UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL, HUMAN AND
MATHEMATICAL SCIENCES
Social Statistics & Demography

Three Papers on Households and Child Health in Botswana

by

Oleosi Ntshebe

Thesis for the degree of Doctor of Philosophy

August 2017

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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The primary objective of this thesis is to examine the change in Botswana households between 1971 and 2011, show the relationship of household composition to child health outcomes and to demonstrate the association of community factors with stunting in Botswana. The thesis focusses on three related papers.

Paper one uses a descriptive approach, and it provides an overview of how households have changed over time in Botswana. This paper analyses data from census reports for the years 1971, 1981, 1991, 2001 and 2011, and three nationally representative surveys: the 1988 Botswana Standard Demographic Health Survey, the 2000 Multiple Indicator Survey (MICS) and the 2007 Botswana Family Health Surveys (BFHS). The findings from this paper indicate a change towards smaller households. The results show a decrease in the average household size, growth in the number of households, and a growing importance in the distribution of other household types (e.g., a rise of one person households, living with family and less with extended and not related household members). At the same time there is a decrease in childbearing and fertility.

Using data from the 2007 BFHS and multi-level logistic models, paper two examines the relationship between household composition, stunting and diarrhoea prevalence. The findings indicate that stunting varies by whom the child lives with. Stunting is higher among children living with no parents compared to those living with both parents, and among those living with not related household members. Stunting is less prevalent among children living with an aunt and among those living with other relatives. Also, children living in mother only households and with a grandparent present have a higher level of stunting compared to those living with both parents. The findings on diarrhoea prevalence show that children living in mother-only households, and those living with no parents are less likely to have the condition than those living with both parents. Across all households, those who are richer, regardless of who is in the household, have lower rates of stunting and diarrhoea prevalence than those that are poorer.

Paper three draws on census and survey data to examine the relationship between community factors and stunting. The results from paper three show a negative association between percentage of professionals in a district and stunting. Children living in the West, East/North East and Central parts of the country had higher levels of stunting compared to those living in the North. In addition, household wealth was found to be a significant moderator between the percentage of professionals in a district and stunting. Finally, the analysis in paper two and three show a clustering effect at household level.

The implications of these findings is that policies aimed at reducing stunting and diarrhoea may be best targeted at individual and household factors, and other adults in a household beside biological parents. While further research is needed to understand the mechanisms by which community factors influence stunting.

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DECLARATION OF AUTHORSHIP

I, Oleosi Ntshebe declare that the thesis entitled *Three Papers on Households and Child Health in Botswana* and the work presented in the thesis are both my own, and have been generated by me as the result of my original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my work;
- I have acknowledged all primary sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- none of this work has been published before submission.

Signed: ……..

Date:…….

Acknowledgements

Several people deserve recognition for the success of this research. First, I wish to thank my supervisors; Dr Andrew Amos Channon and Professor Victoria Hosegood for guiding the research and taking their time to read my work. I value the quality of their comments on the previous drafts of the thesis and the discussions we have had.

Second, I am grateful to my two mentors: Professor John Holm, and my late grandfather Mr Koketso Ntshebe. Special thanks to my husband Sonny for his love, encouragement and emotional support during the various stages of this research. I also wish to thank my daughter Lore, who was an excellent distraction from academic fatigue, and my twin sister Chookhwa for taking care of Lore while I completed the last stages of my research.

I would like to thank my extended family: the Ntshebe's, Sereetsi's, and the Macheng's for their support to pursue my goals. I acknowledge my friends at Millbrook Gospel Hall, my colleagues at the University of Botswana, my friends Cho, Virginia, and Laletsang for all kinds of assistance. I also extend my gratitude to other PhD students at the University of Southampton for moral support and fruitful academic discussions.

I wish to thank Statistics Botswana for providing the data sets used in this research, the Demographic and Health Survey (DHS) team for providing access to the 1988 Botswana data set and the World health Organization (WHO) Anthro team for helping me with the macros to obtain the height for age z scores. My deepest gratitude goes to the University of Botswana, this research would never have been possible without their financial support and grant of study leave. And lastly, God and Saviour who was my primary source of strength and perseverance.

Abbreviations

AIC	Akaike Information Criterion
AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral therapy
BFHS 2007	Botswana Family Health Survey 2007
BAIS	Botswana AIDS Impact Survey
BCWIS	Botswana Core Welfare Indicators Survey
CDC	Centers for Disease Control and Prevention
CSO	Central Statistics Office
DHS	Demographic and Heath Survey
EA	Enumeration area
GDP	Gross domestic product
HAZ	Height for age z scores
HIV	Human Immunodeficiency Virus
HH	Household
HICs	High income countries
H-L	Hosmer-Lemeshow goodness of fit test
IMR	Infant mortality rate
LMICs	Low income and middle income countries
MDGs	Millennium Development Goals
MICS	Multiple Indicator Survey
NACA	National Aids Coordinating Agency
NCHS	National Center for Health Statistics

PCA	Principal Component Analysis
PMTCT	Prevention of mother to child transmission
PSU	Primary sampling unit
SD	Standard deviation
SDGs	Sustainable Development Goals
SE	Standard error
SSA	sub-Saharan Africa
UK	United Kingdom
U5MR	Under-five mortality rate
UNICEF	United Nations Children's Fund
USA/US	United States of America
VPC	Variance partition coefficient
WHO	World Health Organization

CHAPTER 1. INTRODUCTION

Households are domestic units which contain a single person or a group of people who are related or not related, living together and share aspects of domestic life (Allan and Crow, 2001a, Bongaarts, 2001, Simpson, 2012). The demand for these living arrangements reflect underlying demands for goods or functions associated with households; such as physical shelter, domestic service, personal care, privacy and economic support (Burch, 1995, Simpson, 2012). The nature of households (eg. its cleanliness, space allocation and socio-economic resources) provide a physical environment which supports child well-being (Leventhal and Brooks-Gunn, 2000) and child health (Heaton et al., 2005, Justesen and Kunst, 2000). In particular families and households provide financial and time resources needed for child nurturing and support (Thomson and McLanahan, 2012, Thomson et al., 1994, Waldfogel et al., 2010, Houle et al., 2013) and resources to identify and manage health (Williams et al., 2003, Berman et al., 1994).

Globally, there is a shift in households becoming smaller, both in developed and developing countries (Burch, 1995, Kuijsten, 1995, Bongaarts, 2001). For example, a drop in the mean number of individuals in households is reported between 1970 and 2000 in Italy and Britain from 2.9 to 2.5 persons and from 3.5 to 2.8 persons respectively (Hall et al., 1999). The average household size has also decreased across the rest of Europe between 1950 and 1990 (Kuijsten 1995, van Imhoff 1995). Bongaarts (2001) analysis of household size and composition in 43 developing countries also finds the trend toward smaller and nuclear households in Africa. Within this general context, countries in Southern Africa are also experiencing declines in household size and composition.

Traditionally, families and households in low and middle income countries (LMICs) are larger and more complex in terms of membership than in high income countries (HICs), consisting of the nuclear and extended family members (Lloyd and Desai, 1992). The nature of these households presents both advantages and disdvantages for child health and care. For example, one benefit for living with the extended family for parents is that this provides opportunities to the biological parents for child care and a safety net if the parent cannot afford child care alone (Sigle-Rushton and McLanahan, 2002). It also enables access to socio-economic resources provided by other adult household

members such as grandparents and aunts (Mutchler and Baker, 2009, Sear and Mace, 2008). Extended households also provide opportunities for pooling of socio-economic resources to assist with child monitoring and supervision (Desai, 1992, Bronte-Tinkew and DeJong, 2004). Larger households also present competing demands for resources, which disadvantage children with regard to insufficient food, inadequate attention and deficient health care (Heaton et al., 2005).

It is also common to find children living in smaller households in LMICs now than it has been in the past, as is the case in Botswana. Just like larger households, smaller households too are likely to present mixed effects on child health depending on the amount of financial and time resources available in them.

Households and implications for Child Health Outcomes in Botswana

The experience of child rearing and growing up in Botswana is likely to be different now than in the past two decades. For example, the majority of households in 2007 are smaller and less diverse in membership compared to 1988 and in 2000. More households have lower levels of children aged 0-4 years, while many children live with other household members than biological parents (Government of Botswana, 2009a). Also, new household types have emerged in Botswana in the form of one person households, lone parenting (usually by mothers), and an increase in the proportions of individuals cohabiting and never marrying (Mokomane et al., 2006, Letamo and Rakgoasi, 2000). These changes in households will be explored in Chapter 3. Correspondingly, these new household types present both opportunities and challenges for child care and health.

Since 1970 there has been significant socio-economic changes in Botswana, which have brought about transformation of households size and composition. These include increases in educational attainment, participation of women in employment, and a decrease in marriage rates (Central Statistics Office, 2006, Central Statistics Office, 2004). More mothers now are in employment than in 1981 or 1991, and often co-reside with other household members to cope with child care and employment demands (Mokomane et al., 2006). However, there is little evidence on how these socio-economic changes have affected households and child health outcomes in Botswana.

The change in households in Botswana has been occurring amidst increases in child health diseases. Stunting, diarrhoea, acute respiratory infections, HIV and AIDS are reported to be the main causes of child morbidity and mortality in Botswana (Government of Botswana, 2009b, Government of Botswana, 2009a, Republic of Botswana and UNICEF, 2000). This thesis focusses on stunting and diarrhoea prevalence. These have been chosen to represent both long term and short term health implications. Stunting develops over a long period of time, indicating a lack of sufficient nutrition (WHO, 2013b, WHO, 2007a). On the other hand, diarrhoea is a short term indicator of poor health, with most diarrhoea episodes lasting for less than two weeks and is related to poor environmental conditions (WHO, 2013a).

Growth faltering is a common method of investigating the health of children. There are three main indicators of this: stunting (a low height for age), wasting (a low weight for height) and underweight (a low weight for age). These measure different aspects of growth. In 2000, 23 per cent of children below age five in Botswana were stunted, 13 per cent were underweight and 5 per cent were wasted (Government of Botswana, 2001). By 2007, the levels of malnutrition among children less than five years had increased to 29.9 per cent for stunting, 14 per cent for underweight and 7 per cent for wasting (Government of Botswana, 2009a). Conversely, the levels of childhood diarrhoea in Botswana have decreased slightly from 20.0 percent in 2004 to 17.9 percent in 2007 (Central Statistics Office, 2007).

Child Health Outcomes in Low and Middle Income Countries (LMICs)

Child health outcomes investigated in this thesis represent significant health problems for children in LMICs. UNICEF (2012) shows that stunting contributes to more than a third of deaths among children under five years of age, and its prevalence is higher in sub-Saharan Africa (40.0%) and South Asia (39.0%) than the rest of the world. The same report also states that diarrhoeal diseases remain a leading killer of young children; contributing to 1 per cent of world's deaths during the neonatal period and to 10 per cent of the deaths in the post-neonatal period (UNICEF, 2012). Regionally, most of the deaths (90%) among children under five years due to diarrhoea diseases occur in sub-Saharan Africa and South Asia (UNICEF, 2012). Prolonged diarrhoea in children is an underlying cause of malnutrition, either preceding or resulting from the illness itself and due to a

loss of nutrients for proper growth (WHO, 2013a, Keusch et al., 2006, Ochoa et al., 2004).

Although LMICs have made progress in reducing stunting since 2000, in many parts of the developing countries the prevalence of stunting remains high (UNICEF-WHO-Worldbank, 2015). As shown in Table 1.1, the prevalence of stunting decreased from 38.3 percent in 2000 to 31.6 per cent in Africa in 2013/14. In contrast, stunting decreased from 38.1 per cent to 24.3 per cent in Asia over the same period. Estimates of stunting in Southern Africa also remain high for most of the countries in this region. Compared to its neighbouring countries in 2007, stunting in Botswana is high (29.9%), a level similar to Angola (29.2%) and Namibia (29.6%). A prevalence of stunting of above 30% is considered very high, 20-29% high, 10-19% medium and below 10% low, according to the WHO classification scheme for the degree of malnutrition in a population (World Health Organization, 1995).

Table 1.1: Prevalence of stunting in selected regions, 2000-2014

	Per cent stunted		
Country	2000	2007	2013/14
Regions			
Africa	38.3		31.6
Asia (excludes Japan)	38.1		24.3
Oceania (excludes Australia and New Zealand)	36.8		38.2
Latin America & Caribbean	18.4		11.3
Central America	25.5		15.6
South America	15.8		9.9
Southern Africa	33.2		28.4
Angola	50.8 (2001)	29.2	
Namibia	29.5		23.1
South Africa	30.9 (1999)	23.9 (2008)	
Zambia	52.5	45.8	40.0
Zimbabwe	33.7	35.1 (2009)	27.6
Botswana	23.0	29.9	

In brackets are years. Southern Africa only includes neighbouring countries to Botswana.
Source: UNICEF, WHO, World Bank Group joint malnutrition estimates, 2015. Data from Botswana is from the 2000 MICS and 2007 BFHS.

Evidence also shows that malnutrition is a major cause of child death globally (Black et al., 2013, UNICEF, 2012, Pelletier et al., 1995). A study by Pelletier et al. (1995) from 53 developing countries attributes 56 per cent of deaths among children aged 6-59 months

to malnutrition. In the case of Botswana infant and under five morbidity and mortality are relatively high. The infant mortality rate (IMR) increased from 37 to 57 deaths per 1000 live births between 1996 and 2007 (Government of Botswana, 2009a), while the under-five mortality rate (U5MR) also rose from 45 deaths per 1000 live births in 1996 to 76 deaths per 1000 live births in 2007. Undernutrition (Government of Botswana, 2009b) and HIV and AIDS (Shapiro and Lockman, 2010, Shapiro et al., 2007) are reported to be the main cause of child morbidity and mortality in Botswana. In 2008 the HIV prevalence rate in the general population was 17.6 per cent and 2.2 per cent among children aged 1.5 to 4 years (Government of Botswana, 2009c).

Another motivation to investigate stunting and diarrhoea in Botswana is due to the poor performance of the country in some of the Millennium Development Goals (MDGs). For example, goal (1) to eradicate extreme poverty and hunger and goal (4) to reduce child mortality between 1990 and 2015 were not successfully met (Republic of Botswana and United Nations, 2010). Now given the recently introduced Sustainable Development Goals (SDGs), it is important to continue research on child health outcomes in Botswana, in order to tackle the remaining challenges and to inform policy and interventions which facilitate improvement in child health and development. In particular goal 2 of the SDGs aims to end poverty and hunger and goal 3 aims to ensure good health and well-being across the world by 2030 (UNDP, 2016). In order to make progress on these goals it is important to understand how households and the changing household structure in Botswana are related to child health outcomes, with a view to supporting households in ensuring children are as healthy and as supported by the household members as possible.

The Botswana Context

Botswana is a land locked country in Southern Africa. It shares borders with Angola, Namibia, South Africa, Zambia and Zimbabwe (see Figure 1.1). About 70 percent of the country is covered by the Kgalagadi desert (Van Klaveren et al., 2009) and most of the population is concentrated on the eastern side of the country. The capital city of Botswana is Gaborone. At the time of independence in 1966, Botswana had a population of 540,000 and it was one of the poorest countries in Africa (Van Klaveren et al., 2009). In 2011 the population of Botswana was estimated to be 2,024,904 (Statistics Botswana, 2014). The percentage of the population residing in urban areas has increased from 18

per cent in 1981, to 46 per cent in 1991 and 60 per cent in 2006 (UNDP, 2008). HIV prevalence rates have also increased from 17.1 per cent in 2004 to 17.6 per cent in 2008 (Central Statistics Office, 2009).

Since 1990, the Gross National Income (GNI) per capita, a measure of the standard of living has increased from US$7,845 to US$16, 646 in 2014, compared to US$3,363 for sub-Saharan Africa in 2014 (UNDP, 2015). The UNDP (2015) report further shows that major strides in the standard of development index has translated into improved health infrastructure in both rural and urban places across Botswana. Improved health infrastructure has narrowed the gap in access to basic health care between rural and urban areas. Botswana has a comprehensive health care system with 96 per cent of the population currently living within a 25 km radius from a health facility, which ensures improved access and availability of maternal health services. For example, in terms of child birth care, the percentage of birth deliveries supervised by skilled personnel among women aged 12-49 years was 94.1 per cent in 2007, an increase from 78 per cent in 1978 (Government of Botswana, 2009a). However, despite the country attaining a middle income status in the last two decades, improvements in health infrastructure and in the standard of living, the increase in stunting, diarrhoea prevalence and HIV and AIDS prevalence remain a public health challenge.

Figure 1.1: Map of Botswana

Source: http://www.nationsonline.org/oneworld/map/botswana-map.htm

Given this background, this thesis studies how households have changed over time in Botswana and focuses on the relationship between household membership and both stunting and diarrhoea prevalence. This is presented in a three-paper format. The first paper provides a description of how households have changed between 1971 and 2011, and how such changes can be related to fertility and marital status. Since households are the overall guiding unit of the thesis, it is important to understand how they have changed in size and composition over time. Paper one uses data from the census reports for the years 1971, 1981, 1991, 2001 and 2011, supplemented by data from the three nationally representative surveys: the 1988 Botswana Standard Demographic Health Survey, the 2000 Multiple Indicator Survey (MICS) and the 2007 Botswana Family Health Survey (BFHS).

Paper two examines individual households and how these influence stunting and diarrhoea prevalence. This paper uses data from the nationally representative 2007 Botswana Family Health Survey. A “child perspective” is employed in this paper in order to study household relationships and to develop categories that identify household composition. This involves re-orientating the relationships in the household, which are recorded in the survey as being how each household member is related to the head of household, to being how each household member is related to each child in the household.

Lastly, paper three extends this analysis to place the household in the wider context of its community, and it explores the effect of community context on households and child stunting. This analysis draws on census data for the years 2001, 2011 and the 2007 BFHS.

Both the second and third papers use multilevel logistic modelling based on the clustering of 2531 children within 1804 households and within 298 enumeration areas. Unlike the multivariate logistic model, the use of the multilevel modelling avoids violating the assumption of independence of the observation and underestimating the standard errors of the regression coefficients (Snijders and Bosker, 2012). In addition, the use of multilevel modelling is necessary for paper three in order to estimate the cross-level effects and to partition the variance between the different levels (Garner and Raudenbush, 1991).

1.1 Research questions

The fundamental goal of this thesis is to profile households in Botswana between 1971 and 2011, and to highlight the relationship between community, household factors with stunting and diarrhoea prevalence. This information is important for academic knowledge as well as to inform child health policy on the risk factors for stunting and diarrhoea prevalence. The research questions under consideration are:

1. How have households changed in Botswana between 1971 and 2011?
2. How are fertility and marital status related to change in household size and composition over time in Botswana?
3. What types of household composition, as operationalised by the relationship of the child to other household members, are observed in 2007?
4. Do child health outcomes vary by whether the child lives with two parents, one parent or no parents and by the types of others living in the household, such as grandparents, aunts, uncles or other relatives/not related household members?
5. Does the presence of other types of household members moderate the relationship between living with parent(s) and child health outcomes?
6. To what extent are community factors associated with stunting?
7. To what extent is the relationship between community factors and stunting moderated by household factors?

1.2 Structure of the thesis

The thesis consists six chapters. Chapter one provides an introduction. Chapter two presents a review of the literature related to households and child health, the overarching conceptual framework and how the current investigation adds to academic knowledge. Chapter three provides an overview of household structure and change over the period 1971 to 2011. Chapter four explores the association between child health outcomes and household composition. Chapter five examines how community factors are associated with stunting. Finally, chapter six discusses the conclusions and policy implications of the findings from this thesis.

CHAPTER 2. LITERATURE REVIEW

This chapter provides a general literature review on families, households, community factors, and their relationship with child well-being and child health. Also, the literature review presents the main concepts used in the thesis, the theoretical framework, the importance of selection effects, conceptual framework that guides the overall analysis and the research gap for this investigation. Online search engines used for the review include the University of Southampton library catalogs, Web of Science Core Collection, DelphiS, PubMed, MEDLINE, POPLINE and Google Scholar. The search included the use of the terms related to child well-being, child health, child growth, child development, family, household and community variables. Additional articles were obtained through publication bibliographies. The literature used is from countries with different income levels, in order to illustrate the various contextual aspects of family, household, and the relationship between child health outcomes and households.

2.1 Concepts

There is a range of operational definitions that are used throughout this literature review. Most notably, it is critical to understand the concepts family, household, household formation, household change, household dissolution, child well-being and child health.

Family and household

The concept 'family' is based on individuals who are related by blood, adoption, marriage, who have a commitment to each other (Burch, 1979), and are mutually entitled to receive and to provide support of various kinds to each other (Levine, 1990). Other researchers define 'family' as one or two parents with or without children (Farber, 1966), living in the same housing unit, and having common provision for food and necessities for living (Anderson and Sabatelli, 1999). Family as defined above presents a narrow sense of parents and children and a more conventional type of a nuclear family found in high income countries. In contrast, evidence shows that families in many societies expand beyond parents and children to include other members who are not necessarily related by birth, marriage or adoption (Clarke, 1965).

A recent paper[1] on families in South Africa specifies family as:

> *'a societal group that is related by blood (kinship), adoption, foster care or the ties of marriage (civil, customary or religious), civil union or cohabitation, and go beyond a particular physical residence', (Republic of South Africa, 2013).*

Within the family literature there is often complexity and inconsistency on how the terms 'family' and 'household' are used, and with no standardisation of classification of households and relationships within the household, these concepts are often conflated in the literature and general public knowledge (Simpson, 2012). In this thesis, several authors emphasise the use of 'family' to represent genealogical connection between members of a domestic group, and 'household' to indicate co-residence and sharing of domestic activities and economies by members of a domestic group who are related or not (Allan and Crow, 2001a, Bongaarts, 2001, Burch, 1979).

How 'family' and 'household' are conceptualized is also related to the questions considered (Bongaarts, 2001, Allan and Crow, 2001a). The family framework attends to questions on how parents socialise their children, how love is expressed in marital union, between members of the domestic group, and how concerns with care provision are dealt with (Allan and Crow, 2001a, Simpson, 2012). While the household framework emphasises the division of responsibility, workload, strategies for coping, managing household activities and income pooling between members of a domestic group (Allan and Crow, 2001a, Simpson, 2012). However, in spite the difference between the two frameworks, the two concepts overlap empirically as questions asked of them are similar (Allan and Crow, 2001a).

Moreover, disciplines define 'family' different. For instance, Clarke (1965) indicates that demographers tend to define family based on a social group which comprise parents, children or no children and other persons. However, in studies of fertility, the term family is often limited to parents with children. Sociological perspectives emphasize intimate relationships rather than biological or conjugal ties (Farber, 1966).

[1] A document that presents a government policy preferences prior to the introduction of legislation (Republic of South Africa, 2013).

The concept of household has been widely used in large–scale demographic data sets such as censuses and demographic health surveys (DHS) in many countries (McFalls Jr., 2007, Van de Walle, 2006). In fact demographers use household as a primary sampling unit for collecting data about individuals belonging to a domestic group (Simpson, 2012, Van de Walle, 2006, Burch, 1979). Economists have primarily been concerned with household behaviour and they define family based on production and consumption of resources in the household (Chen and Dunn, 1996). On the other hand, evolutionary anthropologists have studied family structure and human well-being in the context of small 'traditional' societies and rural communities, and their perspective emphasise the role of the family especially biological parents and extended kin to child and adult physical health (Lawson and Uggla, 2014).

Several researchers show that the concept of household may be used to characterise either a family, non-family or a mix of family and non-family (Belsey, 2005, McFalls Jr., 2007, Simpson, 2012, Allan and Crow, 2001a). This is because common elements of a household are that they indicate a shared location, activities, and connections among members of a domestic group (Laslett, 1972, Allan and Crow, 2001a, Burch, 1979, Bongaarts, 2001) and who are not necessarily related by marriage or kinship ties. As not all private households contain families, non-family households would therefore consist one person households and two or more individuals who share their residence with unrelated individuals (Simpson, 2012, Van Imhoff et al., 1995).

In spite of the variations in the definition of the word 'family' and 'household', there appears to be a broad consensus on the definition of family consisting father, mother, with or without children, confined to kinship relatedness and including a much wider group such as grandparents, aunts and uncles (Simpson, 2012, Farber, 1966, Clarke, 1965). The standard elements of a household indicate living together and connections among members of a domestic group (Laslett, 1972, Allan and Crow, 2001a) who are not necessarily related by marriage or kinship ties. In addition, as not all private households contain families, non-family households would therefore consist one person households and two or more individuals who share their residence with unrelated individuals (Simpson, 2012, Van Imhoff et al., 1995).

Table 2.1 below presents the broad classifications between the concepts family and household by selected characteristics. From Table 2.1 and the above discussion, it is

clear that the terms family and household take a variety of forms, and some of the diversity in their domestic arrangement can be attributed to membership, ties, types and focus of the institution.

Table 2.1: Selected characteristics guiding the concepts of family and household

Characteristic	Family	Household
Membership		
	Parents with or without children Parents (cohabiting/widowed/divorced/step-parents) with or without children.	Group of people living together (household head, children/no children, related and not related household members).
Ties		
	Marriage Kinship	Members may be related or not related by blood, marriage or adoption.
	Wider group (related or not related members).	Domestic organization.
Types		
	Nuclear or extended family.	Private (family, non-family or mixed households). One person households or multi-person households.
Focus		
	Social or domestic group with a common household, and is based on marriage and kinship ties.	A household is not necessarily a family; it just means a group of people living together. Members usually share meals and have a standard provision for meeting basic needs such as sharing of domestic activities, and pooling of social and economic resources.

Household formation, change and dissolution

Household formation in a broad sense refers to new households formed by individuals, couples or an extension of an existing household through processes of marriage, union formation, childbearing, accessibility of kin to live with, and financial independence of an individual (s) to set up own household (Burch and Matthews, 1987). Decisions to establish a household are influenced by both supply and demand considerations by those in the household and those wishing to co-reside (Burch and Matthews, 1987). The provision and demand factors of household formation include the demographic behaviours and socio-economic determinants (Bongaarts, 1983, Burch, 1979). Burch and Matthews (1987) study of household formation in the developed societies provides a list of component goods such as privacy, companionship, domestic labour of household members, personal care of dependent members and economies of scale in the consumption of the above goods as instrumental in whether an individual or a couple choose to set up or share a household. Further, Burch and Matthews (1987) and Burch

(1995) indicate that modern technological developments, urbanization and a rise in income have made coresidency of adults with other members less desirable as individuals seeks privacy and can afford to live alone or in smaller households.

With respect to Botswana, the conceptualization of household formation emphasize migration, marital status, fertility and labour market conditions. For example, Townsend (1997) reveals the importance of male out- migration to the development cycle of the household. Based on life histories collected in Mmankgodi- a village 45 kilometres to the west of the capital city Gaborone, Townsend (1997) show that men co-reside with kin and relatives through most of their lives, and are only able to set up their household in their forties. In earlier research in Gaborone and three villages in the South East district, Izzard (1985) showed the importance of marital status; those who were previously married and those headed by never married women, in the formation of female-headed households in Botswana. Siphambe (2003) acknowledges the potential importance of labour market to household formation and coresidency of young people with family and relatives. He argues that due to high unemployment rates in Botswana, the ability of young people to leave parental home and set up their own household remains low. Unemployment rose from 15 per cent in 1991 to 20 per cent in 2001 (Central Statistics Office, 2004, Government of Botswana, 1991).

Once formed, a new household can change in size and composition through time. An existing household can also undergo changes over time. The changes to a new household or current household are termed household change. Bongaarts (2001) examined household size and composition using household surveys in 43 developing countries and found that changes to demographic and socio-economic factors contribute to gain or loss of household membership and change in household composition. For example, Bongaarts (2001) shows that once a household is formed either containing one person or multi persons it will increase members over time due to marriage, births and adoption of relatives or other unrelated persons. Further, he shows that a household will lose members due to deaths, divorce and migration of its members.

Similarly, a previous review of the size and structure of the domestic group in England, France, Serbia, Japan and North America shows that household dissolution is the complete disintegration of a household due to deaths, or splitting of a household due to divorce or when a household ends its existence due to death, out migration or merging

with another household (Laslett, 1972). Hence, both the processes of household formation and dissolution contribute to household change (Figure 2.1). Lastly, it is important to point that the processes of household formation, change and dissolution can be captured at a point in time using cross sectional data and through time using longitudinal data. Longitudinal data rather than cross-sectional data is better suited to reflect the changes over the household life cycle.

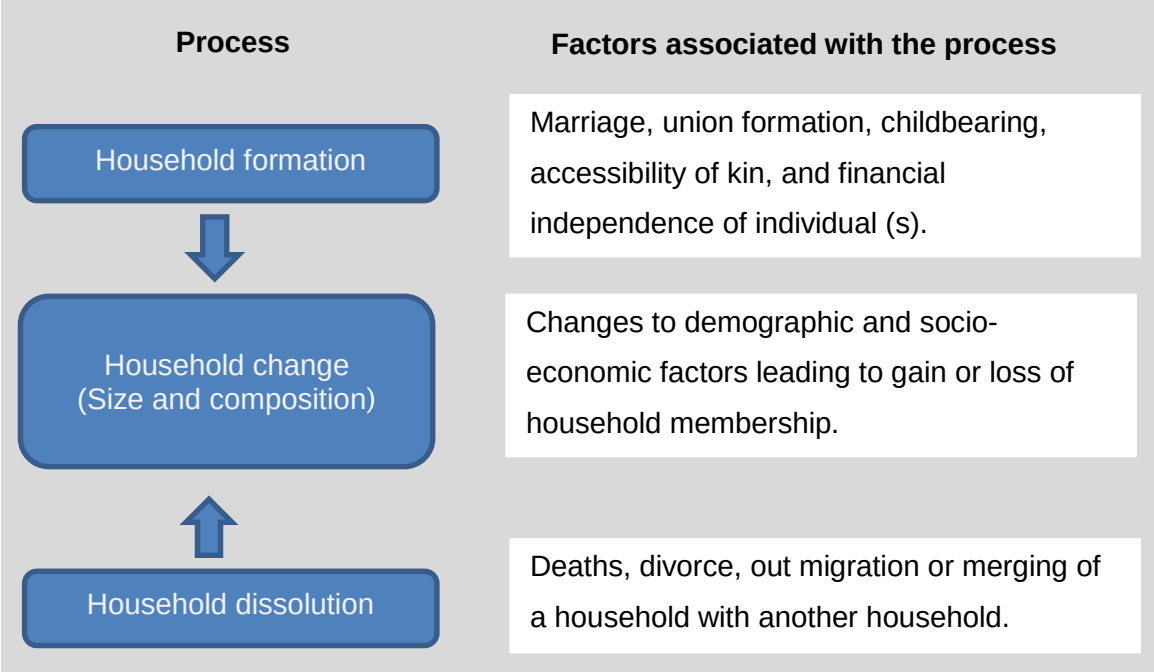

Figure 2.1: Household formation, change and dissolution

Child well-being and child health

Well-being is used as a broad concept that encompasses a wide range of indicators. It is used to define positive outcomes such as emotions, moods, satisfaction with life and feelings ranging from depression to joy (CDC, 2016). In addition, well-being is a measure beyond morbidity, mortality and economic status that shows how people perceive their lives (CDC, 2016). In developed countries, the term child well-being is commonly used to describe child behavioural, emotional and cognitive outcomes (Leventhal and Brooks-Gunn, 2000), while the term child physical health is mainly used in LMICs (Narine et al., 2013). As a result, most of what is known on the association between family structure and child well-being is mostly from the United States of America (USA) and the United Kingdom (UK), with little from developing countries.

Child health is a concept that is commonly used in the LMICs. This is because child health and not child well-being is more researched in LMICs since it remains the main disease burden in this region amongst children aged 0-5 years (UNICEF, 2012). In addition, most of the data sets in LMICs, such as the Demographic Health Surveys (DHS) and Multiple Indicator Survey (MICS), are not designed to examine child well-being. Instead they focus on child physical health, survival and nutritional conditions related to child development and growth from birth to five years of age (DHS, 2007, UNICEF, 2016). For the purposes of this research, child health constitutes physical health within the broad context of child well-being resulting in stunting and diarrhoea.

2.2 Family and household factors that affect child well-being

An increasing number of studies in the USA have emerged to explore the link between family and child well-being. These studies demonstrate that mechanisms centred on parental resources, parental functioning, father involvement, parental characteristics, parent-child relationships, and differences between children are central to explaining the relationship between family structure and child well-being (Thomson and McLanahan, 2012, Waldfogel et al., 2010, Artis, 2007, Leventhal and Brooks-Gunn, 2000). Broadly these mechanisms can be grouped under theories of economic, social, parental engagement, evolutionary psychology and biological relatedness (Biblarz and Raftery, 1999). Other competing theoretical perspectives include social-cultural explanations (Dahlgren and Whitehead, 1991), and hypotheses on selection bias (Waldfogel et al., 2010, Biblarz and Raftery, 1999, Clark and Hamplová, 2013). Appendix 2A gives a list of some of the main studies that provides evidence on family or household influences on child well-being and child health.

This section evaluates and appraises a range of established pathways in order to account for how different family structures are associated with variations in child well-being (focusing on behavioural, emotional and cognitive outcomes). Unless specified, evidence on the family structure and child well-being form the bulk of this discussion, but where applicable reference is made to studies that explain the association between household structure and child health outcomes.

2.2.1 Parental resources and child well-being

A significant aspect of child development relates to financial and time resources available in the household during early childhood and adolescence. The benefits of parental financial and time resources have been well documented in the Western literature. Evidence from the USA shows that different family structures offer various economic and time advantages (Waldfogel et al., 2010, Thomson et al., 1994, Thomson and McLanahan, 2012).

Research in high income countries also indicate that living in a low socio-economic status household is detrimental to child well-being. For instance, single parenting is linked to a marginal economic position resulting from lower earning capacity, declining income, and lack of financial support provided by either non-residential or biological fathers (McLanahan and Sandefur, 1994). The evidence in the United States further shows significant differences between the health of the children of the poor and that of middle class families (Barbara et al., 2002, Angel and Angel, 2006). Angel and Angel (2006) also attributes the risk of compromised health among African American and Hispanic children to the consequence of poverty and minority group status of family disruption and single parenthood among these groups compared to White children. The health effects of family structure clearly demands serious attention given that parental economic resources are necessary for providing warmth, clothing, food, shelter and other experiences that afford positive childhood development (Carlson, 2006, Thomson et al., 1994, Thomson and McLanahan, 2012).

Further examining the importance of economic resources in two married biological parents or intact families and single parent families on the differences in child well-being, other kinds of empirical evidence are examined. Some scholars find two parent families are optimal in terms of financial resources when compared to single parents. Previous work on family structure and child well-being confirm that differences in economic resources between lone parents and two married biological parents family structures account for most of the health disadvantages associated with lone and married biological families (Waldfogel et al., 2010, Brown, 2004, Thomson et al., 1994, Thomson and McLanahan, 2012). In fact, a comparison of four nationally representative data sets in the United States demonstrate single parent families had a higher poverty rate (26%)

than two parent families (with 5% incidence of poverty), or step families with a incidence of poverty of 9 per cent (McLanahan and Sandefur, 1994).

However, if a lack or loss of financial resources solely explained the association between single parenthood and poor child well-being, we would expect children living with single parent who are better off to do better than single parents who are poor. This is not always the case. A study in the Nordic countries by Casper et al. (1994) finds that children do as poorly in single households despite relatively higher economic status, greater social transfers, and highly subsidised child care than single mothers in the USA. The authors indicate that single parenthood is still associated with poor child well-being despite the country's welfare provision, and economic disposition of the single mother. In turn Parke (2003) and Thomson and McLanahan (2012) demonstrate that the degree of differences in child well-being by family structure cannot be attributable only to the small income of single parent families, but that there are other moderating factors.

Past research also adds to our understanding of the differences in economic resources in other family types such as cohabitation, stepfamilies, divorced and widowed on child well-being. The findings from a study in Botswana (Mokomane, 2005) and in Britain (Ermisch and Francesconi, 2000) suggest that cohabitation takes place when two adults of opposite sex live together as if married. Further, an analysis of cohabitation in Britain shows that cohabitation can occur when one of the members of the cohabiting family is an informal step-parent or both could be biological parents (Ermisch and Francesconi, 2000). On the other hand, research findings on cohabitation in the USA indicate that children are more likely to have poor health outcomes when they live with cohabiting families than with married biological parents (Parke, 2003). This is the case because poor child well-being in cohabiting families is partly explained by lack of income, low education levels among the parents, and unstable living situations (Parke, 2003).

About stepfamilies, evidence from a review of four national surveys in the USA show that there is no difference in child well-being between children born to intact parents and stepfamilies (McLanahan and Sandefur, 1994). Further this study indicate that just like cohabitation, and single parent families, the adverse impact of stepfamilies on child well-being are associated with a lack of income from parents separating or from recoupling. Other researchers also find no differences in child well-being among children in intact and divorced families (Amato and Keith, 1991).

In terms of widowhood, losing a parent from death appears to be more of a problem for child health outcomes in developing countries than child well-being in developed countries. For example, most of the children in the USA reach adulthood with both parents alive (Parke, 2003). Also within this context, death of a parent does not economically disadvantage children in single or married parent families. Indeed, Parke (2003) finds that children living with widowed parents have the same behavioural and educational experiences as children with divorced or single parents. On the other hand the picture in Africa is different. A longitudinal study between 1950 and 1974 on survival probabilities of children in Gambia found that death of the mother (but not death of father) is a strong explanatory factor of child mortality during the first two years of life (Sear et al., 2002). The increased child mortality in developing countries is also connected to the loss of mother at a young age leading to reductions in household economic resources needed for child's positive health (Heaton et al., 2005), and a higher risk of infant death due to lack of breastfeeding and co-morbidities (WHO, 2000).

Parental time and child well-being

Another important parental resource is time. Parental time matters for child health and development in both early childhood and adolescence (Waldfogel et al., 2010). Parental time affords children the support and control needed for healthy child care. Parents spend time providing children with personal care, consumer goods, warmth and activities that lead to healthy development. Hofferth (2006) show that parental time and parental economic resources are interlinked and neither is sufficient alone for effective parenting. However, Hofferth (2006) also contends that economic resources have more effect on child well-being than parental time.

Parents are not always able to provide time for child support and control. Parental time can be constrained by a number of factors including economic and emotional stress and absence of a residential father or mother. Most of the disadvantages of a lack of parental time are observed between single and two parent married families. Single parents are likely to have less time available for their children as compared to married parents (Waldfogel et al., 2010, McLanahan and Sandefur, 1994). This in turn can lead to responsibility overload and parental stress (Cherlin, 1992), as the lone parent bears all the burden for child care and financial obligations without support from the non-resident father. Taking care of the entire family burden is also likely to impact negatively on the

mother's welfare and her effectiveness in parenting (Cherlin, 1992, McLanahan and Sandefur, 1994).

About cohabiting couples, an assumption might be that they have as much parental time for child care as married couples. However, when the cohabiting partner is not the biological father, he is likely not to invest as much time with the children as the biological father (Brown, 2004, Artis, 2007). Moreover, cohabiting partners do not necessarily have the same economic and parenting skills as married couples, as discussed in section 2.2.4 on father involvement.

Finally, another issue that remains unexplored in the literature on family structure and child well-being is the economic and time contributions from other household members such as grandparents, aunts, uncles and affinal kin on child well-being. Affinal kin includes relations based on marriage and not blood such as in law families of the mother or father. Little research has been done on household structure and involvement of other family members apart from biological parents. The lack of such analysis in the current literature is not surprising. Most of research on family structure and child well-being is exclusively based on Western contexts of family environment, which are very different from those of the developing countries (Allan and Crow, 2001b).

What would make the difference for child health in Botswana are the levels of parental and resources, resources from the other types of adults involved in child care, and the household context in which these investments are made beyond the family. Already studies in Africa demonstrate the role of other household members such as fathers and grandparents in South Africa on birth weight (Cunningham et al., 2010) and kin and older siblings on child mortality in Gambia (Sear et al., 2002). The finding from studies in Africa generally suggest that parental time need not be restricted to biological parents as other household members may share the burden of child care. However, the actual cost, benefits, context and sustainability of such arrangements might not be known.

2.2.2 Family functioning and child well-being

Family functioning is a multidimensional construct that reflects family processes and conditions that enable the family to meet its material, social goals and health needs of its members (Walsh, 2003, McCreary and Dancy, 2004). Hence, family functioning as

discussed above in the context of HICs places emphasis on parenting support, supervision, family stability, the quality of parenting and parental characteristics that foster the child's well-being and development (Leventhal and Brooks-Gunn, 2000).

Parental practices and child well-being

Parental practices or parental behaviours include processes that relate to parent support, and parent supervision. Studies carried out in the USA show that parental support measures involvement of parents in child activities, and parents' attention to the child's needs such as emotional, physical health, and educational performance (Waldfogel et al., 2010, Thomson et al., 1994). While parental supervision reflects disciplinary practices towards the child and monitoring of the child activities and development (Thomson et al., 1994, Dawson, 1991).

For the most part, evidence in the USA shows that married parents are more involved in their children's activities and they offer better parenting supervision than a lone mother (Astone and McLanahan, 1991, McLanahan and Sandefur, 1994, Ribar, 2015); although this is not necessarily the case with cohabiting biological parents or cohabitating stepfamilies. Other studies demonstrate that cohabiting families are likely to be similar in characteristics to single parents than married parents (Waldfogel et al., 2010, Sweeney, 2010). Also Thomson et al. (1994) work in the USA confirm that parental behaviours are important, even though they account for a smaller proportion of conduct problems and school performance issues for children of intact than non-intact family structures. Further, the authors argue the differences in economic resources between married parents and single parent's families are relevant to the problems of child well-being than the differences in parent support and supervision.

Parent stability and child well-being

With regard to parent stability, research focus on the structure of family life and child well-being in the USA and Britain, respectively defines family stability in terms of parenting practices, family functioning, and the environment that the child grows up in from birth (Waldfogel et al., 2010, Kiernan and Mensah, 2010). For instance, it is shown in the USA that children living with mothers who cohabited after separation and single mothers who re-partner are reported to have higher levels of behavioural problems

compared to children living with two married parents continuously from birth to age 5 (Popenoe, 2009). Similarly, a study among children aged 7-15 years in Romania indicate that parental divorce negatively affects child emotional and behavioural outcomes (Jurma, 2015). The negative effects of parenting stability on child well-wellbeing are also shown to be due to the repeated changes in the family structure from living with two married biological family to living with a single mother or to living with a stepfamily in the UK (Mooney et al., 2009). Lastly, evidence on family stability in the USA indicate that family instability may result in increased risk for parental mental health problems, which in turn is associated with increased risk of emotional and social problems among young children (Crnic et al., 2005, Turney, 2012, Turney, 2011).

Parenting quality and child well-being

The relationship between parenting quality and family stability is also of interest in explaining child well-being. A meta-analysis of 92 studies comparing measures of child well-being among children living in divorced single parent families with two parent families show that parenting quality is compromised when family stability is characterised by persistent unresolved parental conflict, family breakdown and poor relationship quality (Amato and Keith, 1991).While the findings from the UK Millennium Cohort Study indicates that children living with mothers who are married have lower levels of family complexity and lower instability than single mothers (Kiernan et al., 2011).

There is also evidence in the USA to show that parents who are mentally ill can be aggressive and neglect their parenting responsibilities (Klebanov et al., 1994). Consequently, parent-child relationships might suffer as a result of parent not being warm, nurturing and engaging (Shaw et al., 2016, Barrett et al., 2016, Klebanov et al., 1994). Carlson and Magnuson (2011) find that couples with higher quality relationships exhibit higher quality of parenting. In addition, children who live with resident biological father benefit more from parenting of two parents than those who are brought up by lone parents (Lamb, 2004). Single mothers more than married couples are shown to not always cope with the demands of parenting (Astone and McLanahan, 1991, McLanahan and Sandefur, 1994, Ribar, 2015), in part due to a lack of financial resources, emotional support and guidance from non-resident father (Waldfogel et al., 2010). Furthermore, it has been shown that single parents have lower parenting quality than married mothers due to depression and psychological problems (Waldfogel et al., 2010, Ribar, 2015).

Parental characteristics and child well-being

Another perspective on family functioning is that parenting practices are likely to differ by parental characteristics including age, sex, education, financial and health investments. By age, there is evidence of higher risk of injury among children aged 2 years, who live only with teen mothers compared to those living with two parents of similar age in the USA (Sigle-Rushton and McLanahan, 2002). Teenage motherhood is associated with lower financial status, lower educational attainment and poor parent supervision skills (Sigle-Rushton and McLanahan, 2002, Mutchler and Baker, 2009). About gender, evidence in the USA suggests that the absence of mothers has more negative consequences on child well-being relative to schooling and occupational attainment than absence of fathers (Biblarz and Raftery, 1999).

A cross-national study of 42 countries in Latin America, Africa and Asia show that a traditional family structure, where children live with two married parents, higher mother's education and socio-economic status are associated with better child health outcomes (Heaton et al., 2005). For example, infant deaths are significantly higher for children born to mothers with lower educational level than with higher education (Heaton et al., 2005). Why and how do educated women and higher socio-economic status protect child survival appear to be related to measures of health knowledge, economic resources for better child care and sanitary conditions (Heaton et al., 2005). Maternal education also improves hygiene practices and the use of health care services, all of which has a positive impact on child health and survival in LMICs (Barrett and Browne, 1996, Desai and Alva, 1998, Bhuiya et al., 1990).

Other studies argue the conditions that influence child health are associated with the health care investments at the household level, such as knowledge, resources and patterns of behaviour among members that promote and maintain health status (Berman et al., 1994). Although evidence on health investments is limited, a study in the USA by Case and Paxson (2001) finds that children who live with a biological father and stepmother, and those living only with a biological father were less likely to have routine doctor check-ups, or wear seatbelts. The same study argue that the fact that both children in stepfamilies or lone parent families are disadvantaged in health investments and behaviours indicate that the kind of parents and not necessarily the number of parents in the family matters.

Lastly, although parental resources, especially financial resources, have impacted much of the variation in child well-being across different family types, family functioning is important for explaining variations in child well-being from living in various family structures and how this is moderated by parental behaviours, quality of parenting and family stability. Thus the potential effects of family functioning are recognised in contexts of heterogeneous families (as shown in section 2.2.3); where child care and supervision also benefit from contributions of other family members such as grandparents, older siblings, maternal aunts, and non-resident fathers.

2.2.3 Heterogeneity of family membership, parenting and child well-being

Parenting functioning is mostly assessed within the realm of biological parents especially in HICs; however recent work provides perspectives within which the relationship between family structure and child well-being expands beyond the influence of biological parents. Other family members such as grandparents, older siblings, and social fathers could enhance parenting practice, quality and family stability, and result in improved child health outcomes. For instance, doubling up and pooling social and economic resources is common with single parenting and families with low parenting qualities. Evidence suggest that single parents are more willing to live with other members to pool economic, social resources and to enhance their parenting effectiveness (Sigle-Rushton and McLanahan, 2002). Since single parents often carry the burden of caregiving and provision on their own, help from other family members is important to them. In contrast, married parents, who are in stable relationships and have high relationship quality, are less likely to co-reside with other members (Sigle-Rushton and McLanahan, 2002). The finding on married couples is not surprising as they are presumed to have higher capabilities of parenting support and supervision (Thomson and McLanahan, 2012, Ribar, 2015).

Research on the effects of kin on mortality risk in Gambia show that grandparents are associated with positive survival probabilities among children (Sear et al., 2002). Similarly, a study using longitudinal data from South Africa reports the importance of grandmothers on child prenatal development (Cunningham et al., 2010). Although in both studies we don't find details for the kind of support provided, it is possible that grandparents offer additional parenting skills and child supervision when it is needed.

Concerning siblings, an analysis of effects of kin and child mortality in Gambia shows that having a living elder sister has a positive effect on the survival probabilities of the children in later childhood than in earlier childhood (Sear et al., 2002). Having an older brother has no effect. The authors also argue that older daughters help the mother in raising the children and taking over some of the child welfare activities.

Other researchers have examined household structure and child health in Africa, and find no beneficial effects of mother's dependence on other family members for child care, supervision and enhancing parenting skills. Theoretical work on cooperation and competition between relatives by West et al. (2002) argue that kin assistance is not always beneficial, as kin often share the same resources base as the mother, and family members compete for this base if resources are scarce. In addition, work by Sear (2008) on kin and child survival in Malawi indicate that household members who live together are not always biologically related, and hence there may be no obligation to help each other where no kinship exists.

The costs and benefits of augmenting parenting practice from involvement of other members will also depend on the resource endowments of the adults and the quality of the relationship among group members (Sigle-Rushton and McLanahan, 2002). The context within which living arrangements occur is also important. Cunningham et al. (2010) indicate that women whose mothers are still alive have heavier babies. Sear (2008) shows that maternal aunts (affinal kin) only have a protective effect on child survival in marriages where men have more resources and hence less competition for them and mothers for resources. While research in Botswana indicates that of the one third non-resident biological fathers who provided support for child upbringing did so only if they had paid compensation for impregnating the mother, had discussed marriage prospects with the mother and the relationship was still on-going (Letamo and Rakgoasi, 2000). Mokomane et al. (2006) further shows that single mothers rely mostly on support from close relatives such as maternal parents.

2.2.4 Father involvement and child well-being

Turning now to the literature that deals directly with father engagement, the influence of father's presence or absence in terms of parenting responsibility and residence on child well-being is examined. In addition, more attention is paid to the economic resources,

time and parent relationship quality afforded to the family by the father and how it influences child's cognitive, behavioural and emotional outcomes. Most research on topics of child well-being and development has mainly examined mother's engagement, yet the father's participation can be equally important for child well-being (Amato and Gilbreth, 1999, Carlson et al., 2016).

A number of the studies indicate that paternal economic resources afford children better well-being from access to improvements in schooling, nutritious food and social resources (Bradley and Corwyn, 2002, Thomson et al., 1994, Carlson, 2006). Studies for children in fragile families in the USA; where children live with a single mother and in absence of a father find that living without a biological father or resident father disadvantages children with regard to financial resources, parental time (Waldfogel et al., 2010, Thomson et al., 1994, Thomson and McLanahan, 2012, McLanahan and Sandefur, 1994) and a lack of access to social support (Coleman, 1988).

Similarly, studies on parent relationship quality find that father engagement in two parent married families is more beneficial to child well-being than in single parent families. For instance an analysis of social capital in the family shows that father involvement reinforces mother's parenting (Coleman, 1988). One explanation is that if parent relationship is weak in quality from either conflicts in the home, divorce or other changes in the family structure the effects are likely to induce lower child well-being outcomes (Waldfogel et al., 2010). Subsequently, other scholars have considered other elements that go beyond finances to those that include shared interactions with the child and the child's mother. These investments include collaborative parenting roles, engaging in leisure and educational activities with the child, providing moral guidance, and emotional support to the child's mother (Cabrera et al., 2000, Carlson, 2006).

Another justification for continued debate on the relationship of father involvement to child well-being outcomes arises from studies that evaluate cohabiting and single parent families. Since cohabiting families have two adults to offer the resources needed by children, one would expect them to do better than single parent families. However, this is not always the case. Evidence in the USA shows that cohabiting families face the same challenges of lack of economic resources, lower education levels among the adults, and parental instability (Waldfogel et al., 2010, Artis, 2007, Coleman et al., 2000). As a result both have lower child well-being outcomes comparable to single parent families.

Indeed, these studies provide a clear negative contrast to the perspective of economic and time contributions associated with biological relatedness and residency of child's father for positive child well-being.

Although the literature on father engagement is equally concerned about the type of father involved in child care and upbringing. Studies in the USA have found that the relationship of father involvement to child health may differ depending on whether he is a biological father, social father or informal father, cohabiting biological father, stepfather (Lamb, 2004, Hofferth and Anderson, 2003, Carlson et al., 2016) or until recently a multi-partnered father as defined by a father who has biological children with more than one partner (Bronte-Tinkew et al., 2009). Thus, the section below evaluates the impact of a father's parental investments on child well-being based on biological relatedness and co-residency.

Paternal biological relatedness and residency

When distinguishing father involvement by biological relatedness, the evidence in the USA suggests that engagement by biological fathers is better than social fathers and cohabiting fathers. A stark difference in child well-being outcomes is noted between married biological families and social fathers (Hofferth and Anderson, 2003), and married biological father and cohabiting biological or cohabiting stepfamilies (Brown, 2004, Artis, 2007). Research attributes most of the gains from living with a biological father than an informal father to a higher level of transmission of parental investments such as economic contributions (Thomson et al., 1994, Thomson and McLanahan, 2012, Carlson, 2006), modest effects to a stable living environment (Carlson and Magnuson, 2011), and access to immediate family resources for positive child well-being (Sigle-Rushton and McLanahan, 2002). A recent study finds that resident fathers affords more spending time with children, and engage in shared child care than non-resident fathers(Carlson et al., 2016).

Some research contradicts the general expectation that children living with two married biological adults do better than those living with resident or non-resident social fathers. Two studies using data from Fragile Families and Child Wellbeing Survey in the USA share the conclusion that children living with two adults (cohabiting father or stepfather)

do as well as children in two married biological parent homes (Bzostek, 2008, Berger and McLanahan, 2012).

On the other hand, Berger and McLanahan (2012) decomposed and examined separately the influence of family characteristics, relationships and behaviours on internalizing and externalizing behaviours of children at 1, 3 and 5 year old. The authors find that living with a biological father is associated with child behaviour problems in a complex way, while parenting behaviour and quality relationship from social fathers is associated with better behaviour problems. The findings of these studies underscore the potential importance of the content and high quality father-child interactions beyond parental characteristics and economic investments.

Consequently, evidence shows that parenting behaviours and the quality of the father-child relationships in social father families are equal or even higher than among biological father families (Berger et al., 2008, Lamb, 2004). It is also possible that engagement and co-residence with a biological or social father may be associated with child well-being beyond content and quality of father-child interactions and mother relationship. Other aspects of father involvement such as the changes in the content of father-child interactions, context under which involvement of the father is beneficial, and differences in children may influence child well-being across the two family structures.

At the same time, while traditional families indicate more gains in well-being for children living with married biological parents than living with one biological parent families or none, a considerable number of children in HICs currently live with cohabiting and or married stepparents (Parke, 2003). In particular with regard to stepfamilies, studies report that children raised by one biological parent and a stepparent do poorer in well-being than those living with married parents (Amato, 1994) . Other researchers report no difference in child well-being among children living with stepfamilies and a single mother (Coleman et al., 2000), or between cohabiting stepfamily and cohabiting biological family (Artis, 2007, Brown, 2004).

Compared to biological married parents, children in cohabiting biological and cohabiting stepfamilies may have the same economic disadvantages and less parental time and control (Brown, 2004, Artis, 2007). These two studies on cohabitation arrived at the same conclusions even though they used different approaches; longitudinal data and cross

sectional data, respectively. Additional analyses suggest that the lack of difference in child well-being between cohabiting biological and cohabitating stepfamilies indicate that other factors such as content and quality of parenting rather than just economic differences are likely to be at play (Berger and McLanahan, 2012, Bzostek, 2008).

So far the results on stepfather and child well-being remain equivocal. Contradictory findings on stepfather and single mother families seem to suggest that other aspects of family type are overlooked. Therefore, it is important to distinguish differences in instability in the living situation of the father-mother, father-child relationship and availability of socio-economic resources from immediate family members on child well-being between these two family types. This claim also might lend support to look beyond perspectives that firmly focus on economic resources, parental characteristics, to joint arrangements of care beyond biological parents and neighbourhood effects in order to account for differences in child well-being.

Father and multiple partnering

More recent research has begun to investigate multi-partnering fertility and child well-being. For example, the findings from the Fragile Families and Child Well-being Survey indicate that for men, this reproductive behaviour includes those who bring a child from a previous relationship into a marriage or non-resident fathers who have children with more than one woman (Bronte-Tinkew et al., 2009). The same sexual behaviour may be observed among women; that is among those who marry and bring along a child from a previous relationship, those that are single, and those who are cohabiting parents and having kids with different fathers. Although not sufficiently documented, this family pattern appears to affect several mechanisms that influence child well-being, in particular father engagement and parenting stress. In other words, not only does multi partnering fertility directly affect child well-being through father involvement, a number of studies find that it also impacts indirectly on paternal depressive symptoms to influence child externalizing behaviours (Bronte-Tinkew et al., 2009, Carlson and Corcoran, 2001) and is stressful to parenting (Lavee et al., 1996).

