseases to stages of chronic and degenerative diseases**.** Omran (2005:738).
"It was a period of war, famine, epidemics, and unsanitary conditions. Epidemic infections such as phenomena, tuberculosis and parasitic diseases such as cholera, typhus, smallpox would wipe away populations. However, the leading cause of mortality rates being so high was famine and severe malnutrition, causing many deficiency diseases. Life expectancy was very low, varying from twenty to forty years, with infants and women dying more than men'' However, there is a problem in quantifying how much a specific intervention can be attributed as the cause of the mortality decline (Cutler et al. 2006, Diebolt and Perrin 2017). The following section discusses factors involved in the historical morality decline and review the empirical evidence.

2.6.3 Debate on causes of mortality decline

It is difficult to categorise the effects of various factors contributing to mortality decline. However, any plausible explanation of mortality decline in Europe should include the impact of nutrition, public health and sanitation, vaccination and medicine. Moreover, an increase in the standard of living has been caused by increases in real wages and per capita food consumption. Importation of grain and potatoes from the Americas. Of course, specific innovations that led to mortality decline were introduced before others (Cutler et al., 2006). The main determinants of mortality decline are considered namely: nutrition, public health and sanitation improvements urbanization and vaccination,

Several research findings have found that *nutrition* to be a significant factor in the process of the growing life expectancy is nutrition (Fogel 1994, Mckweon 1976, Lee 2003). The agricultural revolution reduced famine. Improvements in agriculture, storage and transportation that permitted integration of country, regional and international food markets, thereby smoothing local variations in agricultural output. Indeed, even the famous Irish famine has been reported to have caused by a lack of distribution and inequalities (Fogel 1989). Furthermore, secular increases in incomes led to improved nutrition in childhood and throughout life, enabling better–nourished bodies that are resistant to diseases. Life expectancy was found to be positively correlated with height in the transitional populations, presumably reflecting child health conditions (Lee 2003, Fogel 1994).

Thomas Mckweon (1965, 1976) using data from England and Wales was the first person to argue that the effects of improved nutrition on health were more important than public health and medicine initiatives. In what became famously known as the Mckweon thesis, he argued precisely that neither medicine nor personal health/ public health initiatives appeared to have much effect before 1900. A period in which most of the mortality decline occurred. In a famous example, Mckweon demonstrated that mortality induced by tuberculosis dropped by 80% before effective methods for treatment of TB were known. The same argument was extended to other infectious diseases as well.

The famines that plagued England in 1500–1800 years were human–made, the consequence of failures in the system of food distribution. The crisis mortality caused by malnutrition accounted for 15% of the total mortality decline in England between the 18th and 19th centuries (Mckweon 1965). In a related follow–up paper, Fogel (1994) also showed the effect of nutrients through calories intake in the 18th century and 19th century. Fogel has argued that calories intake increased by more than three times and height also increased by more than 10 cm in most of Europe. Fogel indicated that mortality is U–shaped in the body mass index (weight divided by height squared) and declines with a height of a given body mass index. Fogel uses these correlations to state improved nutrition was the primary driver of mortality decline in the ‘’late 18th to the late 19th century’’ as well as the half of mortality declines the 20th century (Fogel 1994)

However, Mckweon thesis and the increased nutrition –calorie argument by Fogel (1989, 1994) were not widely accepted by everyone. Cutler et al., (2006) noted that life expectancy increases in England from 1750 to 1820 had nothing to do with improved income per head but was just one of the fluctuations in mortality typical of premodern Europe. Similar findings by Wrigley and Schofield (1981) reveal that England and Wales LE in 1600 was, as in 1820, with 1750 being the lowest point of the trend.

Moreover, several authors have questioned the acceptance of the assumption based on ancient skeletal remains that people were taller because of better nutrition (Cutler et al. 2006, Wrigley and Schofield 1981, Easterlin 2004). They argue that the period of modern mortality decrease in England and other European countries is from 1870, yet the onset of the economic growth is more dispersed across countries than is the onset of mortality decline. As a result, the link between economic growth and mortality becomes weaker (Cutler et al. 2006, Easterlin 2004). Therefore, as discussed later in this section, public health improvements offer a more convincing explanation of mortality declines for the period after 1870.

The nutrition effect to LE improvement further complicated by the fact that people from different classes had a similar life expectancy at birth (LE). Indeed, Cutler et al. (2006) concluded that the English aristocracy had no LE advantage over the rest of the population even though they had presumably better nutrition. Moreover, Livi Bacci (1991) in Cutler et al. (2006) has argued that mortality in well–fed populations such as the United States of the same period was not lower than Western European mortality. Also, using data from 404 English parish registers Wrigley and Schofield (1981) have shown that mortality was not correlated to real wages and the cost of living, including food prices. However, in contrast, Dyson (2013) has concluded that mortality in Europe overseas and France was lower than mortality in Europe.

Nevertheless, disease and nutrition have been found to have a strong interaction presumably by mediating through other factors. Children who are frequently malnourished often continually suffer from poorly controlled diseases such as diarrhoea which prevent food and nutrients intake by the body. Repeated bouts of diarrhoea may cause children to digest less than 80% of their food consumption (Cutler et al. 2006). Therefore, some argue that the curbing of infectious disease was more important than nutrition improvements.

Technically, investments in *public health and sanitation* should lead to a decrease in disease burden and mortality. It, therefore, follows that people who have resources to invest should live longer than those that did not invest. Samuel Preston (1975) argued that if economic growth were the sole reason for improved health countries would move along the Preston curve, but the curve itself would remain fixed, however, even at a given level of income people would substantially live longer at any period than they did in the past. Preston argues that from 1930 to 1960, 15% of life expectancy increase is a result of income alone. While income was undoubtedly challenging to measure, historically, public health improvements explain this shift. It should be noted, however, that most of the public health initiatives were not very expensive, they just depended on gaining scientific knowledge about the cause of disease and eliminating them. Public health can be categorised into macro and micro, and these types interact with each other

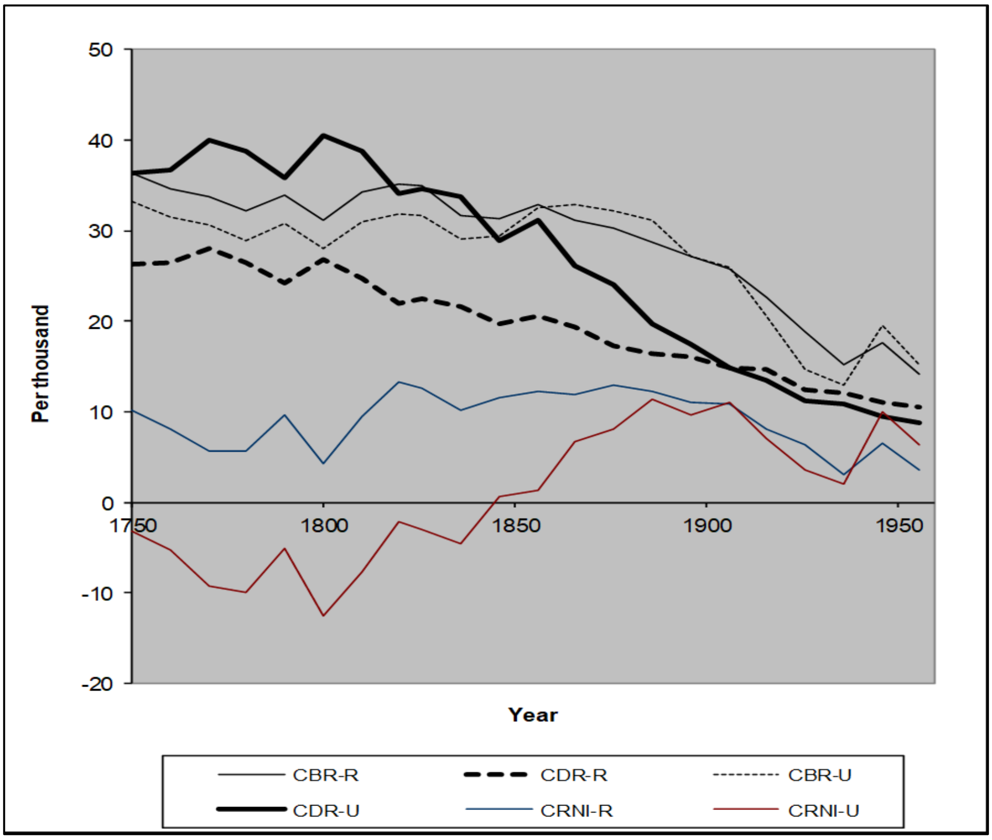
Macro– involves public health, clean water supplies, sewage disposal, draining marshlands, mass vaccinations, pasteurising milk etc. Macro–public works have always been available in the history, e.g. Benjamin Latrobe built a water system in Philadelphia early in the 19th century at least partly to reduce the disease burden. In 1854, John Snow compared cholera fatalities between households supplied by different water companies, one of which was recycling human waste and one which was not and he was able to demonstrate that cholera is water–borne disease (Cutler et al., 2006). The dramatic reduction in water and food–borne diseases after that time; typhoid, cholera, dysentery, and non–respiratory tuberculosis highlights the role of public health. From a mortality rate of 214 per 100,000 in 1848–54, these diseases were virtually eliminated in the United States by 1970. By one estimate, water purification alone can explain half of the mortality reduction in the United States in the first third of the twentieth century (Deaton 2015)

Micro– involves attempts at individual levels even when facilitated by public health attempts. They involve water boiling, washing hands and body, use of detergents, soap, food protection from insects etc. (Cutler et al. 2006).

Urban areas had high mortality. Sanitation public health and supplies were inadequate. The first stages of *urbanisation* were not good for health even though the rising of living standards accompanied it. There is compelling evidence that lack of improvement in mortality between 1820 and 1870 was this was mostly due to increased disease spread in newly expanded cities (Deaton 2015, Wrigley and Schofield 1981). The effect of nutrition cannot be discounted in declining mortality. However, rural–urban differentials in mortality show that urban mortality was comparatively higher, yet urban areas had better nutrition and real incomes up to the middle of the 19th century.

This means other factors were at play. Indeed, literature has demonstrated that unsanitary conditions in urban areas were a significant cause of mortality (Dyson 2011, Cutler et al. 2006). Figure 5, shows the rural–urban differentials in crude birth rates and rates of natural increase for Sweden from 1750–1950. It reveals that urban areas had higher crude death rate than the crude birth rate, and the rate of natural increase was negative before about 1850. In contrast, rural areas always had a positive rate of natural increase. Dyson (2011, 2013) calls the urban cities demographic sinks meaning more people were dying in cities than the people who were being born in them. The only reason cities kept on growing was because of massive rural urban migration and not urban natural growth. It was upon controlling urban factors of death that the urban centres began to experience natural population growth (Deaton 2015).

Fig. 5– Crude death and birth rates in rural and urban areas of Sweden, 1750–1950



Source**:** Dyson (2013)

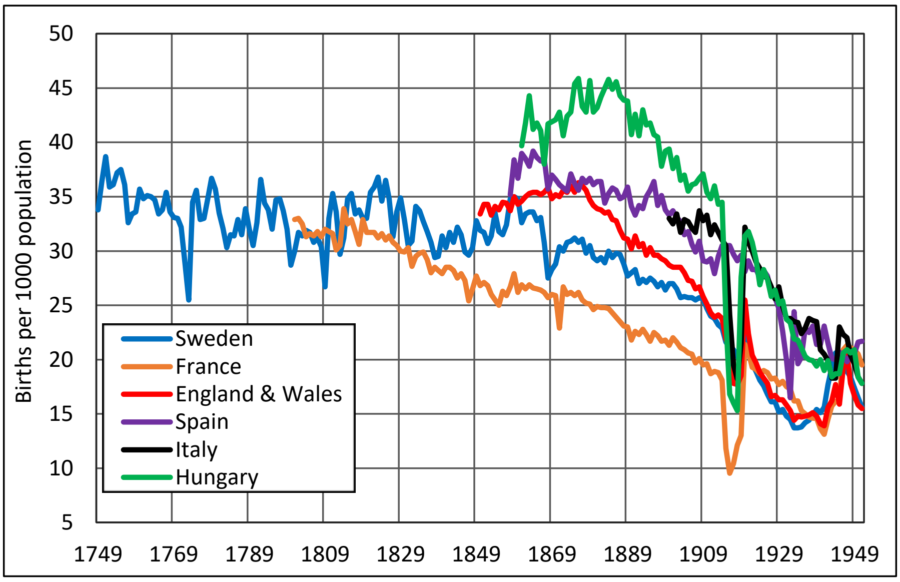
Vaccinations were the first major medical invention against diseases. Some of the breakthroughs are listed below. Edward Jenner introduced vaccination at the end of the eighteenth century, but wide–scale research on vaccines depended on the germ theory of disease and did not occur until a century later. Since the late nineteenth century, there have been a number of new vaccines, including those for rabies (1885), plague (1897), diphtheria (1923), pertussis (1926), tuberculosis (1927), tetanus (1927), yellow fever (1935), polio (1955 and 1962) (Culter et al. 2006, Deaton 2015). The morbidity consequences of these diseases were high, but the best available historical data suggest that, in Europe, direct mortality from these diseases was relatively rare immediately before the introduction of these vaccines, except for tuberculosis.

Excluding tuberculosis, decreases in these causes of death represent only 3% of the complete decrease in mortality. The decrease in tuberculosis mortality is another 10%, but the tuberculosis vaccine has never been regularly used in the United States, unlike most other nations, so none of the decreases was due to vaccination. These findings are parallel to those of McKeown. The BCG for tuberculosis vaccine was commonly used in Britain but without any proof of an impact on child mortality. The same applies to the implementation of other vaccines apart from polio. The indirect effects of eliminating infectious diseases can, of course, be huge. Moreover, individuals with measles can more easily succumb to other illnesses. Evidence indicates that certain waterborne diseases have indirect impacts on mortality (Cutler and Miller 2005), but the extent of such indirect effects in the disease environment as a whole is not known.

2.7 The Fertility revolution

Lack of historical fertility data usually necessitates the use of the crude birth rate in determining the evolution of fertility levels in Europe. Figure 6 shows the crude birth rates trend for selected Europe Countries from 1749 to 1959. Figure 6. shows that crude births rate (CBR) started to decline from high levels of above 35 in the last quarter of the 19th century even though France and Sweden had started earlier. The graph also reveals that by the end of the great WWII, crude births had declined to below 20 per 1000 population for all the countries. Chesnais (1992) considers crude births rate above 35 and below 30 per 1000 individuals as pre–transitional and transitional fertility levels, respectively. The graph also shows that the decline was longer, gradual and fluctuating for countries that began the decline earlier than for countries that started later, e.g. France and Hungary took 150 and 50 years respectively.

Fig. 6 – Crude birth rates, 1749–1949, selected European countries



Source of data**:** Mitchell (1998)

Other Empirical evidence suggests fertility declined earlier in urban cities than rural areas excerpt for France and the USA (Notestein 1953, Dyson 2013, Beaver 1975). The fertility decline was regionally clustered with western countries experiencing earlier fluctuating, longer and finishing earlier than regions in the southern, eastern and central Europe (Dyson 2013, Pavlik and Hampl 1975, Guinnane 2011). Similar results were revealed in a recent paper by Frejka (2016), using cohort fertility data for Europe and North America. Frejka found out that fertility decline was regionally clustered, with North–Western Europe including North America experiencing the first earlier, longer, gradual and fluctuating decline while the decline in southern, eastern and central Europe was typically shorter and happened according to their specific regions. However, for most of the countries, the decline was finished by the mid–20th–century except for a few isolated countries such as Ireland, Albania etc.

2.7.1 Changing patterns of demographic reproductive behaviour

Traditionally, fertility limitation has been known to be maintained in balance through Malthusian factors. Nuptiality factors, precisely celibacy, age at first marriage and low illegitimate births were noted. However, at the turn of the last quarter of 19th century a revolution in reproductive behavioural patterns happened in which fertility was reduced through limiting the number of births within marriage, namely through birth spacing and stopping childbearing after a certain number of children has been achieved (Clark 2008, Coale 1973, Coale and Watkins 1986). Coale (1973) has differentiated the two types of fertility control behaviours as non–parity and parity specific fertility control, respectively. Parity is a number of children ever born. Furthermore, Clark (2008) has pointed out that ''the rationale for fertility control in Malthusian times had nothing to do with individual choices but rather social norms''. Henry (1960) has also defined non–parity as natural fertility regime; meaning uncontrolled fertility regime in which couples do not make a conscious effort to limit the number the children ever born. In contrast, parity–specific fertility is fertility regime in which couples deliberately make efforts to limit the number of children ever borne through birth spacing or stopping altogether (Henry 1961). It can be observed in Figure 2.0 above that nuptiality factors kept fertility was stable before 1870. It is important to investigate how nuptiality kept fertility in check.

Research indicates that nuptiality patterns kept fertility from its biological maximum. Hypothetically a crude birth rate of 60 per 1000 (TFR 18) would be reached if all women married and married early. Thus Coale (1984) reiterated that preindustrial fertility was moderate and not as high as supposed by Notestein thesis. Moreover, Coale (1973) argued that before 1870, fertility rates ranged from 5.0 in England to 8.4 in Cocos Island in Australia. The difference between the highest and lowest pre–transitional fertility levels are big enough to be a comparable change signalling the onset of fertility transition. In 1965, Coale gave a classic example of the highest observed moderate fertility of 10.9 among the Hutterite woman. The Hutterites women are a Christian religious sect of German origin living in North America with early marriage, no fertility control, and have good health (Coale 1984, 1973). Since then, demographers have used Hutterites fertility as a comparison population.

Tab. 1 – Annual birth rates, married women, selected European countries before 1790

Country or group	Birth rate age					All births
	20–24	25–29	30–34	35–39	40–44	(20–44)
Hutterites	0.55	0.50	0.45	0.41	0.22	10.6
Belgium	0.48	0.45	0.38	0.32	0.20	9.1
France	0.45	0.45	0.40	0.32	0.16	9.1
Germany	0.45	0.43	0.37	0.30	0.16	8.6
Switzerland	0.45	0.38	0.34	0.22	0.16	7.8
Scandinavia	0.43	0.39	0.32	0.26	0.14	7.7
England	0.43	0.39	0.32	0.24	0.15	7.6

Source: Clark (2008:73)

Table. 1, shows the birth rates for married women before 1890 for selected countries in North –Western Europe, compared to the Hutterite standard. The marital births rates were below the Hutterite standard of 10.6 children per woman. The graph shows that married women from 20–44 years old in Belgium and France had the highest of all marital births of 9.1, while England had the lowest all marital births of 7.6. Previous literature suggests that the differences emanate mainly from social norms, practices, health and nutritional differences rather than individual fertility choices (Watkins 1981, Clark 2008)

Also, Notestein (1953) asserts that nuptiality patterns were maintained by culture and religion and enforced by community sanctions against those that violated them. According to Hajnal (1965), the European marriage pattern was characterised by

–Late age at first marriage for girls typically between 24–28 years

–High celibacy levels of women. Typically, 20–25% of women never married

–Low illegitimacy births. Typically, below 5% of all births

Thus Hajnal, notes the European marriage pattern can further be divided into western, eastern and southern respectively. With the northern having a higher proportion of celibacy and higher ages at marriage than southern and eastern regions. Therefore, European nuptiality patterns partly explain country differences and the regional clustering of fertility.

Most importantly, Europe's nuptiality patterns ensured that fertility was at half the possible number of births per year (Hajnal 1965, Coale 1973, Watkins 1981). Firstly, late age at first marriage reduced births by nearly 30%. Also, Alter (2008), notes that fertility reduction by late marriage could be higher, considering that women are more fertile from puberty to mid–20s. Secondly, the 10–25% celibate rate also reduced births by another 20% or more. Thus before the fertility revolution, for example, women in North–Western Europe gave birth between 4.5 and 6.2 children and with a median of 4.9. The median corresponds to a crude birth of about 32 per 1000. By implication births rates in Belgium and France were about 40 per 1000 (Alter 2008).

2.7.2 Coale's indices

Coale (1973) developed a set of indices that could be used to determine the historical fertility decline in Europe. The indexes measure the aggregate fertility of women of reproductive age (If), the fertility of currently married women (Ig) and the non–married (I). The indices stated fertility of a specified population relative to what it would experience if it had the highest set of fertility rates by age on reliable record – that of Hutterite woman. Therefore, an index of 1.0 means that the population/age group under consideration has fertility is equal to the Hutterites women. A value of 0.5 implies that fertility on average is half of the Hutterite woman, etc. The index of proportion married (Im) is a fertility weighted aggregate index of nuptiality among women of childbearing age. Universal marriage of women ages 15–50 years would mean index value of 1.0. Coale (1973) has argued, the advantage of these indices over direct calculation of general fertility, marital fertility, and proportion of married woman aged 15–50 years is that the indexes incorporate an indirect standardization for age distribution within the childbearing span and that the value of the fertility indexes has a direct intuitive meaning (i.e. fertility stated relative to the maximum on record. Importantly, there is a useful relationship among the indexes:

$$If = Im * Ig + (1.0 - Im)Ih.$$

Which reduces to $If = Im.Ig$ when the contribution of illegitimate fertility is insignificant.

2.7.3 Age at first marriage, celibacy and illegitimate births

The mean age at first marriage fell or remained the same at the onset and during the fertility transition (Hajnal 1965, Coale 1973, Watkins 1981). A reduction in mean age at first marriage should theoretically lead to an increase in fertility since the period of exposure to pregnancy becomes longer, yet, fertility declined during this period. In North Western Europe, the mean age at first marriage was typically 25 and sometimes would reach as high as 29 (Coale 1973). In a recent paper, Diebolt and Perrin (2017) showed that in France between 1740 and 1948 both female and male median ages at first marriage gradually declined from 29 and 27 to 24.6 and 22.5 respectively.

Similar to, the median age at first marriage, levels of celibacy also decreased in the late 19th Century. Surprisingly, fertility was also decreasing (Coale 1973, Diebolt and Perrin 2017). One would expect a decrease in celibacy and a concomitant increase in natural fertility. Empirical evidence suggests that in France celibacy for women and men decreased from 140 and 80 per 1000 to 100 and 80 per 1000 respectively, between the end of the French revolution and mid–19th century. The decrease in celibacy and a concomitant decrease in fertility presumably means there was birth control within marriage. Similar, trends were observed across Europe.

Using Coale's indices of proportion married (Im) described earlier, in pre–industrial North Western Europe, (Im) was between 0.35 and 0.50 in the United Kingdom Scandinavia, the Low Countries plus Germany, Switzerland and Austria. As a result, Coale has argued, typically less than 50% of the women of childbearing age were married at any given time and thereby effectively keeping fertility at about 50% of what it might have been if nuptiality was universal. Late marriage and high rates if definitive celibacy had similar effects. (ibid)

An increase in illegitimate birth should theoretically increase fertility as the proportion of women exposed to childbearing is increased. However, across Europe, the increase in illegitimate birth was accompanied by a decrease in overall fertility (Coale 1973, Alter 2008). New, historical empirical evidence from Meulan, a city of 1000 families in France, Diebolt and Perrin (2017) suggests that from 1780 to 1789 only about 2.6 per 100 births were illegitimate. By the 1830s illegitimate births had increased to 7.4 per 100 births and 8.4 by the 20th century. The increase in the share of illegitimate births occurred in a parallel decrease in overall fertility and legitimate birth. Moreover, they noted that legitimate births continuously declined across all ages.

Other factors might influence fertility within marriage. Firstly, extended breastfeeding has been found to prolong post–partum amenorrhea period, thus making birth intervals longer. Secondly, many societies had cultural practices and taboos that did not allow sexual intercourse during specific periods of child nursing. Such practices were based on the cultural belief that the sperm was dangerous for the child's milk, and a child would die, or some other bad omen will befall the child (Coale 1973). Louis Henry (1961) has argued that such practices were not standard in Europe. However, Etienne and Francine de Walle in Coale (1984) have found empirical evidence from 17th and 18th–century European medical literature that supports that such practices were standard. For, example Etienne and de Walle gave an example of a medical doctor who advised nursing mothers to the fact that they should abstain from sexual intercourse while breastfeeding because the sperm might curdle the milk and give the child a lifelong distaste of cheese (Ibid).

Fertility might also have been controlled by period separation of couples through seasonal work, e.g. herdsman, shepherds and fisherman who went away regularly for an extended period, e.g. 6 months, as part of their work. Lastly, other forms of the diseases, such as venereal diseases, tuberculosis, as well as nutrition, would reduce fecundability and raise chances of intrauterine mortality (Coale 1984). However, these factors were still limited by entry into marriage. Nevertheless, the downward fertility trajectories observed across Europe and Europe overseas signals that some other force beyond nuptiality and demographic factors was reducing fertility.

Literature suggests the usage of birth control by France and the USA since the French and American Revolution, respectively. In North–Western Europe, since the last quarter of the 19th century (Notestein 1953, Kirk 1996, Coale 1989). Other empirical evidence reports low fertility at the end of the 18th century among the Dukes and peers in France, the bourgeoisie of Geneva as early as the seventh century and among the Quakers in colonial America. The age structure of marital fertility suggests the presence of control in several national populations before the sustained decline. Coale (1973) has argued that the presence or absence of the parity related to fertility control is difficult to establish since there was no direct way of establishing the use of contraception and abortion in traditional societies. However, the control can be inferred indirectly, though crudely by a firstly, a sharp decline trend of marital fertility secondly, more precisely by age at which women stopped childbearing and birth intervals.

2.7.4 Birth intervals and birth stopping behaviour

The birth intervals lengthened from the mid–18th eighteenth century. Empirical evidence by Diebolt and Perrin (2017) suggests that in France City of Melun, the share of parents with (less than 18 months) and medium (between 19 and 30 months) birth intervals declined. Between periods 1669–1709 and 1790–1814, the share of couples with short intervals dropped from 11.6 to 2.9% and that of couples with medium intervals declined from 60.2 to 23.5%. Contrastingly, long birth intervals (31–48) and very long (49 months and more) birth interval increased from 18.8 to 27.1 and from 9.4 to 59.4% respectively. Melun is not the only city to experience this change. Similar trends were also observed in other cities. Moreover, also in Europe although at later periods after 1870. The birth limitation also differed in time between European regions and also between rural and urban migration.

The European fertility decline is characterised by more women stopping bearing children at earlier ages than in the traditional societies, in which women followed natural fertility regime. In Europe, the onset of fertility decline was mainly characterised by birth stopping behaviour. Chesnais (1992) reported that women in France stopped having children by the average age of 35 years. Research indicates that couples who stopped having children are considered as practising contraception (Chesnais 1992, Diebolt and Perrin 2017, Watkins and Coale 1986). The decline in fertility is a result of behavioural changes by couples regarding fertility, i.e. decision to stop having more children (Diebolt and Perrin 2017: 15).

2.7.5 Debate on causes of fertility decline

The fertility revolution in Europe set in a period of economic growth and the industrial revolution, which brought about an increase in the standard of life. It becomes difficult to attribute or quantify the contribution of specific factors. However, Notestein in his (1953:17) follow–up paper to the classic demographic transition theory paper of (1945) summarised that: *"...the new ideal of the family arose typically in the urban industrial society. It is impossible to be precise about the various causal factors, but apparently many were important. Urban life stripped the family of many functions in production, consumption, recreation and education. In factory employment the individual stood with his own accomplishments. The new mobility of young people and the anonymity of city life reduced the pressures toward traditional behaviour exerted by the family and community. In a period of rapidly technology, new skills were needed, and new opportunities for individual advancement arose. Education and rational point of view become increasingly important. As a consequence, the cost of child rearing grew, and the possibilities for economic contribution by children declined. Falling death rates at once increased the size of the family to be supported and lowered the inducements to have many births. Women, moreover, found new independence from household obligations and new roles compatible with child rearing."*

The multiplicity of causal factors is also echoed by Pavlik (1980), who notes that some authors highlight ten factors while some authors highlight up to 21 factors. Van da Kaa (1987), argued the factors could be grouped according to economic, mortality and those that emphasise communication (cultural and ideation factors, diffusion). However, Cummins (2009) has argued that all theories of fertility decline can be categorised as being either "innovation or diffusion'' or ''adaptation''. With innovation, the new behaviour is learnt as a result of new knowledge or changes in culture that makes the fertility control acceptable on moral grounds, and new knowledge is spread to the rest of the population through diffusion. The adaptation aspect states that fertility control is influenced by couples' changes in economic and social circumstances (e.g. rising incomes, urbanisation, declining infant mortality) (Cummins 2009). High pre–transitional fertility is seen as couples

"*rational response to economic and social conditions just as falling fertility is seen to reflect couples rational assessment of the changing cost and benefits of having children" (*Cummins 2009:20*)*.

Nevertheless, the following factors have been highlighted namely, infant and child mortality, women empowerment (women education and female labour participation), economic structural changes (percentages employed in industries vs agricultural economies), secularisation, religion, cultural ideation, diffusion, education etc. In summary Alter and Clark (2010) argued that fertility decline is affected by structural economic changes and the diffusion process acts as a lubricant to the process

The European Fertility Project (EFP) conducted an extensive empirical study on the causes of historical European fertility decline. Socioeconomic progress and mortality are seen as cornerstones of fertility decline (Watkins and Coale 1986). EFP expected to find the onset of fertility decline in provinces where mortality had declined first, with high literacy rates, low agricultural employment, and in more urbanised provinces than rural provinces. In some countries, such correlations between fertility and socioeconomic factors were significant, but no fixed list of factors associated with the initiation of a fall in fertility was found (Coale 1973). Furthermore, the decline in fertility was more complicated when looked upon in detail on a province and by province analysis. For example, the decline started earlier in France than England, yet France was largely rural made up of peasant population with high infant mortality and high illiteracy levels. In England, the fertility decline started about a hundred years later, yet England was the pioneer of the industrial revolution and had high rates of urbanisation (Coale 1973). They also surprisingly discovered that ideation, cultural and linguistic boundaries were significant causal factors in fertility decline. In the end, EFP led to the conclusion that fertility would decline when populations are ready, willing and able (Coale and Watkins 1986)

In a recent study using individual longitudinal micro–level data for five historical cities in Europe and North America, Dribe et al., (2016) found women from richer backgrounds acting as forerunners to fertility decline before other socioeconomic groups while peasants and unskilled workers were the last socioeconomic group to initiate fertility decline. However, fertility would converge at low fertility levels at the end of the fertility revolution despite differences in socioeconomic classes.

Similarly, Diebolt and Perrin (2017) showed the differences in the average length of birth intervals in France between the rich and the poor women before and during the fertility revolution. From 1660 to 1739 more of wealthier households had shorter intervals between consecutive births than poorer households. Diebolt and Perrin have argued, the wealthier household would end up with higher fertility, presumably because they send their children for wet nursing. This pattern changed over time from the mid–18th century and onwards for French women. Poorer households began to have shorter birth intervals than wealthier households. Precisely, from 1815 –1839 for French couples, 62% of wealthier households exhibited very long spacing birth intervals (above 49 months) against only 43% of poorer households. The share of poorer households with medium birth spacing 19–30 months) reached 33% against 17% of wealthier households (Diebolt and Perrin 2017). Therefore, all women eventually drop their fertility irrespective of class, wealthier women acted as forerunners, and poorer women acted as followers.

The demographic revolution theory argues that *mortality decline*, especially infant and child mortality, is the central thread to the fertility revolution (Notestein 1953, Dyson 2010, Kirk 1996). The argument is that in pre–transitional high mortality societies, parents' desire to maintain a certain household size. The preferred household size could only be achieved effectively through child hoarding and child replacement. Child hoarding can be defined as a behavioural response to expected mortality while child replacement effect can be defined as a behavioural response to experienced mortality (Knodel 1982). .Increased survival chances, especially of children, meant that child hoarding and replacement become unnecessary as desired family size could be met with less number of children born. Thus, fertility is reduced directly or indirectly. With direct fertility reduction, parents realise that their children are no longer dying much (in traditional societies about 1/3rd of infants died) and increased survival of children puts upward pressure on household and family resources. Indirectly, fertility is reduced through extended infecundity period when children are breastfeeding, which reduces woman fertility (Guinnane 2011). David Reher et al. (2017) using data from Sweden, Netherland and Spain period (1871 to 1960) shows the child replacement effect in increasing fertility. They argued that families were always regulating their fertility to achieve a certain household size. Couples experiencing high child mortalities show significant increases in the likelihood of having of additional births. Moreover, they found out that the sex composition of surviving children also influenced significantly affected the hazard of having additional births. These results are in line with the demographic transition theory and

epidemiological theory. This position is supported by many authors (Kirk 1996, Dyson 2013). In particular, Dyson (2013: 5) argues that
"*provided mortality decline occurs in a population then all of the transitions other major demographic processes will occur…….the central chain of cause and effect appears to be both reasonable self–contained and inexorable''*.

However, the challenge is that historical fertility decline in France and the USA preceded mortality decline. Using the data from France, Diebolt and Perrin (2017) were able to match infant mortality rate, life expectancy at birth and crude birth rate in 1851 for France. They discovered that in 1851, the average level of infant mortality was 30 per 100 births. LE was 38.79. Of course, regional variations were noted. They revealed a correlational relationship between national regions with infant mortality and life expectancy above the national average (40 deaths per 100 births and LE below 30 years). While regions with a low level of infant mortality below 20 per 100 births and LE above 47 years. The results show that regions with higher infant mortality and lower LE had higher fertility levels. However, upon further analysis of infant mortality and LE, they discovered that the causal relationship of mortality on fertility did not apply to all counties. Similarly, Knodel (1982) also found that historical fertility decline, in German villages preceded a noticeable decline in infant and child mortality. The German pre–transitional infant mortality levels were mainly the same before that 1870, then they decline in tandem to fall in marital fertility. Coale and Watkins (1986) in summarising the European Fertility Project noted that the effect of mortality on causal fertility relationship is almost irresistible, but when province by province records are examined, it is found that in about half the provinces the decline in fertility preceded the decline in infant mortality. The explanations of the effect of mortality on fertility only explain part of the puzzle.

The demographic transition and Becker's economic theory assumes that *modernisation* increased the direct costs related to pregnancy and childbearing inducing and compelling couples to limit the number of children. However, the challenge is that the cost of essential goods like food, clothing etc. dropped due to innovation in technology during the industrial revolution (Alter and Clark 2010). Nonetheless, *urbanisation* aspects, e.g. housing, education etc. provided the only direct significant costs (Ibid). According to Woods (1988) in Guinnane (2011), most of the European, as well as overseas European countries, experienced rapid urbanisation during the 19th century for example urbanisation of England grew from 34% in 1801 to 79% by 1911. The United States grew from 6% in 1800 to nearly 40% by 1900. However, France was less urban than most European countries, yet it had the lowest fertility (Dyson 2013, Chesnais 1992). Urban living in particular housing was more expensive than in rural areas. However, literature has found that rural fertility was significantly higher than urban fertility and that urban areas were pioneers of fertility decline (Dyson 2013, Coale 1973, Guinnane 2011). In the year 1967 –68, marital fertility in Berlin was about 87% of rural Prussia (Knodel 1974). Similar findings were discovered in America, Haines (1989) reported that in 1905–10 United States urban (total fertility rate) TFR was at about 2.7 with rural nonfarm TFR at 4.0 and rural farm TFR at 6.0. Furthermore, urban areas acted as forerunners, and rural areas acted as followers of fertility decline (Diebolt and Perrin 2017, Dribe et al. 2016). However, fertility decline in France happened against a backdrop of rural areas than urban areas, which meant there are other critical mediating factors.

The second type of direct costs was formulated by Richard Easterlin (1976) for the United States fertility decline in rural areas. He argued that the rising costs of farmland as an area were settled. The rising costs of the local farmland meant that parents had to either send their children further west where land was cheaper, or they had to reduce the number of their children. Easterlin argued that parents preferred to reduce the number of their children so that they can have an adequate inheritance. He dates the beginning of fertility decline in New York State to 1805 and Iowa in the west to 1835 (Easterlin 1976). Later research focuses on Easterlin's assumption that parents wanted to give each child a fixed bequest. Sundstrom and David (1988), for example, did their regression analysis using a bargaining model that assumes ''that a primary motivation for the child–rearing is support in old age''. In equilibrium, children can drive a harder bargain with their parents if they can point to better, non–agricultural opportunities. Cross–sectional regressions for U.S. states in 1840 show that fertility is negatively correlated with measures of nonfarm labour–market opportunities. Once such proxies are introduced, land prices have no influence on fertility, which means other factors were also partly responsible for the fertility decline (Sundstrom and David 1988).

The fertility decline reflects a net return to child quality. The growth of literacy and primary *education* is negatively associated with fertility decline. In 1763, Prussia passed laws that all children aged between 5–13 years should attend schools. Reports indicate that about 60% of children attended schools. In 1840, several US states introduced free primary education.

Similarly, German, France, England and Wales introduced free primary education in 1872, 1882 and 1893, respectively (Guinnane 2011:606). Literacy rates varied according to sex and residence. As in line with the Becker theory, the creation of schools indeed reduced the cost of primary education, but the opportunity cost of time spent in school increased with free education. However, Guinnane (2011) has argued that child laws might have been more critical in encouraging schooling than the schools themselves (Becker et al. 1990).

Child labour restrictions are direct costs to parents and potentially reduce incentives to have large families. However, several studies have revealed that industrialisation initially increased income opportunities for children because new technologies did not require physical strength (Dyson 2013, Guinnane 2011) and fertility increased because of demand for children (Dyson 2013). Nardinelli in Guinnane (2011) reports that during early industrialisation, most English counties at least 25% of children aged 10–14 years were working and half of all workers in the textile industry were below 18 years and 6.8% were below ten years. However, by the mid–19th century, the use of children became morally wrong and illegal. Governments imposed working age restrictions and other measures that reduced children's working opportunities. For example, in 1833, "*the British Factory Acts*" specified an age at which children can work and several hours. In Prussia, "1839 act on minimum age'' was stipulated to 9 years and 16 years for children who had at least 3 years of schooling. In Massachusetts, as of 1837, children under the age of 15 who have not attended school for at least 3 months in the previous year could not be employed (ibid). Variations in enforcement between regions as well between urban and rural areas were noted.

Education is an expensive investment, therefore, parents make a trade–off, for quantity to quality. They prefer to have fewer children who are educated than many uneducated children. It is a quantity for the quality trade–off. This happens in the background of low infant and child mortality because, in the past, such an investment in a child's education was not secure as the children would die early (Soares 2005). Investigations into the returns to child schooling by Goldwin and Katz (2000) using data from Iowa revealed that an additional one year in high school for the male child had a return of 11–12%. Moreover, Becker et al. (2013) found a negative relationship between children's education and parental fertility. In traditional societies, children were considered as insurance against old age support, ill–health and injury (Coale 1973). However, increased rural–urban migration made it impossible for parents to be cared for by their children.

Furthermore, in the mid–18th century, *alternative sources of old age insurance* (state insurance and private savings) were developed (Guinnane 2011). Starting with Bismarck in Germany 1851, social insurance rise, is part of the story to fertility decline, although most countries started experiencing fertility decline in the absence of state–sponsored social insurance (Guinnane 2011). However, bloom and Lucas have argued there is very little historical evidence supporting this statement and that it is the only a matter of conjecture. Nonetheless, Sundstrom and David (1988) have found evidence in the US on the importance of children for parental old age support before the civil war (1861–1865). Nevertheless, the demand for children driven by a desire for old age security age was probably not more important than other factors considered.

The *education of women* is a prominent determinant of historical fertility decline (Caldwell 1976, Dyson 2013). Economist Becker's (1960) theory emphasise the demand for children as similar to the demand for other goods in life. The price of the child just like the price of the other goods determines the demand for child or goods. Becker's framework defines prize as something broader than just the monetary cost parents incur in raising the child. However, it includes direct costs of the child, such as school fees and childcare. Indirect costs such as the opportunity costs in time during pregnancy and child–rearing are also included (Becker 1960, Cummins 2009). In traditional societies, mothers spend a significant amount of time with their children than fathers, which made children a burden on women.

Women with higher education would want fewer children than uneducated women because, Firstly, the opportunity costs of educated women are higher than for uneducated women who would want more children (Guinnane 2011). Secondly, the education of women indirectly enables women to have lower fertility through healthy children and lower infant mortality. In turn, studies have revealed that infant mortality is negatively correlated with education (Becker et al. 2013). Thirdly educated women's reduced fertility enables them to provide better education to their children. Evidence from the historical fertility decline in Prussia by Becker et al. (2013) has shown that this a mutually reinforcing relationship. As, the fertility declines, the education system has smaller and smaller birth cohorts for which it can provide better quality education.

Furthermore, parents with lesser children have opportunities to nurture and support their children, raising the quality of their children. Lastly, education plays a pivotal role in breaking language and communication barriers. Diebolt and Perrin (2017) noted that, in France, the compulsory use of French only in the education system among different provinces broke communication barriers. Other studies have found, different languages and cultural practices to be barriers to the diffusion of fertility control (Leasure 1965, Lesthaeghe 1976)

Several studies have confirmed that women's levels of education are linked to lower fertility (Murtin 2013, Becker et al. 2013). Macro studies– studies have revealed that educated women have fewer children as assumed Becker theory and other modernisation proponents. However, correlation does not mean causality, it does not show the independence of women's education factor from mortality or other socioeconomic factors. Similarly, Becker et al (2013) have looked the historical fertility decline in Prussia by controlling for the confounding variables in the 19th century Prussia and found out that the relationship is indeed causal. In another macro study that looks at historical fertility decline in several European countries from 1870–2000 (Murtin 2013). Murtin investigates multiple variables associated with the reduction of fertility. He identified that education was the most important among other factors, e.g. health, economic standards etc. Murtin notes that *'when average years of primary schooling grow from 0 (illiteracy to 6 (full literacy) years, fertility should drop by about 40–80%*'' (Murtin 2013: 618).

The emancipation of women through female labour participation is negatively correlated with fertility decline. The economic theories attribute fertility decline to the fact that children are seen as direct or indirect costs to women in modern societies (Cummins 2009, Becker 1960). This cause–effect relationship can also go both ways as fertility decline can give women more chances of labour participation without the burden of childbearing and rearing (Guinnane 2011).

Women's labour participation increased due to several reasons notable to mention structural changes in the labour market from heavy labour intensive to lighter and more service–oriented as the societies moved from agricultural to modern societies (ibid). Furthermore, to the technological changes from which women benefitted, women were given rights to work in professions from which they were previously banned without good reasons (Guinnane 2011). Industrial and urban centres had higher female labour participation rates as well as lower fertility than rural agricultural areas (Diebolt and Perrin 2017).

The unified growth theory by Galor (2011) advances that there is a close connection between modern economic growth, population, structural transformation, and education. The industrial revolution brought increased demand for female labour is the opportunity cost of several children born per woman, hence lead to a decline in the number of children born per woman (Galor 2011, Becker 1960).

Evidence suggests that, in England and Wales, labour participation rates for wives was high at 65% for period 1787–1815 and corresponds to the peak of the industrial revolution (Guinnane 2011). In Britain, the proportion of women in the workforce in specific industries was at 30% of all measured labour force, and about 40% of all women worked in textile industries (ibid). Similarly, in 1880, about 58% of all American textile workforce was women. Likewise, in German, between years 1830–1840, women made up about half of the workforce (Guinnane 2011). Indeed, married women certainly worked before the industrial revolution, but the industrial revolution created new opportunities and trade–offs for women than preindustrial societies (Notestein 1953, Becker 1960). Guinnane (2011) reported anecdotal evidence that some industries refused to hire married women, thus giving women the incentive to delay getting married and childbearing.

Similarly, Crafts (1989) using women's occupation information and fertility from 1911 census for England and Wales found a negative correlation between women's labour force participation and marital fertility with elasticity ranging from – 0.13 to – 0.34. In particular ‘’birth spacing’’ was found to be practised more in districts with high women employment (Crafts 1989). However, the Crafts' findings do not tally with the European Fertility Project's view that parity specific fertility control is a result of diffusion of improvements in birth control information and technology

Similarly, Schultz (1985) using Sweden data for period 50 years from 1860–1910, discovered that industry induced demand for women's labour and improved women's wages relative to men's wages. This contributed significantly to the decline of fertility. When other confounding variables such as child mortality, urbanisation and real wages of men were held constant, the exogenous appreciation of women labour participation accounted for 25% of Swedish fertility decline (Schultz 1985).

In conclusion on the effects of women empowerment on fertility decline. In traditional societies, the majority of childbearing and rearing fall upon the shoulders of the children and fertility is high when women have little social status and few opportunities outside the home environment. It is when women are exposed to the outside environment through education and female labour participation that women began to decrease their fertility. Lower fertility as a result women empowerment can after that lead to a virtuous cycle in which low fertility give the women more opportunity to work or do other things, and this leads to even further fertility decline.

Fertility decline also reflects the *changing of social norms and values* in which couples prefer a smaller number of children as opposed to a large number of children. The demographic and economic theories expect fertility decline to start in modern societies (Notestein 1945, Becker 1960). Paradoxically, the decline of fertility started earlier in France even though France was more rural and relatively weak as compared to other north–west industrialised regions (Chesnais 1992, Cummins 2009). Lee and Lee (2016) drew a map which compared fertility with urbanisation and education for selected European countries by 1870. They found out that fertility in France was much lower than fertility in countries that were better educated and urban. In particular, they discovered that all of the European regions that experienced at least a 10% decrease in fertility were in France (ibid). This makes France the origin of social norms that lead to the decline of fertility in Europe. The social norms were then culturally diffused to other parts of Europe. Therefore language and cultural barriers mattered for the timing of the decline of fertility as the diffusion happens through intimate personal communication (Alter and Clark 2010, Lesthaeghe 1977, Leasure 1963). Moreover, enlightenment ideas coupled with turning away from the pro–natalist doctrines of the Christian religion in Europe made birth control within marriage ethically and socially acceptable (Lesthaeghe 1977, Alter and Clark 2010)

Leasure, (1963) looking at the demographic transition according to Spanish regions, discovered that linguistic boundaries determined fertility decline. His research was motivated by surprise, finding that there has been a significant fertility decline by 1930 in conservative Catholic Spain. He drew a colour coded map of marital fertility decline in 49 provinces in 1911, Spain when the country was in the middle of fertility decline. A significant finding of the study was that provinces that had the same colour were geographically clustered, although they had different social, economic and educational characteristics. He noted that Catalonia, an area near the border with France, which contains Barcelona as one of its provinces had an earlier onset of low fertility regime than any other region in 1911. The Catalonia region included some rural provinces with little industry and low literacy levels, although these provinces were low on fertility as well as urbanised and industrialised Barcelona.

Contrary to the Catalonia region, the Basque region, which was industrialised had high fertility. Leasure (1963) discovered the colour coded map of marital fertility levels also represented the linguistic map of Spain. He concluded that presumably, one of the reasons for regional fertility clustering was linguistic and cultural boundaries. Similar linguistically regions enables the diffusion of birth control methods. Deliberate limitation of the family involves both a change in ideas and mastery of the technique. These social changes are presumably carried out by a combination of person to person communication and behavioural imitation. A novel idea is intimately and intricately communicated, copied and adopted by populations. Coale (1973) has argued that imitation of birth control and intimate communication usually has linguistic boundaries. The provinces that were homogenous linguistically are more able to communicate an idea than provinces that are not homogenous. However, Coale has also argued that another possibility about regional clustering of fertility is that, Spanish regions that have different dialects also have different histories. Traditionally they were separate kingdoms with different legal and social traditions.

Lesthaeghe (1976, 2015) outlined another outstanding example on the effect of culture on the fertility transition on his study of Belgium communities Walloon (French–speaking) and Flemish (Dutch speaking) that had different languages but with similar socioeconomic conditions. The communities had different fertility levels and the onset of fertility decline. When the two regions were combined into a national figure, they produced ambiguous results. The variations between rural and urban as well as other socioeconomic characteristics persisted within linguistic and cultural regions (Kirk 1996).

Livi Bacci in Coale (1984) studied the effect of secularisation on the decline of marital fertility in Italy. He used voting for divorce as a proxy for determining how much a province is secularised. Using data from the census 1911 to 1961 and the vote in 1974 in a national referendum on the liberalisation of laws regulating divorce. There was a significant correlation between the provinces that voted against the church (meaning more secular) and earlier onset of fertility decline date (including 1911). The correlation among the Northern provinces between marital fertility and the divorce rate was higher than the multiple correlations with six socioeconomic variables from 1931 to 1961. Livi Bacci has argued that the reason why marital fertility in 1931 or 1911 correlated with a vote on divorce legislation was probably because of the conservative adherence to the position of the Catholic Church that led to a vote against the liberalisation of divorce laws in 1974. Furthermore, adherence to the precepts of the church in the same provinces several decades earlier impeded the adoption of contraception (Coale 1984).

Lesthaeghe (2015) has also found that secularisation (as indicated by the proportion of votes cast for socialist or social democrats parties) is strongly correlated in several European countries with date of onset and pace of fertility decline.

Further evidence on the role of the cultural and linguistic factors in the fertility decline was found by Coale et al. (1979) in a book on '*'Human Fertility in Russia since the 19th Century''*. Coale et al. found a correlation between the nationality composition of the population of each province and the timing of marital fertility decline. The Baltic provinces of Russia that were most western in culture– they had German Swedish ties were the first to reduce fertility. Next were the provinces in the west of Russia with Great Russian populations (Ukrainian, white Russian, Polish, or Romanian). Next were the provinces with Great Russian populations, although those with a significant representation of eastern Finish or other Slavic groups were generally later.

In conclusion, socio–economic progress leads to fertility decline. It is difficult to separate and quantify causality of specific factors given scarcity of historical fertility data. Moreover, the socioeconomic progress came with good health, women empowerment, industrial labour participation, rising levels of education, particularly for women and children which are associated with fertility decline. However, cultural and linguistic boundaries plus secularisation were also found to be significant contributors to fertility decline. It is difficult for causality factors to be uniform at the same time as they vary with specific settings. This might explain regional clustering of fertility before and during the revolution. It is possible that third confounding variables might intervene and delay or speed up the process, but the general effect of socioeconomic progress on fertility, in the long run, is apparent. Based on the EFP, Coale has summarised that fertility declines when societies are ready willing and able.

2.8 Summary of the demographic revolution in developed countries

The demographic revolution began mid–18th in the North West European countries driven by science and technology. It roughly ended by the mid –20th century. The French model is the oldest in which fertility and mortality declined together without modernisation. The English model is the classical model in which mortality decline preceded fertility decline and with modernisation. The forerunners (North–West Europe) of the demographic revolution took longer, gradual declines in fertility than the followers (Central, Eastern and Southern Europe).