The findings on fathering with multiple partners have been observed mostly in the USA. Specifically, a study which followed children for three years from birth in the USA, found that father's multi partnered fertility is directly and indirectly associated with child

externalizing behaviours through paternal depression, as well as directly related to father engagement on externalizing behaviours (Bronte-Tinkew et al., 2009). External behaviours were reported by the mother and it includes indicators such as child being defiant, not being able to concentrate for long, and has angry moods. Although this study is the only one to investigate disruptions on child well-being brought on by father's multi partnered fertility, its findings are far from being conclusive. The results are limited to the child and the family that the child lived with at birth, and it does not measure the actual disruptions and alternative arrangements in the resources to separate families across the different households. Further, although the author uses longitudinal data, the time of follow up might be too short to observe prior and future associations of father's multi partnered fertility and child well-being. However, the nature of the data and the extensive controls used for father, mother and child characteristics address selection in a convincing way.

With regard to paternal stress, studies in the USA speculate that children raised under the context of multi partner fertility face reductions in both time and financial resources provided by the father (Carlson and Furstenberg, 2006, Manning and Smock, 2000). A decrease in funds due to fathering with multiple partners is not surprising as the father has to juggle time and family obligations between different households. In the process, the father experience stress due to parenting expectations across different households and having to cope with complex family relationships and demands (Bronte-Tinkew et al., 2009, Lavee et al., 1996). The findings from a study in Botswana also show that the father may experience stress from a lack of social support across different households since the family form is less institutionalized (Letamo and Rakgoasi, 2000). Consequently, fathers who are stressed may not engage effectively in parenting and display lower father-child interactions connected with negative child well-being.

The results on father involvement in child well-being generally give inconsistent findings depending on the measures and data sets used. At the same time, research evidence gives more support for the association of biological father than social or cohabiting father to positive child well-being outcomes. This might not be the case in all socio-ecological environments. For instance, in a matrilineal community in Malawi, there is little evidence for father presence on child survival (Sear, 2008). An earlier study in Malawi also showed that the absence of father due to their death makes no difference for their child's mortality (Sear et al., 2002).

The findings on father effects in developing countries also point to the omission of other factors than paternal economic contributions and paternal-child interactions on child health. These include parenting with other household members such as grandparents (Cunningham et al., 2010), and aunts, uncles, relatives, and perhaps non-biological household members as in the case in Botswana. Research in LMICs has yet to systematically disentangle these factors and different contexts of child support and how they are associated with variation in child health outcomes.

Evidence in developing countries also does not distinguish among the various types of fatherhood: biological, social, stepfathers or fathering with multiple partners. As these types of father differ in paternal resources, characteristics, father-child relationships, and paternal behaviours, and how they influence child health, future research is imperative to establish the significance of the variation. Lastly, since existing research reveals mixed evidence on which type of father is beneficial to child well-being, there is a need to employ better measures in a consistent manner to improve our understanding of biological, social, stepfather and multiple fathered father engagement on child well-being.

2.2.5 Children and their own well-being

Empirical evidence has not adequately explored the differences in children and how it explains association with family structure and child well-being. The literature on the family structure and child well-being has mainly focussed on parental resources, family functioning, and less on individual differences such as child age, and sex. In a way the literature seems to assume that the family structures affect the children the same way irrespective of their individual characteristics. The findings in Ireland on children experiences of family transition indicate that children within the same family may react differently to the family influences depending on their age and sex (Hogan et al., 2003). To gain a perspective on how the differences in children account for the association between family structure and child well-being, the following section discusses studies that consider differentials for child well-being.

Differences in children by age

Research in high income countries has explored age specific measures of child well-being. Brown (2004) investigates the association between living in married biological

parent families, cohabiting biological families, cohabiting stepfamilies and child development stage and child well-being. She found higher levels of behavioural and emotional problems among children aged 6-17 years residing in cohabiting families than in married families. These findings may be viewed as tentative as the study is cross sectional, and could not fully investigate the variations in selection of parents in cohabiting unions, and parental economic resources across the different ages. Nevertheless, the results on parental cohabitation and child well-being taking into account age differences deserve recognition. Another study of children aged 4.5 to 6.5 years in the USA also came to the same conclusion, namely that marital households are better for child well-being than living with cohabiting families (Artis, 2007).

Differences in children by sex

A cohort study carried out by Rodgers and Pryor (1998) in Britain suggests that the adverse effects of the family breakdown might manifest differently among boys and girls during adulthood. Further, the findings on gender, reveal that girls have a higher probability of experiencing poor health outcome in adulthood compared with boys when taking into account the length of time that children have lived in intact and non-intact families (Rodgers and Pryor, 1998). A finding on father involvement and adolescent behaviours in the USA shows no support for the gender socialization theory (Carlson, 2006). However, Rossi and Rossi (1990) account of parent-child relations across the life course show that gender influences may be associated with the level of involvement rather than the consequences of such engagement.

In the case of externalizing behaviours including aggression and antisocial behaviour using data from the Fragile Families and Child Well-being survey, Cooper et al. (2011), show that boys rather than girls are affected by mother's partnership instability at age five. A major advantage of this study is that its findings are useful in studying gender differences in school attainment (Thomson and McLanahan, 2012). Its disadvantage is that it did not investigate internalizing behaviours problems such as anxiety, depression and emotional control for children living in an unstable family environment. These behaviour problems are equally important to understanding gender gap in school performance and how children cope amidst family transitions and instability.

In other settings, the benefits for having elder sisters on child mortality are the same for both male and female children. For instance, the findings from a study carried out in Gambia suggest that the lack of association between elder sister and gender of the child might be due to confounding association of gender and household structure on short and long term basis (Sear et al., 2002). However, girls or boys might show increased risk in adverse health outcomes if the household structure persist and endures. To be sure, a possibility of the problem declining over time cannot be ruled out.

Parenting and child sex

Other factors that are associated with child-well-being are child differences in sex and the patterns of parenting. Research in India indicates that having a male child results in allocation of more parental care, nourishment and attention to the child than having a girl child (Gupta, 1987). A study in India indicate that preference for male children and unequal treatment of children by sex means that the girl child experience more mortality during childhood (Arnold et al., 1998). While the findings on son preference and educational opportunities in China show lower educational attainment beyond childhood among female children compared to male children (Wang, 2005). In these environments, a concern for policy would be how parenting resources and characteristics link with sex differences to moderate the influence of family structure on child well-being.

2.2.6 Selection, family structure and child well-being

It is important to indicate that selection remains important for research on family structure and child well-being. This is because selective entry into certain structures may be particularly relevant for the observed variations in child outcomes. Studies in the USA on the family structure and selection effects show that selection is the cause of differences in child well-being outcomes (Thomson and McLanahan, 2012, Hofferth, 2006). For instance, people who choose to remain in a particular structure, e.g. single parents may not have the same attributes as those who choose to marry (Thomson and McLanahan, 2012). Hence, both the characteristics of these individuals, parental resources, parenting practices, quality of parenting, and family stability may differ, and in turn affect child well-being differently (Waldfogel et al., 2010, Thomson and McLanahan, 2012, Carlson, 2006). As a result, studies in this research topic point to confounding factors and a difficulty in

identifying causal effects of the family structure on child well-being (Hofferth, 2006, Thomson and McLanahan, 2012).

Nevertheless, research does show that selection can be convincingly addressed. Specifically, this is likely the case in high quality analyses using longitudinal data sets, in studies employing a larger set of potential confounders and those that use varied econometric and statistical methods (Thomson and McLanahan, 2012, Hofferth, 2006). To be sure, some scholars' are critical of the selection hypothesis. For instance, Sigle-Rushton and McLanahan (2004) argue the hypothesis is based on the assumptions that are difficult to justify, and it does not fully account for the associations between family structure and child well-being outcomes. Further, Sigle-Rushton et al. (2005) illustrate that in the case of divorce, we would expect its effects on children to diminish over time, but this is not always true. Other researchers report that some research on family structure and child well-being fails to control for all possible confounders, especially the socio-economic and cultural characteristics of families (Panico, 2012, Heaton et al., 2005).

2.3 Community factors that affect child health outcomes

Aside from family and household factors, community factors are also associated with child well-being (educational, behavioural and emotional outcomes), and health outcomes. A review of the literature on neighbourhood effects on child and adolescent well-being by Leventhal and Brooks-Gunn (2000) finds that high socio-economic status is important for educational achievement and low socio-economic status, while residential instability matters for behavioural/emotional outcomes among children and youths.

Several characteristics of the home environment are also linked with indirect neighbourhood effects on children and young people's learning experience (Leventhal and Brooks-Gunn, 2000). For example, a number of studies indicate that the quality of the home environment moderates the effects of neighbourhood effects on children verbal ability (Klebanov et al., 1998, Greenberg et al., 1999), cognitive and behavioural outcomes (Chase-Lansdale and Gordon, 1996). A study by Garner and Raudenbush (1991) on neighbourhood effects on educational attainment among young people in

Scotland finds that deprivation in the home neighbourhood is negatively associated with educational attainment. A longitudinal perspective of neighbourhood effects on youths finds an advantage in high school completion among those living in areas a high percentage of residents who work in occupations of managerial/professionals (Ensminger et al., 1996).

Neighbourhood effects on child well-being act through a broad set of influences such as the quality of interactions among individuals in a residential area that influence cognitive development and educational attainment (Garner and Raudenbush, 1991) economic pressures associated with poor health and experience of poverty (Greenberg et al., 1999). Further, Leventhal and Brooks-Gunn (2000) suggests neighbourhood contextual effects on child well-being are moderated by 1) institutional resources such as availability, accessibility of medical facilities, child care, employment opportunities in a community, 2) relationships including parental characteristics of mental health, coping skills, physical health, parental behaviour and the quality of the home environment, and 3) norms or collective efficacy which show the extent of community institutions to supervise child activities.

Beyond child well-being, community factors are associated with child health outcomes such as child physical health (Narine et al., 2013), malnutrition (Adekanmbi et al., 2013, Wamani et al., 2006, Madise et al., 1999, Magadi, 2011, Griffiths et al., 2004, Moestue and Huttly, 2008), diarrhoea and fever (Kandala et al., 2006), underweight and low birth weight (Luke and Xu, 2011). A study on child physical health in Trinidad and Tobago finds a moderating effect of parent beliefs on the relationship between community health problems- measured as an aggregate of individuals with chronic ailments relative to the population in each community with child physical health (Narine et al., 2013). The study by Narine et al. (2013) is the first of its kind to explore this relationship, but it's cross-sectional, and it is based on self-reports of adult and child health rather than a clinical diagnosis of health status.

Using stunting as an indicator of child malnutrition, a number of studies in LMICs indicate that community illiteracy rate is associated with a higher risk of stunting (Adekanmbi et al., 2013, Moestue and Huttly, 2008, Luke and Xu, 2011). A study on malnutrition among children in Kenya notes the importance of maternal HIV status and the variation in the effects of maternal HIV status on underweight across communities (Magadi, 2011). This

study also finds low risk of stunting and underweight in communities with high HIV prevalence and across countries with higher gross domestic product-GDP (Magadi, 2011). Across other studies on child malnutrition, household effects are more pronounced than community effects and this is reflected by significant clustering of nutrition within households than in communities (Griffiths et al., 2004, Madise et al., 1999, Som et al., 2007).

Overall, previous research brings attention to community effects on child well-being and child malnutrition, but there remain opportunities to explore community effects related to the health system, economic factors, social and ecological factors on child physical health. Another major issue for community and child health research is a need to understand the unobserved heterogeneity from the interaction of community variables with household level factors. Already recent analyses point to the need to include cross-level interactions between community factors and household indicators of household socio-economic status, diet diversity, maternal education, nutrition and health (Corsi et al., 2016, Narine et al., 2013). Future analysis also need to identify other pathways through which community factors affect child health.

2.4 Family context and child well-being versus individual, household and community factors on child health

This section brings together perspectives on family and child well-being and their applicability to the impact of individual, household and community factors on child health outcomes. The potential relevance of evidence from Europe and North America to Botswana and Southern Africa is also discussed.

Of particular note is that most of the family literature on child well-being is from the USA; with few studies from Europe. Despite the geographical focus of the literature on family and child well-being to HICs, the influence of the family cannot be studied in isolation from the rest of the world. The literature on family and child well-being in HICs provide a good theoretical starting point and useful methodological approaches for inquiry into factors associated with child health in LMICs. Typically, variables such as parental economic and time resources in USA are shown to be associated with child well-being

outcomes (Thomson and McLanahan, 2012, Thomson et al., 1994, Waldfogel et al., 2010). In the UK, households are getting smaller (Allan and Crow, 2001a, Hall et al., 1999) and economic development provides added benefits for child well-being (Mendolia, 2016).

The findings from the literature on family and child well-being outcomes in HICs are consistent in respect to maternal education and child nutrition in LMICs: child nutrition is positively associated with mothers', fathers', and grandparents's education (Luke and Xu, 2011, Adekanmbi et al., 2013, Heaton et al., 2005, Moestue and Huttly, 2008). However the impact of parental economic and educational change on child health outcomes has not been fully explored in developing countries such as Botswana. Thus, it is not clear what the implications of economic development would be in a society where child rearing and experience occur within more varied family households contexts, ranging from married single parent, cohabiting, stepfamily, divorced parents, and even non-family households (Mokomane et al., 2006).

Further, in the case of LMICs, it is important to recognize that households in these environments have some different characteristics compared to those in HICs. The kind of adults in households within which children live, may have less education and socio-economic resources. This is important in Africa (Lloyd and Desai, 1992), in Southern Africa (Schatz Enid and Ogunmefun, 2007), and in Botswana where parents often live with other households members including grandparents, aunts, uncles, other relatives and non-related household members (Government of Botswana, 2009a) in greater proportions than seen in Europe and the USA. Section 2.2.3 thus showed that unlike HICs families, households in LMICs bring together resources from other household members such as aunts, uncles, grandparents, other relatives and not related household members (Bronte-Tinkew and DeJong, 2004, Izzard, 1979, Murray, 1987, Lloyd and Desai, 1992).

There is also evidence to show that pathways of family influence on child well-being are also applicable to child health outcomes (Leventhal and Brooks-Gunn, 2000). For example, scholars in HICs focusing on child well-being draw attention to an interaction between family-level and neighbourhood level variables (Leventhal and Brooks-Gunn, 2000, Garner and Raudenbush, 1991, Klebanov et al., 1998, Chase-Lansdale and Gordon, 1996). Consequently, a number of studies in developing countries have begun

to distinguish among the multiple contexts in which children live and the relationships among these on child nutrition outcomes (Luke and Xu, 2011, Adekanmbi et al., 2013, Madise et al., 1999, Magadi, 2011). Further, an interaction between community, parental health and parental beliefs is shown to be associated with child physical health in Trinidad and Tobago (Narine et al., 2013). Studies in Africa also expand research on household influences on child outcomes such as child mortality in Malawi (Sear, 2008) and birth weight in South Africa (Cunningham et al., 2010). Evidence in HICs is based almost wholly on child well-being: behavioural, emotional and cognitive outcomes rather than on child physical health (Allan and Crow, 2001a).

In summary, given the marked demographic and geographical difference between HICs and LMICs, the findings on families, households, child well-being and child health will depend on the context in which children live. Thus, the difference in the context of child rearing and experience might influence the results observed in child outcomes between HICs and LMICs. In particular, the context within biological parent families and living with other household members, larger and diverse households is of great importance for understanding risk factors of child health in LMICs. In HICs, it is clear that two parents are better for child outcomes than single parenting mainly due to time and economic resources (Waldfogel et al., 2010, Hofferth, 2006, McLanahan and Sandefur, 1994).

With regard to methods, research on family structure and child well-being in the USA does not always control for all observable characteristics of parents that are potential explanations for differences in child outcomes among family types (Hofferth, 2006, Thomson and McLanahan, 2012). Details on this are discussed in section 2.2.6. These limitations relate to selection effects which make it difficult to infer causality in studies of family and child well-being. However, selection bias can be addressed in longitudinal studies as well as by controlling for a large set of potential confounders (Thomson and McLanahan, 2012, Hofferth, 2006).

Equally important is that previous work has not defined household composition based on the relationship of the reference child to the rest of the household members in studying child health outcomes. Researchers who have examined this with regard to child health outcomes in LMICs focus on a less extensive detailing of household membership. Again, even within societies in LMICs, there are considerable difference in family types, households, and child health outcomes. For example, work by Sear in Gambia shows

that living with maternal grandparent is not helpful for child mortality (Sear et al., 2002). In contrast, living with paternal aunt in Malawi is protective against child mortality (Sear, 2008). This difference would seem to suggest that the relationship of the reference child to the rest of the household members is of interest in LMICs.

Lastly, the differences between the family and household types in HICs and LMICs, are themselves a reason for a research issue. The goal of this thesis is thus to explore potential pathways of household influence on child health outcomes in Botswana. Botswana makes an interesting case because since the 1990s it has been going through a number of socio-economic changes; which have implications for household size and composition. Moreover, Botswana may be illustrative of what is happening in Southern Africa in terms of development, and how it relates to household composition and child health. However, more data is needed to answer this with certainty.

2.5 An over-arching conceptual framework

The conceptual framework in Figure 2.2 was developed from theoretical evidence on family structure, household, child well-being and health outcomes, as well as from how the author perceived things to be occurring. This was done to give an over-arching framework for the current analysis that takes into account potential factors associated with child health outcomes in Botswana. Figure 2.2 shows that community, household and individual factors have a part to play in determining child health outcomes. This is broken down into the specific conceptual frameworks which organize the focus of chapters 3, 4 and 5.

First, Figure 2.2 hypothesizes that the relationship between the household and child health is through several mechanisms: household composition, household functioning, household resources, parent characteristics, parent behaviours, parenting styles, parental health, parental resources and child characteristics. The framework in Figure 2.2 assumes the difference in households reflects differences in access to economic and social resources that are needed to support child health. A number of studies in both developed and developing countries documents the relevance of households for child rearing and care (Simpson, 2012, Van Imhoff et al., 1995, Van de Walle, 2006). Past research also shows that household change impacts the level and pattern of fertility and marital status of individuals in a population (Bongaarts, 2001, Kuijsten, 1995). Research

in LMICs also indicates that the change in household size and composition has implications for socio-economic resources needed for child care and development (Heaton et al., 2005, Desai, 1992, Bronte-Tinkew and DeJong, 2004). Thus Figure 3.1 presents the determinants of household change. While Figure 3.2 details possible interrelationships between fertility, marital status and household change in Botswana.

Second, is a set of assumptions about the influence of household composition on child health outcomes. Figure 2.2 includes variables such as co-residence with parents, co-residence with relatives and non-related members, to stress the importance of household composition on child health outcomes. As mentioned earlier, past studies on family and child well-being offer insights into the role of two parents versus a single parent for provision of financial and time resources needed for child health outcomes (Thomson et al., 1994, Thomson and McLanahan, 2012, Amato and Keith, 1991). However, the difficulty with these studies is their emphasis on the family context in HICs and less on households in LMICs. Studies in Africa acknowledge the role of households on child health outcomes such as birth weight (Cunningham et al., 2010), child mortality (Sear et al., 2002, Sear, 2008) and mobility (Ford and Hosegood, 2005). Evidence is also emerging on the effects of community and household factors on child nutrition outcomes in Africa (Griffiths et al., 2004, Madise et al., 1999, Som et al., 2007), and on child health in Trinidad and Tobago (Narine et al., 2013).

On the other hand, among investigations that consider households effects on child health outcomes, there are inconsistencies relative to how household composition is defined and the range of membership considered. For example Sear (2008) research on child survival in Malawi describes household membership based on father, mother, maternal and paternal grandmothers/grandfathers, maternal and paternal aunts/uncles, brother and sister co-residence in households with children. Whereas a study on prenatal development in rural South Africa by Cunningham et al. (2010) only refers to household membership based on living with a father and grandparent at the time of a child's birth. These definitions of household membership are inadequate for LMICs where children live with related and non-related household members. Thus, the effects of a more extensive household composition categories are represented in Figure 4.1. Figure 4.1 shows that whoever is in the household and their characteristics also underpin conceptualization of household influence on child health outcomes. Further, Figure 4.1

shows moderating effects from household, parental and individual factors on the relationship between household composition and child health outcomes.

The role of individual factors such as child age and sex are also recognized in the far right of Figure 2.2. Moreover, as indicated by the arrow emanating from the box labelled child characteristics, individual characteristics can also influence parental characteristics such as their health. For example evidence on maternal depressive symptoms in Brazil (De Miranda et al., 1996) and in Taiwan (Howe et al., 2014) shows a higher prevalence of mental health problems among women with malnourished children. Mental illness of the parent can have negative consequences on child health outcomes such as lower quality of parenting and inability of the parent to provide both financial and social resources (Klebanov et al., 1994). However, the precise mechanisms of the relationship of parental mental status on child health outcomes, and vice versa, are less understood.

Third, Figure 2.2 shows that over and above household and individual factors, child health can be directly or indirectly affected by demographic and socio-economic factors operating at community level. Thus, the third aspect of analysis for this thesis is community factors. Papers that consider multilevel models in health research shows that health outcomes are affected by factors at individual, household and community level (Sastry, 1997, Duncan et al., 1998, Luke and Xu, 2011). As shown in Figure 2.2 an individual child resides within a household, which is situated within a community. In turn the community operates under the prevailing socio-economic environment, legal and patterns of family life to influence child health outcomes.

A full account of the relationship between community factors and stunting is touched on in Figure 5.1. Figure 5.1 also has a dimension on the interaction among community and household factors and their impact on stunting. This is a new perspective. Most of the studies on community and child health outcomes in LMICs don't focus on this kind of interaction. The only exception is a study by Narine et al. (2013) which examines the mediating role of adult physical health and parental health beliefs in the link between family economic adversity and child physical health

In summary, the conceptual framework in Figure 2.2 shows that there are many pathways in which households influence child health outcomes. The conceptual framework in Figure 2.2 spans three levels of determinants: community, household and

individual. Second, the framework shows that the household is not the complete explanation of child health; instead there are factors beyond the household such as the social, economic environment in which households are located; which are also important for child health outcomes. Lastly, although this initial part of the framework is general, each of the chapters 3, 4 and 5 explore a more refined model that reflects the variables in the analyses.

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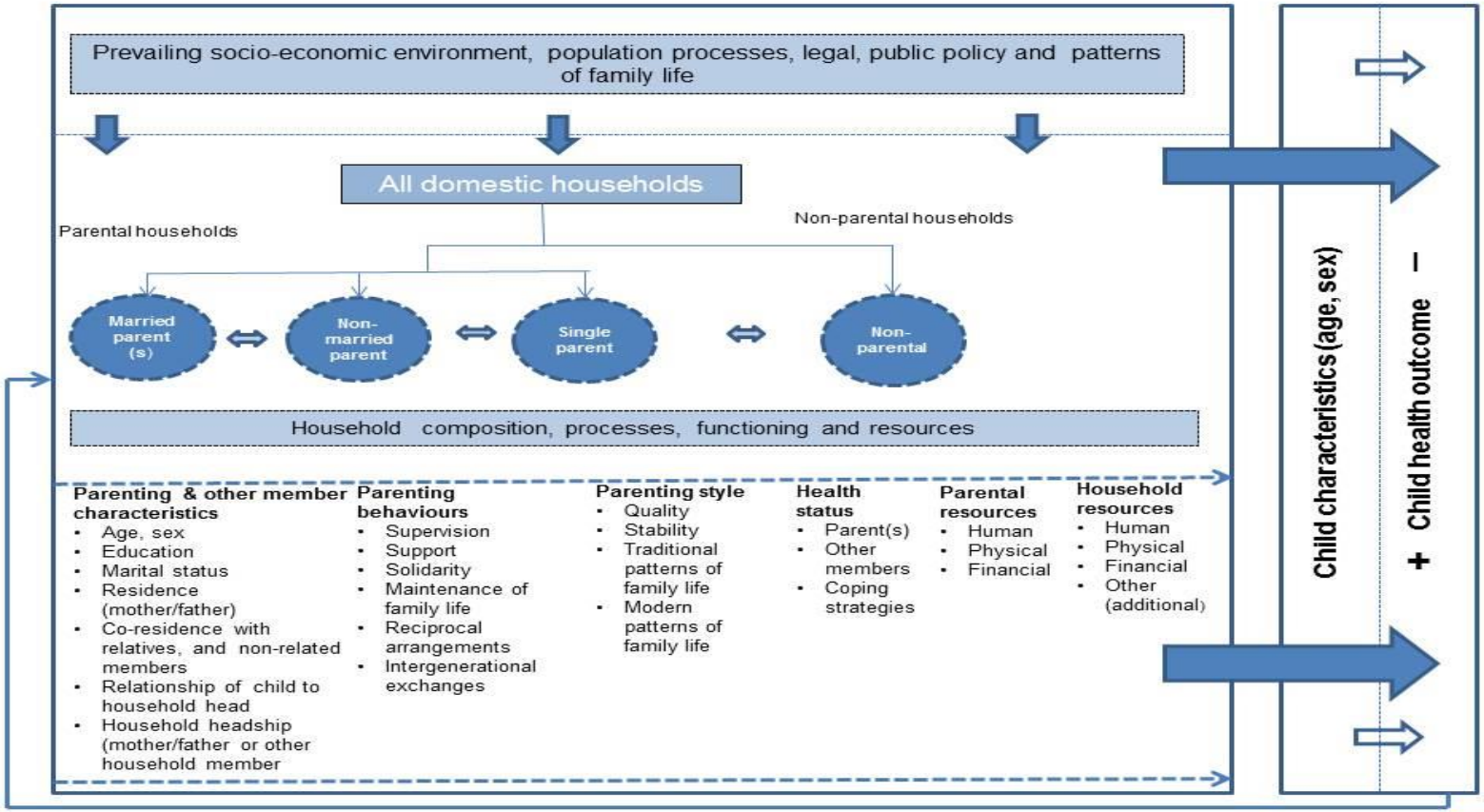


Figure 2.2: Conceptual framework on the multiple factors that influence child health outcomes

2.6 The research gaps and what the thesis addresses

Having discussed the past literature on families and child well-being, it is important to state the contribution of this research to prior work on family influences on child health. The current research aims to provide further evidence on the community, household factors and how they are associated with child health outcomes in Botswana. Previous literature highlights the importance of community factors and family for child and adolescent well-being outcomes (Leventhal and Brooks-Gunn, 2000, Narine et al., 2013, Garner and Raudenbush, 1991) and less on child physical health. Moreover, earlier research efforts shows the beneficial role of two married versus single or cohabiting parents for providing parental time and economic resources needed for better outcomes in child well-being (Thomson et al., 1994, Thomson and McLanahan, 2012, Amato and Keith, 1991). However, what is not fully understood is how child physical health vary by household composition; that is by whether the child lives with two parents, one parent, no parents and by the types of others living in the household (grandparent, aunt, uncle, other relatives and not related members)?

First, the thesis examines the changes in households over time in order to demonstrate the household environment under which children are reared and raised in Botswana. Second, a need to investigate household composition and child health outcomes in LMICs is critical to academic knowledge as most of the previous literature has largely focussed on Western contexts of the family and child well-being indicators. It is not clear if these research findings can be extended to family environments which comprise other household members than biological parents, which is the case in Botswana. A child's view of the household is used to establish relationships of household members to the reference child and to define categories for household composition. Previous work defined household composition from recasting relationships of household members only to the household head.

A third rationale of this thesis is to investigate the relationship between community factors and stunting using a multilevel approach that gives more robust results in the analysis of clustered data than the traditional methods. The final paper also extends previous analyses on stunting among children in LMICs by including cross-level interactions between community and household factors. Cross-level interactions highlights the

effects of the different layers of influence on stunting. Finally, aside from the cross-level interactions, past research has not explored other community variables such as per cent professionals and household size at district level and their association with child nutritional status.

CHAPTER 3. MAKING SENSE OF HOUSEHOLDS IN BOTSWANA OVER TIME

3.1 Introduction

Since the 1970s households in Botswana have changed with a decline in fertility, fewer people marrying, and more people remaining single or choosing to cohabit (Government of Botswana, 1972, Government of Botswana, 1991, Central Statistics Office, 2004). As a result households today are smaller in size and more diverse in terms of partnership arrangements by type and composition. For example, the percentage currently married persons aged 15 years and above have been declining over the years, reaching 19 per cent for men and 18 per cent for women in 2011 compared to 47 per cent and 43 per cent for males and females, respectively in 1971 (Central Statistics Office, 2004, Government of Botswana, 1972). On the other hand, the proportion of adults cohabiting or non-marital living together has increased over the years. Census data from 1991 and 2011 indicate that the rates of cohabitation have increased from 12 per cent to 21 per cent for both men and women. Correspondingly, new household types in the form of extensive non-marital childbearing and parenting with the help of not related household members has also increased over the years (Mokomane et al., 2006). These all may have effects on the society as whole, and those that live in them in particular children.

What is it that has led to changes in households in Botswana? Factors such as increased educational attainment, participation in employment, and opportunities to live in different household types give some indication of the status of household formation and change over the years. For example, relatively high literacy rates may explain why households are becoming smaller and fertility is declining over time. The literacy rates of the population aged 10-70 years in Botswana have increased from 34 per cent in 1981 to 85 per cent in 2010 (Government of Botswana, 2013).

Unemployment rates have also increased over the last twenty years, and this makes living with other family or household members a necessary phenomenon especially among young adults (Siphambe, 2003). Census data indicate that unemployment rates

have increased from 15 per cent in 1991 to 20 per cent in 2001 (Central Statistics Office, 2004, Government of Botswana, 1991). Equally important to household change are social controls on marriage. Mookodi (2004) notes that a rise in cohabitation, a decrease in marriage rates and an increase in non-marital births reflect a broader trend of a freer society than in the past where there were strict social controls that governed non-marital sexual behaviour. This in turn reflects less pressure for women to marry and less stigma to giving birth outside marriage than during the period 1971-1981.

The study of households is of importance for understanding child health and development. At micro level, households are central in supporting childrearing, procreation, consumption and economic production (Simpson, 2012, Van Imhoff et al., 1995, Van de Walle, 2006). The family is shown to be an important institution under which children's health and development are supported (Parke, 2003, Brown, 2004, Thomson and McLanahan, 2012). Other studies confirm links between household socio-economic status with heath, cognitive and behavioural outcomes in children (Bradley and Corwyn, 2002, Aber et al., 1997, Angel and Angel, 2006). In particular, households with low socio-economic status are likely to be associated with increased risks for stunting (Miller and Korenman, 1994), and higher rates of diarrhoea in infancy (Fuchs and Victora, 2002).

Children in households with low socio-economic status are also more likely to have problems in cognitive development and language problems early in life (Aber et al., 1997). A study on child mortality and household characteristics in South Africa finds increased odds of dying among children from households with low socio-economic status than from richer households (Houle et al., 2013). However, even though the evidence shows that household socio-economic status is associated with child health outcomes, it is not easy to determine the precise mechanism through which the influence occurs. Several possibilities have been proposed with low socio-economic conditions reducing the ability to purchase dietary needs and health care needs or limiting opportunities for parental education and ability to deal effectively with child health problems (Bradley and Corwyn, 2002).

At the macro level, household characteristics have implications for broader societal issues such as child care, poverty alleviation, and the housing market (both in terms of demand and tenure). As evident in a study by Houle et al. (2013), the availability of state

support through old-age pensions and child care grants in South Africa has enabled rural households to provide better care to children of migrants. With respect to the housing market, empirical generalizations indicate that housing prices have paradoxical effects: discourage marriage and the formation of family households in societies where leaving parental home is common, as is the case in Italy (Burch, 1995). At the same time, high housing costs reduce the household size in societies where leaving parental home by young adults is postponed until late adulthood (Burch, 1995). Hall et al. (1997) indicate that the increase in one person households among young adults in England and Wales between 1981 and 1991 resulted in more housing demand in large cities

Against this background, understanding households and the associated determinants is critical to informing public policy in Botswana. Household change refers to the changes in size and composition to new household or existing ones. Another part of making sense of households in Botswana also lies with understanding the changes in fertility and marital status between 1971 and 2011. Many surveys conducted in Botswana collect demographic and household information, but none has attempted to characterize such households in detail. Research on the characteristics of households and characteristics of members of households in Botswana is critical as it provides an understanding of the contexts within which household change takes place and the related implications for household life and child health.

3.1.1 Research objectives

The overall purpose of this analysis is to describe and explain how households have changed in Botswana in the period 1971 to 2011. Specifically the paper examines the following objectives:

1. To describe changes in household size and household composition using data from the censuses of 1971, 1981,1991, 2001, 2011 and surveys of 1988, 2000 and 2007.
2. To find the extent to which single person households is driven by compositional factors of age, sex and residence.
3. To examine the level and pattern of fertility using census data.
4. To examine marital status using census and survey data.

5. To explore the interrelationships of fertility and marital status on household change.

3.1.2 Research questions

The research questions addressed are as follows:

1. How have households changed in Botswana between 1971 and 2011?
2. What are the trends and patterns in fertility and marital status across the census years 1971-2011?
3. Which groups of women experience the greatest decline in fertility?
4. How are fertility and marital status related to change in household size and composition over time in Botswana?

The analysis is limited to the demographic determinants of fertility and marital status. Other factors such as mortality, migration and the socio-economic determinants on household change are not reviewed. Data analysed come from the census reports for the years 1971, 1981, 1991, 2001 and 2011 and the nationally representative surveys: the 1988 Botswana Standard Demographic Health Survey, the 2000 Multiple Indicator Survey (MICS) and the 2007 Botswana Family Health Surveys (BFHS).

3.1.3 Conceptualizing households change

Figure 3.1 conceptualizes how households have changed in Botswana. The model adopts Bongaarts' essay on determinants of family and household composition (Bongaarts, 1983, Bongaarts, 2001), which describes and identifies processes associated with household formation and dissolution. In his model, Bongaarts (1983) outlines six factors that determine nuclear family composition (nuptiality, fertility, mortality, migration, adoption, and divorce), and four factors associated with how nuclear families and individuals combine to form households (headship prevalence, household formation, household transition and household dissolution). While Bongaarts restricts his model to nuclear families and individuals within these units, the conceptual model in Figure 3.1 takes an inclusive approach to household change, with an emphasis on the diversity of households and co-residence with family and non-family members. This is

important as households with a nuclear structure are an increasingly smaller proportion of all Botswana households (Gaisie, 1998, Poukouta, 2000).

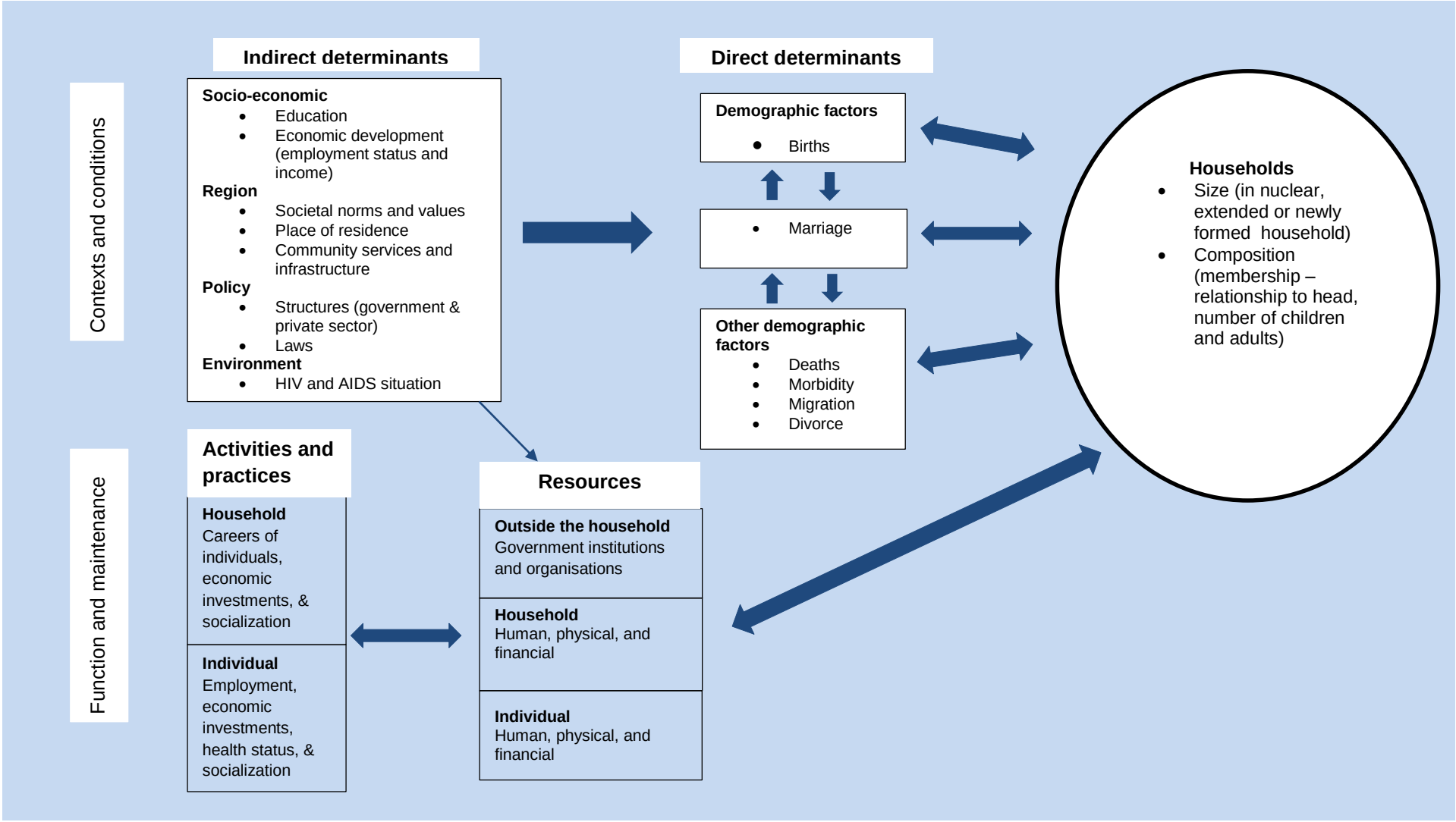


Figure 3.1: Conceptual framework on the factors associated with changes in households in Botswana

Further, Figure 3.1 shows that changes in households are influenced by socio-economic, regional, policy and environmental factors, which operate through a number of demographic factors, or proximate determinants of household change. The proximate determinants of change to a household include those associated with a gain in household size (births and marriage) and those with loss in household size (deaths, divorce and migration). For example, an analysis of family change over a life cycle in the US, suggests that a family may come into being when a couple is married, increase in size when a child is born, reduce in size when the child leaves home for marriage, schooling or work opportunities, and eventually dissolve in old age when the last member dies (Sweet, 1977). Likewise, a household starts out with a few members and it gains members over time for reasons related to demographic and social–economic factors, resource availability, and ability to function and maintain its activities.

Previous studies show that deaths, emigration and divorce are associated with household change (Bongaarts, 2001), and other shifts including migration of individuals to other locations due to household requirements, employment and schooling opportunities (Sweet, 1977). In the case of Botswana, mortality is likely to decrease density in a kin network by reducing the average household size as well as the types of persons in a household. As Zhao (1996) revealed in his work in England, a reduction in mortality increases the number of sibling, cousins, aunts, uncles and nephew/nieces available to an individual. Morbidity rates in Botswana are likely to lead to changes in living arrangements rather than household dissolution. This is possible because AIDS, which is the main cause of adult deaths and morbidity in Botswana, has a long incubation period of around 11 years between illness and death (Stover et al., 2008). In addition, given the almost full coverage of the antiretroviral therapy (ART) programme in Botswana to the population who need it, more people are now able to live longer with HIV (NACA, 2010), thus lessening the disruption in household change due to adult and child morbidity and deaths.

An increased coverage in the national ART programme and the prevention of mother to child transmission (PMTCT) programme in Botswana since 2000 has also helped to reduce annual adult and child AIDS deaths (NACA, 2010). Life expectancy at birth fell from 65.3 years in 1991 to 55.6 years in 2001, a rate similar to the one observed in the 1970s (see Appendix 3A). However, by 2011 life expectancy had improved again from 55.6 years in 2001 to 68.0 years. The main explanation for the decrease in life

expectancy between 1991 and 2001 was an increase in deaths related to AIDS (Central Statistics Office, 2004). In absolute terms, research on HIV trends and program effects in Botswana demonstrates that the provision of ART has reduced annual AIDS deaths from about 15 500 cases in 2003 to 7400 cases in 2007 (Stover et al., 2008). The same study also reports that the combined effects of the PMTCT, child treatment and adult ART programs has averted the considerable number of annual child deaths from 3000 cases in 2001 to 790 cases in 2007.

In the case of migration, the process will likely add or subtract persons from a household, depending on whether they move out or in. Evidence shows that the structure of households can differ over time due to emigration, or as a consequence of death of all its members or being merged with another household (Laslett, 1972, Bongaarts, 2001). Further, international migration has been shown to be more important than internal migration due to its contribution to the country's population gain or loss (Clarke, 1965).

Table 3.1 shows that immigration to Botswana has been increasing over the years from an estimated 10, 861 persons in 1971 to 60, 716 persons in 2001. During the same time the number of Batswana emigrating has declined from 45, 735 in 1971 to 28, 210 in 2001. In 1991, South Africa was reported as the popular destination for 80 per cent of all the departures, followed by Namibia at 7 per cent, Zimbabwe at 6 per cent, the United Kingdom and United States of America both at 1 per cent and the rest went to other parts of the world (Government of Botswana, 1991). The 1991 census data associates the levels of emigration to South Africa and Namibia to working on farms, in mines (in the case of men), and for education purposes.

Table 3.1: International migration, Botswana: Censuses 1971-2001

Migrants	Males	Females	Total	% change
Resident non-citizens (immigrants)				
1971	6114	4747	10861	
1981	8834	6843	15677	44.3
1991	17995	11562	29557	88.5
2001	34731	25985	60716	105.4
2011	..	..	..	..
Citizens abroad (emigrants)				
1971	36661	9074	45735	
1981	32549	9412	41961	-8.3
1991	27870	10736	38606	-8.0
2001	16801	11409	28210	-26.9

Thus given the levels of emigration and the reasons for out migrating among Batswana, it is likely that this process will have very little influence on the change in households. On the other hand, immigration is likely to contribute to household growth given that it increased by six fold between 1971 and 2001. The statistics on immigration in Botswana, still remain limited as they do not include migrants in the informal sector as well as those who are in the country illegally. A study on migration patterns in Botswana notes that the statistics on immigration from censuses and surveys are inadequate as they don't identify undocumented immigrants and those in the informal sector (Oucho et al., 2000).

3.1.3.1 Conceptualizing births, marital status and households in Botswana using census reports

Another aim of this paper is to explore the interrelationships of fertility and marital status on household change. Figure 3.2 hypothesises the relationship between births and household formation to women who marry or stay single for the periods 1971-1980, 1981-1990 and 1991-2011. The three periods, 1971-1980, 1981-1990 and 1991-2011 were chosen to illustrate periods of major change in Botswana. The size of the arrows in Figure 3.2 shows the magnitude of the outcome. For example, the extent of marriage leading to childbearing, then a couple forming their household or the propensity of a

couple forming their household before childbearing. As shown in Figure 3.2 the period 1971-1980 is characterised by less setting up of own households, high fertility and more co-residence with kin and relatives before childbearing than during the 1981-1990 and 1991-2011.

On the other hand, the period from 1981 to1990 and 1991 to 2011 shows that more married and single women are financially able to set up new households before childbearing or after childbearing than during the period 1971 to 1980. The period 1981-1990 and 1991-2011 is associated with a drop in household size, a fall in fertility and less co-residence with kin, relatives and sometimes non-related household members, compared to the period 1971-1980. Finally, it is likely that other partnership types-cohabitation, separated/divorced and widowed in Botswana have implications for the household formation and change. An association of married and single women with household change was chosen to show the relationships between those women in the union and not in a union, but also on the basis that data on marriage and singlehood was available for 1971-2011. Cohabitation data is only available for the census years: 1991, 2001 and 2011.

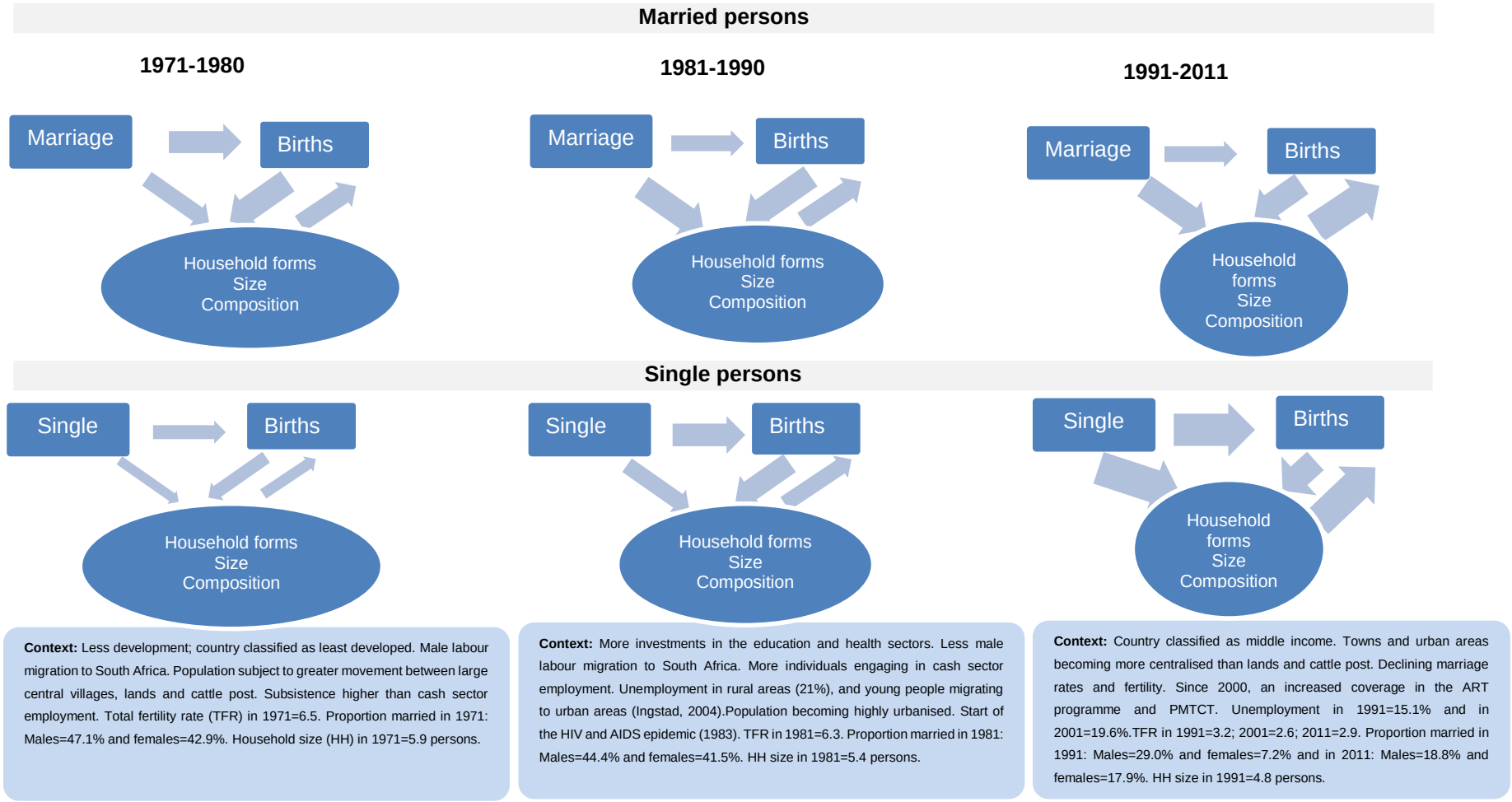


Figure 3.2: Households and births to women who marry or stay single in Botswana, Source: Census data 1971-2011

In overview, it should be noted that the processes under which household change occurs, may not necessarily be sequenced in a simple way as shown in Figures 3.1 and 3.2. It is likely that a household will continue to undergo modifications (in size and composition) over time, depending on whether the living arrangements and situations of individuals in it vary at different stages of each person's life. It is also possible that there are complex interrelationships between the various demographic and socio-economic processes and factors on household change. Moreover, households in Botswana may have multiple links with other households in other locations such as in the village, at the lands, and at the cattle post (Izzard, 1985, Townsend, 1997), which may affect the pace and nature of household formation, household size and composition over time.

3.2 Data and methods

Data analyzed come from the census reports for the years 1971, 1981, 1991, 2001 and 2011 and nationally representative surveys: the 1988 Botswana Standard Demographic Health Survey, the 2000 Multiple Indicator Survey (MICS) and the 2007 Botswana Family Health Surveys (BFHS). The 1988 survey used a two stage sample, which was weighted at household level and by urban and rural location (Government of Botswana, 1989). The 2000 and 2007 surveys also adopted a two stage sampling frame. The first stage involved a selection of primary sampling units (PSU) or enumeration areas from a stratum or an administrative district. The second stage of sampling involved a selection of households within selected PSUs (Government of Botswana, 2001, Government of Botswana, 2009a). Population totals and households enumerated for the censuses of 1971, 1981, 1991, 2001 and 2011 are shown in Table 3.2 below. Table 3.3 gives a summary of the population and number of households interviewed in the three surveys. Both the surveys and censuses were conducted on a *de facto* basis; that is people were enumerated according to where they were found at the time of survey or census. The household is used as the basic sampling unit.

Table 3.2: Population and households enumerated by census year, 1971-2011

Year	Households	Population*		
		Males	Females	Total
1971	97937	262120 (45.7%)	311974 (54.3%)	574094
1981	174264	443104 (47.1%)	497923 (52.9%)	941027
1991	276209	634400 (47.8%)	692396 (52.2%)	1326796
2001	404706	813625 (48.4%)	867238 (51.6%)	1680863
2011	550918	988958 (48.8%)	1035946 (51.2%)	2024904

*Includes persons who usually live in the household and who spent the last night (before the day of census) in the household.

Table 3.3: Population and households enumerated by survey year, 1988-2007

Year	Interviewed households	Population*		
		Males	Females	Total
1988	4471	10257 (46.9%)	11596 (53.1%)	21853
2000	6188	12968 (48.0%)	14074 (52.0%)	27042
2007	7094	12107 (47.8%)	13216 (52.2%)	25323

*Includes persons who usually live in the household and who spent the last night (before the day of survey) in the household.

Concepts

Several concepts are considered in this chapter:

Household change. Refers to the change in the household size and composition. Household size is calculated by dividing the total population in a year by the total number of households during that year. Household composition reflects the distribution of household membership by age of members during the period 1971-2011, the relationship of household members to the household head (e.g Spouse/partner, son/daughter, grandparent, aunt, other relative and not related), and the distribution of households with children (aged 0-4 years) and older children (5-17 years) during 1988, 2000 and 2007.

Fertility. Refers to births per woman and is presented using the mean number of children ever born (CEB) to women aged 12 years and above, child woman ratio (CWR), crude birth rate (CBR), total fertility rate (TFR) and parity progression ratios (PPRs). Child woman ratio is the number of children age 0-4 years to women aged 15-49 years. The CEB is the total number of children divided by the total number of women. The CBR is the number of live births during the year preceding the census per thousand population,

irrespective of exposure to childbearing. The TFR is the average number of children a woman will have at the end of her reproductive life span given the prevailing age specific fertility rates. The TFR is a better measure of fertility than CEB, CWR and CBR, since it is independent of the population age structure (Newell, 1988, Preston et al., 2001). While the child-woman ratio is sensitive to reporting errors, the levels of infant mortality (Newell, 1988). Also it doesn't account for the differences in fertility of women of different ages and marital status (Rowland, 2003). The CBR can be affected by the population age structure (Statistics Sweden, 2009, Preston et al., 2001).

Further, fertility is analyzed using parity progression ratios. The PPRs takes into account the number of children a woman has already had; in other words they measure the extent to which women are having first, second, third, fourth and higher order births (Newell, 1988, Hinde, 1998). In contrast to the conventional age based measures of fertility, the parity progression approach has an advantage that it enables an interpretation of fertility trends based on the decisions relative to having another child given the number of children a woman has already had, rather than her age (Hinde, 1998, McDonald et al., 2015).

In this analysis the PPRs were calculated using Botswana census data for 2001 and 2011. The census data for 1971, 1981 and 1991 were not available. The PPRs were calculated on a cohort basis and are calculated as shown in Preston et al. (2001). The women were tabulated by parity, and then the figures cumulated from bottom up to give the number of women at parity *i* or more (P*i*). Lastly, the parity progression ratios from parity *i* to parity *i*+1 were obtained by dividing the adjacent figures of P*i* (Preston et al., 2001). The PPRs were obtained for women aged 45-49 years and those aged 50-54 years. In addition, the distribution of completed family sizes among these women is shown by rural/urban and by the level of education in order to specify which group of women have the greatest decline in fertility between 2001 and 2011. Education is categorized into four levels: no education, primary, secondary and tertiary. In Botswana, no education means that someone has never attended formal school. While primary schooling is completed in 7 years, and secondary schooling takes five years, provided there is no failure to complete any of the levels. Tertiary education means the woman completed their education at a university and this normally takes 4 years for most of the degree courses, except for the law degree which takes 5 years.

Number of children in a household: Is used to represent fertility at household level. While number of children in a household is not fertility and does not make the births specific to any woman in a household, it serves as a proxy to understand fertility and the interrelationships between fertility, marital status and household change.

Marital status. Shows the proportion of persons who are 12 years and above are single (never married), currently married, cohabiting (living together), separated/divorced and widowed in the population during the census years 1971-2011.

Statistical analysis

Descriptive analysis is carried out to assess the change in household size and composition, and the interrelationships between fertility (shown as the number of children in a household), marital status and household change in Botswana.

3.3 Results

The results presented are from the 1971, 1981, 1991, 2001 and 2011 census reports, and analysis of the 1988, 2000 and 2007 surveys. The censuses provide a general overall view of households, fertility, and marital status. While the surveys are used to provide more details about household change, fertility, marital status, and the interrelationship between these factors. The information from the surveys is also useful to find out if they closely mirror what is observed in the censuses. The results from the 1988 survey are expected to be comparable to the 1991 census, while those from the 2000 survey compare to the 2001 census and the 2007 survey compare to the 2011 census. As stated in the data and methods sections, the surveys were based on carefully selected samples, with a robust design that ensured that selected households are representative of all households in Botswana.

Average household size, number of households and population size

The first question that the analysis seeks to answer is how have households changed in Botswana between 1971 and 2011 in terms of household size, number of households, and household composition? Figure 3.3 below shows that the average household size based on census data has decreased from 5.9 persons in 1971 to 3.7 persons in 2011.

Figure 3.3 also indicates growth in the population size in the same period. This links back to Table 3.2 and the very large increase of households between 1971 and 2011.

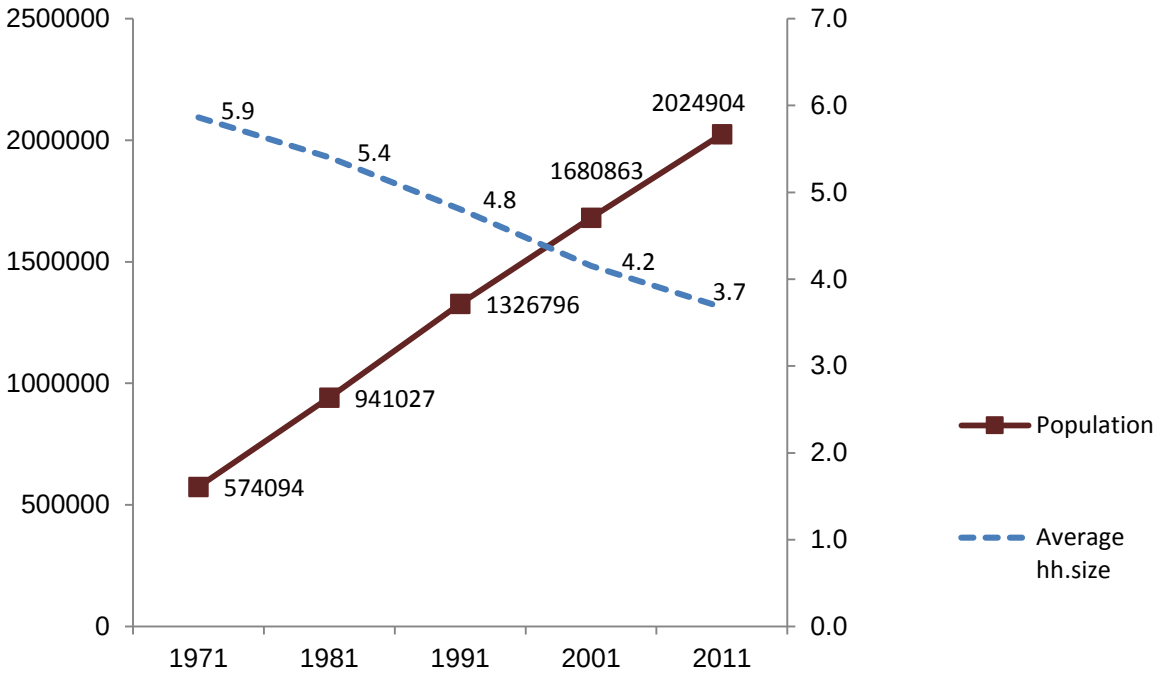


Figure 3.3: A plot of average household size and total population, Source: Census data 1971-2011

Figure 3.4 shows separately the average household size distributions calculated as the number of all households in a census year divided by either the total population (all ages), the population aged 0-14 years, the population aged 15-64 or the population 65 years and above. Across all households the number of children aged 0-14 years are falling, while the number of adults has stayed fairly consistent. For example in 1971 the average household size of 5.9 persons consist mainly children 0-14 years (2.8 persons), adults aged 15-64 years (2.7 persons), and the rest are adults 65 years and above (0.3 persons). In comparison, in 2011 the average household size is 3.7 persons and it is comprised mainly of adults aged 15-64 years (2.3 persons) and children aged 0-14 years (1.2 persons).

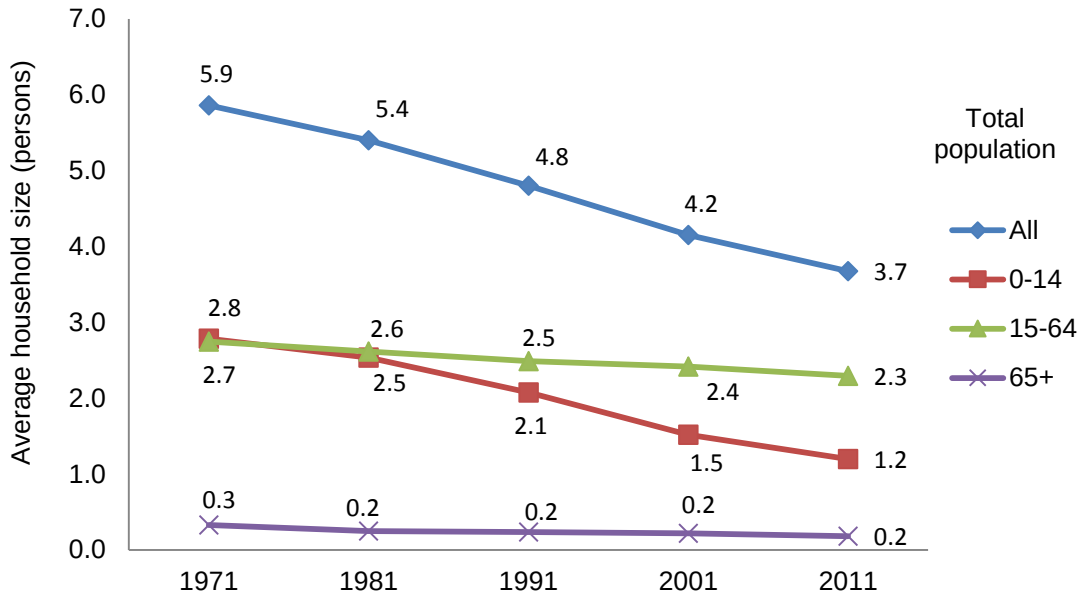


Figure 3.4: Average household size based on the total population, population aged 0-14, population aged 15-64 and population 65 years and above, Source: Census data 1971-2011

A further confirmation of the decrease in the average household size over time is found in the 1988, 2000 and 2007 surveys. As shown in Table 3.4 since 1988, the average household size has dropped from 4.9 (SD=3.4) to 3.6 (SD=2.8) in 2007. These closely match the census reports. It can also be seen in Table 3.4 that the average household size is lower in urban than rural areas, but the difference is declining.

Table 3.4: Per cent distribution of households by size and residence, Surveys 1988-2007

No. of members	1988			2000			2007		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
1	18.9	12.0	15.4	19.3	16.6	18.3	30.3	28.3	29.5
2	17.8	10.5	14.1	17.2	13.9	16.0	18.2	15.7	17.2
3	13.9	11.0	12.4	13.8	12.7	13.4	13.2	11.6	12.5
4	12.4	11.2	11.8	12.4	11.1	11.9	12.0	11.1	11.7
5	9.3	10.2	9.8	9.5	11.7	10.3	8.8	8.8	8.8
6	7.1	10.9	9.0	9.0	9.2	9.0	5.4	7.0	6.0
7+	20.7	34.2	27.5	18.8	24.8	21.0	12.2	17.5	14.3
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of households	2216	2255	4471	3969	2219	6188	4240	2854	7094
Average household size	4.23 SD=3.11	5.52 SD=3.56	4.88 SD=3.41	4.16 SD=3.00	4.73 SD=3.37	4.37 SD=3.14	3.40 SD=2.71	3.83 SD=3.01	3.57 SD=2.84

The change in the household size and membership in Botswana over time is also due to a rise of smaller households. Figure 3.5 below shows an increase in the percentage of smaller households (one person) from 15.4 per cent in 1988 to 29.5 per cent in 2007. At the same time, households with 2-3 persons increase slightly from 26.5 per cent in 1988 to 29.7 per cent in 2007. In comparison, the middle sized households (4-6 persons) and larger households (7 persons) decrease during 1988 to 2007. For instance, the shares of larger households (those with 7 persons) decrease from 27.5 per cent in 1988 to 14.3 per cent in 2007.

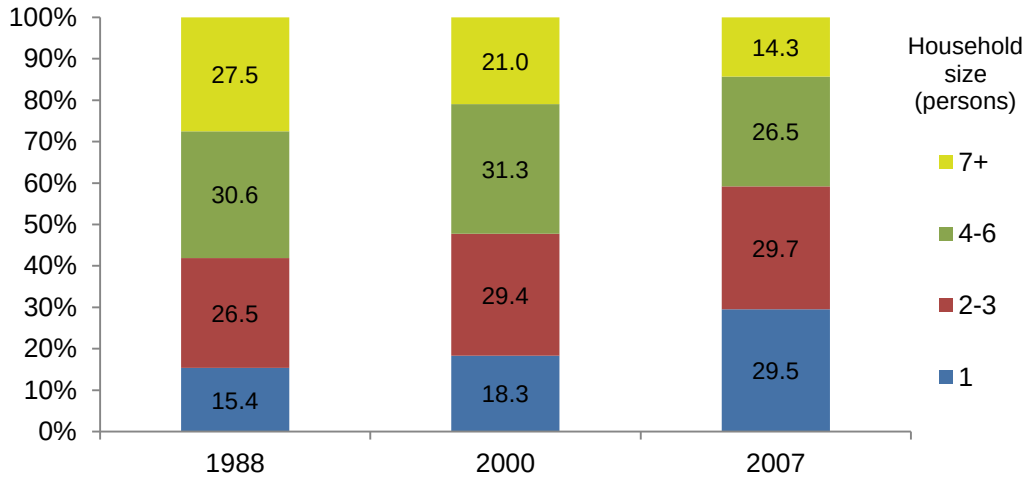


Figure 3.5: Per cent distribution of households by size. Source: 1988 BSDHS, 2000 MICS, and 2007 BFHS

A further analysis of one-person households in Botswana, show that they have a distinctive pattern by age, sex and residence. Figure 3.6 shows the age pattern of all persons who live alone in 1988, 2000 and in 2007. For both the years: 1988, 2000 and 2007, it appears that people living alone are mostly young (aged 20-40 years), with a peak at ages 25-29 years (Figure 3.6). For example in 1988, there is a higher percentage of people living alone in the age group 25-29 (23.6 %), and this compares with 19.2 per cent in 2000, and 20.3 per cent in 2007. Figure 3.6 also shows that the propensity to live alone declines with age. This finding is possible as young people may have the economic ability to do so while older persons may not have a choice and lack the financial ability to do so. Other reasons for living alone could relate to the increase in persons staying single, low marriage rates, and absence of children in households with younger heads between 1988 and 2007.

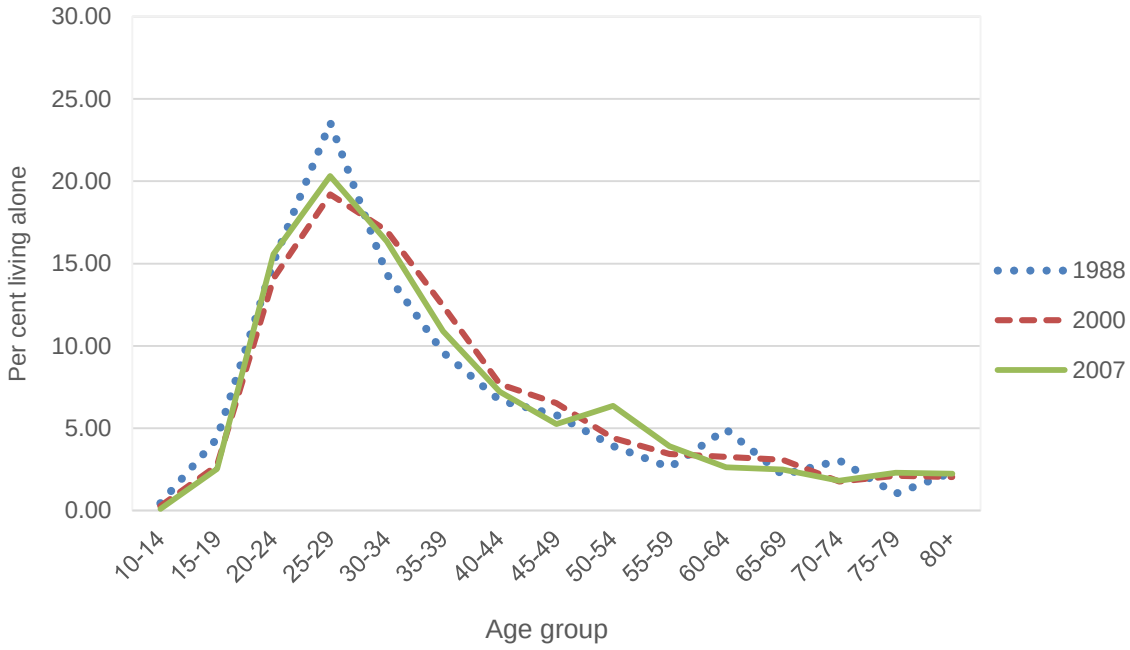


Figure 3.6: Per cent distribution of persons living alone by age in Botswana, Source: 1988 BSDHS, 2000 MICS, and 2007 BFHS

Sex differences in living alone was also evident. In both 1988 and in 2000, 65.3 per cent of the men and 34.7 per cent of the women lived alone. While in 2007, 64.2 per cent of the men and 35.8 per cent of the women lived alone. Figure 3.7 shows that the increasing propensity to live alone is particularly high for younger males and females aged 25-29 years in 1988 and in 2007 and for females aged 20-24 years in 2000. It is also apparent that living alone is higher for males aged 40-60 years, compared to females of the same

age between 1988 and 2007, and this is more pronounced in 2007. Further, the findings on living alone by sex also show that at older ages (65 years and above), there are more females than males living alone. For instance the percentage living alone among females aged 65 years and above increased from 11.3 per cent in 1988 to 11.4 per cent in 2000 and to 13.8 per cent in 2007. In contrast, in 1988, 7.1 per cent of the males aged 65 years and above lived alone. This compares with 7.7 per cent in 2000 and 6.1 per cent in 2007.

Finally, the distribution of living alone by residence is reflected in Table 3.4 above. As seen in Table 3.4, it is apparent that the greatest percentage in one-person households between 1988 and 2007 are in urban areas (18.9% in 1988 and 30.3% in 2007) than in rural areas (12.0% in 1988 and 28.3% in 2007). Albeit, there is a greater increase in one person households in rural areas than in urban areas between 1988 and 20007.

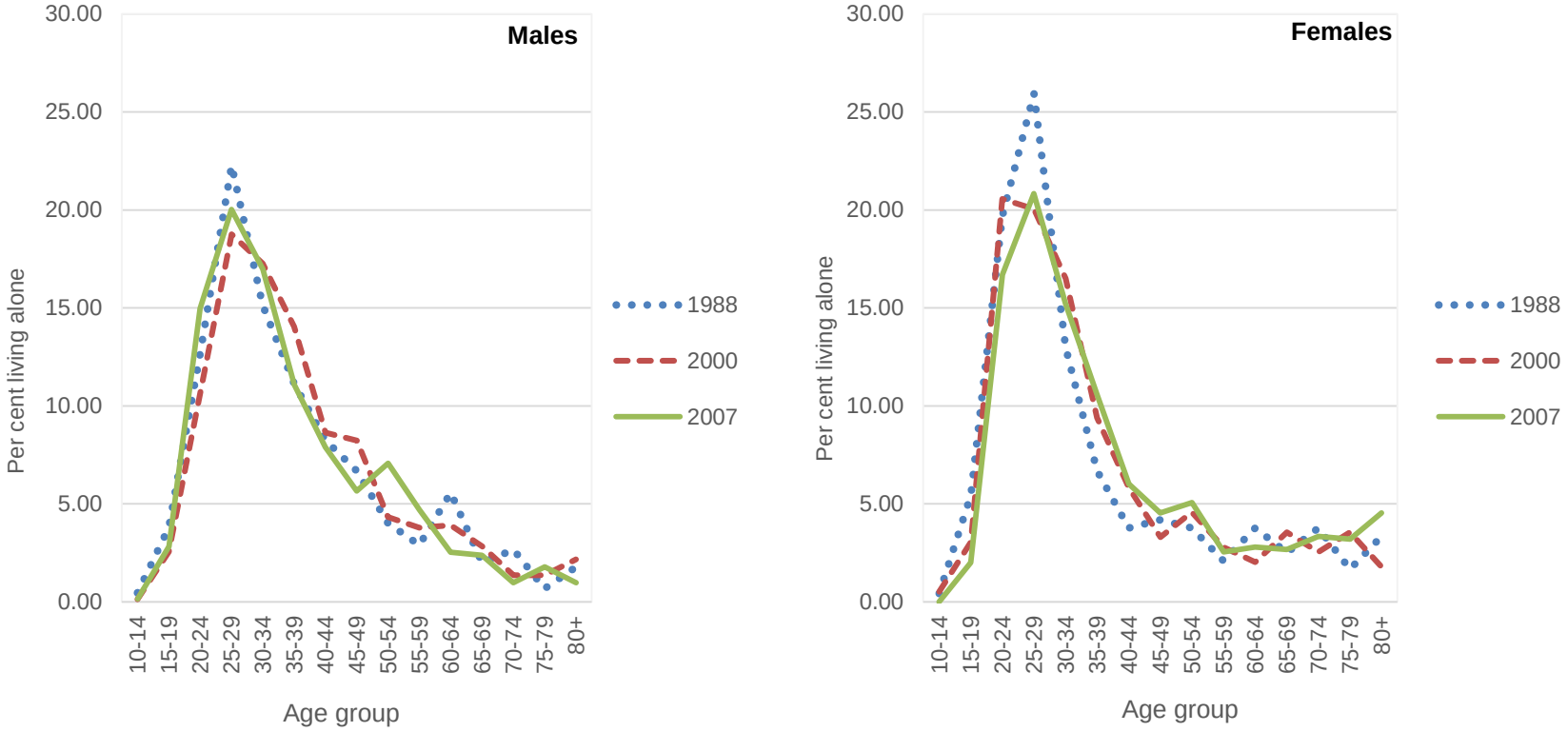


Figure 3.7: Per cent distribution of persons living alone by age and sex in Botswana, Source: 1988 BSDHS, 2000 MICS, and 2007 BFHS

The decline in the average household size over time is also a result of a faster increase in the number of households than the population size during the period 1971-2011. Table 3.5 shows that the number of households grew faster than the population size throughout the census period 1971-2011. The number of households increased more rapidly between 1971 and 1981 (77.9%), followed by an increase of 58.5 per cent between 1981 and 1991 compared to 36.1 per cent increase between 2001 and 2011. The total population also increased more rapidly between 1971 and 1981 (63.9%) than other decades and was slowest between 2001 and 2011 (20.5%).

Table 3.5: Total number of households and population, Censuses 1971-2011

Year	Households		Population*			
	No.	% change	Males	Females	Total	% change
1971	97937	n/a	262120 (45.7%)	311974 (54.3%)	574094	n/a
1981	174264	77.9	443104 (47.1%)	497923 (52.9%)	941027	63.9
1991	276209	58.5	634400 (47.8%)	692396 (52.2%)	1326796	41.0
2001	404706	46.5	813625 (48.4%)	867238 (51.6%)	1680863	26.7
2011	550918	36.1	988958 (48.8%)	1035946 (51.2%)	2024904	20.5

n/a:not applicable. Average household size is total population divided by the total number of households.

Household composition

Household composition is another important aspect of household change. Table 3.6 classifies households by the relationship of household members to the household head. As shown in Table 3.6, it is apparent that households in Botswana includes a much wider group than just the family, namely extended and un-related persons. However, Table 3.6 confirms a decline of extended and unrelated persons in households, but not their disappearance between 1988 and 2007. The proportion of households with other relatives to the household head is 27.8 per cent in 1988, 13.6 per cent in 2000 and 9.0 per cent in 2007. The proportion of households with un- related household member's to the household head decreases over the years1988 to 2007. Living with a spouse/partner to the household head also declined over the years from 36.6 per cent in 1988, 33.6 per cent in 2000 and 28.9 per cent in 2007. The proportion of households with son/daughter to the household head remains notably high over the years: 58.6 per cent in 1988, 55.5 per cent in 2000 and 45.7 per cent in 2007.

Table 3.6: Per cent distribution of households by relationship of each household member to household head, Surveys 1988-2007

	Year		
Relationship to household. head	1988	2000	2007
Head	100.0	100.0	100.0
Spouse/partner	36.6	33.6	28.9
Son/daughter	58.6	55.5	45.7
Grand child	22.9	23.4	20.4
Parent	3.1	2.6	2.5
Brother/sister	12.6	14.7	11.1
Child in law/Step child/fostered	n/a	n/a	2.3
Parent in law	n/a	n/a	0.6
Grand parent	n/a	n/a	0.6
Aunt	n/a	n/a	2.0
Nephew/niece	n/a	11.6	9.6
Other relative	27.8	13.6	9.0
Not related	17.5	9.9	7.4
N	4447	6188	7094

N=Number of households; n/a not applicable since the category was not determined.

Households and children

Previous studies show a link between the decline in the average household size and a decrease in family households with children (Kuijsten, 1995, Sweet and Bumpass, 1987, Bongaarts, 2001). Figure 3.8 presents a distribution of households by number of children aged less than five years in Botswana. The number of households without children in Botswana is relatively high in 2007 (71.7%) compared to 2000 (66.7%) and 1988 (57.1%). A further analysis of the distribution of the households by presence of children and residence showed that the proportion of households with no children aged five years remain highest in urban areas than rural areas. For example in 1988, 63.7 per cent of these children are in urban areas, compared to 70.0 per cent in 2000 and 74.8 per cent in 2007.

The number of households with one to two children aged 0-4 years declined over the years, from 36.9 per cent in 1988, 30.1 per cent in 2000 and 25.8 per cent in 2007. The number of households with 3 and more children aged 0-4 years also declined over the years (Figure 3.8). A further analysis of the households by residence shows that households in rural areas than those in urban areas appear to have more children aged

below five years. For example, in 1988 the proportion of households with 3 and more children is 8.5 per cent in rural areas compared to 3.5 per cent in urban areas. A similar trend in the distribution of households with 3 and more children is observed in 2000 and 2007, but the levels are lower in 2000 (5.2% in rural, and 2.0% in urban) and 2007 (3.6% in rural, and 1.8% in urban).

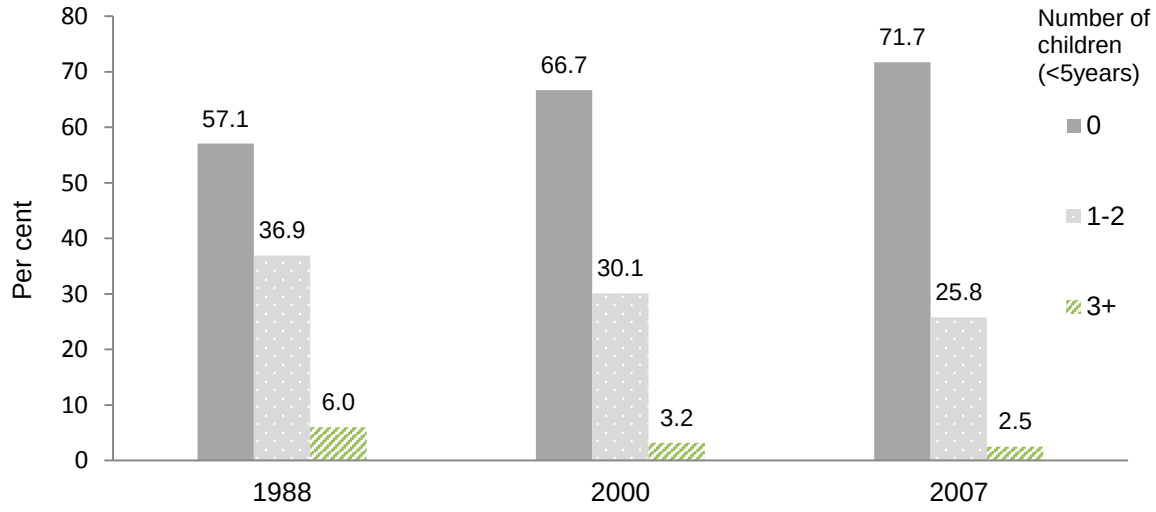


Figure 3.8: Distribution of households by number of children aged less than five years, Source: 1988 BSDHS, 2000 MICS, and 2007 BFHS

Now turning to the number of children aged 5-17 years in a household, Figure 3.9 shows that the proportion of households without children aged 5-17 years increased from 37.0 per cent in 1988 to 53.7 per cent in 2007. Figure 3.9 further shows that the proportion of households with 1-2 children aged 5-17 years remains fairly stable between 1988 and 2007. The proportion of households with 3 and more children declines slightly during the same period. The number of households with children aged 5-17 years also varied by residence. In all the years, the proportion of households with 3 and more children is higher in rural than urban areas. In 1988, the fraction of households with 3 and more children aged 5-17 years is 38.9 per cent in rural areas and 21.4 per cent in urban areas. The proportion of households with the same age group is 28.6 per cent in rural areas and 20.6 per cent in urban areas in 2000. Almost a fifth (19.9%) of children in households with more than three children was in rural areas, compared to 11.9 per cent of such households in urban areas.

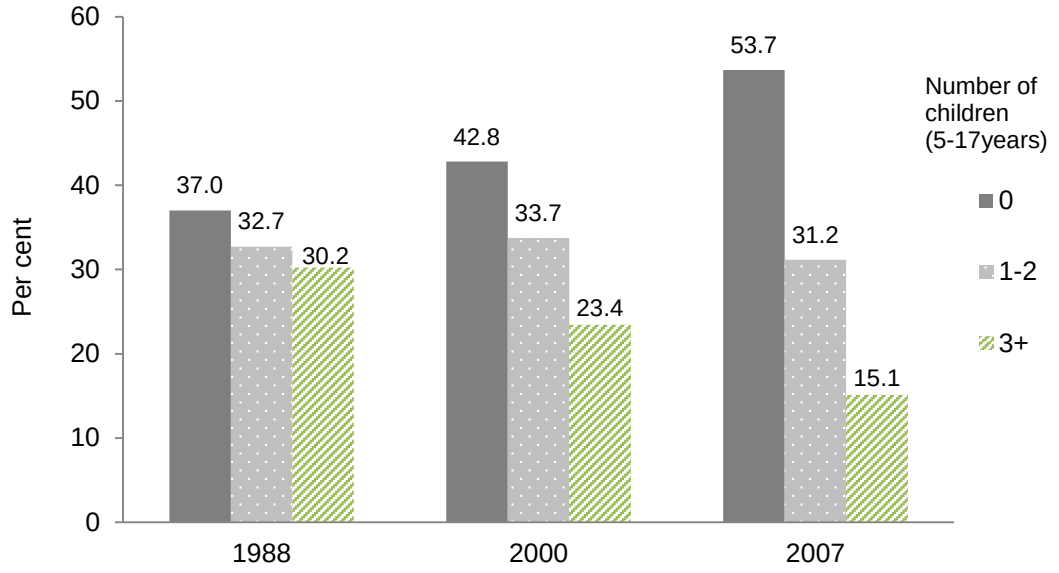


Figure 3.9: Distribution of households by number of older children (5-17 years), Source: 1988 BSDHS, 2000 MICS, and 2007 BFHS

The level and pattern of fertility

In the remainder of this section the analysis is on fertility, marital status and on the interrelationship between fertility, marital status and household change. Table 3.7 shows fertility expressed as the child woman ratio (CWR), crude birth rate (CBR) and total fertility rate (TFR). As shown in Table 3.7 fertility has been declining over the years in Botswana. The child-woman ratio shows a higher number of births to the total of women aged 15-49 years in 1971 than in 1991, 2001 and 2011 (758.8 in 1971, 602.0 in 1991 and 320.6 in 2011). Also in the 1970s and 1980s, Botswana had high crude birth rates; which declined from 45.3 births per 1000 people in 1971 to 39.3 births per 1000 people in 1991 and 25.7 births per 1000 persons in 2011. At the same time the total fertility rate fell sharply from 6.5 children per woman in 1971 to 3.2 children in 1991 and 2.9 children per woman in 2011.

Table 3.7: Measures of fertility in Botswana, Censuses 1971-2011

Fertility measure	Year 1971	1981	1991	2001	2011
CWR (per 1000)	758.8	854.7	602.0	430.0	320.6
CBR (per 1000)	45.3	48.7	39.3	28.9	25.7
TFR (births per woman)	6.5	6.3	3.2	2.6	2.9

CWR- child woman ratio; CBR-crude birth rate; TFR- is total fertility rate and is adjusted.

A further analysis of the CBR and the crude death rate (CDR) shows a relationship between population growth rate and the growth in the number of households between 1971 and 2011. As shown in Figure 3.10, there is a big gap between CBR and CDR in the period 1971-1981 than during 1991 to 2011. This difference indicates more population growth and an increase in the number of households between 1971 and 1981 than between 2001 and 2011. The trend in the population growth and an increase in the number of households is consistent with the already observed declines in the average household size over the census years 1971-2011.

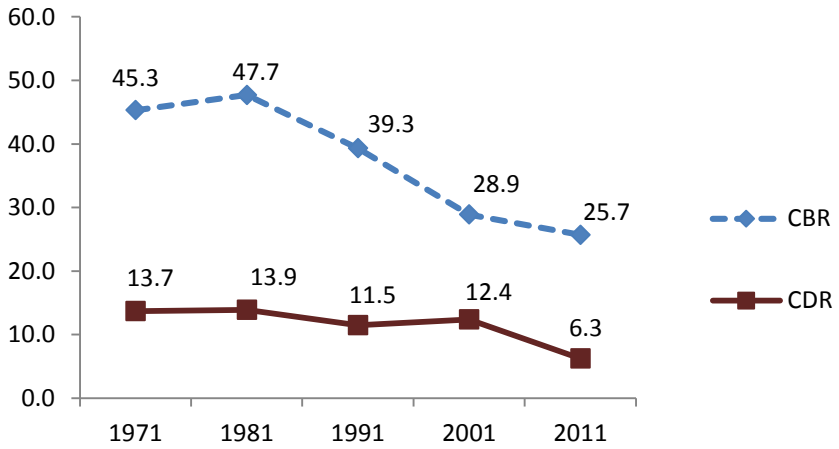


Figure 3.10: Crude birth rate and crude death rate (per 1000 persons), Census data 1971-2011

Figure 3.11 shows the distribution of fertility by age of mothers for the census years 1971-2001. Data for 2011 is not available. In both the censuses, peak fertility occurs among women aged 20-24 years, followed by those aged 25-29 years. The age pattern of fertility for 1971 and 1981 illustrates natural fertility- wherein childbearing begins early, births are observed at every age, and the fertility curve is typical of a society not practicing contraception or induced abortion (Wilson et al., 1988, Rowland, 2003). It can also be seen from Figure 3.11 that high fertility is observed for the years 1971 and 1981 in

comparison to 1991 and 2001. This is illustrated by the convex shape of the fertility curve and the area under the fertility curve being bigger for the former than the latter years.

The stark differences in age at which women have children and the levels in fertility also have implications for the associated differences in household size and composition between 1971 and 2001. For example, the period 1971-1981 is characterized by higher household size and extended households that was largely a consequence of earlier marriage, rapid childbearing and less economic opportunities for women compared to the period between 1991 and 2001.

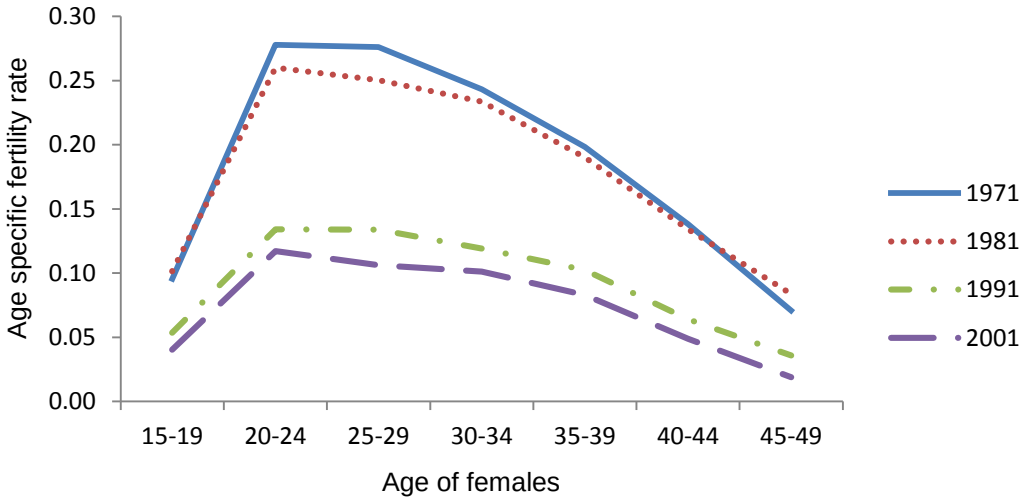


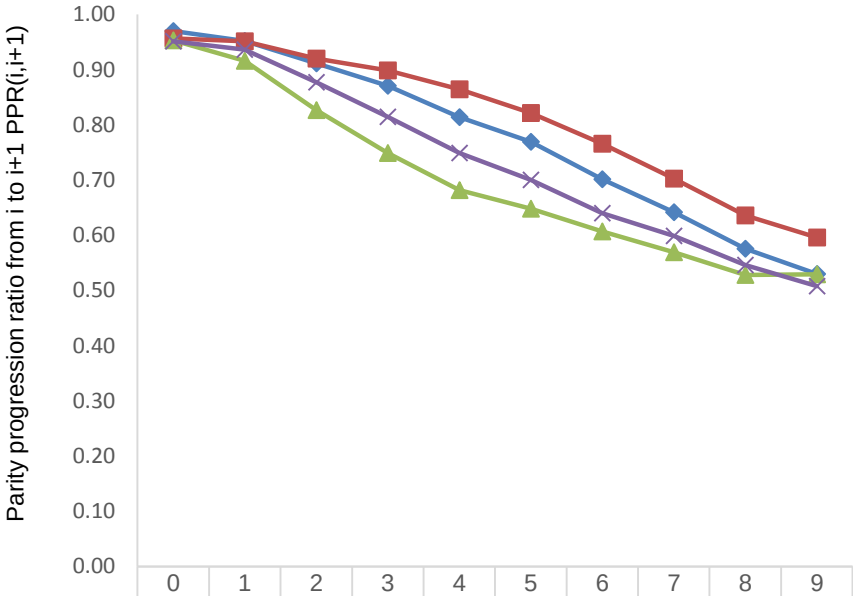
Figure 3.11: Age-specific fertility rates: Botswana, Census data 1971- 2001

Fertility among older women (45-49 and 50-54 years)

A further examination of fertility trends uses parity progression ratios (PPRs) for females aged 45-49 and 50-54 years in 2001 (1952-1956 and 1947-1951 birth cohorts, respectively) and females aged 45-49 and 50-54 years in 2011(1962-1966 and 1957-1961 birth cohorts, respectively).The older women were chosen as their PPRs will be closer to their final fertility, whereas for younger women their PPRs will be smaller and not reflect completed fertility (Newell, 1988). Analysis is also restricted to these groups of women in order to prevent bias in reporting of births for women aged over 54 years.

Figure 3.12 shows the PPRs from zero to the first birth and subsequent progressions up to the tenth birth. From Figure 3.12 there is evidence that the progressions from zero to

first birth and first to second birth are similar between 2001 and 2011. However, there is a difference between 2001 and 2011 with regard to the progression from the second to the third birth. For instance, the progression from the second to the third birth among females aged 45-49 falls from 0.91 to 0.83 between 2001 and 2011. In comparison the progression from the second to the third birth falls from 0.92 to 0.88 among females aged 50-54 years during this period (Figure 3.12). Figure 3.12 also shows that in 2001 there are more females aged 45-49 and 50-54 years progressing to higher parities: 3 and above births compared to women of the same age in 2011, although at 8-9 and 9-10 progressions the pattern is similar again.



	0	1	2	3	4	5	6	7	8	9
2001 Women 45-49 years	0.97	0.95	0.91	0.87	0.81	0.77	0.70	0.64	0.58	0.53
2001 Women 50-54 years	0.96	0.95	0.92	0.90	0.86	0.82	0.77	0.70	0.64	0.60
2011 Women 45-49 years	0.95	0.92	0.83	0.75	0.68	0.65	0.61	0.57	0.53	0.53
2011 Women 50-54 years	0.95	0.94	0.88	0.81	0.75	0.70	0.64	0.60	0.55	0.51

Figure 3.12: Parity progression ratios for women aged 45-49 and 50-54 years in 2001 and 2011, Source Census data 2001 and 2001

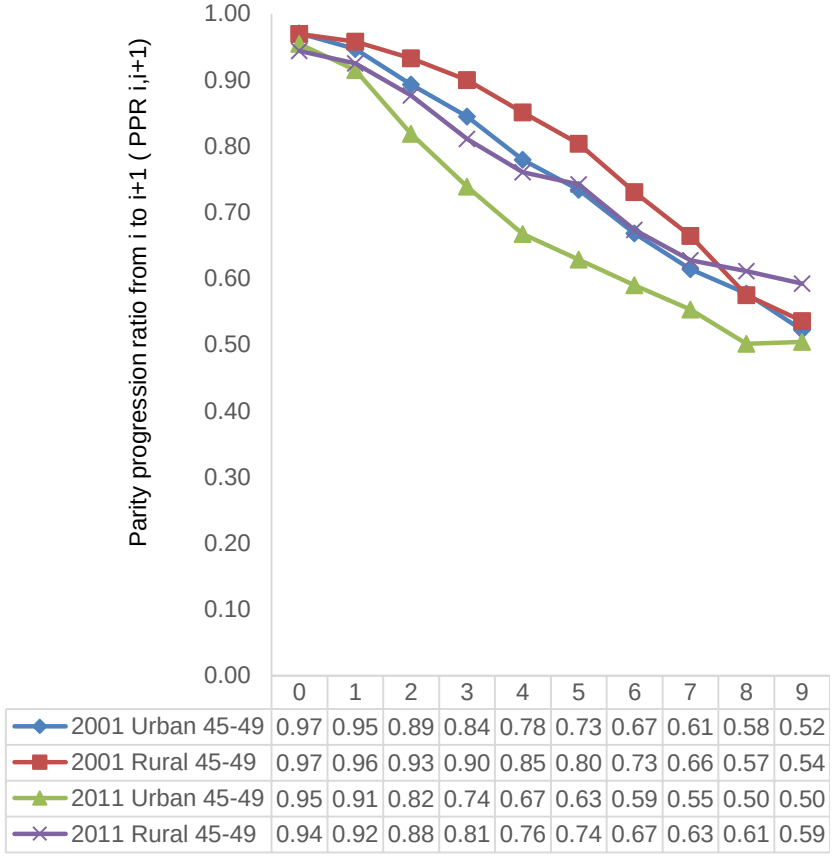
Concerning which group of women have the greatest decline in fertility, Figure 3.13 examined the parity progression ratios for females ages 45-49 and 50-54 in 2001 and 2011 by residence. There is a small disparity in progression from zero to first birth between women in urban and rural areas. However, considering progression to higher parities, a clear gradient emerges by residence, wherein women in urban areas experience a greater decline in progression to third, fourth and higher parities than those in rural areas. The declines are much greater in 2011 than 2001. For example, for women

aged 50-54 years, the 2-3 PPRs in 2001 is 0.91 in urban areas and 0.93 in rural areas. While 2-3 PPRs among the women of the same age in 2011 is 0.87 in urban areas and 0.90 in rural areas (Figure 3.13).

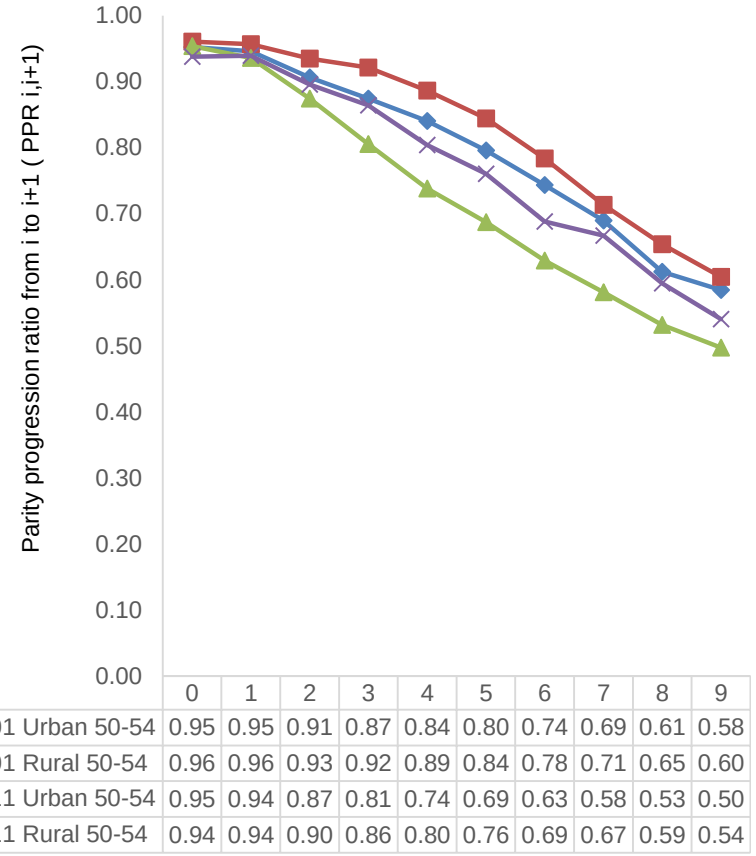
Figure 3.14 presents the results of the parity progression ratios for females aged 45-49 and 50-54 in 2001 and 2011 by level of education. It is apparent that the proportion of women who have a first and second child remained more or less constant in 2001 and 2011. However in 2011 a pattern emerge for 2-3 PPRs whereby the lowest proportion of women having a third child is found in highly educated women. In 2011, the 2-3 PPRs for women aged 50-54 years and with tertiary education is 0.76, compared to 0.82 for those with secondary education, 0.91 for those with primary education and 0.92 for those with no education (Figure 3.14).

Figure 3.14 also shows that low educated women (those with primary and no education) progress faster to higher parities than women with secondary and tertiary education. For example, there is a higher decline in the fourth and fifth parity births among women with higher education (secondary and tertiary education) than those with primary or no education (Figure 3.14). These declines appear more relevant to the fertility pattern in 2011 than in 2001. Finally for higher parities 6 and above, the declines appear to converge for women with secondary and tertiary education (Figure 3.14).

Given the results on the PPRs, it is clear that the urban/rural and educational differences that emerge in fertility patterns among women in Botswana appear to revolve around the third, fourth and fifth births.



	0	1	2	3	4	5	6	7	8	9
2001 Urban 45-49	0.97	0.95	0.89	0.84	0.78	0.73	0.67	0.61	0.58	0.52
2001 Rural 45-49	0.97	0.96	0.93	0.90	0.85	0.80	0.73	0.66	0.57	0.54
2011 Urban 45-49	0.95	0.91	0.82	0.74	0.67	0.63	0.59	0.55	0.50	0.50
2011 Rural 45-49	0.94	0.92	0.88	0.81	0.76	0.74	0.67	0.63	0.61	0.59



	0	1	2	3	4	5	6	7	8	9
2001 Urban 50-54	0.95	0.95	0.91	0.87	0.84	0.80	0.74	0.69	0.61	0.58
2001 Rural 50-54	0.96	0.96	0.93	0.92	0.89	0.84	0.78	0.71	0.65	0.60
2011 Urban 50-54	0.95	0.94	0.87	0.81	0.74	0.69	0.63	0.58	0.53	0.50
2011 Rural 50-54	0.94	0.94	0.90	0.86	0.80	0.76	0.69	0.67	0.59	0.54

Figure 3.13: Parity progression ratios by residence for women aged 45-49 and 50-54 years in 2001 and 2011

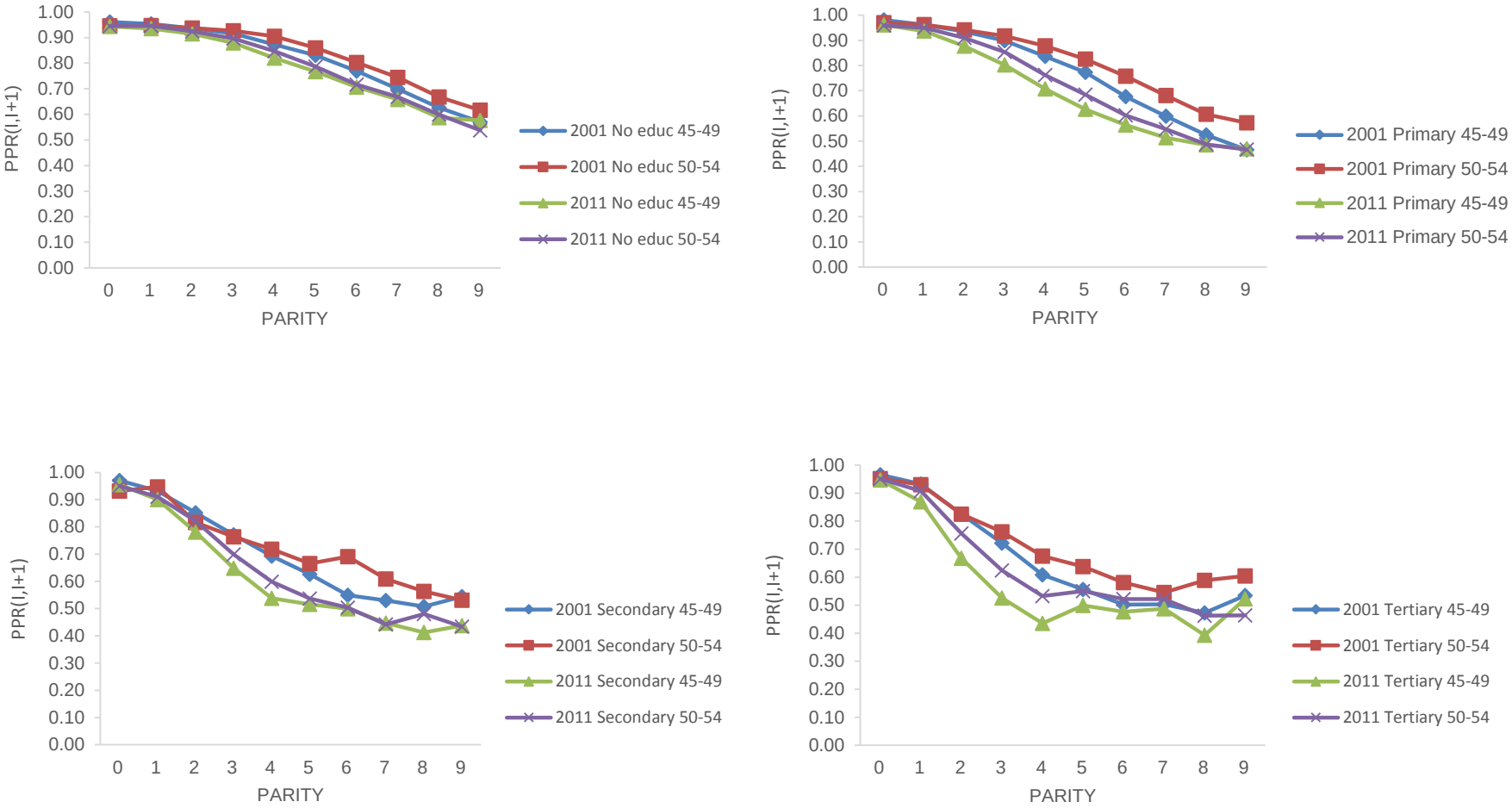


Figure 3.14: Parity progression ratios by level of education for women aged 45-49 and 50-54 years in 2001 and 2011

Finally, Table 3.8 shows the mean parity for women aged 45-49 and 50-54 years in 2001 and 2011 by residence and level of education, respectively. For all the cohorts the mean number of children ever born is higher in rural than urban areas. In 2011, women aged 50-54 years and in urban areas had an average of 4.5 children compared to 5.0 children among those aged 50-54 years and in rural areas. A similar pattern was observed with the other cohorts.

With regard to completed family size by level of education, there is a much higher level of fertility among women with no education, with primary education compared to those with secondary and tertiary education. For example in 2001, women aged 50-54 years and had no education had 5.4 children. This compares with 4.8 children among women with primary school education, 3.6 children among those with secondary education and 3.3 children among those with tertiary education. The differential by education is even larger in 2011 than in 2001 (Table 3.8).

Overall, the results in Table 3.8 indicate a fall in fertility between 2001 and 2011 in terms of the completed family size among both the women aged 45-49 and 50-54 years. Among women aged 45-49 years, the completed family size fell from 5.3 children in 2001 to 4.0 children in 2001. In comparison, among the women aged 50-54 years, their completed family size fell from 5.7 children in 2001 to 4.6 children in 2011.

Table 3.8: Distribution of completed family size of women aged 45-49 and 50-54 years by residence and education, 2001 and 2011

	2001		2011	
Characteristic	45-49 years	50-54 years	45-49 years	50-54 years
Residence				
Urban	4.9	5.3	3.9	4.5
Rural	5.7	6.1	4.6	5.0
Total	5.3	5.7	4.0	4.6
Education				
No education	5.9	6.1	5.1	5.4
Primary	5.5	6.0	4.3	4.8
Secondary	4.2	4.1	3.4	3.6
Tertiary	3.8	4.0	2.9	3.3
Total	5.3	5.7	4.0	4.6

Marital status

Household change can also be an outcome of the changes in marital status of individuals. It can be seen from Figures 3.15 that there has been a steady decline in the proportion currently married among males and females aged 12 years and above. Almost half of the males were married in 1971 (47.1%), and this fell to 18.8 per cent in 2011. Similarly, for women 42.9 per cent in 1971 and 17.9 per cent in 2011. Most noticeably the number of single individuals has increased over the years, from 44.0 per cent in 1971 to 58.1 per cent in 2011 among males (Figure 3.15). Among females the trend is similar (Figure 3.15). Underlying the change in never married individuals is an increase in cohabitation, and a drop in the proportions ever marrying. For example, in 1991, the per cent cohabiting among males was 12.2 per cent, and it increased to 20.6 per cent in 2011. The percentage change for females was similar (Figure 3.15).

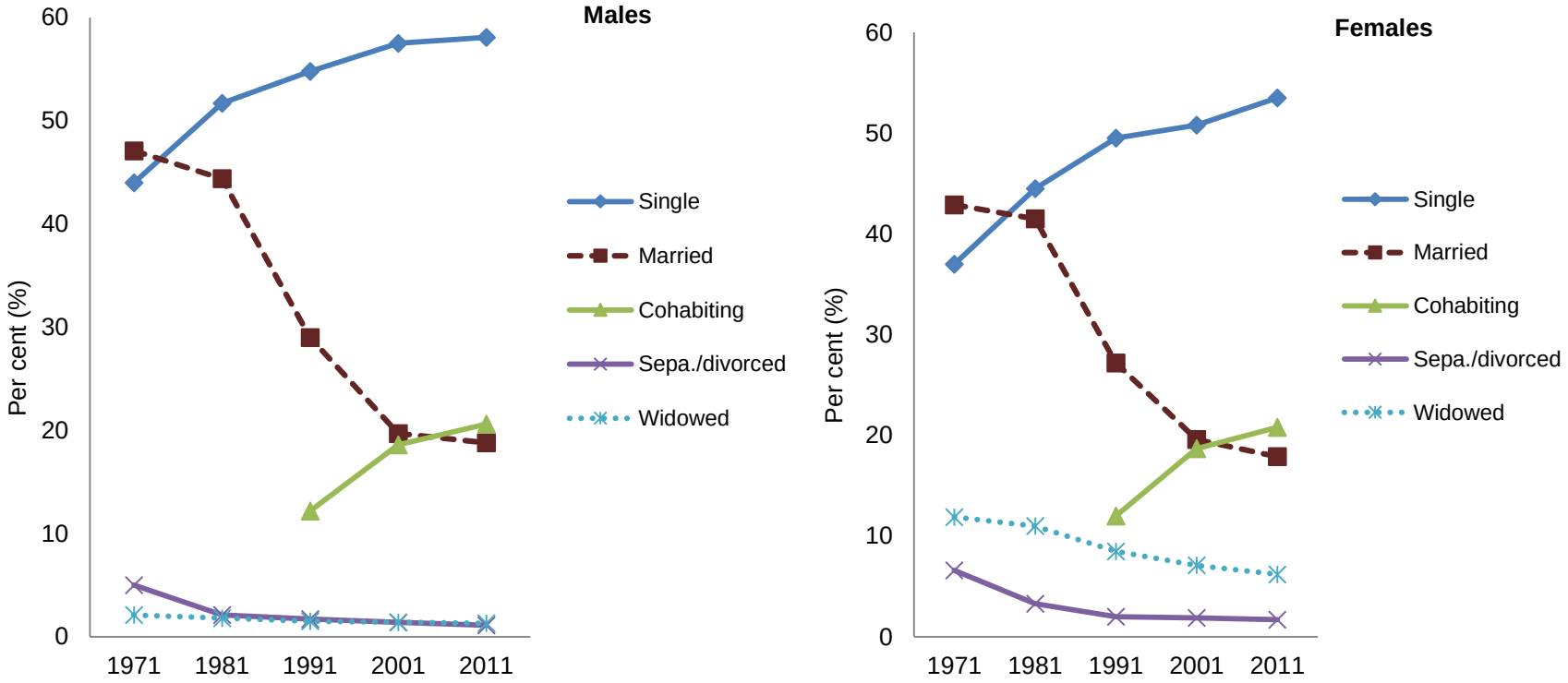


Figure 3.15: Marital status among males and females in Botswana, Source: Census data 1971-2011

Another change to consider is in marital status by age and sex. As can be seen from Table 3.9 the number of people never married has been increasing over the years, while those married decrease over time. For examples among males, those aged 15-19 were most likely to be single (95.1 % in 1971, 97.7% in 1991, 98.8% in 2001 and 96.8% in 2011). A similar pattern in the percentage of people never married at ages 15-19 between 1971 and 2011 is observed among females. By middle age (35-39 years), there is a fall in the percentage of males or females currently married. Almost seventy per cent (69.5%) of the males aged 35-39 years were married in 1971, and this falls to 26.5 per cent in 2011. Similarly, 66.7 per cent of females aged 35-39 are currently married in 1971, and this decreases to 29.6 per cent in 2011.

At the same time Table 3.9 shows a trend towards higher levels of cohabitation between 1991 and 2011. The percentage cohabiting among males aged 30-34 increases from 24.0 per cent in 1991 to 36.3 per cent in 2011, and it increases from 18.7 per cent in 1991 to 34.1 per cent for females in 2011. The observed changes in the proportion of adults who remain single and those cohabiting between 1971 and 2011 in Botswana likely reflect an array of socio-economic choices to set up one's own household, falling marriage rates and the role of cohabitation on marriage. On the latter, evidence show that in much of Europe and North America the increase in cohabitation is coupled with people marrying later, fewer lifetime marriages and an increase in age at first marriage by almost 3 years since the 1970s (Haskey, 1995, Allan and Crow, 2001b).

Table 3.9 also indicates that widowhood is common among older persons, especially women. In 1971, 59.2 per cent of women aged 65 years and above were widowed, compared to 10.0 per cent males. In 2011, 43.8 per cent of females aged 65 years and above were widowed compared to 11.4 per cent of the males of the same age. A possible explanation to sex differences in widowhood is more mortality improvements for women than men throughout the twentieth century, and even during the HIV and AIDS era. Life expectancies at birth were 52.5 years for men and 58.6 years for females in 1971. In contrast, life expectancy was 52.0 years for men and 57.4 years for females in 2001 (see Appendix 3A).