The explanations for levels of fertility decline were more difficult than for mortality decline. The decline of fertility causes includes mortality decline, modernisation aspects such as education, women empowerment, urbanisation, ideation, linguistic and cultural boundaries. The factors' effect also varies with their specific combinations and geographical cultural and socio–economic settings. Coale formulated that fertility declines when conditions of ready willing and able have been fulfilled. The effect of the demographic revolution is far more extensive and go beyond fertility and mortality declines and age structural changes etc. They include changes in family structure from large extended families to small nuclear families, from largely rural societies to urbanisation. Other scholars have also mentioned that the growth of modern economics and the rise of modern democracy resulted in the demographic revolution.

Chapter 3
The demographic revolution in developing countries

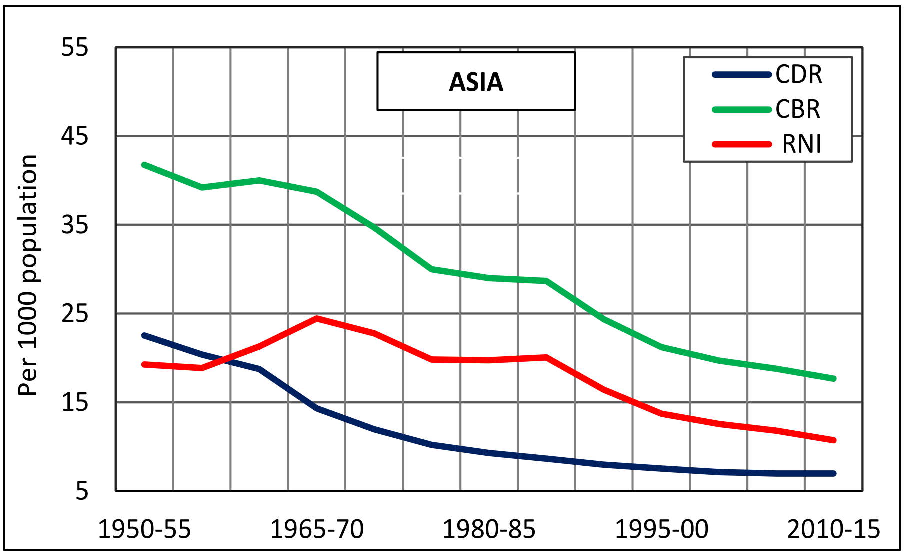
Having discussed the origins, process and effect of the demographic revolution in developed countries, this chapter will discuss the demographic revolution in developing countries. The onset of mortality decline in developing countries in the mid–20th marked the demographic revolution as a global process (Reher 2004, Dyson 2013, Pavlik 1980). Pavlik (1980) has defined the demographic revolution as the Japanese–Mexican model with specific features and differences with the English and French model models discussed above. Although the general pathway is similar to the English model, it occurs later (mid–20th century), at a faster pace, high population growth rates and lower levels of socioeconomic development than historical transitions

Figure 7a, 7b and 7c show CBR, CDR and RNI for continental regions, Asia, Latin America and Caribbean, and Africa, respectively (1950–2015). The Figures shows that in all continents, rapid decline in mortality decline with sustained high natality gave to birth to unprecedented rates of natural increase of more than 2,5% per annum in the 19501970s. Only Figure 7c– Africa has maintained this high rate of natural increase by 2015, while other regions (Figure 7a, 7b) are almost at 1.0% per annum. This means the regions as a whole have not yet finished the demographic transition. Using 10% continuous fertility decline as advocated in the Princeton European Fertility Project, the decline of natality in Africa lagged to that of mortality decline by more 40 years, while other regions had about 10 years.

Moreover, Figures 7a and 7b, show that CBR for Asia and Latin America started at almost similar pre–transitional levels of 40/1000 before declining continuously to a similar rate, 17.8 from 1950 55 to 2010–2015. However, the CDR for Latin America and the Caribbean was declining more rapidly than of Asia before stagnating at 29/1000 from 1975–1990, then resuming with the downward trend. The graph also reveals that crude deaths rate decline from Asia and Latin America 25.5 and 15.7 declined to 7.0 and 5.8 respectively from 1950–55 to 2010–2015. Both countries experienced initial increases in RNI. Latin America increased from 27.1 in 1950 1955 to 28.5 in 1960–1965 before declining rapidly to 11.9 by 2010–2015. The RNI trend for Asia had fluctuations. It initially increased from a stable rate of 18.8/1000 in 1955 –1960 to 24.4/1000 by 1965–1970 before declining to a stagnated level of 19.7 from 1975 to 1990 and then levelling off at 10.6/1000 by 2010–2015.

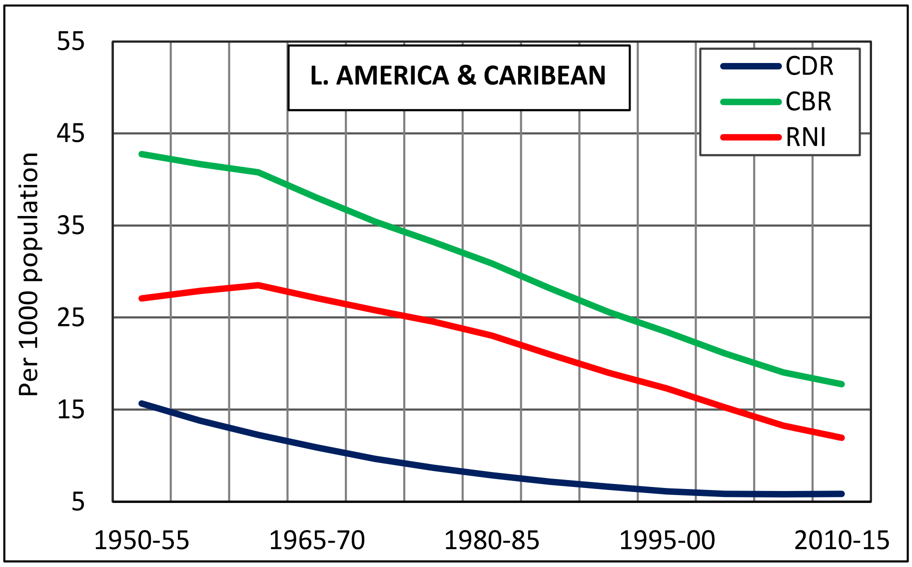
Furthermore, the Figure 7c reveals that Africa had the highest CBR, which declined gradually from 48.3 to 35.9 from 1950–1955 to 2010–2015, respectively. The RNI increased significantly from 21.5 in 1955–1960 to a plateau of 29.0 in 1980–1985 before declining and stabilising at 26.0 by 2010–2015. The decline of vital rates by continental regions starting with Latin America followed by Asia and lastly Africa in a way represents regional clustering. Moreover, intra continental and country spatial demographic clustering have been noted. Precisely, Tabutin et al. (2004) identified four typologies of demographic transitions in sub–Saharan Africa. Similar studies were identified in Latin America, the Arab world and the Middle East (Tabutin et al. 2005), South and South–East Asia (Attane, 2009), South Asia (Veron 2008) Oceania (Rallu 2010) Latin America and Caribbean (Guzman et al. 2009).

Fig. 7a – Crude death (CDR) and crude birth (CBR) rates, rate of natural increase (RNI), Asia, 1950–2015



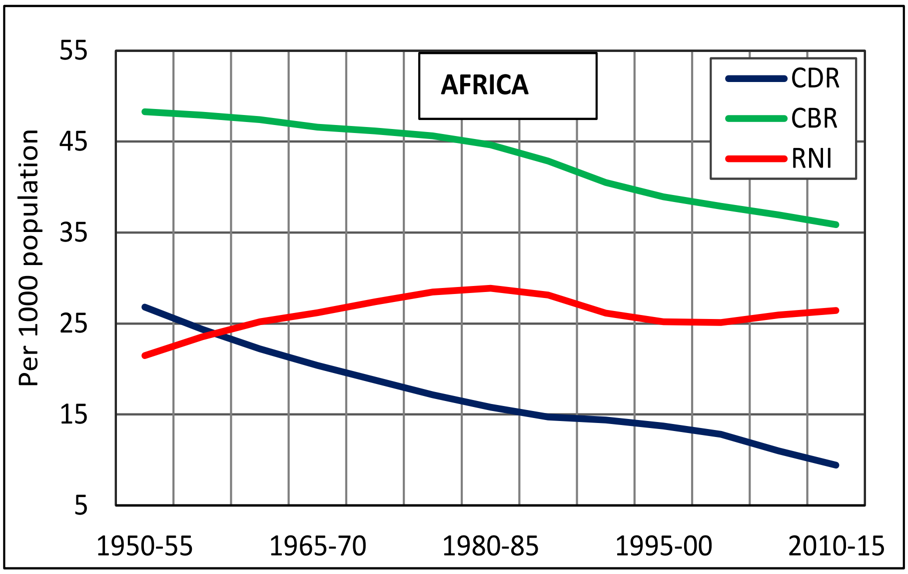
Source of data: UN (2017)

Fig. 7b – Crude death (CDR) and crude birth (CBR) rates, rate of natural increase (RNI), Latin America, 1950–2015



Source of data: UN (2017)

Fig. 7c – Crude death (CDR) and crude birth (CBR) rates, rate of natural increase (RNI), Africa, 1950–2015



Source of data: UN (2017)

Lastly, the population age structure initially becomes younger due to population momentum, before significant fertility decline causes population ageing. Nonetheless, from 1950 to 2015, the population median age for Africa, Asia and Latin America increased from 19.3, 21.3 and 19.4 to 19.4, 30.3 and 29.2, respectively. However, these continental aggregates mask the sub–regional countries and intracountry–specific variations in the developing countries. The specific variations will be discussed in detail in sections on mortality and fertility decline.

Tab. 2 – Length and dynamics of demographic revolution in selected developing countries sub regions

Sub–region[(a)]	Onset of revolution	Gap[(b)] (years)	End of revolution[(c)]	Duration (years)	Maximal rate of natural increase per year (%)
Africa					
Middle	1950–55	65	2090–95	140	>3
Western	1950–55	50	2090–95	140	2.5–2.9
Eastern	1950–55	45	2080–85	130	>3
Northern	1950–55	15	2055–60	100	2.5–2.9
Southern	1950–55	25	2025–30	75	2.5–2.9
Asia					
Western	1950–55	15	2040–45	90	2.5–2.9
Central	1950–55	15	2030–35	80	2.5–2.9
Southern	1950–55	20	2030–35	80	2–2.4
Eastern	1950–55	15	1990–95	40	2.0–2.4
South–Eastern	1950–55	20	2040–45	90	2.5–2.9
Latin & Caribbean					
Caribbean	1950–55	15	2015–20	65	2.5–2.9
Central	1950–55	15	2030–35	80	>3
Southern	1950–55	15	2015–20	65	>3

Notes: (a) Sub–regions are represented by all the countries making up that region using the UN classifications.

(b) The gap is difference in years between onset of CDR and CBR levels decline

(c) The end of revolution period is estimated using United Nations medium population projections.

Source of data: UN (2017) and own calculations

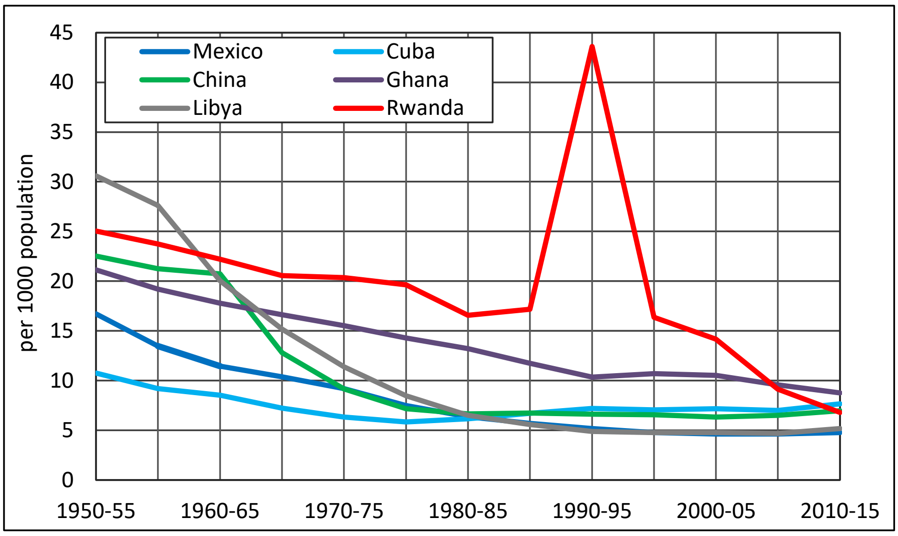
Table 2, shows the onset, end, duration, maximal growth rates, end as well as the gap between mortality and natality declines in selected developing countries regions. Table 2, shows that the demographic revolution started at about 1950–55 across all the regions and ends earliest in Eastern Asia (1990–1995), followed by Latin America Southern and Caribbean sub–regions (2015–2020). Majority of the sub–regions including Southern Africa finish the demographic revolution by 2050 excerpt rest of Sub African regions. Sub African regions have the longest durations excerpt southern Africa ranging from 100 years in Northern Africa to 140 years. Table 2, also show that all the sub–regions in developing countries experienced rates of maximal natural increase above 2.5% excerpt eastern and Central Asia. Countries that finished the transition earlier had a short gap between onset of demographic revolution and onset of fertility decline. The findings suggest that the two stages of the demographic revolutions might be short as compared to the European historical transitions but with longer gaps.

However studies by Chesnais have also shown that there are great sub–regional variations. Mustafina (2014) has demonstrated that onset of the revolution in a number of Asian countries including Japan, South and North Korea, Argentine, Jamaica began in the first quota of the 21st century.

3.1 Mortality levels, trends and patterns

Several authors noted the secular decline of mortality in developing countries started in the mid 20th century (Harper 2016, Chesnais 1992, Coale 1973), however, empirical evidence of such decline is limited by the availability of reliable and valid data. Fortunately, the World Population Prospects (2017) revision offers comparable mortality estimates from 1950–2017

Fig. 8 – Crude death rates, selected developing countries, 1950–2015



Source of data: UN (2017*)*

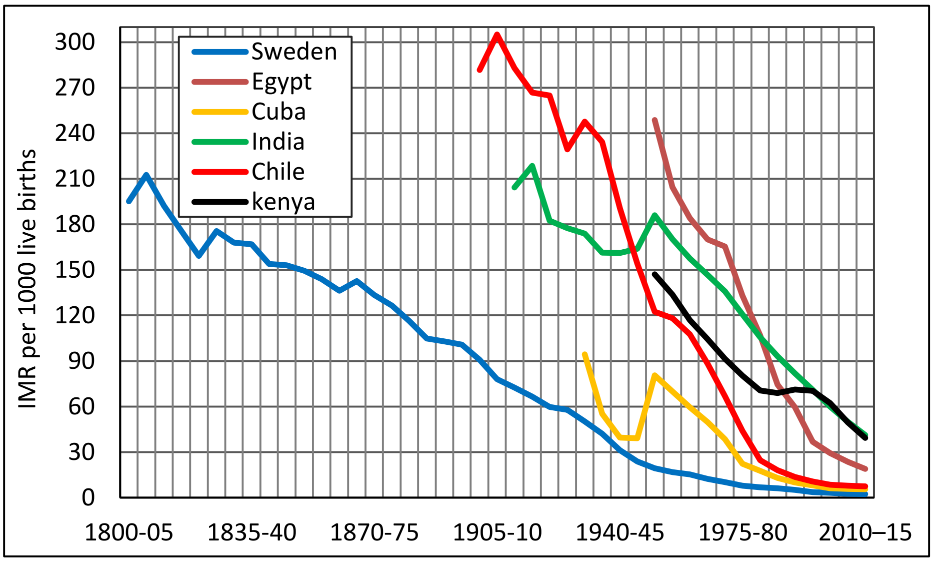
Figure 8, shows crude death rates for selected developing countries, 1950–2015. Firstly it shows that all the countries experienced a decline during the period under consideration. Secondly, countries that started later had steeper declines than countries that began earlier. Thirdly in 1950, mortality decline was at very different levels and declined towards convergence by 2015.

The CDR level in Rwanda temporarily rose dramaticaly in the 1990s due to war and genocide, Since all countries excerpt Libya were below 25 per thousand one can presume that the decline started earlier in some developing countries, given Chesnais (1992) mentions that mortality is considered as having started to decline when it goes to levels below 30 per thousand. Accepting mortality levels in Figure 8 in 1950 imply that mortality in developing countries was at lower levels than in developed countries, yet Notestein's (1945) original formulations state mortality was generally higher in developing countries than in pretransitional Europe. However, the challenge is crude birth rates are affected by population age structure and therefore do not tell the whole story of mortality decline.

3.1.1 Infant mortality

Infant mortality rate (IMR) is an indicator of the health of a population. Previous studies have reported that a third of all infants died before the age of one year (Dyson 2013, Kirk 1996, Pavlik 1980). Figure 9, shows IMR decline in Chile, India, Cuba and (Egypt and Kenya) started in the early part of the 20th and mid–20th century, respectively. Sweden had already started a mortality decline by the early 19th century. The graph also reveals very different IMR levels in the mid 20th century and a decline towards convergence by 2010–2015. Thirdly the graph shows IMR decline in Sweden was gradual, fluctuating and more prolonged. In contrast in developing countries, IMR was 150 years later, more dramatic, smoother and shorter. Accepting the notion that IMR decline started in mid–20th (Notestein 1945, Dyson 2013, Pavlik and Hampl 1975), implies that developing countries started at lower levels of IMR mortality than developed countries.

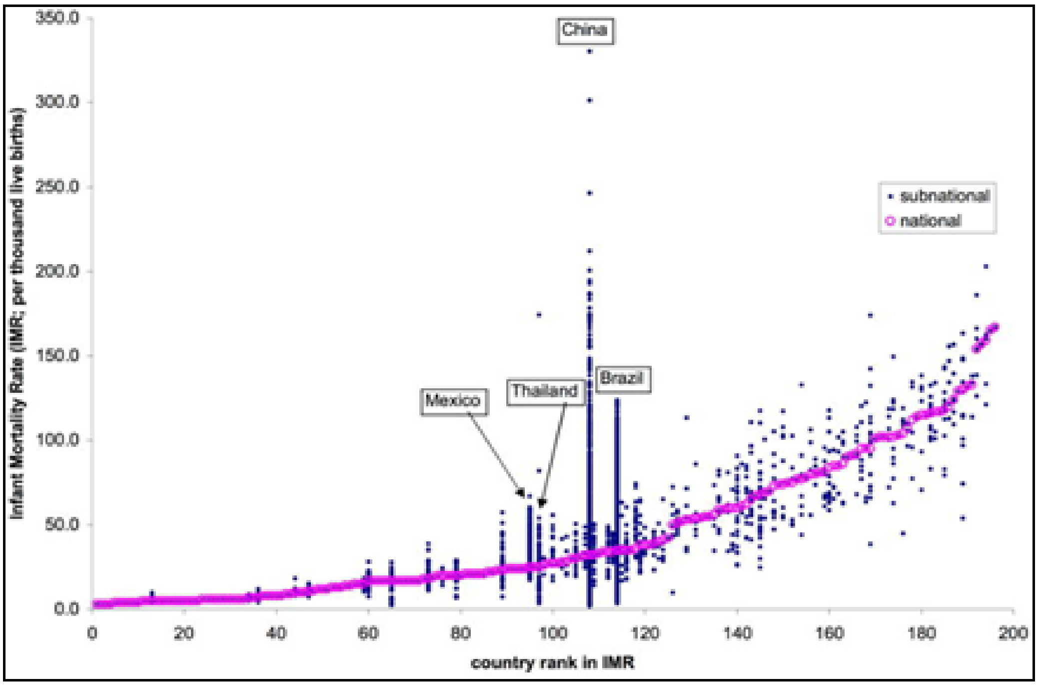
Fig. 9 – Infant mortality rate (IMR), selected countries, 1800–2015



Source of data: Mitchells (1998) 1800–1950, UN (2017) 1950–2015

IMR varies at regional, urban and rural levels. Figure 10, show infant mortality differentials at national and subnational levels for selected countries. China shows the most significant differences. However, variation increases with unit density. Storeygard et al. (2008) note that Mexico has a standard deviation that is a third of Thailand's, despite having over 30 times as many units, so clearly a large number of units is only part of the reason for Brazil and China's wide distributions. Similar variations have been observed in many countries.

Fig. 10 – Scatter plot subnational infant mortality by national rate ranking selected countries, 2004



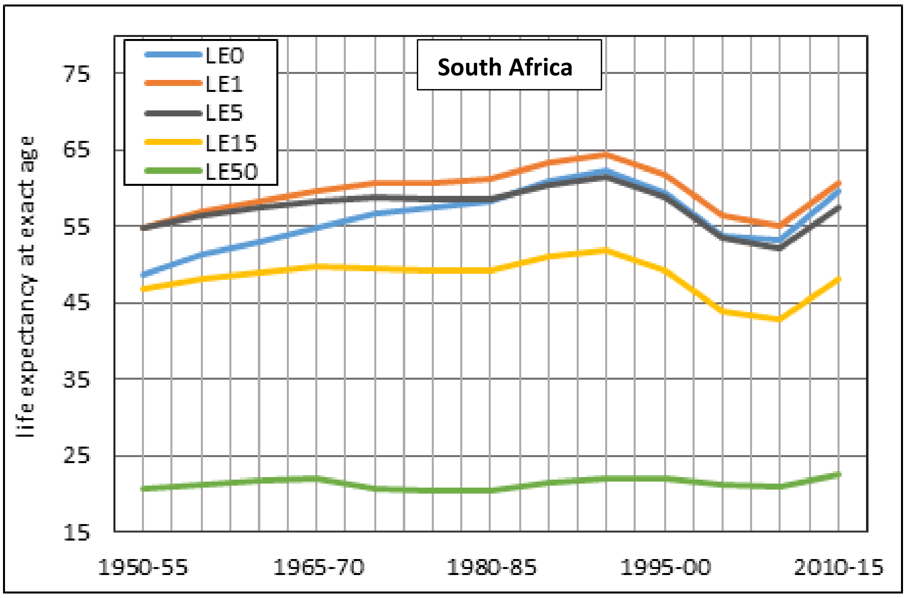
Source: Storeygard et al. (2008)

3.1.2 Life expectancy

Life expectancy gains are reported to have gained mostly in the developing countries in the mid 20th century (Kirk 1996, Dyson 2013b). Literature reveals that most developing countries started in the 1950s even though Brazil Japan and China might have started a little bit earlier. Nonetheless, the graph shows that the LE gains in developing countries were rapid, smooth and took a shorter period. There are also substantial differences between the developing countries in terms of starting levels, the pace of decline and the duration, e.g. Japan was very exceptional. It took a very shorter unprecedented time to reach levels reached by developed countries within a couple of years. The LE gains were also clustered according to regions with Latin America leading and Africa lagging.

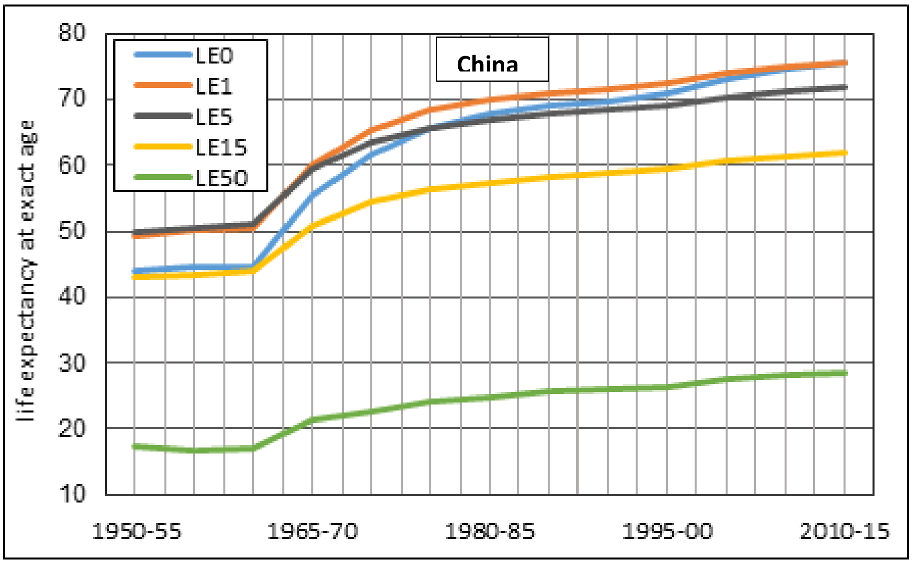
Life expectancy gains have also been noted to vary with age, the graph below shows LE with substantial gains being experienced in infancy and childhood. LE gains at older ages were minimal just like in Europe. Life expectancy gains vary with exact ages". Figure. 11a and 11b, reveal life expectancy at exact ages for South Africa and China from 1950—2015. Both Figures 11a and 11b, reveals three things, firstly life expectancy gains were most significant at birth (LE0), and at exact age 1 (LE1) respectively than all other exact ages from 1950–55 to 2010 15. However, all ages experienced LE gains excerpt for South Africa LE50. Secondly, the graph reveals that the two countries experienced different life expectancy at exact age pathways from the mid–1990s in which for China LE at exact ages continuously increased while for South Africa life expectancies decreased dramatically for all ages excerpt above 60 years which remained almost constant throughout the period. This is because of the HIV/AIDS epidemic, which kills expectancies in South Africa resumed a rapid upward trend at the end of the 2000s. Thirdly, India experienced the most significant gains on all ages than SA. Countries in Africa affected by AIDS epidemic experienced similar life expectancy pathways as South Africa.

Fig. 11a – Life expectancy at exact ages, South Africa and China, 1950–2015



Source of data: UN (2017)

Fig. 11b– Life expectancy at exact ages, China, 1950–2015



Source of data: UN (2017)

3.2 Causes of mortality decline

There were many causes for mortality decline in developing countries (Teitelbaum 1975, Dyson 2013, Kirk 1996). The role of developing country's governments and International organisations' commitment to mortality decline was also noted (Ibid). The demographic transition theory credits the improvement is the standard of life as a prerequisite for mortality decline. Nevertheless, just like the developed countries, many factors were raised including nutrition, urbanisation, public health, children immunisation, education, particularly female education, increased income, secularisation, family planning etc (Notestein 1945, Coale 1973, Kirk 1996, Dyson 2013). Equally, the demographic transition and epidemiological transition theories state that curbing of infectious disease was responsible for most of the mortality decline, especially in infancy and children (Coale 1973, Omran 1971, 2005). Thus mortality declined a faster tempo than in the developing countries than in the developed countries. Specific geographical conditions, epidemics, and political willingness by governments account for onset and mortality decline differences. For example, in malaria burden environments curbing of infections might be more important than in areas with constant famines.

3.2.1 Income and Economic growth

Economic growth and Income–related indicators are the most widely cited independent variables for mortality revolution although others have argued that it is because they have better mathematical precision (Soares 2005, Cutler et al. 2006, Schultz 1993). One of the tenets of the demography transition theory is to find a positive correlational relationship between economic growth measured by GDP per capita and increase in life expectancy (Dyson 2013, Coale 1973). One such attempt is the Preston curve named after its author Samuel Preston in 1975. The Preston curve is an empirical cross–sectional relationship between per capita income and life expectancies. Using decadal data from the 1900s, 1930s 1960s Preston found a positive relationship between high per capita income and high life expectancies and vice versa. However, further increases in per capita income at higher levels were affected by the law of diminishing returns.

Nonetheless, Preston credited improvement in health because of investment in exogenous factors such as better, education, technology, immunisations, nutrition, public health services etc. which he argued are dependent on income. Preston also found out that improvements in health technology accounted for 75–90% of the increase in LE while income growth was responsible for the remainder. However, the challenge to the Preston curve is that the most significant gains in health Life expectancy were achieved in developing countries with very low GDP per capita. Soares (2007) has argued that life expectancy might be achieved by the availability of cheap productive and health technologies rendering GDP per capita useless.

However, an interesting finding was that in the 20th century, developing countries LE increased independently of income, which meant there were other important factors involved (Soares 2007, Bloom and Canning 2007). Firstly, according to Cutler et al. (2006:99), *''Poor countries enjoyed rapid increases in life expectancy in the 1950s, 1960s and 1970s, with the gains in some cases exceeding an additional year of life expectancy per year''*. Soares (2007)

has argued that in Bolivia, Honduras and Nicaragua economic stagnation and even negative economic growth was associated with life expectancy gains at the birth of more than 20 years, and this phenomenon was not related to Latin America alone. Deaton (2015) made similar findings in Latin America. Secondly, Countries affected profoundly by HIV/AIDs in Southern Africa experienced a significant drop in life expectancy of more than 20 years in the 1990s and 2000s even though they experienced significant economic growth (Deaton 2015, Cutler et al. 2006, Soares 2007). Thirdly, interestingly Spencer and Lewis (2009) found that the source of the income growth rather than the growth itself was more important. The income per capita should be accompanied by socio–economic structural changes significant (Pavlik 1980, Dyson 2013, Coale 1973). Likewise, Edwards (2016) argued that the divergences in the Preston curve are partially explained by the size of the mining sector in an economy. He found out that economies that are based on extractive resources, e.g. mining
‘ *’tend to have lower life expectancies and education as compared to other sectors. Countries that double their mining share of economy corresponds to an average the infant death rate being 20% higher life expectancy being 5% lower, total years of education being 20% lower and 70% more people having no formal education’’.*

Therefore, any country can lie above or below the Preston curve independent of its income per capita. In developed countries, the USA has most per capita income compared to west European countries even though it has relatively lower LE than Western Europe. Equally, South Africa, Equatorial Guinea etc. lie below the Preston curve of developing countries even though they have income per capita that is more than double of India. Similar patterns between mining and adverse health and education outcomes were observed on a district level in Indonesia (Edwards 2016). Case and Deaton (2006) also demonstrated that Zimbabwe and South Africa have life expectancies that are lower than would be estimated based on capital level alone. Conversely, India has a life expectancy that is higher than its level of economic development. Recently Lutz and Kebede (2018) demonstrated that maternal education was a better predictor of life expectancy than income.

Nonetheless, the growth of the economy and per capita income enables people to look after themselves, and they are more productive. This has brought the mantra "that wealthier is healthier’’ (Pritchett and Summers 1996) and perpetuated economic–centred policies to improve health indirectly. Cutler et al. (2006) note that data reveals that no relationship exists between changes in life expectancy and economic growth over 10–20 or 40 year periods between 1960 and 2000. Many countries have shown notable improvements in health with little or no economic growth and vice versa. China and India are the two biggest countries that can be used to demonstrate this effect, where there has been a negative correlation between 10 years rates of economic growth and progress in reducing infant and child mortality. Most of China’s infant mortality happened before rapid economic growth in the 1980s, after which there was relatively little infant mortality decline. Likewise, in India, the rapid economic growth after the 1990s was accompanied by a decelerating infant mortality rate decline (Dreze and Sen 2002). Dreze and Sen further note that the slowdown in infant mortality decline in China was a result of changing policies and resources that caused mortality decline and economic growth.

3.2.2 Public health

Public health initiatives are related to GDP per capita Preston 1980. Public health initiatives and effectiveness were more prominent in the 19th century in Europe mortality decline (Cutler et al. 2006). Some rapidly growing economies have neglected their public health interventions in pursuit of economic growth, whereas others have used their command on economy and health to undertake successful public health measures. China then a poor economy established a coerced public health initiative in which all villages were forced to eradicate public health threats such as pests, mosquitos, lice etc.

Moreover, even the one–child policy facilitated the mortality decline (Deaton 2015). There is a positive correlation between high parity and high infant and maternal mortality rates (Coale and Watkins 1986, Dyson 2013). Likewise, Cuba, with very poor GDP per capita after has used its massive number of local doctors to effect mortality decline in the weak economy (McGuire and Frankel 2005, Soares 2007). In recent years HIV infected countries have used successfully cheap and basic sexual behavioural change programs as part of HIV prevention methods to reduce HIV infection and related deaths (Deaton 2015, Tabutin et al. 2004). In Mauritius between late 1940s and 1950s mortality fell significantly because of eradication of malaria and other health improvements (Lutz and Wils 1994).

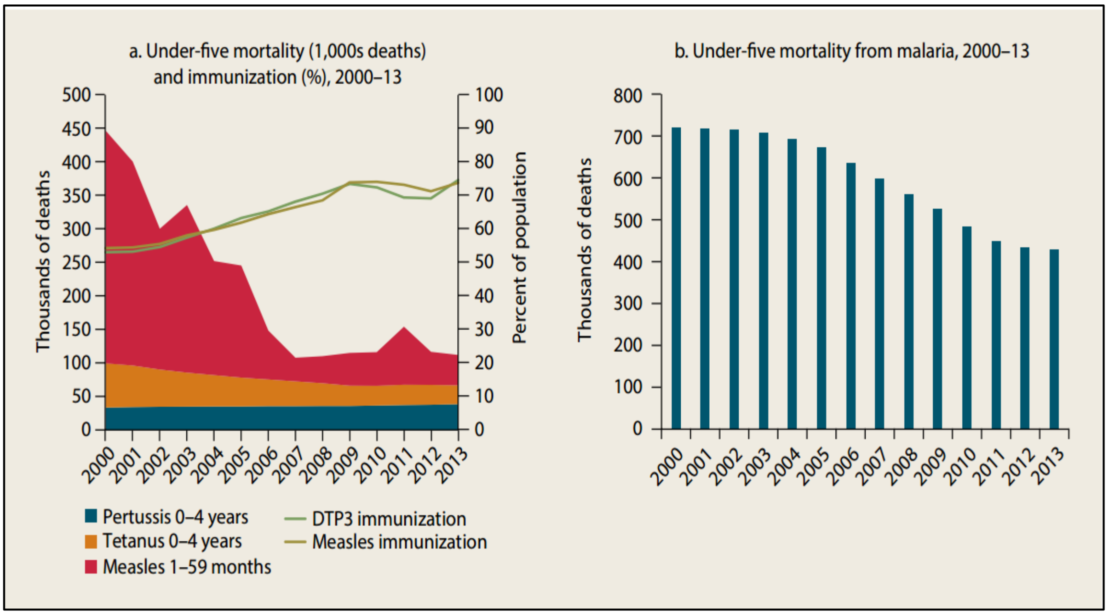
Diarrhoea is one of the leading killers in infants and children (Omran, 2005). The discovery of Oral Hydration Therapy (ORT) has achieved milestones in mortality decline. In 1968, during a cholera outbreak in Bangladesh and Indian refugee camps drinking a simple solution of sugar and salt in water prevented fatal dehydration from diarrhoea at little cost (Deaton 2015). The ORT innovation was praised as "*potentially the most important medical advance''* during 20th by Lancet medical Journal (Deaton 2015). Similarly, in 1987, the United Nations Children's Fund (UNICEF) noted that "*no other single medical breakthrough of the 20th century has had the potential to prevent so many deaths over such a short time and at so little cost*" than ORT. Ever since its discovery, it is estimated that ORT has saved more than 50 million lives. Empirical evidence shows that in the Bangladesh independence war, the ORT reduced cholera related deaths from over 30% to below 3.6%.

3.2.3 Immunisation

After the WWII, immunisation became an important aspect of mortality decline in developing countries (Deaton 2015, Cutler et al 2006). Cheap vaccines for killer diseases have been developed and exported under the United Nations Organisations and embraced by respective developing country governments. In 1974, World Health Organisation (WHO) initiated the Expanded Programme on Immunization (EPI) to eliminate child killer diseases such as against diphtheria, whooping cough, tetanus, measles, polio, and tuberculosis etc. (Deaton 2015). The EPI has since been supported technically through other coordinated programs such as Millennium Development Goals (2000–2015). MDGs have been superseded by Agenda 2030 for Sustainable Development Goals (SDGs). MDGs had specific, measurable targets on mortality decline in developing countries from 2000 to 2015. MDGs stated that immunisation coverage should above 90% of total children. Countries with high immunisation rates have low infant child mortality rates. Most developing countries have immunisation coverage below 90% while all developed countries are above 90%. Africa, as a region, has got the lowest vaccination rates and highest HIV infection rates. In Africa, immunisation and HIV are the most significant determinants of life expectancy.

Figure 12, (a) shows that as vaccination rates increased, infant mortality also declined forthe period 2000–13. However, the most significant declines were registered in measles. Figure 11 (b) shows that as malaria decreased, so did infant mortality for the period 2000–2013. Beegle et al. (2016: 92) notes *''For every ten additional children per 1,000 live births surviving to the age of five, life expectancy increased by 0.7 years, for every percentage point increase in HIV prevalence, life* expectancy *decreased by one year. These two factors alone explain more than three–quarters of the variation in life expectancy in the region (under–five mortality explains 50 percentage points, and HIV'' prevalence explains 28 percentage points). Country gross domestic product (GDP) levels and the number of deaths from conflict in previous years do not have essential effects on life expectancy beyond their effects on child mortality or HIV prevalence.''*

Fig. 12 – Africa (a) under–five mortality (1000s death) and immunization (%), 2000–13 (b) under 5 mortality from malaria, 2000–13



Source: Beegle et al. (2016: 92)

3.2.4 Nutrition

Poor nutrition is associated with half of the mortality worldwide, albeit with regional differences (Beegle et al. 2016, Black et al. 2013). However, Black et al. (2013) argue that synergistic interactions can also operate in the reverse direction, with growth retardation being associated with illness, diminished nutritional intake, and weight loss which increase the likelihood of death. Nonetheless, historically, the positive relationship of nutrition in reducing mortality especially infant and child mortality was first stated by Mckweon (1976) and further investigated by several authors in developed countries (Fogel (1994, 2004, Black et al. 2013). The findings, although controversial, claims most mortality gains in the 19th and 20th century were a result of nutrition improvements. Nonetheless, about 40 years ago, Preston (1975) demonstrated that in 1940–1970 life, expectancy gains were caused by income/GDP per capita mediated through nutrition. However, the challenge is that LE gains were achieved at every level (including the lowest level) of calorie consumption and income.

Similarly, Soares (2007) using data from 1960–2000, demonstrated that for constant levels of income and a slight improvement in nutrition (calorie consumption) between 1960–2000 life expectancy at birth increased. One plausible explanation is that this is caused by better agricultural yields and accompanied by a reduction in food prices. The nutritional and life expectancy at birth increased eight years for constant nutritional uptake between 1960 and 1990 for countries in the lowest calorie intake category. Furthermore, to complicate nutrition/argument, after 1990 HIV / AIDS in some countries in Africa reversed the gains in life expectancy gains to levels just above the pre–transitional levels (Soares 2007: 256, Tabutin et al. 2004). Other studies have also argued that improvements in nutrition might be inadequate to explain mortality decline (Caldwell 1986, Deaton 2015).

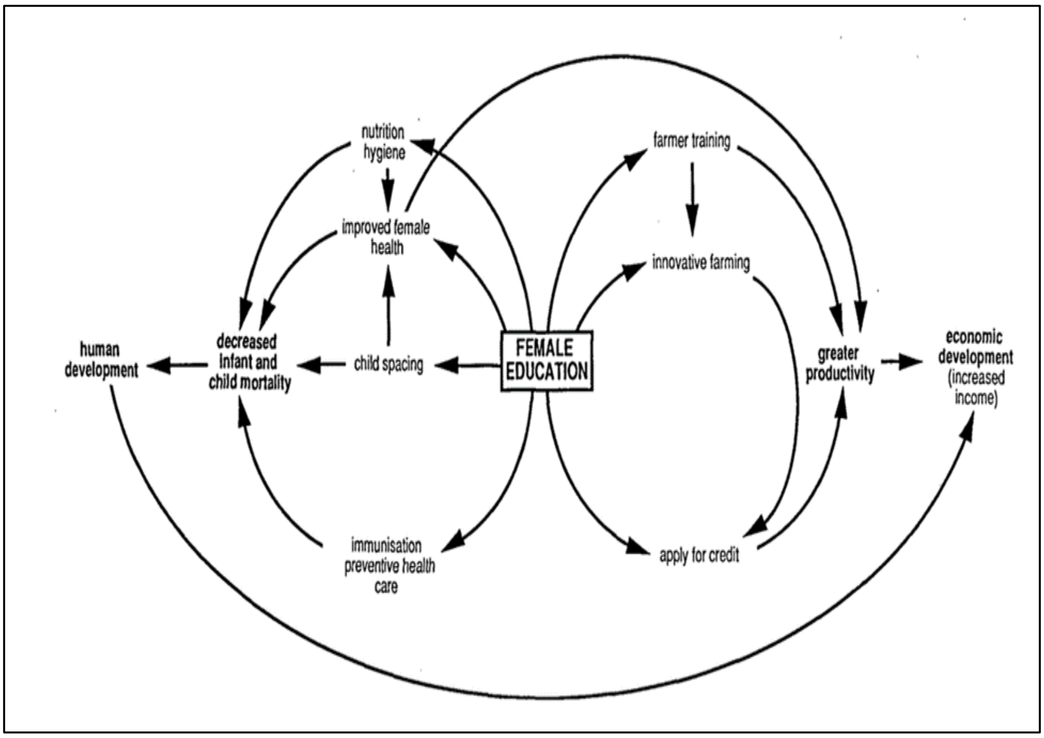
In a recent book: *Poverty in Africa Rising*, Beegle et al. (2016) have argued that malnutrition related death and disability/ disease burden is more prevalent among poor households, rural areas and declines with education. Bhutta et al. modelled various intervention methods using 34 countries that has 90% of the world's children with stunted growth. The study revealed that under mortality rate can be reduced by 15% if vulnerable countries populations can access ten evidence based nutrition interventions at 90% coverage. Further Bhutta notes that progress can be accelerated if monetary investments can be made that improved access to nutrition–sensitive approaches, i.e. women's empowerment, agriculture, food systems, social protection and safety nets etc. Recently Yourkavitch (2018) using disaggregated data from Rwanda's Demographic Health Surveys (DHS) in 2005, 2010 and 2014–15 demonstrated that breastfeeding was high in Rwanda, but it differed with regions but generally decreased as mother's education and wealth increased during the survey years. The study recommended that strategies were needed to increase optimal breastfeeding in urban areas, wealthier households and more educated women.

3.3.5 Education

Several studies have found education in particular female education to be the best predictor of mortality decline, especially infant mortality. (Lutz and Kebede 2018, Browne and Barret 1991, Caldwell 1986).

Figure 13 summarises how education causes infant and child mortality reduction by mediating through, immunisation, preventive health care, child spacing, nutrition and female health. Other secondary benefits, such as human development and economic development, are also indicated. Mosley (1983) has demonstrated that in Kenya, rural–urban differentials and parental education explain infant mortality decline. Caldwell and Caldwell (1985) were able to present evidence for Africa, Asia and Latin America on the superiority of maternal education over paternal education on the survival of children and infants. Nonetheless, both parental educations were significant, and the influence increased with the child's age. Similar, Schultz (1993) in simple bivariate analysis an additional year of mothers schooling has been found to lead to a 5–10 per cent decrease in children's mortality.

Fig. 13 – The effect of female education on infant and child mortality, human development and economic development



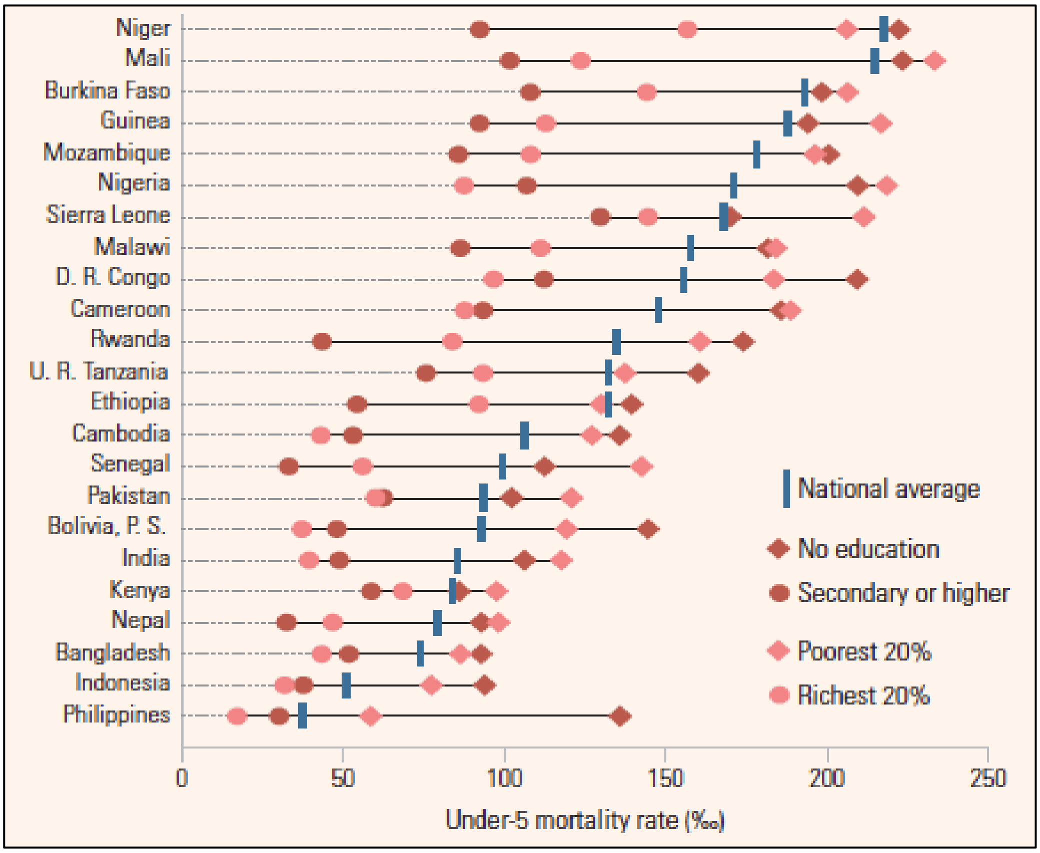
Source: Browne and Barret (1991)

In a recent paper by Lutz and Kebede (2018) using data from 174 developing countries from 1970–2015 to test whether income or education is more important for improving health and life expectancy. Using multivariate analysis to validate their results, Lutz and Kebede indicated education is a better predictor of survival than income. Figure 14 shows that under–five mortality varied with education and wealth. Under–five mortality was higher for the population with no education and poorest. Asian countries had lower infant mortality differences than African countries. The differences tend to be higher in countries with higher under–five mortality, e.g Niger. Moreover, the national average tends to be closer to populations with no education and poor, which means most people are poor and vice versa for countries with lower under–five mortality. However, interestingly Figure 14 shows there are fewer differences between countries for educated women

The UNESCO (2011) report concludes that: "*The effect of education on child mortality is huge. Especially in places with relatively little education, the prospects for extending education are promising. In 2008, 4.4 million children younger than five years died in sub–Saharan Africa. The UNESCO estimates that an extension of secondary education for all women would save 1.8 million children per years''*.

Cutler et al. (2006), argued that the importance of education, particularly women's education, has been confirmed in many subsequent studies. The importance of women's education is likely a result of the fact that, as primary caretakers, women are most likely to implement the behaviours that can improve their children's health. To the extent that education enhances the ability of an individual to make these changes, more educated mothers will have healthier babies. Moreover, mother's education has been found to have significant effect regardless of the mother's socioeconomic class and place of residence (Soares 2007, Caldwell 1986).

Fig. 14 – Under 5 mortality rate, by mother's education and wealth, selected countries 2003 2009



Source: UNESCO (2011)

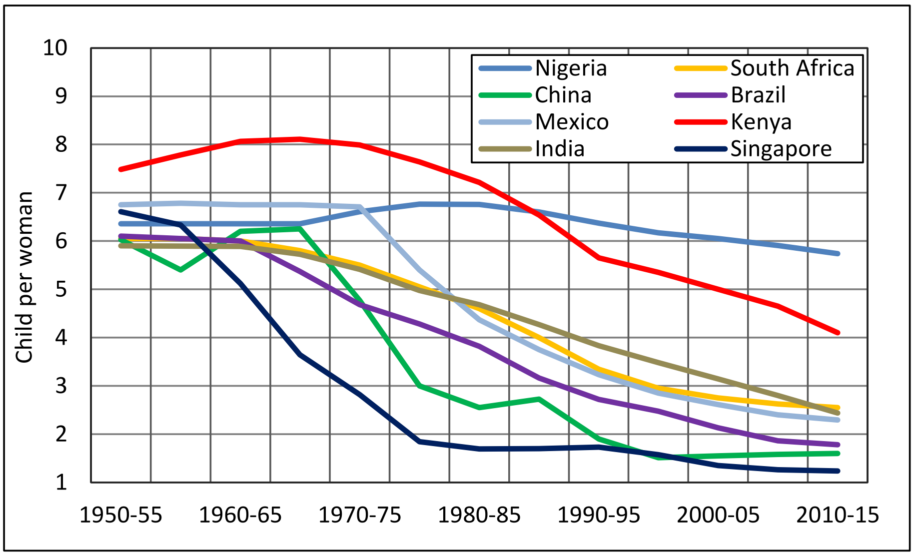
However, as in the case of income, there is also evidence of a reverse relationship between health and education, undoubtedly among children, and poor health in infancy may later predict poor health. Case, Fertig and Paxson (2005) find that children who experienced poor health in childhood entered adulthood with significantly lower educational achievement. Miguel and Kremer (2004) and Bleakley (2002) find that provision of deworming drugs significantly improved schooling in Kenya. The challenge is in quantifying the observed relationship between adult education and health that can be explained by the fact that under health children receive fewer years of education. Black et al (2015) has mentioned that the diseases are caused by other factors for mortality risks in the developing countries, e.g. unsafe sex (HIV/AIDS) unsafe drinking water one causes diarrhoea) and a variety of other factors such malnutrition and indoor smoking from burning solid fuels (respiratory conditions). The challenge is that sometimes, interventions can focus on the immediate problem but not the underlying problem. Poor health from service providers, including absents from work coupled with lack of political will from government and patients to demand best services. Recent surveys in India have shown that, while public doctors are more likely to be qualified, they will also be more likely to be absent and to have insufficient time or medicines to provide effective treatment. Private providers are often ill–qualified and face competitive pressure to over treat: for example, by giving everyone an injection of antibiotics without any prior testing (Das and Hammer 2004)

Outside health intervention (complementing government efforts) this could also be included on fertility and public health, immunization, successful eradication of smallpox polio, or child killer diseases run by WHO, UNICEF etc., although the argument is that the AID should focus more on where the source of the problem is emanating from. This is complicated by the decrease in funding of some programs in the health funding of the developing countries in recent years (Bloom, Canning and Weston 2005). The structural economic adjustment programs affected have been noted to have decreased infant mortality decline and education in the late 1980s and 1990s.