Table 3.9: Per cent distribution of marital status by age group and sex in Botswana, Censuses 1971-2011

Year	Age group	Never married		Currently married		Cohabiting		Sepa/divorced		Widowed		Total (N)	
		M	F	M	F	M	F	M	F	M	F	M	F
1971	12-14	100.0	100.0	0.0	0.0	..	..	0.0	0.0	0.0	0.0	130533	133997
	15-19	95.1	87.3	0.8	8.4	..	..	3.9	4.0	0.2	0.3	24243	30546
	20-24	88.0	56.4	8.3	38.1	..	..	3.5	4.8	0.2	0.7	13130	24118
	25-29	61.8	36.7	33.9	56.0	..	..	3.8	5.8	0.4	1.6	11691	19318
	30-34	36.5	27.2	58.4	62.8	..	..	4.5	6.9	0.7	3.0	10834	15793
	35-39	24.4	20.3	69.5	66.7	..	..	5.3	8.0	0.8	4.9	10097	14530
	40-44	16.0	16.8	76.8	65.6	..	..	5.9	8.9	1.3	8.7	9357	11847
	45-49	12.2	13.5	79.2	64.5	..	..	6.3	9.4	2.3	12.6	9478	11669
	50-54	9.3	10.3	80.7	59.6	..	..	7.2	9.8	2.8	20.3	7791	8371
	55-59	8.0	8.8	81.2	54.8	..	..	7.0	9.4	3.7	26.9	6305	7189
	60-64	7.0	7.9	80.4	45.2	..	..	8.0	8.9	4.6	38.0	5189	5985
	65+	5.3	6.3	77.6	26.4	..	..	7.1	8.0	10.0	59.2	13584	16978
1991	12-14	98.6	98.7	0.8	0.7	0.5	0.4	0.1	0.1	0.0	0.1	50218	53460
	15-19	97.7	94.6	1.2	1.8	0.9	3.3	0.1	0.1	0.1	0.3	71527	78329
	20-24	91.2	73.1	2.8	10.4	5.8	15.7	0.1	0.4	0.1	0.4	52706	61566
	25-29	71.9	52.7	9.6	25.1	18.0	20.0	0.3	1.3	0.1	0.8	43300	53059
	30-34	48.2	39.4	26.3	37.6	24.0	18.7	1.3	2.4	0.2	1.8	33968	42449
	35-39	30.8	31.9	43.3	44.4	22.9	16.6	2.4	3.8	0.5	3.3	27998	34522
	40-44	21.1	25.9	52.9	48.9	21.3	14.3	3.6	4.7	1.0	6.1	21177	24150
	45-49	15.6	22.9	59.5	49.2	18.9	13.0	4.3	5.4	1.7	9.5	17184	19898
	50-54	12.8	20.3	63.9	49.2	16.6	10.1	4.4	5.6	2.3	14.8	15267	17089
	55-59	9.9	17.8	68.0	47.3	13.9	7.9	4.7	5.7	3.5	21.3	12191	14726
	60-64	8.5	15.6	69.7	41.9	12.3	6.2	4.8	6.0	4.8	30.2	10071	12047
	65+	10.1	11.8	65.0	28.1	10.5	4.6	4.3	4.3	10.1	51.2	28511	35701
2001	12-14	99.7	99.7	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	60644	61627
	15-19	98.8	94.7	0.1	0.3	1.1	5.0	0.0	0.0	0.0	0.0	99293	103856
	20-24	89.3	71.2	1.2	4.2	9.3	24.2	0.1	0.3	0.0	0.1	79785	90241
	25-29	68.9	53.0	5.4	14.2	25.4	31.6	0.3	0.6	0.1	0.6	71422	75682
	30-34	48.3	40.6	17.6	27.4	33.2	29.0	0.6	1.4	0.3	1.6	54674	58566
	35-39	34.7	33.8	30.2	35.2	33.0	25.3	1.3	2.7	0.7	3.0	44371	50557
	40-44	24.5	29.7	42.6	39.6	28.9	21.2	2.6	4.3	1.4	5.2	35021	41039
	45-49	18.7	26.7	50.6	42.3	25.2	17.5	3.7	5.1	1.9	8.4	29427	33831
	50-54	15.0	23.9	55.8	44.0	22.0	14.0	4.5	5.3	2.7	12.7	21461	23320
	55-59	12.6	22.2	59.3	43.8	20.0	11.4	4.6	5.4	3.5	17.2	15578	17562
	60-64	11.1	20.7	61.7	42.2	18.0	8.5	4.8	4.8	4.4	23.9	13308	15193
	65+	9.0	15.1	63.4	30.6	12.6	4.9	4.3	3.8	10.6	45.6	34345	48724
2011	12-14	98.4	98.8	0.6	0.5	1.0	0.7	0.0	0.0	0.0	0.0	60020	59837
	15-19	96.8	92.9	0.8	0.9	2.3	6.1	0.0	0.0	0.0	0.0	104687	105805
	20-24	84.9	67.1	1.8	3.9	13.0	28.5	0.2	0.4	0.1	0.1	96943	102942
	25-29	64.7	50.2	5.9	11.8	29.0	37.2	0.3	0.6	0.1	0.2	100714	106527
	30-34	47.7	42.0	15.0	21.8	36.3	34.1	0.6	1.2	0.3	0.8	84126	85920
	35-39	36.9	37.2	26.5	29.6	35.1	29.0	1.1	2.0	0.4	2.1	68123	66697
	40-44	29.2	34.3	37.0	34.3	30.9	24.0	1.8	3.2	1.1	4.2	48530	50444
	45-49	24.2	32.3	42.9	36.4	28.5	20.1	2.7	4.1	1.8	7.1	37697	44289
	50-54	19.7	31.0	49.3	37.4	24.6	15.0	3.5	5.1	2.9	11.4	29582	36528
	55-59	15.9	28.9	54.2	37.5	21.5	12.1	4.3	5.2	4.1	16.3	24243	29622
	60-64	14.1	26.1	56.3	36.4	20.0	9.1	4.1	4.8	5.5	23.6	17229	20191
	65+	14.5	21.6	55.8	26.1	14.7	5.4	3.6	3.2	11.4	43.8	41281	58965

..Cohabiting or living together is not recorded as a separate category in 1971. Currently married refers to formal unions (civil and customary marriages). Currently married and sepa/divorced are not overlapping categories. M=male; F=female; Total (N) =Row total. Census data for 1981 is missing. Although individuals under 15 years are minors, age category 12-14 years is included as child marriages have been recorded in Botswana and occur under the customary legal system (Republic of Botswana, 2011). The legal age of marriage in Botswana is 21 years (without parental consent) and 18 years with parental consent.

Mean number of children born to women by marital status

An analysis of the mean number of children ever born to women by marital status between 1991 and 2001 indicates higher fertility among widowed, currently married, separated or divorced than single or cohabiting women (Figure 3.16). For example widowed women are likely to have more children (5.7 children in 1991 and 5.8 children in 2001), followed by married women (5.0 children in 1991 and 4.8 children in 2001), the separated/divorced (4.8 children in 1991 and 4.6 children in 2001) and cohabiting women (3.4 children in 1991 and 2.9 children in 2001). Lower levels of fertility are found among cohabiting (3.4 children in 1991 and 2.9 children in 2001) and single women (1.2 children in both 1991 and 2001). This pattern of fertility across the different marital groups might be expected as women in unions are likely to have larger families than those who are single. In addition, widowed and married women may be older and have completed family building compared to cohabiting, separated/divorced and single women. However, this can be confirmed by standardizing the results across the years on age and marital distributions of one of the populations.

Figure 3.16 also shows that the mean number of children born to women has decreased over time for all the marital groups, except for widowed women.

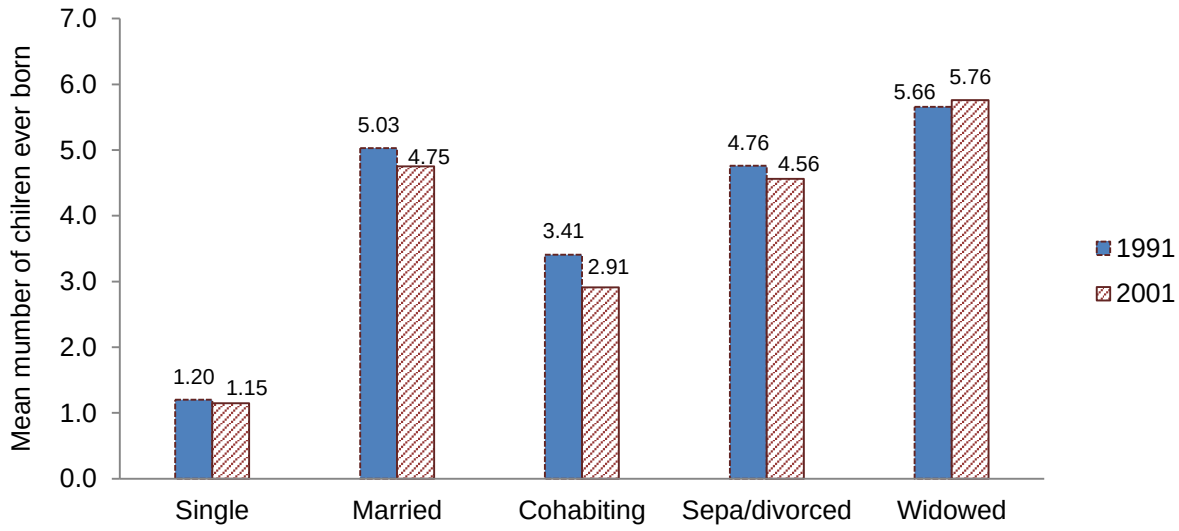


Figure 3.16: Mean number of children ever born to women aged 12 and over by marital status, Source: Census data 1991-2001

A further analysis of fertility that removes the influence of age and marital status distribution on the number of children born to women was performed using direct standardization. The results on standardization are relevant when comparing the mean number of children across marital types because if the groups differ in composition or have age specific fertility rates, then what was observed in Figure 3.16 may be partly due to age and marital differences. The procedure for standardizing is the same as used in Rowland (2003) for more than one variable. The 2001 age-marital status distribution was used as the standard population. It was chosen since its distribution is representative of the middle of the time period for which census data on age, marital status, total number of women by age group and the number of births to women was available (Censuses 1991, 2001 and 2011).

Table 3.10 presents the results from standardization. The mean number of births in 2001 is 2.5, and on standardizing on age and marital status distribution of this population, the mean number of children remains at 2.8 children in 1991. Consequently, if age-marital status distributions in 2001 and 2011 were identical, then the mean number of children would be 2.1. From these results, it appears there is no influence of age and marital status composition on the mean number of births, although there is a decrease in mean number of children from 2.3 to 2.1 children in 2011 (Table 3.10).

A further comparison of the crude and standardized mean number of children by marital type also confirms that there is no confounding from age and marital status distributions. As shown in Table 3.10 there are slight differences in the mean number of children born by marital type in 2001 compared to the standardized children ever born by marital type in 1991 or 2011. These findings therefore confirm that there is no influence of age-marital distributions on the observed differences in fertility between 1991 and 2011. The small differences observed in the original children ever born in 2001 and standardized children ever born in 1991 and 2011 partly represent other compositional factors other than age and marital status composition.

Table 3.10: A comparison of unstandardized and standardized mean number of births to women, Censuses 1991-2011

Census Year	Children ever born (unstandardized)						Children ever born (standardized)					
	Single	Currently married	Cohabiting	Sep./Divorced	Widowed	Overall	Single	Currently married	Cohabiting	Sep./Divorced	Widowed	Overall
1991	1.2	5.0	3.4	4.8	5.7	2.8	1.4	5.4	3.4	5.0	5.7	2.8
2001	1.1	4.7	2.9	4.5	5.7	2.5	1.1	4.7	2.9	4.5	5.7	2.5
2011	1.2	3.8	2.5	3.7	5.6	2.3	1.0	3.8	2.5	3.7	5.5	2.1

Children ever born (standardized): denotes standardized mean number of children born to women on age and marital status distributions of the population in 2001.
The standardized children ever born in 2001 remain the same as unstandardized figures because age-marital status distribution of 2001 was used as the standard.
Further details on standardization are found in Appendix 3B and 3C.

Interrelationships of fertility and marital status on household change

A sense of the interrelationships between fertility, marital status and household change over time are obtained by analyzing the number of children by age of household head and marital status of the household head. This section investigates the interrelationships of fertility (defined here as the number of children in a household) and marital status of the household head, linking this to household change at a country level. Due to the data available, the analysis uses the household head and not the parent to account for the changes in fertility in a household between 1988 and 2007. The person referred to as a household head is a male or female adult household member, and who is a reference person to all other household members. All of the households analysed have a head, and both the census and the surveys asked household members to self-define the head of the household (Central Statistics Office, 2000). Usually the oldest male was chosen, but this is not consistent in all households. However, since the interest is on household change, the head of household informs about the characteristics of the household. For example, the type of household (traditional, multi-generational, extended, nuclear, one person, number of children in a household etc), and household size, all of which can be used to assess changes over time.

Table 3.11 shows that an increasing percentage of households, regardless of age of the household head, have no children aged 0-4 years. In addition, having no children under age 5 is higher among households with younger than older household heads. Figure 3.17 further shows that fertility is falling the most among households with younger than older heads between 1988 and 2007. For example, among households with heads aged under 25 years, the percentage with no children increases from 81.3 per cent in 1988 to 87.5 per cent in 2007. For households with heads aged 25-39 years, the fraction of household with no children aged 0-4 years increases from 58.3 per cent in 1988 to 73.5 per cent in 2007. For those with household heads aged 40-54 years; the increase is from 50.9 per cent in 1988 to 68.9 per cent in 2007.

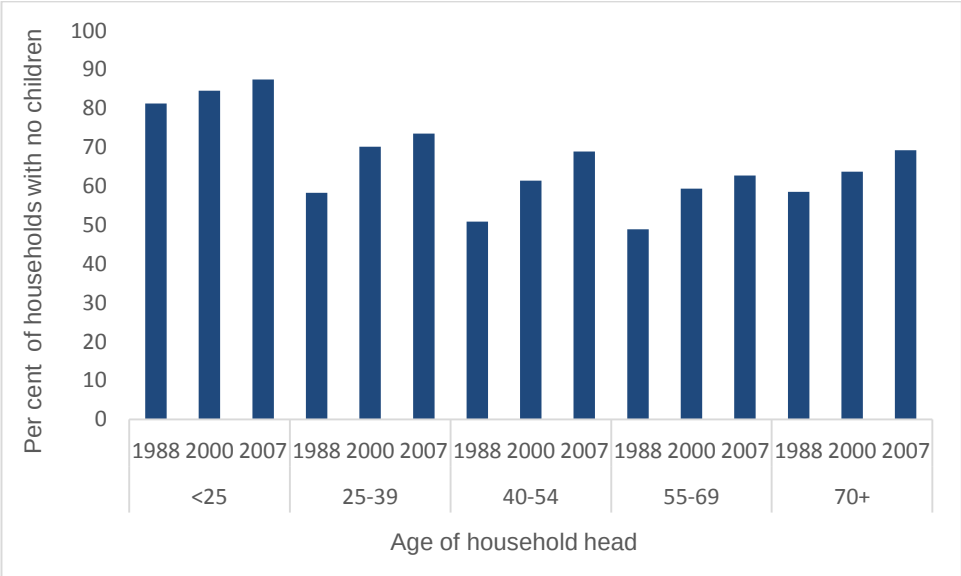


Figure 3.17: Per cent of households with no children by age of the household head, Source: 1988 BSDHS, 2000 MICS, and 2007 BFHS

About households with children, Table 3.11 shows that between 1988 and 2007, there is a decrease in the percentage of households with at least one child aged 0-4 years. This decrease differs by age of the household head. The percentage point fall of households with at least one child aged 0-4 years is highest for heads aged 40-54 years (36.7%), followed by a 36.4 per cent decrease among households with heads aged 25-39 years, and a 33.1 per cent decrease among households with heads aged under 25 years. This compares with a 27.0 per cent decrease for households with heads aged 55-69 years and 25.7 per cent decrease in households where the head is aged 70 years and older.

Table 3.11 also indicates a decrease in the number of households with three or more children aged 0-4 years between 1988 and 2007. Households where the head is older than younger have the largest reductions. The number of households with children (3 and above) aged 0-4 years decrease by 6.4 per cent among households with heads aged 55-69 years, followed by 5.0 per cent where the household heads is 70 years and older. In comparison, a 0.9 per cent decrease is noted for households with heads aged under 25 years and a 2.0 per cent decrease in households where the head is aged 25-39 years.

The pattern for households with children aged 5-17 years is the same as for households with children under five years. Households with no children aged 5-17 years increase

between 1988 and 2007. The number of households with more than two children aged 5-17 decrease over time. Table 3.11 also indicates that the fraction of households with many children (5 and more children) aged 0-17 years is much smaller for younger heads than older heads.

Table 3.11: Per cent distribution of households with number of children aged 0-4 years, 5-17 years and 0-17 years by age of household head, Surveys 1988, 2000 and 2007

	Age group of household head														
	<25			25-39			40-54			55-69			70+		
Year	1988	2000	2007	1988	2000	2007	1988	2000	2007	1988	2000	2007	1988	2000	2007
Number of children aged 0-4 years															
0	81.3	84.6	87.5	58.3	70.2	73.5	50.9	61.4	68.9	49.0	59.4	62.7	58.6	63.8	69.2
1	13.4	11.1	9.3	24.9	21.0	19.2	26.4	25.0	20.2	25.9	23.7	21.2	20.6	19.1	19.6
2	3.5	3.8	2.3	13.1	7.2	5.7	16.0	10.2	8.3	14.2	10.5	11.5	11.7	11.0	7.0
3+	1.9	0.6	0.9	3.6	1.6	1.6	6.7	3.4	2.7	10.9	6.4	4.6	9.1	6.1	4.2
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100	100.0	100.0	100.0	100.0	100.0	100.0
N	427	532	750	1706	2377	2707	1162	1709	1861	768	916	1076	384	654	699
Number of children aged 5-17 years															
0	63.9	63.9	75.9	45.7	51.9	63.3	23.8	28.9	40.5	25.7	35.0	41.7	30.7	40.2	46.4
1	15.2	15.6	11.2	17.1	18.6	16.1	16.0	19.0	21.5	19.7	18.0	18.6	17.2	16.8	17.2
2	10.8	8.3	7.2	14.5	14.4	12.0	18.1	19.3	18.1	16.4	16.6	15.5	17.5	14.2	12.7
3-4	6.1	9.6	5.1	17.1	12.2	7.2	30.3	25.5	16.4	26.8	21.2	17.4	24.2	19.9	18.5
5+	4.0	2.6	0.7	5.6	2.8	1.4	11.9	7.4	3.6	11.5	9.2	6.8	10.4	8.9	5.3
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	427	532	750	1706	2377	2707	1162	1709	1861	768	916	1076	384	654	699
Number of children aged 0-17 years															
0	55.7	57.0	70.0	38.0	44.9	55.2	20.2	24.2	35.5	21.6	29.7	35.3	27.6	34.1	40.8
1	17.3	17.7	13.5	12.7	16.2	15.4	12.8	16.0	17.7	12.5	14.2	14.1	13.0	14.7	15.9
2	12.7	9.0	8.1	13.9	15.5	12.4	12.5	16.0	16.8	12.8	14.9	16.4	15.1	12.2	12.3
3-4	9.4	12.6	6.4	22.0	16.7	12.7	26.9	27.0	20.4	25.9	21.7	19.2	22.1	21.0	17.6
5+	4.9	3.8	2.0	13.4	6.7	4.3	27.5	16.8	9.6	27.2	19.5	15.0	22.1	18.0	13.5
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	427	532	750	1706	2377	2707	1162	1709	1861	768	916	1076	384	654	699

The findings on the number of children and age of the household head point to the differences in the overall household size and membership of these households. Since it is unlikely that household heads aged over 70 years will have children of their own under age five, the presence of children aged below five years in these households suggest multigenerational households. While a reduction of children aged below five years in household with older heads results from the decline in fertility and childbearing between 1988 and 2007, although the proportion of these households remains constant. They are 8.6 per cent of households with a head aged over 69 years in 1988, rising to 10.6 per cent in 2000 and 9.9 per cent in 2007.

An analysis of the average household size by age of household head between 1988 and 2007 indicates that younger household heads (<25 years) reside in smaller, less extended households compared to older household heads. The size of households in which younger household heads reside is 2.6 persons in 1988 and 2.5 persons in 2007 (Table 3.12). In 1988, household heads aged 70 years and above are found in larger households with 5.8 persons, and this remained almost constant through 2007 where the average household size is 5.5 persons (Table 3.12). Finally, it is possible that younger household heads are in the early stages of family building, as compared to older heads who may have completed family building, thus higher number of children in their households.

Table 3.12: Average household size by age of the household head, Surveys 1988, 2000 and 2007

	Average household size (persons)		
Age of household head	1988	2000	2007
<25	2.6	2.1	2.5
25-39	4.1	2.8	3.5
40-54	5.8	4.1	5.2
55-69	6.1	4.9	5.6
70+	5.8	4.7	5.5

In Table 3.13, the distribution of households with children aged 0-4, 5-17 and 0-17 years is shown by marital status of the household head for 2000 and 2007. The data for 1988 is not available, as the survey did not capture marital status of individuals. Households headed by never married individuals show an increase in the percentage that there are

no children aged 0-4 years from 79.3 per cent in 2000 to 82.9 per cent in 2007, while those of currently married increase from 57.6 per cent in 2000 to 63.3 per cent in 2007 (Table 3.13). The increase in the proportion of households with no children aged 0-4 years was equally the same for cohabiting household heads (58.7% in 2000 and 66.6 % in 2007) and it increases from 60.1 per cent in 2000 to 65.0 per cent for widowed household heads. Table 3.13 shows that more children 0-4 years are found in households with currently married heads, followed by households headed by those that are widows, and those that are cohabiting.

Table 3.13 also shows that households with many children (5 or more children in a household) aged 5-17 years are likely to be in households where the head is currently or formerly married, rather than never married. Further, Table 3.13 shows that the decrease in having no children 0-17 years is associated with an increase in childless households across all marital statuses and a reduction in households with higher numbers of children (having 3-4 or 5 children and more), rather than having one or two children aged 0-17 years. From Table 3.13, the fraction of households with many children drops between 2000 and 2007, while the fraction of households with no children increases over time.

Table 3.13: Per cent distribution of households with number of children aged 0-4 years, 5-17 years and 0-17 years by marital status of household head, Surveys 2000 and 2007

	Marital status of household head									
	Never married		Currently married		Cohabiting		Separated/divorced		Widowed	
Year	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007
Number of children aged 0-4 years										
0	79.3	82.9	57.6	63.3	58.7	66.6	67.5	78.8	60.1	65.0
1	13.2	11.4	27.3	25.3	28.9	22.0	21.7	12.6	22.8	21.5
2	5.5	4.0	11.2	8.5	9.8	8.7	8.4	6.8	11.0	9.7
3+	2.0	1.7	4.0	3.0	2.6	2.8	2.4	1.8	6.1	3.9
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	2399	2522	1963	1867	1025	1743	166	222	626	736
Number of children aged 5-17 years										
0	54.5	66.0	31.1	40.8	44.9	55.4	41.6	54.1	32.3	40.2
1	17.0	15.0	17.9	20.0	19.4	17.2	20.5	17.2	20.9	18.6
2	12.4	10.2	19.7	18.9	13.7	13.0	17.5	13.0	16.9	15.1
3-4	12.0	7.0	23.8	16.2	17.5	11.5	15.1	11.5	22.4	20.7
5+	4.1	1.7	7.5	4.2	4.6	2.9	5.4	2.9	7.5	5.4
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	2399	2522	1963	1867	1025	1743	166	222	626	736
Number of children aged 0-17 years										
0	51.1	62.5	24.3	32.9	33.6	45.2	35.5	49.1	27.3	34.7
1	14.8	12.5	15.5	17.5	18.3	17.3	19.9	18.5	15.0	17.1
2	12.3	10.9	16.8	18.4	15.9	13.5	13.9	12.2	15.3	12.2
3-4	13.8	9.9	26.5	20.6	22.2	15.6	18.1	16.2	24.4	21.6
5+	8.1	4.2	17.0	10.6	10.1	8.4	12.7	4.1	17.9	14.4
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	2399	2522	1963	1867	1025	1743	166	222	626	736

NB: The Botswana Standard Demographic Survey 1988 did not capture marital status of individuals.

3.4 Discussion

The current study sheds light on households and how they have changed in Botswana between 1971 and 2011. This is achieved by examining shifts in average household size, growth in number of households and composition of households, as well as how such changes can be related to fertility and marital status. The findings from the surveys of 1988, 2000 and 2007 on fertility and marital status distributions are interpreted in the context of the observed changes in household size and composition during the period 1971-2011.

Household size, composition and growth

The findings indicate that the average household size has become smaller in Botswana due to a decrease in the number of children per household resulting from the decline in birth rates, a drop in households with many members, and a reduction in childbearing among women who are widowed, separated/divorced, or cohabiting. The explanation for the decline in the average house size in Botswana are supported by evidence from other studies. Several studies in developed and developing countries have linked declines in the average household size to a decrease in the number of children per household due to low birth rates, an increase in one person households and a decrease in households with many members (Kuijsten, 1995, Sweet and Bumpass, 1987, Bongaarts, 2001).

A further breakdown of household composition between 1988 and 2007 shows that living with family, extended members and sometimes non-related household members is sustained over the years. However, the number of extended and non-related household members decrease over time. Household membership in Botswana shows that kinship and non-kinship networks are important source of support. As noted by Gaisie (1998) and Poukouta (2000), a traditional Tswana household is rarely made up of only a nuclear family unit; instead it also consists other family members, and sometimes un-related members such as housemaids. Gaisie (1998) and Poukouta (2000) indicate that relatives and not related household members are possibly for support with social, economic and political affairs of the family.

On the other hand, the trend in the persistent presence of other relatives and non-related household members during the period 1971 to 2011 are indicative of labour market

conditions in Botswana. As shown by Siphambe (2003), the changing patterns in employment and unemployment in Botswana have had implications for the decision making and young people's ability to leave parental home and set up their own. Unemployment rose from 15 per cent in 1991 to 20 per cent in 2001 (Central Statistics Office, 2004, Government of Botswana, 1991). The literature that relates household formation and employment in South Africa also indicates that those who are unemployed have a lower propensity to set up their own households, and they continue to stay with parents, close and distant relatives (Klasen and Woolard, 2009, Pirouz, 2005). Likewise, a study by Ermisch and Salvo (1997) from Britain finds that high unemployment rates reduce young people's household formation.

The distribution of households with younger and older children also varies between rural and urban areas. Urban areas in Botswana have more households with no children aged below 5 years than rural areas. The pattern in the distribution of children by residence possibly reflects the differences in the socio-economic circumstances in rural and urban areas that affect fertility and household size. Currently, there are more economic opportunities for jobs, education and more demand for housing in urban areas than rural areas in Botswana. In addition, as previously shown, declines in the average household size are also linked to distribution shifts in the number of children per household (Kuijsten, 1995, Sweet and Bumpass, 1987, Bongaarts, 2001) as well as other circumstances and choices that delay childbearing such as one person households (Bumpass, 1990), which are an important characteristic of urban rather than rural areas in Botswana. The patterns of family interaction and available socio-economic resources for childcare might also explain the changes in household size across urban and rural areas (Sweet and Bumpass, 1987).

About the growth in the number of households, census data shows that between 1991 and 2011 the number of households has increased more rapidly than the total population. A rapid increase in the growth in the number of households compared to the total population has been associated with a long term decline in the average household size (Sweet and Bumpass, 1987, Kuijsten, 1995). Further, research evidence indicates that the growth in the number of households and the decline in the average household size are likely contributions of population growth and size distribution shifts to household growth (Van Imhoff et al., 1995).

The level and pattern of fertility and marital status

Across all households, there is a decline in fertility by about three children per woman between 1971 and 2011 in Botswana. Why fertility has fallen in Botswana can be explained by many factors. One is marital sexual behaviour. The findings on marital status indicate a trend in the growth of alternative partnership types to marriage, and a reduction in childbearing across these marital types. Moreover, the decrease in the mean number of children also coincides with the increase in the number of women remaining single (eg. 37.0 % in 1971 versus 53.5 %. in 2011), cohabitation becoming more common and a reduction in marriage rates over time (Government of Botswana, 1972, Government of Botswana, 1991, Central Statistics Office, 2004). Patterns of never married and cohabitation have become quite common in Botswana (Gaisie, 1998, Letamo, 1996, Mokomane, 2005, Mookodi, 2004) and are partly reflective of the influence of the prevailing socio-economic conditions, and a collapse in marriage due to difficulties in meeting its requirements (Rutenberg and Diamond, 1993). A decline in marriage rates has also been associated with a decrease in marital fertility from a fall in high order births, an increase in age at first marriage and more women having fewer children (Popenoe, 1993, Sweet, 1977).

An earlier investigation of fertility in Botswana by Rutenberg and Diamond (1993) imply economic effects of drought on the decline of fertility in the 1980s. First, the authors argue that agricultural problems during and after the drought meant men spent more time at the lands, and thus reducing availability of partners for reproduction. Second, they state the difficulty for men to raise the resources needed for customary marriage during this time, leading to delays in starting family. Customary marriage in Botswana involves two main stages: *patlo* –which involves a visit by the groom's family to the woman's family to negotiate and ask for her hand in marriage, and *bogadi*-which involves payment of the bride price (either cattle or money) to the bride's family by the groom's family. Both the negotiation and payment of *bogadi* take place before marriage and the processes can be long and arduous, often lasting from a few months to years. Third, economic hardship endured by female headed household during this time affects fertility negatively. This is because during the 1980s to early 1990s most men in the South of the country migrated to work in South African mines leaving females behind to take care of households (Townsend, 1997, Izzard, 1985).

Fourth, the demand for wage labour in urban areas of Botswana during the 1980-1990s resulted in crowded living arrangements and housing shortage, both of which have an overall dampening effect on fertility. Finally, the authors indicate that the mid 1980s, was a period in which family planning services were integrated into maternal and child health services, and resulting in the uptake of modern contraceptive methods and a reduction in childbearing (Rutenberg and Diamond, 1993). The findings on contraceptive use are similar to the results from a study on fertility change in Botswana which showed that contraceptive use reduced fertility by 25 per cent in 1984 and by 31 per cent in 1988 (Letamo, 1996). Further, Letamo (1996) identified breast-feeding and marriage as important determinants of fertility decline in Botswana during the period 1980-1990.

Other factors associated with fertility and household change

Beyond the 1980s, there are other factors contributing to fertility change and changes in the mean number of children born to women across the different marital groups in Botswana. These include improvements in female education, participation in employment, declines in marriage rates (Letamo and Bainame, 2011a, Letamo and Bainame, 2011b), rapid urbanization in the country, and an increasing demand for housing in urban areas (Central Statistics Office, 2006, Central Statistics Office, 2004, Letamo and Bainame, 2011a).

Although the aforementioned socio-economic factors have not been systematically evaluated relative to how they affect fertility and household change in Botswana, other studies demonstrate links between these factors and change in family, household size and composition. For example, an analysis of households in England, Wales and France during 1981 to 1991 points to the role of education especially among women, and higher social class to an increasing propensity to live alone (Hall et al., 1997).

Several studies also suggest links between increases in women's participation in education and employment with increased retreat from marriage, postponement of childbearing (Kneale and Joshi, 2008, Berrington, 2004, Bianchi, 2011, Basu, 2002) and more individuals setting up their own new households (Allan and Crow, 2001a). This is because education is a marker for a rise in female empowerment, rising aspirations (Basu, 2002, Upadhyay et al., 2014) and the postponement effect from being in school and employment (Liefbroer and Corijn, 1999, Blossfeld and Huinink, 1991). Female

empowerment which is measured by the ability to make household decisions is inversely related to fertility according to a review of studies in South Asia (Upadhyay et al., 2014). Further, information from the three surveys of 1988, 2000 and 2007 in Botswana confirm the interrelationships between fertility, marital status and household change. Specifically, younger household heads are consistently found in smaller households, most of which have less than 3 persons, and have fewer children aged below 5 years compared to older household heads. In addition, the relatively large number of households with no children less than 5 years and those aged 5-17 years between 2000 and 2007 in part suggests declines in fertility and the less extended nature of households over time.

The fall in fertility in Botswana is also expected given that the PPRs for women who have reached 45-49 years and 50-54 years provide some support for the decline in fertility between 2001 and 2011 in terms of parity progression. Botswana has seen declines in fertility between 2001 and 2011 from the fall in the larger parity progressions- third, fourth and fifth birth progressions. Again, the relevant changes in fertility levels in Botswana seem to revolve around having smaller families as having one or two children appear to be a social norm.

The findings on PPRs by residence in Botswana show that women with three or more births are becoming rare in urban than rural areas. This result is expected given weakening child care support from families, female labour participation, changing norms and attitudes towards low childbearing and preference for smaller households in urban than rural areas.

Turning now to education, females with secondary and tertiary education are having fewer second, third, fourth and fifth births compared to those with primary and no education in Botswana. This finding may suggest higher opportunity costs for the highly educated women. For example, rising opportunity costs related to income and sustenance-generating activities in Russia are reported to explain the likelihood that a woman will have another birth (Perelli-Harris, 2006), and a woman will have a second birth (Bühler, 2004). Additionally, an investigation of fertility behaviour in Armenia and Moldova finds that the decline in TFR was driven by fewer third births and fewer second births in these countries respectively (Billingsley, 2011). However, caution is required in interpreting this result as the influence may run in both directions. As stated by Billingsley (2011) and Wood et al. (2014) women's fertility choices are affected by their educational

level as well as time spent in school. On the other hand, these authors argue educational attainment may delay childbearing or vice versa.

Taken together, the results on PPRs suggest two things. First, there is some evidence that women in urban areas and those with higher education have the greatest decline in fertility. Second, the analysis highlights other potential areas of future research on determinants of fertility in Botswana. Issues such as the effect of direct costs, opportunity costs, context that women live in, the effect of educational attainment and migration flows of partners and household members are worth exploring. Unfortunately, these factors could not be analyzed due to data limitations.

Moreover, within this general trend, there is a rise in smaller households and a decline in large households during the period 1971 to 2011 in Botswana. In particular there are more people living alone in the age group 20-29 years. The propensity to live alone among people aged under 30 years likely reflects a higher proportion of people staying single, low marriage rates and the decline in the number of children aged 0-4 years in households with younger heads. On the other hand living alone among males aged under 30 years is possible as men who are not married and have children in Botswana are less likely to stay with their children and family members. As shown in a study on non-residential unmarried biological fathers and parenting in Botswana, most of the children born out of wedlock remain in the custody of their mothers as their fathers often don't have any legal claims to them (Letamo and Rakgoasi, 2000).

The analysis also found a higher proportion of females than males aged 65 years and above lived alone between 1988 and 2007. This finding partly reflects an increase in widowhood among older females and women living longer than men in Botswana. In addition, the share of persons living alone at ages 65 years and above relates to a drop in the number of relatives living with older persons in their households. The study observed a sharp drop between 1988 and 2007 in the percentage of households with relatives (from 27.8% in 1988 to 9.0% in 2007).

With regard to differences in living alone by residence in Botswana, there are no ready explanations as to why people in urban areas and rural areas people live alone, except a greater propensity to live alone in urban areas than rural areas might be explained by both labour market and housing market demands. An account of living alone in Britain

and France shows that younger one-person households are much more common in the capital cities of London and Paris and other regional urban centres (Hall et al., 1999). This investigation further states that urban areas in contrast to rural areas are able to respond to the labour and housing demands created by more people preferring to stay alone. Thus, the effects of urban areas on the emergence of living alone in Botswana are likely to be the same as in Britain and France, although how the process works out is not clear from current data. Of note is that urbanization in Botswana has increased from 9.1 per cent in 1971 to 45.2 per cent in 1991 and to 64.0 per cent in 2011 (Gwebu, 2011).

Other researchers indicate that an increase in the number of one-person households and an increase in the number of single parents accounts for a steady drop in the average household size from 3.5 to 2.8 persons across households in Italy and from 2.9 to 2.5 persons in Britain between between 1970 and 2000 (Hall et al., 1999). Kuijsten (1995) and Van Imhoff et al. (1995) also observed declines in household size in Europe between 1950 and 1990 as a result of a marked increase in the number of households that are non-family as well as an increase in the share of persons staying alone and not marrying. In addition, other factors such as changes in marital status, housing tenure, ageing, migration, employment opportunities, social class, and deliberate choice of living alone have been linked to the propensity of people to live alone (Hall et al., 1999, Sweet and Bumpass, 1987). This study couldn't estimate the aforementioned factors due to lack of data.

Thus, putting the above changes in context, in 2011 households in Botswana are characterized by smaller average sizes, with fewer married individuals, fewer children and fewer extended household members than in 1971, 1991 or in 2001. The households' heads are also not likely to be that young in age as people cannot get jobs so they only move out of their parental home once they have the money and are able to economically support themselves. In addition, as the provision of education has increased between 1971 and 2011 in Botswana, so the average educational attainment has increased too. Accordingly, fertility is low, so there are fewer children aged 0-4 years per household and household membership is kept low and less extended in nature. Smaller households presents both demographic and socio-economic implications. For example, as already argued, the impact of the increase in the number of people living alone brings decrease in household size, membership (Bongaarts, 2001, Kuijsten, 1995, Van Imhoff et al.,

1995). Also, it has repercussions for local services, economies and communities (Hall et al., 1999).

Finally, if the relationship between household change and fertility is related to child health then the above changes may imply that there are fewer care givers within each household. As a result child health is likely to deteriorate due to a reduction in adult family resources for child supervision and monitoring. However, there is high unemployment in Botswana (Central Statistics Office, 2004, Government of Botswana, 1991), so many young people are at home, which means that there is ample manpower for child care. In the future it will be important to understand co-residency of unemployed individuals in Botswana and its implications for household food security and child nutritional status. The implications involving related or non-related household members on child care also remain unknown. Hence, the next chapter focusses on the relationship between child health outcomes and household composition.

Limitations

This analysis has a number of limitations. Not fully known is how fertility and marital status interact with each other in presence of other demographic factors such as mortality, migration and an array of socio-economic factors: education, employment status, income and social controls on marriage. Due to lack of data attention is only given to the analysis of household size, household composition, fertility and marital status.

Second, this study is not able to make sense of the possible causal factors associated with household change. The explanations for household change remain “potential” because the study does not directly measure and quantify the effects of fertility and marital status on household change. Rather, the paper relies on prior research evidence of the effect of fertility and marital status on household formation and change.

Third, due to the cross-sectional nature of the survey data, the analysis is unable to isolate all the demographic and socio-economic characteristics associated with household change over time. As evident in a paper by Hall et al. (1999) factors such as changes in job, housing and personal circumstances, migration, widowhood, relationship breakdown, and ageing are important in the creation of one-person households. However, data from the census reports and the three surveys in Botswana is limited and

the study is unable to show the extent to which single person households are driven by factors such as delay in marriage, widowhood, partnership dissolution, economic and personal choices. The study can only distinguish one person households by age, sex, and residence.

In addition, the study is not able to capture characteristics of household members who may be located at different physical locations at the time of the survey, and it misses links with other non-resident household members. Studies on processes of household formation and dissolution in rural areas of Botswana show that at any one time, individual members of households may reside in the village, in the town, at the lands *(masimo)*, or at the cattle post or *moraka* (Murray, 1987, Townsend, 1997, Izzard, 1985). There is also evidence of multiple links between households in the village, in the town, at the lands and at the cattle post (Townsend, 1997, Izzard, 1985). An understanding of households and related processes of change require longitudinal data collection and analyses (Van de Walle, 2006, Hosegood and Timaeus, 2006). The use of longitudinal data will also capture the change in the structure over time, duration of household membership and links with other households.

Fourth, using data from the censuses and surveys does not tell us anything about the process of household change as households are identified at each census or survey date, rather than been followed up. It would be desirable to have longitudinal data in order to capture the changes in household size and composition over the household life cycle. However, in spite the above limitations, the analysis gives a general picture of the changes in Tswana households and conditions which might have contributed to these changes between 1971 and 2011.

Summary and conclusions

This chapter represents one of few efforts to understand household change in Botswana. The analysis demonstrates that Tswana households have changed considerably over the last twenty years, both in terms of the average household size and household composition. The average household size in 1988 was very large in comparison to 2000 and 2007. Another important change is the heterogeneity and complexity of the households. Over the years 1988-2007 the analysis shows that household membership becomes less diverse. In 2007 households consists mainly of family and less of extended

and sometimes non-related household members than in 1988. At the same time, there is an increase in variation of household types compared to the past due to the rise of one person households. The overall decrease in household size and change in household composition between 1971 and 2011 also occur during a period marked by a decline in fertility and a reduction in the number of children across households. In addition, low fertility and low marriage rates would seem to operate in favor of the decrease in household size.

However, it should be emphasized that household change is not only limited to fertility and changes in marital status. Other demographic variables such as mortality and migration directly affect household size and composition. Household change is also indirectly determined by socio-economic factors such as education, employment status and income. Indeed, several authors highlight the importance of demographic data and socio-economic characteristics of individuals and households to household formation and change (Ermisch and Overton, 1985, Burch, 1972, Bongaarts, 2001, Burch and Matthews, 1987, Hall et al., 1999). Future work on household change in Botswana would benefit from investigating these factors in order to understand the causal implications of household change for issues such as child health, demography, lifestyles, housing demands, rural and urban economies.

CHAPTER 4. HOUSEHOLD COMPOSITION AND CHILD HEALTH IN BOTSWANA

4.1 Introduction

Stunting and diarrhoea diseases are prevalent in low and middle income countries. Recent estimates from the United Nations Children's Fund (UNICEF) show that stunting contributes more than one-third of deaths among children under five years, and its prevalence is highest in sub-Saharan Africa (40%) and in South Asia at 39 per cent (UNICEF, 2012). On the other hand, diarrhoea diseases constitute 11 per cent of the world's deaths among children under five years (UNICEF, 2012).

Stunting and diarrhoea also remain a widespread problem among children in Botswana. According to official data in the Botswana, 26 per cent of the children under five years and 23 per cent of children in the same age group were stunted in 1993 and 2000 respectively (Government of Botswana, 2009b, Government of Botswana, 2001). About a fifth of the children under five years are reported to have suffered from diarrhoea during January-December 2004 (Central Statistics Office, 2007) .

In the general literature on stunting and diarrhoea, a number of factors are seen as having an impact. The causes of stunting include poor household food security, inadequate maternal care, poor access to health services and unequal distribution in socio-economic resources (Black et al., 2008c, Lesiapeto et al., 2010, de Onis and Blossner, 2003). Diarrhoea is linked to poor socio-economic conditions, poor breastfeeding practice, and increased risks of frequent illness (Mølbak et al., 1994). Both the effects of stunting and diarrhoea in early childhood are far reaching, and are associated with non-communicable diseases such as diabetes, hypertension and cardiovascular diseases in adult life (Robinson and Fall, 2012). There is also evidence of a link between stunting and diarrhoea and slow growth in early child life and poor educational and economic performance later in life (Dewey and Begum, 2011, Chang et al., 2002, Victora et al., 2008). And early childhood diarrhoea is also associated with poor cognitive function later in life (Niehaus et al., 2002). This paper asks whether child health (stunting and diarrhoea prevalence among children less than five years) in Botswana is associated with household composition.

A considerable amount of literature has been published on family structure and child well-being. A focus of this research includes the impact of parental time, economic, and social resources (Thomson and McLanahan, 2012, Thomson et al., 1994) and parenting stability (Waldfogel et al., 2010). Other studies show that households provide a physical place that support childrearing, procreation, consumption and economic production (Simpson, 2012, Van Imhoff et al., 1995, Van de Walle, 2006). While most of the studies done on the family and child well-being provide a good starting point for understanding the role of the family and household environment on child well-being, not enough has been done on child health outcomes and household composition in low income and middle income countries (LMICs).

The family environments in which children are raised in LMICs are very different from those in higher income countries. In high income countries the focus has tended to be on one parent or two parent families and less on other adults in the household (Manning and Lichter, 1996). Research indicates that households in LMICs are larger, more complex in terms of membership as children are raised in households with parents or without parents and other household members (Bronte-Tinkew and DeJong, 2004, Izzard, 1979, Murray, 1987, Lloyd and Desai, 1992). Children in Southern Africa are also likely to live in multi-generational households and along with grandparents (Schatz Enid and Ogunmefun, 2007), as well as live apart from their mothers (Lloyd and Desai, 1992).

There is a general lack of research in LMICs on the relation of household composition to child health outcomes such as stunting and diarrhoea. Previous work focuses on family structure and child well-being (behavioural, emotional and cognitive outcomes) in high income countries (Allan and Crow, 2001a) rather than on child physical health. A number of recent studies in LMICs have begun to pursue an understanding of child health and the household conditions under which children are raised (Cunningham et al., 2010, Sear, 2008, Sear and Mace, 2008). For instance, an analysis of longitudinal data from South Africa finds that birth weight is positively associated with grandmothers residing elsewhere and with the father co-residing with mother at birth (Cunningham et al., 2010). Sear (2008) identifies the importance of maternal aunts for child mortality. A study on community and parental factors and child physical health in Trinidad and Tobago finds evidence of the role of parental health and parental beliefs on child physical health (Narine et al., 2013).

Other studies have assessed factors associated with child mobility-defined as a move to another household either within or outside the original locality. A study in South Africa by Ford and Hosegood (2005) examined the link between child mobility and AIDS mortality and they show that experience of death of a mother or father in the household is associated with increased risk of child mobility. Another study among children aged 0–14 in Mpumalanga Province, South Africa, found that children whose mothers were temporary migrants, living elsewhere, or dead had higher risk of moving than children whose mothers were co-resident (Madhavan et al., 2012).

Research to date has also not fully explored household relationships from the view of the child. To the best of the author's knowledge, no studies have explored this approach in examining child health. Thus, this study constitutes the first step in using more expanded categories of households to understand child health. Earlier work defined household composition in terms of relationships of household members only to the household head, and not from the view of the child, and establishing his/her relationship to everyone else in the household.

It is against this background that research efforts to understand child health outcomes and child's household experience in LMICs remain critical. This study uses data from the 2007 Botswana Family Health Survey (BFHS 2007), a nationally representative survey. And multilevel logistic regression modelling is used for answering the research questions. The use of multilevel logistic regression modelling is important from both a substantive and statistical point of view. An assessment of the nature of the survey design characteristics indicate that the data collection involved a two-stage probability sample design: selection of enumeration areas (EA) and then a selection of households (Government of Botswana, 2009a). An examination of the data also gives a sample that is clustered. Hence, the observations are not independent and ignoring this will lead to wrong inferences about the parameters and an underestimation of the standard errors of the regression coefficients (Snijders and Bosker, 2012).

4.1.1 Research questions

This paper has three questions:

1. What types of household composition, as operationalised from the relationship of the child to other household members are observed in 2007?
2. Do child health outcomes vary by whether the child lives with two parents, one parent, no parents and by the types of others living in the household, including a grandparent, aunt, uncle or other relatives/not related household members?
3. Do other types of household members moderate the relationship between living with parent (s) and child health outcomes?

4.2 Conceptual framework

Several possible mechanisms link child health outcomes and household composition. It is assumed that child health outcomes and household composition are linked through factors that operate at community, household, parental and child levels (Figure 4.1). At a community level, region and place of residence influence child health through the broader structural factors outside the home which influence household food security, access to education and health care (Heaton et al., 2005). At household level, the health investments and characteristics of household members are important for child health outcomes. For example household composition (which encompasses whom the child lives with) has implications for the nature and availability of social and economic resources for child care (Houle et al., 2013), parenting practices (Thomson and McLanahan, 2012, Thomson et al., 1994), the socialization network for caregiving tasks, and ability to identify and manage health (Williams et al., 2003, Berman et al., 1994).

The relationship between child health and household composition may also differ based on the presence or absence of parents as well as whom the other household members living with the child are: grandparent, aunt, uncle, other relative, or a not related household member. This is because the different households and their composition are not homogenous in their resources and how they provide support for child care (Bronte-Tinkew and DeJong, 2004).

Further, at household level, the influence on child health outcomes could be through three main moderators: household context, parental and child factors. The potential

value of moderators in regard to child health is in light of conditions in which these process operates. A discussion of moderation and mediation effects shows that moderation effects are interaction effects; whether the prediction of the outcome variable, Y from an independent variable, X differs across the levels of a third variable, Z (Hayes, 2009, Fairchild and McQuillin, 2010). While mediation effects are concerned with the process through which an independent variable, X operates to influence an outcome variable, Y (Hayes, 2009, Fairchild and McQuillin, 2010, Bradley and Corwyn, 2002).

Thus, from the Figure 4.1, household wealth, parental and child factors illustrate the context under which the relationship between household composition and child health holds. For example household wealth is assumed to influence food security, financial resources available, the type of home environment, care practices, breastfeeding practices (Heaton et al., 2005), care behaviours and hygiene practices (Mølbak et al., 1994), all of which help to prevent, and control infections. Further, studies of family structure and child health indicate that a child's health status may be compromised in larger families due to lack of sufficient food, inadequate attention and health care (Heaton et al., 2005), unsanitary living conditions and living in close proximity (Justesen and Kunst, 2000). Also related to household wealth is mother's education. Maternal education improves child health through access to quality food, healthcare services, and health knowledge (Heaton et al., 2005, Glewwe, 1991). Paternal factors also reinforce maternal parenting depending on the type of union, co-residence and the living situation of the father and mother (Waldfogel et al., 2010, Thomson and McLanahan, 2012, Coleman, 1988).

Next at child level, Figure 4.1 shows that child health outcomes are related to a child's age and sex. Previous studies show that stunting is higher among males than females (Bronte-Tinkew and DeJong, 2004, Lesiapeto et al., 2010, Gewa and Yandell, 2012, Wamani et al., 2007). Incidence of *Cryptosporidium*, a microorganism that is associated with persistent diarrhoea in infants and young children is also disproportionately higher for boys than girls (Mølbak et al., 1994, Højlyng et al., 1986). However the mechanisms for the biological and environmental factors between child health, age and sex are poorly understood and remain incomplete (Wells, 2000).

The conceptual framework recognises that there is variability in household composition, activities, and processes both between and within households over time. Finally, based

on Figure 4.1, the relationship between household composition and child health can be bi-directional. Although not tested in the current analysis, it is important to mention that child health outcomes can act as a stressor on the health and or aggravates the course of morbidity for parents and other household members (Broome and Stuart, 2006). For example, maternal depressive symptoms have been shown to be higher among mothers with underweight children (De Miranda et al., 1996, Patel et al., 2004, Howe et al., 2014) and among mothers with children of short stature (Surkan et al., 2008). A recent analysis using the UK Millennium cohort study found higher prevalence of paternal depressive symptoms after the birth of a child (3.6 % at 9 months) compared to 1.2 per cent when the child is 3 years, 1.8 per cent at 5 years and 2.0 per cent at 7 years (Nath et al., 2016).

In Africa, evidence on HIV and AIDS indicates that a child's health status may produce strain and pose a threat to family and household efforts to cope with caring tasks (Kuo and Operario, 2009, Kuo and Operario, 2011, Baylies, 2002).

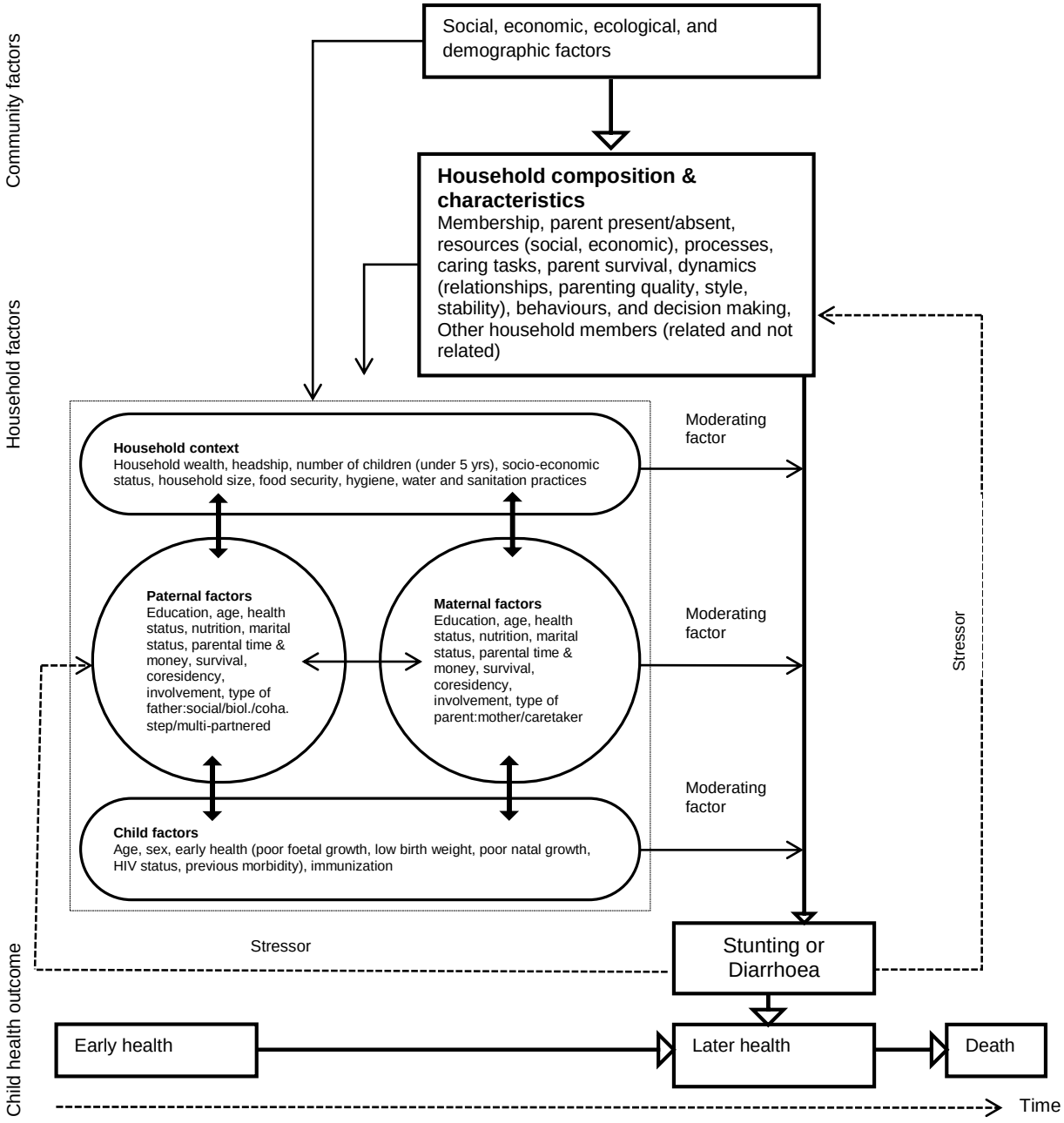


Figure 4.1: Conceptual framework of potential determinants of stunting and diarrhoea, Source: Author

Given the conceptual framework in Figure 4.1, the following hypotheses reflect the assumptions about the link between child health outcomes and household composition.

Two parents, one parent and no parent households

Hypothesis 1: Children living with two parents have better health than those in one parent or no parent households.

The initial hypothesis is that children living with both parents are less likely to be stunted or have diarrhoea compared to those living with one parent, or without a parent. Several studies show that one parent especially families with just mothers, are much more likely to be poor and are unable to provide food and material needed for healthy child growth (Brown, 2004, Thomson and McLanahan, 2012). Further, McLanahan and Sandefur (1994) show that being single limits the ability of the mother to pursue her career due to balancing the responsibilities of child rearing and work demands without the help of the father. On the other hand, living with both parents affords more time and finances, more parental care, and supervision to deal with demands of work and family (Amato, 1987, Dawson, 1991). However, it may be that this relationship depends on two things: on the available resources in the households and on whom the parents live with such as grandparent, aunt, uncle, other relatives and not related household members. A review of living arrangements experienced by children from 19 Demographic and Health Surveys indicate that children are likely to be better off if they live with their parents and other related adults who are committed to their care and provision of financial resources (Lloyd and Desai, 1992).

Two parents and others living in the household

Hypothesis 2: Children in households with two parents and other household members have better health than those in households with two parents and no other household members.

The presence of other household members in households with two parents modifies the relationship between household composition and child health outcomes. Co-residence with other household members is important for parents who are employed to go out to work (McLanahan and Sandefur, 1994). In Botswana child-care services are minimal or

don't exist in most parts of the country and co-residing with other household members makes sense for working parents (Mokomane et al., 2006). Thus, the study assumes that two parents who are working or have money at their disposal are able to afford child care costs by staying with other relatives or household members who are not related. In contrast, evidence indicates that living with two parents and a grandparent might compromise a child's health status (Janssens, 1993, Szinovacz, 1996). The latter type of household may create competition for resources if the grandparent is not economically independent. In addition living with a grandparent (s) might create more health care and caring costs for the parents. Evidence in high income countries shows that live-in grandparents are likely to reflect need for care in old age rather than pooling of financial resources for child support and supervision (Janssens, 1993, Szinovacz, 1996). However, in the case of Botswana, co-residence with grandparents is likely a reflection of need for their care as well as a resource for child support and supervision.

Several studies also note circumstances in which the roles of other household members are important to child health. For example, a more efficient grandparent role may be when they are some distance away. A study in South Africa found that grandmothers contributing from a distance have a positive effect on child birth weight (Cunningham et al., 2010). Studies carried out in Botswana show that the role of the grandparent in child health is likely to be more effective in one parent households: wherein mothers are not able to fulfil financial obligation related to child care (Izzard, 1979, Mokomane et al., 2006). A study among married women in Malawi notes the potential role of maternal aunts on child mortality. This study finds that residing with maternal aunts only has a protective effect on child survival in marriages where men have more resources and there is no competition between mothers and aunts for those resources (Sear, 2008).

Other perspectives on child health and household influences argue living with two parents and other household members are more efficient than living with two parents only or with a single parent (Klassen et al., 2012). The basis for the argument could be tied to both the effectiveness of the household for child care, and socio-economic support afforded by having more household members (Houle et al., 2013, Lloyd and Desai, 1992). For instance, in a two parent household with no extended household members, the spouse is the only primary helper (McLanahan and Sandefur, 1994). In a household with other household members, there is extra help for caregiving tasks and greater access to financial resources to manage health, (Klassen et al., 2012, Lloyd and Desai,

1992). In the case of diarrhoea presence of more household members may be negative for child health as crowding in the household is a possible risk factor of pathogens that cause diarrhoea due to person to person contact and other related unhygienic practices (Højlyng et al., 1986, Victora et al., 1988, Heaton et al., 2005, Justesen and Kunst, 2000).

Further, other research indicates that family networks serve as social service systems for information sharing on health behaviours and emotional support to the parents. In particular, research on African American parents living in extended family structure speaks to the importance of cultural characteristics such as interdependence and reciprocity among family members and its association with providing care and support (Williams et al., 2003). Obviously, the characteristics of who is in the network, age distribution, and education of those in the network might influence the nature of health advice, and caring support that is needed (Williams et al., 2003).

One parent and others living in the household

Hypothesis 3: Children living with a mother and other household members are more likely to be healthier than those living with a mother only.

Ironically, in Botswana, due to the growing economic independence of women, female participation in labour, and low marriage rates there is a rise in single motherhood and parental cooperation with other household members who are not necessarily the biological father (Izzard, 1985). And as elsewhere an increasing number of single mothers double up with other female family members for child support (Sigle-Rushton and McLanahan, 2002). It is therefore hypothesized that children living with a mother and other household members are more likely to be healthier than those living in a mother only household.

The types of persons who co-reside with parents and their children in Botswana include grandparents, uncles, aunts, other relatives such as cousins and not related household members. Several studies suggest that grandmothers play an important role in single mother households, and in which poverty and economic hardship abound (Izzard, 1979, Lichter and Crowley, 2004, Mutchler and Baker, 2009). Co-residence with the grandparent can also be oriented towards the care of grandchildren as well as imply care for the grandparent (Szinovacz, 1996, Noel-Miller, 2006). In the past, grandmothers

played a critical role in the rearing of children in Botswana when mothers had to seek employment elsewhere (Izzard, 1979). Mokomane et al. (2006) notes the difference in child living arrangements in a rural and urban setting in Botswana and finds that relatives and not related household members are essential for more educated and married women, while grandparents are essential to single mothers who are not employed.

These hypotheses are investigated within the context of the conceptual framework (Figure 4.1) in the rest of the chapter.

4.3 Data and methods

Data examined come from the 2007 Botswana Family Health Survey, a nationally representative survey. The survey was carried out by the Central Statistics Office (CSO) Botswana, now known as Statistics Botswana. The survey contains information on maternal and child health outcomes as well as data on demographic, family and household living conditions. The sampling design for the survey involved two stages. The first stage of sampling involved a selection of enumeration areas (EA) proportional to the number of households in the EA. The second stage of sampling involved a systematic selection of 7841 occupied households from the selected EAs (Government of Botswana, 2009a). Within the sampled households, all 5021 eligible women (12-49 years) were interviewed, and detailed information collected about children aged less than 5 years. Data collection was done through direct household interviews. Further details on the survey methodology including sampling design, sampling frame, field work and data management can be found in the survey report (Government of Botswana, 2009a).

Sample

The final sample for this analysis consists of 2531 children with data on stunting (excluding 184 children who had missing data on the age variable and height for age z scores (HAZ) and had implausible values outside the range -6/+6 HAZ, and for diarrhoea prevalence the count is 2713 children (only 2 children had missing data on the outcome). Since data has a hierarchical structure, for stunting, the 2531 children are nested within 1804 households at level 2, and within 298 enumeration areas (ea) at level 3. While for diarrhoea prevalence the 2713 children are nested within 1892 households at level 2 and within 298 enumeration areas at level 3.

4.3.1 Variables

Dependent variables

Two outcomes are of interest: stunting and diarrhoea prevalence. Stunting reflects a long term illness and it is defined through the use of height for age z scores (HAZ). Children with z scores less than −2 standard deviations (SD) below the median on height for age in comparison to the World Health Organization international reference standard are considered stunted (WHO, 2013b, WHO, 2007a). A clear short term illness is diarrhoea. Mothers were asked if their children experienced loose or watery stools or blood in the stool in the last 24 hours or in the last two weeks preceding the survey. Both outcomes are coded for 1 for presence of the illness and 0 for absence of the illness.

Main explanatory variable

The main independent variable is household composition. Household composition consists two variables: parental presence and presence of other types of household members. Parental presence is a four categorical variable related to whether the child lives with two parents, one parent-mother only or father only, and no parents. The types of other household members living in the household are grandparent, aunt, uncle, other relatives and not related household member. Each of the variable for the type of other household members is coded 0 for absence of the household member and 1 for presence of the household member.

Defining the variables for household composition

Much previous work defines household composition by specifying the relationship of household member to the household head (defined by either the interviewer or those in the household themselves). This approach is limited since it does not show the relationship of each member to the rest of the household members. This is an issue, especially when focusing on children, when the relationship of the child to the rest of the members of the household is of interest and not to the head of household. This is especially the case in LMICs where the household may consist of a wide variety of individuals, with extended families co-residing. Simply knowing the relationship of the

child to the head of household does not capture the potential complexity of the relationships that are of interest.

The current study operationalises household composition from the relationship of the child to each of the household members. The process of defining the household composition variables involved several stages. First, the process takes into account the identified relationship of the child to the specific household head (either mother, father, grandparent, aunt, uncle, other relative or not related household). Then a series of steps were used to ascertain parental links and the relationship of the child to each household member. These steps involved noting the sequencing of household members in the household roster, characteristics of a household member (sex, marital status, age), and a match between a child's line number and its mother's line number (see appendices 4A and 4B). Although it is not possible to ascertain the relationships to the child in all situations, an application of the logic in Appendix 4A made it possible to recast a household to represent relationships with the child as the index individual.

Household composition categories defined relate to four parental presence variables (whether the child lives with two parents, one parent-mother only or father only, and no parents) and five types of other household members living in the household (grandparent, aunt, uncle, other relatives and not related household member). The distinct household composition categories were also informed by the fact that child rearing in Botswana expands beyond biological parents, and it reflects single parenting, co-parenting with other household members and parenting with neither biological parent (Mokomane et al., 2006).

Control variables

The control variables include household context and child variables. The household context variables are household wealth, household size, number of children aged less than five years in a household, region, and residence.

- *Household wealth*-has five wealth quintiles from poor to rich: 1. Poorest (1st quintile), 2. Second (2nd quintile), 3. Middle (3rd quintile), 4. Fourth (4th quintile), and 5. Richest (5th quintile) group. Household wealth is measured by constructing an index based on material of construction of the main house (wall,

roof, and floor materials), ownership of durable assets (such as radio, television, bicycle, motor vehicle, tractor, cattle), types of fuels used in the home (for cooking, lighting and heating), source of drinking water and type of toilet facility. All the indicator variables above were put into a factor analysis- using principal component analysis (PCA) as described by Rutstein and Johnson (2004). The wealth score obtained was then divided into five equal groups of 20 percent each (quintiles) at national level.

- *Household size*-has three categories: 2-3 persons, 4-6 persons and 7 and above persons.
- *Number of children aged less than five years in a household*- has 4 categories: 1 child, 2 children, 3-4 children and 5-6 children.
- *Region*- has five categories: North, South, West, East/ North and Central.
- R*esidence*- is categorized into three: city/town, urban village and rural.
- *Child's sex*- is a dummy variable: coded 0 if the child is female and 1 if the child is male.
- *Child's age*-is a continuous variable. A square of child age was also entered in the modelling as a non-linear relationship between age and child health outcomes was observed.

Other potential explanatory variables such as mother's education, mother's marital status and mother's age were investigated. However, these were not retained due to missing data on the variables (see Section 4.3.3 for more details).

4.3.2 Data analysis

Data analysis was conducted in *STATA* and *MLwiN*, and is restricted to households with at least 2 persons (including a child aged 0-59 months). Descriptive statistics and explanatory analysis are presented in the results section.

Model building

The first exploratory analysis used logistic regression modelling to find potential explanatory variables which are associated with child health outcomes. Several models were specified as shown in Appendices 4C and 4D. The models are labelled M0 to M11 for ease of identification. M0 is the basic model or null model. Model M1 contains the

base model and parent presence variables: whether the child lives with parents, mother only, father only and no parents. Model M2 includes the base model, variables in M2 and other household members: grandparent, aunt, uncle, other relatives and not related household member. Model M3 contains variables in models M0, M1, M2 and household wealth.

Model M4 includes variables in model M3 and household context variable: household size, number of children under five years, region and residence. Model M5 includes variables in M4 and two child variables: child sex and child age. Model M6 includes variables in M5 and a transformation of the age variable. A test of linearity with all the variables indicates a nonlinear relationship between child health outcomes and age of the child. Squaring age of the child is included and tested to check if it improves model 5 (M5). Finally models labelled M7 to M11 include variables in M6 and two factor interactions between the parent presence variables and presence of other household members (grandparent, aunt, uncle, other relative and not related member).

The steps outlined above are repeated for diarrhoea prevalence. However unlike with stunting, the best model for diarrhoea prevalence (M6) does not have any interaction terms (see Appendix 4D).

While model building followed the sequence outlined above, other potential explanatory variables on the outcome were determined using the *ulogit* command in *STATA*, which performs univariable logistic regression on a list of categorical and continuous explanatory variables. All the explanatory variables: living with two parents (reference category), one parent (mother or father), no parents and by the types of others living in the household, including a grandparent, aunt, uncle, other relatives and not related household members were kept in the models for stunting and diarrhoea prevalence.

Model selection and assessment

Unweighted versions of the models in Appendices 4C and 4D were also estimated (results not shown here), in order to perform the goodness of fit tests. The models were subjected to the likelihood ratio test and Akaike Information Criterion (AIC) in order to choose the model that best fit the data. Other goodness of fit tests statistics used include the Hosmer-Lemeshow (H-L) goodness of fit statistic, and the Kellie Archer and Stanley

Lemeshow goodness of fit statistic for survey data (Hilbe, 2009). The Hosmer-Lemeshow goodness of fit test provides an assessment of the fitted and observed values of the outcome (Hilbe, 2009). A goodness of fit test designed for evaluating logistic survey models is the Kellie Archer and Stanley Lemeshow (Hilbe, 2009).

Theoretically for the H-L goodness of fit statistic, the fitted and observed values are supposed to be close, a fit statistic is based on the X^2 distribution and a H-L goodness of fit statistic with a p-value greater than 0.05 indicates a good fit (Hilbe, 2009). The results of the H-L goodness of fit statistic suggest that model 7 (M7) for stunting fits the data reasonably well (Hosmer-Lemeshow chi2 (8) =12.48; p-value=0.13), and model 6 (M6) for diarrhoea fits the data (Hosmer-Lemeshow chi2 (8) =8.27; p-value=0.41. The results of the Kellie Archer and Stanley Lemeshow test also confirmed that the models 7 for stunting and model 6 for diarrhoea are well fitted to the data (F-adjusted test statistic =1.34; p-value=0.21, and F-adjusted test statistic=1.41; p-value=0.18), respectively.

Of all the possible models for stunting and diarrhoea prevalence on using the likelihood ratio test, a small p value ($p<0.05$) and the lowest AIC indicates that the fitted model is statistically satisfactory. For stunting, model 7 (M7) was found to be better than model 6 (M6) in Appendix 4C; it had the lowest AIC (AIC=2950.65). The best fit model for diarrhoea prevalence is model 6 (Appendix 4D). Model 6 for diarrhoea was chosen over model 5 (Appendix 4D), as it also had a lower AIC value (AIC=2447.51).

Multilevel regression modelling

The second set of analysis uses multilevel regression modelling to account for household factors which are associated with stunting and diarrhoea. Multilevel modelling is also carried out to account for clustering of children within households and within enumeration areas.

Both the fixed effects and random effects models were specified at higher levels (household and enumeration area level) and the Wald test used to test the effect of improving the random effects models from within *MLwiN* at 5 per cent significant level (Appendices 4E and 4F). The estimations for multilevel modelling were conducted using the 2nd order predictive quasi-likelihood method (PQL2). PQL2 is preferred as Maximum likelihood (MQL1) may produce estimates which are biased downwards (Steele, 2009).

Multilevel analysis is carried out with the explanatory variable identified in model 7 for stunting and model 6 for diarrhoea prevalence (Appendices 4C and 4D). The first step in estimating the random effects models examined the null model (Appendices 4E and 4F). This model allows the intercept to vary by household identifier (HHId) and ea identifier (ea). A Wald test statistic for the null hypothesis for stunting and diarrhoea at 5 per cent significance confirmed a strong evidence that the between household and ea variance is not zero.

The second step adds all the level 1 explanatory variables and level 2 variables to the null model, and the intercept is allowed to vary across households and enumeration areas. The level 1 variables include parent presence variables, other household members, child age, sex, the interaction between parent presence and grandparent. The level 2 variables are household wealth, household size, number of children aged under-five in a household, region, and residence.

At each step of adding the variables above, a change in the estimate for between household variance was noted. A big change in the between household variance suggests that the distribution of a particular explanatory variable is different across the level 2 variable (Steele, 2009). It was noted that an addition of the variable household wealth leads to a reduction in household variance between two subsequent models. The addition of the child variable age, also increased the household variance between subsequent models.

The third step estimated random slopes on household wealth (richest category) and on age of the child. A random slope on wealth and age of the child for stunting and diarrhoea prevalence were not significant. The random intercept models were then tested at level 3 to explore between enumeration areas variances in stunting and diarrhoea. The results from fitting the random intercept model at level 3 are outlined in Appendices 4E and 4F. A Wald test confirmed that model 5 (M5) is better than model 4 (M4) for stunting (Test statistic=9.877; DF=3; $p < 0.05$. While for diarrhoea a Wald test showed that model 4 (M4) is better than model 3 (M3) (Test statistic=23.840; DF=3; $p < 0.001$).

The fitted random intercept model is given by:

$$\gamma_{ijk}=\beta_{0jk} + \beta_1 x_{ijk,}\ldots\ldots\ldots,\beta_p x_{ijk} \quad (1)$$

Where γ_{ijk} is the logit of the outcome for the *i*th child within the *j*th household within the *k*th enumeration area. The term β_{0jk} is the intercept at level two (household) within the level three *(*enumeration area) and it includes the average intercept in level three unit *k* (δ_{0k}) and the random effect at level two unit j (U_{0jk}).

$\beta_{0jk} = \delta_{0k} + U_{0jk}$

The level three model is therefore:

$\delta_{0k} = \gamma_{00} + V_{0k}$

The random effects at household and enumeration area level are represented by the error terms U_{0jk} and V_{0k}, respectively. For the logistic multilevel model, the random effects U_{0jk} and V_{0k} are assumed to follow a normal distribution with mean 0 and variances σ^2_{u0} and σ^2_{v0} (Hilbe, 2009, Snijders and Bosker, 1999, Goldstein et al., 2002a). Finally, from the equation, $x=(x_{1,\ldots} x_p)$ denotes the set of explanatory variables in the model, and $\beta=(\beta_{1,\ldots} \beta_p)$ are the coefficients associated with the explanatory variables in the model. The explanatory variables include parent presence variables, types of other household members, child age, child sex, the interaction between parent presence variables and grandparent (in the case of stunting), household wealth, household size, number of under-five in a household, region, and residence.

Residual diagnostics from the random intercept models

Finally, residual analysis at enumeration area level was determined for the fitted models for stunting and diarrhoea. The results of the residual plot in appendices 4G show that the predicted effects are approximately normally distributed. This further confirms that the models selected for stunting (M5S) and diarrhoea (M4D), as shown in appendix 4E and appendix 4F- respectively, reasonably fit the data.

4.3.3 Missing data

Before running the above analysis, all the variables were investigated for missing values. Missing data can bias the results, and reduce the power of analysis (Rabe-Hesketh, 2004). Hilbe (2009) indicates that missing values are problematic for building a well-fitted statistical model. Again, comparisons between nested models are hard to evaluate using

a likelihood ratio test or a deviance test if the numbers of model observations are different, unless there is an adjustment to the model data (Hilbe, 2009).

The original data had missing cases on the outcomes: stunting (24.4%) and diarrhoea (0.1%), and on maternal variables of education (33.2%), marital status (18.7%) and age (18.7%). The missing data on stunting which was reflected by missing on height for age z scores was due to two reasons: 1) A child had no measurement of height or length (76 cases or 2.8%) and 2) The measurement of the child was outside the minimum and maximum values for height for age (-6/+6 HAZ) and the measurement of length/height was not uniquely identified (586 cases or 21.6%).

In order to obtain measures of height for age z scores, the macros in *STATA* only accept one variable height/length. Otherwise the cases are declared missing. Missingness on stunting was resolved using the WHO child growth standards macros in *STATA* (WHO, 2007b). The procedure reduced the missingness from 24.4 per cent to 7.1 percent. The characteristics of the final 7.1 per cent missing cases (188 weighted count or 184 unweighted count) on height for age z scores are reflected in Table 4.8.

Pattern of missing values for maternal factors

An examination of the pattern of missing values for maternal factors (age, education and marital status) was also determined by residence, region and household wealth (results not shown here). The analysis showed that the distribution of missing values on mother's age and mother's marital status was 60.4 per cent in rural areas, 31.3 per cent in urban villages and 8.3 per cent in a city/ town. The distribution of missing values for mother's education by residence also shows a similar pattern with most missing values observed in rural areas (61.8%), 29.8 per cent in urban villages and the rest in cities/towns. For missingness that is associated with mother's age, mother marital status, mother's education, and region, the distribution shows more missing values in the Central, South,West,North and least cases in the East & North East regions. Missing values for mother's variables are also patterned by household wealth. For example, mothers from poorer households than richer households have a sizeable number of missing values on the three variables; age, marital status and education.

A sensitivity test was conducted by testing how well the models predicted stunting and diarrhoea by adding the variables mother age, education and marital status. The estimates from this model were compared to the already fitted model. Although mother's higher education compared to primary education was negatively associated with stunting ($p<0.1$) and diarrhoea prevalence ($p<0.1$), the variables mother education, age, and marital status were excluded from the final analysis due to higher number of missing values.

4.4 Results

This section presents descriptive and explanatory analysis of the relationship between child health outcomes and household composition.

4.4.1 Descriptive statistics

Sample characteristics

Table 4.1 reports the means for continuous variables used in the analysis. The mean age of the children in the sample is 28.5 months (SE=0.35), and the mean household size is 7.03 (SE=0.07) persons. Although the household size seems large, it is not surprising considering that the general arrangement in LMICs is that households with children include biological parents, relatives and other non-related members (Bronte-Tinkew and DeJong, 2004). Such feature can also be related to the economic situation of the household, characteristics of the household members, and the relevance of such members for household social support and child care. Particularly in urban areas, couples may be living with parents, other relatives or non-related members to assist with child care if the mother is employed. Alternatively, in rural areas, larger families and the presence of other household members might signify strategies to pool socio-economic resources from other relatives and to strengthen ties among family members (Bronte-Tinkew and DeJong, 2004).

Table 4.1: Summary statistics of continuous variables used in the analysis, BFHS 2007

	Observations	Mean[a]	Std. Err.
Household characteristic			
Household size (persons)	2715	7.03	0.07
Child characteristic			
Child's age (months)	2715	28.53	0.35

a=weighted mean. NB: 2622 is the count obtained when the weights were used, and 2715 is the count without weights. Std.Err=standard error.

Household membership. All the children in the analysis conform to one of the parenting household types: what is called living with mother only, father only, both parents and living in households with no biological parents. The first notable feature of Table 4.2 is a larger share of children come from households with both parents (44.1%), 25.5 per cent come from mother only families, and 14.1 per cent of the children come from father only families. Table 4.2 also indicates that no parent households are not uncommon (16.3%).

Co-residence with other household members was ascertained from investigating the listing of these members in the households. The results in Table 4.2 confirm that most of the households with children have other household members present. The distribution of children by household members shows that a fifth of the children live with grandparents (20.0%), 31.0 per cent live with uncles, 33.1 per cent live with aunts, 10.1 per cent live with other relatives and 9.1 per cent live with non- related members. The category grandparent does not make a distinction between maternal and paternal grandparent. Although the analysis recognises the potential differential contribution of maternal or paternal grandparent to child health outcomes; the question of 'which grandparent' is not the focus of the current analysis.

Household headship. Another illustration of living arrangements of children is household headship. Household headship just like household membership may vary with family, household and socio-economic characteristics of the household members. Table 4.2 indicates that a majority of the children live in households headed by grandparents (46.0%), biological mother (19.9%), biological father (20.9%), and very few live in households headed by uncle (2.5%), aunt (4.1%), other relative (4.4%), not related member (1.7%), and ambiguous head (0.4%). Children in households headed by ambiguous heads were recorded as brother/sister to the household head (see Appendix 4B for further details). Households headed by mothers are not a surprise for Botswana.

There are many reasons females can become a household head. In particular, evidence in Botswana suggests unmarried, divorce, widowhood and economic independence as some of the conditions for their existence (Izzard, 1985). A classification of the children by the marital status of their biological mother indicate that 46.7 per cent of them were living with a cohabiting parent, 35.6 per cent live with single parent, 13.0 per cent live with a currently married parent, and 4.5 per cent live with a divorced/separated parent.

Household size. Table 4.2 shows separately the classification of the children by the groups of household size. Children from smaller households constitute 10.3 per cent of the total sample, while most of them are raised in households with 4-6 members (48.6 %) and households with seven or more members (41.1%).

Household wealth. Household differences in wealth were examined, and Table 4.2 shows that most of the children are from poorer and middle households. Only 12.5 per cent of the children come from rich households, nearly three-tenths of children (27.8%) are from the poorest households, and the rest fall in between the two groups.

In the bottom panel of Table 4.2 is the distribution of children by residence and the number of children less than five years in a household. Nearly a fifth of the children live in cities/town (16.6%), and 33.0 per cent are in urban villages and the rest are in rural areas (50.4%). Forty-six per cent (46.1%) of the children are the only child under 5 years in the household, 33.9 per cent are in households with one other child, 20.0 per cent are in households with three or more children (Table 4.2).

Table 4.2: Summary statistics for categorical variables explored in the BFHS 2007 analysis

Variable	Observations	Per cent	Std.Err.*
Biological parent[a]			
Mother only			
Yes	680	25.5	0.009
No	1982	74.5	0.009
Total	2662	100.0	
Father only			
Yes	375	14.1	0.007
No	2286	85.9	0.007
Total	2661	100.0	
Both parents			
Yes	1174	44.1	0.010
No	1488	55.9	0.010
Total	2662	100.0	
No parents			
Yes	433	16.3	0.007
No	2229	83.7	0.007
Total	2662	100.0	
Other adult household members[a]			
Grandparent			
Yes	531	20.0	0.008
No	2130	80.0	0.008
Total	2661	100.0	
Uncle			
Yes	825	31.0	0.010
No	1837	69.0	0.010
Total	2662	100.0	
Aunt			
Yes	881	33.1	0.010
No	1780	66.9	0.010
Total	2661	100.0	
Other relative			
Yes	268	10.1	0.007
No	2394	89.9	0.007
Total	2662	100.0	
Not related member			
Yes	243	9.1	0.007
No	2418	90.9	0.007
Total	2661	100.0	
Mother present in household[b]			
Yes	1853	69.6	0.009
No	808	30.4	0.009
Total	2661	100.0	
Father present in household[b]			
Yes	1549	58.2	0.010
No	1112	41.8	0.010
Total	2661	100.0	
Mother currently present in household[c]			
Yes	2043	77.9	0.009
No	579	22.1	0.009
Total	2622	100.0	

Variable	Observations	Per cent	Std.Err.*
Father currently present in household[c]			
Yes	829	35.9	0.011
No	1482	64.1	0.011
Total	2311	100.0	
Household headship			
Mother			
Yes	530	19.9	0.009
No	2132	80.1	0.009
Total	2662	100.0	
Father			
Yes	557	20.9	0.009
No	2105	79.1	0.009
Total	2662	100.0	
Grandparent			
Yes	1225	46.0	0.010
No	1437	54.0	0.010
Total	2662	100.0	
Uncle			
Yes	66	2.5	0.003
No	2596	97.5	0.003
Total	2662	100.0	
Aunt			
Yes	109	4.1	0.004
No	2553	95.9	0.004
Total	2662	100.0	
Ambiguous			
Yes	10	0.4	0.001
No	2652	99.6	0.001
Total	2662	100.0	
Other relative			
Yes	118	4.4	0.004
No	2544	95.6	0.004
Total	2662	100.0	
Not related			
Yes	47	1.7	0.003
No	2615	98.3	0.003
Total	2662	100.0	
Household size (persons)			
2-3	273	10.3	0.006
4-6	1094	41.1	0.010
7+	1294	48.6	0.010
Total	2661	100.0	
Household socio-economic status			
Poorest	740	27.8	0.009
Second	771	29.0	0.009
Middle	429	16.1	0.008
Fourth	390	14.7	0.008
Richest	332	12.5	0.007
Total	2662	100.0	
Region			
North	302	11.3	0.007
South	778	29.2	0.010
West	486	18.3	0.008
East & North East	271	10.2	0.007
Central	826	31.0	0.009
Total	2662	100.0	

Variable	Observations	Per cent	Std.Err.*
Residence			
City/Town	441	16.6	0.008
Urban village	879	33.0	0.010
Rural	1342	50.4	0.010
Total	2662	100.0	
No.of under-fives in a household			
1	1226	46.1	0.010
2	903	33.9	0.010
3	401	15.1	0.007
4	94	3.5	0.004
5	21	0.8	0.002
6	16	0.6	0.001
Total	2662	100.0	
Child's age group(months)			
0-2	98	3.7	0.004
3-5	140	5.2	0.005
6-11	299	11.2	0.006
12-23	577	21.7	0.009
24-35	572	21.5	0.008
36-47	526	19.8	0.008
48-60	450	16.9	0.008
Total	2662	100.0	
Child's sex			
Female	1324	49.7	0.010
Male	1338	50.3	0.010
Total	2662	100.0	

a= It indicates whether a household member was listed in the household regardless of the household headship.b=this is determined by author and indicates whether the biological mother or father is listed in the household regardless of the household headship and household membership.c=Determined from a question asked in the household roster. Std.Err=standard error.

Co-residence with biological parents and other household members

Table 4.3 presents the distribution of children in households headed by different households' members and whether biological parents are listed in the household. A large share of children living in households headed by the biological mother, live with mother only (69.8%), 27.1 per cent live with both parents, and 3.1 per cent live with no parents. Most of the children in father headed households live with their biological father (92.8%) and father only (7.2%) without the biological mother. On the other hand, children in households headed by grandparents, live mostly with both parents (33.7%), no parents (25.0%), 22.2 per cent with father only and the 19.2 per cent live with mother only. In contrast children in households headed by uncle, aunt or ambiguous heads, are more likely to live without biological parents.

Table 4.3 also shows that most of the children in households headed by other relatives, mainly live with both parents (51.2%), 30.4 per cent live with father only, 10.8 per cent live with mother only, and 7.6 per cent live with neither biological parent. Only 7.9 per

cent of children in households headed by a not related member are without parents, 37.9 per cent in this group live with father only, 34.9 per cent live with both parents and the rest live with mother only.

Table 4.3: Per cent distribution of household headship by whether a child's biological parents are in the household, BFHS 2007

	All children (N=2662)											
	Mother only			**Father only**			**Both parents**			**No parents**		
Characteristic	%	n	Total	%	n	Total	%	n	Total	%	n	Total
Household headship												
Mother												
Yes	69.8	370	530	0.0	0	530	27.1	144	530	3.1	17	530
No	14.5	310	2132	17.6	375	2132	48.3	1030	2132	19.5	416	2132
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Father												
Yes	0.0	0	557	7.2	40	557	92.8	517	557	0.0	0	557
No	32.3	680	2105	15.9	335	2105	31.2	657	2105	20.6	433	2105
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Grandparent												
Yes	19.2	235	1225	22.2	272	1225	33.7	413	1225	25.0	306	1225
No	31.0	445	1437	7.2	104	1437	53.0	761	1437	8.8	127	1437
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Uncle												
Yes	41.4	27	66	4.3	3	66	12.2	8	66	42.1	28	66
No	25.1	652	2596	14.4	373	2596	44.9	1166	2596	15.6	405	2596
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Aunt												
Yes	24.0	26	109	6.7	7	109	14.6	16	109	54.8	60	109
No	25.6	653	2553	14.4	368	2553	45.4	1158	2553	14.6	373	2553
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Ambiguous												
Yes	0.0	0	10	0.0	0	10	0.0	0	10	100.0	10	10
No	25.6	680	2652	14.2	375	2652	44.3	1174	2652	15.9	423	2652
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Other relative												
Yes	10.8	13	118	30.4	36	118	51.2	60	118	7.6	9	118
No	26.2	667	2544	13.4	340	2544	43.8	1114	2544	16.7	424	2544
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662

	All children (N=2662)											
	Mother only			**Father only**			**Both parents**			**No parents**		
Characteristic	%	n	Total	%	n	Total	%	n	Total	%	n	Total
Not related												
Yes	19.3	9	47	37.9	18	47	34.9	16	47	7.9	4	47
No	25.6	671	2615	13.7	358	2615	44.3	1158	2615	16.4	429	2615
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662

Row total adds to 100%.

Table 4.4 shows the distribution of children in households with other household members and whether the child's biological parents are present in the household. When a grandparent of the child is present, 34.5% of the children are likely to be living with both parents, in comparison to 56.6% when the uncle is present and 38.7 per cent when the aunt is present. The proportion of children living with both parents is also higher when other relatives (40.4%) and not related members (56.0%) are present. Table 4.4 also shows that children co-resident with neither parents are more likely to be in households with their grandparent (22.9%) and in households with non-related members (16.1%). Children living with mother only are common in households with other relatives (34.0%) and aunts (26.5%). In comparison, children in father only households mostly live with uncles (33.6%) and grandparents (24.0%).

Table 4.4: Per cent distribution of co-residence of other household members related to the child by whether a child's biological parents are in the household, BFHS 2007

	All children (N=2662)											
	Mother only			**Father only**			**Both parents**			**No parents**		
Characteristic	%	n	Total	%	n	Total	%	n	Total	%	n	Total
Presence of other household members												
Grandparent												
Yes	18.6	99	531	24.0	128	531	34.5	183	531	22.9	122	531
No	27.3	581	2130	11.6	248	2130	46.5	991	2130	14.6	311	2130
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Uncle												
Yes	7.8	64	825	33.6	277	825	56.6	467	825	2.1	17	825
No	33.5	615	1837	5.4	98	1837	38.5	707	1837	22.6	416	1837
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Aunt												
Yes	26.5	234	881	18.9	166	881	38.7	341	881	15.9	140	881
No	25.0	446	1780	11.8	209	1780	46.8	833	1780	16.4	293	1780
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Other relative												
Yes	34.0	91	268	9.5	26	268	40.4	108	268	16.1	43	268
No	24.6	588	2394	14.6	350	2394	44.5	1066	2394	16.3	390	2394
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662
Not related												
Yes	15.5	38	243	13.4	33	243	56.0	136	243	15.1	37	243
No	26.5	642	2418	14.2	343	2418	42.9	1038	2418	16.4	396	2418
Total	25.5	680	2662	14.1	375	2662	44.1	1174	2662	16.3	433	2662

Row total adds to 100%.

Child morbidity, household composition, household context and other factors

The second set of questions investigated the relationship between child health outcomes, household composition and household context. Overall the prevalence of stunting is 29.9 per cent, while 18.0 per cent of children were reported as having suffered from diarrhoea (Table 4.5). Table 4.5 indicates a significant association between stunting, diarrhoea prevalence and household headship; p value =0.008 and p value=0.036, respectively. The association between stunting and household head indicates that children who live in households headed by biological parents and grandparents are less likely to be stunted compared to those living in households headed by uncle, aunt, other relative or not related member. For example the results on stunting indicate that 30.1 per cent of children in mother headed households, 24.8 per cent in father headed households are stunted. In contrast, 45.7 per cent of children in households headed by an uncle, and 35.1 per cent in aunt headed households are stunted. Interestingly, a larger proportion of children in households headed by mother's are stunted (30.1%) compared to those in households headed by fathers (24.8%).

The results on diarrhoea prevalence give a somewhat mixed picture, although it seems now children in households headed by mothers do better than those headed by fathers (15.2% versus 19.1%), and those headed by a grandparent (18.6%). Variations in diarrhoea prevalence by uncle, aunt, ambiguous, other relative and not related household head remain hard to interpret due to the small number of cases in these groups (Table 4.6).

Table 4.5: Per cent distribution of child health outcomes by household headship, BFHS 2007

	Stunted (below -2 SD height/age)				Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey			
	%	Total	N	% miss.	%	Total	N	% miss.
Household head's relationship to the child								
Mother	30.1	496	530	6.4	15.2	530	530	0.0
Father	24.8	515	557	7.6	19.1	557	557	0.0
Grandparent	30.0	1150	1225	6.1	18.6	1223	1225	0.2
Uncle	45.7	65	66	0.7	13.0	66	66	0.0
Aunt	35.4	94	109	13.7	10.6	108	109	1.3
Ambiguous	58.4	6	10	44.3	33.9	10	10	0.0
Other relative	33.2	106	118	10.2	27.0	118	118	0.0
Not related	41.7	42	47	10.0	18.7	47	47	0.0
Grand Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1
p value	0.008				0.036			

Total=is number of children with or without the condition and living with a specific head. N=All children including those with missing data.

Table 4.6 shows the per cent distribution of child health outcomes by presence of biological parents and other household members. Stunting seems to be associated with living with neither parent (32.6%), not related household members (31.1%), and living only with a father (30.8%). Children living in households where only the father is present (21.1%), and those living with a grandparent (20.6%), are also more likely to have diarrhoea.

Table 4.6: Per cent distribution of child health outcomes by presence of biological parents and other household members, BFHS 2007

	Stunted (below -2 SD height/age)				Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey			
	%	Total	N	% miss.	%	Total	N	% miss.
Children by presence of parents and other household members								
Mother only[a]	30.4	631	680	7.2	15.5	680	680	0.0
Father only[b]	30.8	349	375	7.1	21.1	373	375	0.6
Both parents	28.4	1093	1174	6.9	20.1	1174	1174	0.0
No parents	32.6	401	433	7.3	13.5	431	433	0.3
Mother present[c]	29.1	1724	1853	7.0	18.4	1853	1853	0.0
Father present[d]	29.0	1442	1549	6.9	20.3	1547	1549	0.1
Grandparent	29.5	505	531	5.0	20.6	531	531	0.0
Uncle	30.9	779	825	5.7	19.7	823	825	0.3
Aunt	29.9	828	881	6.1	18.6	879	881	0.2
Other relatives	27.3	252	268	6.1	14.8	268	268	6.1
Not related member	31.1	229	243	5.8	14.5	243	243	0.0
Grand Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1

Total=is number of children with or without the condition and living with a household member. N=All children including those with missing data. **a**=only mother of the child is listed in the household, and not the father.**b**=only father of the child is in the household, and not mother. **c**=determined from type of household head and whether mother is present in household; MH+MP, FH+MP, GH+MP, UH+MP, AH+MP, ORH+MP, NRH+MP. **d**=determined from type of household head and whether father is present in household; MH+FP, FH+FP, GH+FP, UH+FP, AH+FP, ORH+FP, NRH+FP.

Table 4.7 reports the means of child outcomes by household size and age of the child. Both the household size and age of the child are significantly associated with stunting and diarrhoea. For example the results on stunting indicate that children who are stunted are in larger households (7.4 persons) compared to those who are not stunted (6.9 persons). The mean age for children who are stunted is lower than those not stunted, 25.8 months and 30.1 months, respectively (Table 4.7).

Table 4.7: Weighted means of child health outcomes by household size and age of the child, BFHS 2007

	All children (N=2662)															
	Stunted (below -2 SD height/age)								Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey							
	Yes		**No**				**Missing**		**Yes**		**No**				**Missing**	
Characteristic	Mean	n	Mean	n	Total	p value	N.missing	% missing	Mean	n	Mean	n	Total	p value	N.missing	% missing
Household size (persons)[a]	7.4	741	6.9	1733	2474	0.002	188	7.1	7.4	478	7.0	2180	2658	0.045	3	0.1
SE.	0.1		0.1						0.2		0.1					
Child's age (months)[a]	25.8	741	30.1	1733	2474	0.000	188	7.1	22.0	478	29.9	2180	2658	0.000	3	0.1
SE.	0.6		0.5						0.7		0.4					
Grand Total	29.9	741	70.1	1733	2474		188	7.1	18.0	478	82.0	2180	2658		3	0.1

a=the variables are continuous and the analysis gives the mean and standard error of the explanatory variable on the outcome. SE= standard error. % missing = per cent missing on the outcome. n denotes the number of children in the subgroup.

Child health outcomes and selected categorical variables

Table 4.8 examines child health outcomes by household and child characteristics. Household wealth, child's age and child's sex are significantly associated with both stunting and diarrhoea. Household size, region, residence also matter for stunting. The number of children under 5 years old is important only for diarrhoea prevalence.

The variation in stunting and diarrhoea prevalence by household wealth is stark. Poorer households (1^{st}-4^{th} quintiles) have higher disease prevalence than those in rich households (5^{th} quintile). Children living in the poorest households are more likely to be stunted (33.8%), whereas those living in the richest households were least likely to be stunted (17.6%). Even so, the pattern for diarrhoea shows that 22.3 per cent of the children in the poorest households are more likely to have the disease compared to only 8.9 per cent in the richest households. The findings on household wealth, stunting and diarrhoea prevalence are not surprising, and they are consistent with prior research evidence. Several studies indicate that wealthier households confer better nutrition, and economic and social resources for better child health care than poorer households (Miller and Korenman, 1994, Fuchs and Victora, 2002, Bradley and Corwyn, 2002).

Table 4.8 examines child health outcome by residence. Children living in the rural areas (32.8%) are more likely to be stunted compared to those living in urban villages (27.8%), or those in city/town (25.6%). Table 4.8 also considered the variation in stunting and diarrhoea by the number of children aged 0-5 years in a household (inclusive of the reference child). Stunting is higher in households with more children than fewer children, 33.3 per cent and 29.1 percent, respectively. The difference in diarrhoea prevalence by the number of children in the household reflects that in households with 1-2 children, 17.1 per cent of the children have diarrhoea, and in households with 3-6 children, 21.5 per cent of the children have diarrhoea.

In Table 4.8, child health outcomes are categorised by child's age group and sex. Stunting and diarrhoea are high among children aged 12-23 months. For example, the proportion stunted at 0-2 months is 25.2 per cent, 43.4 per cent at ages 12-23 months, and 16.4 per cent at 48-60 months. Further, Table 4.8 shows that child's sex is significantly associated with stunting; 32.6 per cent of males compared to 27.3 per cent of females. On the other hand, for diarrhoea there isn't a large difference between males

and females (19.0% versus 17.0%). The results on stunting by child's age and sex are consistent with evidence in the literature. Generally, males are at greater risk of stunting than females (Bronte-Tinkew and DeJong, 2004, Lesiapeto et al., 2010, Wamani et al., 2007). Stunting is also shown to be pronounced at later ages, since it is an indicator of long term illness and its effect is cumulative (Horton, 1986, Dewey and Begum, 2011).

Table 4.8: Per cent distribution of child health outcomes by household and child characteristics, BFHS 2007

Characteristic	Stunted (below -2 SD height/age)				Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey			
	%	Total	N	% missing	%	Total	N	% missing
Household size (persons)								
2-3	27.3	263	273	3.7	17.0	273	273	0.0
4-6	27.7	1004	1094	8.2	16.3	1092	1094	0.2
7+	32.4	1206	1294	6.8	19.6	1293	1294	0.1
Total	29.9	2473	2661	7.1	18.0	2658	2662	0.1
Socio-economic status								
Poorest	33.8	687	740	7.1	22.3	736	740	0.5
Second	35.1	719	771	6.8	18.2	771	771	0.0
Middle	27.7	398	429	7.3	18.1	429	429	0.0
Fourth	25.3	361	390	7.6	16.9	390	390	0.0
Richest	17.6	309	332	6.7	8.9	332	332	0.0
Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1
Region[a]								
North	26.2	280	302	7.3	21.3	302	302	0.0
South	25.3	718	778	7.7	16.3	778	778	0.0
West	33.0	442	486	8.9	21.6	484	486	0.3
East & North East	33.8	256	271	5.6	14.3	271	271	0.0
Central	32.5	779	826	5.7	17.5	824	826	0.3
Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1
Residence								
City/Town	25.6	411	441	6.8	15.8	441	441	0.0
Urban village	27.8	822	879	6.5	17.3	879	879	0.0
Rural	32.8	1241	1342	7.5	19.1	1339	1342	0.3
Total	29.9	2473	2662	7.1	18.0	2658	2662	0.1
No.of under-fives in a household								
1-2	29.1	1975	2129	7.2	17.1	2125	2129	0.2
3-6	33.3	499	533	6.4	21.5	533	533	0.0
Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1
Child's age group(months)								
0-2	25.2	81	98	17.6	8.7	98	98	0.0
3-5	23.1	134	140	4.1	22.5	140	140	0.0
6-11	28.7	271	299	9.6	28.3	299	299	0.0
12-23	43.4	539	577	6.7	29.1	577	577	0.0
24-35	35.7	534	572	6.6	17.7	572	572	0.0
36-47	24.0	487	526	7.3	9.1	524	526	0.3
48-60	16.4	429	450	4.8	8.3	448	450	0.5
Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1
Child's sex								
Female	27.3	1233	1324	6.9	19.0	1322	1324	0.2
Male	32.6	1241	1338	7.3	17.0	1336	1338	0.1
Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1
Grand Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1

Total=is number of children with or without the condition. N=All children including those with missing data. a= Region is coded from all the districts in Botswana, and **North** includes: Ngamiland East, Ngamiland West, Ngamiland Chobe, Kgalagadi North. **South** includes: Gaborone, Lobatse, Jwaneng, South East, Kweneng East, Kgatleng.West includes: Southern Ngwaketse, Southern Borolong, Southern Ngwaketse West, Kgalagadi South, Kweneng West, Ghanzi**. East and North East includes**: Francistown, Selebi Phikwe, and North East, and **Central** includes: Orapa, Sowa, Serowe/Palapye, Mahalapye, Bobirwa and Tutume.

Table 4.9 classifies the types of stunting by child's sex and age group. Of the 29.9 per cent of children who are stunted, 25.9 per cent are mildly stunted, 16.7 per cent are moderately stunted, 13.4 per cent are severely stunted, and the rest are better nourished. The prevalence of stunting is higher for males (32.6%) than females (27.3%). Table 4.9 also shows that stunting is higher in the age group 12-23 months (43.4%) and it is lowest in the age group 48-60 months (16.4%).

Table 4.9: Per cent distribution of types of stunting by child's sex and age, BFHS 2007

Characteristic	Severe ht/age ≥ -6 and <-3 SD %	Moderate ht/age ≥ -3 and <-2 SD %	Mild ht/age ≥ -2 and <-1 SD %	Normal ht/age ≥ -1 SD %	Overall stunted %	Total n	Total Count	Missing %	Missing n
Child's sex									
Female	11.49	16.11	26.72	45.67	27.3	1233	1324	6.9	91
Male	15.32	17.23	25.15	42.29	32.6	1241	1338	7.3	97
Child's age group (months)									
<6	15.3	8.6	18.4	57.7	23.9	215	238	9.7	23
6-11	15.7	13.0	22.9	48.4	28.7	271	299	9.6	29
12-23	19.1	24.3	23.8	32.8	43.4	539	577	6.7	39
24-35	15.0	20.7	27.8	36.6	35.7	534	572	6.6	38
36-47	10.3	14.5	26.8	48.5	24.0	487	526	7.3	39
48-60	5.4	11.0	31.0	52.6	16.4	429	450	4.8	21
Total	13.4	16.7	25.9	44.0	29.9	2474	2662	7.1	188

Count denotes number of children in an age group, n is the number of children in a sub group, ht/age is height for age z scores. The number of observations is 2662, it includes all children in addition to those with missing values on stunting.

Household composition. In the remainder of this section, further details on the association between child health and household composition are described (Table 4.10-4.12). Generally the distribution of stunting by household category indicates a higher percentage of stunted children in no parents households (32.6%), followed by father only households (30.8%), mother only households (30.4%), and least in households with both parents (28.4%). Further, Table 4.10 shows that 21.1 per cent of the children in father only households have diarrhoea, compared to 20.1 per cent who live with both parents, 15.5 per cent living in mother only households and the rest who live with no parents (13.5%).

Table 4.10: Per cent distribution of child health outcomes by household composition (Independent events), BFHS 2007

Characteristic	Stunted (below -2 SD height/age)				Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey			
	%	Total	N	% miss.	%	Total	N	% miss.
One parent (mother) present in household								
Mother+all	30.4	631	680	7.2	15.5	680	680	0.0
Mother+child only (2 persons)	24.3	37	37	1.9	11.5	37	37	0.0
Mother+grandparent+all	36.4	95	99	4.2	17.6	99	99	0.0
Mother+aunt+all	29.3	216	234	7.6	16.4	234	234	0.0
Mother+uncle+all	40.4	62	64	3.8	16.7	64	64	0.0
Mother+other relatives+not related+all	26.7	114	122	6.4	17.2	122	122	0.0
One parent (father) present in household								
Father+all	30.8	349	375	7.1	21.1	373	375	0.6
Father+child only (2 persons)	0.0	2	2	0.0	45.7	2	2	0.0
Father+grandparent+all	36.1	119	128	6.8	18.7	128	128	0.0
Father+aunt+all	29.4	154	166	7.4	22.1	164	166	1.2
Father+uncle+all	32.8	260	277	6.4	21.5	275	277	0.7
Father+other relatives+not related+all	31.4	49	52	6.8	9.9	52	52	0.0
Two parents present in household								
Both parents+all	28.4	1093	1174	6.9	20.1	1174	1174	0.0
Both parents+child only (3 persons)	31.2	88	91	3.6	20.9	91	91	0.0
Both parents+grandparent+all	24.1	174	183	4.9	25.6	183	183	0.0
Both parents+aunt+all	28.5	327	341	4.2	20.6	341	341	0.0
Both parents+uncle+all	28.4	441	467	5.6	19.2	467	467	0.0
Both parents+(other relatives+not related) +all	29.4	217	230	6.0	14.7	230	230	0.0
No parents present in household								
No parents+all	32.6	401	433	7.3	13.5	431	433	0.3
No parents+ child (2 persons)	22.3	13	13	0.0	4.5	13	13	0.0
Grandparent +all	25.3	117	122	3.6	17.7	122	122	0.0
Aunt +all	34.8	131	140	6.5	13.2	140	140	0.0
Uncle+all	32.4	17	17	2.7	15.9	17	17	0.0
Other relatives+not related member +all	32.8	74	77	3.8	11.3	77	77	0.0
Grand Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1

The categories for household composition are defined from whether the child's parents and other adult members are listed in the household. The categories in this table are independent events; they can occur at the same time. All refers to other household members, which is any of the combinations of grandparent/aunt/uncle/other relative/not related household member. N= all children under 5 years from all the households. Row total adds to 100%.

Table 4.11 shows the distribution of child health outcomes for the four parent presence variables (mother only, father only, both parents and no parents) split into whether a child lives with only a parent, grandparent, aunt, uncle, other relatives/not related household member or other household member combinations (multiple membership). Here unlike in Table 4.10 where the events are independent and can occur at the same time, the groups in Table 4.11 are mutually exclusive; that is they can't occur together. Among children living in mother only households, those living with a grandparent are much more likely to be stunted (61.4%), compared to those living with an uncle (49.3%), living in multiple membership (30.9.8%), living with an aunt (29.5%), living with a mother (28.1%), and living with other relatives/not related household member (21.9%).

The distribution of diarrhoea prevalence for the mother only category indicates that 20.3 per cent of the children in this group and living with an uncle had the greatest risk of the illness, followed by 17.8 per cent in multiple membership, 16.9 per cent living with other relatives/not related household members, 15.9 per cent living with an aunt, 14.3 per cent living with mother and 10.3 per cent living with a grandparent (Table 4.11). Living in households with only the father also shows that the proportion of children with diarrhoea in these households varies by whether the father stays alone or stays with other household members (Table 4.11).

Table 4.11: Per cent distribution of stunting and diarrhoea by household composition (Mutually exclusive), BFHS 2007

Characteristic	Stunted (below -2 SD height/age)				Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey			
	%	Total	N	% miss.	%	Total	N	% miss.
One parent (mother) present in Household								
Mother	28.1	281	307	8.3	14.3	307	307	0.0
Mother+grandparent	61.4	30	32	6.1	10.3	32	32	0.0
Mother+aunt	29.5	125	137	8.5	15.9	234	137	0.0
Mother +uncle	49.3	17	17	0.0	20.3	17	17	0.0
Mother +(other relatives+not related)	21.9	61	63	3.3	16.9	63	63	0.0
Multiple membership[a]	30.9	116	123	6.5	17.8	123	123	0.0
Total			679				679	
One parent (father) present in household								
Father	25.8	69	76	8.8	23.1	76	76	0.0
Father+grandparent	23.7	5	5	0.0	14.9	5	5	0.0
Father+aunt	3.6	5	6	13.3	13.3	6	6	0.0
Father +uncle	35.2	52	54	4.4	21.7	54	54	0.0
Father+(other relatives+not related)	29.1	10	12	13.8	6.0	12	12	0.0
Multiple membership[a]	32.2	208	223	6.8	21.4	221	223	0.9
Total			375				375	
Two parents present in household								
Both parents	28.3	489	532	8.1	22.3	532	532	0.0
Both parents+grandparent	33.6	11	12	4.5	62.2	12	12	0.0
Both parents+aunt	29.3	20	22	7.4	15.8	22	22	0.0
Both parents+uncle	30.2	72	80	9.6	15.5	80	80	0.0
Both parents+(other relatives+not related)	29.0	125	134	7.0	10.5	134	134	0.0
Multiple membership[a]	27.8	376	395	4.7	20.2	395	395	0.0
Total			1174				1174	
No parents present in household								
No parents[b]	35.8	149	167	10.9	12.5	166	167	0.8
Grandparent	20.5	56	58	3.2	17.6	58	58	0.0
Aunt	39.4	77	84	7.9	12.8	84	84	0.0
Uncle	31.4	13	14	3.4	19.9	14	14	0.0
Other relatives+not related member	26.9	31	33	5.9	6.3	33	33	0.0
Multiple membership[a]	31.1	75	77	3.3	15.3	77	77	0.0
Total			433				433	
Grand Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1

Categories for household composition are defined from whether the child's parents and other adult members are listed in the household, and are mutually exclusive. For example mother + grandparent, includes mother, grandparent and child, the child (ren) in this group can't be in the other groups under mother only households. a=parent/no parent plus other persons. b=no parents in the household. Grand total= all children under 5 years from all the households.
% miss=per cent missing. Row total adds to 100%.

Table 4.12 shows additional information to Table 4.11 on the variation of child health outcomes among children living with a parent and combinations of grandparent, aunt, and uncle. For both the conditions, it appears living with an aunt is beneficial to the child, except for stunting where children living with no parents and aunt were stunted (39.4%), compared to 20.5 per cent living with a grandparent and 31.4 per cent living with an uncle (Table 4.12).

Table 4.12: Per cent distribution of stunting and diarrhoea by multiple memberships (Mutually exclusive), BFHS 2007

	Stunted (below -2 SD height/age)				Diarrhoea in the last 24 hours and in the 2 weeks prior to the survey			
Characteristic	%	Total	N	% mis.	%	Total	N	% mis.
One parent (mother) present in hh.								
Mother	28.1	281	307	8.3	14.3	307	307	0.0
Mother+grandparent	61.4	30	32	6.1	10.3	32	32	0.0
Mother+aunt	29.5	125	137	8.5	15.9	234	137	0.0
Mother +uncle	49.3	17	17	0.0	20.3	17	17	0.0
Mother +(other relatives+not related)	21.9	61	63	3.3	16.9	63	63	0.0
Mother+aunt+uncle	41.5	23	25	4.8	9.9	25	25	0.0
Mother+grandparent+aunt+uncle	0.0	5	5	0.0	0.0	5	5	0.0
Multiple membership[a]	29.8	87	94	7.2	20.8	94	94	0.0
Total			679				679	
One parent (father) present in household								
Father	25.8	69	76	8.8	23.1	76	76	0.0
Father+grandparent	23.7	5	5	0.0	14.9	5	5	0.0
Father+aunt	3.6	5	6	13.3	13.3	6	6	0.0
Father +uncle	35.2	52	54	4.4	21.7	54	54	0.0
Father+(other relatives+not related)	29.1	10	12	13.8	6.0	12	12	0.0
Father+aunt+uncle	27.4	86	92	7.2	26.1	90	92	2.2
Father+grandparent+aunt+uncle	34.2	63	68	7.1	17.5	68	68	0.0
Multiple membership[a]	37.2	59	62	6.1	18.9	62	62	0.0
Total			375				375	
Two parents present in household								
Both parents	28.3	489	532	8.1	22.3	532	532	0.0
Both parents+grandparent	33.6	11	12	4.5	62.2	12	12	0.0
Both parents+aunt	29.3	20	22	7.4	15.8	22	22	0.0
Both parents+uncle	30.2	72	80	9.6	15.5	80	80	0.0
Both parents+(other relatives+not related)	29.0	125	134	7.0	10.5	134	134	0.0
Both parents+aunt+uncle	31.4	195	204	4.2	17.6	204	204	0.0
Both parents+grandparent+aunt+uncle	24.2	107	112	3.8	25.3	112	112	0.0
Multiple membership[a]	23.3	74	80	7.1	19.9	80	80	0.0
Total			1174				1174	
No parents present in household								
No parents[b]	35.8	149	167	10.9	12.5	166	167	0.8
Grandparent	20.5	56	58	3.2	17.6	58	58	0.0
Aunt	39.4	77	84	7.9	12.8	84	84	0.0
Uncle	31.4	13	14	3.4	19.9	14	14	0.0
Other relatives+not related member	26.9	31	33	5.9	6.3	33	33	0.0
Aunt+uncle	54.0	2	2	0.0	0.0	2	2	0.0
Grandparent+aunt+uncle	.	.	.	.	.	.	.	.
Multiple membership[a]	30.4	72.4	75	3.4	15.8	75.0	75	0.0
Total			433				433	
Grand Total	29.9	2474	2662	7.1	18.0	2658	2662	0.1

N:B The categories are mutual and can't occur simultaneously. There are no observations for the combination of no parents+ grandparent+aunt+uncle and this is represented by (.). N= all children under 5 years from all the households. a=parent/no parent plus other persons; combinations not in the list.b=no parents in the household. Row total adds to 100%. % mis= per cent missing.

4.4.2 Explanatory analysis

The results of the random effects models for stunting and diarrhoea prevalence are shown in Table 4.13. The results from Table 4.13 are interpreted as log-odds of the outcome (coefficient or β) and as odds ratios (OR=exp (β)). An odds ratio less than 1 is synonymous to a negative coefficient and it represents reduced morbidity. While an odds ratio greater than 1, is represented by a positive coefficient and it indicates increased morbidity (Hilbe, 2009).