3.3 Fertility levels, trends and patterns

Several authors have established that, in most developing countries, the TFR has increased before sustained decline (Mhloyi 1988, Dyson 2013). However, in Asia and Latin America countries, fertility has decreased continuously to replacement level (UN 2017). In this respect, Africa has been unique not only in terms of having the highest level of pre–transitional fertility but also being late in the onset and pace of fertility decline. Indeed, several authors have noted that in Western and Central Africa, fertility has not started or is in the early stages of fertility decline. Moreover, in a significant number of African countries studies have revealed fertility stalling at midway fertility decline or in the early stages of fertility (Maharaj and Pillay 2013, UN 2017).

Fig. 15 – Total fertility rate (TFR), selected countries, 1950–2015

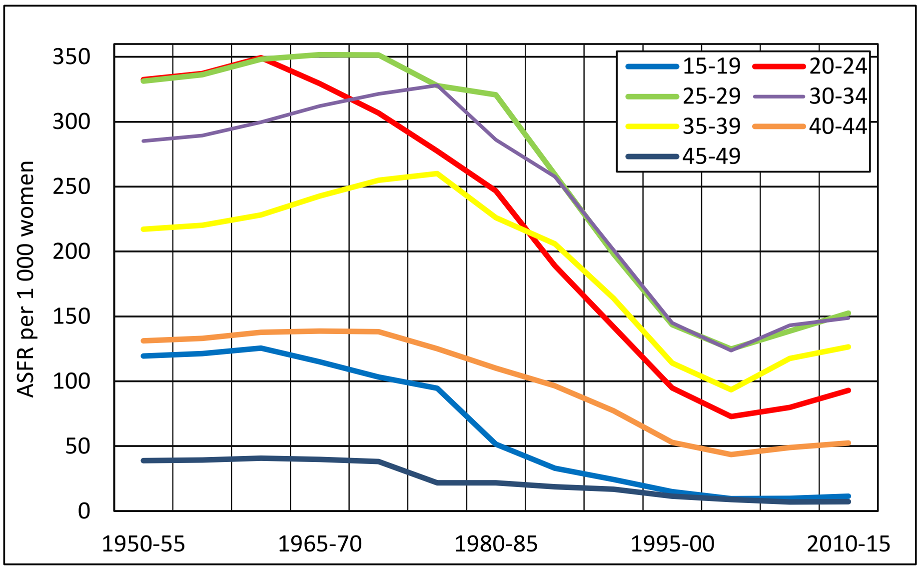


Source of data**:** UN (2017)

Figure 15, reveals that for selected countries, fertility started to decline between the 1960s and 1970s excerpt for Kenya and Nigeria. Most of the countries are at below replacement level, namely Singapore, Brazil, China or near replacement levels Mexico South Africa and India depending with their mortality levels. Research shows that countries in eastern and southern Asia have some of the lowest low fertility in the world (Asian tigers – South Korea, Singapore, China, North Korea, Japan, Taiwan). It is only in Africa that fertility has remained high. However, even in Africa, Northern and Southern regions are advanced in the fertility transition with fertility either near replacement level given high levels of mortality in these regions. This also represents the regional clustering of fertility decline in developing countries. Authors have identified different pathways to fertility decline in Sub Saharan Africa (Pillay and Maharaj 2013)

The level of fertility decline from above six to two children per woman which took about 130 years in Britain (1815 to 1930) took just 20 years (from 1965 to 1985) in South Korea, Brazil China Asian tigers (Massey garth 2016, Norris 2013). In Iran, fertility happened from 7.0 in 1984 to 1.9 in 2006. However, fertility varies with age and unfortunately, TFR does not show fertility decline by age groups. A comparison of age–specific trends can demonstrate which age groups experienced the most considerable fertility decline.

Fig. 16 – Age specific fertility rates (ASFR), 1950–2015, Algeria



Source of data: UN (2017)

Figure 16, shows that Algeria's age–specific fertility rates declined from high levels in 1950 1955 to low and moderate levels by 2010–2015. However, the most significant fertility declines were experienced in the age groups 25–29, 30–34 and 35–39 years, respectively. The smallest fertility declines were experienced in the age group 45–49 years. It is interesting to note that age specific rates declined earlier in the youngest age groups 15–19 and 20–24 years than older age groups. Age groups 25–29 to 35–39 experienced initial age–specific fertility rise up the to late 1970s before experiencing fertility decline. In comparison with historical fertility transitions in developed countries (1), European fertility transitions showed that fertility started by declining in older ages by women practising stopping behaviour, e.g. in France (Chesnais 1992, Diebolt and Perrin 2017). In developing countries fertility decline across all ages, i.e younger women might have practised birth postponement at younger ages and birth stooping at older ages. The fertility pathways experienced Algeria were observed in most developing countries was also noted by several authors (Reher 2004, Dyson 2013).

3.4 Pre–transitional fertility behaviour

In pre–transitional societies, fertility was limited through Malthusian factors; nuptiality factors (1) age at first marriage, (2) percentages married and (3) low illegitimate birth. In Africa and Asia, excess women were married by polygamy (Dyson 2013). Moreover, physiological factors were also responsible for limiting fertility from its biological maximum (Henry 1961, Coale 1973, Dyson 2013). Nonetheless, proximate determinants in developing countries were more conducive to higher fertility than witnessed in pre–transitional European societies.

The onset of modernisation in developing countries through colonisation and globalisation in the developing countries led to slight changes in the reproductive behaviours, e.g. improvements in nutrition, sanitation health and living conditions. Healthy women tend to experience earlier age at menarche, delayed onset of menopause and increased fecundity (Chesnais 1992). In some developing countries (infertility belt in Africa), fertility might also have been affected by the increase in sterility caused by sexually transmitted diseases (Harper 2016).

Just like in developed countries, in developing countries, various cultural factors also controlled fertility. Duration of breastfeeding periods of sexual abstinence after giving birth, age composition of population and nuptiality patterns. Chesnais (1992) has argued that with improved standard of living, the most crucial factor is the age of first marriage, because fecundability increases at younger ages and decreases at older ages, maybe as a result of decreased sexual activity and fecunditity.

Anthropologist Marjorie Shostak (1993) studied pre–transitional society in 1969–1971. The !kung populations of the Kalahari deserts in Southern Africa have been said to present a demographers delight. She discovered that women had an average of 4.5 TFR per woman. The TFR was achieved through intense and prolonged breastfeeding for up to five years. Moreover, the infant mortality rate was low, which means child replacement and hoarding fertility behaviour was absent from the populations.

Fertility in developing countries had tended to rise briefly before sustained decline, commonly referred to as pre–decline fertility rise**.** This is plausibly caused by an increase in marriage rates or a decrease in age at first marriage or age at childbearing. They can also be caused by a decrease in breastfeeding practices or decrease in cultural factors that limited sexual intercourse, e.g. during the breastfeeding period. Moreover, the pre–decline fertility rise might have been caused by a decline in child mortality as more girls survive to be potential mothers. Chesnais (1992) also reported that in England between 1815 decline in the age of marriage was accompanied by a fertility level rise. Dyson (2013) reported that in India between the 1950s and 1960s fertility levels might have risen from 4.5 to 6.1 because of decrease in widowhood and changes in breastfeeding patterns.

Similarly, this was also experienced in Latin America in the 1930s and 1960s after which fertility experienced a sustained decline. Interestingly, in the mid–20th century in southern Africa, it is reported that fertility might have increased because of the treatment of sexually transmitted diseases that cause sterility (Chesnais 1992, Dyson 2013). Moreover, initial reductions in marital age and changes in breastfeeding patterns might have led to fertility increase in southern Africa. However, the subsequent reduction in fertility as reflected by age–specific marital rates cited above for Algeria (Figure. 16) might have been caused by subsequent later marriages. Similarly, Dyson (2013) has reported that in 1815, temporary fertility increase in England was caused by an increase in marital age. It was only in 1970s England that fertility declined as a result of birth control. Nonetheless, the fertility transition in the developing countries is characterised by women of younger ages postponing birth and older women stopping childbearing. Whereas in Europe the decline was a result of older women of reproductive ages limiting their fertility.

3.5 Theoretical perspectives on fertility decline

The fertility decline in developing countries can be explained from three perspectives. The typical demographic revolution theory emphasises that fertility declines as a reaction to modernisation and mortality decline (Dyson 2013, Harper 2016, Notestein, 1953). The second perspective draws from economic theories which emphasise urbanisation changes in consumer tastes and rising costs in childbearing and rearing. Children begin to compete with other consumptive goods etc. (Becker 1960, Caldwell 1976, Easterlin 1975). Caldwell's wealth flow theory, which is also economical in nature argues that fertility decline is driven by a change in the direction of wealth flow from children to parents as societies modernise. He identifies female mass education as a driver in this case. Caldwell also talks about the diffusion of western values of ideal smaller family size from developed countries to developing countries as also instrumental in fertility decline.

The third perspective emphasises the effects of communication (ideation, innovation and diffusion) on fertility decline. Each of these perspectives has influenced the approach to fertility decline in developing countries. The demographic revolution theory has focused on modernisation, which leads to improvement in the standard of living and mortality decline, which eventually leads to fertility decline. The economic centred approach focus on urbanisation, women employment, etc., has led to "*development is a best contraceptive*" approach which focuses on economic development. The last approach has focused on providing family planning to women across the board, irrespective of the level of development. However, there is a thin line between these theoretical perspectives, e.g. education can be used as a communication diffusion factor as well as an economic or modernisation factor. Same applies with secularisation media factors etc. The factors or models work in mutual reinforcement to each other. Bongaarts (2002) has shown that the more developed a country, the more extensive is its channels for social interaction and diffusion of innovative ideas, information and attitudes. Also, just like in the developed countries Alter and Clark (2010) argued that fertility decline is affected by socioeconomic changes, and the diffusion process acts as a lubricant process. The highly developed a country is in terms of modernisation (railways roads television, urban education, etc.), the faster has been the process of fertility decline.

Realising the importance of diffusion on fertility decline in Europe the developing countries and the international organisation changed their focus and programs. Initially, the focus was on economic development, which was thought will lead to demand for contraceptives and ultimately, fertility decline. Therefore, the motto "development is the best contraceptive". However, faced with overwhelming evidence from the European Fertility Project, which showed the importance of communication (ideational, cultural and linguistic boundaries) demographers were forced to change their attitude to towards demographic transition theory. Moreover, evidence was also coming from the World Fertility Surveys of the 1960s and 1970s in developing countries which demonstrated that fertility was falling in poor and rural areas and that women desired smaller families (Bongaarts 2014). The importance of family planning was born. Family planning could work at two levels (1) providing for unmet need for contraceptives to women who wanted to limit their fertility but did not have the means to do so. (2) Creating demand for contraceptives (innovation) and raise contraceptives prevalence rates.

Nonetheless, specific factors have been named as the causes of fertility decline in developing countries including, mortality decline, women empowerment, the secularisation of religion and traditional practices, westernization, mass media, family planning, diffusion, ideation and linguistic boundaries etc., (Notestein 1953, Dyson 2013, Bhrolcháin and Dyson 2007). These factors and the role of the government and international organisations explains why the fertility decline in developing countries was more rapid in developing than in developed countries.

3.6 Theoretical empirical evidence on fertility

3.6.1 Role of mortality decline

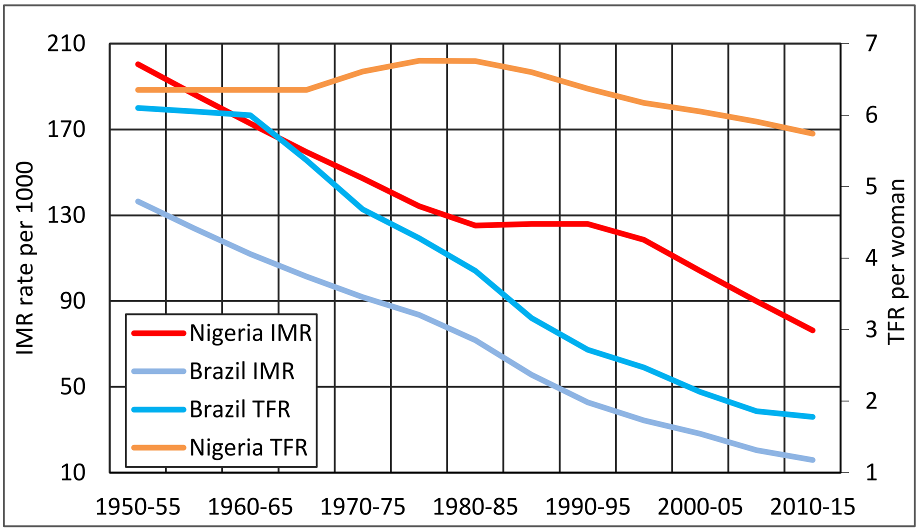
“*Development is the best contraceptive*” Indian health Minister in 1974, Bucharest World Population Conference Bucharest in Romania.

Studies have highlighted the importance of mortality especially child mortality on fertility decline in both developed and developing countries (McCord 2017 et al., Reher 2004, Kirk 1996, Notestein 1945, Dyson 2013, Cleland 2001). Reher (2004: 25) notes that mortality reductions are prerequisite for fertility decline in historical transitions as well as in developing world; *“Nowhere in the world independent of the period the levels of wealth or the degree of modernisation has fertility change taken place without significant prior mortality change.”*

However, there is conflicting evidence on the effect of mortality reduction on fertility decline. This is reflected by two conflicting articles published in the same journal in 1996; (Kirk 1996, Dirk Van de Kaa 1996). Precisely, Kirk (1996: 379) stated mortality reduction as the principal cause of the fertility decline. In contrast, Dirk van de Kaa (1996: 409) stated that reduction in mortality does not automatically lead to fertility decline even though modelling shows the plausibility of such effects. Dirk van de Kaa findings were confirmed in a latter by Palloni and Rafalimanana (1999) using long–range data from the 1920s and (Demographic Health Surveys (DHS) data from Latin America. They found a very weak correlation between child mortality and fertility decline (Palloni and Rafalimanana 1999).

The demographic transition postulates that average household size was never very high in pre–transitional societies because many children were born, and many died (Wilson and Airey 1999, Reher 2004, Dyson 2013, Pavlik 1980). In maintaining household size, the critical factor is the surviving number of children not the number of children ever born. In high mortality societies, child hoarding (in expectation of child death) and child replacement (experienced child death) were fertility copying mechanisms to sustain desired family sizes. The question is in determining the threshold at which child mortality reductions influences fertility decline? Nonetheless, the decline in child mortality necessitates that parents should also decrease household size. Thus Reher (2004) argued that ‘ *’within this context fertility control could be seen as an attempt to maintain family size, not to decrease it’’*. Other post–natal methods such as sending children away to ever–expanding urban areas and abortion only worked in the limited run (Mason 1997). Empirical evidence of parity control at older ages by women of reproductive ages after achieving a specific household size substantiate the importance of child mortality decline on fertility reduction

Fig. 17 – Relationship between infant mortality (IMR) and total fertility rate (TFR), Brazil and Nigeria, 1950–2015



Source of data: UN (2017)

Figure 17, shows the relationship between infant mortality and fertility. Firstly, when IMR is high TFR is also high and vice versa. However, infant mortality reduction always declines before TFR. In this case, the preceding decline of IMR to TFR shows the effect of IMR on fertility. Precisely, Nigeria's sustained high fertility levels (almost 6) from 1950–2015 should have driven IMR upward. Reher (2004) has pointed out that declines in fertility in developing countries always responded to mortality decline between 30–40 years, which explains partly why TFR responded late in Nigeria. In Brazil, the IMR reduction happened earlier than in Nigeria. Challenge is correlation does not mean causality.

In a recent paper, Soest and Saha (2018) focused on the two–way relationship between infant mortality, birth spacing and fertility in rural Bangladesh. They found bi–directional results (1) infant mortality causes child replacement behaviour and shortens birth intervals, and (2) a short birth interval causes a high probability of infant mortality. Their results reveal children replacement effect on total fertility of about half (0,54) a child for each infant death. Eliminating the replacement effect would lengthen birth intervals and reduce the total number of births by 2.45 per 1000 live births. These treatment effects were much smaller in the areas with extensive health services (lower IMR and TFR, longer birth intervals) (Soest and Saha 2018). In a related study McCord et al. (2017) find that ecological temporal variation in malaria is positively correlated with a reduction in child mortality and reduction in total fertility rate (McCord et al. 2017).

3.6.2 Urbanisation

Numerous studies have cited that in most developing countries, fertility is lower in urban areas than in rural areas (Becker 1960). Other studies have argued that this related in socioeconomic structural changes and fall in infant mortality that reduces demand for children (Notestein 1953, Kirk 1996). Diffusion theorist would argue that ''ideation'' (creates new demand for contraception) and availability of contraception (reduces unmet need for contraception) is higher in urban areas than in rural areas (Cleland and Wilson 1987, Bongaarts 2014).

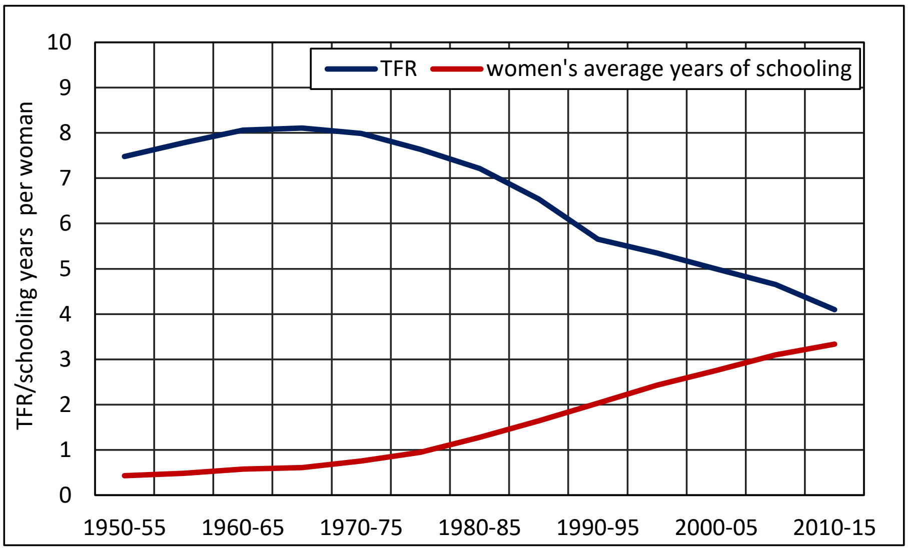
Modernisation makes profound economic structural changes in which demand for children is compelled to decrease. The theoretical work of Becker (1960) and Caldwell (1976) helps to explain the fertility revolution as societies modernise. Becker sees demand for children as related to the cost of children just like other goods. The prize is in this framework would include none monetary costs in childcare, schooling, indirect costs such as opportunity costs during pregnancy or upbringing child. If the price of bringing up children is high in terms of such cost, fertility will decline. Relatedly, Caldwell argues that fertility declines because intergenerational wealth flow is reversed from parents to children. Indeed, opportunity costs are more significant for women since they do the childbearing and most of the child rearing. Educated women have higher opportunity costs than uneducated women from high fertility.

Flückiger et al (2017) find a close relationship between urbanisation, investment in human capital and fertility decline is Sub Saharan Africa. They argue that fertility is lower in urban areas than in rural areas because human capital investments are higher in urban than in rural areas. These patterns are consistent with the fertility education nexus observed in Europe (Guinnane 2011). Education is higher in urban areas because if the demand for skilled workers. In most developing countries, fertility is always higher in urban areas than in rural areas. Relatedly in other modernisation factors should lead to a decrease in demand for children (Notestein 1953). In Europe, gender revolution was core to fertility revolution (Frejka 2016, Pavlik 1980), through empowerment factors such as female education, and increased female labour participation etc. Relatedly in developing countries, women empowerment tools are positively negatively correlated with fertility decline (Dyson 2013).

3.6.3 Education

Investments in education especially female leads to fertility decline (Lutz et al 2011). Figure 18, shows an inverse relationship between women's education and Total fertility rate. The graph shows that as women's average years of schooling increased from 1950–2015, the TFR also decreased. Assuming that an increase in the years of schooling will lead to further fertility reduction, then there is need to be hopeful as the future generation of girls will be more educated. The intergenerational education gap is narrowing as more, and younger girls are getting educated (Lutz et al 2011). The challenge is to disentangle the effect of education from other modernisation factors. Nevertheless, studies indicate the effect of education mediates through a number of factors,, 1) infant mortality reduction and better use of health services, 2) better usage of contraceptives, 3) opportunity cost as educated women are more employable or get involved in more outside home activities, 4) education makes girls stay longer in school there delay the age at first child or age at first marriage, 5) educated mothers also prioritise the education of their daughters

Fig. 1 Relationship between women's average years of schooling and total fertility rate (TFR), Kenya 1950–2015



Sources of data: WPP (2017) Total fertility rate, Barro and Lee (2016) Women's average years of schooling,

Others have suggested that compulsory education leads to fertility declines as children become expensive, and they stop their household contribution. Chicoine (2012) using Kenya DHS data looks at the change in education policy affects fertility decline. Results indicated that Kenya' s 1985 increase in primary schooling by one year led to fertility decline through delay in marriage and reduced fertility from the age of 20 and progressively after age 25. This suggests that postponement of marriage and increased early use of contraceptives led to fertility decline. Reduction in marital education gap is an essential tool for further fertility decline in developing countries.

Recently, Shapiro and Tenikue (2017) using DHS data from 30 sub–Saharan African countries show that fertility declines in both rural and urban settings, and from educated to uneducated women. However, the results show that fertility decline more for women in the two highest educated groups (Shapiro and Tenikue 2017). Interestingly they also found mixed results which indicated that in some cases, increased schooling was the major contributory factor to fertility decline and in other, reduced mortality was significantly more critical. Moreover, in other settings, both factors were important. (Shapiro and Tenikue 2017).

A majority of countries in developing countries experienced fertility stalling (stagnation) in the 1990s–2000s (Howse 2015, Bongaarts 2006, Garenne 2013). Interesting Goujon et al. (2015) have attributed that the fertility stalling is related to a decline in education investment in the 1980s which affected the 1980s birth cohorts who were in primary education during the time. The affected 1980s birth cohorts subsequently went on to have fertility stalling later on in life. They linked the education experiences of successive birth cohorts of young women from sub–Saharan Africa (SSA) and recent fertility stalls by age gender and level of education. In SSA they observe that countries that went to have fertility stalls had had education stalls in the earlier years 1980s, 1990s particularly generation or cohorts of young women. Surprisingly countries that did not experience fertility stalls also did not experience economic Structural Adjustment Programs (SAPs) induced education stalls. In essence, their results show the importance of education as a mediating factor between economy (government education spending) and fertility decline.

Dreze and Murthi (2001) find that female education and child's survival were the most significant predictors of fertility decline differentials within India and in the long run. Furthermore, they find out that son preference was also related to fertility decline. Other general indicators of modernisation such as urbanisation, poverty reduction, male literacy were not related to fertility decline.

The demographic transition postulates that the decline in infant and child mortality motivates children to educate their children as their education investment is safe. Educated children are attractive for employment in urban societies. Having fewer children enables them to invest more for each child (Becker 1960). Anderson and Kohler (2013) found fertility in East Asia to below replacement level is driven by education investment s of children. Anderson and Kohler (2013) using South Korea as a case study for East Asia demonstrated that Asian fertility decline is driven by quantity for a quality trade–off in which parents desire to invest in their children s education results in the limitation of their fertility. As they cannot afford to invest in more children. "*Education fever*"–exemplifies quantity for a quality trade–off as pointed out by Becker (1960).

3.6.4 Children as a source of old age support

Structural changes in the economy make also makes profound functional changes to the roles played by children as sources of social support in old age. Development of government social support pensions system and other old age support systems is related to the decline in fertility. Moreover, parents realise children are better at taking care of them in older ages if the children are educated. Thus, because education is expensive directly and indirectly to parents, couples are then motivated to have few educated children. Couples make a quantity–quality tradeoff (Guinnane 2011, Becker 1960). The wealth flow theory argues that it is the investment in children (wealth flows from parents to children) that causes parents to limit their fertility (Caldwell 1976).

3.6.5 Female labour participation

Both in developing and historical transitions, studies have shown that female labour participation as a women empowerment tool leads to fertility decline (Guinnane 2011, Dyson 2013). Women's participation in the labour force increase opportunity costs for childbearing and rearing (Becker 1960). Furthermore, female labour participation makes women independent socioeconomically and broaden their life choices beyond childbearing (ibid). However, the relationship can be mutual in both ways, as less number of children gives women more opportunity to work. Moreover, female labour participation is intricately linked to other socioeconomic variables such as industrialization, urbanisation, education etc. Modernisation is related to services employment than demanding physical employment typical of traditional societies. Furthermore, government policies on gender equity have given women access to professions they were initially inhibited (Dyson 2013).

In a study is based on two treatment groups in rural India, Jenson, (2012) finds that labour market opportunities for females in rural areas cause fertility reduction. Moreover, employed women were less likely to marry during the period of employment. Instead, they were likely to further their education, desire fewer children and work persistently throughout their lifetime (Jensen 2012). Van den Broeck and Maertens (2015) found out that in rural Senegal, female employment significantly reduces fertility by 25% through postponement of age at first marriage and age first childbirth irrespective of wealth and literacy level. They argue that the *"results show that changes in the fertility preferences not necessarily result from cultural evolution but can be also be driven by sudden and individuals changes in economic opportunities*" (Van den Broeck and Maertens 2015: 21).

In a related study, Kim, (2014) uses South Korea Income and labour panel study 1998–2008 to assess effects of a female labour participation rate (FLPR) on fertility. Results FPLR does not affect the transition to first birth significantly, however, affects second and successive birth. In a later study using similar data, Ma (2016) uses event history analysis on longitudinal data from 1980–2006 South Korea Income and labour panel study. The results revealed that a mother's employment after birth of a first child reduced the propensity of having a second birth. In contrast, none employment after first birth was associated with propensity for a second child. Women with higher economic status (highly educated husbands) had increased chances of having a second birth. The U–relationship of income and fertility. This partly explains why in South Korea women had less than the lowest TFR of less than one child in the 2000s. ''Family planning is regarded as the primary source of initial fertility decline since the 1960s. Women are expected to take care of the home and give birth, while men are expected to provide for the family. The economic crisis of the 1990s provided an opportunity to women to contribute facility to mitigate economic challenges'' (Ma 2016)

Beguy (2009) finds conflicting results in Africa on the effects of female employment on fertility. The paper looks at female employment effects on fertility in two urban cities in Africa, Dakar in Senegal and Lomé in Togo. The author found out that in Lomé women employment was negatively correlated with fertility while in Dakar Senegal women labour force is not the main reason for fertility decline. Family formation and maternal compatibility with employment to differentials (Beguy 2009).

To a substantial extent, female employment, and female education is the catalyst to fertility decline. They are a necessary part of the gender revolution and women empowerment that also swept through historical fertility transition in Europe (Becker et al. 2013, Perrin and Diebolt 2017)

3.6.6 Culture and norms

Changes in traditional norms and culture to modern values is related to fertility reduction. Caldwell (1976) has differentiated between modernisation and westernisation. Caldwell (2007) defines modernisation as socioeconomic structural changes that happen when a society industrialises urbanise accumulate wealth gets more educated, civic representation and has complex commerce and services.

In contrast, westernisation is when values and norms from developed countries such as small family, later marriages, etc., are adopted by developing countries even in the absence of structural economic changes. Westernisation in African developing countries can be related to colonisation and lately globalisation (Caldwell 1976). Much of the fertility decline in the developing countries has been due to mass media intervention strategies that work through the diffusion process. Fertility has fallen in affluent poor and religious communities. Diffusion process explains some of this decline in very different communities (Bongaarts 2014).

Governments actively pursue social media as part of an agenda to change reproductive health and fertility norms through the usage of radios dramas TV, newspapers, magazines. Access to media has been noted to be positively correlated with fertility decline. The use of role models promotion of nuclei family units etc. (Bongaarts 2014, Cleland and Wilson 1987). Jensen and Oster (2009) show that the introduction of cable television in rural Indian villages also led to gains in women's schooling and reductions in fertility, potentially by providing new information on roles women might play outside of the home more generally and in the labour market in particular. Other studies have noted the impact of western television programs fertility reduction in developing countries.

Modernisation is associated with an increase in secularisation in values and a consequent reduction in the number of children. This is related to changes in norms and values discussed above. Diffusion has also been demonstrated to have a similar effect. However, diffusion is useful in a modernising society as there are more communication channels such as media, roads, etc., and the relationship also works in reverse direction. (Knobloch–Westerwick et al. 2016, Cleland and Wilson 1987, Ardiansyah 2016, Cleland et al. 2012, Bongaarts 2014)

3.6.7 Family planning

The introduction of family planning by governments in the represents the importance of innovation and diffusion in fertility decline in developing countries. The existence of the significant unmet need for contraception, large numbers of illegal abortion and unwanted pregnancies have given governments and international organisations enough evidence to implement family planning in developing countries (Cleland and Bongaarts 2004, Singh and Darroch 2012). WHO (2015) defines that women with unmet need are those;

"who are fecund and sexually active but are not using any method of contraception, and report not wanting any more children or wanting to delay the next child''.

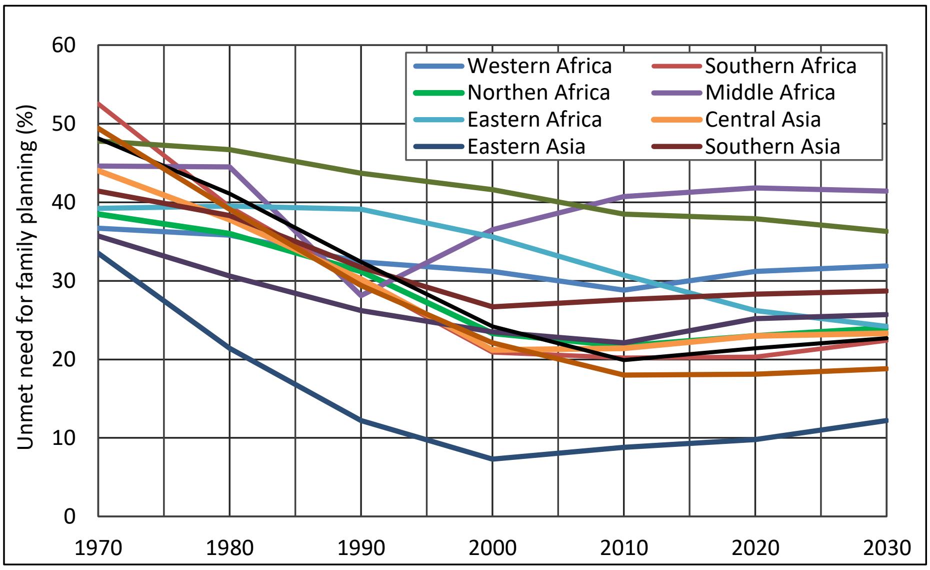
The notion of unmet need indicates the gap between the reproductive intentions of women and their contraceptive behaviour. Diffusion of contraceptive information through mass media and personal communication can help to reduce this gap and create new demand for contraceptive (innovation). Family planning programmes are effective when accompanied by extensive information on Education and Communication campaigns (IEC).

Numerous Studies, especially from Latin America utilising World fertility Surveys data in the 1960s and 1970s and the European fertility project led by Ansley Coale, had shown that fertility could decline in poor settings without development (Bongaarts 2014). Subsequently, Family planning and reproductive health programs were given importance in fertility decline than never before starting with the (1) World Population Summit in 1974 Bucharest, Romania, followed (2) International Conference on Population and Development (ICPD) in Cairo, Egypt, followed (3) Millennium Development Goals, (MDGs) and recently (4) Agenda 2030 for Sustainable Development Goals (SDGs).

The effect of family planning has been discussed extensively, but it remains not elusive (Bongaarts 2014). The turning point came with Easterlin's (1975) perceptive analysis that added two critical elements that; firstly fertility is biologically determined and sexually active women not practising contraceptive will get pregnant even if they do not want another child. So birth control must be used. Secondly, he recognised that birth control cost, including non–economic cost, health concerns, social disapproval, partner resistance and unnecessary medical barriers) could be high, therefore discouraging users and leading to unplanned pregnancies. The theoretical background for family planning investment came from the theory by Easterlin (Bongaarts 2014).In short, the family planning programs reduce unmet need for contraception and increase contraceptive use, demand, per cent satisfied, and per cent using modern methods.

Figure 19, shows contraceptive prevalence rate for married women aged 15-49 years old estimates from 1970–2018 and projections from 2019 to 2030 by sub–regions. The contraceptive prevalence rate show a general decrease in all sub regions. The results reveal that in 1970 contraceptive prevalence rate ranged from Eastern and South Eastern Asia (61%), Southern Africa (53%) and Latin America (38%) and increased and converged at about 77% prevalence rate by 2030. While in 1970 African sub regions Western, Eastern and Middle converged at contraceptive prevalence rate below 3% increase and diverge to Middle (32%), Western (39%) and Eastern (57%) by 2030.This suggest increases in modern methods contraceptive adoption by women

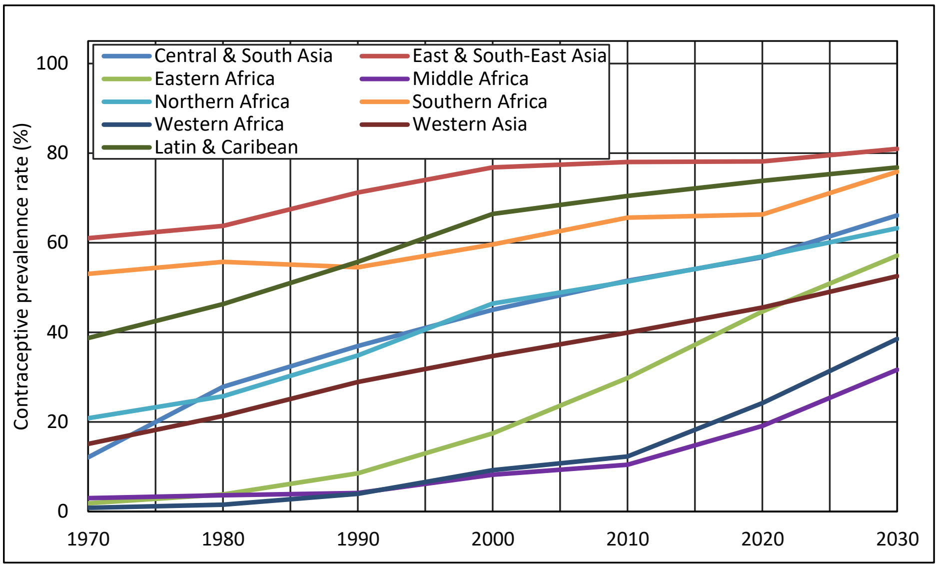
Fig. 19 – Married women (15–49 years) who are currently using any modern method of contraception by sub regions, 1970–2030



Source of data: United Nations Estimates and Projections of Family Planning Indicators (2019)

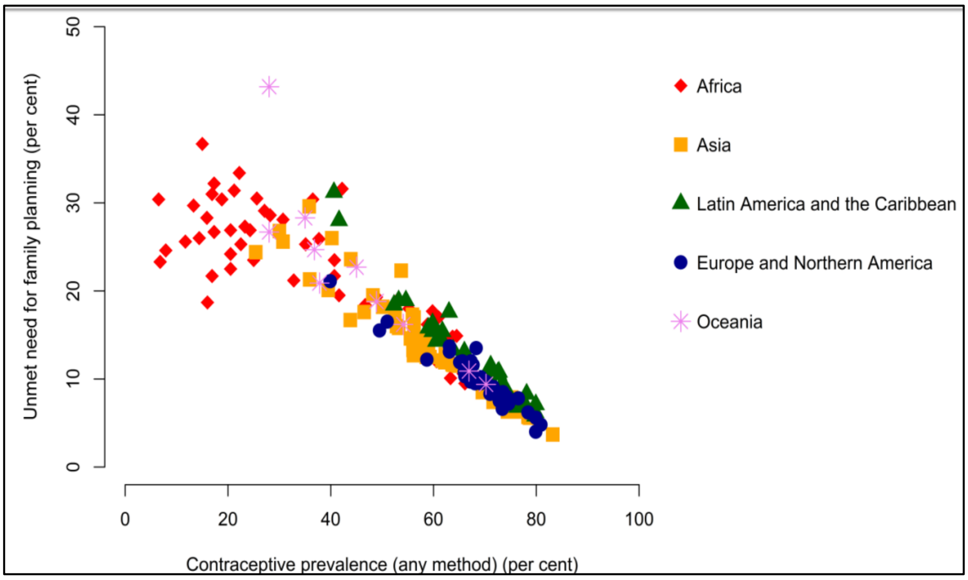
Figure 20, shows that unmet need for family planning estimates from 1970–2018 and projections from 2019 to 2030. The results reveal that there are wide variations in unmet need for FP. However in general the unmet need for FP has declined across all sub–regions from a narrow unmet need for FP prevalence rate in Eastern Africa (53%) to Eastern Asia (32%) to wide range from Middle Africa (41%) to Eastern Asia (12%) in 1970 to 2030 respectively. Three out of five Sub African regions (Eastern, Middle and Western) had highest unmet need for FP for period 2000 to 2030. Interestingly all the sub regions experienced unmet need for FP reversals in decreases or stagnation since 2000–2030. In middle Africa unmet need for FP actually increased from 29% to 41% from 1990 to2030 respectively

Fig. 20 – Unmet need for family planning (per cent) by world regions, 1970–2030



Source of data: United Nations Estimates and Projections of Family Planning Indicators (2019)

Fig. 21 – Relationship between contraceptive prevalence and unmet need for family planning 2017



Source: United Nations Estimates and Projections of Family Planning Indicators (2019)

Figure 21, shows the relationship between contraceptive prevalence and unmet need for family planning. It shows that they are inversely correlated. Moreover, it shows that African countries have the highest unmet need for family planning the lowest contraceptive prevalence use. However, some scattered countries show progress in contraceptive prevalence use. The challenges with the above trends they show correlation, but they do not show causation. Another way of demonstrating causation is in reviewing countries/regions with similar socioeconomic levels of development, but one has an absence of family planning program. Below I review such studies starting with an experimental study from Bangladesh Matlab in 1977. Lastly, I review empirical evidence from specific countries.

The most significant known Family planning controlled study was in Matlab, Bangladesh, in 1977. Bangladesh was poor and very agricultural. The study divided 173 000 people in 1977 into two equal populations. Individuals in the control area received similar treatment as the rest of the country while in the treatment area they received intensive and extensive family planning services with low socioeconomic cost adopting modern birth control (free IUDs, condoms, injectables etc.) were made available. The program used well–educated women to do community and home visits. Outreach to all community stakeholders, including husbands, was done to reduce community resistance. Results revealed that within 18 months, contraceptive prevalence use rose from 5–33per cent (Cleland 1994).

In contrast, the control did not experience significant changes in contraceptive use for five years. In 1984 the contraceptive prevalence rate had risen to 39 and 17 per cent in the experimental area and controlled areas respectively.

Moreover, Koening et al. (1992) reported that in 1990, 15–49 years old women using traditional methods of family planning prevalence was at 6 per cent and 26 for controlled and intervention area, respectively. Cleland (1994) in Bongaarts (2014) reported that fertility declined by 1.5 births more in the experimented area than in the controlled area. The challenge the study does not show how fertility decline by meeting an unmet need or by raising awareness or demand. Nonetheless, the study revealed that fertility could decline in rural areas as a result of family planning.

3.6.7.1 Country case studies on family planning

When two or more countries have similar socioeconomic and cultural characteristics, but one of the countries has implemented fertility planning earlier than the other that can be taken as a natural experiment where the effectiveness of family planning can measure. It can be observed that the decline in fertility in countries with family planning represents the effectiveness in creating demand and meeting the unmet need for contraception.

Bangladesh and Pakistan had similar socioeconomic conditions but they were separated in 1971 after years of internal conflict. Bangladesh had an intensive family planning program drawing from the experience of the Matlab experiment (Cleland et al. 2004, 2006, Bongaarts 2014). In contrast, Pakistan had a weak family planning program lacking government commitment (Bongaarts 2014). Firstly use of radio Bangladesh (IEC) and secondly use of literate women in the home to home visits to avoid cultural seclusion of women in public spaces.

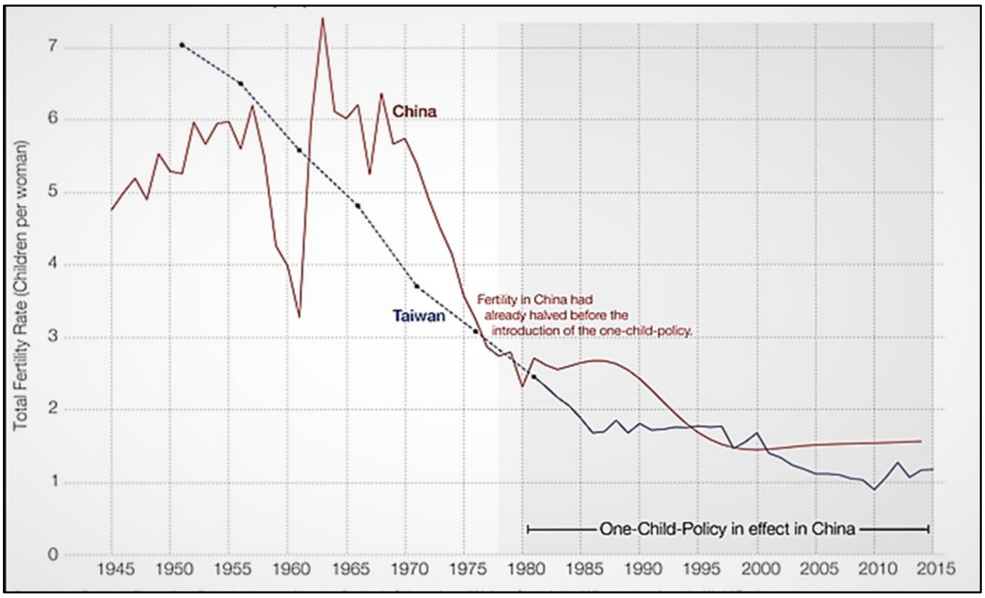
Kenya and Uganda –share colonial history, similar socioeconomic profiles. Kenya was the first to introduce family planning in the1960s, in contrast, Uganda only made family planning investments recent. It was afraid of population decline due to HIV. In the periods 1960-65, 1990 95 and 2010-2015, fertility in Kenya decline from TFR 8.07, 5.65 and 4.10, while in Uganda from TFR 7.05.7.06 and 5.91 respectively. However, the Kenya program stalled in the 1990s because government funding and donors funding was reduced (Bongaarts 2014, Murunga et al. 2013).

Rwanda and Burundi, they were at similar levels until the 2000s when Rwanda get lobbied for support and intensified its family planning program (Bongaarts 2014). Since then, between 1990–95 and 2010–15 fertility decline in Rwanda has been dramatic from TFR 6.55 to 4.20, while in Burundi from TFR 7.40 to 6.00 respectively (UN 2017).

Coercive family planning policies have been used in developing countries. China, in 1978, introduced the one–child policy, which becomes effective in 1980. The government of China has reported that it has averted more 400m births since the introduction of the one–child–policy. How the replication of the policy might be difficult in democratic societies given issues on reproductive health?

Figure 22, shows fertility decline in China and Taiwan were almost an equal level in 1980. When China's one–child policy was introduced, the most significant fertility declines had already happened. In 2015 both countries were below replacement TFR, but the TFR in China was about 1.5 while Taiwan, which did not have one child policy was about 1.2 (lowest low fertility). Feng et al. (2013) found similar results when they compared China's one–child policy with countries with similar fertility trends as China. They found that surprising results in countries that did not even implement the one–child policy, fertility decline more than what was expected for China. Additionally, they find that even without the one–child policy, China's birth rate would have continued to decline to current levels by 2010 (Feng et al. 2013).

Fig. 22 – A comparison of China and Taiwan fertility decline from 1945–2015



Source: Roser (2018)

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Having looked at the demographic revolution in developing countries as a whole, the next chapter will focus on fertility component of the demographic revolution in Africa

Chapter 4

The demographic revolution in Africa with regards to fertility levels, trends and spatial differentiation

4.1 Introduction

The fertility transition in Africa as a region has lagged, and it is progressing at a slower pace than other world regions (Bongaarts 2013, Dyson 2013). Africa has the highest population growth rates of 2.5 per cent per annum (UN 2017). Consequently, the United Nations projects that the Africa population will grow from about 1.1 to 4.5 billion from 2015 to 2100, respectively (UN 2017). High fertility has huge social, economic and environmental implications on earth. Undoubtedly, such sustained population growth rates can drive living standards on a downward trajectory of poverty. This situation is made worse by the fact that already, the majority of the least developing countries are located in sub–Saharan Africa (UN 2017).

Most studies refer to Africa as a homogenous continent (Chesnais 1986, Dyson 2013, Notestein 1945). Several studies that attempt to show differentiation only make a distinction between North Africa and sub–Saharan Africa (Ahmed et al. 2016, Caldwell and Caldwell 2002, Cohen 1993, Garenne 2013, Gebreselassie 2011, Tabutin et al. 2004). Yet UN (2017) shows that Southern Africa always had lower fertility than North Africa. Undeniably, such simple differentiation on a large and diverse continent is not useful for fertility or population policies formulation and programme implementation. On contrary studies, have shown that fertility levels in Africa has always differed since time immemorial, i.e., during pre–transitional times to transitional times because of proximate determinants of fertility (Bongaarts 1978, Bongaarts 1982, Mhloyi 1988). However, analysis of pretransitional fertility differentials dating back before the mid–20th century might be difficult as it is incapacitated by lack of data, because Africa, unlike Europe, did not benefit from historical parish registers. Moreover, fertility in Africa has also shown signs of regional clustering. Moreover, there are also isolated cases or outliers in regions with lower and high fertility, i.e., Sudan in North Africa and Mauritius in eastern Africa, respectively (Pillay and Maharaj 2013).

Convectional demographic transition theory explains how differential fertility levels are caused by different levels of development. In addition, research has also pointed out the importance of culture and linguistic boundaries in contributing to differential fertility levels (Cleland and Wilson 1987, Cleland 2001). Family planning has also been noticed to be an essential factor. In the pretransitional societies, fertility differentials were primarily caused by nuptiality factors (Coale 1973, Hajnal et al. 1976). Bongaarts' (1978) model has explained that proximate determinants in Africa are responsible for the fertility differentials. Davis and Blake (1956) have argued that the proximate determinants are mediated by background variables. However, fertility has always declined as a result of the adoption of deliberate contraceptive methods (Caldwell 1997, Dyson 2013). It can be hypothesised that even though Africa is diverse, fertility decline is a complex interplay of development and diffusion of contraceptive behaviours. Fertility decline is always positively correlated with high contraceptive use and negatively correlated unmet need for family planning.

The demographic transition theory predicts fertility to decline rapidly and continuously once the process began in developing countries (Notestein 1945, Coale 1973). However, a significant number of countries in Africa have also faced unique fertility transitions in which fertility has stalled. Indeed fertility stalling has raised questions about prospects of future fertility decline (Bongaarts 2006, Garenne 2013). Women have also postponed childbearing but being able to control their desired number of children at high parity (Moultrie et al., 2012). Fertility decline has also been affected by other factors like poverty, HIV and AIDS, wars, and high mortality rates. These factors wholesomely shifted attention away from family planning programs.

This section of the study seeks to add more scientific knowledge on the fertility differentials in Africa from 1960s to 2015 using cluster analysis. Such analysis will help to focus attention according to the needs of a country or region. Furthermore, countries or regions with similar fertility levels can share knowledge and experiences in terms of policy formulation and programme implementation rather than having uncoordinated and fragmented policies. Such an analysis also enables the achievement of Agenda 2030, for Sustainable Development Goals, which put emphasis on inclusive development and leaving no one behind.

4.2 Literature review

As defined previously fertility transition is the movement from high to low fertility regime (Coale 1973). According to the demographic transition theory, fertility decline is brought by modernisation (Notestein 1945, Coale 1973). However, Coale has argued that fertility in pretransitional societies was not high but was moderated through nuptiality factors. Hajnal (1965) further made similar findings that in pretransitional Europe, fertility varied by nuptiality factors. Although the demographic transition theory links fertility decline to socioeconomic development, however, research from the 1970s the Princeton project (Coale 1973) and World Fertility Surveys (WFS) (Bongaarts 2014) has also shown that fertility decline can also decline in the absence of significant socioeconomic development which brings the importance of diffusion and linguistic boundaries. In addition, WFS showed even in pretransitional Latin America women did not necessarily desire a high number of children (Bongaarts 2014). This might help explain why fertility started to decline in Africa, even at low levels of socioeconomic development. Indeed, access to modern methods of family planning is negatively associated with fertility decline in African countries (Bongaarts 2014, Cleland 2014, Oronje et al. 2013)

A significant number of sub–Saharan African countries have experienced fertility stalling the period post–2000 (Bongaarts 2006, Garenne 2013). Since fertility decline started at low levels of socioeconomic, studies have highlighted that further socioeconomic development might be needed for further fertility decline (Bongaarts 2006, Pavlík & Hampl 1975). Other studies have highlighted the need to invest in education, especially women education (Goujon et al. 2015, Lutz et al. 2015). In contrast, some studies have shown that women are postponing childbearing, which initially depresses fertility and inflates again when the women begin childbearing years later (Moultrie et al 2012).

In the 1960s, Africa fertility rate as measured by total fertility rate (TFR) differed from 4.5 in Gabon to 8.07 in Kenya, 8.20 in Rwanda while the crude birth rate (CBR) ranged from above 50 in Kenya, Malawi, Sudan, Rwanda Zambia, Mali, Senegal, Cote d'Ivoire, Niger to as low as 34 in Gabon. During the 1970s, 1980s to 1990s periods, a significant number of countries experienced an increase in fertility as measured by the just mentioned indicators while a significant number of countries had also initiated sustained fertility decline. The increase in fertility may be explained by more daughters surviving to be potential mothers. Literature has also pointed out disintegration of traditional guards of fertility control, might also lead to fertility increase. Nonetheless, by 2010–2015, some countries in northern and southern Africa had experienced significant fertility decline to near replacement level while Central and Western Africa was lagging significantly (UN 2017). Notestein has argued that in pretransitional societies high fertility:

''…are strongly supported by popular beliefs, formalised in religious doctrine and enforced by community sanctions. They were deeply woven into the social fabric and slow to change.''

(Notestein 1953: 142) Therefore fertility differentials or rather the homogeneity or heterogeneity in Africa can be explained by unique African traditions and religions. Modernisation and women empowerment is always related to increasing in modern contraception use and fertility decline.