Table 4.13: Fitted random intercept models for child health outcomes, BFHS 2007

	Stunting			Diarrhoea		
Variable	Coef.	S.E.	p-value	Coef.	S.E.	p-value
Fixed Part						
Intercept	-1.791	0.375	***	-0.284	0.434	
Parent (s) in a household						
both parents (ref.)						
mother only	0.055	0.154		-0.431	0.176	**
father only	0.000	0.200		0.287	0.191	
no parents	0.419	0.181	**	-0.480	0.215	**
Other household members						
grandparent	-0.253	0.241		0.173	0.168	
aunt	-0.297	0.132	**	0.103	0.157	
uncle	0.147	0.160		-0.305	0.187	
other relative	-0.348	0.191	*	-0.092	0.229	
not related	0.367	0.182	**	-0.265	0.237	
HH. Socio-economic status						
Poorest (ref.)						
Second	0.100	0.151		-0.136	0.181	
Middle	-0.253	0.194		-0.271	0.232	
Fourth	-0.594	0.213	***	-0.394	0.248	
Richest	-0.917	0.248	***	-1.367	0.321	***
Household size (persons)						
2-3 persons (ref.)						
4-6 persons	-0.069	0.193		-0.024	0.233	
7+ persons	0.063	0.219		-0.035	0.263	
No.of under fives						
1 (ref.)						
2	0.159	0.130		-0.103	0.156	
3-4	0.228	0.169		0.117	0.197	
5-6	0.770	0.516		-0.558	0.772	
Region						
North (ref.)						
South	0.156	0.224		-0.153	0.259	
West	0.343	0.217		0.136	0.246	
East & North East	0.521	0.277	*	-0.430	0.335	
Central	0.281	0.201		-0.184	0.232	
Residence						
City/town (ref.)						
Urban Village	-0.004	0.222		-0.440	0.258	*
Rural	-0.018	0.228		-0.496	0.271	*
Child's sex						
Female (ref.)						
Male	0.360	0.103	***	-0.137	0.123	
Child's age(months)						
age	0.078	0.013	***	0.012	0.015	
age^2	-0.002	0.000	***	-0.001	0.000	***
Interactions						
both parents*grandparent (ref.)						
motheronly*grandparent	0.694	0.366	*			
fatheronly*grandparent	0.498	0.359				
noparents*grandparent	-0.529	0.388				

	Stunting			Diarrhoea		
Variable	Coef.	S.E.	p-value	Coef.	S.E.	p-value
Random Part						
Level 3: ea						
cons/cons	0.127	0.073	*	0.150	0.100	
Level 2: HHId						
cons/cons	0.703	0.161	***	0.922	0.225	***
Level 1: ChildId						
bcons.1/bcons.1	1.000	0.000		1.000	0.000	
Statistics						
EA. level VPC (%)	3.08			3.44		
Household level VPC (%)	17.06			21.14		
Units: ea	298			298		
Units: HHId	1804			1892		
Units: ChildId	2531			2713		

ref.=reference category. Coef. =coefficient; S.E=standard error; EA=enumeration area; VPC=Variance partition coefficient. Legend: * p<.1; ** p<.05; *** p<.01. Note: Variable 'parent (s) in a household' is a categorical variable with four levels and both parents is the reference category. The variables 'other house members' are each dummies (1 for presence of a household member and 0 for absence of the household member).

Factors associated with prevalence of stunting

Table 4.13 shows that several variables are statistically associated with stunting, and they include living with no parents, living with an aunt, other relatives and not related household members, household wealth, region, sex of the child and age of the child. None of the parent presence variables (the child lives with mother or father), compared with a child living with two parents are statistically significant at 5 per cent level of significance, although the association is in the expected direction (Table 4.13). There is also evidence of a grandparent being a moderator between the effects of mother on stunting, as compared to children living with both parents.

Household characteristics

Controlling for the rest of the other explanatory variables in Table 4.13, children living in rich households (5^{th} quintile) have 60 per cent decrease in the odds of being stunted compared to those in the poorest households (1^{st} quintile). Children in the 4^{th} quintile also have lower odds of being stunted [(1-0.55)*100=45.0%], compared to those in the poorest households.

Table 4.13 further indicates that children living in the East and North East parts of the country have greater odds of being stunted (68%) compared to those staying in the North part of the country.

Child characteristics

Males have 43 per cent greater odds of being stunted than female children (OR=1.43; 95% CI 1.17-1.75). With respect to the age of the child, there is 8 per cent increase in the odds of being stunted with each additional month (OR=1.08; 95% CI 1.05-1.11).

The interaction term in the model for stunting

To evaluate the possibility of an interaction between the two variables: presence of parent (s) and grandparent in a household was tested for significance. Only one interaction term between mother and grandparent present in the household was significant at 10 per cent level, the rest were not statistically significant (Table 4.13). In determining the meaning of this two way interaction, four possible combinations of the binary explanatory variables (mother only and grandparent present in household) were obtained as shown in Table 4.14.

Table 4.14: Four possible combinations from the interaction term between mother and grandparent presence in the household

Group	mother only (β_1)	grandparent (β_2)	mother only*grandparent (β_3)
A	0	0	0
B	0	1	0
C	1	0	0
D	1	1	1

0=No or absent and 1=Yes or present. Note: The other interactions between father, no parents and grandparent presence in the household are not shown here since they were not statistically significant.

Subsequently, the associated log odds of stunting were obtained for the four groups (A-D) using the coefficients from Table 4.13 on the intercept (-1.791), coefficient on mother presence in household (0.055), coefficient on grandparent presence in household (-0.253) and coefficient on the interaction term mother and grandparent present in household (0.694) as follows:

Group A= α = -1.791

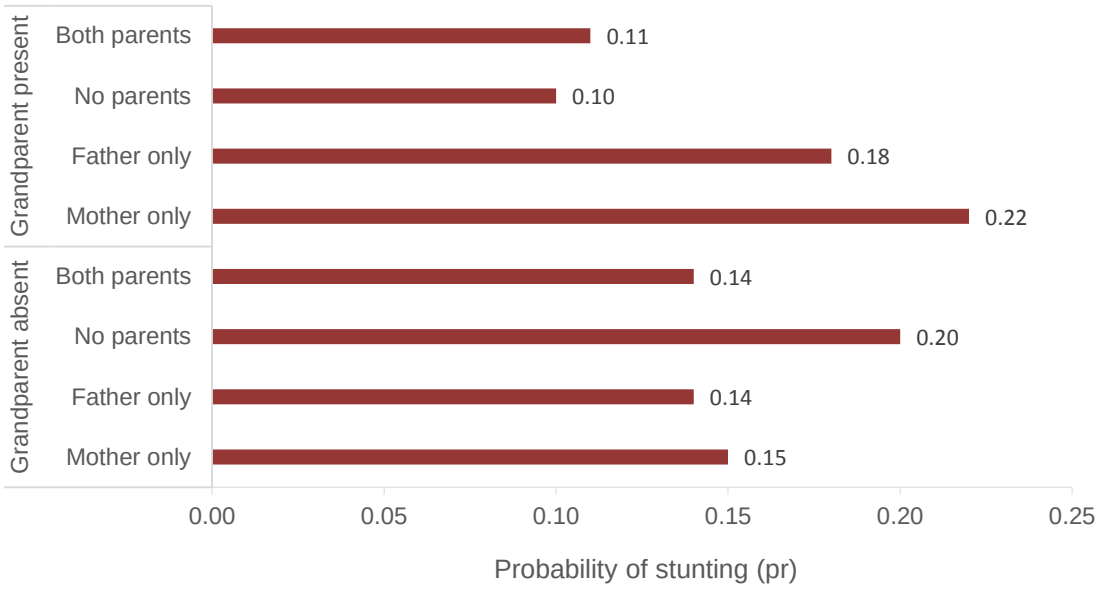
Group B= $\alpha + \beta_2$ =-1.791 +-0.253 = -2.044

Group C= $\alpha + \beta_1$ =-1.791 + 0.055 = -1.736

Group D= $\alpha + \beta_1 + \beta_2 + \beta_3$ = -1.791 + 0.055 + -0.253 + 0.694= -1.296

The results on the log odds were then exponentiated to obtain the associated odds, and the probabilities (pr=odds/ (1+odds)) of stunting. The values of log odds, odds and probabilities of stunting were also obtained for the other groups defined in the study: father only, no parents, father only*grandparent and no parents*grandparent. This was done in order to enable a comparison of predicted probabilities of stunting for children living with either mother, father, no parents or both parents to those children living with or without a grandparent in the household. A graphical picture of the calculated predicted probabilities of stunting is shown in Figure 4.2.

As seen in Figure 4.2, the presence of a grandparent in the household moderates the impact of parent presence on stunting. For example, in Figure 4.2, the probability of being stunted in households with a grandparent is highest among children living with a mother only (pr=0.22), followed by children living with father only (pr=0.18), children living with no parents (pr=0.10), compared to those living with both parents (pr=0.11). On the other hand, in households with no grandparents, the results in Figure 4.2 suggest a higher risk of stunting among children living with no parents (pr=0.20), followed by children living in mother only households (pr=0.15), compared to those children living with both parents (pr=0.14). A similar pattern of stunting is observed among children living with no grandparent and no parents (pr=0.14) to those living with both parents (Figure 4.2).



Note: The predicted probabilities are based on the coefficients in Table 4.13 (Intercept, parent(s) presence, grandparent presence and the associated interaction terms) and holding other covariates constant. None of the interaction terms were statistically significant for stunting except the coefficient for mother only and grandparent presence in the household (p value=0.1)

Figure 4.2: Graphical representation of the probability of stunting corresponding to the presence of a parent (s) and grandparent in the household

Factors associated with diarrhoea prevalence

The results of diarrhoea prevalence are also shown in Table 4.13 above. There is an indication in the data that living with a mother and living without parents is associated with a decrease in diarrhoea prevalence compared to living with both parents. For example the coefficient attached to mother only (β=-0.431; S.E=0.176) and no parents (β=-0.480; S.E=0.215) are negative, and significant at $p<0.05$ (see Table 4.13). The types of other living in the household, including a grandparent, aunt, uncle, other relatives or not related household members are not significantly associated with diarrhoea prevalence.

Other factors associated with diarrhoea prevalence are household socio-economic status, and residence, although the results of residence are weakly associated ($p<0.1$) with diarrhoea prevalence. Children living in rich households are less likely to have diarrhoea compared to those in poorer (β=-1.367; S.E=0.321).

Random effects

Table 4.13 also displays the results of the random effects. The results indicate that for stunting, 17.1 per cent of the unexplained variation in the disease lies at the household level and 3.1 per cent of the variation lies at enumeration area level. For diarrhoea prevalence, 21.1 per cent of the overall variation in the disease is attributable to the household, and 3.4 per cent is due to enumeration area. The findings from the random effects also show between variation in stunting across households and enumeration areas.

4.5 Discussion

This study examined the association between household composition and child health, using relationships cast from a child's perspective using BFHS 2007 data. The findings from the descriptive results illustrate the diversity in households in which children reside. On the question of the relationship between child health and presence of parents and other household members, the results indicate that whether the child lives with none, one or two parents, as well as whom the parent lives with, matters for stunting and diarrhoea prevalence. In particular, for stunting, living with neither parent increases the odds of stunting, compared to living with both parents. In accordance with these findings, the hypothesis that children living with both parents have better nutritional status than those living with no parents is supported.

There are several reasons why children in households without their parents have higher levels of stunting compared with children living with their biological parents. Living with biological parents offer more care and provision of food resources (Bronte-Tinkew and DeJong, 2004). A study on child feeding practices and access to health services in Sierra Leone finds household discrimination in food allocation and access to medical care among fostered children (Bledsoe et al., 1988). In Guinea-Bissau fostered children are placed in smaller and grandparent's households, which often have a traditional approach to health care (Masmas et al., 2004). The latter is applicable to Botswana in 2007 where most of the children who don't live with their parents live with grandparents instead (22.9% as seen in Table 4.4). Descriptive analysis also shows that households with grandparents in Botswana are poorer households (36.4%), followed by 28.5 per cent in second poorest, 14.4 per cent in the middle, 12.1 per cent in the fourth, and only 8.6 per cent in the richest quintile.

It was also hypothesised that stunting or diarrhoea prevalence varies based on whether a child lived with parents and other types of household members. The results showed that stunting is more prevalent among children living with household members who are not related to them, and it is less among those children living with an aunt and those living with other relatives. The finding on aunts and other relatives and stunting suggests that these adults may care more about the child than non-related household members in terms of better provision of socio-economic resources and nurturing. A review of living arrangements of children from 19 developing countries indicate more commitment to

child care and provision of financial resources among children in households with parents and other related adults (Lloyd and Desai, 1992).

Other factors significantly associated with stunting are household wealth, region, child age and sex. The results on household wealth show that across all households, those which are richer, regardless of who is in the household, do better in stunting and diarrhoea prevalence than those who are poorer. This evidence is consistent with other findings on child health outcomes. For example, low socioeconomic status is associated with increased risks for stunting (Miller and Korenman, 1994), and higher rates of diarrhoea in infancy (Fuchs and Victora, 2002) from a lack of resources to ensure proper nutrition and good hygienic practices (Bronte-Tinkew and DeJong, 2004). It may also be that richer in contrast to poorer households are able to offer opportunities for economic and social influences that promote and maintain good health (Berman et al., 1994, Williams et al., 2003, Houle et al., 2013).

However, even though the evidence clearly shows that household socioeconomic status is negatively associated with child health outcomes, it is not easy to determine the precise mechanism through which the influence occurs. Several possibilities have been proposed with low socio-economic conditions reducing the ability to purchase dietary and health care needs or limiting opportunities for parental education (Bradley and Corwyn, 2002), and limiting ability to deal effectively with child nutrition problems (Bronte-Tinkew and DeJong, 2004).

The results on stunting and region show that children living in the East and North East of the country are more stunted compared to those in the North. Region has been shown to reflect broader structural factors outside the home such as the access to education, access to health facilities and other opportunities that promote household food security (Horton, 1986).

At an individual level, the results indicate a significant relationship between age, sex of the child and stunting. The findings on child's sex and age are as expected and consistent with prior research which indicates that stunting is more prevalent among male than female children (Bronte-Tinkew and DeJong, 2004, Lesiapeto et al., 2010, Gewa and Yandell, 2012, Wamani et al., 2007). Although it is not clear why males are more at risk of stunting than females. A study by Côté et al. (2003) shows that males are

more prone to low birth weight; which is affected by maternal nutrition and health behaviours during pregnancy.

The findings on age indicate that stunting is highest at 12-23 months. This result is not surprising given that the effect of stunting is long-term, cumulative, and hence is more pronounced at 12-23 months (Horton, 1986, Dewey and Begum, 2011). The lack of care and nourishment during early childhood has been associated with unfavourable household socio-economic conditions and higher risks of stunting among children aged between 6 and 23 months (Reyes et al., 2004). The findings on age and stunting also demonstrate the effects of maternal education and negative consequences for child care when other key actors in the household are involved.

It has been argued that education and employment outside the home draws mothers away from child care during the early years of child rearing, and this results in negative consequences for child nutrition children are left in the care of other household members with less education (Moestue and Huttly, 2008). Mokomane et al. (2006) note that employed women in Botswana, often engage relatives and unrelated household members to help them balance responsibilities of child care and work. Thus, the characteristics of other adults living in households with children, timing of involvement of these household members, and conditions under which child care takes place are important in understanding the relationship between stunting and child's age.

The findings on diarrhoea prevalence in Botswana indicate that children living only with a mother and those living with neither parent are less likely to have diarrhoea compared to those living with both parents. This finding is contrary to expectation since it is often assumed that living with both parents is beneficial for child well-being compared with living with a single parent (McLanahan and Sandefur, 1994, Waldfogel et al., 2010, Thomson et al., 1994, Amato and Keith, 1991). It is possible that the excess risk of diarrhoea among children living with both parents compared to those living with a mother is suggestive of other factors such as financial resources of the parent or household member involved or this factor moderating the relationship between having both parents and short term illness.

The comparison of living with neither parent and living with both parents on diarrhoea prevalence may be related to the transitory movement of children with no parents into

households which can provide for them. A study on orphanage and nutritional status of Luo children in Kenya indicates that orphans often end up in wealthier households than non-orphans (Zidron et al., 2009). Evidence from Botswana also show that working or income-earning households are often the preferred choice for providing the basic needs of orphaned children in a short term (Miller et al., 2006). However, the cross-sectional nature of the data used in the study by Miller et al. (2006) and Zidron et al. (2009) do not allow an analysis of financial resources of the parent (s) and the nature and timing of fostering of children by extended family members on child health outcomes. This information would aid in interpreting the effects of no parents household on long term illness (stunting) and on short term illness (diarrhoea).

A moderating effect of the types of other household members on the relationship between living with parents or no parents with both health outcomes does not confirm the third hypothesis. It was hypothesized that the risk of stunting or diarrhoea prevalence will be lower among children living with the mother and other household members than those living with parent(s) only. Only one interaction between parental presence and grandparent presence showed a modifying effect on the relationship for stunting. Children who live with a mother and grandparent were slightly more stunted compared to those living with both parents. This finding is likely due to the strained coping capability of the mother only households to provide economic and food resources that are needed to prevent stunting. As reflected in other studies mother only families are much more likely to be poor and not able to provide food and material needed for healthy child growth (Brown, 2004, Thomson and McLanahan, 2012), compared to living with both parents (Amato, 1987, Dawson, 1991).

A study by Mokomane et al. (2006) in a rural and an urban setting in Botswana shows that most of the single mothers who co-resided with their mothers were not employed. Thus, for mother only households, co-residing with a grandmother may imply a lack of economic resources to maintain one's own household. On the other hand, two parent households where grandparents co-reside may have enough financial resources to ensure proper child nutrition and care of extra members. Other studies suggest that co-residence with grandparents implies care of the grandparent(s) and grandchildren (Szinovacz, 1996, Noel-Miller, 2006).

Finally, although family and households have been studied to demonstrate the importance of shared household resources on child well-being, previous work has tended to focus on more gains for children living with married biological parents than living with one parent, or without parents (Thomson et al., 1994, Thomson and McLanahan, 2012, Amato and Keith, 1991). Prior evidence on families and child well-being is also limited to developed countries (Allan and Crow, 2001a). Recently, the role of the family and household composition for child's physical health has been increasingly emphasised. A considerable number of the studies in LMICs indicate a particular role of biological parents as well as other household members such as aunts, siblings, and grandparents on child mortality and child health (Sear, 2008, Sear et al., 2002, Cunningham et al., 2010).

The current study adds to the latter literature by pushing beyond the focus on biological parents to other household members, and exploring pathways through which household composition influences child health in Botswana. This study also provides evidence for variability in stunting and diarrhoea prevalence across household types and enumeration areas; with most of the unexplained variation in stunting and diarrhoea prevalence at household level.

Limitations

This study has some limitations. First, given the cross-sectional nature of the data, no causal effects are made. Instead the findings provide information on a child's experience of a household at a point in time. Longitudinal data would be necessary to illuminate the causal effects and influences which led to the household composition, intra-household links and its implications for child health.

Second, there remains considerable variation in the way households are categorised in the literature. I have defined households based on the relationship of the household members with the reference child. While previous work defines household composition by establishing relationships of household members to the household head and not orientating relationships from the view of the reference child. Although defining household composition from the view of the child is unique and is an advantage, it makes the study not comparable to others using a different definition.

Third, mothers or caretakers reported information on the child. This may have introduced some bias based on the characteristics of the mother/caretaker e.g. age, experience with child care, education and social context they live in.

Fourth, a measure of diarrhoea prevalence is subjective and future research needs to use medical diagnosis of the illness.

Fifth, the data set does not permit control for other variables such as mother's age, marital status, and education. These variables were considered for the analysis but were dropped due to a high number of lot missing values. The limitation was mitigated by the inclusion of the household wealth variable to capture the influence of the household environment and household resources on child health outcome.

Beyond these limitations, it is possible that other factors that are not investigated here are associated with either stunting and or diarrhoea. Potential factors include parental health, maternal and child HIV status, breastfeeding practices, maternal nutrition, the duration of living in a particular household and the nature of child care (who is involved, practices and conditions under which child care takes place). Including key variables not captured in the current analyses in the future analysis would ensure that the associations between child health and household composition are not overstated.

Lastly, despite these limitations, the study highlights the need to understand the relationship between child health and household composition in LMICs. The results are satisfactory, and the data quality is adequate. An additional confidence in the findings is the fact that the data is nationally representative, and it was collected by Central Statistics Office (CSO), which made sure training of the interviewers was thorough, and accuracy and completeness were checked at field work stage. Another major strength of the study is the importance of conceptualizing household relationships from the view of the child. This approach constitutes the first step in using more expanded categories of household's relationships to understand child health and using more information about the household members (e.g. age, sex, marital status and parental link's) in establishing their relationships with the index child.

4.6 Summary and conclusions

These results provide a basis for enhanced efforts to improve child health in Botswana. The results show that the range of actors involved in child rearing in Botswana is much broader than biological parents. It includes grandparents, aunts, uncles, other relatives, and persons not related to the child. Further the results indicate that the effect of household composition differs by whether the condition is long term as in the case of stunting and whether it is short term as with diarrhoea prevalence.

Specifically, the findings show that stunting is prevalent among children living with no parents and among those living with not related household members. While living with an aunt and living with other relatives protect against stunting. Other factors significantly associated with stunting are region, child's sex, and child's age. A test for an interaction between parental presence and grandparent presence in the household was also significant, indicating that living with a mother and a grandparent was associated with higher odds of stunting, in comparison to living with both parents.

The findings on diarrhoea prevalence show that children living in mother-only have 35.0 per cent lower odds of suffering from diarrhoea than those living in a two-parent household. Children living with no parents are less likely (38.1% lower odds) to have diarrhoea than those living with both parents. The results on both stunting and diarrhoea prevalence show that children living in a rich household are much more likely to be healthier than those living in a poor household.

The results further indicate variability in child health outcomes across households and enumeration areas. The research has also demonstrated a nuanced way of investigating household relationships from a child's view rather than establishing household relationships from the view of the household head as in previous research. About policy and program improvements in stunting and diarrhoea prevalence, the analysis underscores the importance of interventions that caters for all household composition types: whether the child lives with two parents, one parent, no parents and by the types of others living in the household. Also, for health programs to reduce stunting and diarrhoea prevalence they need to take into account the socio-economic condition of households in which children live.

CHAPTER 5. COMMUNITY INFLUENCES ON STUNTING IN BOTSWANA

5.1 Introduction

The status of growth in early childhood is an important indicator of contextual and compositional influences on child health and development (World Health Organization, 1995). This is so because causes of child stunting occur at multiple levels: individual, family or household, community, district or geographical areas (Madise et al., 1999, Griffiths et al., 2004, Kandala et al., 2011). Stunting is defined as a failure to reach one's growth potential for height at an attained age and it reflects long term malnutrition (WHO, 2013b, WHO, 2007a). Stunted linear growth is a main indicator of child malnutrition in LMICs, where its prevalence is high and it bears consequences for impaired child health and development (Black et al., 2013, Dewey and Begum, 2011).

Several studies have examined community level variables such as literacy of mothers, health problems, household variables such maternal education/health, adult education/health, parent beliefs, household socio-economic status with the aim to explain variability in child malnutrition. Community illiteracy rates among women has been linked to an increased risk of stunting in Nigeria (Adekanmbi et al., 2013), underweight in India (Luke and Xu, 2011) and child nutrition in Vietnam (Moestue and Huttly, 2008). Access to health services in a community is reported to be linked to child health outcomes through parent and household influences as moderators (Heaton et al., 2005). However studies on child health outcomes fail to include the extent of medical services in a community in their analysis (Leventhal and Brooks-Gunn, 2000). Although not on malnutrition, a more recent study on child physical health in Trinidad and Tobago finds a direct link between adult perception of overall health and child physical health, and that community health problems influence child physical health through parent beliefs (Narine et al., 2013).

At household level, maternal education (Adekanmbi et al., 2013, Moestue and Huttly, 2008, Som et al., 2007, Heaton et al., 2005), education of other adults living within a child's household (Moestue and Huttly, 2008), and household socio-economic status

play an important role on child malnutrition (Wamani et al., 2006, Magadi, 2011, Griffiths et al., 2004). An analysis of Demographic Health Surveys (DHS) from 18 countries in Africa finds that the risk of child undernutrition is higher for children whose mother is HIV positive and the effect of mother HIV status on underweight varies across communities (Magadi, 2011).

While attention has been devoted to community and household factors associated with child malnutrition, the prevalence of stunting among children in Africa (40.0%) and South-Asia (39.0%) remain high, compared to other parts of the world (UNICEF, 2012). Stunting also remains a public health concern in Botswana where the prevalence has increased from 23.0 percent in 2000 to 29.9 per cent in 2007 (Government of Botswana, 2009a). An understanding of stunting in Botswana is important for a number of reasons. Malnutrition remains a problem for child morbidity and mortality (Government of Botswana, 2009b), just as it is the case globally (Wamani et al., 2006, Pelletier et al., 1995, Dewey and Begum, 2011).

Moreover, if not addressed stunting has negative effects which continues into adult life. The detrimental effects of stunting include poor cognitive, motor skills, social-emotional development, poor health and poor school achievement (Grantham-McGregor et al., 2007, Chang et al., 2002). The extent of undernutrition also has implications for child developmental potential, which in turn places a lot of strain on their families, households and communities (Black et al., 2008a). Another implication is that the prevention of stunting has a potential to reduce other child health outcomes such as diarrhoea prevalence. Malnourished children are prone to diarrhoea which worsens a child's nutritional status through nutrient loss, loss in water, a general loss in appetite (Madise et al., 1999) and increased risk of infections (Mølbak et al., 1994).

As yet no studies in Botswana has examined factors at community level and how they influence stunting. Previous research on child nutrition in Botswana is limited to multivariate regression modelling and to a few household and individual factors (Gobotswang, 1998, Nnyepi, 2007, Tharakan and Suchindran, 1999). For example, a study by Nnyepi (2007) on indicators of child nutritional status found that care giver perception about adequacy of food in a household, child age and birth weight were associated with stunting among children aged 0-5 years. In another study on underweight in Botswana it was found that ownership of cattle, education of household

head, sex household head, type of toilet facility were positively associated with better child nutrition (Gobotswang, 1998). In addition, Tharakan and Suchindran (1999) show that incidence of cough and diarrhoea are significantly associated with child malnutrition. The mechanisms through which community variables influence child physical health are also still less understood and not fully explored (Narine et al., 2013, Luke and Xu, 2011). Even far less in LMICs has been done to find out the differential effect of household factors that may depend on community level factors to influence stunting. This therefore necessitates the need to think of new ways of understanding stunting among children less than five years. This paper goes beyond previous analyses by exploring several community variables and by using a more complex analysis which takes into account community and household factors, and how they interact to influence stunting.

5.1.1 Research questions

To understand risk factors for stunting among children under five in Botswana in more depth, this study examines the role of community factors. The specific research questions of the paper are: (1) To what extent are community factors associated with stunting? (2) To what extent is the relationship between community factors and stunting moderated by household factors?

5.1.2 Conceptual framework

Based on past literature on the determinants of child malnutrition and the UNICEF's 1998 conceptual model which outlines the basic, underlying and immediate influences on child nutritional status (UNICEF, 1998), the following conceptual framework (Figure 5.1) was developed. Figure 5.1 extends previous work by exploring the effects of several community variables on stunting. As shown in Figure 5.1, the causes of malnutrition are many and they include community, household and individual factors. Community factors serve as a context within which children are born and nurtured. Community level factors associated with stunting include health factors (density of health services and community health problems), economic factors (illiteracy rate, wealth status, affluence, unemployment rate and participation in work), social factors (household size and access to social resources) and ecological factors (political, water & sanitation, food availability & pricing, region and residence) in a district (Figure 5.1). The community factors in Figure 5.1 affect stunting indirectly through household and parental factors.

At household level, the underlying influences of stunting relate to the health of adults in a household, household socio-economic resources, household composition and household characteristics (Figure 5.1). The household factors influence stunting through child feeding patterns or diet intake and child care practices. The household factors also operate indirectly through the child's inherent factors (age and sex), risk of infection, illness and infant/child health to contribute to child's poor nutritional status (Figure 5.1).

Finally, in addition to community and household factors, Figure 5.1 indicates that individual factors are directly linked to stunting. As previously described in chapter four, individual factors such as child age and sex are directly associated with stunting. Additionally, the risk and occurrence of infections, illness and infant /child health (before and after delivery) are direct causes of poor nutritional status (UNICEF, 1998, Stewart et al., 2013). It has been suggested that prolonged illness suppresses a child's appetite and cause nutrient loss which eventually result in a child being malnourished (Madise et al., 1999). Persistent of diseases such as diarrhoea is also associated with poor nutritional status (WHO, 2013a, Keusch et al., 2006, Ochoa et al., 2004).

In what follows data from the Botswana Family Health Survey (BFHS 2007) and information on community variables from census and survey data is used to test the association of all community factors with stunting.

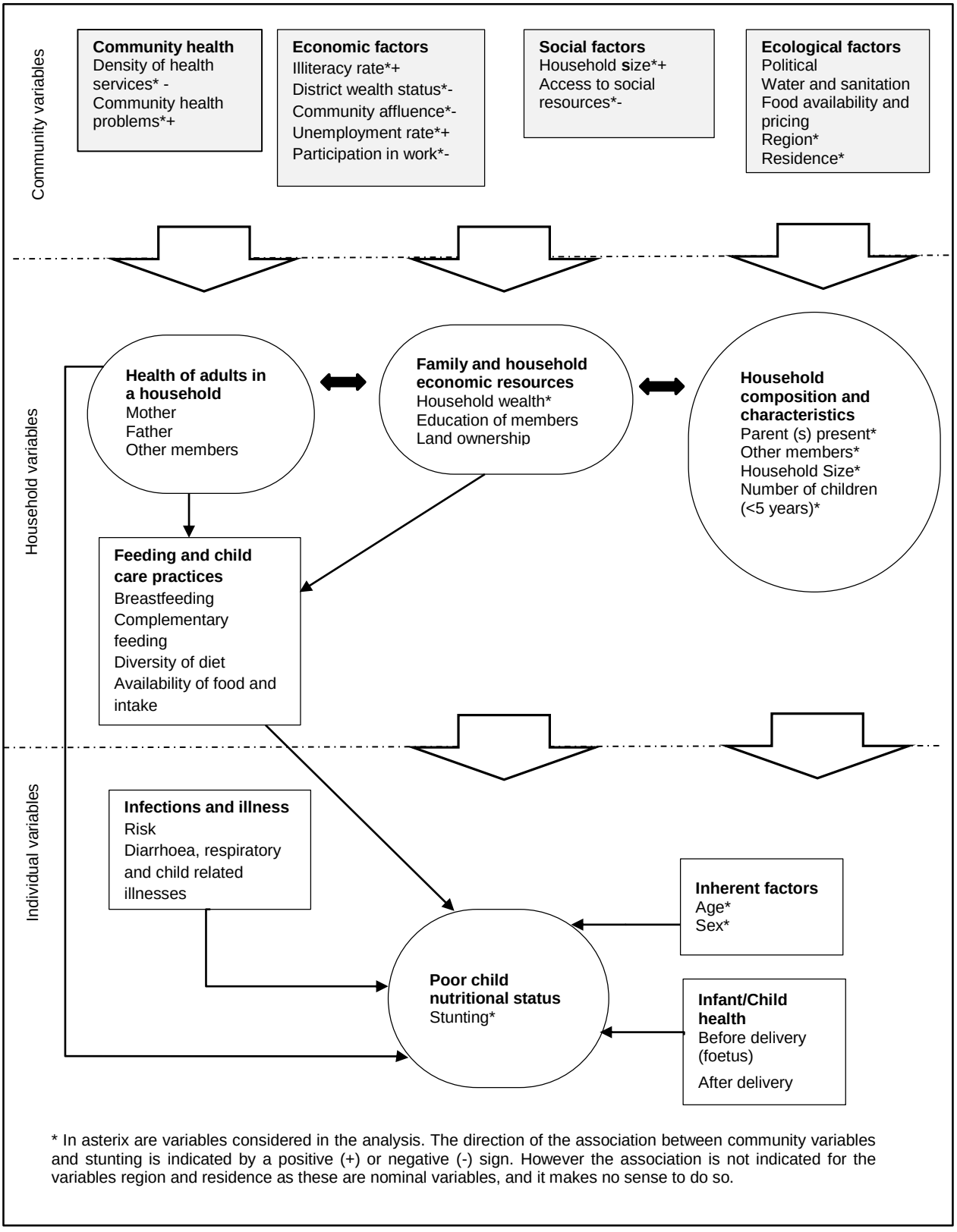


Figure 5.1: Conceptual framework on community, household and individual determinants of stunting

5.2 Data and methods

Study design

To obtain data required to examine community, household and individual variables relationship with stunting, a cross sectional study entitled the 2007 Botswana Family Health Survey (BFHS 2007) was used along with census reports 2001 and 2011, the Botswana AIDS Impact Survey (BAIS III 2008), and the Botswana Core Welfare Indicator Survey 2009/10 (BCWIS). The community variables here relate to the context in a district. Although the district may be too large to describe the influence of the community or geographical setting on stunting, it is the level at which data could be obtained. Analysis of the geographical setting at a smaller level; enumeration area was also possible and this is described in section 5.2.2.

BFHS 2007 was conducted by the Central Statistics Office in Botswana and it is the source of information on child stunting as well as data on child characteristics and household characteristics, but it has no information about the context in which children live. Census reports of 2001 and 2011 provide information on the context in which children live and these are described as community variables: (a) per cent never schooled, (b) per cent professionals, (c) household size, (d) ratio of adult to child, (e) per cent richest households and (f) wealth score (see Appendix 5A). Information on unemployment rates by district is obtained from BCWIS, and BAIS III 2008 is the source of information on HIV prevalence rates by district (see Appendix 5A).

Sampling

A two stage sampling was used to obtain the sample. The first stage selected enumeration areas (EAs) as the primary sampling units (PSUs) for both the urban and rural localities according to the 2001 Population and Housing Census (Government of Botswana, 2009a). Accordingly, the relationship between EAs, urban/rural localities and district depends largely on the type of district and locality. In the modeling, the word community is used to refer to EA or PSUs. This is because the EAs were designed to be homogenous units with respect to living conditions, ecological and income categories within urban and rural localities in the 26 districts (Government of Botswana, 2009a).

The second stage of sampling, then involved a systematic selection of occupied households from the selected EAs. The initial data had 393 EAs and 7841 households (Government of Botswana, 2009a).

Sample

A total of 2531 children aged 0-59 months in households with at least 1 person are included in the analysis. Of the original sample, 184 children (7.0%) were excluded as they had no information on anthropometric indices of length for those younger than 24 months or height measurements for those 24 months and older, and they had implausible anthropometric values outside the range -6/+6 HAZ (WHO, 2013b). A full description of the missing cases and their characteristics is provided in chapter 4 in section 5.2. Information on child characteristics, health status, on the demographic and household living conditions was provided by 5021 women aged 12-49 years from the selected households.

5.2.1 Variables

Dependent variable

The dependent variable is stunting, and it is categorized into (1) Yes and (0) No. Stunting is measured as height for age z scores and observations below -2 standard deviations (SD) from the median of the reference population of the WHO Child Growth Standards are regarded as stunted (WHO, 2007a, WHO, 2013b). Stunting is considered the most reliable indicator of child's nutritional status since it reflects long term food shortages and chronic effects of diseases (Zere and McIntyre, 2003, Black et al., 2013). Other conditions of child malnutrition include: wasting which signifies insufficient weight for height and underweight which signifies insufficient weight for age. Weight for height reflects short changes in malnutrition and recent exposure to infection, while weight for age reflects both the long and short terms changes in malnutrition (O'Donnell et al., 2008). Underweight is often difficult to interpret unlike stunting and wasting (Black et al., 2013, O'Donnell et al., 2008). Anthropometry was applied to all children under five found in the selected households by Statistics Botswana enumerators (Government of Botswana, 2009a). The response rate for anthropometric measurements was 98.3 per cent.

Explanatory variables

Eleven explanatory variables were identified at district level, and they are included in the analysis to reflect characteristics such as 'community' illiteracy rate, 'community' health problems, community affluence etc (see Appendix 5A). These explanatory variables were defined at district level and they reflect the influence of district on stunting through local administrative policies. Districts in Botswana serve as communities within which central and local government coordinate and deliver service relative to activities such as primary education, secondary education, primary health care, roads infrastructure, water, sanitation, and district development (Republic of Botswana, 2003). As stated earlier, a range of sources: Census reports from 2001, 2011 and the BCWIS and BAIS III surveys, were used to obtain these variables. In addition these variables were hypothesised to have a relationship with child nutritional status, based on the conceptual framework in Figure 5.1.

Below is a description of the identified community variables:

1. *Percent never schooled:* this variable was obtained from the Census in 2001 based on the question relating to the number of people with no formal education in a district. It is a continuous variable, with the highest percentage of 42.6 in Ngamiland West district and the least percentage of 7.4 in Orapa district. The variable was used as a proxy for community illiteracy. Evidence indicates that community illiteracy rates especially among women are associated with higher risks of stunting (Adekanmbi et al., 2013, Luke and Xu, 2011).
2. *Unemployment rate:* reflects the level of unemployment in a district. It is measured by relating the number of people seeking work to those who are economically active in a district. Unemployment rates were calculated for 2009/10 and they range from 7.3 per cent in Jwaneng to 29.3 per cent in Ngamiland West.
3. *HIV prevalence rate:* is used as a measure of community health burden on child nutritional status. Based on past research and high HIV prevalence rates in Botswana, it was reasonable to include HIV prevalence rate as a potential risk factor for stunting. For example, high HIV prevalence rates are shown to have negative effects on household food security (Weiser et al., 2011). Maternal HIV rate is also associated with child undernutrition in Kenya (Magadi, 2011). The HIV prevalence rate in Botswana in 2008 ranges from 10.3 per cent in Kweneng West to 26.5 per cent in Selebi-Phikwe. It is a continuous variable.

4. *Density of health facilities:* is used as an indicator for access to health care and services. It is calculated from the total number of public hospitals and clinics relative to the population in a district and expressed per 100 000 persons (Mean=51.4, SD=30.3, and range 7.0 to 124.2). It is a continuous variable.
5. *Ratio of adult to child:* is a comparison of the number of adults aged 15-64 years to children aged 0-14 years in a district. It represents access to social resources and quality of child care that is available in a district. A review of the implications of child care services on child development in the USA shows that more children per adult care giver is associated with more distress in infants and more injuries among toddlers due to less adult supervision (Hayes et al., 1990).
6. *Wealth score*: is a measure of community affluence. It is calculated by the total number of households in each of the five wealth quintiles relative to the total number of households in a district. It is classified into three categories: 1) <2.7 which means poor, 2) 2.7 to 3.4 which means middle income and 3) 3.5 and above which means rich. The distribution of wealth score were as follows: Mean=3.0, SD=0.7, and range 1.7 to 4.7, with highest values (3.5^{+}) indicating greater affluence in a district.
7. *Per cent richest households:* is also a measure of district wealth status. Unlike the wealth score, this variable only focusses on the number of the households in the richest quintile (q5) relative to all households in a district. It is used as a continuous variable. High community socio-economic status is linked to better parent functioning and better child well-being and health outcomes (Leventhal and Brooks-Gunn, 2000). While living in a poor neighbourhood is associated with lower maternal warmth and poor child well-being (Klebanov et al., 1994).
8. *Per cent professionals:* is used as a proxy of the level of employment and participation in formal employment in an occupation classified as professionals in a district (Republic of Botswana, 2014). The mean per cent professionals is 5.6 (SD=2.3; range 2.2% to 13.0%). Per cent professionals is a continuous variable.
9. *Household* size: reflects the total number of people in a district relative to the number of households in a district. Like the variable adult to child ratio, household size is used to capture social and economic resources for child care and supervision across districts. It is represented as a continuous variable and it ranges from 2.8 persons per household in Sowa to 4.8 persons per household in Ngamiland West.

10. *Residence*: is used to reflect heterogeneity in child nutritional status by location. It is represented by three categories: 1) City/town, 2) urban village and 3) rural.
11. *Region*: the 26 administrative districts in Botswana were grouped into five groups: 1) North, 2) South, 3) West, 4) East/North East and 5) Central. The five regional groups were defined based on district geography, culture, ethnic composition, administration, level of development and proximity.

Only four community variables were retained in the final analysis and these are per cent professionals, household size, region and residence. Of the variables included in the analysis per cent professionals is the most important. The rest of the variables: per cent never schooled, unemployment rates, HIV prevalence rates, density of health facilities, ratio of adult to child, wealth score and per cent richest households were excluded from the final analysis since they didn't significantly improve the multilevel models or because they were correlated with the variables per cent professionals and household size (see appendix 5B). For example, per cent professionals was highly correlated with proportion never schooled (r=-0.74, p value=0.000), and adult child ratio (r=0.80, p value=0.000).

Household size at district level was highly correlated to richest households (r=-0.73, p value=0.000), wealth score (r=-0.86, p value=0.000) and adult child ratio (r=-0.85, p value=0.000). A test for collinearity (Appendix 5C) and an avpplot were carried out to determine which of the community variables richest households, wealth score or household size could be kept. Household size was selected.

Unemployment rate and HIV prevalence rate and density of health facilities were excluded from the analysis since they didn't show a significant relationship with stunting. Perhaps the influence of these variables could have been identified if unemployment rates and HIV prevalence rates were obtained for mothers only. Moreover, for community health, it has been found in Trinidad and Tobago that an aggregate measure of a number of health problems relative to the population in a community influences child health outcomes through parent beliefs (Narine et al., 2013). However, data on the health problems across districts in Botswana apart from HIV was not available.

The effects of community factors was allowed to vary across household factors by interacting the covariates. The only cross level interaction that was significant was between per cent professionals and household socio-economic status.

Control variables

A number of control variables were included. These were all the household and child variables identified from chapter four (see Appendix 5A). The household variables included in the analysis are a parent presence variable (mother only, father only, both parents and no parents), variables representing other household members (grandparent, uncle, aunt, other relative and not related), household size, household socio-economic status, and number of under-fives in a household. The variable for parent presence is categorical. Each of the other household member variables are dichotomous. The child variables include sex and age. Age squared was also included in the analysis since the relationship of age with height for age z scores was not linear and including the variable 'age squared' improved the models.

5.2.2 Data Analysis

Exploration of data and data analysis were performed in *STATA* and in *MLwiN*. Descriptive analysis of the data was carried out to show the distribution of the variables and the distribution of stunting by selected explanatory variables. Chi-squared tests and t tests were used to examine the significance of the differences between two or more categorical variables and continuous variables respectively.

The approach embraced was to model both the enumeration area and household effects as random components in a multilevel framework. Thus, the resultant multilevel analysis is a three-level model with 2531 children at the lower level (level 1) grouped within 1804 households (level 2), and within 298 enumeration areas at the highest level (level 3). The characteristics of the individuals, households and community variables on the variation in stunting was also investigated.

Analytic strategy

The first step in the explanatory analysis used logistic regression models in order to identify an individual model that best fits the data. Several logistic regression models were fitted and evaluated using the Hosmer-Lemeshow, Kellie Archer and Stanley Lemeshow and Akaike Information Criterion (AIC) goodness of fit tests (Hilbe, 2009). From the fitted logistic regression models, Model 7 was chosen as the best fit (Appendix

5D) and it was used to fit a series of multilevel models. The results from the logistic regression modelling are placed in the appendix because there is not much difference in the parameters between logistic and multilevel regressions, except for the standard errors (they are underestimated in the logistic regression models).

The second step then involved multi-level analysis. Several models were specified. This involved fitting the following models: (1) Null model at level 2, (2) Null model at level 3, (3) A random intercept model at level 3 with all the individual and household variables from chapter four, (4) A random intercept model at level 3 with all the individual and household variables from chapter 4 and community variables, (5) A random intercept model at level 3 with all the individual and household variables from chapter 4, community variables and a cross level interaction, (6) A random slope model, and (7) A random intercept model with district as level 4 (Table 5.1). From model 6 in Table 5.1, a random slope model was estimated on per cent professionals in a district. However there was no evidence that the coefficient for per cent professionals in a district on stunting varies across district at 5 per cent significance level. As a result, it was not useful to include this model in the final results in Table 5.6.

To further understand the relative usefulness of EA and district as levels in the multilevel modelling, Table 5.1 shows the results of multilevel modelling at levels 3 and 4. As shown in Table 5.1, although it was possible to fit a random intercept model with district as level 4, the results of this model with all the individual, household and community variables showed no variance at this level (see model 7 in Table 5.1). A focus on EA effects as the highest level in multilevel modelling is therefore justified given that the between enumeration area variance is significant at 5 per cent significance level (model 1 in Table 5.1).

Also the large number of EAs made it practical to implement multilevel analysis with EA as level 3, compared to a small number of districts. Thus, the EA or primary sampling unit constituted the geographical contextual effects or ‘community level’ in the multilevel analysis. While district has been modelled as a fixed effect and not as random effect, and it is represented by the variable region in the final model (model 6 in Table 5.1).

Table 5.1: Exploratory results of logistic multilevel modelling of stunting, BFHS 2007

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Variable	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.
Fixed Part														
Intercept	-0.996***	0.050	-1.017***	0.055	-1.791***	0.375	0.204	1.188	0.449	1.252	1.034	1.276	1.073	1.380
Community variables														
Household size							-0.400	0.329	-0.486	0.350	-0.480	0.331	-0.459	0.360
Percent professionals							-0.087**	0.044	-0.105**	0.047	-0.257**	0.100	-0.284***	0.107
Household variables														
Parent (s) in a household														
both parents (ref.)														
mother only					0.055	0.154	0.054	0.153	0.062	0.155	0.051	0.153	0.044	0.155
father only					0.000	0.200	-0.011	0.199	-0.002	0.201	-0.001	0.199	0.003	0.201
no parents					0.419**	0.181	0.419**	0.180	0.426**	0.182	0.422**	0.180	0.426**	0.182
Other household members														
grandparent					-0.253	0.241	-0.258	0.240	-0.230	0.244	-0.262	0.240	-0.236	0.242
aunt					-0.297**	0.132	-0.304**	0.132	-0.304**	0.133	-0.313**	0.132	-0.327**	0.133
uncle					0.147	0.160	0.147	0.160	0.143	0.162	0.151	0.159	0.158	0.161
other relative					-0.348*	0.191	-0.361*	0.191	-0.377*	0.193	-0.344*	0.191	-0.325*	0.193
not related					0.367**	0.182	0.371**	0.182	0.356*	0.184	0.369**	0.182	0.378**	0.184
HH. Socio-economic status														
Poorest (ref.)														
Second					0.100	0.151	0.109	0.151	0.129	0.153	-0.866	0.621	-0.965	0.642
Middle					-0.253	0.194	-0.220	0.195	-0.220	0.197	-1.653***	0.605	-1.781***	0.634

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Variable	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.
Fourth					-0.594***	0.213	-0.569***	0.214	-0.536**	0.216	-1.279*	0.664	-1.498**	0.693
Richest					-0.917***	0.248	-0.875***	0.250	-0.825***	0.255	-1.328*	0.712	-1.590**	0.745
Household size (persons)														
2-3 persons (ref.)														
4-6 persons					-0.069	0.193	-0.069	0.192	-0.070	0.195	-0.062	0.192	-0.068	0.194
7+ persons					0.063	0.219	0.073	0.218	0.071	0.221	0.085	0.219	0.050	0.221
No.of under fives														
One (ref.)														
Two					0.159	0.130	0.154	0.130	0.141	0.131	0.158	0.130	0.165	0.131
Three-Four					0.228	0.169	0.237	0.168	0.243	0.170	0.246	0.168	0.261	0.170
Five-Six					0.770	0.516	0.806	0.512	0.809	0.517	0.836	0.513	0.905*	0.519
Region														
North (ref.)														
South					0.156	0.224	0.288	0.247	0.314	0.256	0.255	0.247	0.234	0.269
West					0.343	0.217	0.421*	0.219	0.476**	0.234	0.411*	0.218	0.369	0.238
East & North East					0.521*	0.277	0.497*	0.281	0.611**	0.291	0.581**	0.292	0.611*	0.320
Central					0.281	0.201	0.370*	0.204	0.428**	0.215	0.410**	0.206	0.371	0.226
Residence														
City/town (ref.)														
Urban Village					-0.004	0.222	0.131	0.478	0.292	0.503	0.396	0.495	0.419	0.533
Rural					-0.018	0.228	0.126	0.473	0.279	0.496	0.385	0.487	0.389	0.525

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Variable	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.
Child variables														
Child's sex														
Female (ref.)														
Male					0.360***	0.103	0.357***	0.103	0.358***	0.104	0.357***	0.103	0.363***	0.104
Child's age(months)														
age					0.078***	0.013	0.077***	0.013	0.077***	0.013	0.077***	0.013	0.078***	0.013
age^2					-0.002***	0.000	-0.002***	0.000	-0.002***	0.000	-0.002***	0.000	-0.002***	0.000
Interactions														
bothparents*grandparent(ref.)														
motheronly*grandparent					0.694*	0.366	0.702*	0.366	0.666*	0.370	0.699*	0.367	0.695*	0.369
fatheronly*grandparent					0.498	0.359	0.519	0.358	0.514	0.362	0.525	0.359	0.514	0.361
noparents*grandparent					-0.529	0.388	-0.516	0.386	-0.544	0.390	-0.510	0.387	-0.555	0.390
Cross level interactions														
Poor*Professionals														
Second* Professionals											0.212*	0.127	0.232*	0.132
Middle*Professionals											0.287**	0.118	0.312**	0.124
Fourth*Professionals											0.170	0.124	0.208	0.130
Richest*Professionals											0.142	0.122	0.180	0.129

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Variable	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.
Random Part														
Level 4: district														
cons/cons													0.000	0.000
Level 3: ea														
cons/cons			0.116*	0.065	0.127*	0.073	0.123*	0.071	1.032	0.630	0.103	0.069	0.262***	0.095
cov(cons,Professionals)									-0.142	0.095				
var(Professionals)									0.021	0.014				
Level 2: HHId														
cons/cons	0.633***	0.137	0.585***	0.147	0.703***	0.161	0.681***	0.159	0.710***	0.163	0.691***	0.160	0.603***	0.164
Level 1: ChildId														
bcons.1/bcons.1	1.000		1.000		1.000		1.000		1.000		1.000***		1.000	
Statistics														
District. level VPC (%)													0.0	
EA. level VPC (%)			2.9		3.1		3.0		22.8		2.5		6.3	
Household level VPC (%)	16.1		14.7		17.1		16.6		14.1		16.9		14.5	
Units: district													26	
Units: ea	298		298		298		298		298		298		383	
Units: HHId	1804		1804		1804		1804		1804		1804		1804	
Units: ChildId	2531		2531		2531		2531		2531		2531		2531	

Model 1=null (random intercept level 2); Model 2=null (random intercept level 3); Model 3=random intercept level 3 + individual and household variables. Model 4=Model 3+community variables.
Model 5=Model 4+random slope. Model 6=Model 4+Cross level interaction. Model 7=random intercept level 4+individual+household+community variables.
Legend: * p<.1; ** p<.05; *** p<.01 ref. =reference category. Coef.=coefficient and S.E=standard error.EA=enumeration area. VPC=Variance partition coefficient

Finally, it is important to note that at each stage of modelling the models were evaluated in *MLwiN* using the Wald test. A Wald test statistic is used to confirm evidence that an additional parameter contributed to the model fit at 5 per cent significance level. The Wald test is preferred over the likelihood ratio test which is normally used to test whether a predictor (s) improves the model fit since the -2 log likelihood test can't be performed with logistic multilevel model. The Wald test is also suited to random effects models since the estimation is quasilikelihood instead of maximum likelihood (Twisk, 2006, Hilbe, 2009). The final random models are shown in Appendix 5E. These models also appear in the text in Table 5.6. Since the *MLwiN* output didn't provide the significance of the parameter estimates (as asterisks), the models in Appendix 5E were also estimated using the *runMLwiN* command in *STATA* (Table 5.6). The *runMLwiN* command allows *STATA* to run *MLwiN* within *STATA* (Leckie and Charlton, 2013).

The equation for the final random intercept model can be written as:

$$\gamma_{ijk}=\beta_{0jk} + \beta_1 x_{ijk},\ldots\ldots\ldots,\beta_p x_{ijk} \quad (1)$$

Where γ_{ijk} is the logit of stunting by the *i*th child within the *j*th household within the *k*th enumeration area. The term β_{0jk} is the intercept at level two (household) within the level three *(*enumeration area) and it includes the average intercept in level three unit *k* (δ_{0k}) and the random effect at level two unit j (U_{0jk}), as shown in section 4.3.2. For logistic multilevel model, the random effects U_{0jk} and V_{0k} are assumed to follow a normal distribution with mean 0 and variances σ^2_{u0} and σ^2_{v0} *,* respectively (Hilbe, 2009, Snijders and Bosker, 1999, Goldstein et al., 2002a). From equation 1, $x=(x_{1,\ldots\ldots}x_p)$ denotes the set of explanatory variables in the model measured at any of the three levels, and $\beta=(\beta_{1,\ldots\ldots}\beta_p)$ are the 35 corresponding parameter estimates as shown in Appendix 5F.

The variance partition coefficient (VPC) or how much of percent variation in the data is attributable to a particular level was calculated for level 3 and 2 as below:

$$\text{VPC at ea} = \frac{\sigma^2_v}{\sigma^2_v + \sigma^2_u + \pi^2/3} \quad (2)$$

$$\text{VPC at household} = \frac{\sigma^2_u}{\sigma^2_v + \sigma^2_u + \pi^2/3} \quad (3)$$

Where total variance at ea level is σ^2_v =0.103, total variance at household level is σ^2_u=0.691 and total variance at level 1 (child) is $\pi^2/3$=3.29 (see Table 5.6). In multilevel logistic regression models, level 1 variance is binomially distributed, with mean zero and variance $\pi^2/3$ (Goldstein et al., 2002b, Snijders and Bosker, 2012). Hence $\pi^2/3$ is substituted for level 1 variance in the equations 2 and 3 above. Further, the assumptions of normality of the level 3 residuals were checked. The residual plot shows that the normality assumption of the residuals is reasonable (Appendix 5G). The assumption of constant variance was not estimated since for a binary outcome, it doesn't make sense.

5.3 Results

Descriptive analysis

The mean age of the sample is 28.5 months (SE=0.35). The mean height for age z scores is -1.27 (95% CI:-1.39,-1.15) for boys and -1.14 for girls (95% CI:-1.24,-1.05). Figure 5.2 shows the HAZ curves are quite similar for boys and girls.

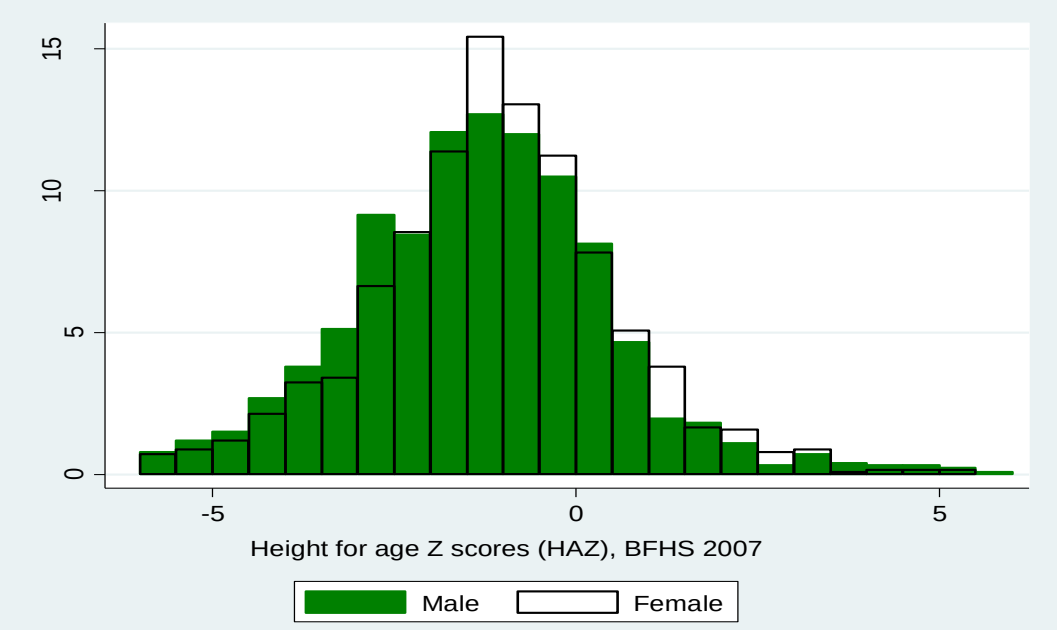


Figure 5.2: Per cent distribution of height for age z scores for children less than 60 months by sex, BFHS 2007

Table 5.2 shows the distribution of children by categorical explanatory variables. The sample consists of an equal distribution of females (49.7%) and males (50.3%). It is apparent that most of the children live in rural areas (50.4%), compared to 33.0 per cent

who live in urban villages and the rest in cities or towns. A classification of districts by region indicates that majority of the children are found in the Central (31.0%), followed by 29.2 per cent in the South, 11.3 per cent in the North and the rest are in the East/North East parts of the country (Table 5.2).

Table 5.2: Summary statistics for categorical community, household and child variables, BFHS 2007

Variable	Observations	Percent	SE.
Region			
North	302	11.33	0.007
South	778	29.23	0.010
West	486	18.25	0.008
East & North East	271	10.17	0.007
Central	826	31.02	0.009
Residence			
City/Town	441	16.57	0.008
Urban village	879	33.01	0.010
Rural	1342	50.43	0.010
Presence of parents			
Mother only	680	25.53	0.009
Father only	375	14.11	0.007
Both parents	1174	44.11	0.010
No parents	433	16.26	0.007
Presence of other household members			
Grandparent	531	19.96	0.008
Aunt	881	33.11	0.010
Uncle	825	31.00	0.010
Other relative	268	10.06	0.007
Not related member	243	9.14	0.007
Household socio-economic status			
Poorest	740	27.80	0.009
Second	771	28.96	0.009
Middle	429	16.13	0.008
Fourth	390	14.65	0.008
Richest	332	12.46	0.007
Household size (persons)			
2-3	273	10.26	0.006
4-6	1094	41.11	0.010
7+	1294	48.63	0.010

Variable	Observations	Percent	SE.
Child's sex			
Female	1324	49.74	0.010
Male	1338	50.26	0.010

Household variables showing presence of other household members are dummies and the variable presence of parents is categorical. Presence of parents and other household members reflect the relationships to the index child. For example mother only indicate that only the mother of the child is listed in the household, and not the father of the child. Grandparent shows that a child grandparent is present in the household. Number of observations is 2662.

Description of the community variables

In Table 5.3 per cent never schooled ranges from 7.4 per cent in Orapa to 42.6 per cent in Ngamiland West. Ngamiland West also has the lowest per cent of richest households (5.0%) compared to the other districts. The highest number of richest households is found in Orapa (75.9%). Orapa also has the highest wealth score (4.7) compared to the least wealth score which is in Ngamiland West (1.7). Per cent professionals is lowest in Kweneng West (2.2%) and highest in Gaborone (13.0%).

In general it is clear that cities or towns which include Gaborone, Francistown, Selebi Phikwe, Lobatse, Orapa and Sowa tend to have higher levels of wealth score, richest households, per cent professionals, adult to child ratio than the rest of the other districts (Table 5.3). The urban districts also have lower household size and per cent never schooled. The distribution of the community variables by districts in Table 5.3 are not surprising given more economic resources in urban than rural districts. Gaborone is the capital city of Botswana and it is fully urban. Orapa and Jwaneng are diamond mining towns, while Sowa and Selebi-Phikwe mine soda ash and coal, respectively. However, the pattern of HIV prevalence and the density of health care facilities by district is equivocal (Table 5.3). An ordered distribution of the community variables by district is shown in Appendix 5H.

Table 5.3: Distribution of community variables by district

	Community variable								
District	Never schooled (%)	Household size (persons)	Unemployment rate (%)	HIV prevalence rate (%)	Health facilities('100 000 persons)	Ratio of adult to child	Professionals (%)	Richest households (%)	Wealth score
Gaborone	10.2	3.1	9.8	17.1	14.0	3.6	13.0	45.0	4.0
Francistown	13.6	3.5	18.0	23.1	24.1	2.5	6.9	28.5	3.7
Lobatse	15.7	3.4	11.8	16.3	27.0	2.5	7.9	28.9	3.5
Selibe Phikwe	14.2	3.2	19.1	26.5	26.1	2.3	5.9	27.9	3.7
Orapa	7.4	3.2	14.3	16.7	32.8	2.3	9.2	75.9	4.7
Jwaneng	12.6	3.1	7.3	15.7	39.5	2.9	5.8	46.3	4.0
Sowa	9.0	2.8	10.7	25.4	104.2	2.5	6.3	45.6	4.3
Southern Ngwaketse	36.8	4.6	23.6	13.3	7.0	1.6	5.6	11.6	2.7
Southern Borolong	29.8	4.6	19.7	13.5	77.9	1.6	5.5	9.5	2.5
Southern Ngwaketse West	37.9	4.4	20.3	16.1	124.2	1.5	3.0	6.8	2.0
South East	21.0	4.1	18.5	12.6	24.7	2.9	8.9	28.9	3.7
Kweneng East	32.3	4.3	20.8	16.7	24.2	2.1	5.3	15.4	3.1
Kweneng West	41.9	4.6	14.7	10.3	59.2	1.4	2.2	49.7	3.3
Kgatleng	26.6	4.3	22.5	15.8	42.2	2.0	5.3	18.2	3.1
Central Serowe/Palapye	34.2	4.5	26.2	20.0	37.3	1.7	5.6	14.1	2.7
Central Mahalapye	34.2	4.6	18.7	17.1	41.0	1.5	4.6	11.3	2.5
Central Bobirwa	32.3	4.4	12.5	18.9	34.4	1.5	4.8	9.4	2.4
Central Letlhakane	39.2	4.6	21.1	14.6	54.1	1.6	3.9	9.1	2.3
Central Tutume	31.3	4.5	14.0	20.0	26.7	1.4	4.9	8.5	2.3
North East	21.6	4.6	14.8	21.8	85.0	1.5	5.3	13.5	2.8
Ngamiland East	33.7	4.6	16.8	19.8	45.6	1.7	4.5	12.7	2.7
Ngamiland West	42.6	4.8	29.3	16.5	54.4	1.3	3.0	5.0	1.7
Ngamiland Chobe	23.3	3.6	10.5	23.0	76.4	2.3	3.2	17.1	3.1
Ghanzi	40.4	4.2	14.2	13.5	69.3	1.8	4.1	12.7	2.5
Kgalagadi South	31.5	4.5	17.5	19.1	84.8	1.6	4.0	12.7	2.5

Kgalagadi North	29.7	4.0	14.8	11.8	99.3	2.0	5.9	13.3	2.5
Summary statistics									
Per cent (%)	27.0	4.1	17.0	17.5	51.4	2.0	5.6	22.2	3.0
SD.	11.0	0.6	5.2	4.1	30.3	0.6	2.3	17.3	0.7
Min.	7.4	2.8	7.3	10.3	7.0	1.3	2.2	5.0	1.7
Max.	42.6	4.8	29.3	26.5	124.2	3.6	13.0	75.9	4.7

All the community variables included in this table are continuous. a denotes variables for which the means are given instead of percentages. Observations are from the 26 districts.SD= standard deviation, Min=minimum and Max=maximum.

Bivariate analysis

Table 5.4 shows the distribution of stunting by community variables. It is apparent that at 5 per cent level, stunting is significantly associated with all the community variables except unemployment, HIV prevalence rate and the density of health facilities. Table 5.4 shows that the highest proportion of children that are stunted live in districts with higher levels of never schooled persons (30.50% versus 28.96%, p<0.001) and those with large average household size (4.28 versus 4.21, p<0.004). Stunting is less prevalent among districts with higher per cent professionals (5.38% versus 5.80%, p<0.000), richer districts (2.82 versus 2.92, p<0.014) and those with as large proportion of richer households (17.00 versus 18.73, p<0.001). The proportion of stunted children is lower in districts with higher adult to children ratio (Table 5.4). Overall the prevalence of stunting is 29.9 per cent.

Table 5.4: Distribution of child stunting by community variables

	(All children N=2662) Stunted	Not Stunted	
Characteristic	%	%	pvalue
Community variable			
Percent never schooled	30.50 (0.345)	28.96 (0.265)	0.001
Household size in a district[a]	4.28 (0.017)	4.21 (0.012)	0.004
Unemployment rate	18.75 (0.184)	18.42 (0.122)	0.133
HIV prevalence rate	17.74 (0.131)	17.66 (0.084)	0.602
Health facilities per 100 000 persons[a]	40.89 (0.917)	39.04 (0.574)	0.083
Ratio of adult to child[a]	1.84 (0.012)	1.94 (0.014)	0.000
Percent professionals	5.38 (0.071)	5.80 (0.057)	0.000
Wealth score[a]	2.82 (0.012)	2.92 (0.014)	0.000
Percent richest households	17.00 (0.410)	18.73 (0.307)	0.001
Overall (%)	29.93	70.07	
Count of children (n)	741	1733	

In parentheses are the standard errors. The p-values are the levels of significance from the t-test. a denotes variables for which the means are given instead of percentages. N=All children including those with missing data. 188 children are missing since they had implausible reading and had no values for height for age z scores.

A further examination of the association of categorical explanatory variables with stunting and the result of χ^2 test of significance is shown in Table 5.5. The bivariate relationship between stunting and each of the following factors: living with an aunt, household wealth, residence, number of children in a household, region, child's age and child's sex is significant at 5 per cent level. None of the parent presence variables is significant,

although the relationship is in the right direction. More details about stunting and the categorical variables in Table 5.5 has already been discussed in chapter 4.

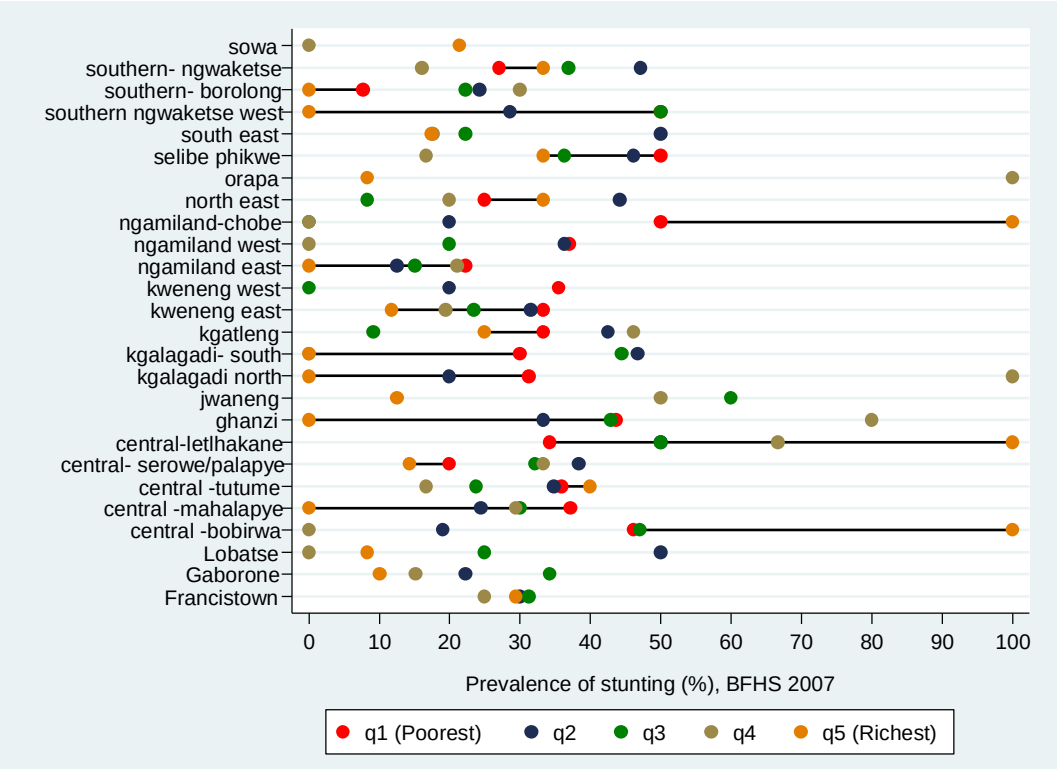
Table 5.5: Percent distribution of child stunting by selected categorical variables, BFHS 2007

	(All children N=2662)					
	Stunted				Missing	
Characteristic	%	n	Total	χ^2	%	n
Presence of parents[a]						
Mother only	30.4	192	631	0.11 (0.761)	7.2	49
Father only	30.8	107	349	0.14 (0.730)	7.1	27
Both parents	28.4	310	1093	2.27 (0.174)	6.9	81
No parents	32.6	131	401	1.68 (0.219)	7.3	32
Presence of other household members[b]						
Grandparent				0.06 (0.814)		
Yes	29.5	149	505		7.6	26
No	30.1	592	1969		5.0	162
Uncle				0.55 (0.494)		
Yes	30.9	241	779		5.7	47
No	29.5	500	1695		7.7	141
Aunt				0.002 (0.97)		
Yes	29.9	247	828		6.1	53
No	30.0	493	1646		7.6	135
Other relative				0.95 (0.469)		
Yes	27.3	69	252		6.1	16
No	30.2	672	2222		7.2	172
Not related				0.16 (0.721)		
Yes	31.1	71	229		5.8	14
No	29.8	669	2244		7.2	174
Household wealth				41.85 (0.000)		
Poorest	33.8	232	687		7.1	53
Second	35.1	252	719		6.8	52
Middle	27.7	110	398		7.3	31
Fourth	25.3	91	361		7.6	30
Richest	17.6	55	309		6.7	22
Household size (persons)				6.95 (0.056)		
2-3	27.3	72	263		3.7	10
4-6	27.7	278	1004		8.2	90
7+	32.4	391	1206		6.8	88
Residence				10.41 (0.020)		
City/Town	25.6	105	411		6.8	30
Urban village	27.8	229	822		6.5	57

	(All children N=2662)					
	Stunted				Missing	
Characteristic	%	n	Total	χ^2	%	n
Rural	32.8	407	1241		7.5	101
Number of children under five				8.01 (0.033)		
1	27.2	311	1143		6.8	83
2	31.6	263	832		7.9	71
3^+	33.3	166	499		6.4	34
Region				15.83 (0.014)		
North	26.2	73	280		7.3	22
South	25.3	182	718		7.7	60
West	33.0	146	442		8.9	43
East & North East	33.8	86	256		5.5	15
Central	32.5	253	779		5.7	47
Child's age group (months)				107.092 (0.000)		
0-2	25.2	20	81		17.6	37
3-5	23.1	31	134		4.1	32
6-11	28.7	78	271		9.6	94
12-23	43.4	234	539		6.7	255
24-35	35.7	190	534		6.6	95
36-47	24.0	117	487		7.3	84
48-60	16.4	70	429		4.8	66
Sex of the child				8.35 (0.009)		
Female	27.3	337	1233		6.9	91
Male	32.6	404	1241		7.3	97
Total	29.9	741	2474		7.1	188

Total=is number of children who are stunted and those not stunted. n=Number of children in a subgroup. a and b are the relationships to the child in question. The figures in parentheses are the levels of significance. Household variables showing presence of other household members are dummies and the variable presence of parents is categorical.

Children in the sample came from households with diverse socio-economic status. The prevalence of stunting is highest among children living in poorer households compared to those in richer households (Table 5.5). Notably some districts have less than 5 groups of wealth (quintiles) as seen in Figure 5.3 and in Appendix 5I. For example Gaborone does not have the poorest group and Orapa only has the fourth and richest households (see Figure 5.3).



The length of the connecting lines represent the change in wealth quintile, and a circle represent the value of the wealth quintile.

Figure 5.3: Prevalence of stunting among children 0-59 months for household wealth quintiles by district, BFHS 2007

Multilevel analysis

Table 5.6 shows the results of the multilevel logistic regression of stunting by community, household and individual factors. Table 5.6 presents the coefficients, standard errors and the level of significance for the fixed and random effects. The analysis takes into account the hierarchical relationships assumed in the conceptual framework in Figure 5.1 on the potential determinants of stunting at community, household and individual levels. The results on fixed effects represent measures of association or the contribution of each explanatory variable to the variation in stunting. The results on the random effects adjusts for clustering and decomposes the variation in stunting according to the grouping of children in households and enumeration areas.

Fixed effects (measure of association)

Community variables: Three models were specified. The first model (model1) is adjusted for household and child variables. Model 2 is adjusted for household, child and

community variables. Model 3 is the final model and it extends model 2 with an interaction between per cent professionals and household socio-economic status (Table 5.6). As shown in model 3 the coefficient for per cent professionals is negative and statistically significant at 5 per cent level (β= -0.257, $p<0.05$). The result on per cent professionals indicates a 23 percent decrease in the odds of stunting with each additional per cent. Region is also significantly associated with stunting. Children who reside in West (exp (0.411)-1)*100=50.8%]), East/North East (78.8%) and Central (50.7%) regions compared to those in the North region were more likely to be stunted. Children in the South region and North region do not seem to differ by risk of stunting.

Model 3 shows that the coefficient attached to household size is negative, indicating that larger households are associated with a decrease in the odds of stunting. However the coefficient for household size is not significant. Further model 3 shows no evidence that living in urban villages or rural areas comparison to living in cities increase the odds of stunting. Residence is not significantly associated with stunting (Table 5.6). Comparing models 1 and 3 in Table 5.6, the results show that over and above the factors controlled for in model 1, community variables had an additional effect on stunting.

Household and individual variables: Further the results in Table 5.6 indicate that a number of household and individual level factors are associated with stunting. The variables linked with increased odds of stunting are living with no parents compared to living with both parents, living with a not related member, being male and age. Living with a mother and grandparent also increases the odds of stunting compared to living with both parents a grandparent. While living with an aunt, living with other relatives and a higher household socio-economic status is associated with decreased odds in stunting (Table 5.6).

Table 5.6: Parameter estimates for multilevel models of stunting among children less than five years, BFHS 2007

	Model1		Model2		Model3	
Variable	Coef.	SE.	Coef.	SE.	Coef.	SE.
Fixed Part						
Intercept	-1.572***	0.268	0.204	1.188	1.034	1.276
Community variables						
Household size			-0.400	0.329	-0.480	0.331
Percent professionals			-0.087**	0.044	-0.257**	0.100
Region						
North (ref.)						
South			0.288	0.247	0.255	0.247
West			0.421*	0.219	0.411*	0.218
East & North East			0.497*	0.281	0.581**	0.292
Central			0.370*	0.204	0.410**	0.206
Residence						
City/town (ref.)						
Urban Village			0.131	0.478	0.396	0.495
Rural			0.126	0.473	0.385	0.487
Household variables						
Parent (s) in a household						
both parents (ref.)						
mother only	0.062	0.152	0.054	0.153	0.051	0.153
father only	-0.013	0.198	-0.011	0.199	-0.001	0.199
no parents	0.429**	0.179	0.419**	0.180	0.422**	0.180
Other household members						
grandparent	-0.257	0.239	-0.258	0.240	-0.262	0.240
aunt	-0.296**	0.132	-0.304**	0.132	-0.313**	0.132
uncle	0.148	0.159	0.147	0.160	0.151	0.159
other relative	-0.345*	0.190	-0.361*	0.191	-0.344*	0.191
not related	0.362**	0.181	0.371**	0.182	0.369**	0.182
HH. Socio-economic status						
Poorest (ref.)						
Second	0.136	0.139	0.109	0.151	-0.866	0.621
Middle	-0.222	0.171	-0.220	0.195	-1.653***	0.605
Fourth	-0.558***	0.185	-0.569***	0.214	-1.279*	0.664
Richest	-0.859***	0.209	-0.875***	0.250	-1.328*	0.712
Household size (persons)						
2-3 persons (ref.)						
4-6 persons	-0.053	0.191	-0.069	0.192	-0.062	0.192
7+ persons	0.069	0.216	0.073	0.218	0.085	0.219

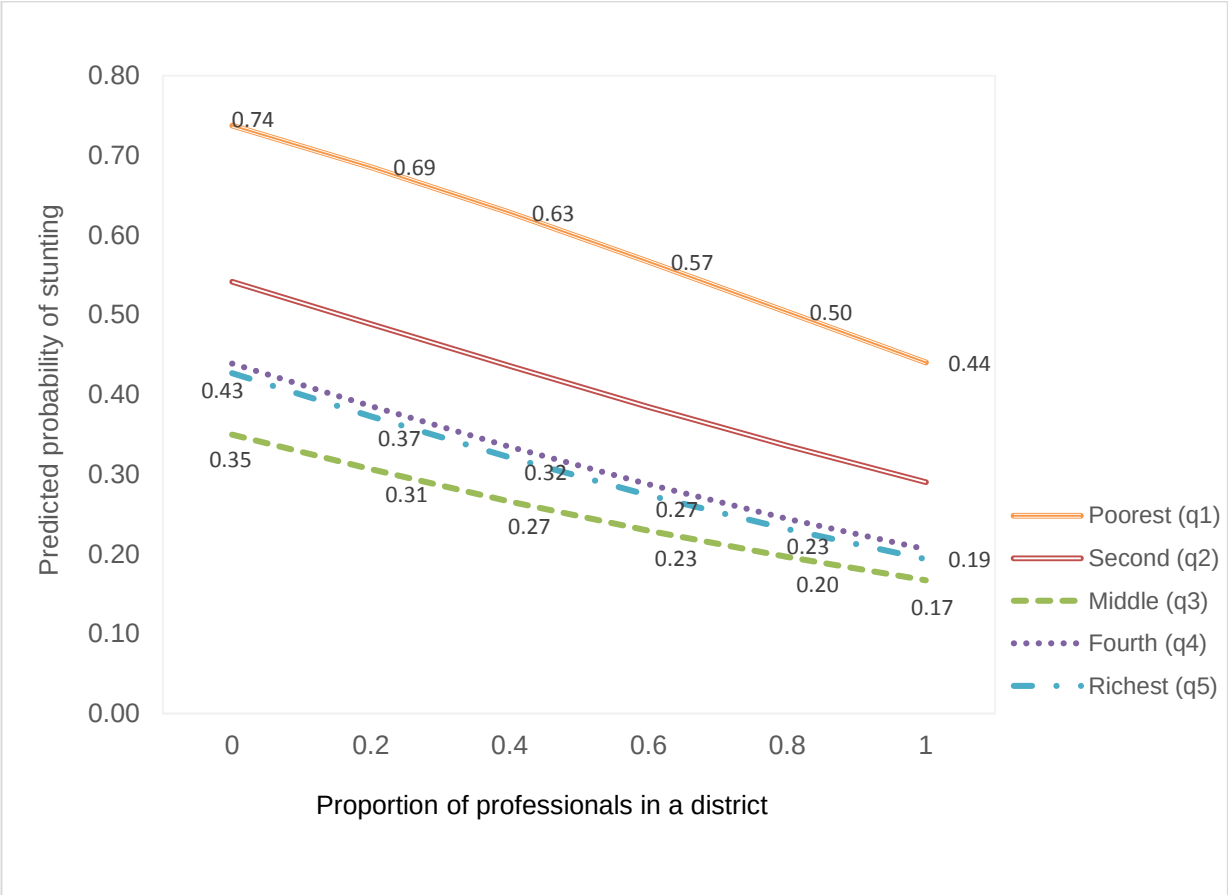
	Model1		Model2		Model3	
Variable	Coef.	SE.	Coef.	SE.	Coef.	SE.
No.of under fives						
One (ref.)						
Two	0.159	0.129	0.154	0.130	0.158	0.130
Three-Four	0.225	0.168	0.237	0.168	0.246	0.168
Five-Six	0.729	0.507	0.806	0.512	0.836	0.513
Individual variables						
Child's sex						
Female (ref.)						
Male	0.364***	0.102	0.357***	0.103	0.357***	0.103
Child's age(months)						
age	0.077***	0.013	0.077***	0.013	0.077***	0.013
age^2	-0.002***	0.000	-0.002***	0.000	-0.002***	0.000
Interactions						
bothparents*grandparent(ref.)						
motheronly*grandparent	0.710*	0.363	0.702*	0.366	0.699*	0.367
fatheronly*grandparent	0.516	0.357	0.519	0.358	0.525	0.359
noparents*grandparent	-0.515	0.384	-0.516	0.386	-0.510	0.387
Cross level interactions						
Poor*Professionals						
Second* Professionals					0.212*	0.127
Middle*Professionals					0.287**	0.118
Fourth*Professionals					0.170	0.124
Richest*Professionals					0.142	0.122
Random Part	Coef.	SE.	Coef.	SE.	Coef.	SE.
Level 3: ea						
cons/cons	0.117*	0.073	0.123*	0.071	0.103	0.693
Level 2: HHId						
cons/cons	0.690***	0.161	0.681***	0.159	0.691***	0.160
Level 1: ChildId						
bcons.1/bcons.1	1.000		1.000		1.000	
Statistics						
EA. level VPC (%)	2.8		3.0		2.5	
Household level VPC (%)	16.8		16.6		16.9	
Units: ea	298		298		298	
Units: HHId	1804		1804		1804	
Units: ChildId	2531		2531		2531	

Model1=Individual Household variables. Model2=Model1+Community variables.Model3=Model2+Cross-level Interaction. Legend: * p<.1; ** p<.05; *** p<.01 .Cons/cons=residual variance at a particular level.

Cross-level interactions

A cross-level interaction between the per cent of professionals in a district and household wealth status was added to model 2. The interaction showed that household wealth was a significant moderator between the level of employment at district level and stunting (Table 5.6). The significance of the interaction is clarified by the effects on stunting by household wealth quintiles at different levels of per cent professionals (Figure 5.4). As shown in Figure 5.4, a plot of the predicted probabilities of stunting by household wealth quintiles across the levels of professionals in a district suggests that the effect of professionals in a district vary by household wealth. Figure 5.4 shows that in general children living in the poorest household were more stunted than those in the richer households.

Figure 5.4 also indicates that the level of professionals in a district matters mainly for the poorest group, more than the other wealth groups since it has a big differential effect. For example there is a decrease from 74 per cent stunting among children in the poorest households and in a district with no professionals to 44 per cent stunted in a district with 100 per cent professionals. (Figure 5.4). In contrast, there is a decrease in stunting from 43 per cent to 19 percent among the richest households in districts with no professionals to that with 100 per cent professionals, respectively (Figure 5.4). Figure 5.4 also shows that the effect of the level of professionals in a district on stunting is greater for the middle group than the richest and fourth richest group. This is because at the lowest and the highest level of per cent professionals in a district, the probability of stunting is lower for the middle group than the fourth and richest group.



NB: The data labels are only shown for the poorest, middle and richest group to ease reading of the graph.

Figure 5.4: Predicted probabilities of stunting by household wealth quintiles across the levels of professionals in a district

Random effects (measure of variation)

In the random part of model 3, the significance of variance at household level (p-value <0.01) shows that the height for age z scores are correlated within households. This finding indicates that there is difference in stunting across households; with some households likely to increase the risk of stunting while others lower the risk. The results of the VPC indicate that 2.5 per cent of the unexplained variation lies at enumeration area level, and 16.9 per cent lies at household level (Table 5.6). The results on VPC suggest that community factors are conflated with individual and household factors, and there is little variation in communities compared to households in the odds of stunting.

5.4 Discussion

The aim of this study was to investigate how community level factors affect stunting and how they are moderated by household level factors. The findings demonstrate that community variables have an extra effect on stunting over and above household and individual factors. Per cent professionals and region were significantly associated with stunting. However, household size at district level and residence are less important as determinants of stunting in Botswana.

The finding that per cent professionals is negatively associated with stunting is consistent with earlier research on the economic effects of neighbourhoods on child health outcomes. For example, a study on neighbourhoods influence on child development finds that the per cent of male workers employed in professionals/managerial occupations is negatively associated with 3 year olds behaviour problems (Brooks-Gunn et al., 1993). Crane (1991) indicates that for both Blacks and Whites, dropping out of school is more likely among individuals living in neighbourhoods where fewer than 5 per cent of the workers are in professional or managerial jobs. A study of longitudinal data of disadvantaged youth in Chicago suggest that living in a neighbourhood with fewer professionals or managerial workers is positively associated with male's completion of school (Ensminger et al., 1996).

Theoretical work on neighbourhood effects on child well-being show that the effects are indirect and operate through three key mechanisms: institutional resources, relationships and norms/collective efficacy (Leventhal and Brooks-Gunn, 2000). Further, Leventhal and Brooks-Gunn (2000) states that institutional resources include the availability and accessibility of learning, child care, medical facilities and employment opportunities in the community. While the mechanisms related to relationships include parent characteristics (mental health, behaviour, coping skills, health, and education), support networks and the quality of the home environment. The pathways on norms/collective efficacy draws on the community institutions' abilities to supervise and monitor residents and prevent physical risk.

Thus, to the extent that per cent professionals reflect the economic and social characteristics of communities on stunting, its effect is likely to be moderated by parental and household characteristics. For example, communities with more professionals, may

have more adult economic resources and health knowledge about the prevention and treatment of child health diseases (Leventhal and Brooks-Gunn, 2000).

The proportion of professionals in a district may also determine stunting as a consequence of community literacy and maternal education. Related research has documented the association between community illiteracy rates among women with stunting in Nigeria (Adekanmbi et al., 2013), underweight in India (Luke and Xu, 2011) and child nutrition in Vietnam (Moestue and Huttly, 2008). Research also shows that children born to mothers with lower education levels have higher risks of stunting compared to those born to mothers with higher education (Adekanmbi et al., 2013, Som et al., 2007, Moestue and Huttly, 2008). Educated mothers or educated individuals in a community are likely to display healthy behaviours such as breastfeeding and good feeding practices which support good nutrition (Heaton et al., 2005).

Furthermore, per cent professionals may affect stunting indirectly through household food security and parent functioning pathways. Evidence on community disadvantage due to percentage of professionals in the neighbourhood, economic hardship and unemployment rates provides the link between lower percent professionals and negative effects on children's outcomes (Leventhal and Brooks-Gunn, 2000). Thus the way in which percentage of professionals can lead to poor nutritional status among children is likely to be through nutritional pathways from insufficient food in households in districts with lower levels of per cent professionals (Weiser et al., 2011). A study by Klebanov et al. (1994) finds that living in poorer neighbourhoods is associated with parental stress and subsequent poor parenting which leads to poor child health outcomes. However, the precise mechanisms involved remain less understood.

With respect to region, the results suggest that the environment in the North part of the country might be better for child nutritional status than in the West, East/North East and Central. However there does not seem to be any difference in the prevalence of stunting between the North and South regions. This result is expected as the South includes Gaborone, which is the capital city of Botswana and it is the most economically advanced district. The results on region are not to be overly interpreted as the way the districts are grouped is only relevant to stunting through the differences across the regions in economy, geography, culture, and ethnicity.

It is possible that the current classification of region conceals some of the district spatial effects related to district pattern of stunting. A spatial process that controls for remoteness and nonlinear effects of the covariates on climatic, environmental and geographic factors is a potential option for studying geographical effects on child health outcomes (Kandala et al., 2006). In their study, Kandala et al. (2006) report associations between environmental exposure and the spatial distribution of diarrhoea and fever among children in Malawi. Geographical location has also been found to explain differences in child stunting, with children living in regions with good health infrastructure, food resources better off than those in other regions (Heaton et al., 2005).

About household size, there is no evidence in the data to suggest that household size at district level has a significant effect on stunting, although the bivariate analysis showed that stunting was prevalent in districts with larger household size. Instead, the effects of household size are more discernible at household level. Previous studies show child health outcomes may be compromised in larger households from inadequate care and food (Heaton et al., 2005), unhygienic conditions and risks of disease spreading due to a large number of people living in a small space (Justesen and Kunst, 2000). In other settings, households with a large number of adults are associated with lower risks of child malnutrition due to more help with child care and supervision by several adults (Christiaensen and Alderman, 2001). Other explanations of the impact of household size on child health outcomes are based on wealth status and the impact of infant mortality. Kandala et al. (2006) suggest rich households attract more occupants and households with higher infant mortality risks remain small.

For residence the effect on stunting is in the right direction, but not significant. The results indicate no differences in terms of factors influencing stunting in urban and rural areas in Botswana. Another interpretation of the result on residence is that residence has no direct role on stunting. In fact in a study of underweight in six African countries, it was found that residence is less important than membership of a particular family (Madise et al., 1999). The results on residence are in contrary to evidence from other studies which shows that children living in rural areas have poor nutritional status than those in urban areas (Smith et al., 2005, Magadi, 2011, Black et al., 2013). Thus, the finding on residence in Botswana suggest that efforts to prevent stunting should target all children, regardless of rural or urban location.

Turning to the second goal of the study on moderation effects, the results show that an interaction between percentage of professionals and household wealth was significantly associated with stunting. The predicted probabilities of stunting were used to illustrate the effect that per cent professionals on stunting is dependent on the household socio-economic status. From the predicted probabilities of stunting, it is clear that children in poorer households and those with lower levels of professionals are at greater risk of stunting compared to those in richer households and those in districts with a higher proportion of professionals. The results also suggest that being poor places a strain on the household ability to provide sufficient food and variety of diet for child's growth and development.

Given the finding on the cross-level interaction, child policy could aim at improving the socio-economic conditions of households with children, especially the poorest group, since some of the effects of living in a community with less professionals can be ameliorated if children are in richer households. None of the other cross level interactions between the other community variables and other household variables studied were significant at 5 per cent level, implying that the influence of these community variables do not differ by household characteristics.

In addition to the results from the fixed effects, the results on the random effects indicate that stunting is correlated within households and there are differences in stunting across households. This is so since household are shared contexts, and children within the same household have similar risks of time and resources for child stunting. Evidence from other studies indicate that differences in economic resources (Adekanmbi et al., 2013, Wamani et al., 2006), child care practices, feeding practices (Madise et al., 1999), diet (Corsi et al., 2016), use of health services (Steele et al., 1996, Pebley et al., 1996) between households account for variation in child health outcomes across households. Other factors such as maternal nutrition (Madise et al., 1999, Luke and Xu, 2011, eLife, 2016, Espo et al., 2002, Corsi et al., 2016), maternal education (Luke and Xu, 2011, Moestue and Huttly, 2008, Heaton et al., 2005) and maternal HIV status (Magadi, 2011, Sunguya et al., 2011, Shapiro et al., 2007) also explain why some households have children with better nutritional status than others.

Further, the results of VPC indicate that enumeration area (2.5%) accounts for a very small amount of unexplained variation in stunting compared to households (16.9%). The

results of higher unexplained variance and significance of unobserved heterogeneity at household level imply that households are more influential than enumeration areas in determining stunting levels. However the result of little variation at ea level and no significant ea effect doesn't mean that area effects are less important than household factors in explaining the variation in stunting. The small clustering effect at ea level indicates a lack of a strong geographical contextual effect on stunting. Also, a small unexplained variance at ea level implies there could be other real ea effects which are not accounted for in the present analysis. Another interpretation of a small clustering effect at enumeration area effect could be that the clustering at this level is already explained by variables already included in the model such as region and household wealth. These variables are reported to describe shared environment conditions within communities (Griffiths et al., 2004).

The finding on the minimal enumeration area effect is consistent with findings from elsewhere. The estimates of VPC at ea and household levels are similar to those seen in other studies, where households rather than area effects on child health outcomes (Madise et al., 1999, Narine et al., 2013), and on child well-being (Garner and Raudenbush, 1991, Duncan and Raudenbush, 1999, Leventhal and Brooks-Gunn, 2000) have a larger effect. In addition, the percentage in unexplained variance in stunting across ea and households is in the range that is expected. The implication of this analysis is that policies aimed at reducing stunting among children in Botswana should address individual and household factors. Moreover, these interventions should understand the place and environment in which these households are found.

Limitations

Future analysis of stunting in Botswana would benefit from exploring other variables that have been shown elsewhere to be associated with child stunting such as feeding patterns of children (both breastfeeding and weaning), the type of the diet (adequacy and diversity), child illness, maternal health, maternal height, maternal nutrition and education. These variables were not available in the current data, but are likely to lead to an overestimation of the community effects on stunting.

The current data is limited to the community variables obtained from the census reports and from BAIS 2008 and BCWIS 2009/10 surveys. There are potentially other contextual

variables that are associated with stunting which include the social dynamics of communities. As pointed out by other researchers social organization and social networks in communities are important for child well-being and developmental through pathways on health behaviours and child care practice (Leventhal and Brooks-Gunn, 2000, Duncan and Raudenbush, 1999). The present study also acknowledges that the way the region is defined is limited. For example, it has been shown that spatial analysis is suited to examining the geographical effects on child health outcomes (Kandala et al., 2006, Garner and Raudenbush, 1991). Nonetheless, the aggregation of districts into five regions is assumed to represent reasonable differences across districts in economy, geography, culture and ethnicity. It should also be noted that areal effects as represented by EA is limited as it represents the data collection process rather than the local cultural and geographical effects on stunting.

Lastly, the analysis used the WHO Anthro software to obtain the height for age z scores, and this resulted in 184 cases declared not applicable due to missing on height/age and implausible HAZ scores outside the range -6 to +6 HAZ (WHO, 2013b, WHO, 2007). The use of WHO rather than the National Center for Health Statistics (NCHS)- which is another child growth standard is ideal since the WHO is for a developing context and it doesn't inflate the HAZ like NCHS which is for a developed context. WHO is also arguable better based on the fact that the standard is based on 6 countries and NCHS is only based on data from the USA (Black et al., 2013).

In spite these shortcomings, the study adds to knowledge about the relationship between community factors and long term malnutrition in Botswana. The other strength of the analysis are with the large sample of children aged under five years (2531) who were found in selected households, and with a good response rate (98.3%) for anthropometry measurements. A large sample means robust estimates and lower standard errors (Hilbe, 2009) were obtained. The next step in the analysis of risk factors for stunting and informing interventions targeted at improving stunting in Botswana, would consider variables missing from this study. Future use of longitudinal studies is also desirable to explore causal links and consideration of other dimensions of community which are not currently available.

5.5 Summary and conclusions

The results highlight the importance of community factors especially percentage professionals in a district and region to stunting. The significant interaction between per cent professionals and household wealth indicate that poorer households are not able to overcome community adverse effects (lower levels of per cent professionals) in order to improve child stunting. This is the case as children in poorer households and in districts with lower percentage of professionals are at a higher risk of stunting than those in richer households.

The results also show very little of the unexplained variation in stunting at enumeration area than at household level. This suggest that households than enumeration areas have a larger effect on stunting and there remain more heterogeneity in stunting at household level which could be due to other factors not included in the current analysis.

Taking the results of the present study together with those from previous studies, more evidence is needed to understand the mechanisms by which community factors interact with household factors to prevent stunting among children in Botswana. By implication policies aimed at reducing stunting would be beneficial if they target community, household and individual factors. Special attention is needed for children living in poorer households and in districts with lower levels of per cent professionals.

CHAPTER 6. SUMMARY AND CONCLUSIONS

6.1 Key findings

In summary, the findings from this thesis underscores the importance of community and household composition to stunting and diarrhoea prevalence among children in Botswana. As shown in the general conceptual framework in Figure 2.2 potential factors associated with child health outcomes operate at community, household and individual levels. The conceptual framework in Figures 3.1 describes factors associated with household change, and the model in Figure 3.2 suggests that fertility and marital status are important for household change. The conceptual framework in Figures 4.1 demonstrates the link between household composition, stunting and diarrhoea prevalence. While the conceptual framework in Figure 5.1 posits that community factors, and cross level interactions between community and household factors are also important in explaining the variations in child nutritional status.

Specifically, the analysis in chapter three provides a detailed examination of the changes in household size, growth and composition in Botswana between 1971 and 2011. Also examined is the level and pattern of fertility and marital status and how these two processes relate to the changes in households size and composition. The results from chapter three show that households in Botswana have become smaller and simpler (in terms of membership) between 1971 and 2011, owing to a drop in household membership, an increase in the number of households, a rise of one person households and a decrease in living with extended family and those that are unrelated to the family. Further, the proportion of households with young children aged 0-4 and 5-17 years drops across all ages and marital statuses of household heads.

While the findings from chapter three are important for providing an overall picture of households in Botswana, chapter four further explores how individual households influence stunting and diarrhoea. Chapter four explores the impact of other household members beyond biological parents on child health outcomes. The results from this

chapter indicate that stunting and diarrhoea prevalence varies by whom the child lives with. In particular, stunting is higher among children who do not live with either parent compared to those living with both parents. Stunting is also prevalent among children living with a household member who is not related to them, but is improved among those children living with an aunt, and those living with other relatives.

In agreement with previous studies, the findings from chapter four also show that other factors associated with stunting are household wealth (Miller and Korenman, 1994, Bronte-Tinkew and DeJong, 2004), region (Horton, 1986), child's sex and age (Lesiapeto et al., 2010, Wamani et al., 2007). The findings on diarrhoea prevalence show that the presence of a mother and, surprisingly a lack of biological parents in the household are associated with lower diarrhoeal morbidity compared to children living with both parents. Across all households, those who are richer, regardless of who is in the household, have lower levels of stunting and diarrhoeal prevalence than those who are poorer. In addition to evidence from past studies the analysis in chapter four highlights the difference in the effects of household composition on long term illness, as measured by stunting and short term illness, as measured by diarrhoea. It seems that extended family (aunts and other relatives) are important for reducing long term illness, while the presence of a mother and absence of both parents are more important for short term illness.

Finally, the analysis in chapter five, shows that over and above household and individual factors, community factors are also associated with stunting. The level of adults who are professionals and the region itself are significantly associated with stunting. The cross-level interaction between the percentage of professionals and the household socio-economic status show that improvements in household socio-economic status may help to ameliorate the effects of fewer workers in professional jobs on stunting. The findings from chapter five also imply that differences between households are important for the variation observed in child stunting.

Taken together, these findings call for policy interventions that provide for different types of households and the fact that households are becoming smaller over time. The results on fertility and marital status are important for understanding the changes in household size and household composition, while the findings from chapter four and five suggest interventions that go beyond biological parents to those that encompass other household members and to those that investigate moderation effects among community and

household factors. The findings also show that differences in household socio-economic status are a source of unequal levels of child stunting. Thus resources that support better child health outcomes need to be targeted to the lower income households. Further, the findings from chapters five call for interventions that improve the level of professional services in a district relative to household socio-economic levels.

6.2 Policy recommendations

In light of the above findings and conclusions, several policy implications emerge. These aim at reducing stunting and diarrhoea prevalence among children aged less than five years in Botswana. Primarily it is important to acknowledge that the relationship between family structure and child well-being in HICs provide a theoretical starting point and methodological domain for inquiry into other key pathways in LMICs through which community and household factors influence child health. Specifically related to Botswana, the policy suggestions proposed here relate to three main areas:

(1) Policies that take into account the importance of individual and household factors;
(2) Policies designed to recognise other key actors in the household which are also involved in child care; and
(3) Policies that strengthen and extend strategies aimed at improving stunting and diarrhoea beyond individual and household factors.

The specific details of the policy recommendations are as follows:

Individual and household factors

- The results on the decrease in household size and fertility in Botswana has implications for household's resources which are important for child health and development. Thus, programs for children in Botswana need to understand and recognize the characteristics of households with children. Specifically, the findings in chapter three on households becoming smaller and simpler are bringing changes in the quality of child care support and household resources (time and socio-economic). Large families have previously represented a large pool of resources and flexible structure for child care (Heaton et al., 2005, Desai, 1992, Bronte-Tinkew and DeJong, 2004). The question remains whether smaller

households offer the same benefits or better or worse resources for child health than larger households.

- Child factors of age and sex consistently feature as significantly associated with stunting. As seen from the results on age, an increasing trend in stunting up 24 months in Botswana calls for interventions that target the prenatal period into childhood. A cohort study in rural Guatemala demonstrates that interventions implemented during the prenatal period until 3 years have a huge impact on reducing stunting among children (Kuklina et al., 2006). Evidence also shows that interventions targeting the prenatal period, or as sometimes referred to as 1000 days from conception to a child's second birth day, have a potential to improve stunting if good nutrition and healthy growth of a child is maintained (Black et al., 2013).

- With regard to sex, male children in Botswana remain at a higher risk of stunting compared to females. Since Batswana do not hold rigid notions and preference of children by sex this finding is probably for biological and behavioural reasons. A longitudinal study of child development in Quebec by Côté et al. (2003) finds that males are more prone to lower birth weight, and birth weight can be affected by maternal nutrition and health behaviours in prenatal period. Therefore the finding on male vulnerability to stunting necessitates continued care and more monitoring of males in infancy and childhood.

Recognising other key actors living in households with children

- Policy needs to acknowledge that children live in different circumstances. It is important that policy in Botswana takes into account the types of adults in households and the level of the socio-economic resources they provide for child nutritional and child care needs. As shown in chapter four it is common for children to live with other non-related household members. Policy also needs to pay special attention to households with no parents and non-related household members since children in these households are at greater risk of stunting. For diarrhoea prevalence, it is important to recognize that living with only the biological mother or without any parents in the household is only protective in a short term. It is not clear if this is the case in long term.

- There is also a need for child health programmes that show an understanding of factors beyond families to those that take into account the characteristics of household members (eg. sex, age, education and income). For example, previous research in the Philippines (Horton, 1986) and in India (Moestue and Huttly, 2008) has documented the importance of educated parents for favourable child health outcomes. One of the limitations of the data studied in this thesis is that it provides no variables related to maternal or paternal education, let alone that of other household members.

Extending strategies to household and community contexts

- Child health programmes need to take into account other aspects of the household if they are to be of relevance for prevention of stunting and diarrhoea prevalence in the country. It was found that household wealth is a means of coping with the lack of professionals at community level to counter stunting. The significance of this has major implications for child health programmes in Botswana- whose focus has mainly been on a few individual and household factors.

- The Government of Botswana needs to strengthen programmes geared at economic inequalities in districts with low percentage of professionals. If these inequalities are allowed to persist, children in these areas will continue to be disadvantaged both in their childhood and later in life from poor health, poor cognitive abilities, poor school achievement and poor employment opportunities. As already shown, efforts to reduce stunting are likely to improve other child health outcomes such as diarrhoea prevalence, cognitive development and school achievement (Grantham-McGregor et al., 2007, Dewey and Begum, 2011).

- Intervention strategies in Botswana can also build on existing programmes. Currently there is the nutrition programme which provides *Tsabana* to children aged 6-59 months. *Tsabana* is a locally produced energy and nutrient rich food supplement which is given to children aged 6-59 months (UB and UNICEF, 2012). This nutrition programme has a wider coverage and is reported to have positive effects on child health across several rural districts in Botswana (Kopong, 2013). However Tsabana has never been assessed of its nutrient benefits and implementation.

- The national nutrition programme could also integrate with other programmes such as those related to health improvement and poverty eradication. An integration with the health programme will ensure that children are screened early and health advice provided early on. While an integration with the poverty eradication programme will address the socio-economic disadvantages at community and household levels. At present the nutrition programme is only linked to the health programme but not with the poverty alleviation programme which gives access to employment options for household members.

- Efforts to prevent stunting are also likely to be effective if they improve mother's and carers' education, knowledge on child health, nutrition before and after birth, feeding and hygiene practices. Current maternal child programmes in Botswana only focus on the clinical aspects of the health condition and less on the mother, her household and community characteristics. Higher maternal education leads to improvement in household socio-economic situation, better living conditions and greater health knowledge (Barrett and Browne, 1996, Desai and Alva, 1998, Bhuiya et al., 1990). All of these elements are essential for enhanced child nutritional status (Frost et al., 2005, Tagoe-Darko, 1995) and reducing the risk of child illness and death (Heaton et al., 2005, Caldwell, 1993). Further, research shows that improvements in mother's nutrition knowledge translate into improved health and survival of their children (Dewey and Begum, 2011, Black et al., 2008b).

Strengthening existing programmes and implementation

- The 2009 Guidelines for Community based Management of Acute Malnutrition (CMAM) sets out to link both the hospital and community management of malnutrition in Botswana (Republic of Botswana, 2009). If implemented accordingly, the CMAM has a potential to increase the identification and coverage of malnutrition programmes at both community and household levels.

- Policy interventions in Botswana also ought to remedy socio-economic inequalities across the country. The Government's investments in making education free for all from primary through tertiary education has improved livelihoods of most people in Botswana. For example, free education in the country has created equal opportunities for all to gain and enhance their

education, skills and access employment regardless of their social class. However some districts such as the Ngamiland West and Kweneng West still lag behind in education attainment and have higher poverty rates compared to the rest of the country. If free education is implemented in poorer areas, this policy option will address community influences on child health outcomes by improving the percentage of people involved in work. In turn, the benefit would be greater ability of households to manage the economic strain of supporting child health and nutrition.

- Finally, while the suggested policy strategies and interventions for improving stunting and diarrhoea are unique to Botswana, they can also provide lessons for other countries with the same household composition and contextual influences.

6.3 Suggestions for future research

The findings generate evidence for additional research and future analysis:

- The findings on household change suggest the need to better understand why households are becoming smaller, what this means for child health outcomes and to identify other factors associated with household change in Botswana. Factors such as changes in mortality and morbidity due to HIV and AIDS were not investigated in the thesis but are potential determinants of household change.

- It is also possible that the decrease in household size and fertility will continue in the future due to the improvements in women's education and participation in employment. Thus, it is important to understand the effects of smaller households, decrease in fertility, increasing parental education, and expanding employment opportunity on child health outcomes in Botswana. Critical questions to ask are: Do smaller households provide more financial and social resources needed to support child health than larger ones? How does child care compare between households with mothers who work outside the home and those who stay at home? And what are the benefits if any of maternal education, education of other household members on child nutrition and health?

- The findings from chapter three and four also raise a number of issues. Chapter three fails to show what's driving the delay in marriage and to explain large

changes in partnering behaviour among Batswana women. While from chapter four, the relationship between household factors and child health problems in Botswana is not complete without accounting for other factors such as parental health, maternal nutrition, household food security (diet adequacy and diversity), child care practices, and education of other key actors involved in child care other than the mother and father. Future research needs to explore these factors. Unfortunately, the necessary data were unavailable in the current investigation.

- In addition, given the complexity of factors associated with stunting and diarrhoea, there is need for new research efforts to understand the broader context of household and community on child health outcomes.

- Finally, future work needs to identify pathways through which community effects influence child health outcomes. Research that uses longitudinal analysis and involves follow up of children in households can identify causal pathways through which stunting and diarrhoea could be prevented. Cross sectional data cannot prove causality.

APPENDICES

APPENDIX 2A. Summaries of the main literature on families, households, child well-being and health

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
Thomson and McLanahan (2012)	Child well being	Family structure classified as married-parent, stepparent, cohabiting parent, divorced mother and never married mother families.	Cohabitation, importance of stability, complexity, context and selection.	High income countries (HICs).	Review of the literature and the 1987-88 National Survey of Families and Households (NSFH) from the USA, birth cohort studies in Australia, United Kingdom, France and Ireland.	1. Children living with mother and cohabiting partner have the poorest outcomes. 2. No differences in children's outcomes by duration in different types of family structures. 3. Family complexity associated with less parental cooperation. 4. Research on selection in family studies is based on assumptions that are often difficult to support.
Sear and Mace (2008)	Child survival	Importance of kin, grandparents and older siblings.	Human childrearing subsidized by other family members.	Matrilineal society -two villages in Southern Malawi Sample size:1635 children Only married women and who owned land included.	Single round of demographic survey collected by author in 1997.	1. Detrimental effect of maternal grandmothers on child survival 2. Mortality rates high in children whose mothers have living older sisters, and where men own resources, maternal aunts have a protective effect on child mortality. 3. Kin not always beneficial. 4. Older siblings associated with lower mortality risks. 5. Little evidence that fathers matter for child survival. 6. Who owns land appears to be more important than the level of wealth available.
Author	**Outcomes**	**Household influences**	**Analytical frameworks**	**Setting and participants**	**Data, design and analytic strategy**	**Findings**
Sear et al. (2002)	Child mortality	Effect of kin.	Matrilineal kin and effect of grandmothers.	Rural areas in Gambia.	1950-1974 data collected continuously. Multilevel event history models.	1. Matrilineal kin important: Having a living mother, maternal

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
				2294 Children under 5 years		grandmother, and elder sister had a positive effect on child survival. 2. Death of father had no effect. 3. Mother's remarriage had a detrimental effect. 4. No differences between children born to monogamous or polygynous fathers.
Cunningham et al. (2010)	Birth weight	Access to fathers and grandparents.	Social support, family environment, grandparents and men's involvement in child health.	Northern KwaZulu-Natal, South Africa 3993 children.	Longitudinal and multivariate OLS.	1. Infants to mothers with no partner at birth are lighter than those to married women or women with non-marital partner. 2. Regular partner, marital relationship, joint membership and co-residence of father with mother are associated positively with birth weight. 3. Birth weight associated with grandmothers living elsewhere. 4. Birth weight positively associated with financial (reduction in resources) than health shock (emotional stress).
Waldfogel et al. (2010)	Cognitive, behavioural, (aggressive behaviour, anxiety & depression) and health outcomes (obesity and asthma).	Family structure at birth: single mother, cohabiting families and married couple households. Family structure stability since birth.	Parental resources, parental mental health, parental relationship quality, parenting quality, father involvement,	5000 children in medium to large USA cities.	The Fragile Families and Child Wellbeing Study (FFCWs), longitudinal (1998-2000)	1. Family instability matter more than family structure for cognitive and health outcomes. 2. Growing up with a single mother matter more than instability for behavioural problems. 3. Children raised by stable single or cohabiting parents are less at risk than those raised by unstable single or cohabiting parents.

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
			selection, and family stability			
Houle et al. (2013)	Child mortality	Information on mothers and household information. The household definition includes temporary migrants.	Household composition can affect child mortality in several ways: young children, presence of adults, and household socio-economic status.	Rural Northeast South Africa. Children aged 0-59 months.	Household census data 1994-2008 (annual data).	1. Children under 24 months of age whose subsequent sibling was born within 11 months experience increased odds of dying. 2. The odds of dying remain high at the time of another child's death. 3. Having a related but non-parent adult aged 20–59 years in the household reduces the odds. 4. Inverse relationship between a child's odds of dying and household socio-economic status.
Hosegood et al. (2007)	Experiences of households directly affected by HIV and AIDS.	Household experience s of multiple episodes of illness and death during the 2 and half years of observation.	Reveals household experience with information on events outside the household; often not addressed by population based surveys.	12 households directly affected by HIV and AIDS in rural KwaZulu Natal, South Africa, between 2002 and 2004.	Analysis of field notes collected between 2002 and 2004.	1. Households experience multiple episodes of illness and death during the 2 years of observation. 2. The household responses are conditioned by history, circumstances and events. 3. Other causes compound the impact of AIDS. 4. Illness and AIDS deaths of people outside the household, who are connected with it, had repercussions for the household.
Matthews et al. (2010)	Whether the urban poor in different countries have an advantage over rural populations in	Household wealth : classified into five equal groups (quintiles)	Inequalities within urban areas (poor rich gap) in health and access to services, and	Demographic and Health Survey data from 30 developing countries in Africa, Asia and Latin America	Demographic and Health Survey data from 30 developing countries in Africa, Asia and Latin America	1. Three patterns of typologies identified; substantial urban exclusion, marginalisation of urban poor and minimal urban exclusion. 2. Different policy solutions are necessary to the inequality pattern

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
	health and access to services.		quantified urban poverty			that prevails and the inequality context. 3. One of the first studies to distinguish between poverty groups in urban settings and those in rural areas.
Clark and Hamplová (2013)	Single Motherhood and Child Mortality in Sub-Saharan Africa	Single parents (pre-marital and post-marital). Single motherhood: Giving birth before marriage and experiencing a union dissolution through divorce/ widowhood/and having at least one dependent child.	Three main mechanisms to explain why children of single mothers fare poorly: (1) lower economic status, (2) less parental supervision and care, and (3) **selection effects** into and out of single motherhood (whether unions polygamous and mother HIV status).	11 Demographic and Health Surveys (DHS) from Sub-Saharan Africa (SSA) **Child mortality:** DRC, Ghana, Liberia, Nigeria, Sierra Leone, Zambia **Marital history:** Ethiopia, Kenya, Malawi, Tanzania, Zimbabwe	DHS, cross -sectional.	1. Indicate that having a single mother & formerly married significantly increases the risk of a child dying before age 5 compared to married parents. 2. Children whose mothers were divorced were especially vulnerable. 3. Whether premarital or post marital single motherhood is most detrimental varies across countries.
Madhavan et al. (2012)	Child mobility	1) Maternal status :co-resident member of HH, temporary migrant, living elsewhere, and 4 for deceased 2) Maternal substitutes: females 15-59	1)Parental status, particularly that of mothers 2) the coping capacity of households in the face of economic hardship and	South Africa. The child cohort is aged 0–14 who ever lived in the site in the period July 1, 1999–July 1, 2008. **50978 Children.**	Agincourt Health and Demographic Surveillance System, annual data collection. Event history-mixed and fixed effects models in STATA.	**1.** Children whose mothers were temporary migrants, living elsewhere, or dead had higher odds of moving than children whose mothers were co-resident. **2.** Older children and children living in richer households faced lower odds of mobility. **3.** For children whose mothers were co-resident, there was no effect of

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
		years and elderly female (60+)	shocks resulting from death			maternal substitutes on child mobility. **4.** However, among children whose mothers were temporary migrants or living else-where, the presence of prime-aged and elderly females lowered the odds of mobility. **5.** For maternal orphans, the presence of elderly women in the household lowered their odds of mobility
Ford and Hosegood (2005)	Child mobility.	Mother, father, both parents deaths(all cause, AIDS)	1.Household membership(may change, simultaneous) 2.Residency	39163 children aged 0-17 years. Kwa Zulu Natal.	Africa Centre Demographic Surveillance Area (DSA), KwaZulu Natal. Observed for two years. Jan 2000-Jan 2002.	**1.** Children whose mothers or the fathers died either before the study began or during the observation period had an increased probability of likely to move. **2.** Child mobility after mother's death from AIDS death was lower than mobility following death from another cause. **3.** Younger children and children whose parents were not resident in the same households were likely to move. **4.** Children living in households with more assets were also less likely to move.
Schatz Enid and Ogunmefun (2007)	A qualitative study to understand caring and	Older women 60-75 years.	1.AIDS and HH of elderly women	Agincourt field site, North-eastern SA.	**Sampling frame** comes from the Agincourt Health and Demographic	1. HIV/AIDS continues to increase household's reliance on older women's pensions.