Marriage or sexual union offers exposure to the risk of childbearing and consequent fertility (Bongaarts) therefore age at marriage, proportions married and duration of marriage influence the number of children born (Hajnal 1965, Coale 1973, Mhloyi 1988). Africa is characterised by early marriage and universal marriage by 25 years of age. However, North African countries have higher proportions remaining single by the age of 30 years. However, in Botswana, marriage was the least powerful proximate predictor of fertility since significant birth occurred outside marriage (Letamo 1996, Letamo & Letamo 2001). Mhloyi (1988) noted that marital dissolution was not crucial since remarriages were high and occurred very early. Polygyny is generally high and variable in Africa and McDonald (1985) found that it ranged from 10 to 67 per cent in Lesotho and Senegal, respectively. Sexual exposure is lower in polygyny than monogamous unions. Studies have found polygyny to be negatively associated with the use of contraception and positively associated with post–partum amenorrhea behaviour (Mhloyi 1988, Rutaremwa et al. 2015). One can hypothesise that the overall effect of polygyny on fertility in preindustrial societies is negative.

Postpartum abstinence and anovulation are results of breastfeeding practices in Africa (Bongaarts 1978, Bongaarts 1982). Mhloyi reported that average sexual abstinence varied from 2.2 to 17.8 months in Tunisia and Benin, respectively. Extended male migration to urban areas and mines (diamond mines in South Africa from neighbouring countries) has also been noted to increase sexual abstinence (Notkola and Siiskonen 2016). On the contrary, long and almost universal breastfeeding practices averaging 18.4 months are noted across Africa (Mhloyi 1988). The practices can happen simultaneously, however, postpartum abstinence tends to be shorter than postpartum anovulation. However, Bongaarts argues that the intensity and duration of breastfeeding is the most powerful predictor of natural fertility differentials in natural fertility regimes. Thus recent studies in countries with high fertility Rutaremwa (2015) and Chola (2016) in Uganda and Zambia respectively found breastfeeding as the most critical fertility in inhibiting the effect. Moreover, infant mortality can interrupt breastfeeding and postpartum amenorrhea effects or cause parents to practice child hoarding and replacement and consequently raise fertility. Mhloyi (1988) highlighted that in some Africa societies, couples practice sexual abstinence when certain child sickness happens, e.g. measles. This can lead to further fertility inhibiting effects beyond post–partum effects reported by Bongaarts (1984), although it is difficult to quantify such inhibiting effects.

Study of 18 African countries by Frank (1983) noted out that 60% of fertility differentials can be explained by pathological sterility. Sterility ranged from standard 3% (Bongaarts 1984) to highest of almost 40% in Central Africa (Frank 1983), which is commonly referred in the literature as the in fertility belt (Collet et al. 1988, Inhorn 1994, Larsen 2003). It is difficult to quantify the effects of HIV on fertility directly, but one can hypothesise that increased illness due to the diseases might lead to loss of sexual exposure, sterility, on the other hand, it is possible that women might postpone sexual relations, and use contraceptive barriers like condoms. Southern Africa has the highest prevalence of both HIV and condoms use (Bongaarts 2017).

4.3 The history of data collection in Africa

Most of the data sociodemographic data collection in Africa began after WWII, particularly period starting in 1960. The early data collection by colonial governments (French, British, Portuguese Belgium Italian) focused mainly on the white population at the exclusion of the black population. In certain instances, like in Zimbabwe, only the absolute number of males aged 15 years and older were enumerated directly or indirectly for the tax collection (Brownell 2011). Vital registration systems functioned poorly or were nonexistent at all. The challenges of vital registration systems have since persisted about 60 years later as only a few countries have the capacity to record the demographic events. The success has been witnessed in a few countries, mainly islands with small population, e.g. Cape Verde, Mauritius, Sao Tome and Principe Seychelles and South Africa and some capital

However, data collection has improved significantly since the 1970s, with regard to censuses and surveys. The offering of external support has helped, both financial and human capital in training of demographers, statisticians, and setting up institutes. The most significant milestone in measuring the health and fertility of population was particularly the setting up of regular international comparable surveys such as the World Fertility Surveys (WFS) between 1974 and 1982, which was succeeded by the Demographic and Health Surveys (DHS) sponsored by the United States since 1984. The demographic health surveys have been reported to have more than 90% coverage of births and deaths (Tabutin et al. 2004).

Tab. 3 – Number of Censuses, World Fertility Surveys (WFS), Demographic and Health Surveys and other surveys since 1950–2018 in 48 African countries

Survey Type	1950–69	1970–79	1980–89	1990–99	2000–09	2010–18	Total
Census	37	41	43	36	46	23	226
WFS[a]	–	7	4	–	–	–	11
DHS[b]	–	–	13	41	49	46	149
Malaria/AIDS indicator Surveys (MIS, AIS)	–	–	–	–	7	24	31
MICS[c]	–	–	–	37	46	27	110
Other demographic survey[d]	8	–	–	–	–	–	8
Total	45	48	60	114	148	120	535

(a) Surveys conducted in the World Fertility Survey programme from 1974 to 1982.
(b) Demographic and Health Surveys were done, since 1984 under the supervision of Macro International, Westinghouse and other organisations.
(c) Multiple Cluster Indicators (MICS) since 1990
(d) Other than the socio–economic surveys conducted by the World Bank (Living Standards Measurement Study, priority surveys)
–no data collected
(see Appendix 1 for full countries details)
Source: UN (2017), Tabutin et al. 2004, Gendreau (1993) and personal studies.

The 48 countries shown in Table 3, have total populations estimate above one million (Appendix 1). The countries were selected because population errors are less for large than smaller populations (UN 2017). Table. 3shows that demographic surveys have been conducted in the 48 countries in Africa since 1970, and most of all since 1980, on average, practically one census and one survey every ten years. The national situations vary considerably (Table 3 Appendix 1) ranging from 3–5 censuses and 5–8 surveys (Zimbabwe, Botswana Kenya Ghana Egypt) to countries that are very statistically neglected (Liberia Equatorial Guinea, Ethiopia, DRC Congo, Congo Guinea Gabon Chad Somalia Swaziland). Among the 48 countries, a total of 226 censuses have been done, 11 WFS, 149 DHS. For the period 2000–2009 at least 42 out the 48 countries had one census, 32 countries had done at least one DHS survey for the same period. The DHS have significantly enhanced data collection and knowledge about fertility, mortality, maternal and child mortality and health in many African countries.

4.4 Data and Methods

Data from UN, World Population Prospects, (2017) Revision on global and regional population estimates from 1960–2015 was used. The study selected 48 countries with a total population of more than 1 million people in 2017. Exclusion of small countries with a population less than a million is because population estimates errors are higher for populations that are smaller than more significant populations (Randall and Coast 2016, Keilman 1998). Also, Mauritius was excluded because it is a unique island and demographic outlier (Nair 2014), therefore affects clustering. The standard UN regional classification of African countries into five regions was adopted for this study (UN 2017).

The selection of data was not done arbitrary but informed by the accuracy of the UN data population estimates and projections for Africa which are constantly updated at the two–year interval to keep at par with new data from censuses, demographic surveys and vital registration systems. In addition, previous studies have shown that UN population projections have a small margin of error are accurate if previous projections which can be compared with historical or current population figures (Bloom and Lucas 2016:9, Velkoff & Kowal 2006). Consequently, in the absence of reliable and accurate data by individual African countries, the UN population estimates and projections become handy in examining fertility dynamics in Africa in line with evidence–based policy formulation and planning. The following periods, 1960–65, 1990–95, 2010–2015 were used to create cluster analysis (Analysis 1, Analysis 2 and Analysis 3) respectively. The following demographic indicators were selected namely total fertility rate (TFR), crude birth rate (CBR) and net reproductive rate (NRR) (see Table 4).

A cluster analysis of African countries based on selected fertility indicators. The k means method has been chosen as the most suitable for clustering of African countries among the available multivariate analysis methods and techniques. In addition, this method allows the number of clusters can be pre–determined in advance. The two objectives of using the k means method for clustering is to decrease total intra–cluster variance or the squared error function. The K–means clustering method involves several steps in computing. For instance, the first step involves classifying of objects/subjects into K–groups, where K is defined as the number of predetermined groups (Jain 2010, Yüceşahin and Tulga 2017). In the second step, the algorithm randomly selects k points as cluster centres. Thirdly, clustering was done assigning objects to their nearest cluster distance according to the sum of squared distances (Euclidean distances) between items and corresponding centroid. A centroid or mean of all objects in each cluster is calculated. K–means was deemed most appropriate because it considers homogeneity and heterogeneity of countries or spatial units and clusters them into groups. The method is appropriate when you have a large number of objects. Moreover, the method chooses the initial clusters means by randomly choosing values within the same range as the highest and the lowest in the data values (Jain 2010). The chosen data sets have different measurement units, therefore, they were standardised into z–scores of +3 to –3 on a continuum line using SPSS version 21 (Yüceşahin and Tulga 2017).

The K–mean does not have a global theoretical method to determine the ideal number of clusters (Jurun, Ratković and Ujević 2017). Therefore several k–mean clusters are computed, and the outcomes are compared, and one outstanding output is selected based on a predefined criterion. In this study, 2–5 clusters were computed based on the means of the selected demographic variables. Only 3 cluster results for each analysis period produced acceptable results. Two cluster analysis was found to be too simplistic, while large clusters (4 and 6) minimises the error but increases the risk of overfitting. Some clusters produced only one or two countries in some of the clusters. Therefore, the three cluster results were inherently chosen to be the appropriate method. Also, analysis of variance F statistics was computed to form groups that are different and to measure the contribution of each variable to the final cluster analysis/groups.

Tab. 4 – Selected fertility indicators of Africa 1960–1965, 1990–1995, 2010–2015

		Crude birth rate (per 1,000 population)			Total fertility rate (children per woman)			Net reproduction ratio (per woman)		
		1960–65	1990–95	2010–15	1960–65	1990–95	2010–15	1960–65	1990–95	2010–15
Eastern	Burundi	48.2	48.2	43.3	7.07	7.40	6.00	2.17	2.58	2.37
	Eritrea	48.3	39.4	34.3	6.82	6.20	4.40	2.00	2.17	1.96
	Ethiopia	48.0	46.7	33.6	6.90	7.09	4.63	2.04	2.50	2.00
	Kenya	51.0	40.2	33.1	8.07	5.65	4.10	2.84	2.12	1.83
	Madagascar	48.4	44.1	34.1	7.30	6.10	4.40	2.26	2.35	1.96
	Malawi	52.6	47.2	38.1	7.00	6.60	4.88	1.97	2.30	2.10
	Mozambique	49.2	45.9	40.4	6.90	6.10	5.45	1.88	2.05	2.21
	Rwanda	50.7	44.8	33.5	8.20	6.55	4.20	2.59	1.96	1.87
	Somalia	47.4	49.5	44.4	7.25	7.53	6.61	2.03	2.73	2.56
	South Sudan	51.3	46.6	37.3	6.75	6.65	5.15	1.70	2.22	2.00
	Uganda	49.3	50.1	43.9	7.05	7.06	5.91	2.35	2.51	2.47
	Tanzania	49.1	43.3	39.8	6.80	6.05	5.24	2.22	2.16	2.30
	Zambia	50.3	45.0	39.3	7.25	6.30	5.20	2.43	2.15	2.20
	Zimbabwe	48.2	35.8	35.6	7.30	4.77	4.00	2.73	1.64	1.72
Central	Angola	54.5	51.9	43.7	7.60	7.10	5.95	2.03	2.27	2.51
	Cameroon	43.6	43.6	38.2	5.81	6.22	4.95	1.84	2.09	2.01
	CAR	43.8	40.6	37.3	5.90	5.70	5.10	1.70	1.90	1.90
	Chad	45.6	51.3	45.2	6.30	7.39	6.31	1.87	2.59	2.36
	Congo	42.6	38.1	36.8	5.99	5.21	4.86	2.15	1.96	2.13
	DRC	46.8	46.1	44.0	6.04	6.77	6.40	1.87	2.37	2.58
	E Guinea	41.3	41.6	36.0	5.67	5.97	4.99	1.62	2.20	2.02
	Gabon	34.3	36.3	31.3	4.59	5.22	4.00	1.41	2.01	1.77
Northern	Algeria	49.5	28.8	25.3	7.65	4.12	2.96	2.55	1.30	1.38
	Egypt	45.6	30.1	28.5	6.65	4.12	3.38	2.20	1.55	1.58
	Libya	50.1	26.5	21.3	7.30	4.22	2.40	2.49	1.47	1.12
	Morocco	49.7	27.4	21.3	7.10	3.70	2.60	2.47	1.33	1.21
	Sudan	46.9	41.6	34.4	6.75	6.00	4.75	2.38	2.26	2.04
	Tunisia	45.2	22.9	19.1	6.99	2.98	2.25	2.26	1.09	1.07
Southern	Botswana	46.9	31.9	25.1	6.65	4.25	2.88	2.49	1.43	1.28
	Lesotho	42.3	34.3	28.7	5.81	4.70	3.26	2.04	1.74	1.35
	Namibia	42.3	36.9	30.4	6.20	4.91	3.60	2.21	1.82	1.62
	South Africa	39.7	27.3	22.0	6.00	3.34	2.55	2.30	1.28	1.13
	Swaziland	47.9	39.5	30.2	6.75	5.20	3.30	2.27	1.76	1.39
Western	Benin	45.3	45.3	38.4	6.42	6.56	5.22	1.80	2.35	2.14
	Burkina Faso	47.2	47.1	40.8	6.35	6.93	5.65	1.71	2.38	2.29
	Côte d'Ivoire	54.6	42.5	37.7	7.76	6.41	5.14	2.23	2.11	1.98
	Gambia	49.7	46.9	41.2	5.70	6.08	5.62	1.47	2.34	2.37
	Ghana	47.3	37.7	32.7	6.84	5.34	4.18	2.27	1.99	1.77
	Guinea	45.6	45.8	37.5	6.15	6.51	5.13	1.67	2.26	2.09
	Guinea–B	42.0	45.1	38.4	5.95	6.50	4.90	1.74	2.24	1.95
	Liberia	49.2	44.1	35.8	6.47	6.27	4.83	1.81	2.19	2.02
	Mali	50.1	48.9	44.7	7.00	7.15	6.35	1.53	2.31	2.48
	Mauritania	48.4	40.3	35.5	6.79	5.91	4.88	2.19	2.29	2.07
	Niger	58.3	55.2	49.2	7.50	7.75	7.40	1.96	2.59	2.98
	Nigeria	46.2	43.7	40.5	6.35	6.37	5.74	1.81	2.05	2.12
	Senegal	50.3	42.0	37.6	7.10	6.28	5.00	2.03	2.27	2.23
	Sierra Leone	47.9	46.7	37.3	6.25	6.69	4.84	1.54	1.83	1.82
	Togo	47.7	40.8	35.8	6.65	6.02	4.69	2.07	2.13	1.96

Source of data: UN (2017)

4.5 Results

As a result of the three cluster analysis 1, 2 and 3, Table. 5 shows country cluster membership for respective periods. The z–score averages (final cluster centres) of the fertility variables are presented in Table 6. Moreover, the z–scores in Table 6, have been converted into bar graphs in Figure. 23a, 23b, 23c to demonstrate cluster differences visually. In Analysis 1 (1960–65), a total of 13 (27.1%) out of 48 countries were assigned to cluster 1/1. Cluster 2/1 and cluster 3/1 consisted 26 (54.2%) and 9 (18.8%) out 48 countries respectively (see Table 5). In analysis 2 which covered the period 1990/95, a total of 28 (58.3%), 13 (27.1%) and 7 (14.6%) out of 48 countries were assigned to clusters 1/2, 2/2, and 3/2 respectively. On the other hand, in analysis 3 (2010–2015), 10 (20.8%), 28 (58.3%) and 10 (20.8%) out of 48 countries were assigned to cluster 1/3, 2/3 and 3/3 respectively.

It is imperative to outline at the very onset that the description and presentation of results using high, medium and low are merely meant to enable comparison of fertility differentials, see (Figure 23a, 23b, 23c, 24, Table 6) The results from Analysis 1 (1960–1965) shows that the spatial distribution and clustering of fertility levels of African countries in 1960–65. Cluster 1/1 was characterised by high positive z–score of CBR, TFR and NRR as compared to other clusters 2/1 and 3/1 respectively. Cluster 3/1 is the opposite of 1/1 and was characterised by negative z–score of CBR, TFR and NRR. The fertility levels of cluster 3/1 are low as compared to other clusters. This cluster consists of Southern and Central African countries, Lesotho, Namibia, South Africa, Equatorial Guinea, CAR, Congo, Cameron and Guinea Bissau. Cluster 2/1 is sandwiched between the two clusters just described above, with both medium negative and positive z–scores close to zero. The higher the CBR score means that more are being born into the general population, higher TFR z–score means more children are born per woman, and higher NRR means that more daughters are born per woman who survive to the ages of their mothers and vice for low CBR TFR and NRR.

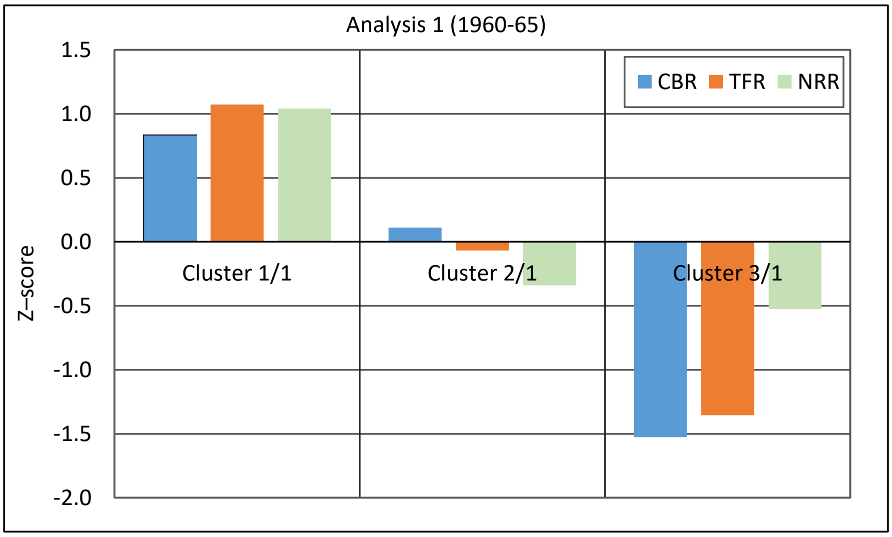
The results from Analysis 2 (1990 –1995) reveal that there are similarities and differences in fertility clustering in Africa (middle panel Figure 23b, 24 and Table 5). Cluster 1/2 shows that majority of the countries had high positive z–score of CBR TFR and NRR. This group consisted of 15/17 west African countries, and 10/14 from eastern Africa, two from middle Africa and surprisingly, Sudan from North Africa were also in this group. Cluster 3/2 is the opposite of 1/2 as it had the highest negative z–scores of CBR, TFR, and NRR. Cluster 3/2 consisted of South Africa, Botswana and North Africa countries except Sudan. The group had experienced significant fertility decline. Cluster 2/2 is in the middle of 1/2 and 3/2 with slightly negative z scores of CBR, TFR and NRR. The countries in cluster 2/2 had just past the early stages of fertility decline are approaching the middle of fertility decline. In short, the countries in cluster 1/2 are in the early stages of fertility decline, and some of the countries are still in the pretransitional stage. Countries in cluster 2/2 are approaching the middle of fertility transition. Lastly, countries in cluster 3/2 have just passed the middle of fertility transition are working their way towards replacement fertility. The results further reveal that a significant number of countries moved from cluster 2/1 in 1960–65 to cluster 1/2 in 1990–95 probably as a result of fertility increase in some countries.

Tab. 5 – Cluster memberships of African countries obtained from Analysis 1 (1960–65), Analysis 2 (1990–95), Analysis 3 (2010–2015), Africa

Region	Country	Analysis 1 (1960–65)	Analysis 2 (1990–95)	Analysis 3 (2010–15)
Eastern	Burundi	2	1	1
	Eritrea	2	1	2
	Ethiopia	2	1	2
	Kenya	1	2	2
	Madagascar	1	1	2
	Malawi	2	1	2
	Mozambique	2	2	2
	Rwanda	1	2	2
	Somalia	2	1	1
	South Sudan	2	1	2
	Uganda	1	1	1
	Tanzania	2	1	2
	Zambia	1	1	2
	Zimbabwe	1	2	2
Central	Angola	1	1	1
	Cameroon	3	1	2
	CAR	3	2	2
	Chad	2	1	1
	Congo	3	2	2
	DRC	2	1	1
	Equatorial Guinea	3	2	2
	Gabon	3	2	2
Northern	Algeria	1	3	3
	Egypt	2	3	3
	Libya	1	3	3
	Morocco	1	3	3
	Sudan	2	1	2
	Tunisia	2	3	3
Southern	Botswana	1	3	3
	Lesotho	3	2	3
	Namibia	3	2	3
	South Africa	3	3	3
	Swaziland	2	2	3
Western	Benin	2	1	2
	Burkina Faso	2	1	1
	Côte d'Ivoire	1	1	2
	Gambia	2	1	1
	Ghana	2	2	2
	Guinea	2	1	2
	Guinea–Bissau	3	1	2
	Liberia	2	1	2
	Mali	2	1	1
	Mauritania	2	1	2
	Niger	1	1	1
	Nigeria	2	1	2
	Senegal	2	1	2
	Sierra Leone	2	2	2
	Togo	2	1	2

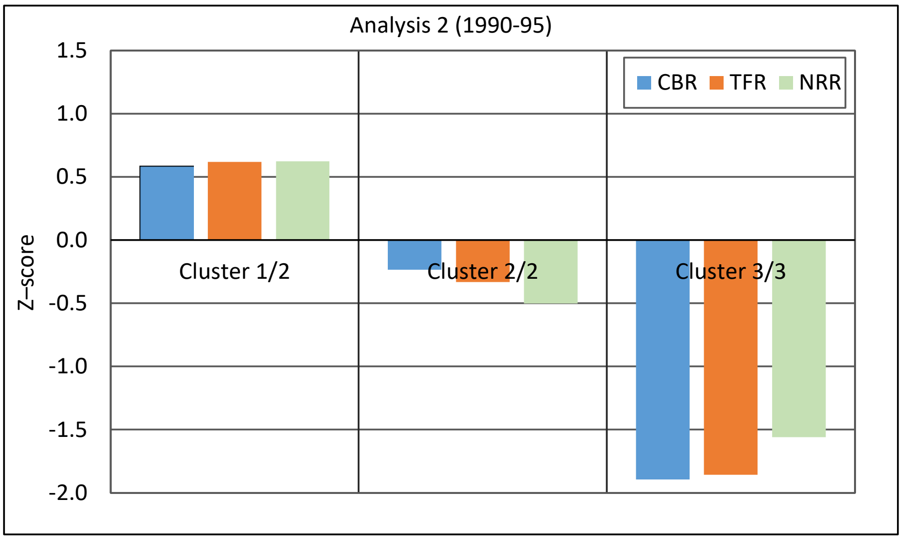
Source of data**:** UN (2017) and own calculations

Fig. 23a – Z–score bar graphs, Analysis 1 (1960–1965), Africa



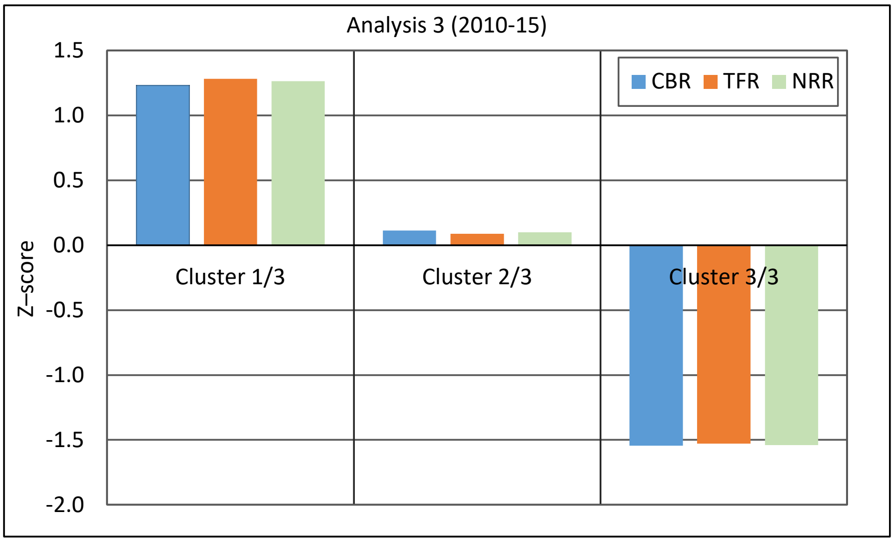
Source of data: UN (2017) and own calculations

Fig. 23b – Z–score bar graphs, Analysis 2 (1990–1995), Africa



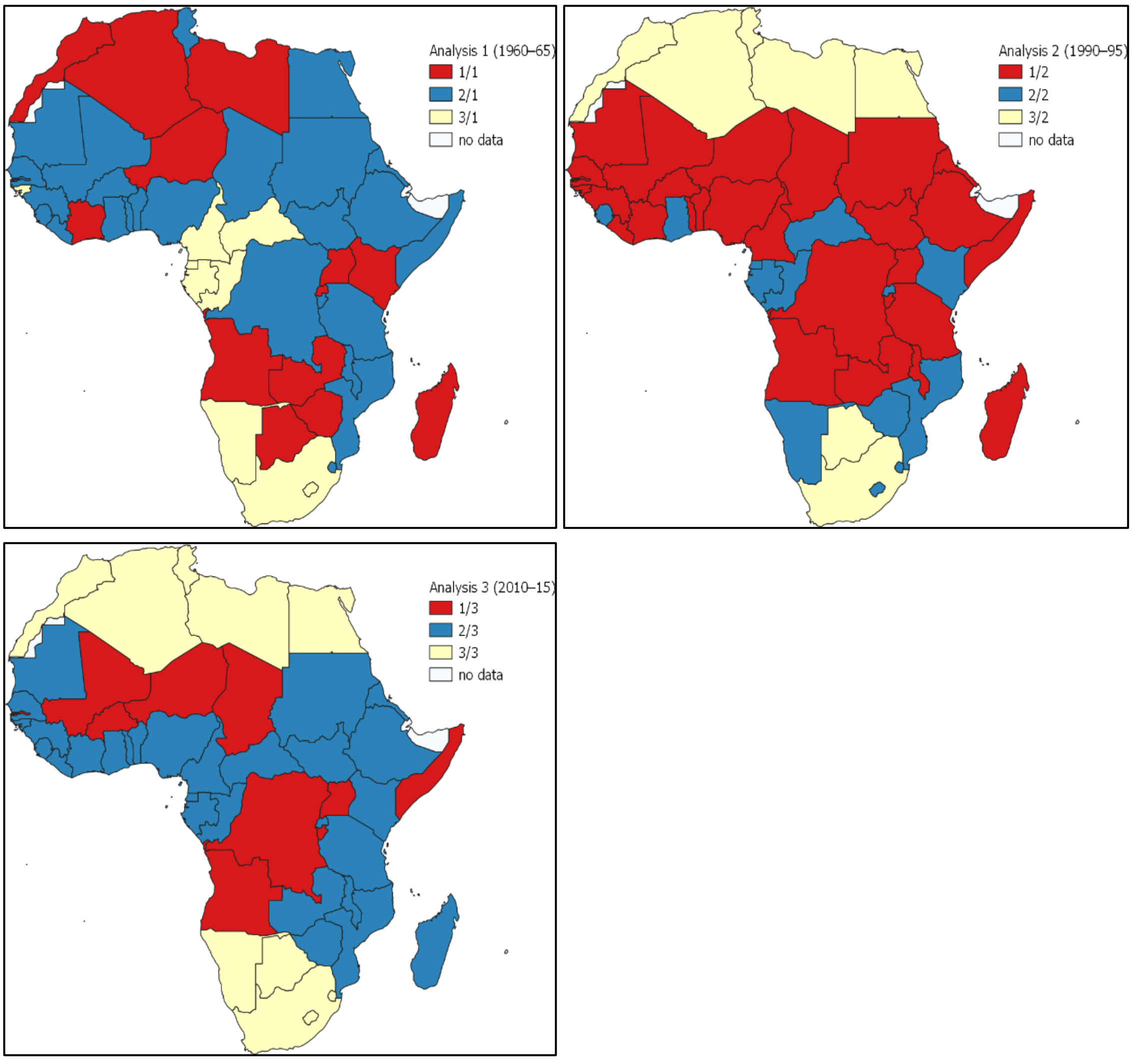
Source of data: UN (2017) and own calculations

Fig. 23c – Z–score bar graphs, Analysis 3 (2010–2015), Africa



Source of data: UN (2017) and own calculations

Fig. 24 – Countries spatial distribution of fertility indicators, Analysis 1 (1960–1965), 2 (1990–1995), and 3 (2010–2015), Africa



Source of data: UN (2017) and own calculations

Tab. 6 – Final cluster centres from Cluster Analysis 1 (1960–65), 2 (1990–95), and 3 (2010–2015), Africa

			Fertility Indicators			
			Crude birth rate	Total fertility rate	Net reproduction ratio	Number of countries (n=48)
Analysis 1 1960–65	z-score	Cluster 1/1	0.83	1.07	1.04	13
		Cluster 2/1	0.11	–0.07	–0.34	26
		Cluster 3/1	–1.53	–1.35	–0.52	9
	Anova test	F value	40.92	46.10	15.99	
		P	0.003	0.001	0.81	
Analysis 2 1990–95	z-score	Cluster 1/2	0.58	0.62	0.62	28
		Cluster 2/2	–0.24	–0.33	–0.50	13
		Cluster 3/2	–1.89	–1.86	–1.56	7
	Anova test	F value	68.27	76.05	44.20	
		P	0.001	0.001	0.001	
Analysis 3 2010–15	z-score	Cluster 1/3	1.23	1.28	1.26	10
		Cluster 2/3	0.11	0.09	0.10	28
		Cluster 3/3	–1.54	–1.53	–1.54	10
	Anova Test	F value	114.89	128.53	128.50	
		P	0.001	0.001	0.001	

Source of data: UN (2017) and own calculations

The results in analysis 3 (2010–15) shows the fertility levels clustering of countries in Africa from 2010–15. Cluster 1/3 reveals high positive z–score of CBR, TFR and NRR. These countries are now in the early stages of fertility decline. The majority of the countries (28/48) are in cluster 2/3 (middle cluster) with slightly positive CBR, TFR and NRR. Cluster 3/3 is the contrast of 3/1 with high negative z–score of CBR, TFR and NRR. The analysis also reveals that most of the countries in cluster 1/2 decreased from 28 to 10 between 1990–95 and 2010–15 respectively, while countries in cluster 2/3 (middle cluster) simultaneously increased from 13 in 1990 to 28 in 2010–15. The countries in cluster 3/3 also increased from 7 in 1990 to 10 in 2010–15. Therefore, it can be said that countries are moving from the pre–transitional phase to the middle and to the later stages of fertility transition, which shows that countries are undergoing fertility transition at different times and pace.

The results of a cluster analysis shown in Table 6 show other essential characteristics of the fertility clustering regarding similarities and differences in fertility transition. Looking at the F values in analysis 1 (1960–65) we can discern that the most important variables contributing to the fertility clustering of the variables were TFR (46, 10), CBR (40.92) and NRR (15.99) respectively. Child mortality is high at this time, and high fertility is related to high mortality. In cluster analysis 2 (1990–95), the f–values contributed TFR (76, 05) CBR (68.27) and NRR (44.20) respectively, in the spatial clustering of fertility.

The F–values in analysis 3 (2010–15), are the most critical factor contributing to the spatial clustering of fertility in Africa were TFR (128.53), NRR (128.58), and CBR (114.89). The closeness of all the F–values in 2010–15 and TFR in 1960–65 and 1960–65 means that the variables contributed closely to each other for the respective periods. This means that the countries have transitional and mixed characteristics of fertility decline. Some countries are near replacement levels, others are at early stages of fertility decline, and the majority of the countries are in the middle of fertility transition.

4.6 Discussion and conclusion

The findings of this research demonstrate that fertility differentials using CBR, TFR and NRR can be spatially clustered into 3 distinct groups (high, medium, low) for each period 1960–65, 1990–1995 and 2010–15. The differences and similarities in fertility are present in the pre transitional (1960–65) to the transitional phases (1990–95, 2010–15). Moreover, during the specified periods, countries moved from pre–transitional stage to transitional stages at different onset and paces, creating further differences and similarities in the fertility transition. The movement from high to low fertility can be explained by the demographic transition theory (Notestein 1945, Dyson 2013). The countries or regional fertility differentials during the fertility pre–transitional and transitional period can be explained by the proximate determinants of fertility and adoption of contraception, respectively (Bongaarts 1978, 1984). However, Davis and Blake (1956) argue that the socioeconomic/modernisation factors operate through proximate levels. Nonetheless, the evidence point to the fact that most countries are moving towards low fertility, which might create a homogenization of fertility at low levels in the future beyond 2010–15. However, such an analysis was beyond the scope of this paper. The increased survival chances of mothers are also recognised in initially increasing fertility before the adoption of modern contraceptives.

In the period 1960–65 the spatial differentiation of fertility into high, medium and low clusters can be explained by proximate determinants of fertility, since this period can be classified as pre transitional period characterised by natural fertility regimes (Henry 1961), as only a few selected countries in Northern and Southern Africa had started experiencing fertility decline Namibia (Notkola 2016), South Africa Timæus et al. 1993, Egypt and Tunisia (Tabutin et al 2005). Bongaarts (1978, 1982, 1984) has put forward that fertility differentials in pre–transitional societies can be explained by proximate determinants. Of these proximate determinants marriage (sexual union) and postpartum infecundability is the most important in pretransitional societies. Nonetheless, In the 1960s majority of the countries (54%) had medium fertility than high and low fertility. This is a surprise finding since most of the countries were following natural fertility, one would have expected to find high fertility for all or at least majority countries. Similar country fertility differentials were also found by Hajnal (1965) and Coale (1973) in the historical fertility transitions in Europe when he argued that regional pre–transitional fertility differentials were moderated from its maximum through different nuptiality factors. The clustering of few countries with moderate but high fertility shows the importance of proximate determinants that can promote higher fertility than the African average.

However, countries with the lowest fertility are mostly located in the ‘’Central *African infertility belt’’* and Southern Africa (Cameroon, CAR, Congo Equatorial Guinea, Gabon, Lesotho Namibia, South Africa and Guinea Bissau). Low fertility in Central Africa is presumably a depressant effect of unprecedented high sterility on fertility caused by STI than elsewhere in Africa. Studies have shown than sterility in the *African infertility belt* ranged from 10–50% (Larsen 2003, Romaniuk 1961), whereas Bongaarts (1978) reported that 3% is the standard natural sterility in most countries. The clustering of Southern African countries which share borders might explain diffusion and early adoption of protective behaviours in the 1960s, Namibia (Notkola, Siiskonen and Shemeikka 2016) and South Africa (Caldwell & Caldwell 1993, Moultrie and Timæus 2003). The low fertility in South Africa can also partly be explained by the higher percentages (10–20%) of the white population, which by 1960s were almost on replacement level fertility (Chimere–Dan 1993). Lastly, for Lesotho, the low fertility could have been affected by Lesotho’s high rates of male migration to South Africa, which affects marriages and sexual exposure and has a consequent depressant effect on fertility. This is consistent with Gordon, (1981) in Mhloyi (1986), who reported that approximately 40–60% of Lesotho wives had husbands who had immigrated to South Africa. This is also consistent with studies conducted in Namibia (Notkola and Siiskonen 2016)

In the 1990s countries had three distinct clusters with the majority of the countries (58%) with high fertility. This might be a surprise finding given that the majority of the countries in Africa had started fertility decline. The surprise finding in the dynamics of fertility levels can presumably be explained by the fact that Western (17) and Eastern African (8) experienced later fertility decline than Southern and Northern countries. This consistent with findings by Maharaj (2013) who show that fertility in Western and Central Africa is lagging. The fertility in this cluster might still be affected by proximate determinants rather than the adoption of modern fertility limitation methods. Fertility differentials can be explained by contraceptive prevalence and unmet need for family planning (Bongaarts 2014). Countries with high fertility have low contraceptive use and high unmet need for family planning and vice versa (Bongaarts 2014). Moreover, it is possible that the high fertility might also be encouraged by a high number of potential mothers/daughters surviving to be mothers leading to population momentum. Some studies have also noted that countries with high infant and child mortality (including girls) practice high fertility facilitated by child hoarding and replacement fertility. Moreover, the availability of STI antibiotics in the infertility belt and the decline of secondary sterility might also cause fertility to rise (Inhorn 1988). Mhloyi (1988) also noted that proximate determinants such as the reduction in breastfeeding and abstinence practices during breasting feeding, abstinence during infant and child sickness might temporarily lead to fertility increase in some African countries. Majority of the countries in this cluster might be in the pretransitional or early stages of fertility decline.

The countries in the medium cluster had experienced significant fertility decline as a result of socioeconomic development and adoption of fertility limiting practices. This is consistent with the demographic transition theory (Notestein 1945, Dyson 2013). However, the countries in Africa have experienced fertility decline at low levels of socioeconomic development using modern methods of contraceptives. Studies have also noted that development factors such as female education, industrialisation and urbanisation have facilitated the diffusion of access to contraception. Moreover, birth intervals, age at first marriage or sexual intercourse has been noted to increase. Other factors such as widowhood and marital dissolution might not be useful as remarriages occur very quickly in Africa (Mhloyi 1988). Africa has also presented a unique transition, for example, using proximate determinants, it was found that fertility in Botswana happened outside marriage. Nonetheless, it means the level of countries development and availability of family planning services is inversely related to fertility.

In 1990–95 the minority of countries had low fertility. These countries have progressed in the fertility transition even though they have not yet reached replacement level of fertility. These countries include Botswana, South Africa and all North Africa countries excerpt Sudan. It is surprising that Kenya was not found in this cluster even though it was the first Africa country to introduce family planning in the 1960s, given that fertility in developing countries declined with modern methods of family planning.

In 2015, few mainly Western and Central African countries had high fertility. This represents regional clustering of fertility patterns. Similarly, regional fertility clustering's were also found in European historical transitions (Coale and Watkins 1986) and also in Asia (Attané and Barbieri 2009, Véron 2008). The countries in this cluster still experience high TFR, NRR and CBR. This is presumably because the countries in this cluster still experience high infant and child mortality as compared to other countries. The birth intervals in this cluster are still small, age at marriage is still low and coupled with universal marriages, such populations will experience high fertility rates than other regions. These countries represent some/most countries in the early stages of fertility transition.

In 2010–15, the majority of the countries was in the middle stage of fertility transition. Fertility is influenced by modernisation, which encourages/engenders less demand for children and adoption of fertility contraceptive behaviours. Even though fertility has declined at low levels of modernisation (Bongaarts 2014), this represents other factors like communication (ideation, diffusion) in the decline of fertility (Cleland and Wilson 1987). However a number of studies have noted that a significant number of countries have experienced fertility stagnation /stalling (Bongaarts 2006, Garenne 2013, Goujon et al. 2015, Lutz et al. 2015), otherwise the countries in this cluster should have been less as some of the countries should have experienced further fertility decline and moved into cluster 3 with low fertility.

The fertility stagnation might have been caused partly by initial fertility decline at low levels of socioeconomic development. Studies have noted the need for further structural socio–economic development to facilitate less demand for children and increase access and uptake for family planning services. In Zimbabwe fertility increased from 3.3 to 3.8 between 2002 and 2012 respectively, women postponed childbearing during the period of economic hyperinflation (2007 8) and increased their childbearing when the economy stabilised in 2009 (ZIMSTAT 2015). Lutz et al. (2015) and Goujon et al. (2015) have emphasised the importance of education in fertility stagnation. Lutz et al. 2015 argued that world Economic Structural Adjustment Programs (SAPS) introduced in the 1990s have caused a drop in women education enrolment rates and completion rates resulting in these birth cohorts later experiencing higher fertility later. This also related to the fact that the birth cohorts affected by economic structural adjustment programs experience higher infant and child mortality than birth cohorts not affected. The demography transition theory holds that low mortality is necessary for fertility decline (Reher 2004, Kirk 1996). The importance is the surviving number of children and not the number of children ever born. Hence mortality decline is a prerequisite. Once parents realise that their families are growing, they initiate family planning methods. Reher (2004, 25) notes *"within this context fertility control can be seen as an attempt to maintain family size, not decrease".*

Notkola (2016) highlighted the HIV pandemic made women postpone, childbearing, however, the availability of drugs made fertility increase in Namibia. Similar arguments can be extended to African countries ravaged by HIV and AIDS. The fertility stagnation might also be related to the tempo and quantum effects of fertility decline. Majority of women might temporarily postpone fertility in pursuit of education or laws that raise the age of entry into marriage, but women can subsequently able to have the desired number of children when childbearing resumes. Median ages of childbearing have risen in most countries.

Last but not least, in 2010–15, the countries with the lowest fertility are all Southern and Northern Africa. The absence of Sudan in North Africa region is consistent with historical fertility transitions where Ireland lagged in the European fertility transition. The countries are nearing replacement levels of fertility. The grouping together of Northern and Southern Africa is not consistent with most studies that separate sub–Saharan Africa especially Southern Africa and North Africa in terms of fertility decline (Caldwell and Caldwell 2002, Tabutin et al. 2004). Moreover, it is surprising that Southern Africa has embarked on a continued trajectory of fertility decline despite high mortality (NRR) caused by HIV /AIDS. One would expect the impact of HIV on mortality to almost pre–modern levels to lead to fertility rebound to higher levels. Nonetheless, this shows that there other factors operating in fertility decline in the countries affected by HIV. More, Botswana and South Africa are the only two countries to have legalised abortion in Southern Africa.

Chapter 4

Population development in Africa with special regards to ageing

5.1 Introduction

The world has been ageing at an unprecedented rate since the 21st Century. Globally, the number of people aged 60 years and over is projected to increase by 56 per cent to 1.4 billion from 0.9 billion between 2015 and 2030 (UN 2017). Moreover, a significant body of literature has shown that globally, the share of the elderly (60 years and over) is growing fastest than all the other age groups (Harper 2016, Pillay and Maharaj 2013). However, the growth of the elderly has not been uniform across the world regions between 2015 and 2100. Although, Africa is the last region to experience demographic revolution, its growth of the elderly is at a faster pace and magnitude in comparison to other world regions. It is clear that the number is increasing in Africa, yet the magnitude, extent, and differentiation of this phenomenon remained unexplored. Few fragmented studies in Africa have looked on different aspects of ageing, mainly at country levels or sub–regions e.g. Sub–Saharan Africa (Suntoo 2012, Cohen and Menken 2006, Apt 2002, Kinsella 1992, Nair 2014, Aboderin et al 2015, Kyobutungi et al. 2009, Ferreira and Kowal 2006, Dhemba and Dhemba 2015).

In addition, inadequate research on ageing in Africa is compounded by the lack of quality and reliable data on the elderly that enables comparability across countries. Data on elderly Africans is limited in scope and accuracy (Randall and Coast 2016). There is a misconception and generalisation that the African continent is ageing homogeneously. Undeniably, such generalisation is not useful in terms of ageing policy formulation and programming on a large and diverse continent. Undoubtedly, most African governments have other more pressing problems such as economic crises, infant and child mortality, HIV and AIDS, rapid population growth, rapid urbanisation, youth unemployment and conflicts, which they are focusing on (Aboderin 2012, Pillay and Maharaj 2013). Thus, rapid population ageing without socioeconomic improvement might mean that the human development needs of the elderly are compromised. Population ageing is highlighted in the Agenda 2030, for Sustainable Development Goals (SDG), which emphasise paying attention to the human development needs of the vulnerable population groups including the elderly and leaving no one behind (Kudo, Mutisya and Nagao 2015). To ensure its success, the agenda must remain of the people, by the people and for the people committing the world to global action as from 2015–2030 (UN 2017).

The age structural transformation towards more elderly ages has enormous health and socioeconomic implications. In countries burdened with HIV/AIDS pandemic ageing creates skipped generation households and feminisation as HIV/AIDS kills more young adults and men than elderly and women, respectively (Nabalamba and Chikoko 2011). Moreover, ageing increases old–age dependency ratios, social security costs non–communicable diseases, changes in living arrangements, etc. This is a challenge as Africa is already the world's poorest continent (Harper 2016, Kinsella and Wan 2009). Unlike Europe, Africa's rapid population ageing does not give time to reap a demographic dividend, which might alleviate the continent's poverty (Groth and May 2017) and time to prepare and adjust socioeconomically. This means Africa may get demographically old before getting socioeconomically developed. Thus, governments concerned have little time for preparation for the welfare of the aged. For example, a fertility transition to replacement level fertility, which took Sweden about 100 years (Dyson 2013), was achieved in Tunisia in less than 40 years (UN 2017).

This section of the study aims to provide more evidence, which will assist in understanding population development and ageing in Africa. The specific objectives of the study are to (1) examine countries' differentials and similarities in terms of determinants and selected population ageing indicators from 2000, 2015 and 2030 and (2) do countries clustering based on the indicators above. The understanding of population ageing will enable countries that share similar demography profiles to share experiences and learn from each other. Furthermore, such endeavours will help in meeting Sustainable Development Goals (SDGs) 1 and 3 of ending poverty in all its forms everywhere and ensuring healthy lives and promoting well–being for all at all ages, respectively.

5.2 Literature review

Although the demographic transition in Africa began later as compared to other regions, its ageing process is happening at a faster pace and magnitude than elsewhere (Pillay, Maharaj, 2013). The demographic transition is defined as the movement from high to low mortality and fertility regimes accompanied by age structural changes due to socioeconomic development (Tabutin et al. 2004). Africa is still regarded as the youngest continent, even though spatial ageing variations have been noted between and within countries and regions (Nabalamba and Chikoko 2011, Pillay and Maharaj, 2013). For example, in 2000, 2015, and 2030 projections Northern countries had the highest percentage of the population aged 60 years and over of (6.8%, 8%, 11%) respectively, followed by Southern Africa with almost similar values, whilst Western, Central and Eastern experienced a slight increase with an average of 5% for respective periods. However, exponential increases in absolute numbers of elderly were recorded in all regions (UN 2017). Various studies have revealed that not only are there more elderly females than males but, also a significant number of the elderly population resides in rural than urban areas, although in future more elderly people will be urbanites than rural (Nabalamba and Chikoko

2011, Pillay and Maharaj 2013). Further, population ageing is accompanied by an increases in the median ages, old age dependency ratio and a simultaneous decrease in the child dependency ratios of the population.

The determinants of population ageing in Africa like everywhere else are rooted in the fertility and mortality decline processes, although migration is insignificant (Nabalamba and Chikoko 2011, Dyson 2013). Most importantly, the overlapping processes are causally related to each other, a fact which explains why they always occur relatively sequentially, i.e., mortality decline – population growth – fertility decline – population ageing (Dyson 2013). Even though mortality and fertility remain high and variable in Africa as compared to other world regions, the rapid decline of mortality especially infant mortality with sustained high fertility has created unprecedented rates of natural increases (RNI) which is still above 2.5% per annum in 2015 (UN 2017). In this context, it is possible to hypothesise that such high RNI creates a future elderly population, given that from the 1950–2015 probability of survival to 60 years old increased from 0.44 to 0.64 respectively with simultaneous declining fertility levels.

In 2015, the middle–income countries of Northern and Southern Africa's fertility had declined to 3.3 and 2.6 respectively, while the Central and Western countries were in the early stages of fertility decline (UN 2017). However, in the period 2000–2015, a significant number of countries have experienced fertility stalling or stagnation midway of fertility transition (Goujon, Lutz and Samir 2015, Garenne 2013, Bongaarts 2006), which might delay population ageing. Generally in Africa, life expectancy at birth was found to be 3–6 years higher for females than males (Pillay and Maharaj 2013, Muhwava and Rutaremwa 2016), even though recent study by Muhwava and Rutaremwa (2016) found that in Swaziland and Mali, men had slightly higher life expectancy at birth than females. The outbreak of HIV/AIDS pandemic has since created life expectancy at birth gaps between North Africa and Southern Africa (Pillay and Maharaj 2013). Thus, from 1990–2005, South Africa, Botswana, Lesotho, Malawi, Swaziland and Zimbabwe, life expectancy at birth fell from about 60 to almost 40 years in less than 15 years, whilst Northern Africa experienced a continued increase in life expectancy at birth of about 5 years (Tabutin, et al. 2004, Nabalamba and Chikoko 2011). HIV/AIDS–induced mortality kills more sexually active young adults than the elderly and children, therefore initially speeds–up ageing process (Nabalamba and Chikoko 2011, Pillay and Maharaj 2013). Socially, it creates *young adults skipped generation households*. In Southern Africa, over 60% of orphans were reported to be living with grandparents (Nabalamba and Chikoko 2011). Increased caring responsibilities are placed on grandparents, despite such grandparents being already health and socioeconomically vulnerable and in need of supporting themselves.

5.3 Data and Methods

Data were extracted from World Population Prospects (2017) Revision on global and regional population estimates from 2000–2017, and a medium variant of population projections from (2015–2030) was used (UN 2017). The rationale for selecting the data source emanates from its comparability across all African countries. This is important given the scarcity of reliable and accurate data on ageing persons in Africa (Randall and Coast 2016).

The study selected 48 out of 58 countries with a total population of more than one million people in 2017. Countries that were excluded had less than 1million population in 2017 (Comoros, Djibouti, Mayotte, Seychelles, Reunion, Sao Tome, and Principe, Western Sahara, and Cape Verde). This is because errors are more significant for populations that are smaller than bigger populations (UN 2017, Randall and Coast 2016). Also, Mauritius (with the highest proportion of the old aged population at 10% in Africa), was excluded because, being an island, it is demographically and socio–economically an outlier (Nair 2014), therefore affects clustering. The study adopted the following five regional classifications of Africa with a specific number of countries: Southern (5), Northern (6), Central (8), Eastern (14) and Western (15) regions (UN 2017).

The following years 1995–2000, 2010–2015 and 2025–2030 were used to create cluster analysis (Analysis 1, Analysis 2 and Analysis 3) respectively. Table 7, shows selected seven demographic indicators for the respective periods namely, total fertility rate (TFR), rate of natural increase (RNI), Median age, percentage aged 60 years plus, infant mortality rate (IMR), child and total dependency ratios.

As discussed in section 4.3, this section also used K–means clustering analysis in our research. K–means clustering is a method of classifying objects or subjects into K–groups, where K is defined as the number of prechosen groups (Jain 2010). K–means was deemed most appropriate because it considers homogeneity and heterogeneity of spatial units and clusters them into groups. Clustering was done by minimising the sum of squared distances (Euclidean distances) between items and corresponding centroid. A centroid is the mass of a geometric object of uniform density or also means vectors. The method is appropriate when you have a large number of objects. Moreover, the method chooses the initial clusters means by randomly choosing values within the same range as the highest and the lowest in the data values (Jain 2010). The chosen data sets have different measurement units, therefore, they were standardised into z–scores of +3 to –3 on a continuum line using SPSS version 21 (Yüceşahin and Tulga 2017). Moreover, Post hoc analysis (Turkey's HSD test) was computed to compare the internal differences and similarities of the cluster analysis.

Analyses were done by trying various clustering alternatives, between 2–5 clusters based on the means of the selected demographic variables. Only 3 clusters result for each analysis period produced acceptable results. Two cluster analysis was found to be too simplistic, while 4 and 5 clusters produced only one or two countries in some of the clusters, therefore the three cluster results were inherently chosen to be the appropriate method findings.

Tab. 7 – Determinants and selected indicators of population ageing, 1995–2000, 2010–2015, 2025–2030, Africa

		Median age			Total Fertility Rate			Infant Mortality Rate			Rate of Natural Increase		
	Country	2000	2015	2030	1995–00	2010–15	2025–30	1995–00	2010–15	2025–15	1995–00	2010–15	2025–30
Eastern	Burundi	15.3	17.6	18.6	7.2	6.0	4.8	102.7	77.9	53.6	28.6	31.7	26.7
	Eritrea	17.1	18.9	21.7	5.6	4.4	3.4	71.2	45.0	19.4	23.0	26.7	21.8
	Ethiopia	16.6	18.6	22.6	6.8	4.6	3.1	96.7	45.8	22.9	30.3	26.1	20.4
	Kenya	17.0	19.0	22.5	5.4	4.1	3.3	70.3	39.4	28.1	28.1	26.8	21.9
	Madagascar	17.3	18.7	21.2	5.8	4.4	3.6	77.7	36.8	19.1	31.5	27.2	24.4
	Malawi	16.5	17.4	19.9	6.3	4.9	3.8	115.5	66.5	49.8	28.3	29.8	26.7
	Mozambique	17.4	17.2	19.1	5.9	5.5	4.5	114.1	67.3	50.2	27.9	29.2	26.9
	Rwanda	17.3	19.4	22.9	5.9	4.2	3.2	122.0	44.0	30.3	25.4	26.7	20.0
	Somalia	16.5	16.5	17.7	7.7	6.6	5.2	105.1	79.5	55.9	33.7	32.1	30.0
	South Sudan	17.6	18.6	20.6	6.4	5.2	4.0	113.9	77.7	49.2	27.7	25.3	22.8
	Uganda	15.2	15.8	17.9	6.9	5.9	4.6	96.2	60.2	43.4	31.7	34.5	30.0
	Tanzania	17.2	17.3	19.0	5.8	5.2	4.3	89.0	44.0	31.9	27.6	31.9	28.7
	Zambia	16.6	17.1	19.0	6.1	5.2	4.4	101.2	53.8	36.2	26.7	30.5	28.3
	Zimbabwe	17.8	19.0	21.8	4.2	4.0	3.1	64.8	46.5	35.3	19.1	26.0	19.5
Central	Angola	16.2	16.4	18.1	6.8	6.0	4.9	134.0	65.4	49.2	29.9	34.4	30.2
	Cameroon	17.3	18.3	20.4	5.8	5.0	4.0	101.9	67.5	45.9	25.9	27.1	23.5
	CAR	18.6	17.8	20.3	5.6	5.1	4.0	115.4	93.5	65.6	21.2	22.0	22.7
	Chad	15.6	16.1	18.1	7.4	6.3	4.9	114.2	91.2	64.9	33.2	31.2	26.8
	Congo	19.0	18.9	20.5	5.1	4.9	4.0	84.6	46.5	31.3	25.0	28.5	25.2
	DRC	17.2	16.8	18.2	6.8	6.4	5.0	112.9	73.2	50.5	29.3	33.1	29.0
	Equatorial G.	19.6	22.2	22.7	5.9	5.0	3.8	99.3	70.0	48.4	26.6	25.3	21.6
	Gabon	19.4	22.6	24.3	4.8	4.0	3.2	59.0	40.8	28.3	23.4	22.9	17.5
Northern	Algeria	21.7	27.5	31.8	2.9	3.0	2.3	41.9	27.7	16.2	16.3	20.5	10.8
	Egypt	21.2	24.7	26.6	3.4	3.4	2.8	36.7	18.9	11.9	19.2	22.4	14.7
	Libya	22.1	27.2	32.5	3.2	2.4	1.9	29.6	24.3	16.5	18.0	16.1	8.9
	Morocco	22.7	27.9	33.0	3.0	2.6	2.2	44.0	28.1	13.3	16.7	16.1	10.2
	Sudan	17.9	18.9	21.6	5.7	4.8	3.9	70.1	48.7	36.5	29.4	26.6	22.7
	Tunisia	25.1	31.1	36.2	2.3	2.3	2.0	28.6	18.5	10.8	13.2	12.8	6.8
Southern	Botswana	20.1	24.4	28.7	3.7	2.9	2.3	73.2	35.2	21.4	16.3	17.0	12.6
	Lesotho	18.7	21.3	23.7	4.4	3.3	2.6	81.2	59.8	36.1	20.0	15.1	12.7
	Namibia	19.5	21.0	23.8	4.3	3.6	2.9	60.3	36.4	23.0	23.5	22.1	17.7
	South Africa	22.8	26.1	29.6	3.0	2.6	2.2	55.7	36.5	24.8	15.2	10.9	8.2
	Swaziland	17.2	20.4	23.5	4.5	3.3	2.6	80.7	56.3	33.2	22.3	19.4	15.0
Western	Benin	17.3	18.2	20.1	6.2	5.2	4.2	93.4	67.7	51.6	30.2	28.7	24.9
	Burkina F.	16.4	17.0	19.0	6.7	5.6	4.5	99.5	64.8	38.9	30.5	31.2	27.4
	Côte d'Ivoire	18.0	18.3	19.6	6.1	5.1	4.2	99.2	71.6	43.3	25.2	24.3	23.6
	Gambia	16.8	17.0	19.1	6.0	5.6	4.6	67.1	49.8	38.2	33.4	32.6	26.8
	Ghana	18.8	20.4	22.8	5.0	4.2	3.4	66.9	46.5	31.5	25.7	24.0	19.2
	Guinea	17.8	18.4	20.4	6.2	5.1	4.0	111.7	65.7	30.2	28.4	27.0	24.5
	Guinea–B	17.1	18.9	21.0	6.0	4.9	3.9	109.1	80.4	53.2	27.7	27.0	22.0
	Liberia	18.1	18.6	20.9	6.0	4.8	3.9	128.7	59.0	27.7	29.1	27.1	24.5
	Mali	16.6	16.0	17.8	7.0	6.4	5.0	121.3	78.5	47.5	29.3	33.1	29.9
	Mauritania	18.2	19.7	21.8	5.6	4.9	4.0	76.2	68.0	55.1	29.3	27.4	22.4
	Niger	15.9	14.9	15.7	7.7	7.4	6.4	102.6	65.8	42.4	35.6	38.5	37.1
	Nigeria	17.9	17.9	19.2	6.2	5.7	4.7	118.6	76.3	47.1	25.1	27.0	24.7
	Senegal	17.3	18.3	20.2	5.7	5.0	4.1	68.3	43.9	21.6	28.9	31.0	25.4
	Sierra Leone	17.5	18.3	21.2	6.5	4.8	3.5	148.7	94.4	59.6	19.9	23.3	18.8
	Togo	17.9	18.9	21.2	5.5	4.7	3.8	80.2	55.7	41.3	26.7	26.5	22.2

Source**:** UN (2017)

Tab. 7 – (Continued) Determinants and selected indicators of population ageing, 1995–2000, 2010–2015, 2025–2030, Africa

		Child dependency ratio			% aged 60 years and over			Total dependency ratio		
	Country	2000	2015	2030	2000	2015	2030	2000	2015	2030
Eastern	Burundi	106.8	87.7	87.7	4.5	4.2	4.2	116.6	96.0	88.7
	Eritrea	89.4	80.8	60.4	5.4	5.3	5.2	100.3	90.9	69.2
	Ethiopia	95.4	78.3	58.4	4.8	5.2	6.0	105.2	88.1	68.6
	Kenya	88.7	75.8	58.9	4.0	4.1	5.6	96.5	83.3	68.4
	Madagascar	89.8	77.5	66.5	4.6	4.6	5.9	98.9	86.2	76.8
	Malawi	96.2	87.5	70.3	4.4	4.3	4.4	105.3	95.9	78.1
	Mozambique	89.7	90.5	76.3	4.8	4.8	4.9	99.3	100.1	85.5
	Rwanda	86.2	74.8	56.5	4.3	4.6	6.5	94.6	83.3	67.5
	Somalia	97.1	95.2	86.0	4.3	4.3	4.5	105.9	104.1	94.7
	South Sudan	89.3	79.7	68.4	4.9	5.1	5.7	99.1	89.5	78.5
	Uganda	106.7	99.6	82.0	3.8	3.3	3.6	114.9	106.5	88.9
	Tanzania	89.4	90.1	77.0	4.4	4.6	5.1	98.2	99.4	86.4
	Zambia	93.8	89.1	76.2	4.1	3.7	4.1	102.0	96.4	83.7
	Zimbabwe	81.2	76.4	58.7	4.6	4.2	4.6	89.9	84.2	66.4
Central	Angola	97.4	96.1	82.5	3.9	3.9	4.6	105.3	104.1	91.3
	Cameroon	90.2	82.5	68.3	5.2	4.8	5.1	100.6	91.6	77.4
	CAR	81.2	86.1	68.8	5.9	5.5	5.3	92.6	96.9	78.3
	Chad	104.6	98.2	81.1	4.5	4.0	4.0	114.1	106.4	88.6
	Congo	78.3	80.8	69.1	5.4	5.1	6.2	88.5	90.5	80.4
	DRC	91.6	94.6	82.1	4.7	4.7	5.0	101.1	104.1	91.6
	Equatorial G.	75.7	64.5	57.9	5.7	4.6	4.2	86.4	72.4	64.8
	Gabon	80.1	61.8	54.1	8.3	6.4	7.7	96.5	72.9	66.9
Northern	Algeria	57.8	45.9	39.8	6.4	8.9	13.3	68.5	60.2	61.2
	Egypt	65.0	56.0	48.6	7.2	7.7	9.9	77.8	69.0	64.9
	Libya	56.0	44.0	33.8	5.7	6.5	11.0	65.4	54.0	50.3
	Morocco	57.1	44.3	38.4	7.7	10.0	15.7	70.2	60.3	64.2
	Sudan	85.2	78.1	64.5	4.8	5.4	6.5	94.4	88.2	75.9
	Tunisia	48.6	36.7	35.2	9.6	11.7	17.7	64.4	54.7	64.3
Southern	Botswana	65.2	51.2	41.7	4.7	6.1	8.6	73.3	61.0	55.0
	Lesotho	79.0	61.9	53.5	6.5	6.7	5.9	91.5	73.6	63.1
	Namibia	74.2	64.3	55.1	4.9	5.4	6.8	83.3	73.6	66.5
	South Africa	55.9	46.9	40.3	6.3	8.0	10.5	66.4	59.7	56.8
	Swaziland	87.4	65.4	53.3	4.7	4.8	5.4	96.5	73.7	62.1
Western	Benin	90.5	82.7	71.2	5.0	5.0	5.6	100.5	92.3	81.4
	Burkina Faso	95.6	90.1	75.4	4.3	3.8	4.4	104.5	97.7	83.5
	Côte d'Ivoire	84.2	81.2	39.2	4.6	4.7	10.2	93.0	90.3	82.8
	Gambia	92.2	90.3	75.1	4.1	3.8	4.5	100.3	97.7	83.4
	Ghana	78.2	69.3	58.3	4.8	5.2	6.5	87.2	78.7	69.4
	Guinea	87.8	81.6	69.4	5.4	5.1	5.6	98.5	91.3	79.4
	Guinea–B	89.8	78.1	65.4	4.5	4.9	5.3	98.8	87.2	74.5
	Liberia	83.5	80.3	67.3	5.0	4.8	5.7	93.2	89.5	77.3
	Mali	96.1	99.8	83.3	5.0	4.0	4.0	106.4	108.1	90.9
	Mauritania	83.0	73.4	63.9	4.9	4.9	6.2	92.5	82.4	74.7
	Niger	100.8	109.9	102.3	4.0	4.1	4.2	109.2	119.0	111.1
	Nigeria	84.3	85.8	75.3	4.7	4.5	4.8	93.4	94.5	84.1
	Senegal	89.2	82.4	68.8	5.0	4.7	5.3	99.2	91.3	78.2
	Sierra Leone	86.9	80.4	62.7	4.2	4.1	4.7	95.1	88.2	70.7
	Togo	83.4	78.6	64.7	4.6	4.5	5.4	92.1	87.1	74.1

Source**:** UN (2017)

5.4 Results

Table 8, shows the results of the three cluster analysis, Analysis 1 (1995–2000), Analysis 2 (2010 2015), Analysis 3 (2025–2030) and show country membership grouped into 3 clusters, represented by numbers 1 (low), 2 (medium), and 3 (high) for the demographic determinants and selected ageing indicators in Africa. Furthermore, the heterogeneity and homogeneity of countries were clustered using z–score averages (final cluster centres) as shown in Table 9.

In addition, the z–score averages shown in Table. 9 have been converted to bar graphs in Figure 25a, 25b, and 25c in order to demonstrate visually the differences between the determinants and indicators of population ageing in clusters for the respective periods. Moreover, the list of country cluster membership in Table 8, have been imputed into the geographical map as shown in Figure 26, to demonstrate the regional and geographical spatial clustering of the mentioned demographic variables of population ageing in Africa . Final cluster centres result from cluster Analysis (1) 1995–2000, (2) 2010–2015, (3) 2025–2030 (n=48)

In Analysis 1 (1995–2000) the results show that 6 out of 48 countries, mainly north African countries and South Africa were clustered in 3/1 with high (positive z–score) median age and percentage aged 60 plus and low (negative z–score) for TFR, RNI, IMR, child and total dependency ratios compared to other clusters. Cluster 2/1 had 14 countries with very low (positive z–score) median age and percentage above 60 plus and low (negative z–score) for TFR, RNI, IMR, child and total dependency ratios. The majority of the countries belonged to cluster 1/1 with 28 countries with very low (negative z–scores) median and percentage aged 60 plus and low positive z–scores TFR, RNI, IMR, child and total dependency ratios. This implies that in 1995–2000, clusters 1/1, 2/1 and 3/1 (58, 29 and 13 per cent) were in the early, middle and later stages of fertility decline respectively.

In Analysis 2 (2010–2015),7 (15%) countries out of 48 belonged to cluster 3/2, all North African countries (except the Sudan), plus Botswana, and South Africa with high median age and percentage above 60 plus and low (negative z–score) for TFR, RNI, IMR, child and total dependency ratios. In addition, in Analysis 2, about 24 (50%) countries out of 48 belonged to cluster 2/2 with low negative z–score values for all indicators. The remaining 17 (35%) countries were assigned to cluster 1/2 with very low (negative) median age and percentage above 60 plus and low (positive z–score) for TFR, RNI, IMR, child and total dependency ratios.

Again in Analysis 3 (2025–2030), Cluster 3/3 had 7 (15%) out of 48 countries comprises of North African countries, (except Sudan) plus Botswana and South Africa). Nevertheless, cluster 3/3 was characterised with very high positive z–score for median age and percentage above 60 plus and very low (negative z–score) for TFR, RNI, IMR, child and total dependency ratios. Cluster 2/3 had the bulk of 26 (54%) countries with low negative z–score values for all indicators. Only two countries Malawi and Central Africa Republic (CAR) moved from cluster 1/2 into 2/3. The remaining 17 (31%) countries were assigned to cluster 1/3 with very low (negative z–score) median age and percentage above 60 plus and low (positive z–score) TFR, RNI, IMR, child and total dependency ratios.

Tab. 8 – Cluster membership of African countries from Analysis 1 (1995–2000), 2 (2010–2015), 3 (2025–2030)

	Countries	Analysis 1, cluster Membership (1995–00)	Analysis 2, cluster Membership (2010–15)	Analysis 3, cluster Membership (2025–30)
Eastern	Burundi	1	1	1
	Eritrea	2	2	2
	Ethiopia	1	2	2
	Kenya	1	2	2
	Madagascar	1	2	2
	Malawi	1	1	2
	Mozambique	1	1	1
	Rwanda	1	2	2
	Somalia	1	1	1
	South Sudan	1	2	2
	Uganda	1	1	1
	Tanzania	1	1	1
	Zambia	1	1	1
	Zimbabwe	2	2	2
Central	Angola	1	1	1
	Cameroon	1	2	2
	CAR	2	1	2
	Chad	1	1	1
	Congo	2	2	2
	DRC	1	1	1
	Equatorial G	2	2	2
	Gabon	2	2	2
Northern	Algeria	3	3	3
	Egypt	3	3	3
	Libya	3	3	3
	Morocco	3	3	3
	Sudan	2	2	2
	Tunisia	3	3	3
Southern	Botswana	2	3	3
	Lesotho	2	2	2
	Namibia	2	2	2
	South Africa	3	3	3
	Swaziland	2	2	2
Western	Benin	1	1	1
	Burkina F.	1	1	1
	Côte d'Ivoire	1	2	2
	Gambia	1	1	1
	Ghana	2	2	2
	Guinea	1	2	2
	Guinea–B	1	2	2
	Liberia	1	2	2
	Mali	1	1	1
	Mauritania	2	2	2
	Niger	1	1	1
	Nigeria	1	1	1
	Senegal	1	2	2
	Sierra Leone	1	2	2
	Togo	2	2	2

Notes: Cluster number 1, 2 and 3 = low, medium and high respectively

Source of data: UN (2017) and own calculations

Tab. 9 – Final cluster centres, results from cluster Analysis 1 (1995–2000), 2 (2010–2015), 3 (2025 2030, Africa

		Demographic Indicator`							
		Child Dependency Ratio	Median Age	Total Fertility Rate	Rate of Natural Increase	Percentage Aged 60 and over	Total dependency Ratio	Infant Mortality Rate	Number of Countries
Analysis 1 (1995–00)	Z–score Cluster 1/1	0.61	–0.58	0.64	0.58	–0.49	0.59	0.58	26
	Cluster 2/1	–0.33	0.22	–0.43	–0.40	0.23	–0.31	–0.40	14
	Cluster 3/1	–2.07	2.18	–1.97	–1.76	1.76	–2.03	–1.75	6
	Anova Test F–value	89.62	103.12	85.03	40.38	28.14	71.77	39.61	
	P	****	****	****	****	***	****	****	
Analysis 2 (2010–15)	Z–score Cluster 1/2	0.93	–0.77	0.95	0.86	–0.59	0.96	0.66	17
	Cluster 2/2	–0.11	–0.06	–0.17	–0.13	–0.15	–0.15	–0.02	24
	Cluster 3/2	–1.88	2.08	–1.70	–1.63	1.96	–1.80	–1.53	7
	Anova Test F–value	122.00	145.94	74.96	46.69	54.35	104.06	23.09	
	P	****	****	****	****	**	****	**	
Analysis 3 (2025–30)	Z–score Cluster 1/3	1.05	–0.82	1.08	0.98	–0.63	1.11	0.67	15
	Cluster 2/3	–0.13	–0.09	–0.19	–0.08	–0.18	–0.27	0.00	26
	Cluster 3/3	–1.76	2.09	–1.59	–1.79	2.01	–1.39	–1.44	7
	Anova Test F–value	107.66	150.19	74.97	82.52	66.77	58.74	18.53	
	P	****	****	****	****	**	****	**	

Notes: Significance levels ****P<0.001, ***P<0.01, **P<0.5

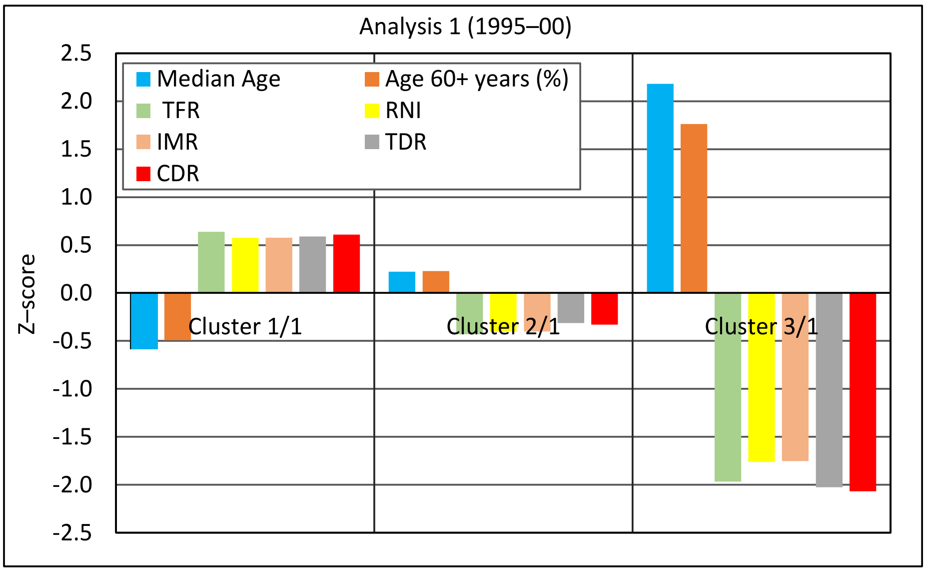
Source of data**:** UN (2017) and own calculations

The results in 9, further reveals that in cluster Analysis 1 (1995–2000) the most important factor for the differentiation of the demographic profile and ageing in cluster 1/1 was TFR with positive z–score of 0.64. The high TFR keeps the median age and percentage above 60 plus negative. This shows the cluster had a youthful population structure. Furthermore, Table 9 shows that cluster 1/1 in relation to other clusters 2.1 and 3.1 had the highest TFR. In addition, cluster 1/1 had the majority of 28 countries mainly from Eastern, Central and Western Africa in 1995 2000. Cluster 3/1 had the highest negative z–score TFR of all the clusters of –1.97 compared to all other clusters. The RNI, IMR, child and total dependency ratios z–scores had the highest negative z–scores to all other clusters. On the contrary, cluster 1/1 had higher positive z scores for (TFR, RNI, IMR, child) and lowered negative z–scores for total dependency ratios, median age and percentages above 60 plus than other to clusters 2/1 and 3/1 for this period. The Median age and percentage above 60 had positive highest z–score for the analysis period as compared to other clusters. Cluster 3/1 had the highest median age and percentage above 60 plus and a corresponding lowest TFR, RNI, IMR, child and total dependency ratios. This cluster consisted of Algeria, Egypt, Libya, Morocco, Tunisia, and South Africa (see Table 8).

The results indicate that Analysis 1 (1995–2000), (top panel in Table 9, Figure 25a and 26) cluster 3/1 have experienced significant fertility decline which had caused infant mortality rates, the rate of natural increase, child dependency and total dependency ratio to be negative whilst median age and percentages aged 60 plus increased. This pattern was similar to cluster 2/1 to a slight extent. In summary, cluster 1.1 was the opposite of 2/1 and 3/1 because it is in the early stages of fertility decline while the 2/1 and 3/1 were in the middle and advanced stages of the demographic revolution respectively. Consequently, this suggest the that majority of the countries

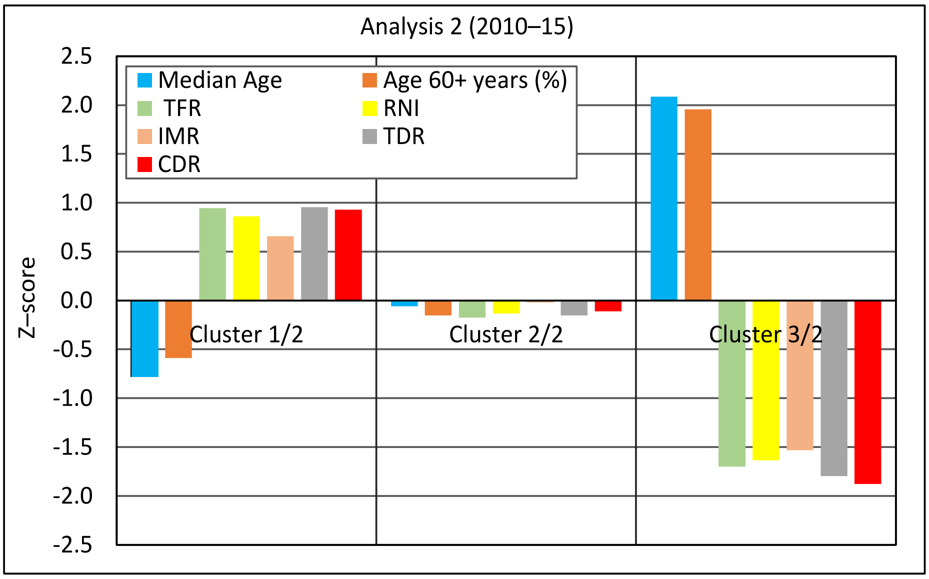
(58%) were in analysis 1 and cluster 1/3, had a predisposition towards youthful population age structures whilst, 30% and 13% of total countries in cluster 2/1 and cluster 3/1, respectively, had experienced significant fertility decline (see Table 7 with indicators in absolute terms

Fig. 25a – Z–score bar graphs, Analysis 1 (1995–2000), Africa



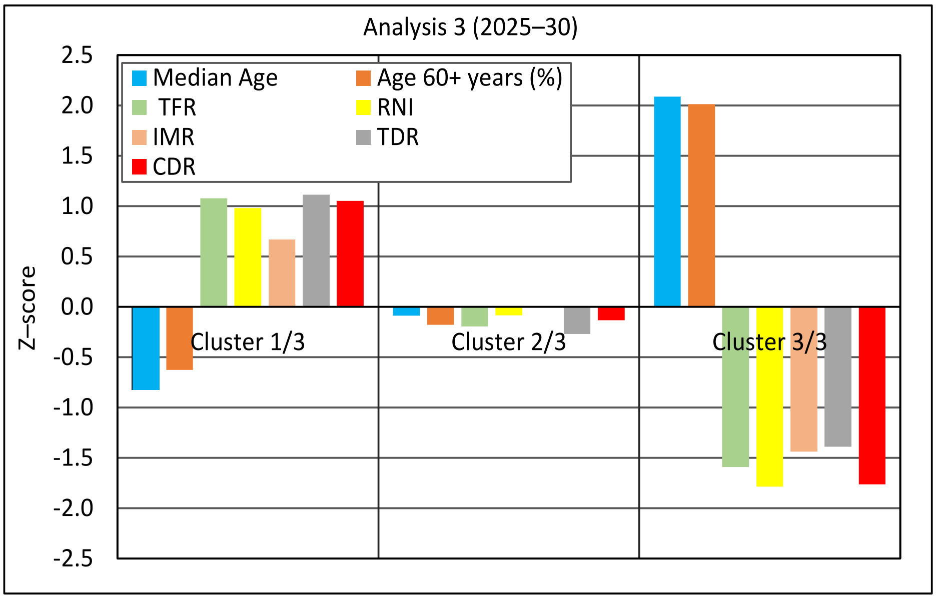
Source of data: UN (2017) own calculations

Fig. 25b – Z–score bar graphs, Analysis 2 (2010–2015), Africa



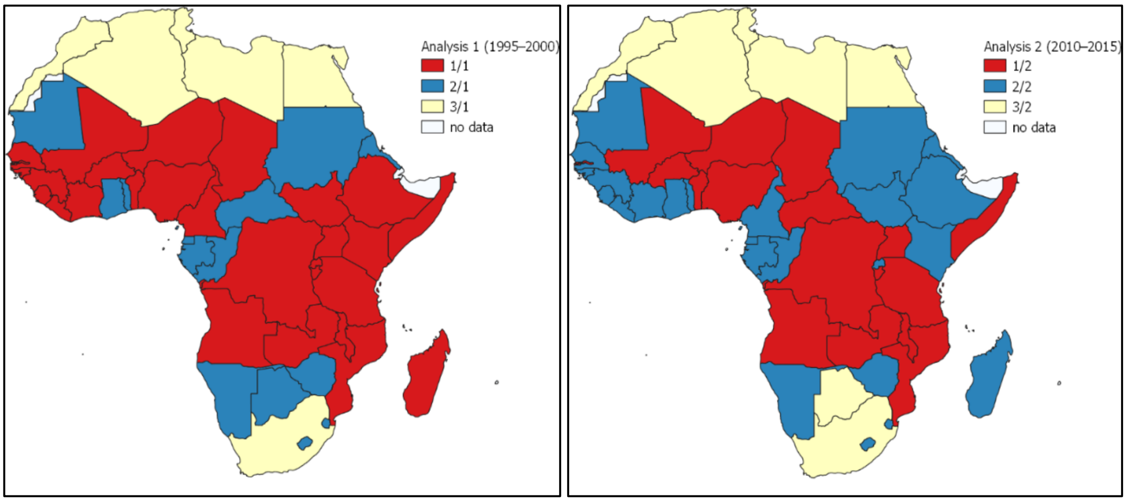
Source of data: UN (2017) own calculations

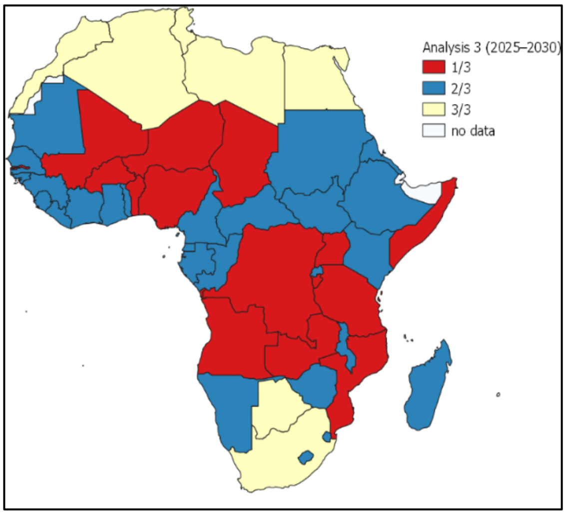
Fig. 25c – Z–score bar graphs, Analysis 3 (2025–2030), Africa



Source of data: UN (2017) own calculations

Fig. 26 – Clustering of African countries based on final cluster centres of demographic indicators in Analysis 1 (1995–2000), 2 (2010–15), 3 (2025–2030)





Source of data: UN (2017) and own calculations.

Furthermore, analysis 2 (2010–2015) depicts the spatial demographic determinants, and ageing indicators for Africa was differentiated into three clusters namely 1/2, 2/2, and 3/2 (See Middle panel in Table 9, Figure 25b and 26). The positive TFR z–score in the cluster showed that it was the most important variable. The positive TFR z–score kept RNI, IMR, child and total dependency ratios also high and positive. High TFR also kept median age and percentage of aged 60 plus negative. Table 8, shows the group consisted of Central, Eastern and Western African countries. Cluster 3/2 was the opposite of 1/2 with high negative TFR z–score of –1.70. The TFR negative z–score kept RNI, child and total dependency ratios also negative, while median age and percentage above 60 plus were positive (highest) as compared to other clusters. In this cluster, 3/2, Algeria, Egypt, Libya, Morocco, Tunisia, South Africa were joined by Botswana (Table 8) In Cluster 2/2 TFR was slightly negative, which made all the variables to be negative and the cluster 2/2 was sandwiched between cluster 1/2 and 1/3. Furthermore, the results show that some countries shifted in clustering from cluster 1/1 (1995–2000) to 2/2 (2010–2015). Consequently, the nine countries shifted, and the number of countries increased from 14 to 24 in the respective periods. While Botswana moved out of cluster 2/1 in 1995–2000 to cluster 3/2 in 2010–2015. Due to fertility decline, cluster 2/2 was in the third stage of the demographic revolution. The number of countries in cluster 2/2 increased as more countries experienced further significant fertility declines from analysis 1 (1995–2000) cluster 1/1.

Countries in clusters 3/2 had experienced significant fertility decline which caused other demographic variables to change, causing ageing of population age structure– which was predominated by young adults (demographic dividend period). Countries in cluster 2/2 were in the middle of fertility decline with 50% of the countries while 35% of countries in cluster 1/2 were in the early stages of fertility decline (dominated by more children and few elderly). Cluster 1/1 had a young age structure while cluster 2/1 had a predominance of population ageing *(*See Table. 8, Table. 9 and Figure. 25).

Analysis 3 (2025–2030), shows countries were clustered into three 3 groups representing their geo–demographic determinants and ageing indicators (Middle panel in Table 9, Figure 25c and 26). Cluster 3/3 had the highest negative z–score TFR of –1.59 compared to other clusters. This negative z–score TFR causes the rate of natural increase, infant mortality rate, child and total dependency ratios also to have very high negative z–scores while the median age and percentages above 60 was very high (positive z–score) compared to other clusters. The cluster consisted of 7 countries, Algeria, Egypt, Libya, Morocco, Tunisia, Botswana, and South Africa. Cluster membership countries did not change from analysis 2010–2015, cluster 3/2.

An interesting observation was that cluster 1/3 was the opposite of 3/3. It had a declining high TFR which contributed to high rate of natural increase, infant mortality rate, child and total dependency ratios and lowest (negative z–score) median age and percentages above 60 plus compared to other clusters. In this cluster, membership decreased by two countries as Cameron and Malawi moved into cluster 2/3 resulting in the number of countries increasing from 24 to 26 Cluster 2/3 was characterised by slightly negative / or near zero scores, which causes all the other demographic variables to be slightly negative near zero. Two more countries, Malawi and Cameroon joined cluster 2/3 from analysis 2 (2010–2015), and its member countries increased from 24 to 26.

In summary, it is projected that from 2025–2030 countries in cluster 3/3 will be on their way to complete the demographic revolution with at or near replacement fertility level and maturing of the population age structure. Countries in the cluster 2/3 will be passing into the middle fertility transition. Lastly, countries in cluster 1/3 would be in the early stages of fertility decline and still experiencing high fertility.

Looking at the F–value in cluster Analysis 1(1995–2000) in Table 9, the most important variables contributing to the spatial clustering regarding demographic variables contributing to population ageing of the African region were median age (103.12), child dependency ratio (89.62), (TFR, 85.03), total dependency ratio (71.77), rate of natural increase (40.38), infant mortality rate (39.61) and percentage aged 60 years and over (28.14). All the variables made a significant contribution to the spatial clustering with regards to demographic indicators of the countries except for the percentage of the population aged 60 plus which contributed the least (28.14) because during this period the majority of countries had young population age structures.

According to F values in Cluster Analysis 2 (2000–2015), it can be observed that infant mortality contributed the least (23.09) as compared to the other determinants and demographic indicators of population ageing in Africa. However, the percentage aged 60 plus almost doubled between Analysis 1, (1995–2000) to Analysis 2, (2010–2015) thus showing the rapid changing of population ageing. According to F–values in Analysis 3 (2025–2030), indicate a slight change in the variables which contributed to geographical spatial clustering for the period 2010–2015 and 2025–2030. However, a significant difference is noted in the F–values for the above mentioned periods for total dependency ratio (104.06 and 58.74) and the rate of natural increase (46.69 and 82.52) respectively.

This implies that the rate of transition in Africa is not the same. For instance, the rate of natural increase and the total dependency ratio almost doubles from cluster analysis 2 and 3. Therefore, the countries in Cluster 3/3 analysis (2025–2030), were in the last stages of the demographic revolution (ageing) characterised by very high median age and percentage above 60 plus and a concomitantly low TFR (near replacement rate), very low rate of natural increase, low child and total dependency ratios, and infant mortality rates. In analysis 3, Cluster analysis 2/3 (2025–2030) was characterised by countries with a young population age structure and a preponderance towards ageing. Lastly, cluster 1/3 shows 15 countries that are lagging in their demographic profiles and ageing, with very young population age structures and very small percentages of elderly.

5.5 Discussion and conclusion

The findings from this study suggest that determinants and indicators of ageing in Africa can be divided into three clusters for each analysis period: 1995–2000, 2010–2015 and 2025–2030. The number of countries in the first cluster decreased (early phase of fertility transition), as the number of countries in the second cluster increased (middle phase fertility transition) from 1995–2000 to 2010–2015, respectively. The last and smallest cluster 3 (last phase of transition) stays relatively the same number of countries in the periods under study. Majority of countries were stagnated in the middle cluster and failed to move to cluster three. The fertility and mortality in African countries decline at different intensities creating different ageing profiles and show regional variation. This is in line with other studies in Africa (Pillay and Maharaj 2013, Bloom, Mitgang and Osher 2016, Nabalamba and Chikoko 2011). However, middle–income countries of North Africa and Sothern Africa (in cluster 3) are ahead in the demographic revolution, and least developed countries of Sub Saharan Africa are trailing behind. This suggests that in a way, regional and socioeconomic development is related to the demographic revolution.

In Africa (2010–2015), there are about three distinct clusters of determinants and profiles of population ageing based on the demographic revolution theory. The first group with about 35% of countries had a predominance of young children, low median ages, high TFR, IMR, total dependency ratios and percentages above 60 and over. This group of countries just entered the second stage of the demographic revolution characterised by the early stage of fertility decline and rapid population growth. There made up about 60%, 35% and 31% of total countries in 1995 2000, 2010–2015 and 2025–2030 respectively, which meant a significant number of countries experienced further fertility and mortality decline and moved out into the second cluster in 2010–2015 and 2020–2030. Also, fertility and mortality decline was accompanied by a concomitant upward age structural change increase. This is typical and consistent of the demographic revolution as postulated by demographic transition theory (Notestein 1945, Dyson 2013), as expected, the second cluster's share of countries grew significantly from 29%, 50% and 54% from the periods under discussion respectively. This is consistent with Notestein's (1945, 1953) formulation that countries reduce mortality and fertility as they develop.

Lastly, the third cluster's share of countries remained stagnant at about 7% for the respective periods. Only Botswana moved from cluster 2 (1995–2000) to cluster 3 in (2010 2015) The presence of Botswana and South Africa in this cluster and absence of Sudan is not consistent with other studies revealing North African countries as a homogeneous group and distinctly different from sub–Saharan Africa (Yüceşahin and Tulga 2017, Ferreira and Kowal 2006, Velkoff and Kowal 2006, Nair 2014). Lack of movement by all countries in the second cluster to the third cluster might be related to fertility stalling in a significant number of sub Saharan Africa countries (Garenne 2013, Goujon, Lutz and Samir 2015, Bongaarts 2006). Although the causes of fertility stalling are beyond the scope of this paper, and we recommend further investigation with appropriate demographic techniques. However, plausible causes of fertility stalling have included impact of HIV/AIDS through increased child mortality, lower priority assigned to family planning as funds were directed to HIV/AIDS pandemic and slower trends socioeconomic development (Goujon et al 2015, Garenne 2013, Bongaarts 2006, Lutz et al. 2015)

Cluster 3 (North Africa region, South Africa and Botswana), are characterised by countries with predominant young adults and elderly populations are already in need of efficient policies that cover the needs of current elderly and an emerging predominant elderly population by 2030. However, currently, there is a need to reap the benefits of the demographic dividend, and at the same time, take care of the elderly. In contrast to the European experience, the North African countries' failure to meet the needs and expectations of an ever–growing young adult population in terms of employment, housing, and health (Groth and May 2017). Consequently, around 2010 North African countries experienced revolts and social upheavals commonly referred as the

''*Arab springs/Awakening*'' in academic literature and the popular mass and social media (Yüceşahin and Tulga 2017, Groth and May 2017)

In 2010–2015 most African countries were in 2/2 cluster (middle stage of fertility revolution), although the majority of countries has experienced fertility stalling, the risk of population ageing is very real considering the tempo and magnitude of population ageing in Africa (Pillay and Maharaj 2013). The countries are likely to be simultaneously faced with the twin burden of a youthful and ageing population at the same time. Most sub–Saharan countries (in cluster 2 and 3) have faced increased mortality due to the HIV and AIDS pandemic. Age specific mortality patterns of HIV and AIDS kill more young adults than the elderly. This age–specific mortality pattern initially makes the population appear aged (Pillay and Maharaj 2013). Unlike developed countries, it means developing countries affected by HIV and AIDS might face a double burden of infectious diseases and non–communicable diseases simultaneously. However, sharing local knowledge and experiences can enable and enhance governments' preparedness to take care of the increased number of orphans and the elderly.

Moreover, 85% of countries which are in clusters 1 and 2 (early and middle stages of fertility decline) are still experiencing population growth, and high mortality from infectious diseases (Omran 2005). Interestingly, the UN (2012) Report on Population Ageing and non communicable diseases using non–communicable standardised deaths rates has highlighted that non–communicable diseases deaths are now higher in Africa than in developed countries. Non communicable diseases are chronic and expensive to treat for poor countries. This means developing countries in the early stages might face a double burden of diseases: non communicable and communicable, simultaneously. The situation will be exacerbated by population ageing. Countries in cluster 1 and 2 have higher mortality and fertility rates than countries in cluster 3. High mortality rates especially infant mortality rates, are related to high TFR through child replacement and hoarding (Pavlík 1980). Infant mortality decline to lower levels should theoretically lead to fertility decline in the least developed countries.

Bongaarts (2014) though, has argued that even in the least developed countries, women might not necessarily want a high number of children but lack access to family planning. Women have a high unmet need for contraceptives. Family planning programmes have also been noted to create demand for contraception through diffusion–innovation and adoption of contraceptive behaviours even in poor countries and drive fertility down (Cleland and Wilson 1987, Cleland 2001 Bongaarts 2014). Maybe there is mutual interaction of fertility determinants. It might be feasible that ageing in cluster 1 will happen at low socioeconomic development levels.

In conclusion, given that fertility has a strong effect on population ageing and most of the countries are experiencing fertility stalling, we recommend that countries should invest more on determinants of fertility stalling/decline including access to family planning, women empowerment, and socio–economic development to achieve further fertility decline to replacement level. Moreover, since the demographic window of opportunity is short countries need to prepare to avoid demographic disaster. Therefore, countries within a classification can share knowledge and experiences to meet the human development needs of the elderly. However, further research is needed to look at intra country and gender differentials of population ageing and their policy implications.

Chapter 6

The demographic revolution in Zimbabwe

6.1 Geographical, political, and socioeconomic profile

This section presents the background characteristics of Zimbabwe, which are crucial in influencing the demographic revolution in Zimbabwe. First, the geographical setting and political history of Zimbabwe are reviewed, followed by a brief discussion of the demographic characteristics, the agrarian and land settlement structure and socioeconomic characteristics. A historical perspective is incorporated into the discussion because the current demographic and socioeconomic conditions in Zimbabwe are a result of the precolonial period (before 1890), about a century of colonialism (1890–1980), and post–colonial independence of 1980. Studies have noted the importance of history in understanding contemporary Zimbabwe (Jhamba 1995 Brownell 2010).

6.1.1 Geographical positioning

Zimbabwe is a landlocked country located between 15° and 23° S latitudes and 25° and 34° E longitudes in Southern Africa. It is bordered on the south by South Africa, on the west and southwest by Botswana, on the northwest by Zambia, and on the southeast by Mozambique. The majority of the nation is flat, composed of a central plateau (high veld) with elevations extending from the southwest to the north. Most of the nation is elevated, composed of a central plateau (high veld) stretching northward from the northeast at elevations between 1,000 and 1,600 m. The extreme west of the country is mountainous, known as the Eastern Highlands, with Mount Nyangani at 2,592 m as the largest point. Zimbabwe has an estimated of about 390 759km^2 of total land area.

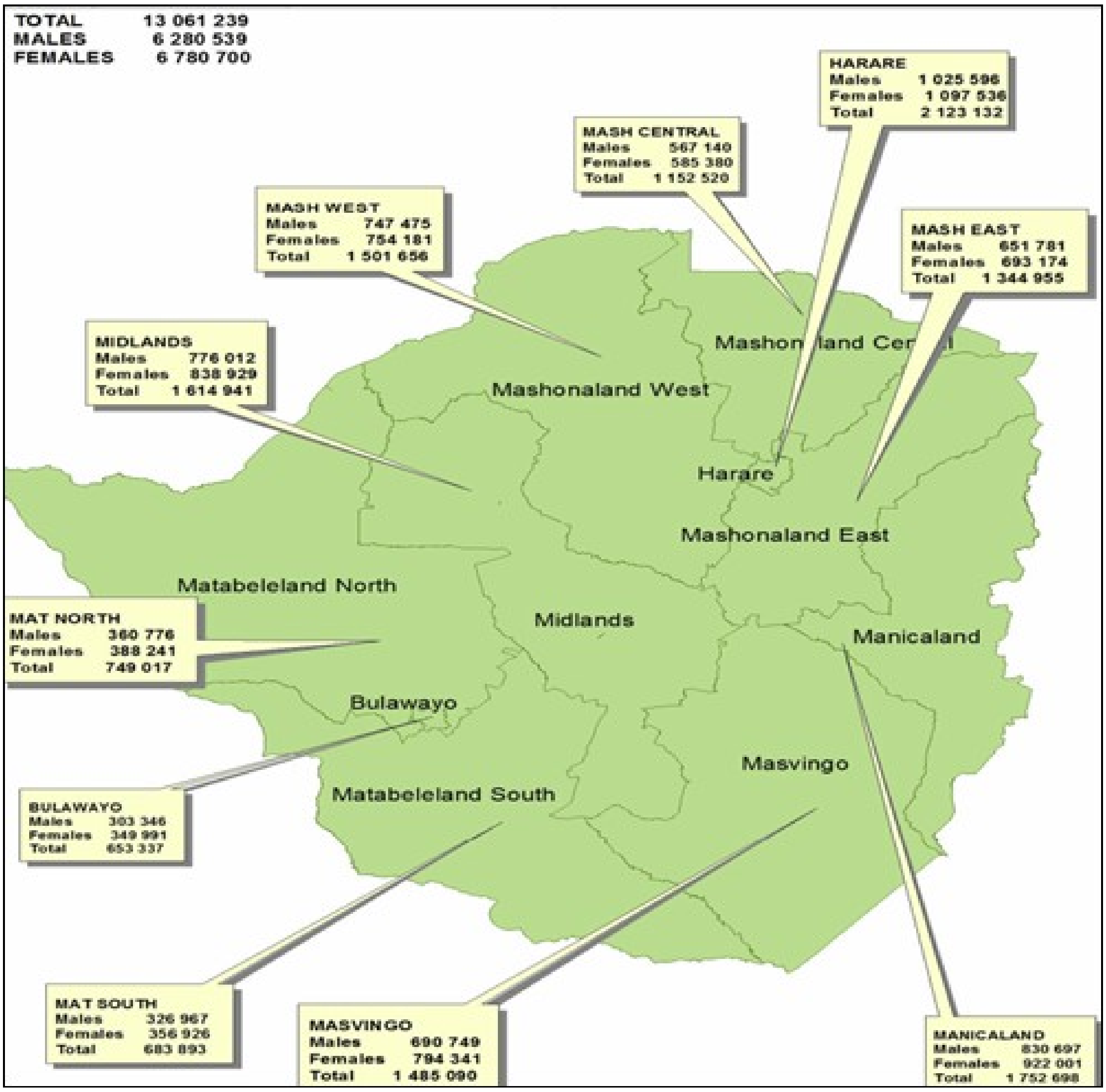
6.1.2 Climate and environment

With many local differences, Zimbabwe has a tropical climate. The Southern regions are known for their heat and aridity, sections of the central plateau get freezing temperatures in winter, the Zambezi valley is also known for its intense heat temperatures, and the Eastern Highlands generally experience cool temperatures and the country's most rainfall. The rainy season of the country usually runs from late October to March and growing altitude moderates the warm climate. Zimbabwe is facing recurring droughts, the latest from early 2015 to 2016. Wildlife has been decreased by deforestation and poaching. Due to population growth, urban development and absence of fuel, woodland degradation and deforestation are significant concerns and have resulted in erosion and land degradation that decrease fertile soil. Environmentalists have also criticised local farmers for burning off vegetation in order to heat their tobacco barns.

6.1.3 Political history

Zimbabwe has moved from precolonial (before 1890), the colonial period and the post–colonial period. During the precolonial period, two main tribal groups lived in Zimbabwe, namely the Shona and Ndebele. The Shona, who were mainly agriculturalists and traders, occupied the northern and Eastern parts of the country. The Ndebele, who were mainly pastoralist and occupied the drier region around the modern day city of Bulawayo in the south–west and carried out regular raids on the Shona to obtain grain stock, animals and women (Zanamwe 1996, Brownell 2010 Jhamba 1995).

Fig. 27– National and provincial population size, 2012, Zimbabwe



Source: ZIMSTAT (2012)

The colonialization of Zimbabwe began in 1890 led by Cecil John Rhodes, after whom the country adopted its colonial name Southern Rhodesia. Colonial discriminatory laws such as the ‘’Land apportionment act of 1930’’ and ‘’Land tenure act 1969’’ segregated settlement and other resources according to racial lines in favour of the white minority. Precisely the white population occupied fertile, cooler and better rain Highveld which was divided into large scale commercial farms and was easily accessible by infrastructure and communication lines. In contrast, the Africa population was forcibly moved into (Tribal trust lands) which were dry rock, inaccessible, poorly serviced (roads, education, health etc.) and marginally productive. However, some relatively productive areas were reserved for the purchase by African farmers. About equal sizes 40 and 42 per cent of the land was reserved for whites and blacks, respectively, despite the white population numbering less than 5% of the population (Brownell 2010, Zanamwe 1989, Jhamba 1995).

The fighting for independence intensified in Zimbabwe as across everywhere in Africa. In 1965 the colonial government defied orders from the British government to grant political independence to Africans. The colonial government declared a Unilateral Declaration of Independence (UDI) in 1965 from Britain. However, after 14 years of combined forces of the political independence war, sanctions from the UN and World Bank, etc., political independence was granted to African liberation movements (Jhamba 1995 Brownell 2010). A government was formed under the leadership of Robert Mugabe in 1980.

6.1.4 Political and Administrative divisions

Zimbabwe has a centralised government and, for administrative reasons, is split into eight provinces and two provincial cities (Harare and Bulawayo). Each province has a provincial capital from which the administration of government generally takes place (Figure 27).

The provinces are further sub–divided into 59 districts and 1,200 wards and 32 urban municipalities. An appointed District Administrator is responsible for each district. A Rural District Council is also in place, appointing a chief executive. The Rural District Council is made up of elected councillors from the ward, the district administrator and one representative from the district chiefs (traditional rulers appointed under customary law). There is a Ward Development Committee at the ward level, which includes the elected ward councillor, the kraalheads (traditional rulers subordinate to chiefs) and representatives of village development committees. Wards are divided into villages, each with an elected Village Development Committee and a Headman (traditional Kraalhead leader) (ZIMSTAT 2012)

6.1.5 Health

The Ministry of Health provides a large part of the health provision. Voluntary agencies such as missionaries’ hospital are also visible, especially in rural areas. Private sector provision of health services is limited to urban areas. Further, the public health delivery system is ordered hierarchically with each lower case refereeing severe cases to the next higher level. There are ten provincial hospitals in Zimbabwe with 62 district hospitals and 2500 rural and urban district smaller clinics. In pre–colonial, there was no access to modern health services. Dual health system– In the colonial period, access to health was biased towards the white. Provision of health for the African in the rural areas was left in the hand s of the mission health facilities. Infectious diseases such as measles, malnutrition, pneumonia diarrhoeal diseases, and neonatal tetanus were the major causes of infant and child mortality. Under–five malnutrition was most significant among children of labourers on large scale commercial farms, labourers, mine workers, with urban children having the lowest levels malnutrition (Jhamba 1995).

The provision of preventive services to the rural population was very limited because the clinics operated basically as a curative centre and were often inadequately staffed. Hence a significant number of people suffered from diseases that could be prevented. In the 1976/77 financial year, only 10% of the health budget was allocated to the preventive services, and of this, only 17% went to field operations intended to cover rural population (Ministry of Health 1979, cited in Agree 1986: 362).

The government in 1980 was faced with the problem of redistributing and increasing health care resources in order to ensure improved conditions for the majority of the population. The government adopted a policy of *"Equity in Health*" which primarily aimed to redress inequity in health care through a comprehensive, integrated strategy based on the primary health care approach and focusing on the goal of health for all by the year 2000. MDG goals. The new approached involved a shift of resources from urban areas to rural areas and from curative to preventive services. As a first step in improving access to health services for the economically disadvantaged public health services were made free for low–income groups earning below the threshold of $ Z$150 per month which was increased to $400 in 1992). In 1986 the minimum wage was raised to Z$158 so that theoretically only the unemployed benefited from free health care (Sanders and Davies 1988). Currently, the only children (<5 years) and old age are eligible for free medical services in Zimbabwe.

His primary health care (PHC) approach envisaged the establishment of a rural health centre within the 8km radius for every household. In addition to the construction of new rural health centres, the existing rural clinics, which were primarily curative outpatient stations doing no outreach work and limited preventive care, were upgraded to function as rural health centres. The rural health centre provides basic but comprehensive preventive, curative and rehabilitative services, concentrating on maternal and child health (ante–natal care, delivery of uncomplicated birth family planning child health, nutrition and routine immunisations) environmental sanitation, control of communicable diseases and general curative care. The PHC program included the training of village health workers chosen from their respective villages. VHW were trained in basic health promotion, hygiene mobilising villages for the construction of toilets, wells and boreholes etc. (Agere 1986).

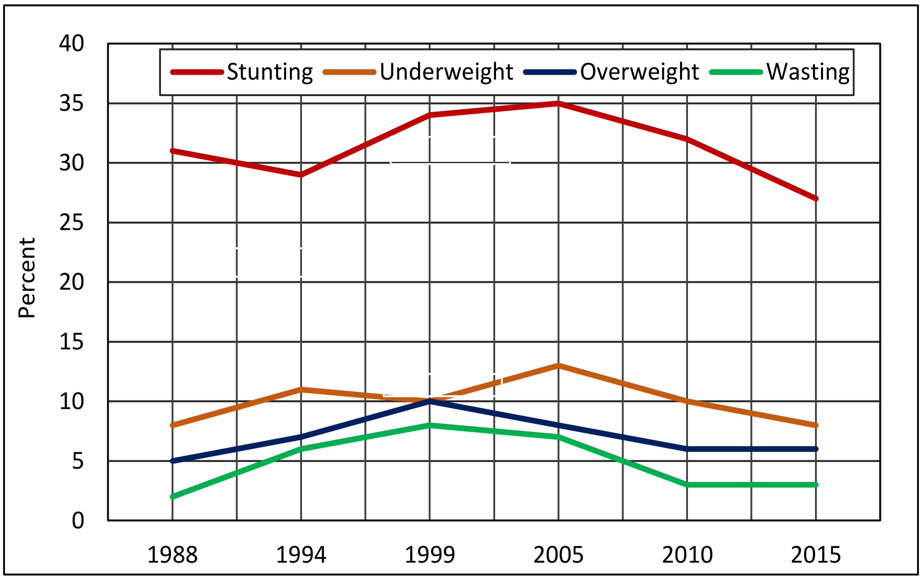
Even though over 1,500 health services presently exist throughout the nation, some places are not yet serviced and are still challenging to reach. The government provided health services dominates Zimbabwe's health system, which offers an approximately 65% of the country's health care facilities. In rural regions, the mission (faith–based) industry plays a significant role, courtesy of the colonial legacy, while the private–for–profit industry plays a significant role in metropolitan regions. Municipalities run some facilities and receive public block grants. Most communities live within 5 kilometres of their closest health centres, while 23% live between 5 and 10 kilometres and 17% are more than 10 kilometres from their closest health centre. Because of the presence of both traditional and biomedical systems, health care in Zimbabwe has been classified as pluralistic. Historically, Zimbabwe has concentrated on primary health care, with a great focus on community–based methods and robust referral systems and equipment (Dodzo and Mhloyi 2017).

6.1.6 Family Planning services

Family planning is a fundamental aspect of maternal and child health care in Zimbabwe. The use of FP could improve child health and survival by reducing the incidence of pregnancies, for example, by preventing early teenagers, old age and closely spaced pregnancies. In 1953 modern FP was introduced as a voluntary organisation targeting the white population. With growing concern about the rapid population of the African population, Family planning was later introduced to the African population in the 1960s. However, it was not accepted by Africans as it was seen as a political gimmick to limit the African population. Moreover, the FP introduction timing was with the liberation war. African nationalist discouraged adoption of FP. After independence, the Government of Zimbabwe (ZNFPC) under the umbrella of the ministry of MHCW (ZNFPC 1985). The sources of FP are community–based distributors (CBD) and clinics of ZFP, government hospitals, clinics, rural health centres, NGOs, as well as private physicians and pharmacies. However, CBD and ZNFPC clinics are the most popular. The CBD are trained to educate and motivate and supply pills and condoms to clients in their homes, and they are members of the communities in which they service. Prevalence of any method of modern contraceptives from 36% in 1988 to 66% in 2015. Proportion currently married using, knowledge, source etc. decrease in the desired size.

6.1.7 Nutrition

Fig. 28 – Percentage of children under age 5 years old classified as malnourished, 1988–2015, Zimbabwe



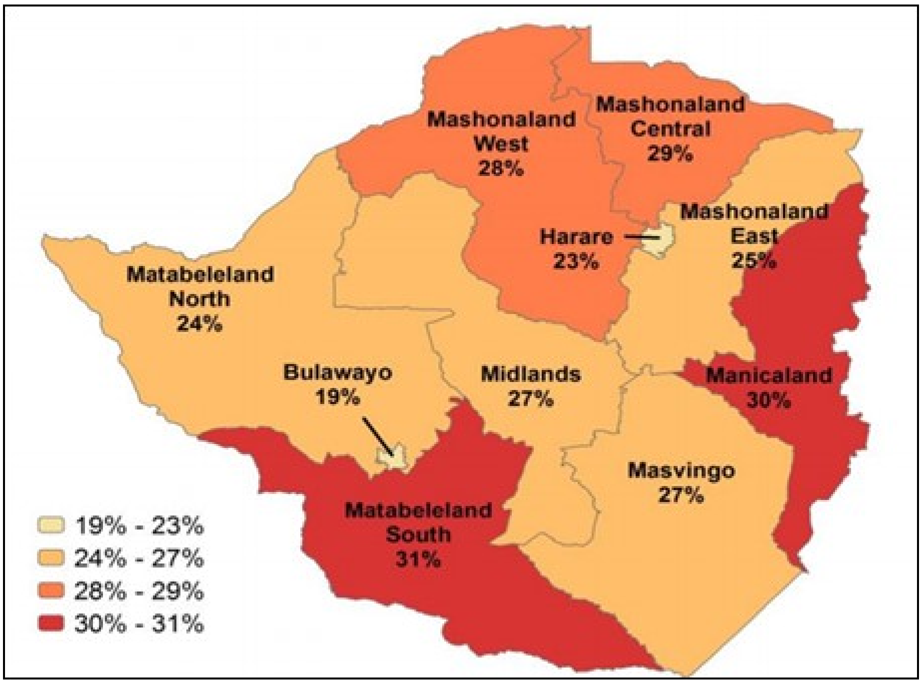
Source: Zimbabwe Demographic Health Surveys (ZDHS)

Malnutrition results from eating a diet that does not contain sufficient nutrients or too much to cause health problems. Diseases include undernutrition and over–nutrition. Overnutrition can lead to obesity and overweight. Overnutrition in the form of obesity in some Zimbabwe is starting to occur in the same societies as undernutrition (ZIMSTAT and ICF 2016).

Figure 28, shows overview of trends in dietary status in Zimbabwe, the incidence of kids stunted underweight and wasted increased moderately from 1988 to 2005–06, the incidence of stunting underweight and wasting has decreased gradually to rates below or similar to 1988 since 2005–06. Over the same era, the percentage of underweight kids increased from 2% in 1988 to 10% in 1999, before decreasing to 6% in 2010/11, whereas in 2015 the percentage remained the same.

Figure 29 shows percentage of children under age of 5 years' stunting differs from province to province and is highest in Southern Matabeleland (31%) and lowest in Bulawayo (19%). The ZDHS shows that stunting is highest among kids whose mothers have no schooling (45%) and lowest among kids whose mothers have more than secondary schooling (9%). The incidence of overweight, on the other hand, is the lowest among kids whose mothers have more than secondary education (9%). Moreover, with growing household wealth, the incidence of stunting waste and underweight usually reduces. Moreover, the prevalence of overweight, by comparison, rises with growing wealth.

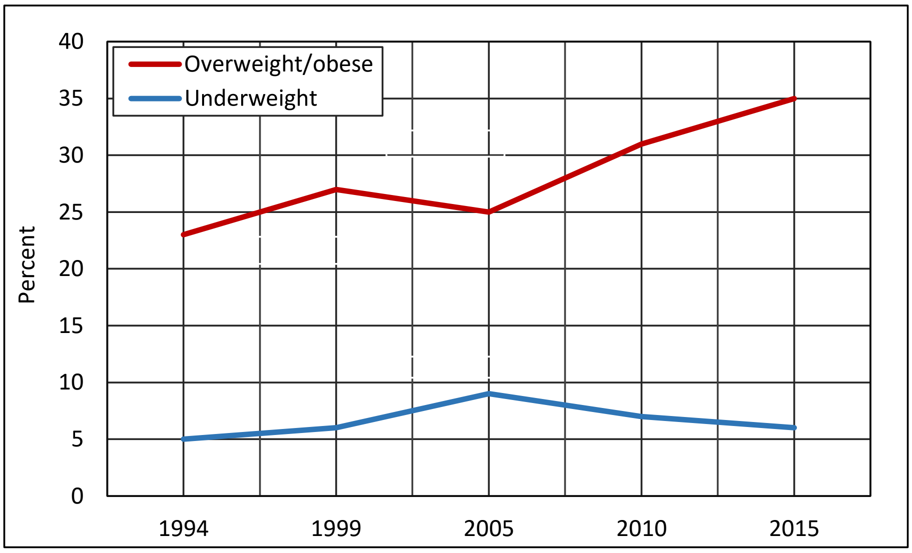
Fig. 29 – Percentage of children under age 5 years who are stunted by Zimbabwe's provinces 2015



Source: ZDHS

Figure 30 shows that obese/overweight among women 15–49 increased by 52% from 23% to 35% from 1994 to 2015, while underweight percentage remained relatively the same at about 6% for the same period. Urban women were more likely to be overweight or obese when compared with their rural counterparts. Women in metropolitan cities (Harare and Bulawayo were overweight or obese (46 and 48% respectively). Overweight and obesity increases with wealth and generally with education. For example, 19% of women in the lowest wealth quintile are overweight or obese compared with50% of women in the highest wealth quintile (DHS 2015). The fact that childhood malnutrition coincides with an onset of adult obesity indicates that the main issue in Zimbabwe's families may not be food security, but inadequate sanitation and inadequate health care services. Besides, insufficient food consumption, unfavourable child feeding habits and the burden of repeated infections (primarily acute respiratory infections) and illnesses (diarrhea) present a particular danger of malnutrition to young kids

Fig. 30 – Trends in nutritional status among women 15–49 years, 1994–2015



Source: ZDHS

6.1.7 Economy

A significant stimulus to economic growth was the establishment of the railways that reached Bulawayo from South Africa in 1987, linking with Salisbury in 1902, linking Beira port (Mozambique) with Umtali 1898, linking Salisbury–Umtali in 1899. The railways enabled easy movement of goods services and information between Zimbabwe South Africa, Mozambique, and Europe. The Zimbabwe economy has primarily been agro–based and supported by mining.

The Zimbabwean economy has faced many challenges since 2000, including high unemployment rates. In 20003 the World Bank reported that 81.8% of the secondary school leavers in Zimbabwe were unemployed in the period 1999–2000. According to Central Statistical office (2008), Inflation reached unprecedented levels of 164 900% in February 2008 Simultaneous with hyperinflation the Zimbabwean dollar was devalued to the extent of Z$100 000 0000 000 was equivalent to US$2.5 in January 2009. However, the currency stabilised after that in 2009, after the formation of the government of national unity between two major political parties ZANU–PF and MDC. The economic meltdown has forced many people to leave the country as economic refugees. Majority of the people have migrated to neighbouring countries, and the preferred overseas destinations were the United Kingdom, Canada, Australia.

Zimbabwe is naturally endowed with human and natural resources. It has the potential to develop successfully given the country's available natural and human resources, as well as technology. Before the 2000 land redistribution program, Zimbabwe was considered the South

African region's breadbasket, being self–sufficient and a net food exporter. In 1998 to 2000 and beyond, the nation encountered adverse development. This was triggered by several variables such as hyperinflation in extended droughts and a critical foreign exchange shortage.

6.1.8 Agriculture

Traditionally, Zimbabwe's commercial agriculture sector was a source of exports and foreign exchange, providing 400,000 employment. However, the government's land reform program has severely damaged the sector, turning Zimbabwe into a net importer of food products. For example, annual wheat production dropped from 250,000 tons to 60,000 tonnes between 2000 and 2016 maize dropped from two million tons to 500,000 tons, and beef cattle killed fell from 605,000 tons to 244,000 tonnes. The International Crops Research Institute for Semi–Arid Tropics (ICRISAT) has been helping Zimbabwean farmers embrace conservation farming methods for the previous ten years, a viable farming technique that can assist boost returns. Farmers can enhance infiltration, decrease evaporation and soil erosion, and build up organic soil content by implementing the three principles of minimum soil disruption, legume–based cropping and the use of organic mulch. In the period 2005 and 2011, the number of smallholders practising conservation farming in Zimbabwe risen from 5000 to over 150000. Cereal yields in separate areas grew between 15% and 100%.

6.1.9 Water, Sanitation, and Electricity

According to ZIMSTAT and ICF (2016), 33% of families in Zimbabwe have power. Over 80% of families in urban regions have electricity energy contrasted to just 10% of families in rural areas. In Zimbabwe, more than seventy–five per cent of households has an improved water source. Access to improved water is practically universal in 97% and 69% in rural and urban areas, respectively. More than one–fourth of families (29%) spend at any rate 30 minutes (round trek) to acquire drinking water. About 33% of household units have an improved toilet facility, while 30% have a facility that would be considered improved if it was not shared. 33% of family units have an unimproved toilet facility, including 23% that do not have any sanitation office whatsoever.

6.1.10 Science and technology

Zimbabwe has a comparatively well–developed domestic infrastructure and a long tradition of encouraging research and development (R&D), as demonstrated by the market research tax enforced on tobacco growers since the 1930s. The nation also has a well–developed education scheme, with one in eleven adolescents holding a tertiary degree. Given the strong knowledge base of the country and the abundance of natural assets, Zimbabwe has the opportunity to be among the nation’s leading development in sub–Saharan Africa by 2020.

6.1.11 Education

Missionary station stations that evangelised mainly in Shona and Ndebele were established between 1891 and 1895 across Zimbabwe. Missionaries were responsible for African education.

The main purpose of missionary education was religious education. Reading was seen as strengthening the faith of the new converts by reading the bible. The missionary schools received funding from the government under the strict conditions that the students would learn English and vocational training (Zvobgo 2009). Table.10 shows colonial government grants to mission schools, number of mission schools and number of African students enrolled 1901–1920. It shows that the number of African students was growing at a faster pace than government grants to mission schools and the number of missionary schools.

Tab. 10 – Government grants to mission schools, number of mission schools and number of African students enrolled 1901–1920

Year	Grants to mission schools	Number of mission schools	Number of pupils
1901	£ 133.00	3	265
1910	£ 2,780.00	115	9,873
1920	£ 9,467.00	750	43,094

Source: Zvobgo (2009)

According to census report 2012, the literacy rate in Zimbabwe is almost universal at 96% Moreover, males and females have comparable education rates from age 15 to age 39 years. From 39 years, educational gender inequality in favour of males than females. Moreover, the educational intergenerational gaps are narrowing as younger people are more educated across sexes than older generations (ZIMSTAT 2012).

During the colonial period, there was a systematic denial of access to education black African children. The education scheme of Zimbabwe was split between African and European schools. Precisely the segregation of race–based schools and financing was most extreme in the 1970s because Europeans represented only a few per cent of Zimbabwe's population, but about 90 per cent of government spending on education was allocated (Zindi 1996). Secondary school funding was also provided disproportionately not to Africans, but to Europeans (Kanyongo Gibbs 2005). In the 1970s, only 43.5% of African kids attended college, while only 3.9% registered in high school (Gordon Rosemary 2005)

Since independence, through the fast development of educational resources to meet demand, the state has concentrated on offering fair and free education for all (MacKenzie. 1988). Within a year, the education system almost doubled the number of students it served from 885,801 to 1,310,315 for both primary and secondary school students. Exponential increases in the number of students attending school increased the need for more infrastructure and teachers (Goronga and Pedzisai 2014).

The education ministry brought educators from Australia, Britain, and Canada to fill the teaching gaps for a brief period (Goronga and Pedzisai 2014). By practising "hot–seating," also known as double–session education, schools extended their human resources to serve as many kids as possible with restricted facilities.

More education infrastructure was also quickly constructed up by communities. The number of primary schools in service, for instance, rose by 73.3 per cent from 1979–1984 and the number of secondary schools increased by 537.8 per cent (MacKenzie 1988). Despite difficulties, Zimbabwe asserted to attain universal primary schooling by the late 1980s. Primary schooling was almost universal by the 1990s, with more than half of the population completing secondary education (Goronga and Pedzisai 2014).

UNICEF argues that the education system of the country was once the most advanced on the continent, although the sector continues to suffer from a decline in government financing related to hyperinflation and financial mismanagement. A 40 per cent decline in GDP from 2000 to 2008 marked a period of the financial downturn in the first decade of the 21st century .Health and education social spending also fell by over half (UNICEF 2011).

By the end of 2008, the majority of colleges and hospitals were closed owing to thousands of students leaving the profession, a financial crisis, a rise in HIV and AIDS deaths and a cholera outbreak in 2008 leading to a domestic epidemic. UNICEF stated that 94% of rural schools serving the majority of the population were closed in 2009. This is an inclusive government established to address domestic challenges. To introduce complete dollarisation, reduce hyperinflation and increase social spending, the Government of National Unity has suspended Zimbabwe's currency (Noko 2011)

Zimbabwe's focus on extending educational possibilities over the previous 25 years has resulted in domestic achievements, including attaining the most significant literacy rate in Africa at 91 per cent between the ages of 15 and 24 years. In 2014, 3,120,000 students were enrolled in primary and secondary education, with 76 per cent enrolled in primary schooling. Although the constitution recognises education as a fundamental right, there are still gender disparities in education. In primary education, gender differences predominate less than in secondary schooling (UNICEF 2011). UN Zimbabwe argues that 85 per cent of women finished primary school in 2009, compared to 80 per cent of men (UN 2012). By 2010, 48.8% of women had attained secondary or higher schooling, while 62% of men had attained secondary or higher schooling (Emina Chirwa and Kandala 2014).

Because of early marriages, continuing education costs, and gender–based violence, females are more likely to drop out than their masculine colleagues in secondary school (UNICEF 2011). Because of marriage, females are regarded as a source of revenue and families are more likely to marry off their young girls to boost their earning potential. Sadly, an absence of female education correlates with developmental hazards including pregnancy among adolescents, HIV and AIDs, bad health and poverty Due to employment roles, social values and gender expectations, resources for education are assigned more to men than to women in moments of financial distress (Gordon, Rosemary 1994). The UN Children's Fund accounts, however, argue that the gender gap in education in Zimbabwe is lower than many other African nations (Emina, Chirwa and Kandala, 2014)

6.1.12 Religion

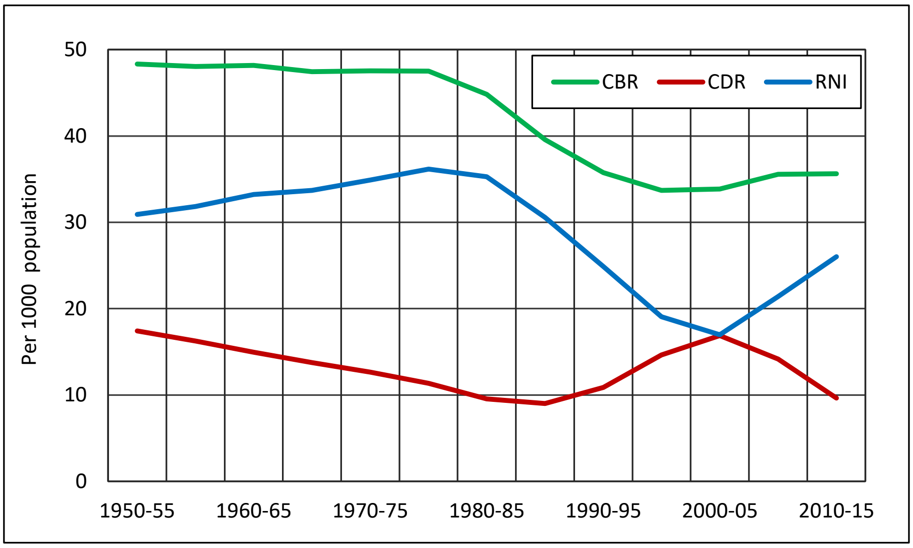
An approximately 80% of the people of the country identify as Christians. Protestants (mostly Pentecostal African Church members) make up about 63% of the population. There were 1,145,000 Roman Catholics in Zimbabwe, according to estimates from 2005. This is about 9% of the population as a whole. Ethnic religion adherents are around 11%. Approximately 1% are Muslims, mostly from Mozambique and Malawi, 0.1% are Hindus. Approximately 7% of people do not have religious practice or are atheist (ZIMSTAT 2012).

6.2 Overview of demographic revolution in Zimbabwe

The levels, trends, causes, and pathways of the demographic revolution or population development can only be understood by the revealing of Zimbabwe's socio–economic and cultural development. Zimbabwe has undergone roughly three distinct socioeconomic stages, which had three corresponding and distinct population development characteristics. As highlighted above, the first stage (before 1887) was mostly traditional socio–economic structures in which population homeostasis is maintained by high fertility and mortality. The second stage (1888–1980 colonial stage) had pockets of modernisation, which increased after WWII, characterised by the onset of mortality decline, and consequent rapid population growth. Lastly, the third stage (post–colonial stage of 1980) characterised by the onset of fertility decline and continued rapid population growth. The fertility and mortality differentials in the stages are primarily a result of socioeconomic–cultural differentials which moderates the demographic transition. The socioeconomically advanced groups in all the stages are further ahead in the demographic transition process ((Mhloyi et al. 2013)).

Figure 31, shows that CBR and CDR started at higher 48.3 and lower levels 17.4 per 1000 population respectively. CDR declined earlier than CBR. Rate of natural increase (RNI) increased rapidly from 30.9 to a peak of 36.2 per 1000 between 1950/55 and 1970s. The onset of natality (CBR) declines about 35 years later. CDR declined rapidly from about 48 to 34 per 1000 population and after that stalled and (oscillated) at about 33/1000 until 2015. Interestingly CDR also started to increase from the late 1980s to almost 1950 levels before rapidly declining to 10/1000 by 2010/15). The combined decline of fertility and increased in mortality saw an unprecedented decrease in RNI in Zimbabwe.

Fig. 31 – Crude death (CDR) and crude birth (CBR) rates, rate of natural increase (RNI), 1950–2015, Zimbabwe



Source of data**:** UN (2017)

The onset of the demographic revolution in Zimbabwe using Chesnais (1992), the definition can be characterised by continuous mortality–crude death decline to levels below 35/1000 deaths. The second stage of the natality decline can be characterized by 10% continuous decline of fertility from peak fertility. Third, life expectancy at birth exceeds the age of 50. The first criteria can be considered to have been met before 1950 since mortality was already at 17/1000 population. The second criteria were met in the early to middle 1980s. The end of the demographic transition (Tω) – the point of lasting return (at least 5 years) to an average rate of natural increase which equals, or is less than the one before the beginning of the demographic transition. This plausibly means that Zimbabwe has not yet completed the demographic revolution since the rate of natural increase is at 26/1000 in 2010/2015. Table 11 below shows the length and dynamics of the demographic revolution in Zimbabwe. This suggests that the overall the length demographic revolution in Zimbabwe is expected to be about 90 years. Similar findings on a sub–regional level were made by Mustafina (2014).

Tab.11 – Length and dynamics of the demographic revolution in Zimbabwe

Onset of revolution	End of revolution	Duration (years)	Maximal rate of natural increase per year %	Current rate of natural increase per year %
1950–55	2040–45	90	3.79	2.4

Source of data: UN (2017) and own calculations

6.3 Mortality levels trends and patterns

All societies covet life to the extent that mortality declines at a lower level of modernisation than fertility. Moreover, mortality is considered a human right and development efforts are directed towards its reduction (Sayi and Sibanda 2016). Thus mortality in developing countries inherently precedes fertility decline (Coale 1973). Studies have reported that in historical transitions in Europe, mortality also preceded fertility transition (Coale 1973, Kirk 1996, Chesnais 1992, Notestein 1945). However, development has a significant effect on mortality, which explains mortality differentials between different socioeconomic groups. Substantial literature argues that the decline of mortality in Africa and Zimbabwe started during the colonial period, especially period after WWII (Pavlik 1980, Caldwell 1986, Coale 1973). Anecdotal by beach 1999 and Brownell (2010) mentions that Zimbabwe African mortality is assumed to have declined in the first quarter of the 20th century. However, Beach (1999) and Brownell (2010) notes that Zimbabwe is one of the few countries that in the south of Sahara that experienced population growth before WWII.

Further, hospital admissions and deaths 1906–1928 by race show that there were more deaths per hospital cases admitted in the African population than white population even though the white population was less than 5% of the total population (Marindo 1999). It is possible that the African population was seeking health hospital care at advanced stages of the disease, or hospital access was limited to the African population. According to Omran (2005), such high case fatalities by the African population are typical of pretransitional mortality societies. However, the causes of death with predisposition degenerative diseases show that the white population was already in the advanced stages of the epidemiological transition (Marindo 1999).

The mortality decline was facilitated by governments and missionaries' importation cheap medical technologies such as immunization and antibiotics for infectious diseases. Public health initiatives learned in Europe were quickly implemented in the emerging urban areas and mining towns, which became pockets of development. Tertiary care was facilitated at central hospitals and missionary hospitals in rural. However, substantial public health measures such as public sanitation safe water and personal hygiene could not be implemented especially in the rural where the majority of Africans live. Agriculture has also not developed to the levels of the developed nations, to the extent that malnutrition remains one of the most underlying causes of infant and child deaths in Zimbabwe ((Mhloyi et al. 2013)).

Nonetheless, mortality decline to such an extent that life expectancy at birth increased to 60 years by 1980 (Muhwava 2016**.** However, as consistent with Coale and Demeny life tables most significant life expectancy gains were experienced in younger than older age groups and women always had higher life expectancy than males (CSO 1982, 2002, ZIMSTAT 2012). However, mortality started to increase in the mid–80s, reaching a peak in 2000 as a consequence of high HIV/AIDS levels (Tabutin et al. 2004). Lack of development facilitates the spread and impact of HIV in affected countries. First lack of knowledge regarding the causes of HIV diseases makes it difficult for people in SSA to even appreciate HIV as a cause of increased mortality. Moreover, within Africa, there are cultural practices that enhance the spread of HIV, including polygamy, levirate, widow cleansing ceremonies, virginity testing by fathers–in–law, intergenerational sex and marriages of young girls to older males and multiple concurrent sexual partners (Bassett and Mhloyi 1991, Sayi and Sibanda 2016).

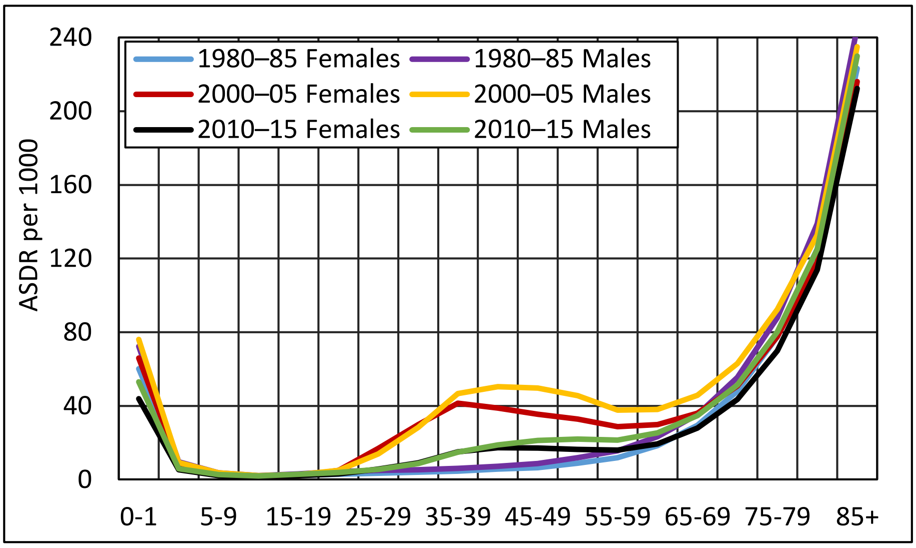
Poverty not only exposes a population to more diseases but also necessitates commercial sex work, which spreads the diseases further. HIV kills more young adults than children creating a young adult skipped generation household with corresponding increases in grandparent and child–headed households. However, AIDS–related deaths and infections have since decline although they still remain intolerably very high. Life expectancy at birth has since increased to 58 years (ZIMSTAT 2012). The Global Burden of Disease Collaborative Network (2018) also show that non communicable diseases are increasing rapidly, and this means that Zimbabwe is in the middle of a mortality transition and is facing the double burden of diseases.

6.3.1 Age–specific death rates (ADSR)

Age death rates can be used to compare mortality at different age groups and the same age groups over time. They show the intensity of death by ages and sex. The ASDR is calculated as a ratio of deaths in a particular age group to the population in that age group. Figure 32, shows that ASDR were higher among infants and decreased with age. The ADSR is high in infant and reproductive ages (15–49 years) and rising drastically in older ages 60 years and over. The ASDR increased notably in the reproductive ages to the highest levels period 2000/05 before declining to intermediate levels in 2010/15. The rates were higher among females aged 15–30 years compared to rates of males in the same age group. This could be indicative of relatively high maternal mortality in this age group or the impact of AIDS death, which is more pronounced in younger ages for females than males. For the rest of the age groups, males experienced relatively higher mortality than females. The age pattern of mortality for Zimbabwe is similar to that of selected regional countries as affected by HIV/. Notably, the pattern reflects populations affected by HIV and AIDS, with high mortality among infants and older age groups AIDS (Stoneburner 2017, ZIMSTAT 2012, ZIMSTAT 2015).

The ratio of male to female deaths in the world is about 1:1 until adolescence. After about age 15, male deaths exceed female deaths at a ratio of about 1:1.5–2.0 (WHO 2008). In Zimbabwe, in every province, from 1996 to 2008, the ratios are inverted: female deaths exceed male deaths for ages 15–30. After 2008, the ratio of male to female deaths under age 30 follows the expected pattern. This may be related to the decrease in HIV–related deaths in Zimbabwe since 2004 which, because young women had a higher prevalence than young men, disproportionately favoured improved survival rates among young women (UNAIDS 2016, MOHCC 2014).

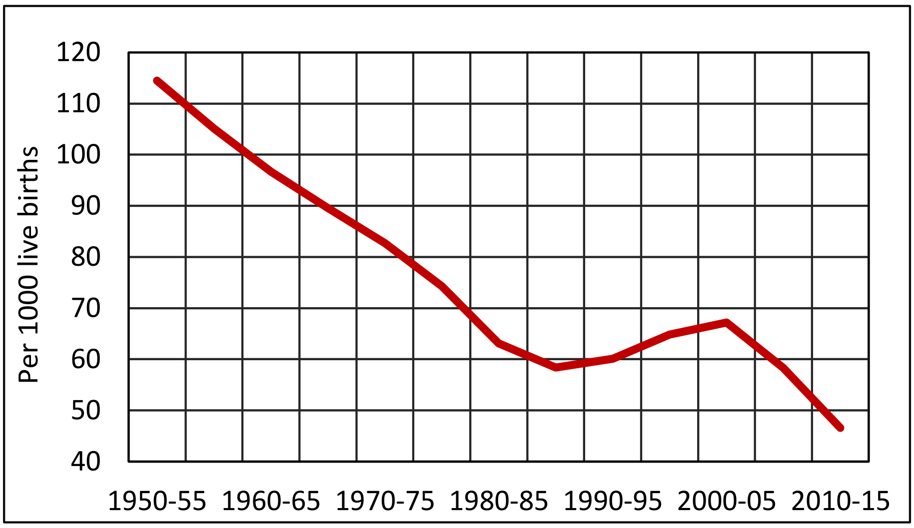
Fig. 32 – Age–specific death rates (ASDR), males and females, 1980–85, 2000–2005, 2010–15, Zimbabwe



Source of data: UN (2017)

6.3.2 Infant mortality and child mortality

Fig. 33 – Infant mortality rate, 1950–2015, Zimbabwe



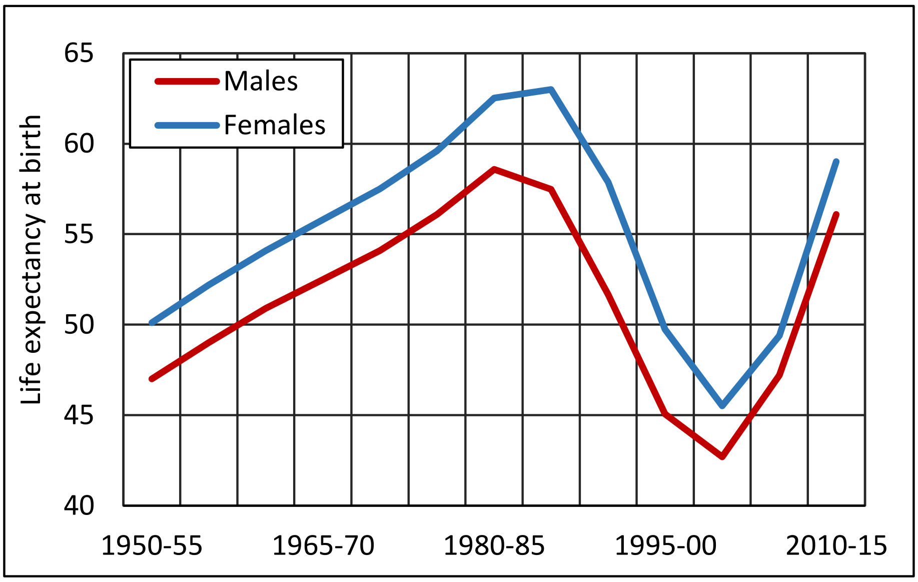
Source of data: UN (2017)

There was universal progress in infant and child mortality decline between 1950 up until the late 1980s, although Zimbabwe was ahead of most sub–Saharan African countries. There reversal stagnation and low progress ever since (Tabutin et al. 2004, ZIMSTAT 2012). The graph reveals that the probable onset levels of mortality in the 1950s are lower (115/1000) than proposed by the demographic transition of about above (300/1000). This probably means the transition might have begun earlier than 1950. Furthermore, Figure 31, reveals that infant mortality declined by 61% from 115 to 45 from 1950–55 to 2010–15 respectively before increasing to almost 70 by 2000 2005 briefly before decline again to 45/1000 by 2010–2015

The increase in mortality for the periods is related to the increase HIV/AIDS mortality. This is consistent with other findings (ZIMSTAT and ICF 2016, Tabutin et al. 2004). Currently, Zimbabwe is ahead in the infant mortality transition as compared to Central and Western African countries even though with the burden of HIV/AIDs, which also involves mother to child transmission. There are no studies using recent data that show how much contribution the bio– demographic, environmental and cultural factors contribute to the infant and child mortality in Zimbabwe. (This is discussed in chapter 8)

6.3.3 Life expectancy by sexes

Fig. 34 –Life expectancy at birth by sex, 1950–2015, Zimbabwe

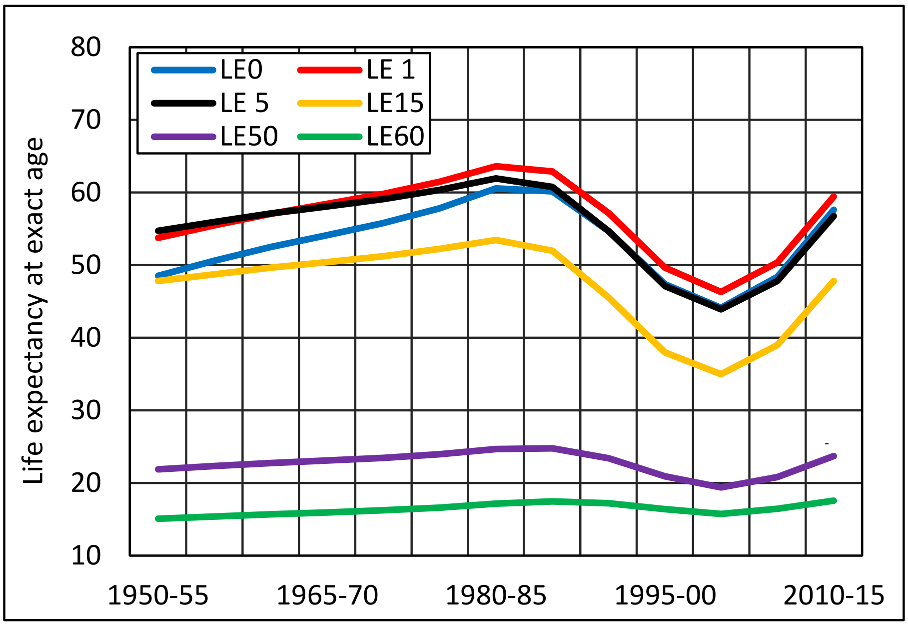


Source of data: UN (2017)

The increase in life expectancy is mostly a result of improvements in infant and child. Figure 34 shows life expectancy at birth by sex from 1950–1955 to 2010–2015. Firstly, Life expectancy increased dramatically from 47 and 50 years in the 1950s to reach a peak of 58 and 64 for males and females respectively in 1980–85 before dropping to 43 and 46 for males and females respectively by 2000–2005. The rapid drop in LE is consistent with HIV/AIDS death (Tabutin et al. 2004, ZIMSTAT 2012). In 2010–2015 life, expectancy had increased to 55 and 57 years for males and females respectively. Secondly, life expectancy at birth varied with sex for the period under consideration with females enjoying an average of 2–3 years extra years than males. However, the life expectancy gap between males and females increased to 6 years in the late 1980s to 1995 before narrowing again to 2–3 years with females in advantage.

Life expectancy gains, stagnation, and reversals vary with age (Tabutin 2004). In 1950–2015 to, Figure 35, shows life expectancy at exact ages 15 years and below (younger ages) fluctuated significantly whilst for older ages LE 50 and 60 did not change significantly. from 1950–1955 to 1980–1985, in absolute numbers the most significant life expectancy gains were for ages LE1 and LE5 who gained an additional years of 10 and 7 years respectively, and whilst the biggest LE reversal was for ages 15 years and below lost an average of 17 years. From 2005, 2010 to 2015, life expectancy increased across all younger ages by an average of an additional 13 years. However, in percentage terms, the most significant gains in life expectancy at exact age were experienced by LE1 (16%) 1950–1980–85, while the biggest reversal (35%) 1985–90 –2000–05 and gains (36%) were experienced by 15 years 2000–05–2010–2015.
This might be related to HIV mortality risk factors for young adults. What about studies that show the gap. The AIDS pandemic was severe in all Southern African countries and neighbouring Eastern countries including Zimbabwe (Tabutin et al. 2004)

Fig. 35 – Life expectancy at selected exact ages, 1950–2015, Zimbabwe

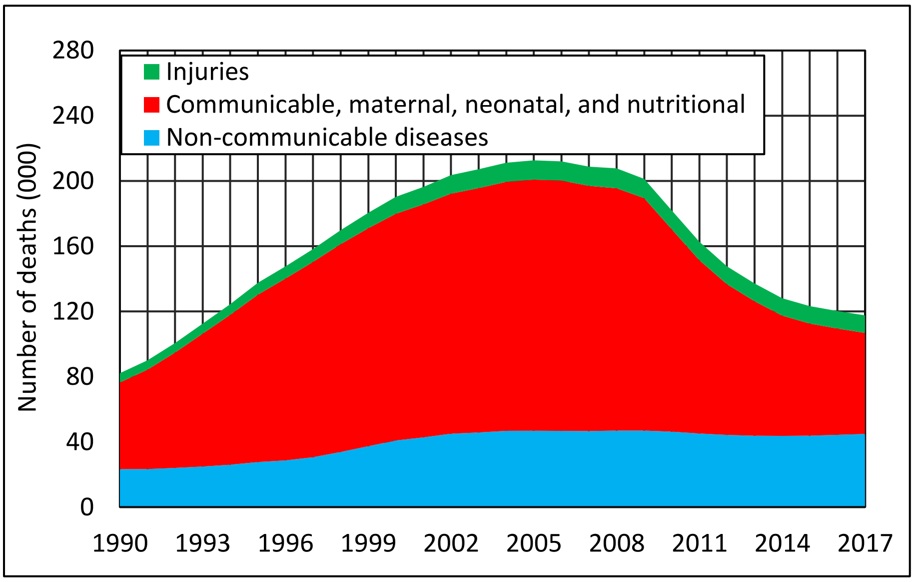


Source of data**:** UN (2017)

6.4 Causes of death

Zimbabwe, like its neighbouring countries, is country facing a double burden of both communicable (CD) and non–communicable diseases. Figure 36 shows the distribution of age standardized deaths by major causes of death, communicable maternal, neonatal and nutritional diseases, non–communicable diseases and injuries for the period 1990–2017. Communicable diseases are the biggest causes of diseases in absolute numbers. Precisely (CD) diseases increased rapidly by 183% from 53000 in 1990 to a peak of about 150 000 in 2002–2008, before rapidly decreasing to current levels of about 62000 per annum. The non–communicable diseases also increased rapidly by 96% from about 23000 to 45 000 per annum, where it stabilised after that to 2017. The injuries diseases (NCD) increased by 83% from about 6000 to 11000 per annum. This finding is consistent with findings that mortality in Africa increased rapidly in the mentioned period before the discovery of HIV/AIDS drugs in 2001 (Muhwava 2016). The discovery of HIV/AIDS lifesaving drugs means that in future, the non–communicable diseases will leading cause of death.

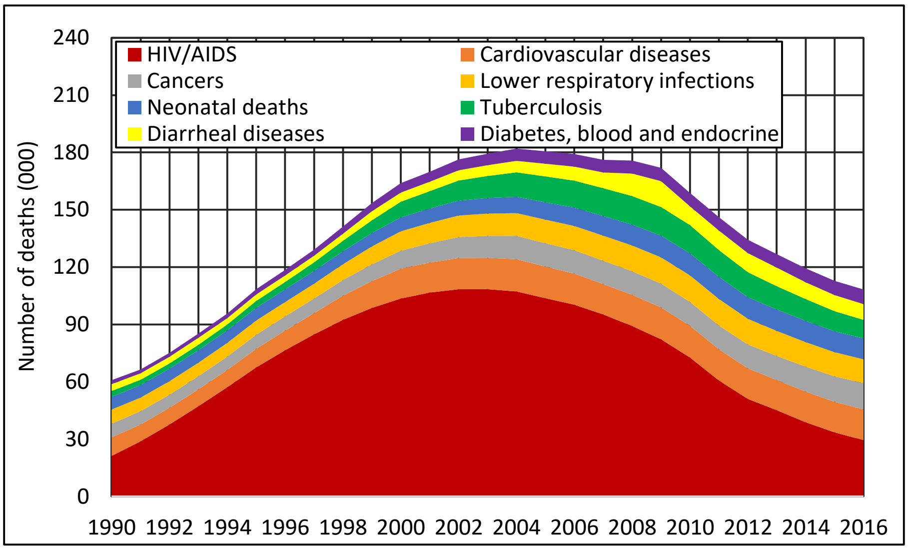
Fig. 36 – Age–standardised death rates by major causes of death, Zimbabwe 1990–2017



Source of data: Global Burden of Disease Collaborative Network (2018)

6.4.1 Specific causes of death

Fig. 37 – Annual number of deaths by specific causes of death, Zimbabwe, 1990–2016

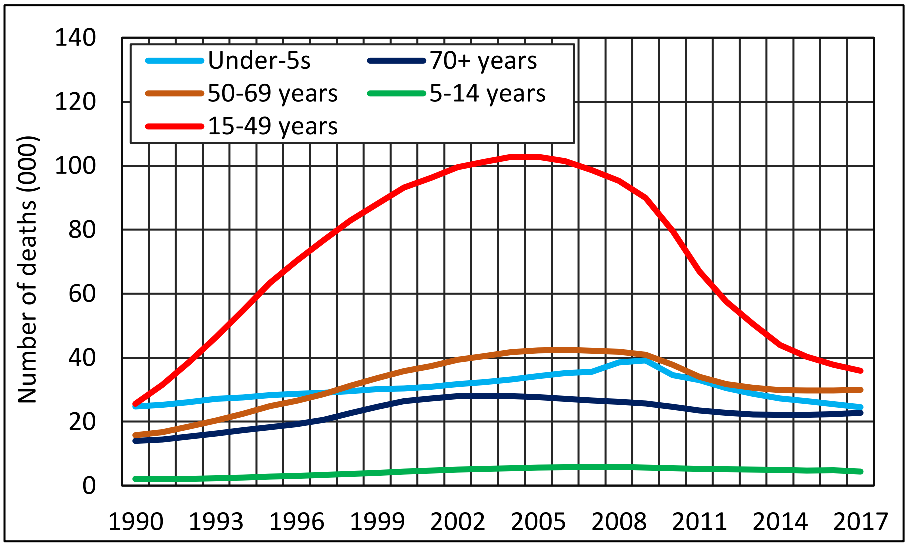


Source of data: Global Burden of Disease Collaborative Network (2017)

The contribution of diseases to mortality differ by specific causes and also the population age structure (Omran 2005). Figure 37 below show that in Zimbabwe, the specific leading cause of death in 2016 is HIV/AIDS. It is interesting to note that cardiovascular diseases, cancers, lower respiratory infections. Diseases are on 2nd, 3rd and 4th positions, respectively. This means that Zimbabwe is in the middle of mortality transitions. Secondly, the high prevalence of neonatal diseases and diarrheal diseases, nutritional deficiency also means Zimbabwe still has still a high infant and child mortality and maternal mortality typical of high fertility societies. This finding is in line with other countries in Southern Africa (Tabutin et al. 2004).

6.4.2 Causes of death by age groups

Fig. 38 – Distribution of deaths by age groups, 1990–2017, Zimbabwe



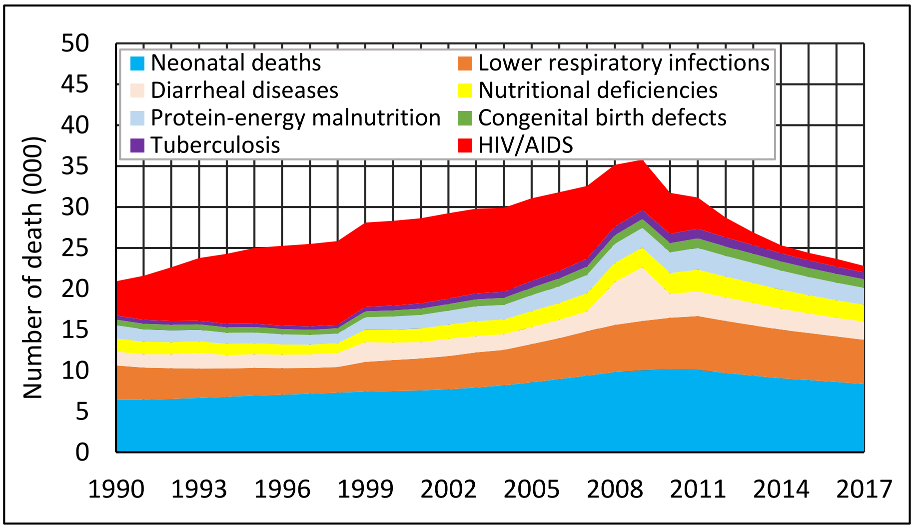
Source of data: Global Burden of Disease Collaborative Network (2018)

The cause of death varies by age groups (Harper 2016, Omran 2005). Figure 38, below shows absolute death by broad age groups for Zimbabwe from 1990–2017. The age group 15–49 years had the most significant number of death, probably because of HIV/AIDS in this reproductive age group. The increase in mortality from the 1990s to a peak of 2008 is also parallel with the spread of the diseases before the wide availability of HIV drugs. The increase in mortality in the age group 50–69 is directly related to infection while they were in late ages of (15–49) years. The increase in mortality in infancy ages is also related to children born with HIV and to high infant and child mortality related to infancy stages. Luckily the government of Zimbabwe has since introduced measures that can reduce HIV mortality and transmission of HIV/AIDs during pregnancy birth and lactation periods (ZIMSTAT 2016).

6.4.3 Causes of death in children under 5 years old

Figure 39, demonstrates the number of fatalities by cause in children under the age of 5 years in 2017. Through the mixture of neonatal (newborn babies under the age of 28) illnesses, diseases and congenital (birth–related) deficiencies, we see that the most significant proportion of fatalities in children under the age of 5 results from complications at birth or in the first few weeks (neonatal disorders). Also, under–5s are extremely prone to reduced respiratory conditions. The infectious and nutritional deficiencies are large causes of mortality in Zimbabwe and low–income countries (ZIMSTAT and ICF 2016).

Fig. 39 – Causes of death in under–5 years old, 1990–2017, Zimbabwe



Source of data: Global Burden of Disease Collaborative Network (2018)

In all societies, the value of life is so important to such an extent that policies and programmes are unidirectional towards mortality decline. The developmental factors such as education, health nutrition, agriculture, economy, medicines and vaccinations has a significant effect on mortality decline. The development and rise of the modern state in Africa are consistent with colonisation. Therefore, the role of government is very important to mortality decline in Zimbabwe. Developmental and socioeconomic differentials can also explain the differentials in mortality according to regions, age gender etc.

6.5 Fertility levels trends and patterns

In pre–transitional societies, demand for children was high. Ideal family size was big, although the net family size was never big because of high mortality (Reher 2004). Children provided parents with labour, social security, psychological value, and old age security. In pretransitional Zimbabwean society fertility differentials can be explained by proximate determinants including early marriage for girls, sterility, breastfeeding, pregnancy wastage, and infant mortality, etc. Henry (1961), defined it as natural fertility and Coale (1973) defined it non–parity specific fertility. The key feature is that in such fertility regimes, there is no contraception. Nonetheless, in pre–transitional fertility Zimbabwe, high value was placed on fertility to such an extent that fertility supply variables become the dominant factor underlying such fertility. Moreover, fertility is commensurate with the level of development, e.g. traditional agrarian society. Children are perceived as assets since they provide labour along with their mothers whose productivity in the fields is perceived only as necessary support for their most important role reproduction (Mhloyi 1988, Kamuzora 1987, Mhloyi 1987). Under these circumstances, fertility is the essence of femininity, while sterility is perceived as a curse from the gods (Mhloyi 1987). As children were perceived to offer economic security to their mothers, as such mothers are also accrued status with increased childbirth. Therefore, the demand for children was high

Generally, women in pre–transitional Africa were not educated nor employed, hence their low status. Colonisation brought pockets of development in urban areas. Colonial laws that demanded men above 15 years of age to pay taxes caused sex–selective migration of men to work in mines, farms and urban areas while women remained in the homesteads. Migration for girls to urban areas was not encouraged at it was associated with prostitution. Moreover, in urban areas, the housing conditions were not meant for families. Moreover, the education of boys was encouraged than education for girls because it was also perceived that boys provide current earnings and future old age security, especially for mothers ((Mhloyi et al. 2013)). Under those circumstances, high fertility did not carry a heavy penalty for the mothers. Instead, high fertility was associated with wealth flow from children to parents (Caldwell 1987). High fertility also carried social and cultural value by extending the fathers name or bloodline. The woman's contribution only came from via high fertility by having sons who looked after her and earned respect for her from her husband and mother–in laws. Thus with the migration of husbands and young men to work, women's demand for new children rose to replace missing labour (Mhloyi et al. 2013, 1988) In essence they practice replacement fertility of boys who migrated to work. The demand for children led to an increase in fertility rates to above seven children per woman. Other studies have noted that the increase in fertility is related to the disintegration of traditional fertility proximate determinants in a changing society, i.e., sexual abstinence and breast feeding months became shorter with a commensurate uptake of contraception ((Mhloyi et al. 2013))

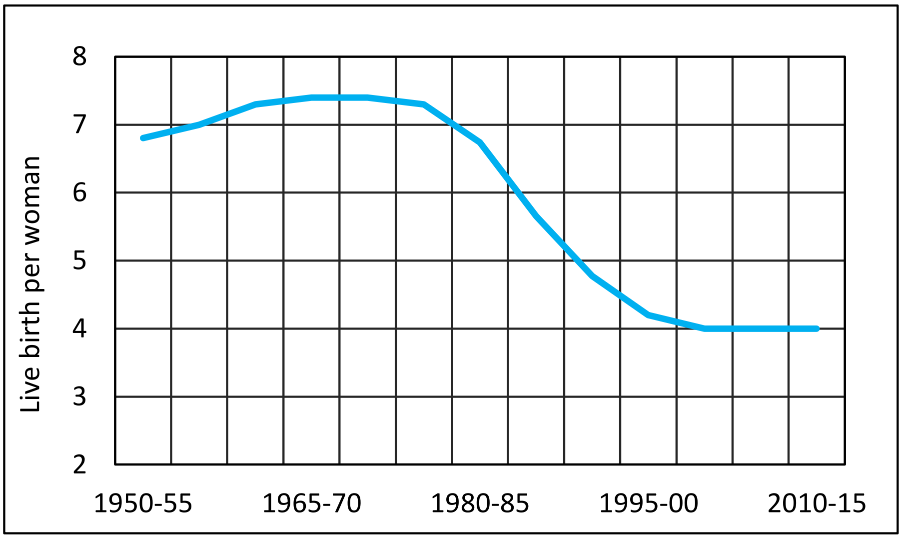
The last stage of the demographic transition in Zimbabwe was entered in the early–mid 1980s characterised by fertility decline. Fertility decline from above seven prior 1980 to 6.5 in 1981 to 3.3 in 2002 to 3.8 in 2012 (ZIMSTAT 2012). This period was marked with postcolonial political and socio–economic changes. The government of Zimbabwe made concerted efforts in addressing sex balances in education and employment supported by legislation ((Mhloyi et al. 2013)). Several women were appointed to the position of authority, a situation which created simultaneous effects of the empowering (income) the appointed women themselves, but also acting as role models to the girl child and other families (diffusion). Moreover, more and more women had the opportunity to live in urban areas with their husbands as colonial legal barriers were removed, and urbanisation grew. Within the urban context, women's decisions making power was not only increased but also access to female education, health and female employment in the ever–growing industry and service sector.

Within the urban context, life became expensive, and during this period, fertility declined further to 6.5 in 1984 ((Mhloyi et al. 2013)). However, women in the urban areas were further ahead of the fertility transition than their counterparts in rural areas. Rural fertility decline for different reasons. As education became increasingly necessary for children to be marketable in the growing modern labour sector hence maintaining their role of providing old age security. Children were still valuable in providing labour in rural parents, even though some parents found it necessary to limit their fertility to the number of children educable. This need increased as the economic situation in the county deteriorated coupled with economic adjustment programs in the 1990s, which transferred the cost of education and health from state to parents. Moreover, successive droughts in the 1990s reduced the utility of children in rural areas. Fertility was 3.8 in 2002 (CSO 2002) Mhloyi et al. (2013) noted that under these circumstances, fertility could be said to have declined because of development and lack of development (crisis driven fertility decline).

However, fertility has since stalled in Zimbabwe or increased to 3.8 by 2012 (ZIMSTAT 2012). Fertility stalling is lack of sustained fertility decline between two successive surveys (Bongaarts 2008). Nzimande and Mugwendere (2017) located stalling at ages 20–29 years, Wekwete (2009) found that adolescents aged 15–24 increased their fertility. The stalling of fertility has been related to lack of progress or reversal in investments in the same causal factors o fertility decline. Thus the fertility stalling might be related to the reversal of same causal factors of fertility decline. Thus with other studies economic reversals of during 2000–2008 of hyperinflationary period (Mhloyi ZIMSTAT Nuptiality report 2015), lower socioeconomic development (Shapiro and Gebreselassie 2007), impact of HIV through increased HIV/AIDS induced mortality (Westroff and Cross 2006), lower priority assigned to family planning as resources were directed HIV/AIDS pandemic (Bongaarts 2008, Machiyama 2010), Socioeconomic adjustment programs and cohort educational discontinuity of girls affected (Goujon et al 2015), tempo and quantum of fertility decline (ZIMSTAT 2015), Bongaarts and Feeney 1998, Bongaarts 1999). The fertility stalling at high fertility levels puts into question the prospects of future fertility decline to replacement and the assumptions of the demographic transition theory that fertility would decline continuously.

The timing, prevalence, and stability of marriages and unions not only shape the reproductive behaviour of women and men but are also linked to more extensive social and economic changes such as improvements in women's educational attainment and labour force participation.

Fig. 40 – Total fertility rate, 1950–2015, Zimbabwe

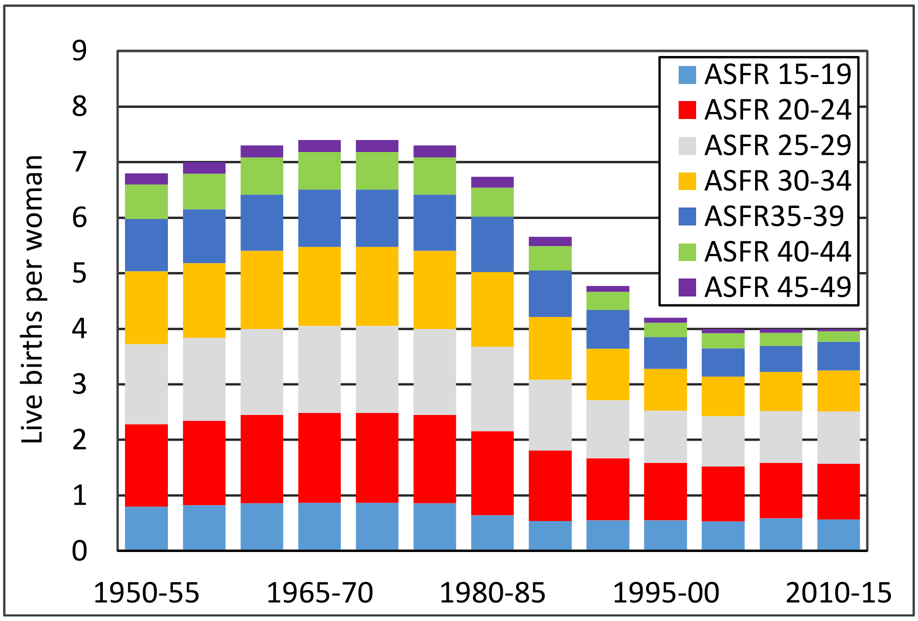


Source of data: UN (2017)

Figure 40, shows the decline of fertility in Zimbabwe from 6.8 to 4.0 in 1950–2015, respectively. However, fertility went from pre–decline fertility rise from 6.8 in 1950–55 to 7.4 in 1960–1965. In fact, Figure 40, shows that from 1950–55 to 1960–65 fertility increased by an average of 8% across all age groups. Nonetheless, fertility started to decline rapidly in 1980–85 to stabilise at about 4 children per woman from 2000–05 to 2010–15. This also shows that Fertility in Zimbabwe has stalled since 2000–2015.

Figure 41 shows that fertility declined across all age groups from 1950–2015. However, when we look at the percentages of the declines, we can see that women in older age groups experienced the biggest declines in percentages. Moreover, Fertility decline increased significantly with age, respectively. For example percentage change from peak ASFR for 15–19, 20–24, 35–39 and 45 49 years were 35.2%, 37.4%, 50.1 and 79.5 respectively. All age groups experienced fertility pre–decline fertility rise, although the biggest increases were in younger women. Figure 41, further shows that in 2000 and 2015, there has not been fertility decline. Interestingly for the period 2000-2015, Figure 41, shows that fertility stalling has happened for younger age groups below 35–39 years old, while women aged 40–44 and 45–49 had experienced further significant fertility decline of 28.9% and 45.3% respectively

Fig. 41 – Age–specific fertility rates, 1950–2015, Zimbabwe



Source of data: UN (2017)

6.6 Chapter conclusion

The demographic revolution in Zimbabwe began in the middle of the 20th century and like all developing countries followed the Japanese–Mexican model. Mortality declined the most in younger ages than older ages. However mortality decline reversed and discontinued due HIV/AIDS mortality, particularly in the reproductive age groups. The onset of fertility was lagged by about 40 years to mortality onset. Fertility initially increase before a sustained decline across all ages and stalled at midway transition (TFR 4.0). The ASFR rates show that fertility stalling is driven by women of younger reproductive age groups below 35 years of age. The onset of fertility decline coincided with the colonial independence and increases in contraceptive prevalence. Having presented the demographic revolution overview in Zimbabwe, the next chapter will discuss in detail the fertility revolution in Zimbabwe

Chapter 7
The fertility revolution in Zimbabwe with special regards to proximate determinants of fertility

7.1 Introduction

A significant number of African countries have experienced either sustained high fertility or fertility stalling at midway transition, which has put prospects of fertility decline into doubt and made demographers question the demographic transition theory. According to Bongaarts (2008: 109), fertility stalling is when a country does not experience significant (10%) fertility decline between two successive surveys. Consequently, because of sustained high fertility and low mortality, the population growth rate in Africa has remained high at about 2.5% per annum since 1960 (UN 2017). The population doubling time associated with such an annual growth rate is 28 years. Thus, the population of Africa grew from 0.3 to 1.2 billion from 1960 to 2015 (UN 2017). The challenge is that high population growth has been shown to negatively affect socio–economic and human development (Birdsall and Sinding 2001). This is alarming since Africa is already the world's least developed region (UN 2017).

In 1956, it was propounded that socioeconomic background factors operate through 11 proximate determinants to influence the level of fertility in any society (Davis and Blake 1956). Further, Bongaarts (1978) revised Davies and Blake's 11 into 8 proximate determinants. However, Bongaarts demonstrated, that 96% of fertility levels and variation in developing countries is a result of four main proximate determinants; marriage, postpartum infecundity, abortion and contraception (Bongaarts 1982). The remaining seven variables explain the very little variation of the total fertility rate (Bongaarts 1982). The challenge is that Africa lacks historical and current complete vital registration systems for conducting such analysis (Muhwava and Rutaremwa 2016, Machiyama 2010). However, the seminal work of Notestein (1945) has established that the fertility revolution from natural to controlled fertility regimes is a result of the deliberate adoption of birth control methods (contraception). Unlike Europe where women of older reproductive ages used stopping reproductive behaviour and natural methods of fertility limitation, in Africa, efficient modern methods of contraception were used for both child spacing and stopping in younger and older reproductive ages respectively (Caldwell and Caldwell 2002).

Thus, in Africa, the fertility revolution, although still incomplete, once started, is more rapid than Europe's historical transitions.

In Zimbabwe, fertility decline from TFR 5.4 in 1984 to 3.8 in 1999 has been both development and crisis–driven fertility decline (Mhloyi 1988, Müller et al. 2013). Development–driven fertility decline is typical of the Becker's theory of fertility decline when for instance, highly urbanised, educated and high incomes women were further ahead in the fertility transition than disadvantaged socio–economic groups (Mhloyi 1988, Müller et al. 2013). In contrast, *crisis driven* fertility decline is when a combination of high costs of living, declining incomes, civil unrest and persistence droughts in Zimbabwe has forced couples, regardless of their levels of modernisation, to adopt their fertility downwards (Mhloyi 1988). For instance, the costs related to the education of the children rather than the education of mothers themselves have led women to decrease their demand for children. In other words, the high costs of living reverse the wealth flow from children to parents (Caldwell 1982).

However, Gould (2015) has argued that crisis–driven fertility decline cannot be sustained in the long run. Precisely fertility in Zimbabwe has stalled at midway transition at about 4 children per woman since 2000 (ZIMSTAT and ICF International 2016). The question is whether fertility stalled as a result of changes in background variables or changes in proximate determinants?

Although the effects of the proximate determinants on fertility have been documented in Zimbabwe (Guilkey and Jayne 1997, Mhloyi 1986, Muhwava and Muvandi 1994, Sibanda 1999, Letamo and Letamo 2001), little has been done recently to show the current scenario concerning proximate determinants. Undoubtedly, the socio–economic circumstances appear to have since changed significantly, which might also change the proximate determinants. Thus, this section of the study seeks to assess the proximate determinants of fertility in Zimbabwe, incorporating recent data. The data were pooled from 6 consecutive Zimbabwe Demographic and Health Surveys (ZDHS) (1988, 1994, 1999, 2005 2010, and 2015). Results from this study contribute to knowledge on proximate determinants of fertility in Zimbabwe and how they have associated fertility levels and trends.

7.2 Literature review

A substantial body of literature has generally agreed that Africa's early and universal nuptiality conditions are more conducive to high fertility rates than witnessed in Europe's historical conditions (Dyson 2013, Coale 1973, Chesnais 1992). Undeniably, entry into marriage serves as a risk factor to childbearing as most of the childbearing was happening in marriages (Bongaarts 1982, Coale 1973). In Zimbabwe, recent studies by Sayi and Sibanda (2016) from Zimbabwe Multiple Indicators Cluster Survey (2014) (MICS 2014) indicates that 1 in 4 women aged 15 19 years were currently married, while among 20–49 years about 32% were married before 18 years of age. Further, the gap between marriage and childbearing is very small as couples seek to strengthen their marriage with children (Chitereka and Nduna 2010). Marital dissolutions are insignificant to fertility levels as remarriages occur early (Mhloyi 1988). However, it is possible that nuptiality patterns changed with time and consequently fertility levels.

Polygyny is generally high and variable in Africa. McDonald (1985) reported that polygyny ranged from 10% to 67% in Lesotho and Senegal, respectively. In Zimbabwe in a recent survey (ZDHS 2015), polygamous unions are 8% and 16% in urban and rural areas, respectively (ZIMSTAT and ICF International 2016). Studies on the effects of polygamy on fertility offer contradictory evidence. On the one hand, since women in the polygamous union share time of husband, they have less exposure to sex than women in monogamous relationships and correspondingly have less risky to pregnancy. Moreover, women in polygamous unions have been noted to breastfeed longer than women in monogamous unions (Sayi and Sibanda 2016, Mhloyi 1988). On the other hand, Mhloyi (1988) argued that women in polygamous unions' demand for children is higher than women in monogamous unions, as more children offer them security, respect and access to husband wealth. The question is, has the polygyny levels and trends changed with modernisation?

Furthermore, although variable and decreasing with modernisation, Africa's long postpartum abstinences were strategies ensuring the survival of already born children through prolonged birth spacing rather than deliberate birth control methods (Mhloyi 1988). Caldwell and Caldwell (2002) have argued that child spacing is embedded in the African culture, and high levels of contraceptive use might be for spacing and not stopping childbearing. Nonetheless, it can be hypothesised that postpartum infecundity has decreased with modernisation. In the absence of alternative contraceptive adoption or increments, fertility can increase.

Several studies have employed the Bongaarts framework for the analysis of the fertility differentials, levels and transitions in Africa (Bongaarts 1978, Majumder and Ram 2015, Mturi and Kembo 2011, Rutaremwa et al. 2015, Chola and Michelo 2016, Sibanda 1999). A recent analysis of countries in the early stages of fertility transition namely Zambia (Chola and Michelo 2016), Uganda (Rutaremwa et al. 2015), Malawi (Palamuleni 1996), and Namibia (Palamuleni 2017) found the dual importance of marriage and postpartum infecundability as most important predictors of fertility outcomes. The contribution of contraception was least although it was increasing rapidly.

In African countries that have experienced significant fertility decline, it has been established that the contribution of contraception is the most important and amenable to fertility reduction (Sibanda 1999, Mturi and Kembo 2011, Majunder and Ram 2015, Finlay et al. 2018). Sibanda (1999) looking at the relative contribution of proximate determinants in Zimbabwe and Kenya using two consecutive surveys for each country show that in Zimbabwe contraception is the most crucial factor in fertility decline in younger and middle ages. In Kenya, with slightly higher fertility than Zimbabwe, it was found that postpartum infecundity was the most important factor followed by marriage. In a later study using 2005/06 DHS data on Zimbabwe Mturi and Kembo (2011) reveal that high contraception prevalence rate was the most critical factor of fertility decline even during periods of socio–economic development and socio–economic crisis. The question is why fertility in Zimbabwe has stalled at midway transition given such high contraceptive prevalence rate? South Africa (TFR 2.3) and Botswana (TFR 2.6) with similar contraceptive prevalence levels and they have lower fertility approaching replacement level fertility (UN 2017). This is important given that studies have revealed contraception prevalence of 75% is associated with replacement level fertility (Mahjabeen and Khan 2011).

It is also possible that contraceptives such as condoms might be used for HIV prevention but not parity–specific fertility limitation behaviour (Terceira et al. 2003). Nonetheless, studies have revealed the contributory effects of the proximate determinants vary positively with women empowerment, i.e. women's education, wealth quintiles, urban and rural residence. In Zambia, secondary education, urban residence and wealth were established to be positively related to higher relative fertility inhibition effect in marriage and contraception while postpartum infecundability was inversely correlated (Chola and Michelo 2016). Similar findings were made in Uganda (Rutaremwa et al. 2015) and Zimbabwe (Mturi and Kembo 2011, Sibanda 1999)

7.3 Data and methods

This section utilises pooled data from 6 consecutive Zimbabwe Demographic and Health Surveys (ZDHS) from the following years; 1988, 1994, 1999, 2005, 2010 and 2015. In each survey year, a nationally representative survey of ever–married women of age 15–49 which were conducted under the Central Statistical Office (CSO) and Zimbabwe National Statistics Agency (ZIMSTAT). The ZDHS provide nationally representative on basic health social and demographic indicators. The study utilised this data in order to fit the aggregate fertility model, thereby assessing the contribution of marriage, contraception and postpartum infecundability in Zimbabwe. The fertility estimates were also disaggregated by a number of selected socio–economic variables, namely residence, education and wealth quintiles.

7.3.1 Sampling

The sample sizes of the interviewed women age (15–49) were selected based on a master sampling plan, which was provided by CSO (1988–2005 and ZIMSTAT (2010–2015). Sampling was done using a two–stage cluster sampling process. Initially, clusters are selected from a list of clusters obtained from the master sampling plan provided by ZIMSTAT, followed by a section of households from each cluster. The data obtained were stratified by rural and urban areas. The samples are considered adequate to enable analysis and comparisons that would be useful in the identification of socio–economic and demographic locus that could guide fertility and population policy interventions in Zimbabwe.

7.3.2 Analytical framework: The Bongaarts proximate determinants model

Bongaarts' proximate determinants model (1978, 1982) was applied for analysing proximate determinants of fertility from the six successive ZDHS surveys named above. Bongaarts and Potter (1983) developed a technique to quantify the impact of four proximate determinants on fertility, namely marriage, contraception, abortion, and postpartum infecundability. They assume that the total fecundity rate (TF) of all women is the same, but their real reproductive performance is modified by the above four mentioned proximate determinants. The mechanism of the model is summarised by relating the fertility measures to the proximate determinants.

The basic model equations are:

$$TFR = C_m * C_i * C_c * C_a \quad \text{(Bongaarts 1982).}$$

$$TM = C_i * C_c * TF$$

$$TN = C_i * TF$$

Where TFR is the number of births, a woman would have at the end of her reproductive years if she were to bear children at the prevailing age–specific fertility rates throughout the reproductive period. Total marital fertility rate (TM) is the number of births a woman would have at the end of her reproductive year if she were to bear children at the prevailing age–specific marital fertility rates and remain married during the entire reproductive period (Bongaarts 1987). Total natural fertility rate (TN) is observed under conditions in which contraception and abortions are eliminated (Bongaarts 1982). Bongaarts noted that while TFR, TM, and TN vary in many populations, total fecundity is constant in all populations. Total Natural Fecundity rate (TF) index is estimated as follows:

$$TF = \frac{TFR}{C_m * C_i * C_c * C_a}, \quad \text{(Bongaarts 1982)}$$

Where, C_m, C_i, C_c, and C_a are indexes of marriage, postpartum infecundability, and contraception and induced abortion, respectively. ‘’The indexes can only take values between 0 and 1’’. Where there is no fertility inhibiting effect of a given intermediate fertility variable, the corresponding index equals 1 and when the fertility inhibition is complete the index equal 0 (Bongaarts 1982). It is important to note that since, abortion is illegal in Zimbabwe (ZDHS 2015, Sibanda 1999) and there is limited and unreliable information available, the index of abortion in this study will be 1.0. Therefore the contribution of abortion is regarded as insignificant. The indexes can be approximated from the measure of proximate variables.

7.3.2.1 Index of marriage (C_m)

The (C_m) measures the inhibiting effects of marriage on fertility in the population. The lower the proportions of married, the higher the inhibiting effects of marriage and the inverse is true. However, age–specific marital proportions are used since inhibiting effects of marriage are marital age distribution sensitive. Childbearing is highest in the central age distribution years. Marriage is defined as formal or consensus marriages. Implicit in this definition is the assumption that only women in marriages are exposed to the risk of childbearing. The ZDHS 1999, 2005, 2010, 2015 has classified cohabitation as a marital union in Zimbabwe. This was not the case in 1988 and 1994 since no information was collected on this variable. In order to make the ZDHS marital definition comparable, we take the earlier definition used in 1988 and 1994. The (C_m) was estimated as follows:

$$C_m = \frac{\sum m(a)g(a)}{\sum g(a)}, \quad \text{(Bongaarts 1982)}$$

Where m(a) age–specific poportions currently married. It is computed by dividing the number of married women in the same age group, g(a)=age specific marital fertility rates, it is computed by dividing the births of a particular age group (from married women) by the number of married women in the same age group.

7.3.2.2 Index of contraception (C_c)

The C_c measure the inhibiting effects of modern methods of contraception on fertility in a population which also varies with the prevalence and use–effectiveness of contraception used by couples in the reproductive age groups. The higher the level of contraception in a population, the higher the inhibiting effect of contraception and vice versa. The C_c is estimated using the following;

$C_c = 1 - 1.08 * u * e$ (Bongaarts and Potter 1983)

Where u =average proportion of married women currently using contraception; e=average contraceptive effectiveness. The coefficient 1.08 is the sterility correction factor (represents the adjustment for the fact that women do not use contraception if they know they are sterile). The indexes use of effectiveness proposed for particular contraceptives are pill=0.90, IUD=0.95, injection=0.99, sterilization=1.00, others=0.70 (Bongaarts and Potter 1983)

Index of postpartum infecundability (C_i)

The index C_i measures the inhibiting effect of breastfeeding or sexual abstinence on fertility in a population (Bongaarts 1982). The C_i in the model is estimated using the effect of breastfeeding (lactation amenorrhea) or postpartum abstinence. The index was calculated as follows:

$C_i = \frac{20}{18.5} + i,$ (Bongaarts 1982).

Where i = average duration in months of infecundability from birth to the first postpartum ovulation (menses). In this research, the index of postpartum infecundability was estimated using the mean duration of breastfeeding.

7.3.2.3 Index of abortion (C_a).

The index of abortion measures the inhibiting effect of abortion on fertility in a population. In this research, the index of abortion was set 1.0 due to lack of data. Abortion is illegal in Zimbabwe excerpt for health and legal reasons (ZIMSTAT and ICF 2016). Moreover, abortion data in the ZDHS include stillbirths and miscarriages, therefore, it is difficult to isolate abortion data. The index of abortion is estimated using g the following formula;

$C_a = \frac{TFR}{TFR} + B * TA = \frac{TFR}{TFR} + 0.4 * (1 + U) * TA,$ (Chola and Michelo 2007)

Where u= contraceptive prevalence use, b=average number of births averted per induced abortion and b=0.4 (1+u); b=0.4 when u=0 and b=0.8 when u=1.0TA=Total abortion (Average number of induced abortion per woman at the end of the reproductive period if induced abortions remain at prevailing levels throughout the reproductive period). C_a=1.0 if TA is 0. Therefore, the total abortion rate in this study is 1.0.

Based on the studies of historical populations with the highest recorded fertility, Bongaarts recommends using 15.3 as the maximum number of births per woman. This is referred to as the Total fecundity rate (TF) (Bongaarts 1978, 1982). The value is the theoretical number that a woman would have if she were to be continuously married from age 15–44, did not use contraceptives and did not abort any pregnancies. Multiplying all the indexes together by the total fecundity rate of 15.3 produces the predicted TFR for the population. The predicted TFR will normally differ from the observed TFR because of underreporting of births, misreporting of behaviours measured by the indexes or omission of proximate factors that help determine fertility levels in the population under study. The Bongaarts' Model was also applied for calculation of the proximate determinants for selected background characteristics, residence, education and wealth quintiles.

7.4 Results

Tab. 12 – Percentage distribution of respondent women, 15–49 years by selected characteristics (weighted), 1988–2015, Zimbabwe

		1988	1994	1999	2005	2010	2015
Children born	1–3	34.9%	38.1%	44.7%	47.6%	52.3%	50.2%
	4–5	16.7%	15.0%	12.9%	14.0%	14.6%	17.0%
	6+	19.9%	17.5%	12.6%	9.0%	6.7%	6.1%
Marital status	Never married	27.0%	26.9%	27.7%	27.0%	24.0%	25.2%
	Married	62.9%	61.8%	56.3%	56.3%	59.4%	58.7%
	Divorced	7.6%	7.8%	3.5%	4.5%	3.7%	5.0%
	Widowed	2.5%	3.5%	4.2%	7.5%	6.1%	4.4%
Age group	15–19	24.3%	24.0%	24.5%	24.2%	21.2%	22.1%
	20–24	20.0%	20.7%	21.9%	21.9%	20.1%	17.0%
	25–29	16.2%	14.9%	17.5%	16.5%	18.4%	16.6%
	30–34	14.0%	14.2%	11.3%	13.7%	14.1%	16.3%
	35–39	11.0%	10.8%	10.8%	9.4%	11.5%	12.4%
	40–44	7.6%	8.7%	7.9%	7.8%	8.0%	9.7%
	45–49	6.9%	6.6%	6.1%	6.6%	6.8%	5.8%
Residence	Urban	33.5%	32.2%	38.6%	39.3%	38.7%	38.5%
	Rural	66.5%	67.8%	61.4%	60.7%	61.3	61.5%
Education	No education	13.5%	11.1%	6.7%	4.3%	2.3%	1.35
	Primary	55.9%	47.3%	40.2%	32.6%	28.0%	25.8%
	Secondary	29.7%	40.0%	50.2%	60.15	65.1%	65.6%
	Higher	0.9%	1.6%	2.8%	3.0%	4.6%	7.3%
Wealth quintile	Poorest	–	18.2%	17.1%	17.4%	16.9%	17.1%
	Poorer	–	16.1%	17.3%	16.8%	17.4%	17%
	Middle	–	18.9%	18.4%	17.4%	18.3%	17.6%
	Richer	–	21.8%	22.3%	22.5%	22.6%	23.2%
	Richest		25.0%	24.9%	25.9%	24.8%	25.1%
Family Planning	Modern (any)	36.1%	42.2%	50.4%	58.4%	57.3%	65.8%
	Traditional	7.0%	4.3%	2.8%	1.4%	1.1%	1.0%
Mean duration of breastfeeding	Months	18.9	18.8	19.0	18.7	17.5	18.1
Total (n)		4,201	6,128	5,907	8,907	9,171	9,955

–Missing values.

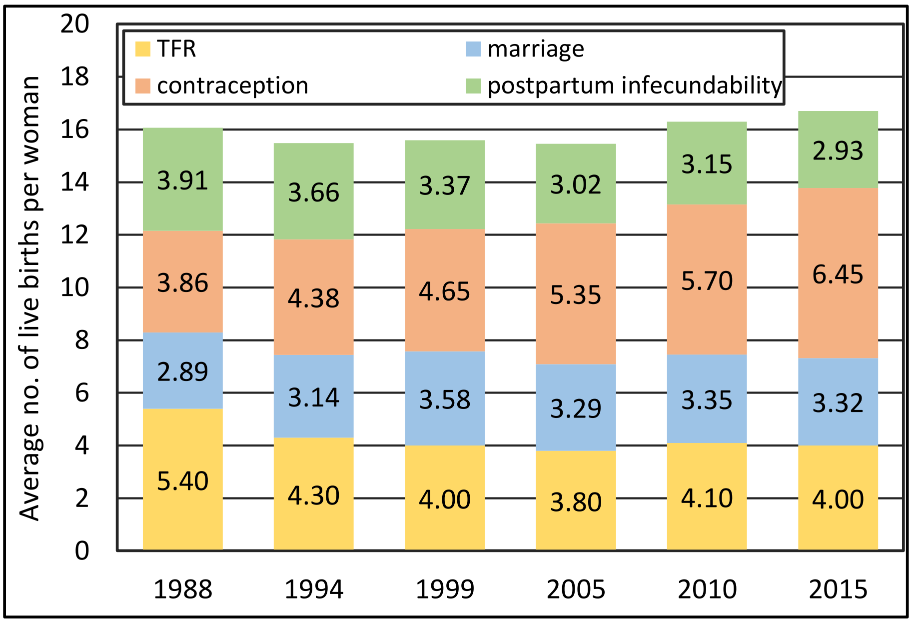
Source of data**:** Zimbabwe Demographic and Health Surveys (ZDHS)

The individual characteristics of the respondents women aged 40–49 years for 6 successive DHS from 1988–2015 are shown in Table 12. The results show that the percentages of women living in rural areas decreased from 67% in 1988 to 61% by 2015. The results reveal that women with no education and primary education were reduced from 13.5% to 1.3% and 56% to 26% while women with secondary education simultaneously increased from 30% to 66% between 1988 and 2015 respectively. The percentage of women with higher education is still very low, although it increased from 1% to 7% from 1988 to 2015 respectively. The distribution of the population by age group demonstrates that percentage distribution diminished with an increase in age, with about quarter comprising 15–19 years followed by a fifth 20–24 years. The oldest group

(45–49 years) comprised about 6% of the population for the respective periods. The 1988 ZDHS did not collect wealth quintiles variable. Nonetheless, for the later survey periods with available data, the wealth quintiles stayed relatively the same with respondents in the lowest wealth quintile slightly decreasing from 18% to 17% and a simultaneous increase in the fourth wealth quintile from 22 to 23% in 1988 and 2015 respectively.

The percentage currently married and single declined from 63%, 56%, 59% and 27% 24%, 25% in 1988, 1999, 2015 respectively. The currently married percentages were considered as proportion currently married in computing the indexes for marriage. Mean duration of breastfeeding ZDHS reports was, on average 18.5 months from 1988 to 2015, respectively, and this is what was used in the calculations to represent the average duration of the postpartum infecundability. About contraception, there has been an increase in modern contraception use by married women from 36.1% in 1988 to 66% by 2015 and a simultaneous decrease in traditional methods from 7% to 1% from 1988 to 2015 respectively. The above–mentioned information was used in the calculation of fecundity. As highlighted in equation 1 above, the observed fertility levels in a population are a product of the relationship of proximate determinants and the maximum biological level of fertility ($TFR = \mathrm{C_m} * \mathrm{C_i} * \mathrm{C_c} * \mathrm{C_a} * TF$). The fecundity rate (TF) has been observed to vary from 13–17 (Bongaarts 1982), and this study uses an average of 15.3 births per woman.

Fig. 42 – Effects of proximate determinants on the total fertility rate, 1988–2015, Zimbabwe



Source of data: ZDHS and own calculations

Figure 42, reveals the effect of each proximate determinant in absolute terms towards fertility reduction from the biological maximum of 15.3 children per woman, for 6 ZDHS surveys from 1988 to 2015. In 1988, the most prominent fertility inhibition (TFR) was caused by postpartum infecundity ($\mathrm{C_i}$) 3.91, followed by contraception ($\mathrm{C_c}$) 3.86 and marriage ($\mathrm{C_m}$) 2.89 children per woman. The contraception fertility inhibition effect continuously increased to 6.45 children per woman by 2015, while marriage fertility inhibition increased to a peak of 3.58 in 1999 before decreasing to 3.32 children per woman in 2015. The postpartum infecundability fertility inhibition effect has decreased to 2.93 children per woman by 2015. TFR has also decreased from 5.40 in 1988 to 4.10 by 2015. Surprisingly, the TFR decline reversed from 3.80 in 2005 to 4.10 in 2010.

In terms of percentages, the impact of each proximate determinant is displayed in Table 13 In 1988 contraceptive and postpartum infecundity accounted for 26% and 25% of fertility reduction, with marriage accounting the least of 19% respectively. Similarly as in levels and trend in absolute TFR inhibition effect, in 2015 the fertility reduction effects of marriage and contraception significantly increased to 42% and 21.7% respectively, while the effect of postpartum infecundability decreased to 19.7 from 26% for the same period. Table 13, also show that the effect of marriage and postpartum infecundability stagnated/reduced in 1994 and 1999, respectively, while the effect of contraception significantly increased continuously. This suggests that married women who used contraception contributed the most towards fertility reduction.

Tab. 13 – Estimated proximate determinants and their effect on fertility reduction in Zimbabwe, 1988–2015

Proximate determinant index	1988	1994	1999	2005	2010	2015
	Proximate determinants indexes					
Index of marriage (C_m)	0.72	0.69	0.61	0.62	0.65	0.63
Index of contraception (C_c)	0.65	0.60	0.53	0.46	0.47	0.41
Index of postpartum infecundability (C_i)	0.65	0.65	0.63	0.65	0.66	0.66
Index of abortion (C_a)	1.00	1.00	1.00	1.00	1.00	1.00
	Impact on fertility reduction percentage					
Index of marriage (C_m)	18.9%	20.6%	23.4%	21.5%	21.9%	21.7%
Index of contraception (C_c)	25.2%	28.6%	30.4%	35.0%	37.3%	42.2%
Index of postpartum infecundability (C_i)	25.5%	23.9%	22.0%	19.7%	20.6%	19.2%
Index of abortion (C_a)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TFR predicted	4.64	4.12	3.14	2.82	3.10	2.60
TFR observed	5.40	4.30	4.00	3.80	4.10	4.00

Source of data: ZDHS and own calculations

Table 14, shows the effects of the proximate determinants on fertility by residence, education and wealth. As noted above, the closer the index to zero or one, the bigger or, the lesser the effect on fertility reduction, respectively. Table 14, reveal contraception fertility inhibition effect increased with time and is positively related to the socio–economic variables. For example, between 1994 and 2015 contraception inhibition effect of higher educated women increased from 60% to 68% respectively, while least educated women's contraception fertility inhibition effect increased from had 25% to 42% in 1994 and 2015 respectively. The wealth quintile data collection starts from 1994 and shows that the higher the wealth quintile, the stronger the effect of contraception, for example in 1994 poorest and richest quintiles had 30% and 53%, which increased to 55% and 65% respectively by 2015. Urban areas had greater contraception inhibition effect than rural areas, which increased from 47% and 30% to 64% and 56% between 1988 and 2015 respectively. Table 14 shows contraception fertility inhibition stagnation or reversals for period 2010 for most socio–economic variables. Surprisingly, married women in rural areas, of middle and poorest wealth quintiles did not experience contraception fertility inhibition stagnation for periods under analysis. In 2015, married women with no education were the only socio–economic groups with fertility contraception inhibition effect below 50% with 42%.

Tab. 14 – Estimated proximate determinants of fertility by selected background variables, 1988–2015, Zimbabwe

		1988	1994	1999	2005	2010	2015
Index of contraception (C_c)							
Residence	Urban	0.53	0.49	0.42	0.37	0.45	0.36
	Rural	0.70	0.64	0.60	0.51	0.49	0.44
Education	No education	0.76	0.75	0.68	0.72	0.62	0.58
	Primary	0.67	0.63	0.59	0.52	0.52	0.46
	Secondary	0.50	0.48	0.45	0.40	0.46	0.39
	Higher	–	0.40	0.38	0.30	0.40	0.32
Wealth Quintile	Poorest	–	0.70	0.62	0.58	0.52	0.45
	Poorer	–	0.69	0.61	0.49	0.51	0.45
	Middle	–	0.64	0.60	0.49	0.48	0.44
	Richer	–	0.53	0.50	0.39	0.45	0.38
	Richest	–	0.47	0.37	0.35	0.42	0.35
Index of postpartum infecundability (C_i)							
Residence	Urban	0.68	0.67	0.64	0.68	0.68	0.69
	Rural	0.63	0.64	0.62	0.63	0.65	0.65
Education	No education	0.61	0.62	0.62	0.62	0.63	0.65
	Primary	0.64	0.64	0.61	0.63	0.66	0.65
	Secondary	0.69	0.66	0.65	0.65	0.66	0.67
	Higher	0.73	0.85	0.73	0.77	0.70	0.72
Wealth Quintile	Poorest	–	0.63	0.61	0.63	0.65	0.65
	Poorer	–	0.63	0.61	0.64	0.65	0.65
	Middle	–	0.64	0.65	0.63	0.65	0.66
	Richer	–	0.65	0.64	0.65	0.68	0.68
	Richest	–	0.68	0.64	0.71	0.70	0.70
Index of marriage (C_m)							
Residence	Urban	0.71	0.69	0.60	0.62	0.65	0.65
	Rural	0.72	0.69	0.62	0.62	0.63	0.62
Education	No education	0.69	0.67	0.62	0.61	0.58	0.69
	Primary	0.70	0.66	0.59	0.60	0.61	0.60
	Secondary	0.71	0.69	0.62	0.62	0.64	0.64
	Higher	0.82	0.77	0.65	0.64	0.73	0.72
Wealth Quintile	Poorest	–	0.69	0.61	0.62	0.62	0.62
	Poorer	–	0.68	0.62	0.62	0.64	0.62
	Middle	–	0.70	0.63	0.61	0.62	0.63
	Richer	–	0.67	0.60	0.60	0.63	0.62
	Richest	–	0.70	0.61	0.64	0.67	0.67

Notes: – missing values.

Source of data: ZDHS and own calculation

The index of postpartum infecundability was observed to be inversely related to the selected socio–economic characteristics. The postpartum infecundity, although fluctuating, has slightly increased from 1988 to 2015. For example, in 1988 to 2015, poorest and richest women had 37% and 32% postpartum infecundity, which decreased to 35% to 30% respectively. This suggests that the fertility inhibition effect of post–partum infecundity is more significant at lower socio–economic levels than high socio–economic levels and have been slightly reduced across all socio–economic groups over time.

The marriage inhibition index effect on fertility is inversely related to education, urban and wealth quintiles. However, the marriage inhibition effect across all the selected socio–economic variables slightly decreased with time (1988–2015). Marital fertility inhibition effect trend is fluctuating between rural and urban areas between 1988 and 2005 rural. However between 2005 and 2015 rural areas had slightly greater marital fertility inhibition effect than urban areas, (37%, 38% and 35% 35%) respectively. Higher educated women had lower marital fertility inhibition than less educated women. Further, there is a general fluctuating but increase in marital fertility inhibition across all educational categories with the least decrease experienced by women with no educated. Marriage fertility inhibition by no education and higher education decreased from (31%, 18%) to (39%, 36%) and (0.31%, 0.28%) between 1988, 2005 and 2015 respectively. This suggests that education increases are related to marital fertility reduction over time.

7.5 Discussion and conclusion

The results from the Bongaarts model presented above reveal levels, trends and the impact of proximate determinants of fertility namely: marriage, postpartum infecundability, and contraception for the 6 consecutive DHS survey periods (1988, 1994, 1999, 2005, 2010 and 2015). The results quantify the impact of each proximate determinant in absolute as well as percentage terms to total fecundity and fertility decline in Zimbabwe. The results uncovered that contraception was the most critical factor contributing to fertility decline experienced in Zimbabwe by married women from TFR of 5.4 to 4.0 in 1988 to 2015 respectively. Precisely, the contraception inhibition effect increased significantly and continuously from 25% to 42%, while marital inhibition effect although fluctuating increased from 19% to 22% and postpartum infecundity inhibition effect decreased from 26% to 19% in 1988 to 2015 respectively. A similar trend is observed in fertility (TFR) suppression, as presented in Figure. 42. This finding concurs with previous studies that found that contraception adoption is the most important factor for fertility decline in Zimbabwe (Mturi and Kembo 2011and Sibanda 1999, Mhloyi 1994). Moreover, this finding is consistent with other previous studies in sub–Saharan Africa (Finlay, Mejía–Guevara and Akachi 2018) and Asia (Majumder and Ram 2015). More broadly, the results confirm the hypothesis that contraception adoption is associated with further fertility decline as countries move from non–parity specific fertility to parity–specific fertility regime (Coale 1973).

Further, the decomposition of contraception fertility inhibition by residence, education and wealth quintiles demonstrate a positive relationship. Analysis of change associated with contraception use helps us examine in some limited way whether any increase in the fertility inhibiting effects of contraception constitute evidence of what Coale (1973) postulated as the necessary conditions for a fertility decline to start, i.e.; (1) fertility is within the calculus of the conscious choice, (2) lower fertility is seen as advantageous, (3) effective means of birth control are readily available and couples are willing to use them. The idea of using contraception (and socio–economic variables) to achieve a smaller ideal family size is grounded in van de Walle's concept of numeracy (van de Walle 1992, Sibanda 1999). Caldwell (1980) also advances mass education, especially female education, as a powerful tool for fertility decline in developing countries.

In contrast to findings in this study, Palamuleni (2017) and Chola and Michelo (2016), found out that marriage, not contraceptive was the most crucial proximate determinant for fertility inhibition in Namibia and Zambia respectively. The differences between Zimbabwe and Namibia might be explained by the fact that in Namibia, percentage currently married for women aged 15 49 years was about 25%, while in Zimbabwe, it was about 60% for the respective periods. The discrepancy between Zimbabwe and Zambia which have similar marital rates can plausibly be explained by the fact that Zambia is in the early stages of fertility transition (TFR 6.2 in 2007) where fertility is more amenable to Malthusian preventative checks (Malthus 1798), while Zimbabwe is in the midway of fertility transition (TFR 4.0 in 2005, 2010 2015) where fertility is more susceptible to contraception adoption. This is made possible by increases in the prevalence rate of modern contraceptive use from 36% in 1988 and 66% in 2015 and was responsible for fertility decline (ZIMSTAT and ICF International, 2016).

TFR at the national level fell from1988 (5.4) to 2005 (3.8) as shown in Figure 42. Thus the fall in TFR is well above 10%, a figure that is cited in the historical fertility transitions as a critical threshold for entry into non–reversible decline (Coale 1973). However, the fertility between 2005 2010 and 2015 increased from TFR 3.8, 4.1 and to 4.0 respectively. This means fertility decline in Zimbabwe stalled, as there was less than 10% sustained TFR decline between successive surveys as defined by Bongaarts (2008). The fertility stalling finding in Zimbabwe is in line with other findings in a substantial number SSA (Garenne 2013, Bongaarts 2006, Goujon, Lutz and Samir 2015, Lutz et al. 2015). However, during the respective stalling periods, the overall contraceptive fertility inhibition effects continuously strengthened from 5.35, 5.70 and 6.45 children per woman, respectively. Viewed from this empirical evidence, this suggests that fertility stalling in Zimbabwe has not been caused by a lack of priority assigned to family planning services suggested by (Bongaarts 2008). However, it is plausible that modern contraceptive methods such as condoms were used for HIV prevention rather than for fertility limitation, given high HIV prevalence rate of 16.7% among women (15–49 years) in Zimbabwe (ZIMSTAT and ICF International 2016).

Results indicated that marital fertility inhibition effects of marriage were the least important of all the proximate determinants in 1988 and 1994 and after that become the second important after contraception. Equally important, marital fertility inhibition effects increased from 2.89 to 3.58 children per woman in 1988 and 1999, before declining to 3.29 and 3.32 children per woman in 2005 and 2015, respectively. It is plausible that the erosion of the marital fertility inhibition effect might be partly responsible for fertility stalling during 2005 and 2015. This finding is consistent with other studies that have found the erosion of marital fertility inhibition effect as countries move along the fertility transition (Sibanda 1999, Mturi and Kembo 2011, Chola and Michelo 2016, Muhwava and Muvandi 1994). Ministry of Health and Child Care (2016), research show an increase in early teenage pregnancies in Zimbabwe. This is important, considering the gap between marriages and childbearing is very small in Zimbabwe (Chitereka and Nduna 2010, Sayi and Sibanda 2016). Thus fertility stalling might be due to sustained cultural and traditional practices which promote early marriage and childbearing.

The results show that the index of postpartum infecundability fertility–reducing effect has since decreased from the most significant (26%) in 1988 to the least fertility inhibition effect by

1999 (22%) and continuously after that. This is consistent with previous findings in Zimbabwe (Sibanda 1999, Kembo and Mturi 2009) and other countries in the region: Namibia (Palamuleni 2017), in Zambia (Chola and Michelo 2016), Malawi (Palamuleni 1996). This means short breastfeeding possibly contributes to fertility stalling noted above. In India, it was found that the risk of pregnancy increases substantially after giving birth in the absence of breastfeeding (Bongaarts and Potter 1983, Singh et al. 1993). Besides that, prolonged breastfeeding practices and postpartum abstinence have been used effectively in Africa, not only for birth spacing and subsequently reducing total fertility but also for increased child survival (Guikey and Jayne 1997, Mhloyi 1988). ZIMSTAT (2015) notes higher infant mortality among employed than unemployed women in Zimbabwe, which is plausibly related to inadequate and short breastfeeding by employed women. Child survival is considered a principal component of fertility decline (Coale 1973, Dyson 2013). This suggests that the promotion of universal breastfeeding among women can contribute to significant fertility decline through postpartum amenorrhea and increased child survival.

The analysis of education and wealth quintiles shows an inverse relationship with marriage and postpartum infecundability. Rural women have generally had higher postpartum infecundity and marriage fertility reduction effect than urban areas. The fertility inhibition effect of the selected socio–economic variables generally increased, although they were fluctuating. This corresponds with what emerged from other researches in Zambia (Chola and Michelo 2016), Uganda (Rutaremwa et al. 2015) and Ethiopia (Alazbih, Tewabe and Demissie 2017) and sub–Sahara Africa (Finlay, Mejía–Guevara and Akachi 2018). This could be attributed to the effects that marriage and wealth have on fertility.

The effect of contraception was positively correlated to education, wealth and residence. Furthermore, contraceptive fertility reduction effect increased with time across all socio economic groups (rich or poor, educated or not, urban or rural). These results are consistent with other findings that show that contraceptive inhibition effect of fertility from biological maximum is more significant among high socio–economic groups than lower socio–economic groups, in Uganda (Rutaremwa et al., 2015), Namibia (Palamuleni 2017), Ethiopia AMHARA region (Alazbih, Tewabe and Demissie 2017) and Zambia (Chola and Michelo 2016)., This could imply that women empowerment (access to education especially tertiary, female employment, poverty alleviation) could be powerful tools for fertility decline.

An interesting finding is a decrease in the contraception of fertility inhibition across all socio economic groups in 2010. Although such a finding was not revealed when looking contraceptive inhibition effect without background variables. Nonetheless, the decomposition of contraception effect by socio–economic variables could partly explain fertility stalling noted above. This finding is consistent with findings from ZIMSTAT Census (2012) Nuptiality and Thematic Report which found that fertility stalling could have been caused by fertility postponement in earlier during periods of economic hardships and the fertility rebounded when the economy stabilized in 2009 (ZIMSTAT 2015).

Moreover, the contraceptive fertility inhibition gap between and within each socio–economic group is narrowing. However, women with no education are lagging, e.g. in 2015, they had contraception inhibition effect of 42% when other socio–economic variables are below 64%. This is in line with the van de Walle's (1992) concept of numeracy discussed above. Similar studies also highlight the importance of mass education in fertility decline in developing countries (Goujon et al 2015). The narrowing of the contraceptive fertility inhibition gap between socio economic variables might suggest better prospects for fertility decline. The strengthening contraception fertility inhibiting effect among women of low socio–economic classes means that it is possible for fertility to decline in the low socio–economic development environment. This is consistent with findings in other developing countries in Latin America (Bongaarts 2014) and also a phenomenon witnessed in the French fertility revolution (Pavlík and Hampl 1975). These results suggest empowerment of women might be necessary through female education and access to resources.

The study has several strengths. The study used a large, nationally representative population based sample conducted over 30 years. The data has a high response rate above 90%, standardized surveys as enabling comparisons across countries and periods. The decomposition of proximate determinants was done in order to understand sources of fertility changes over time.

The study also had a weakness. The index of abortion was taken as 1 throughout the analysis, i.e. induced abortion was assumed to have no significant fertility inhibition effect on fertility due to lack of data. It is possible that excluding abortion in the model could have affected the estimation of total fecundity. Furthermore, studies have shown that abortion rates in sub–Saharan Africa are proliferating (Remez, Woog and Mhloyi 2014, Alazbih, Tewabe and Demissie 2017). Another limitation is that the data used failed to include reproductive data of males. The survey also used retrospective data on women's birth history. It is possible that such respondents might suffer from recall bias, which might affect the accuracy and validity of the data. Thus predicted TFR will typically differ from the observed TFR because of underreporting of births, misreporting of behaviours measured by the indexes or omission of proximate factors that help determine fertility levels in the population under study.

In section, I applied the Bongaarts model to assess and compare changes in the relative importance of proximate determinants of fertility between 6 sets DHS conducted in Zimbabwe. The results indicate that the fertility inhibition effects of contraception are the most important than the effects of marriage, and postpartum infecundability in Zimbabwe. Moreover, the results show that the contraceptive patterns vary positively with education, wealth quintiles and areas of residence. There was a gradual erosion of post–partum infecundability through the analysis period and of marriage after 1999. It is plausible that the fertility stalling could have been caused by the cumulative effects of marriage and postpartum infecundability. The results of this study have important policy implications. The strengthening of fertility inhibition effects of contraception, late marriage, and prolonged breastfeeding must be promoted. There is a need to research further on proximate determinants of fertility according to age groups as such research can illuminate the age–specific reproductive contributions of fertility.

The next chapter discusses under–five mortality in Zimbabwe

Chapter 8

Levels and determinants of under–five child mortality in Zimbabwe

8.1 Introduction

Globally, the probability of dying before reaching the age of five is estimated at 45 deaths per 1000 live births. This translates into approximately 59 million childhood deaths every year throughout the world (UN 2017). Studies have revealed that the majority of this death (95%) occur in the sub–Saharan and South Asia (Chadoka–Mutanda and Odimegwu 2017). In sub–Saharan Africa the under–five mortality has declined by 49% from 183 in 1990 to 93 per 1000 children in 2015, this is still unacceptably high as 1 in 11 children aged below five years still dies every year compared with 1 in 147 on developed countries (UN 2017).

An estimated 45% of newborn babies die within the first month of being born as a result of infections, birth asphyxia, preterm birth complications or intrapartum–related complications (Liu Johnson et al. 2012, Chadoka–Mutanda and Odimegwu 2017). However, a large proportion of this mortality is avoidable mortality. Specific causes of death including pneumonia, undernutrition, diarrhoea and malaria account for 50% of the death that occurs after the first 30 days of life and before turning five years (Black et al. 2010, Liu Oza et al. 2015, Chadoka Mutanda and Odimegwu 2017, Black et al. 2013). Access to health and family planning by girls and mothers before pregnancy, during and after delivery is vital for the welfare of both the mother and the survival of the child (Dodzo and Mhloyi 2017). While immediate and exclusive breastfeeding for six months and immunisation is essential for the survival of children beyond five years (Liu et al. 2015, Black et al. 2013). Furthermore, studies have shown that improvements in sanitation, safe drinking water, vaccinations, and exclusive breastfeeding can reduce childhood deaths caused by diarrhoea and pneumonia (Browne and Barrett 1991, Liu et al. 2015, Pradhan et al. 2018).

Mothers are the primary caregivers of children under five. Their health seeking behaviour during, before and after pregnancy tends to influence the chances of child survival during the first five years of life. Literature has shown that the access to health of mothers is, in turn, defined by maternal education, province, residence (urban–rural), marital status (Browne and Barrett 1991, Black et al. 2010). To the extent that women are not empowered to seek such services, such women might experience high infant and child mortality, accompanied by high maternal mortality (Black et al. 2013, Caldwell 1986, Cutler et al. 2006).

Mass education has been shown to reduce child mortality in developing countries (Caldwell 1976, Goujon et al. 2015). Mass education opens access to family planning, increases, utilisation of health services, and better employment for mothers. Moreover, female mass education reduces childbearing that is too early, too close and too late in the mother's reproductive life, which typical of high infant and child mortality societies. Child Mortality has fallen both the rich and poor developing societies. Furthermore, empowered women are on the forefront in experiencing and leading infant and child mortality decline (Caldwell 1976, Reher 2004).

Several researches have shown that mothers age at last birth, age first birth, mothers level of education, sanitation, source of drinking water, wealth status, preceding birth interval, birth weight and birth order are significantly associated with risk of dying during childhood (Kembo and Ginneken 2009, Kembo and Ginneken 2011, Mturi and Curtis 1995, Black et al. 2013). Taken together, these factors influence child survival probability.

Mother's province of residence affects their children's mortality experiences. This stems from variations in provincial economic and socio–cultural environments, which may influence children's chances of survival. According to ZIMSTAT (2012), infant mortality for the five years preceding the survey ranged from 36 deaths per 1000 live births in Bulawayo province. During the same period, it ranged from 49 deaths per 1000 children in the province of Bulawayo to 87 deaths per 1000 children in the province of Manicaland. Children in the urban provinces and the two provinces of Matabeleland were less exposed than their counterparts in other provinces to the risk of dying in childhood. During the same period, the under–five mortality rate was 80 deaths per 1,000 live births in rural areas compared to 62 deaths per 1,000 live births in urban areas (ZIMSTAT 2012). Access to health facilities also plays a role in affecting the mortality rates between the urban and rural areas.

Children of widowed women experienced the highest infant and under–five mortality rates of 63 and 97 respectively, followed by those of divorced (53 and 79 respectively) and married (49 and 72, respectively). Infant and under–five mortality rates were 49 per 1,000 live births and 73 per 1,000 children born to women who responded as unmarried at the time of the Census. Infant and under–five mortality rates were 49 per 1,000 live births and 73 per 1,000 children respectively for children born to women who responded as never married at the time of the Census. It may not be surprising that kids of formerly married females suffered the largest mortality rate as it may reflect the elevated correlation between their husbands and children's mortality.

Zimbabwe is one of the countries in the sub–Saharan Africa region, where under–five mortality is still unacceptably high. The under–five mortality in Zimbabwe has declined from 103 to 69 death per 1000 live births in 1999 to 2015 respectively (ZIMSTAT and ICF 2015). The progress or gains in under–five mortality decline has been affected significantly in the 1990s due to HIV/AIDS–induced mortality (Adetunji 2000, Garrenne and Gakusi 2006, ZIMSAT 2012), Economic Adjustment Structural Programmes (ESAP) in the 1990s (Kebede et al. 2019, Lutz et al. 2015) and the general economic collapse in 2000 (ZIMSTAT 2012). In 1994, the high prevalence of HIV among adults of reproductive age was accountable for 61% of under–five deaths. Goujon et al. (2015), have argued that mortality has stalled or increased in sub–Saharan Africa because of lack of investments in female education in the 1990s (Goujon et al. 2015).

In Zimbabwe, the National Child Survival strategy for the 2010–15 report has shown that HIV/AIDs accounted for 22% of childhood deaths. Specific causes of death like pneumonia, diarrhoea, measles and malaria are common and still contribute to the deaths that occur before children reach fifth birthday (Liu et al. 2015). This means Zimbabwe has still a high prevalence of infectious diseases as defined by (Omran 2005). Thus Zimbabwe is one of the countries that failed to meet the MDG–4 goal of reducing deaths by 2/3 by 2015 (Chadoka–Mutanda and Odimegwu). It remains unknown if Zimbabwe can achieve the newly set Agenda 2030 for sustainable goals (SDGs). Previous studies have explored the determinants of under–five mortality utilising country's' specific Demographic Health Survey (Aheto 2019, Akinyemi et al 2013, Johanna Stenström Johansson 2016, Magarura, Tindyembwa and Bishop 2017) there is dearth of studies which have used Census data. In most African countries, civil registration and vital statistics (CRVS) are not easily utilisable. Thus, leaving most countries relying on their censuses to inform planning. Nevertheless, existing census data sources are underused and insufficiently analysed because of lack of resources and time. Therefore, utilising the census data will enable the production of indicators at highly disaggregated levels. This section of the thesis seeks to investigate the under–five mortality in Zimbabwe using recent 2012 census data.

8.2 Data and Methods

This study draws on data from the 2012 Zimbabwe National Census (ZIMSTAT 2012). The decennial national censuses are used to inform policy decisions and planning in Zimbabwe. The 2012 census collected data on various demographic and health indicators including maternal and child health, as well as fertility data, employment, education, occupation, migration and mortality. From the census, a total of 1,373,263 live births occurred five years before the census, and 47,401 under–five deaths occurred.

8.2.1 Model specification

The study employs the Mosley and Chen (1984) model of infant and child mortality in developing countries. The model is based on the assumption that socio– economic determinants of under-five mortality essentially work through a common set of biological mechanisms, or proximate determinants, to apply an effect on mortality. Moreover variables considered in this study were selected based on previous studies that have been conducted at the global level. Potential determinant factors expected to be correlated with under five child mortality were included as variables of the study. Variables considered in this study were categorised into dependent and explanatory/predictor variables.

8.2.2 Dependent Variables

Data was extracted from the 2012 census section E (for women age 15–49 years). This section, with regards to women's childbirth history, is solely answered by the women. The section on the women's questionnaire asks the status of the last live birth,, (When was (name's) last live birth? This was used during data analysis to filter birth that occurred five years before the census (2012, 2011, 2010, 2009, 2008). Later the survival status of the last birth was ascertained by the following question: Is the child still alive? The outcome variable is child survival status (alive or dead). Hence, this variable exhibited a binary outcome; a child born within the previous five years and still alive a value of one (1) was assigned. On the other hand, a value of zero (0) was assigned to those deceased children within the previous five years.

8.2.3 Independent variables

In this study, socio–economic, demographic, and environmental possible determinants of child mortality related factors were considered. Demographic variables: marital status, age of mother at first and last birth. Socio–economic variables: maternal education and environmental factors: place of residence, sanitation: sources of drinking water and type of toilet.

Education was categorised as: "1= no education", "1= primary", "3= secondary and tertiary". Place of residence of the child was according to provinces which were: 1=Bulawayo, 2=Manicaland, 3=Mashonaland Central, 4=Mashonaland East, 5=Mashonaland West, 6=Matabeleland North, 7=Matabeleland South, 8=Midlands, 9=Masvingo and, 10=Harare. Harare and Bulawayo are also metropolitan cities. Marital status categorised as (1=never married, 2=married, 3=formerly married, which included divorced/separated and widowed). Maternal Age: The respondents were asked about their age in completed years. However, for the purposes of the present analysis, Mother's age at first birth ages were grouped into 4 categories such as: <20, 20–29, 30–39 and 40–49 years. Maternal age at last birth into two categories, 1=<20 years: 2 = 40–49 years. Toilet facility: categorised as 1= safe toilet (flush toilet, ventilated/improved latrine or toilet) and 2= unsafe toilet (bucket, open field, bush). Drinking water source: 1= safe (piped water, protected: wells, borehole, spring or rain water): 2 =unsafe water (unprotected; rain, spring, well water, other.).

8.2.4 Methods of analysis

Data were statistically analysed using SPSS version 22 and analysed at three levels (univariate, bivariate and multivariate). Descriptive statistics were presented in frequency tables, testing for associations between two variables was done using $\chi 2$ (were used to examine the statistically significant relationship between sociodemographic and child survival), while at the multivariate level logistic regression model was used. The dependent variable for this study was dichotomised; hence, a binary regression model (negative log–log) was used to analyse the factors associated under–five mortality. When the probability of a case is very low or very big, negative log–log models are frequently used (Mangombe and Kalule–Sabiti 2018, McCullagh 1980). The adverse log–log feature is asymmetrical, unlike logit and probit models. In SPSS, the function of the nlog log link is the same as the additional log–log in STATA. The complete number of participants reported to be alive was 1,325,682 and dead were 47,401 children, representing only 3.5 % of the total children born.

8.3 Results

8.3.1 Univariate results

Tab. 15 – Frequencies and percent distribution of explanatory variables, 2012, Zimbabwe

Variable		Frequency	Percent
	Alive (yes)	1,325,862	96.5
	Dead (No)	47,401	3.5
Provinces			
	Bulawayo	60,830	4.4
	Manicaland	185,088	13.5
	Mashonaland Central	125,720	9.2
	Mashonaland East	142,636	10.4
	Mashonaland West	166,596	12.1
	Matabeleland North	70,695	5.1
	Matabeleland South	63,373	4.6
	Midlands	169,297	12.3
	Masvingo	152,032	11.1
	Harare	236,996	17.3
Mothers age at first birth			
	<20 years	104,534	7.6
	20–29 years	779,174	56.7
	30–39 years	424,074	30.9
	40–49 years	65,481	4.8
Mothers age at last birth			
	< 29 years	1,353,955	98.6
	30–49 years	19,308	1.4
Marital status			
	Never Married	65,889	4.6
	Married	1,196,778	87.1
	Formerly married	113,596	8.1
Education			
	No education	3,639	0.2
	Primary	407,409	29.7
	Secondary and higher	962,215	70.1
Toilet type			
	Safe Sanitation	688,752	50.2
	Unsafe Sanitation	684,511	49.8
Water safety			
	Safe	976,580	71.1
	Unsafe	396,683	28.9

Source of data: ZIMSATAT (2012) and own calculations

Table 15, presents the socio–economic and demographic characteristics of the respondents and their under–five survival status. Of the total eligible under–five children born alive (1,373,263) in Zimbabwe since 2008–2012, 1,325,682 (96.5%) were alive, and 47,401 (3.5%) were dead. The results indicate that, Harare (capital city) had the highest number of births recorded (17%) while Bulawayo the second biggest city had the lowest (4.4%). The results show that 13.5 % of the children were born in Manicaland province compared to 9.2 % in Mashonaland Central. Moreover, majority of children, 57% and 30% were born to mother's age at first birth in the age group 20–29 and 30–39 years old respectively while 7% and 4.6% were born to mother's age at first birth age group <20 and 40–49 years old respectively. The study further reveals that most last births (98.6%) occurred to mothers <29 years old. Table 15, further shows that at least 29.9

% of children born were to mothers with primary education compared to 70.1% of those born to mothers with secondary and higher. An overwhelming 87% of under–five children had mothers who were married. About an equal percentage of the respondents and children had safe and unsafe toilets facilities. Of water safety, 71% and 29% of children had access to safe and unsafe water respectively.

8.3.2 Bivariate results

Table 16, shows the relationship between the socio–demographic characteristics and survival status of their under–five children. A chi–square (**χ2**) test for independence was used to assess whether there were significant associations between each of the background variable and survival status of the children below five years**.** The results reveal that all the selected variables; provinces, mothers age at last birth, mother's age at first birth, marital status, mother's education, sanitation variables water safety and toilet type were all statistically significant at $p< 0.05$, 0.01 or 0.001.

Tab. 16 – Cross–tabulation of under–five mortality and selected background characteristics, 2012, Zimbabwe

		Dead %	Alive %	χ2	Total
Survival status					
	Total	3.5	96.5		1,373,263
Provinces				0.018	
	Bulawayo	2.9	97.1		60,830
	Manicaland	3.9	96.1		185,088
	Mashonaland Central	3.5	96.5		125,720
	Mashonaland East	3.7	96.3		142,636
	Mashonaland West	3.6	96.4		166,596
	Matabeleland North	3.0	97.0		70,695
	Matabeleland South	2.9	97.1		63,373
	Midlands	3.6	96.4		169,297
	Masvingo	3.4	96.6		152,032
	Harare	3.1	96.9		236,996
Mothers age at first birth				0.021	
	<20 years	4.2	95.8		104,534
	20–29 years	3.2	96.8		779,174
	30–39 years	3.6	96.4		424,074
	40–49 years	4.6	95.4		65,481
Mothers age at last birth				0.006	
	< 29 years	3.4	96.6		1,353,955
	30–49 years	4.4	95.6		19,308
Marital status				0.028	
	Never Married	3.9	96.1		65,889
	Married	3.2	96.8		1196,778
	Formerly married	4.4	95.6		113,596
Education				0.016	
	No education	4.1	95.9		3,639
	Primary	3.9	96.1		407,409
	Secondary and higher	3.3	96.7		962,215
Toilet type				0.007	
	Safe Sanitation	3.3	96.7		688752
	Unsafe Sanitation	3.6	96.4		684511
Water safety				0.002	
	Safe	3.4	96.6		976,580
	Unsafe	3.5	96.5		396,683

$P < 0.05$

Source of data: ZIMSTAT (2012) and own calculations

Table 16, also reveals that a significant relationship was found between provinces and survival status. The study also indicates that child mortality is lowest among children born to mothers from Bulawayo and Matabeleland South at (2.9%) for each province. Manicaland had the highest percentage of under–five mortality, 3.9%, and Mashonaland provinces had an average of about 3.6% per province. Mother's age at first birth and under–five mortality show statistically significant a U–shaped relationship. The mortality of under–five children born to older mothers, 40–49 and youngest mothers <20 years were 4.6 and 4.2% respectively The study also indicates that child mortality is higher among children born to mothers who had their last birth at aged 30–49 years while mother's aged less than 29 years had the lowest (3.4%) under–five mortality . The study further reveals that child death to mothers who never married had a higher rate of child mortality compared to married women.

A statistically significant relationship was found between the level of mother's education level and under–five mortality. Women with no education had higher (4.1%), than primary, secondary and higher education, which had 3.9% and 3.3% respectively. There was a significant association in under–five mortality between and availability of safe toilets. Three percent (3.6%) of death were recorded among children who resided in households with unsafe toilets compared to 3.3% with safe toilets. Another important finding was a marginal difference in child mortality between children whose household had access to safe water (3.4%) and unsafe water (3.5%).

8.3.3 Multivariate results

In order to examine the factors that determine the under–five child mortality rate in Zimbabwe, a negative log–log logistic regression model was fitted, and the results are presented in Table 17. The results indicated that provinces, mothers' age at first birth, marital status, education, toilet type and water safety were the main predictors of child survival. Mashonaland provinces (Central, East and West), Manicaland, Midlands and Masvingo provinces were less likely to experience child survival than Harare province. The place of residence (province) shows a statistically significant relationship with under five child mortality. Children from the following Matabeleland provinces: Matabeleland South and Matabeleland North had a higher risk of dying before five years of age (OR= 1.05, p<0.001 and OR=1.04, p<0.001) respectively than Harare province. In addition, children from Manicaland province were less likely to die compared to Harare province (OR=O.94, p<0.001). The mother's age at first birth revealed a strong association with child survival. Women who had their first birth at <20 years were more likely to have reported a child who died before five years (OR=1.03,p<0.001) than those who first gave birth at 40–49 years. There was an unexpected finding by women had had their first birth aged 20 29 years who had the highest likelihood ratio (OR=1,1, p<0.001) of a child under–five mortality than any other age group. Mothers who have last birth at age <29 years were less likely to experience child death than older mothers at age 40–49 years, although this likelihood was not statistically significant.

It can be seen from Table 17, that children born to mothers who reported that they were never married had more risks of dying before age five years when compared to those born to married mothers (OR=1.028, p<0.001). Under–five children born to formerly–married mothers also had more likelihood of dying (OR=1.149, p<0.001) compared to children of formerly married mothers. Children born to mothers with secondary and higher education (OR=0.953, p<0.1) and primary education (OR=0.96, p<0.01) were less likely die before five years than those of women with no education. The statistics show that children born to mothers who had unsafe water were more likely to die before the age of five years (OR=1.006, p < 0.05). Children who had access to safe toilet facilities were less likely to die (OR=0.990, p < 0.01) than children with unsafe toilet.

Tab.17 – Odds ratio of selected predictors of under–five mortality, 2012, Zimbabwe

		95% CI	
	Exponentiated β	Lower	Upper
Threshold	– 1.016	– 1.093	– 0.938
Provinces			
Harare (Ref.)			
Bulawayo	1.043****	0.027	0.056
Manicaland	0.946****	– 0.065	– 0.045
Mashonaland Central	0.984***	– 0.028	– 0.005
Mashonaland East	0.961****	– 0.050	– 0.029
Mashonaland West	0.972****	– 0.038	– 0.017
Matabeleland North	1.044****	0.029	0.057
Matabeleland South	1.058****	0.041	0.071
Midlands	0.968****	– 0.043	– 0.022
Masvingo	0.989**	– 0.022	0.002
Mother's age first birth			
40–49 years (Ref.)			
<20 years	1.036****	0.020	0.050
20–29 years	1.105****	0.088	0.112
30–39 years	1.073****	0.058	0.083
Mother's age at last t birth			
30–49 years (Ref.)			
<29 years	0.972	– 0.107	0.051
Marital status			
Married (Ref.)			
Never married	1.028****	0.013	0.043
Formerly married	1.149****	0.130	0.148
Education			
No education (Ref.)			
Secondary and higher	0.953*	– 0.098	0.002
Primary	0.960***	– 0.047	– 0.035
Toilet type			
Safe sanitation (Ref)			
Unsafe sanitation	1.006**	0.001	0.013
Water safety			
Unsafe (Ref.)			
Safe	0.990***	– 0.017	– 0.004
	$\chi 2$	Df	Sig.
Pearson	3867.105	3204	0.000
Deviance	3355.05	3204	0.031

Notes**:** Negative Log–log regression.

*p < 0.1, **p < 0.05, ***p < 0.01, ****p < 0.001

Source of data: ZIMSTAT (2012) and own calculations

8.4 Discussion and Conclusions

The results of the multivariate analysis revealed that in general, the strength of the independent variables with dependent variables under–five (U5MR) were strong for the period under consideration. The provincial inequalities in the odds ratio of the mortality burden of U5MR were statistically significant. Harare, Bulawayo Matabeleland North and South had the highest odds of under–five mortality. Since both Harare and Bulawayo are metropolitan cities, this finding is not consistent with other studies that have found lower risks of under–five mortality. It is possible that the high odds of under–five mortality in the metropolitan cities (Harare and Bulawayo) than rural areas is related to the deteriorating socio–economic conditions in Zimbabwe (ZIMSTAT and ICF 2016). Urban cities in Zimbabwe faced water and sanitation in 2008 leading to the resurgence of infectious diseases such as cholera (Chikova 2015, ZIMSTAT and ICF 2015)

The finding of high under–five mortality in Matabeleland North and South and Bulawayo than in Mashonaland provinces of (Central, South, East), Manicaland and Masvingo provinces ties very well with the hypothesis that provincial inequalities of child survival in Zimbabwe are perhaps driven by socio–economic and cultural differentials (Liu et al. 2015, Adedini et al. 2015). The geo–sociocultural regions in Zimbabwe composed of predominantly 2 groups, Ndebele speaking people in Matabeleland provinces (Bulawayo, Matabeleland North and South), and Shona speaking in seven remaining provinces. Similar, results have been reported in Nigeria (Adedini et al. 2015).

Unlike Kembo and Ginnkem (2009) who found U–shaped under–five mortality curve by mother's age at first birth, this research find that the mortality risks for under–five is higher for children born to mothers of 20–40 years of age groups. The research expected to find high mortality risks to children born to very young mothers <20 years and older mothers 40–49 years old. Although the statistic was not significant, mothers who had their last birth <29 years had less likelihood of under–five child death than mothers who had their last birth at 30–49 years. This is in line with other studies that find under–five mortality risks increases in older reproductive age groups (Mugura et al. 2018, Kembo 2011, Adedini et al. 2015)

Children born to formerly married mothers had more likelihood of death than those born to married and never married. It is possible that such mothers might be vulnerable widows given the patriarchal nature of Zimbabwe, which promotes the intergenerational marriage of older men to younger girls (Mhloyi 1988, Tabutin et al. 2004). It is possible to hypothesise that such male partners will die before the wife leaving the mothers vulnerable. This might be amplified by the fact that Zimbabwe has a high prevalence rate of HIV, which kills more men than women in reproductive ages (ZIMSTAT 2012). Moreover, HIV is one of the leading causes of under–five mortality (Global Burden of Disease Collaborative Network 2018). Overall this finding suggests the need for protective policies for children to divorced separated and widowed women.

The findings of this study show that under–five mortality decreased with increases in the mother's educational status. This finding is line with other studies in Zimbabwe (Kembo and Ginnekem 2009, Kembo 2011, in Nigeria, (Adedini et al. 2015) and in Kenya, (Gruebner Lautenbach et al. 2015). This is probably because maternal education has been found to better women's socio–economic status, nutrition, housing, sanitation, access to reproductive health, family planning, and child health services (Caldwell 1976,) all of which reduce under–five mortality (Caldwell 1986, Cutler et al. 2006). Maternal education was also found to be an essential factor in the European historical child mortality revolutions (Reher 2004, Dyson 2013). This suggests the need for empowering girls beyond universal primary education as was proposed by MDG–2.

The findings of this study indicated that the provision of improved drinking water and toilets to households has a stronger impact on under–five mortality reduction. This finding supports the thesis that exogenous factors are dominant during the childhood stage (Kembo and Ginnekem 2009, Mosley and Chen 1984). Table 15, above revealed that only about half of the households had improved sanitation. This suggest that Zimbabwe needs to invest more on water and sanitation improvement.

There were significant limitations to the research which should be taken into consideration when interpreting the findings of this study. First, a recall prejudice for household death documents may have underestimated numbers slightly. At the same time, data on deaths reported by respondents during surveys are also incomplete partly because some relatives are reluctant to discuss details of their deceased relatives. However, I am confident that this bias is negligible since I only used the data about the last born kid. Second, since I only looked at the last born baby, this research did not consider all children born alive who died. Moreover, my measure did not include maternal mortality, which could have resulted in less reported under–five deaths in Zimbabwe. Third, it is possible that age heaping of under–five deaths might have affected the study findings. Children under five ages might have been reported older than their actual age, hence their ages plausibly fell outside the under–five age criteria.

Finally, the combination of exposure variables in the model is only one of the possible outcomes, and it should, therefore, be borne in mind that these are not the only possible risk factors that could predict under–five deaths in Zimbabwe. Other factors, such as birth intervals, breastfeeding duration, wealth, place of birth etc., were also discovered to be significant predictors of under–five mortality (Dodzo et al. 2016, Kembo and Ginnekem 2009, Kembo 2011). Some of this data, however, was not accessible from the census and could not, therefore, be used.

Notwithstanding these constraints, this is the first study to my understanding that used a comprehensive national census data to explore risk factors of under–five death in Zimbabwe at the individual level. The research showed that individual and socio–economic risk variables differ between provinces, maternal age at birth, maternal education, marital status, sanitation and secure drinking water. Public health interventions on under–five mortality should ideally include improvements in maternal education, toilet sanitation, and provision of safe drinking water. Promoting birth postponement by younger mothers and birth stopping before older reproductive ages should also be at the core childhood mortality interventions.

Chapter 9
Summary of findings, conclusion, and recommendations

In this study, the demographic revolution theory has been employed to explain mortality, natality and associated age structural changes in the developing countries. The theory provided compelling evidence regarding secular declines of mortality and natality and the associated changes in diseases and reproductive patterns. In the Japanese Mexican model the process followed the historical English model, although centuries later. Mortality decline first rapidly especially in younger ages creating unprecedented natural population growth rates. Under these circumstances prior mortality decline is considered a precondition for fertility decline although other factors including diffusion of birth control methods, linguistic and cultural barriers are also important. Regional clustering in which Africa is generally lagging is discussed.

Previous chapters examined, fertility levels, trends and spatial differentiation in Africa; population development in Africa with particular regards to ageing; proximate determinants of fertility revolution in Zimbabwe and lastly determinants of under –five years children's mortality in Zimbabwe. The present study sought to examine the demographic revolution in developing countries and Africa, with particular regards to Zimbabwe. The study was grounded on the demographic revolution theory, which is an all–encompassing theory. The other specific theories used are Mosley and Chen's framework of child mortality and Bongaarts' proximate determinants of fertility in developing countries. First, I provide a summary of the findings from research purpose one of this study; I examine fertility levels, trends and spatial differentials in Africa. Second, I discuss the findings from the research purposes two of this study. Specifically, I examine regional population development and ageing levels, differentials and similarities in Africa. Third, I identify and examine the proximate determinants of fertility decline in Zimbabwe. Fourth, I examine the levels and determinants of under–five mortality in Zimbabwe. Lastly, I explore the implications of this research for policy and programming that address the demographic revolution in developing countries, Africa and with particular regards to Zimbabwe

9.1 Fertility levels, trends, and differentials in Africa

In this chapter, the quantitative analysis of the UN, World Population Prospects, (2017) Revision on global and regional population estimates from 1960–2015 was used to explore the fertility differentials in Africa using cluster analysis. The analysis demonstrates clustering of fertility indicators (TFR CBR NRR) for the periods 1960–65, 1990–95 and 2010–15 into high, medium and low fertility for the respective periods provided compelling evidence of fertility differentials, levels and trends during the pre–transitional and transitional periods. The findings show three clusters for each respective period with high, medium and low fertility. In the 1960s more than half (54%) of countries had medium–fertility whereas Southern and Central Africa had the lowest fertility. The 1990s period revealed that 58% of countries were located in high fertility cluster. In the 2010–2015 period had the same proportion (58%) of countries like the 1990s but had medium fertility rate with significant fertility decline representing the pervasiveness of fertility decline. The Southern and northern Africa countries (21%) were also at/nearing replacement level fertility. In 2015, the number of countries with low and medium fertility was increasing while the number of countries with high fertility was simultaneous decreasing.

These analyses also illustrate that the increase in fertility in the period 1990–95 provides empirical evidence of the typical pattern of fertility decline characterised by initial fertility rise before the sustained decline. The sustained fertility decline is driven by the deliberate adoption of contraception (Coale 1973, Bongaarts 1978, 1982). These findings suggest that although fertility was high in pre–transitional Africa, it varied greatly and also suggesting regional clustering. In the 1960s Southern Central and Eastern African countries (19%) had the lowest fertility. The fertility differentials can be explained by proximate determinants (excluding modern contraception) in the pre–transitional period characterised by natural fertility regimes as defined by Henry (1961).

9.2 Population development in Africa with particular regards to ageing

This section synthesizes the empirical findings of objective two. The study examined population development and ageing differentials and similarities in Africa. The results showed clustering of countries according to fertility, mortality and population age structure indicators (TFR, IMR, median age, child and total dependency ratio, percentage aged 60 years and over) for the period 1995–2000; 2010–15; 2025–2030. The selected population age and sex structure indicators and determinants of population ageing were taken from World Population Prospects (UN 2017) for periods 1995–2000, 2010–2015 and 2025–2030. The k–means method of clustering data analysis was used, and this resulted in the grouping of countries according to their heterogeneity and homogeneity characteristics. The results found that African countries were grouped into three clusters for the respective periods (1995–2000; 2010–15; 2025–2030) associated with low, medium and high population development and ageing respectively.

The existing clustering indicates a strong relationship between population development and fertility transition. Precisely the countries in low population development decrease in 2010, with a simultaneous increase in the medium in 2010 and a further continuous increase of medium population development into 2025–2030. The findings indicate that the majority of the countries; 58%, 50%, and 54% were at low, medium and medium levels of population development in 1995 2000; 2010–2015 and 2025–2030 respectively.

The findings suggest population development as countries move along the demographic transition, especially fertility transition. Major points that emerged were: The number of countries in the first cluster decreased (early phase of fertility transition), as the number of countries in the second cluster increased (middle phase fertility transition) from 1995–2000 to 2010–2015, respectively. The last and smallest cluster 3 (last phase of transition) stays relatively with the same number of countries in the periods under study. Majority of countries were stagnated in the middle cluster and failed to move to cluster three with high population development. The fertility and mortality in African countries decline at different intensities creating different ageing profiles and show regional variation. Countries with low population development are typically in the early stages of fertility decline or pre–transitional fertility stages. This stage has also corresponding high infant, child dependency typical of high fertility societies (Coale 1973). Countries with medium population development are in the middle stages of fertility decline. Lastly, countries with high population development and ageing are approaching replacement level fertility. This group has low infant mortality, low child dependency and increasing percentages of elderly. This group is continuously made up of Northern and Southern Africa countries. The continuous clustering of Northern and Southern African countries together suggest regional clustering of population development. Similar findings were made by Maharaj and Pillai (2013). This study found a surprising finding which contradicts the demographic revolution assumptions. For example, countries are supposed to have a linear progression in the population development. However, this research found failure by a significant number of countries to move from medium to high population development and age ageing cluster. Since fertility has the biggest effect on population ageing than mortality, perhaps this is related to fertility stalling identified by many studies in sub–Saharan Africa (Goujon et al. 2015, Bongaarts 2006, Garenne 2013)

9.3 Proximate determinants of fertility revolution in Zimbabwe

This section provides findings of the proximate determinants of the fertility of pooled data from 6 DHS consecutive surveys from (1988, 1994, 1999, 2005 2010, and 2015). The findings provide empirical evidence, that fertility decline from (TFR) 5.4, to 3.8 and 4.0 from 1988, 1999 and 2015 respectively was caused by the contraceptive inhibitive effect which increased from (TFR) 3 to 4.65 and 6.45 children per woman for the respective periods. The results show that in 1988, the most prominent fertility inhibition (TFR) was caused by postpartum infecundity (Ci) 3.91, followed by contraception (Cc) 3.86 and marriage (Cm) 2.89 children per woman. This suggests Zimbabwe was in the early stages of fertility decline. Furthermore, results show that contraception fertility inhibition effect continuously increased to 6.45 children per woman by 2015, while marriage fertility inhibition increased to a peak of 3.58 in 1999 before decreasing to 3.32 children per woman in 2015. The postpartum infecundability fertility inhibition effect has decreased from 3.91 to 2.93 children per woman from 1988 to 2015, respectively. This suggests that fertility stalling observed in 1999 and after that may be caused by decreases in postpartum infecundity and marital fertility inhibition. The decomposition of contraception fertility inhibition by residence, education and wealth quintiles demonstrate a positive relationship. This suggests that educated urban women and wealthy women were ahead in the fertility transition than socio– economically disadvantaged women. However, fertility declined across all socio–economic groups. In 2015, married women with no education were the only socio–economic groups with fertility contraception inhibition effect below 50% with 42%.

9.4 Levels and determinants of under–five child mortality in Zimbabwe

Due to the dearth of research on determinants of under–five mortality in sub–Saharan Africa utilizing census data. This study, as specified by research purpose three of this study, examined the determinants of under–five mortality in Zimbabwe using the 2012 Zimbabwe National Census (ZIMSTAT 2012). Results from the bivariate analysis showed a significant relationship between place of residence, mothers' age at first birth, marital status, level of education, toilet type and water safety and under–five survival. Multivariate analysis consistently confirmed the same determinants to influencing under–five child mortality. One interesting finding was that children from the following provinces: Manicaland, Mashonaland Central, Mash East, Midlands, Masvingo and Mashonaland West were less likely to die before the age of five compared to children from Harare. Harare is the capital city of Zimbabwe and is highly urbanised, relatively better developed than all other provinces of the country. Therefore, it is not expected to have high under–five survival. Despite being the capital, it has its own share of development challenges such as, overpopulation, dilapidated roads and poor infrastructure such as, water and sewerage system. In addition, it is densely populated with 2 123 132 million people (Zimbabwe National Statistics Agency, 2012) and has had a resurgence of infectious disease outbreaks such as cholera outbreaks since 2008. This could have contributed to higher under–five child mortality observed in Harare than rural provinces.

Women who reported that they were married had a lower probability of reporting higher under–five mortality than formerly and never married. These results are consistent with other studies in Zimbabwe (Kembo and Ginnekem 2009, Kembo 2011). The literature points out that child survival is higher among married women because of their decision power in the family (Kaharuza et al. 2001). The results showed that women who were never married women reported a higher probability of child mortality. Children born to mothers with no education and those with primary education were less likely to die before five years than those of women with secondary and higher education. These results do concur with other studies which found that women with lower educational attainment were more likely to report higher child mortality than those with higher education (Kembo and Ginnekem 2009). The results further suggest that under reporting could have been possible which could have affected results accuracy. In addition, death is a not a palatable experience, so some child mortality could have not been reported. Also, census data in most developing countries is marred by inaccurate data collection.

With respect to water safety and child survival, children born to mothers who had unsafe water connected to their dwelling unit were more likely to die before the age of five years. This suggests that safe water is an important determinant of child survival. In addition, water from unsafe water sources contributes to diarrhoea in children**.** Access to safe toilet facilities was found to have a contribution in child survival. Children who had their households connected to safe water facilities were less likely to die before the age of five.

9.5 Theoretical Implications

The research for this study focused mainly on the demographic revolution theory in developing countries. The argument behind is that socio–economic development leads to fertility mortality decline and age structural changes. The clustering of fertility and population indicators levels and trends shows the importance of regional demographic clustering in Africa as countries move along the demographic revolution. This may be related to different socio–economic levels, cultural and linguistic boundaries of the populations. The ageing of Northern and Southern countries is a function of significant fertility decline to almost replacement fertility level and also mortality decline than in Central and Western African regions. Such a phenomenon was also witnessed in the European historical transition where Northern Europe was demographically ahead than Southern and Eastern Europe (Coale 1973, Dyson 2013)

The proximate determinants of fertility revolution in Zimbabwe provide compelling evidence that the second stage of the demographic revolution, namely the fertility decline is a function of deliberate adoption of modern methods of contraception. Secondly, fertility can decline across all socio–economic groups, even though socio–economically advanced married women will be further ahead in the fertility revolution. This is in line with the demographic revolution theory that fertility in developing countries will happen at a faster pace and at lower levels of development. The process all represents the diffusion aspect of the demographic transition. The demographic transition theory assumes a linear decline in fertility but however, this study finds that fertility decline stalled since 2000. The stalling of fertility maybe related to the weak government of Zimbabwe which do not promote of socio–economic development (Dyson 2013, Harper 2016). Thus fertility decline might be related to the diffusion of family planning methods and westernization of ideal small family size as espoused by Caldwell (1976, 2007), rather than economic development. Secondly, in the context of low socio–economic development, direction of the wealth flow may benefit the parents or women per se thus sustain fertility stalling (Caldwell 1976 2007). This particularly true in Zimbabwe where contraceptive prevalence significantly increased to 67% by 2015 yet fertility remain stalled at about 4.0 since 2000.

Under–five mortality is an indicator of development and is also central to fertility decline (Black et al. 2013). The under–five mortality provide empirical, theoretical evidence that under– five mortality varies according to province and selected demographic and socio–economic indicators. The geospatial under–five mortality variation is related to different socio–economic and cultural differences in Zimbabwe. Further, it provides interesting evidence that lack of development in urban areas can lead to a higher probability of under–five mortality in urban than rural areas. Formerly married mothers' under–five children have a higher probability of death than married women. In Zimbabwe, this may be related to the effect of HIV/AIDS pandemic, which kills more men than women of reproductive ages. Public health initiatives need to be strengthened in urban areas in both rural and urban areas. Programmes that ensure the survival of under–five mortality should also focus on the less educated and women across all education groups.

9.6 Limitations of research

The study also had a weakness. The challenge with fertility and population development levels trends and differentials in Africa sections is that it is difficult to pinpoint age groups which experienced fertility decline. Moreover, the indicators do not show the effect of males on women's fertility, limiting behaviour. Moreover, the indicators did not show the age and sex distribution of the variables. In the proximate determinants of fertility in Zimbabwe, the index of abortion was taken as 1.0 throughout the analysis, i.e. induced abortion was assumed to have no significant fertility inhibition effect on fertility due to lack of data. It is possible that excluding abortion in the model could have affected the estimation of total fecundity. Furthermore, studies have shown that abortion rates in sub–Saharan Africa are proliferating (Alazbih et al., 2017; Remez et al., 2014). Another limitation of the data used is that it failed to include reproductive data of males. The survey also used retrospective data on women's birth history on fertility and under–five mortality. It is possible that such respondents might suffer from recall bias, which might affect the accuracy and validity of the data. Thus predicted TFR will typically differ from the observed TFR because of underreporting of births; misreporting of behaviours measured by the indexes or omission of proximate factors that help determine fertility levels in the population under study. The same argument also affects under–five mortality, which used women's retrospective census data.

9.7 Policy implications and recommendations for future work

A common finding in most developing countries is the importance of increased child survival for fertility decline. This implies that developing countries lagging in fertility decline or population development should integrate and strengthen child survival not only as a fundamental human right but also as central to for fertility decline. In developing countries, socio–economic development has been found to stimulate the demographic transition. Lack of fertility decline and stalling is caused by weak governments that do not promote socio–economic development, including family planning. Women empowerment through education, employment, secularisation, and family planning should are necessary tools for increased child survival and fertility decline. Notably, mass education is the best predictor of fertility decline. Firstly, mass education for women causes low child mortality (Caldwell 1976, Dyson 2013, Harper 2016). Secondly, education opens up the mindset to new ideas, diffusion and acceptability of contraception (Cleland 2001). Finally, education promotes female labour participation (Becker 1976) and changes the direction of the wealth flow (Caldwell 2007). The clustering of African countries based on fertility population development and ageing suggest spatial homogeneity of countries. This suggests that countries with similar profiles can share knowledge and experiences as recommended in The Agenda 2030 for SDGs.

Rapid population development is problematic in either direction as it gives little time for preparation of high population growth, reaping the demographic dividend and the impending population ageing. For example, Southern African countries have a double burden of both communicable and non–communicable diseases — high unemployment rates and increasing pensions.

Since data production is an obstacle in developing countries, more research that can find ways of improving quality data collection at a lower cost is needed. There is a need to research further on proximate determinants of fertility according to age groups as such research can illuminate the age–specific reproductive contributions of fertility. Moreover, the indicators do not show the effect of males on women's fertility limiting behaviour. Since ageing is an inevitable outcome of demographic revolution, further research is needed to look at intra–country and gender differentials of population ageing and their policy implications. Contraceptive prevalence is related to fertility decline. In Zimbabwe, however, there is a need to investigate why fertility has stalled with increasing contraceptive prevalence. In Zimbabwe, most women use pills as a method of contraception. There is a need to look at accessibility and promotion of (Long Acting Reversible Contraceptives) LARC. This particularly crucial as LARC does not daily accounting as pills since there is a high number of low and uneducated women.

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APPENDIX 1

Sub–region and country	Censuses	Fertility–health surveys (WFS, DHS and equivalent)	Other demographic and household surveys
West Africa			
Benin	1979 1992 2002 2013	1982 1996 2001 2006 2011/12 2017/18	1961
Burkina Faso	1975 1985 1996 2006	1993 1998/99 2003 2003 2006 2010/11	1960–1961 1974–1975(a) 1984 1991 1993(a) 2000(a)
Côte d'Ivoire	1975 1988 1998 2014	1981 1994 1998/99 2005 2006 2011/12	1957/58 1962–1964 1978–1979(b) 1993(a) 2005
Gambia	1963 1973 1983 1993 2003 2013	2000 2005/06 2010 2013	1990 1993/1994 2001
Ghana	1960 1970 1984 2000 2010	1979–1980 1988 1993 1998 2003 2006 2011 2008 2014 2016	1960(c) 1968–1969 1970© 2007 2013/14
Guinea	1983 1996 2014	1992 1999 2003 2005 2012	1993(a)
Guinea Bissau	1950 1970 1979 1989 2009 1991 2000	2000 2006 2010 2014	
Liberia	1962 1974 1984 2003 2008	1986 2007 2013	1979/1971 1974(c) 1978–1979 1988 2009 and 2011 MIS
Mali	1976 1987 1998 2009	1987 1995 2001 2006 2012/2013	1960–1961 1992–1993(a) 2003 2010
Mauritania	1977 1988 2000 2013	1981/82 1996 2000/01 2007 2011	1964–1965 1990/91 1993(a) 2003/04
Niger	1977 1988 2001 2012	1992 1998 2000 2006 2012	1959–1960 1993(a) 2010 2016
Nigeria	1963 1973 1991 2004	1981–1982 1990 1999 2003 2007 2008 2011 2013	1965/66 1971/73 1980–1981 1993(a) 2000 2010
Senegal	1976 1988 2002 2013	1978 1986 1992 1996 1997 2000 1999 2005 2012 2014	1960 1970–1971 1979–1980 1993(a) 2006 2008/09
Sierra Leone	1963 1974 1985 2003 2015	2000 2005 2008 2010 2013	1969–1970 1987 1992 2007
Togo	1958/60 1970 1981 2002 2010	1988 1998 2000 2006 2010 2013/14	1961 1971 1996
Central Africa			
Angola	1960 1970 1984 2002 2014	1996 2001 2006/07 2015/16	2006/07 2008/09 2011
Cameroon	1976 1987 2005	1978 1991 1998 2000 2004 2006 2011 2014	1960–1962
Central African Republic	1962 1975 1988 1998 2003	1980 1994/95 2006 2010	1959–1960
Chad	1993 2003 2009	1996 2000 2004 2010 2014/15	1964 1980 1998(a)
Congo	1974 1984 1996 2007	2005 2011 2014/15	1960–1961
Congo (D.R.)	1984	2001 2007 2013/14	1955/57 1975–1976(d) 1995
Equatorial Guinea	1960 1971 1983 1994 2002	2000 2011	1981
Gabon	1960 1970 1980 1993 2003 2013	2000 2012	1960–1961 2005
East Africa			
Burundi	1979 1990 2000 2008	1987 2000 2002 2005 2010	1960 1965 1970–1971(b) 2000 2005 2012
Eritrea	1984 2003	1995 2002 2010	
Ethiopia	1984 1994 2007	1990 1995 2000 2005 2011	1964–1967 1968–1971 1981 1989–1990 2003 2014
Kenya	1962 1969 1979 1989 1999 2009	1977–1978 WFS, 1983 1989 1993 1998 2003 2008/09 and 2014 DHS	1962(c) 1973 1977 1984(e)
Madagascar	1975 1993 2003 2011	1992 1997 2003/04 2008/09, 1995 and 2000 MICS	1966 1980 2011 2013
Malawi	1966 1977 1987 1998 2008	1984 1992 2000 2004 2010 2015/16, MICS 2006	1961 1970–1972 1982 2014
Mozambique	1960 1970 1980 1997 2007	1987 1997 2003 2011 DHS 1995 2009 MICS	1991
Rwanda	1978 1991 2002 2012	1983 fertility survey 1992 2000 2005 2010 2014/15 DHS	1970 1981© 1996
Somalia	1975 1986	1999 2006 2011 MICS 2002/03 RHS	1980–1981 1982
South Sudan	1973 1983 1993 2008	1978–1979 1989–1990 1992–1993 2000	1964–1966 2006 2010
Tanzania	1967 1978 1988 2002 2012	1991 1996 1999 2004/05 2010 2015/16	1973
Uganda	1959 1969 1980 1991 2002 2014	1988/89 1995 1999 2006 2011 DHS 2009 MICS	2002
Zambia	1963 1969 1980 1990 2000 2010	1992 1996 2001/02 2007 2013/14	1974 1988
Zimbabwe	1962 1969 1982 1992 2002 2012	1984 1988 1994 1999 2005 2010 2015, NRHS 1984, MICS 2014	1982–1983 1984 1987–1988

Sub–region and country	Censuses	Fertility–health surveys (WFS, DHS and equivalent)	Other demographic and household surveys
Southern Africa			
Botswana	1964 1971 1981 1991 1996 2001 2011	1984 1987 2007 1988	1961 1978–1979 1983 1984(e) 1986–1987 1999(a)
Lesotho	1956 1966 1976 1986 1996 2006	1977 1991 2002, 2001 2004 2009 2014 DHS	1968 1971 1973 1988–1989 1993 2001
Namibia	1960 1970 1981 1991 2001 2011	1992 2000 2006/07 2013	
South Africa	1951 1960 1970 1980 1985 1991 1996 2001 2011	1989 1998 2003/4 2007 2016	2013 1991
Swaziland	1956 1966 1976 1986 1997 2007	1986 2006 2010 2014	1973 1988 1991
North Africa			
Egypt	1960 1976 1986 1996 2006	1980 1991 1988 1992 1995 2000 2003 2005 2008 2014	1984 1987 1998 2003
Tunisia	1956 1966 1975 1984 1994 2014	1978 1988 1994 2001 2013	19832003 2007 2009
Algeria	1966 1977 1987 1998 2008	2000 2006 2012/13	1992 2002
Sudan	1973 1983 1993 2008	1978/79 1988/89 1992/93 1999 2014	2001 2006 2010
Morocco	1960 1971 1982 1994 2014	1980 1987 1992 2003/04 2011	1995 1988/89 1996/97
Libya	1954 1964 1973 1984 1995 2006	1995 2007 2012 2014	

Note: Two small countries are excluded: the Seychelles (about 80,000 inhabitants in 2000) and St. Helena (about 7,500 inhabitants).

(a) Migration survey.

(b) Multi–round survey.

(c) Complementary or post–enumeration survey.

(d) Multi–purpose demographic survey on Western Zaire (EDOZA).

(e) Contraceptive prevalence and fertility survey.

Sources: Gendreau (1993); U.S.Census Bureau; personal studies. Tabutin et al. and Schoumaker 2004, UN (2017)