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
	contribution of older women.		2.Gender and spending patterns		Surveillance System (AHDSS). 24 out of 30 were interviewed.	2. The older women meet the needs of their households, with little left over for savings or themselves. 3. Poor households common: when an older woman is caring for a number of her daughters' children from non-marital births, or when the older woman receives the sole steady income in a household with many unemployed adults. 4. Extreme poverty among older women who lived alone and were not getting any assistance from their children.
Monserud and Elder (2011)	(3) High school completion, college enrolment, and college graduation.	Two biological parent stepfather families, single-mother families, extended households (grandparents), divorced and never married mothers.	SES(total family income, welfare receipt, and maternal education), Parenting quality, gender (influence of hh structure may vary by child sex).	Adolescents in grades 7 through 12 from a sample of 80 high schools and 52 middle schools in the United States. 10,083 youths.	Wave1 (1994 – 1995) and Wave 4 (2007 – 2008) of the National Longitudinal Study of Adolescent Health (Add Health	1. Extended households with two biological parents were not detrimental to high school completion or college enrolment. 2. Co-residence with grandparents seemed to be beneficial for the educational attainment of youth from single-mother households. 3. Skipped-generation (grandparent, child) households were associated with a persistent disadvantage for educational attainment. 4. Limited socioeconomic resources partially accounted for the adverse effects of alternative households. 5. Parenting quality did not explain these effects.

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
						6. Interactions of gender by household structure shows that stepfather households could have negative consequences for high school completion and college enrolment only for girls.
Mookodi (2008)	Opinion/qualitative review on biological identity with respect to children and parents.	Realities of gendered family life and parenting in Botswana	Biological identity with respect to children and parents.	Botswana	Qualitative review	1. Highlights some of the socially constructed realities of gendered family life and parenting in Botswana. 2. Discussed the acceptance and enforcement of the Children's Bill which advocates for inclusion of both their names in the child's birth certificate. 3. A majority of birth certificates that include the names of biological fathers are those of children born within the [legitimate] context of marriage. 4. Recommends the need to recognise diversity in families for supporting child development.
Mookodi (2000)	Composition, sources of income, survival strategies employed by women and men within households.	Household headship	Concept of household headship.	Women and their dependants, low income females and male supported hh in Manyana (rural village, and Gaborone).	Qualitative study, 1996	1. Criticisms that the concept of headship in itself presents a monolithic and often limited notion of social organisation that fails to take into account complex gendered social interactions that occur within and outside the confines of domestic units.

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
						2. Interviews with women and men pointed to the complexity of domestic organisation and the significance of gender hierarchies that are often obscured by focusing on discrete notions of 'headship'.
	Involvement of non-residential unmarried biological fathers in child rearing and child-caring	Single mothers and non-resident fathers.	Father child contact, Socio-economic and psychological deprivation of children.	2564 single women who had at least one child, Botswana.	Botswana Family Health Survey 1996, cross sectional	1. Most of the child support comes from the child's maternal relatives, especially the woman's mother, her father and other relatives. 2. Non-resident unmarried biological fathers were not providing any child support for close to two thirds of women in the sample. 3. Non- residential fathers provide support where compensation has been claimed, marriage prospects discussed and relationship ongoing. 4. More than two-thirds of women in the sample reported that non-resident unmarried fathers were maintaining contact with their children.
Townsend (1997)	Men, migration, and households in Botswana.	Men's relationship to different kinds of households	Links between residential groups and non-co-resident individuals.	Mankgodi, 92 men aged above 20.	Qualitative study, April 1993 through January 1994.	1. A complex picture of the relationships between adult men and children in Botswana. 2. Men have claims on them from the family, as sons, sons-in-law, mother's brothers, and grandfathers. 3. The men also contribute to the well-being of their own children.

Author	Outcomes	Household influences	Analytical frameworks	Setting and participants	Data and design	Findings
						4. In addition the men may face claims from more than one household at a time.

APPENDIX 3A. Summary of demographic indicators from the 1971-2011 censuses

Indicator	1971	1981	1991	2001	2011
Population					
Per cent of females aged 15-49 (out of total females)	42.8	42.9	46.5	52.4	56.3
Dependency ratio (per 100)	101.4	97.0	83.4	62.8	52.2
Sex ratio (Males per 100 females)	84.0	89.0	92.0	93.8	95.0
Per cent urban	9.0	17.7	45.7	54.2	64.1
Population density (per Sq. Km.)	1.0	1.6	2.3	2.9	3.5
Rate of natural increase (%)	3.1	3.4	2.7	1.7	1.9
Population growth rate per annum (%)	..	5.7	3.5	2.4	1.88
Mean age (years)					
Male	22.6	22.0	22.4	24.2	25.2
Female	24.1	23.4	23.5	25.3	26.8
Total	23.4	22.7	23.0	25.3	26.2
Median age (years)					
Male	13.5	15.0	16.0	19.4	22.0
Female	16.7	16.5	17.4	20.8	24.0
Total	15.0	15.3	16.8	20.1	23.0
Enumerated population					
Males	262120	443104	634400	813625	988958
Females	311974	497923	692396	867238	1035946
Total	574094	941027	1326796	1680863	2024904
Per cent of population in each age group					
0-4	17.6	19.7	14.6	11.6	11.7
5-14	29.9	27.3	28.6	25.0	20.9
15-49	39.4	41.6	45.5	52.0	54.6
50-64	7.5	6.9	6.3	6.4	7.8
65+	5.6	4.6	4.9	5.0	5.0
Fertility measures					
Child-woman ratio (per 1000)	758.8	854.7	602.0	430.1	320.6
Crude birth rate (per '000)	45.3	48.7	39.3	28.9	25.7
Rural	..	..	35.0	..	..
Urban	..	..	43.5	..	..
General fertility rate (per 1000 women aged 15-49)	189.0	210.0	161.0	106.9	92.2
Mean age at child bearing	30.5	30.6	30.0	30.3	..
Total fertility rate (births per women)	6.5	6.6	4.2	3.3	2.9
Rural	..	7.3	5.9	..	..
Urban	..	6.0	4.6	..	..
Mortality measures					
Crude death rate (per '000)	13.7	13.9	11.5	12.4	6.25
Rural	..	..	12.2	..	..
Urban	..	..	10.6	..	..

Indicator	1971	1981	1991	2001	2011
Infant mortality rate (per 1000 live birth)	97.0	71.0	48.0	56.0	..
Child mortality rate	56.0	35.0	16.0	19.0	..
Under 5 mortality	152.0	105.0	63.0	74.0	..
Life expectancy at birth (years)					
Male	52.5	52.3	63.3	52.0	66.0
Female	58.6	59.7	67.1	57.4	70.0
Total	55.5	56.2	65.3	55.6	68.0
International migration					
Batswana abroad					
Males	36661	32549	27870	16801	..
Females	9074	9412	10736	11409	..
Total	45735	41961	38606	28210	..
Non-Batswana					
Males	6114	8834	17995	34731	..
Females	4747	6843	11562	25985	..
Total	10861	15677	29557	60716	..

Source: National census 1971,1981,1991,2001 and 2011

.. Missing data or not available yet. Measures for sex ratio, dependency ratio and child woman ratio were recalculated by author. Child woman ratio=children 0-4/women aged 15-49

APPENDIX 3B. Direct Standardization of children ever born on age and marital status of women,1991 and 2001 Censuses

	Age structure,2001						CEB per 1000 in 1991						Expected births					
Age group	Single	Married	Cohabit.	Sepa/Di	Widowed	Total	Single	Married	Cohabit.	Sepa/Di	Widowed	Total	Single	Married	Cohabit.	Sepa/Di	Widowed	Total
12-14	61463	0	164	0	0	61627	2.23	43.72	89.55	76.92	94.59	3.02	137	0	15	0	0	186
15-19	98326	358	5170	2	0	103856	152.99	583.33	677.46	621.62	411.17	179.45	15043	209	3502	1	0	18637
20-24	64244	3774	21844	268	111	90241	952.99	1702.94	1479.26	1891.05	1995.78	1125.32	61224	6427	32313	507	222	101550
25-29	40100	10782	23933	440	427	75682	1886.77	2782.68	2498.83	3017.65	4117.78	2277.41	75659	30003	59805	1328	1758	172359
30-34	23759	16062	16984	802	959	58566	2904.33	3933.13	3671.28	3716.76	4651.34	3503.34	69004	63174	62353	2981	4461	205177
35-39	17107	17802	12771	1355	1522	50557	3763.39	5100.69	4715.35	4615.50	5253.68	4615.68	64380	90803	60220	6254	7996	233355
40-44	12203	16244	8703	1766	2123	41039	4445.84	6090.33	5641.54	5259.57	5988.67	5575.00	54253	98931	49098	9288	12714	228792
45-49	9026	14322	5907	1736	2840	33831	4871.90	6613.70	6008.46	5547.20	6261.97	6062.09	43974	94721	35492	9630	17784	205087
50-54	5673	10266	3274	1240	2967	23420	4978.20	6883.41	6169.63	5821.25	6349.88	6303.67	28241	70665	20199	7218	18840	147632
55-59	3902	7689	2000	954	3017	17562	4879.98	7009.54	5998.29	5595.82	6447.26	6369.78	19042	53896	11997	5338	19451	111866
60-64	3147	6405	1285	727	3629	15193	4622.76	6765.26	5712.00	5539.73	6188.09	6133.51	14548	43332	7340	4027	22457	93186
65+	7364	14917	2383	1830	22230	48724	3599.67	6188.93	5080.02	4685.53	5460.66	5407.42	26508	92320	12106	8575	121390	263471
Total	346314	118621	104418	11120	39825	620298	1199.71	5032.91	3412.62	4757.14	5656.72	2776.26						
												Expected births=	472013	644481	354439	55148	227073	1753154
Total expected births=			1753154															
Total Standard population=			620298									Expected births/total standard pop=	1.4	5.4	3.4	5.0	5.7	2.8
CEB standardized by age and marital status=				2.8														

APPENDIX 3C. Direct Standardization of children ever born on age and marital status of women,2001 and 2011 Censuses

Age group	Age structure,2001						CEB per 1000 in 2011						Expected births					
	Single	Married	Cohabit.	Sepa/Di	Widowed	Total	Single	Married	Cohabit.	Sepa/Di	Widowed	Total	Single	Married	Cohabit.	Sepa/Di	Widowed	Total
12-14	61463	0	164	0	0	61627	2.15	3.36	79.37	0.00	0.00	2.72	132	0	13	0	0	168
15-19	98326	358	5170	2	0	103856	67.13	375.87	590.60	1166.67	0.00	102.23	6600	135	3053	2	0	10617
20-24	64244	3774	21844	268	111	90241	533.48	1089.92	1131.55	1248.72	1530.77	729.38	34273	4113	24718	335	170	65820
25-29	40100	10782	23933	440	427	75682	1196.00	1626.11	1726.45	1768.71	2128.63	1449.50	47960	17533	41319	778	909	109701
30-34	23759	16062	16984	802	959	58566	1804.72	2222.78	2434.40	2184.62	2629.52	2122.24	42878	35702	41346	1752	2522	124291
35-39	17107	17802	12771	1355	1522	50557	2372.30	2827.31	3159.92	2564.58	3084.05	2754.56	40583	50332	40355	3475	4694	139262
40-44	12203	16244	8703	1766	2123	41039	2922.11	3481.58	3892.46	3078.52	3811.86	3389.40	35659	56555	33876	5437	8093	139098
45-49	9026	14322	5907	1736	2840	33831	3448.01	4190.36	4502.58	3716.66	4420.67	4010.34	31122	60014	26597	6452	12555	135674
50-54	5673	10266	3274	1240	2967	23420	3891.80	4859.11	4912.87	4184.03	5010.52	4550.21	22078	49884	16085	5188	14866	106566
55-59	3902	7689	2000	954	3017	17562	4367.31	5473.79	5376.68	4573.48	5571.49	5111.98	17041	42088	10753	4363	16809	89777
60-64	3147	6405	1285	727	3629	15193	4615.11	6076.30	5548.37	5026.01	6048.66	5590.36	14524	38919	7130	3654	21951	84934
65+	7364	14917	2383	1830	22230	48724	4749.10	6539.42	5449.14	5389.86	6200.95	5924.64	34972	97548	12985	9863	137847	288672
Total	346314	118621	104418	11120	39825	620298	1205.89	3802.93	2491.11	3732.67	5609.88	2251.70						
												Expected births=	327822	452822	258230	41300	220415	1300590
Total expected births=			1300590															
Total Standard population=			620298									Expected births/total standard pop=	1	3.8	2.5	3.7	5.5	2.1
CEB standardized by age and marital status=				2.10														

APPENDIX 4A. The logic of coding household relationships

Specific household head	Child relationship to hhead.	serial no (p01)	Mother line no.	Child line no.	Presence of a specific household member: Mother	Father	Grandparent to the child	Aunt to the child	Uncle to the child	Other relative to the child	Not related to the child
Mother	son/daughter (P05=2,3)				head (p05_1)	partner(p05==2) and father is p05_1 and p06==1	parent and parent in law	brother/sister & p06==2	brother/sister & p06==1	other relative	4, 13
Father	son/daughter (P05=2,3)				partner(p05*==2) and mother p05_1 & p06*==2	head, p06_1==1	parent and parent in law	brother/sister & p06==2	brother/sister & p06==1	other relative	4, 13
Grandparent	grandchild(P05 =5)				daughter(p05*==2|3) and p06*==2 & child is grandchild	son(p05*==2|3) and p06*==1	grandhead==1	daughter	son	other relative	4, 13
Uncle	nephew (P05=11|10)				sister (p05*==9) and p06*==2	brother(p05*==9) and p06*==1	parent and parent in law	brother/sister & p06==2	brother/sister & p06==1	other relative	4, 13
Aunt	niece(P05=11|10)				sister (p05*==9) and p06*==2	brother (p05*==9) and p06*==1	parent and parent in law	brother/sister & p06==2	brother/sister & p06==1	other relative	4, 13
Ambiguous	brother/sister*										4, 13
Other relative	other relative(P05=4, 12)	✓	✓	✓	otherela (p05*==10|11|12), niece and p06*==2	othereal (p05*==10|11|12),nephew and p06*==1	parent and parent in law	brother/sister & p06==2	brother/sister & p06==1	other relative	4, 13
Not related	not related(P05=13)	✓	✓	✓	notrela (p05*==4|p05*==13) and p06*==2	notrela (p05*==4|p05*==13) and p06*==1	parent and parent in law	brother/sister & p06==2	brother/sister & p06==1	other relative	4, 13

* Presence of specific household members. Blank spaces= not easy to validate.
Legend: P05= relationship to the household head: 1. Head 2.Son/daughter 3.Child in law 4.Step child/foster/adopted 5.Grandchild 6.Parent 7.Parent in law 8.Grandparent 9. Brother/sister 10. Nephew/niece 11.Aunt 12.Other relative 13.Not related member.
p05_* (p05_1= position 1 in household roster); p06 (sex 1=male and 2=female

APPENDIX 4B. Defining household relationships from the view of the child

Part 1: Initial steps

The process of defining a child's relationship to other household members involved two steps. The first step established the relationship of the child to the household head as illustrated in Appendix 4A. The initial distribution of the relationship of the child to the household head for BFHS 2007 is presented in Table 1 below:

Table 1: The relationship of the child to the household head

Relationship of child to household head	n	Per cent
Son/daughter	1129	40.0
Child in law	4	0.1
Step child/foster/adopted	12	0.4
Grand child	1312	46.5
Brother/sister	12	0.4
Nephew/niece	184	6.5
Other Relative	130	4.6
Not Related	39	1.4
Total	2822	100.0

*Note from the initial child file with 2822 cases, 12 cases had an ambiguous relationship to household head. The final sample is 2715 children (unweighted) or 2622 children (weighted).

Second, the relationship of the child to the household head was used to identify parental links, child relationship to the household head and other household members. The following diagrams demonstrate how parental links and relationship of the child to the household head were identified:

a. Mother is head of the household

Here the index person is the son/daughter or child in law to the household head.

Mother (Head of household; mother)

Child (son/daughter; child in law)

b. Father is head of household

Here the index person is the son/daughter or child in law to the household head.

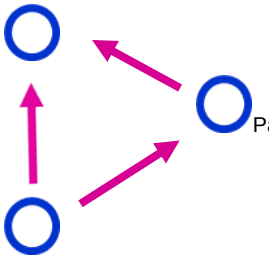
Father (Head of household; Father)

Child (son/daughter; child in law)

c. Grandparent is head of household

The index person is the grandchild and grandparent is the head of the household. The child parents are either son/daughter or child in law of the head of household (grandparent).

Grandparent (Head of household)



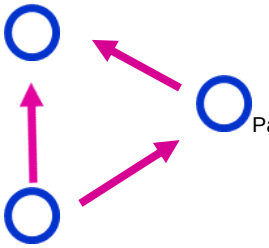
Parental link (Son/daughter; child in law)

Child (grandchild)

d. Ambiguous relationship

For this relationship, the child is recorded as brother/sister to the household head, and parents links observed from the 12 children who were coded as brother/sister to household head are: head, other relative, brother/sister, aunt, spouse, parent, and grandparent. A verification of these cases didn't not warrant them to be kept as a separate category. Information on the surnames of all household members and a correct sequencing of household members in the household list would have helped to interpret the results of this category satisfactory, and perhaps allowed a recording of the initial coding. However, information on the full names of the individuals and the sequencing of the individuals in the household was not available and useful to tell persons apart, respectively. A decision was made later to exclude these children from the final analysis of defining household composition.

Head of household



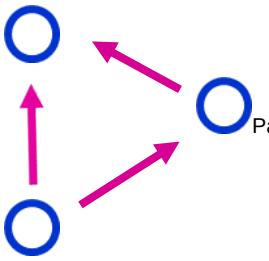
Parental link (Head; other relative; brother/sister; aunt; spouse; parent; grandparent)

Child (brother/sister)

e. Uncle is head of the house

The index person is the nephew/niece to the head of the household (uncle). The child's parent is either parent in law or sister to the head of household.

Uncle (Head of household)



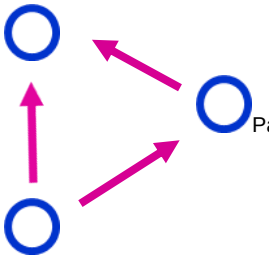
Parental link (Parent in law; brother/sister)

Child (nephew/niece)

f. Aunt is head of the house

Here the index person is the nephew/niece to the head of the household (aunt). The child's parent is either parent in law or sister to the head of household.

Aunt (Head of household)

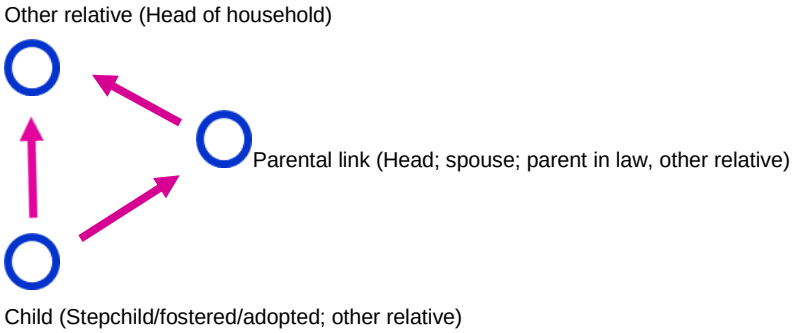


Parental link (Parent in law; brother/sister)

Child (nephew/niece)

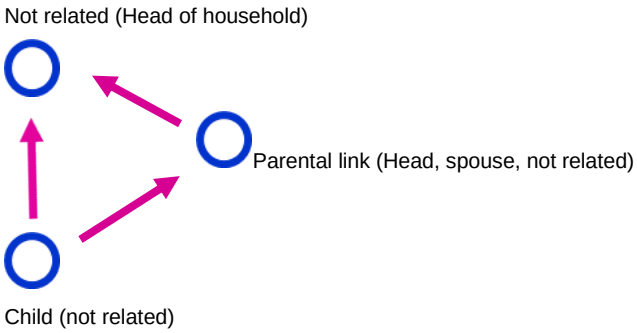
g. Other relative is head of household

The child is either stepchild/fostered/adopted or other relative, and the parents are either head of the household, spouse, parent in law or other relative. The head of the household is other relative.



h. Not related is head of household

The index child is not related to the household head, and his parents are either the head, spouse to the head or not related to the household head.



Part 2: Household relationships, characteristics of the members and household composition

Having assigned links between the child, parents and other household members, it was possibly to create the types of household composition in *STATA* using a programming approach. The programing involved identifying a variable that identifies whether parent (mother, father, both parents and no parents) and either household member (grandparent, aunt, uncle, other relative, and not related member) is present in the household that a child currently lives in. For example, to generate a variable capturing if mother of the index child is present in the household, the looping investigates a household headed by mother/father/grandparent/aunt or uncle and established if the mother is present (see Appendix 4A). The same approach is used to find out if the father

of the child is resident in the household. After determining parental co-residence a variable was created for mother only, father only, both parents and no parents present in the household. Determining whether a child lives with other household members (grandparent, aunt, uncle, other relatives/not related) also involved establishing presence of each of the members given the type of household head (mother/father/grandparent/aunt or uncle). Further information on household sequencing of members, sex, and relationship of household member to the head was also incorporated in the looping process for determining both the co-residence of the parents and other household members.

Categories for household composition were then defined as a child lives with both parents, one parent (motheronly or fatheronly), no parents and presence of other household members include grandparent, aunt, uncle, and other relatives/not related household members (seeTable 2 below).

Table 2: Household composition categories for the BFHS 2007 analysis

Household composition category	Individuals in the household
1. One parent (mother only)	Mother, child and other household members
2. One parent (father only)	Father, child and other household members
3.Both parents	Mother, father, child and other household members
4. No parents	No parents, child and other household members
5.Grandparent present	Grandparent , child and other household members
6.Aunt present	Aunt, child and ohousehold members
7.Uncle present	Uncle,child and other household members
8.Other relatives/not related member present	Other relatives/not related household member, child and other household members to the child present in the household

Possible sources of errors

To estimate the relationship between the child and household members, the author carried out a number of checks. These included verification of the data, through browsing of the households and mapping out the households on paper to ascertain the relationships. Obviously, the results might differ depending on whether the person who provided the information for the household is the household head; mother of the index child or guardian to the index child. The information about the household and child was provided by any of the women who were eligible for the survey. For instance, within

sampled households, all women eligible for individual question were interviewed, and information on their child (ren) collected if they had any children less than five years old. In the absence of a biological mother in the household, the guardian was interviewed. Two issues relating to the coding of household relationships from the original data and determining parental co-residence in the household are of importance.

Issues relating to coding

Though it was easier and straightforward to establish child relationship to his/her parents, and relationships of the child to other household members, it was a challenge in the case when the child is originally coded as a brother/sister to household head. To avoid introducing some ambiguity when the relationship of the child to household head is brother/sister, through checks were performed to confirm the linkage between the index child and mother, and relationships of all the household members to the household. The relationship proved to be ambiguous and not consistent. There were 12 cases (0.43% of the 2822 children in the initial data set) where child is brother/sister to household head. Parental links of these children to the household head were coded as parent, brother/sister, other relative, aunt, not related, spouse/partner to head, and head.

Issues relating to parental co-residence in the household

A measure defined by the author on parent co-residence in the household (mother/father present) is used in the analysis rather than the variables P12, P14. Although there is a difference in the observations obtained from the variables P12 and P14 in the household roster, the measures for parent presence are deemed satisfactory. The rigor in the checks for consistency and correct identification of the household members and their relationship to the child is sufficient to render the measure satisfactory. Also, the consistency checks based on age, sex, marital status, household size, child line number, mother line number, and sequencing of the household members in the household roster rendered the measure defined for household composition (parents and other household member presence) complete. A check on parental survival given whether the mother or father is present in the household was also done (Table not show here).

Lastly, the author has assumed the information provided by any of the women interviewed to be the best possible answer given the context of the household and the characteristics of the person who provided the information at the time of the survey. A

further investigation on how household head is determined, sequencing in the household roster and the use of surnames and how they influence then results would be explored in future work.

APPENDIX 4C. Possible models fitted to Stunting, BFHS 2007

Variable	Model										
	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
Parent (s) in a household												
both parents (ref.)												
mother only		1.10	1.19	1.10	1.13	1.14	1.18	1.07	1.17	1.01	1.23	1.22
father only		1.12	1.07	1.06	1.09	1.21	1.14	0.95	1.03	0.86	1.15	1.09
no parents		1.22	1.34**	1.13	1.15	1.30*	1.24	1.39*	1.09	1.11	1.22	1.25
Other household members												
grandparent			0.92	0.90	0.88	0.86	0.87	0.69	0.87	0.89	0.87	0.87
aunt			0.93	0.93	0.88	0.86	0.84	0.82	0.70*	0.88	0.84	0.83
uncle			1.22	1.09	1.08	1.08	1.11	1.12	1.20	0.88	1.11	1.11
other relative			0.86	0.89	0.87	0.92	0.92	0.92	0.90	0.90	1.05	0.92
not related			1.08	1.18	1.16	1.19	1.21	1.25	1.22	1.21	1.21	1.25
HH. Socio-economic status												
Poorest (ref.)												
Second				1.07	1.01	1.03	1.04	1.03	1.04	1.04	1.05	1.05
Middle				0.76*	0.74*	0.78	0.81	0.81	0.80	0.81	0.93	0.81
Fourth				0.67**	0.65**	0.66**	0.66**	0.65**	0.65**	0.65**	0.66*	0.67**
Richest				0.43***	0.41***	0.41***	0.43***	0.42***	0.43***	0.42***	0.51***	0.43***
Household size (persons)												
2-3 persons (ref.)												
4-6 persons					0.94	0.96	0.98	0.96	0.97	0.96	0.81	0.97
7+ persons					1.07	1.07	1.08	1.09	1.08	1.07	0.93	1.07
No.of under fives												
One (ref.)												
Two					1.12	1.14	1.15	1.17	1.15	1.15	1.24*	1.17
Three-Four					1.11	1.12	1.22	1.22	1.23	1.21	1.10	1.23
Five-Six					1.39	1.52	1.81	1.96*	1.83	1.85*	2.69**	1.84
Region												
North (ref.)												
South					1.29	1.29	1.24	1.26	1.23	1.26	1.32	1.22

Variable	Model											
	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
West					1.49**	1.51**	1.51**	1.51**	1.51**	1.53**	1.77***	1.50**
East & North East					1.90***	1.80**	1.80**	1.78**	1.80**	1.82**	1.63*	1.76**
Central					1.42**	1.38*	1.38*	1.41**	1.38*	1.41**	1.61**	1.37*
Residence												
City/town (ref.)												
Urban Village					0.93	0.94	0.98	0.98	0.97	0.99	1.12	0.98
Rural					0.95	0.99	1.01	1.00	1.02	1.03	1.14	1.02
Child's sex												
Female (ref.)												
Male						1.30***	1.32***	1.32***	1.33***	1.32***	1.31**	1.32***
Child's age(months)												
age						0.98***	1.07***	1.07***	1.07***	1.07***	1.07***	1.07***
age^2							1.00***	1.00***	1.00***	1.00***	1.00***	1.00***
Interactions												
motheronly*grandparent								1.98**				
fatheronly*grandparent								1.89*				
noparents*grandparent								0.75				
motheronly*aunt									1.13			
fatheronly*aunt									1.24			
noparents*aunt									1.67*			
motheronly*uncle										2.04**		
fatheronly*uncle										1.58		
noparents*uncle										1.57		
motheronly*other relative											0.83	
fatheronly*other relative											0.81	
noparents*other relative											0.78	
motheronly*not related												0.51
fatheronly*not related												1.66
noparents*not related												0.92
Intercept	0.43***	0.40***	0.38***	0.49***	0.36***	0.47**	0.20***	0.20***	0.20***	0.21***	0.19***	0.20***

Legend: * p<.1; ** p<.05; *** p<.01 and ref. =reference category. NB: the models are weighted and the results shown are odds ratios.
Model 7 (M7) best fits the data.

APPENDIX 4D. Possible models fitted to diarrhoea prevalence, BFHS 2007

Variable	Model										
	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
both parents (ref.)												
mother only		0.73**	0.69**	0.62***	0.64***	0.63***	0.64***	0.67**	0.64**	0.57***	0.57***	0.63***
father only		1.07	1.04	1.02	1.04	1.32*	1.26	1.56**	1.12	1.11	1.32	1.26
no parents		0.62***	0.56***	0.48***	0.49***	0.61**	0.59***	0.54***	0.60**	0.53***	0.60**	0.57***
Other household members												
grandparent			1.32*	1.28*	1.28*	1.25	1.26	1.48*	1.26	1.31*	1.27	1.26
aunt			1.07	1.10	1.10	1.10	1.09	1.08	1.04	1.14	1.11	1.09
uncle			0.87	0.76	0.78	0.74*	0.74*	0.76	0.74	0.62**	0.73*	0.74*
other relative			0.79	0.84	0.82	0.86	0.86	0.85	0.85	0.84	0.75	0.86
not related			0.72*	0.75	0.75	0.76	0.76	0.74	0.75	0.76	0.76	0.68
HH. Socio-economic status												
Poorest (ref.)												
Second				0.80*	0.80	0.78	0.79	0.80	0.79	0.79	0.79	0.79
Middle				0.77	0.72*	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Fourth				0.67**	0.62**	0.59**	0.59**	0.60**	0.59**	0.58**	0.59**	0.59**
Richest				0.31***	0.27***	0.27***	0.27***	0.27***	0.27***	0.26***	0.27***	0.27***
Household size (persons)												
2-3 persons (ref.)												
4-6 persons					0.86	0.88	0.89	0.89	0.90	0.88	0.88	0.90
7+ persons					0.91	0.87	0.89	0.87	0.90	0.88	0.88	0.90
No.of under fives												
One (ref.)												
Two					0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Three-Four					1.21	1.21	1.26	1.27	1.27	1.26	1.23	1.26
Five-Six					0.57	0.64	0.70	0.65	0.70	0.70	0.69	0.65
Region												
North (ref.)												
South					0.81	0.83	0.81	0.80	0.81	0.82	0.81	0.81
West					1.06	1.08	1.08	1.08	1.09	1.08	1.07	1.08

Variable	Model											
	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
East & North East					0.66	0.60*	0.60*	0.60*	0.60*	0.60*	0.59*	0.60*
Central					0.78	0.77	0.77	0.75	0.77	0.77	0.75	0.77
Residence												
City/town (ref.)												
Urban Village					0.71	0.70	0.71	0.71	0.70	0.71	0.71	0.70
Rural					0.64*	0.65*	0.65*	0.66*	0.64*	0.66*	0.66*	0.64*
Child's sex												
Female (ref.)												
Male						0.86	0.87	0.87	0.87	0.87	0.86	0.87
Child's age(months)												
age						0.97***	1.02	1.02	1.02	1.02	1.02	1.02
age^2							1.00***	1.00***	1.00***	1.00***	1.00***	1.00***
Interactions												
motheronly*grandpa.								0.80				
fatheronly*grandpa.								0.49**				
noparents*grandpa.								1.25				
motheronly*aunt									1.02			
fatheronly*aunt									1.33			
noparents*aunt									0.93			
motheronly*uncle										1.86		
fatheronly*uncle										1.26		
noparents*uncle										2.66		
motheronly*other relative											2.15*	
fatheronly*other relative											0.31	
noparents*other relative											0.67	
motheronly*not related												1.41
fatheronly*not related												0.93
noparents*not related												1.65
Intercept	0.22***	0.25***	0.26***	0.38***	0.70	1.63	1.05	1.02	1.07	1.10	1.09	1.06

Legend: * p<.1; ** p<.05; *** p<.01 ® =reference category. NB: the models are weighted and the results shown are odds ratios.

Model 6 (M6) best fits the data.

APPENDIX 4E. Estimated multilevel models for stunting at level 3

	M0S		M1S		M2S		M3S		M4S		M5S	
Variable	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Fixed Part												
Intercept	-1.02	0.06	-1.09	0.08	-1.13	0.10	-1.06	0.32	-1.79	0.37	-1.79	0.37
Parent (s) in a household												
both parents (ref.)												
mother only			0.06	0.12	0.18	0.13	0.11	0.14	0.16	0.15	0.05	0.15
father only			0.15	0.15	0.11	0.16	0.11	0.16	0.15	0.17	0.00	0.20
no parents			0.23	0.14	0.34	0.15	0.17	0.16	0.27	0.17	0.42	0.18
Other household members												
grandparent					-0.07	0.13	-0.10	0.13	-0.10	0.14	-0.25	0.24
aunt					-0.16	0.12	-0.22	0.13	-0.29	0.13	-0.30	0.13
uncle					0.23	0.14	0.11	0.15	0.15	0.15	0.15	0.16
other relative					-0.41	0.18	-0.39	0.18	-0.35	0.19	-0.35	0.19
not related					0.23	0.17	0.28	0.17	0.34	0.18	0.37	0.18
HH. Socio-economic status												
Poorest (ref.)												
Second							0.07	0.14	0.11	0.15	0.10	0.15
Middle							-0.33	0.18	-0.25	0.19	-0.25	0.19
Fourth							-0.58	0.20	-0.59	0.21	-0.59	0.21
Richest							-0.91	0.24	-0.90	0.25	-0.92	0.25
Household size (persons)												
2-3 persons (ref.)												
4-6 persons							-0.08	0.18	-0.04	0.19	-0.07	0.19
7+ persons							0.06	0.21	0.06	0.22	0.06	0.22
No.of under fives												
1 (ref.)												
2							0.11	0.12	0.15	0.13	0.16	0.13
3-4							0.10	0.16	0.23	0.17	0.23	0.17
5-6							0.32	0.47	0.64	0.51	0.77	0.52
Region												
North (ref.)												
South							0.18	0.21	0.14	0.22	0.16	0.22
West							0.31	0.20	0.34	0.21	0.34	0.22
East & North East							0.57	0.26	0.53	0.27	0.52	0.28
Central							0.27	0.19	0.25	0.20	0.28	0.20
Residence												
City/town (ref.)												
Urban Village							-0.05	0.21	0.00	0.22	0.00	0.22
Rural							-0.06	0.22	0.00	0.23	-0.02	0.23
Child's sex												
Female (ref.)												
Male									0.35	0.10	0.36	0.10
Child's age(months)												
age									0.08	0.01	0.08	0.01
age^2									0.00	0.00	0.00	0.00

	M0S		M1S		M2S		M3S		M4S		M5S	
Variable	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Interactions												
both parents*grandparent (ref.)												
motheronly*grandparent											0.69	0.37
fatheronly*grandparent											0.50	0.36
noparents*grandparent											-0.53	0.39
Random Part	**Coef.**	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**	**Coef.**	**S.E.**
Level 3: ea												
cons/cons	0.12	0.06	0.11	0.07	0.11	0.07	0.10	0.06	0.11	0.07	0.13	0.07
Level 2: HHId												
cons/cons	0.59	0.15	0.60	0.15	0.60	0.15	0.56	0.15	0.72	0.16	0.70	0.16
Level 1: ChildId												
bcons.1/bcons.1	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Statistics												
EA. level VPC (%)	2.91		2.87		2.83		2.57		2.66		3.17	
Household level VPC (%)	15.10		15.43		15.48		14.53		18.04		17.62	
Units: ea	298		298		298		298		298		298	
Units: HHId	1804		1804		1804		1804		1804		1804	
Units: ChildId	2531		2531		2531		2531		2531		2531	

M0S=null(intercept, level 2,3); M1S=M0S+HH.composition;M2S=M1S+Other HH.members;M3S=M2S+HH.variables;

M4S=M3S+Child variables; M5S=M4S+interactions. ref. =reference category. Coef.=coefficient;
S.E=standard error; EA=enumeration area; VPC=Variance partition coefficient. Legend: * p<.1; ** p<.05; *** p<.01. Model 5 (M5S) best fits the data.

APPENDIX 4F. Estimated multilevel models for diarrhoea at level 3

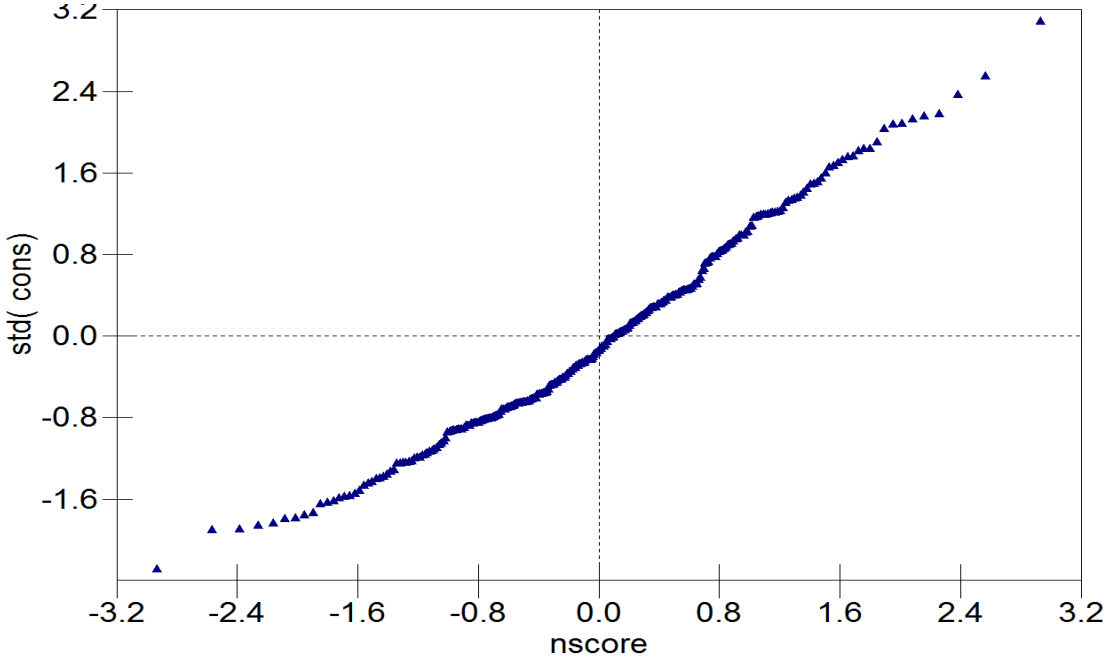
	M0D		M1D		M2D		M3D		M4D	
Variable	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Fixed Part										
Intercept	-1.94	0.07	-1.77	0.10	-1.72	0.12	-0.80	0.38	-0.28	0.43
Parent (s) in a household										
both parents (ref.)										
mother only			-0.32	0.16	-0.38	0.17	-0.42	0.17	-0.43	0.18
father only			0.10	0.18	0.08	0.19	0.08	0.18	0.29	0.19
no parents			-0.48	0.20	-0.57	0.21	-0.66	0.21	-0.48	0.21
Other household members										
grandparent					0.20	0.17	0.18	0.16	0.17	0.17
aunt					0.11	0.15	0.12	0.15	0.10	0.16
uncle					-0.16	0.18	-0.24	0.18	-0.31	0.19
other relative					-0.22	0.23	-0.19	0.22	-0.09	0.23
not related					-0.31	0.24	-0.28	0.23	-0.26	0.24
HH. Socio-economic status										
Poorest (ref.)										
Second							-0.12	0.18	-0.14	0.18
Middle							-0.28	0.22	-0.27	0.23
Fourth							-0.36	0.24	-0.39	0.25
Richest							-1.33	0.31	-1.37	0.32
Household size (persons)										
2-3 persons (ref.)										
4-6 persons							-0.03	0.23	-0.02	0.23
7+ persons							0.00	0.26	-0.04	0.26
No.of under fives										
1 (ref.)										
2							-0.16	0.15	-0.10	0.16
3-4							0.08	0.19	0.12	0.20
5-6							-0.77	0.75	-0.56	0.77
Region										
North (ref.)										
South							-0.14	0.25	-0.15	0.26
West							0.09	0.24	0.14	0.25
East & North East							-0.33	0.33	-0.43	0.33
Central							-0.17	0.22	-0.18	0.23
Residence										
City/town (ref.)										
Urban Village							-0.38	0.25	-0.44	0.26
Rural							-0.46	0.26	-0.50	0.27
Child's sex										
Female (ref.)										
Male									-0.14	0.12
Child's age(months)										
age									0.01	0.01
age^2									0.00	0.00

	M0D		M1D		M2D		M3D		M4D	
Variable	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Random Part										
Level 3: ea										
cons/cons	0.18	0.11	0.18	0.11	0.17	0.11	0.13	0.09	0.15	0.10
Level 2: HHId										
cons/cons	1.24	0.25	1.15	0.24	1.13	0.24	0.84	0.21	0.92	0.22
Level 1: ChildId										
bcons.1/bcons.1	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Statistics										
EA. level VPC (%)	3.80		3.97		3.95		3.10		3.57	
Household level VPC (%)	27.30		25.93		25.56		20.43		21.88	
Units: ea	298		298		298		298		298	
Units: HHId	1892		1892		1892		1892		1892	
Units: ChildId	2713		2713		2713		2713		2713	

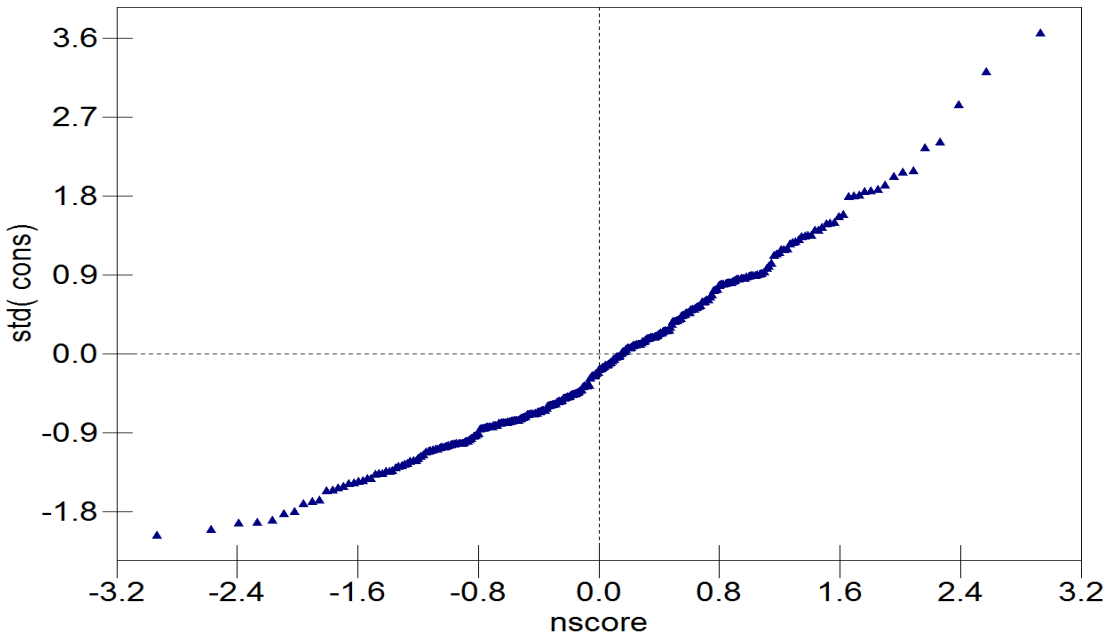
M0D=null(intercept, level 2,3); M1D=M0D+HH.composition;M2D=M1D+Other HH.members;M3D=M2D+HH.variables; M4S=M3S+Child variables. ref. =reference category. Coef.=coefficient; S.E=standard error; EA=enumeration area; VPC=Variance partition coefficient.
Legend: * p<.1; ** p<.05; *** p<.01. Model 4 (M4D) best fits the data.

APPENDIX 4G. Residual diagnostics for random intercept models at level 3

Graph 1: A quantile-quantile plot for enumeration area random effects, Stunting



Graph 2: A quantile-quantile plot for enumeration area random effects, Diarrhoea



APPENDIX 5A. A description of community and control variables

Characteristic	Description of the variable	Coding of the variable	Conceptual framework *	Source
Community variable				
Percent never schooled	Proportion of people in a district who have no formal education	Continuous	Illiteracy rate	Census 2001
Household size	Indicator of average household size at district level, is calculated by dividing total population in a district by the total number of households in that district.	Continuous	Household size	Census 2001
Unemployment rate	An indicator of the level of unemployment in a district. It is calculated by diving those seeking work (unemployed) by the total economically active.	Continuous	Unemployment rate	Botswana core welfare indicators poverty survey (BCWIS) 2009/10
HIV prevalence rate	Proportion of people in a district living with HIV.	Continuous	Community health problems	BAIS 2008
Health facilities	The total number of public hospitals and clinics in a district relative to the population in a district per 100 000 persons.	Continuous	Density of health services	Health Statistics 2008
Ratio of adult to child	A comparison of number of adults aged 15-64 years relative to children aged 0-14 years in a district.	Continuous	Access to social resources	Census 2001
Per cent professionals	Proportion of people in a district with formal employment (white collar jobs). These are people who are employed in sectors such as public administration, local government, real estate, education, health and finance.	Continuous	Participation in work	Census 2011
Wealth score	An indicator of district wealth status. Wealth scores are computed from the wealth quintiles, and categorized into three groups: (1) <2.7 which means poor, (2) 2.7 to 3.4 which is middle economic status and (3) 3.5 and above indicates a rich district.	Categorical	District wealth status	Census 2011
Per cent richest households	Proportion of rich households in a district.	Continuous	Community affluence	Census 2011
Region	Region is coded from all the 26 districts in Botswana, and North: Ngamiland East, Ngamiland West, Ngamiland Chobe, Kgalagadi North. South: Gaborone, Lobatse, Jwaneng, South East, Kweneng East, Kgatleng.West: Southern Ngwaketse, Southern Borolong, Southern Ngwaketse West, Kgalagadi South, Kweneng West, Ghanzi.East and North East: Francistown, Selebi Phikwe, and North East. Central: Orapa, Sowa, Serowe/Palapye, Mahalapye, Bobirwa and Tutume.	1.North 2.South 3.West 4.East & North East 5.Central	Region	BFHS 2007
Residence	Place of residence, coded into 3 categories: city/town, urban village and rural.	1.City/town, 2.Urban village and 3.Rural	Residence	BFHS 2007

Characteristic	Description of the variable	Coding of the variable	Conceptual framework *	Source
Household variables				
Presence of parents				
Mother only	Mother to the child is present in the household was determined from recasting household relationships from a child's perspective.	1 if mother is present in the household, and 0 otherwise	Parent(s) present	BFHS 2007
Father only	Father to the child is present in the household was determined from recasting household relationships from a child's perspective.	1 if father is present in the household, and 0 otherwise	Parent(s) present	BFHS 2007
Both parents	Determined from established presence of both the mother and father in the household.	1 if both biological parents are present in the household, and 0 otherwise	Parent(s) present	BFHS 2007
No parents	Determined from established presence of none of the biological mother and father in the household.	1 if none of the biological parents are present in the household, and 0 otherwise	Parent(s) present	BFHS 2007
Presence of other household members				
Grandparent	Grandparent to the child is present in the household. It was determined from recasting household relationships from a child's perspective.	1 if grandparent to the child is present in the household, and 0 otherwise	Other members	BFHS 2007
Uncle	Uncle to the child is present in the household. It was determined from recasting household relationships from a child's perspective.	1 if uncle to the child is present in the household, and 0 otherwise	Other members	BFHS 2007
Aunt	Aunt to the child is present in the household. It was determined from recasting household relationships from a child's perspective.	1 if aunt to the child is present in the household, and 0 otherwise	Other members	BFHS 2007
Other relative	Other relative to the child is present in the household. It was determined from recasting household relationships from a child's perspective.	1 if other relative(s) to the child are present in the household, and 0 otherwise	Other members	BFHS 2007
Not related	A not related member to the child usual resident in the household. It was determined from recasting household relationships from a child's perspective.	1 if not related member to the child are present in the household, and 0 otherwise	Other members	BFHS 2007
Household size	Number of persons in a household coded into three groups.	1.2-3 persons, 2.4-6 persons and 3.7+ persons	Household size	BFHS 2007

Characteristic	Description of the variable	Coding of the variable	Conceptual framework *	Source
Household socio-economic status	A wealth index score was computed for the whole country and it is based on material of construction of the main house, tenure of housing unit, number of rooms, ownership of durable assets, types of fuels used in the home, access to water supply, sanitation facility and refuse disposal. The technique used for computing this measure is the principal component analysis (PCA).	1.Poorest 2.Second 3.Middle 4.Fourth 5.Richest	Household wealth	BFHS 2007
No.of under-fives in a household	Number of children aged less than five years, and it is coded into three groups.	1. One child, 2. Two children and 3. Three -Six children	Number of children (<5 years)	BFHS 2007
Child characteristics				
Child's age (months)	Age of a child in months.	Continuous	Age	BFHS 2007
Child's sex	Sex of a child.	0.Female 1.Male	Sex	BFHS 2007

* How a community variable appears in the conceptual framework (Figure 5.1).

APPENDIX 5B. Correlations between community variables

Variable	Stunted	Never schooled	Household size	Unemployment	HIV	Healthcare	Adult /Child ratio	Professionals	Richest HH.	Wealth score
Stunted	1.000									
Never schooled	0.5663*	1.000								
p value	0.003									
Household size	0.4402*	0.8957*	1.000							
p value	0.024	0.000								
Unemployment	0.187	0.5606*	0.6252*	1.000						
p value	0.359	0.003	0.001							
HIV	-0.085	-0.4658*	-0.4017*	-0.148	1.000					
p value	0.679	0.017	0.042	0.471						
Healthcare	0.315	0.200	0.108	-0.093	0.018	1.000				
p value	0.117	0.327	0.601	0.652	0.930					
Adult /Child	-0.4838*	-0.8089*	-0.8488*	-0.5185*	0.164	-0.316	1.000			
p value	0.012	0.000	0.000	0.007	0.425	0.116				
Professionals	-0.6516*	-0.7374*	-0.6129*	-0.321	0.043	-0.4699*	0.8005*	1.000		
p value	0.000	0.000	0.001	0.110	0.836	0.015	0.000			
Richest HH.	-0.5360*	-0.6929*	-0.7257*	-0.4979*	0.022	-0.206	0.6086*	0.5446*	1.000	
p value	0.005	0.000	0.000	0.010	0.914	0.313	0.001	0.004		
Wealth score	-0.6114*	-0.8704*	-0.8569*	-0.5197*	0.234	-0.314	0.7954*	0.6780*	0.9050*	1.000
p value	0.001	0.000	0.000	0.007	0.249	0.118	0.000	0.000	0.000	

legend: * p<.05

APPENDIX 5C. Results for multi-collinearity between community variables

Community variable	VIF	SQRT VIF	1/VIF=Tolerance	R-squared
Professionals	2.17	1.47	0.4613	0.5387
Household size	4.19	2.05	0.2384	0.7616
Richest households	4.6	2.14	0.2176	0.7824
Wealth score	7.59	2.76	0.1317	0.8683
Mean VIF	4.64			

The variables household size, richest households and wealth score are collinear, and the tolerance (VIF) for these variables is above 2.50. A high VIF (above 2.50) and mean VIF larger than 1 reflects presence of multi-collinearity (UCLA Stat Consulting Group, 2016).

APPENDIX 5D. Logistic models fitted to stunting, BFHS 2007

Variable	model1	model2	model3	model4	model5	model6	model7	model8	model9	model10	model11	model12	model13
Percent never schooled	1.00												
Household size	0.77			0.79	0.72*	0.58*	0.73		0.57*	0.50**		0.67	0.48
Unemployment rate	1.00												
HIV prevalence rate	1.00												
Health facilities per 100 000 persons	1.00									1.00			
Percent professionals	0.91	0.91**	0.92**	0.92***			0.93**	0.93**	0.94*	0.93**	0.93*	0.81***	0.60
Percent richest households	1.00		1.00										
Ratio of adult to child	1.00	1.14	1.04		0.68**	0.71							
District Wealth status	0.76	0.85		0.79	0.82				0.73*	0.70*	0.85		
Parent (s) in a household													
both parents (ref.)													
mother only						1.07	1.07	1.07	1.06	1.06	1.06	1.07	1.06
father only						0.97	0.97	0.97	0.97	0.97	0.97	0.98	1.00
no parents						1.38**	1.38**	1.38**	1.37**	1.37**	1.37**	1.39**	1.37**
Other household members													
grandparent						0.77	0.77	0.77	0.76	0.76	0.77	0.77	0.78
aunt						0.77**	0.77**	0.78**	0.77**	0.77**	0.78**	0.77**	0.77**
uncle						1.12	1.12	1.12	1.11	1.11	1.11	1.12	1.10
other relative						0.74*	0.74*	0.74*	0.74*	0.74*	0.75*	0.75*	0.76*
not related						1.40**	1.39**	1.38**	1.39**	1.39**	1.38**	1.39**	1.37**

Variable	model1	model2	model3	model4	model5	model6	model7	model8	model9	model10	model11	model12	model13
HH. Socio-economic status													
Poorest (ref.)													
Second						1.06	1.08	1.10	1.08	1.08	1.10	0.48	0.31*
Middle						0.79	0.81	0.82	0.81	0.81	0.82	0.23***	0.12***
Fourth						0.60***	0.61***	0.62***	0.62***	0.62***	0.63**	0.33**	0.18**
Richest						0.46***	0.48***	0.49***	0.49***	0.50***	0.50***	0.35*	0.18**
Household size (persons)													
2-3 persons (ref.)													
4-6 persons						0.94	0.94	0.94	0.94	0.95	0.94	0.95	0.96
7+ persons						1.09	1.09	1.09	1.10	1.11	1.09	1.10	1.12
No.of under fives													
One (ref.)													
Two						1.12	1.13	1.13	1.12	1.12	1.12	1.13	1.13
Three-Four						1.18	1.19	1.19	1.19	1.18	1.19	1.20	1.19
Five-Six						1.88*	1.95*	1.94*	2.03*	2.07*	1.97*	2.02*	1.86
Region													
North (ref.)													
South						1.20	1.24	1.30	1.43*	1.38	1.42	1.21	
West						1.28	1.36*	1.32	1.46**	1.46**	1.36*	1.36*	
East & North East						1.43	1.48*	1.42	1.67**	1.69**	1.48*	1.60**	
Central						1.17	1.30	1.28	1.33*	1.30	1.29	1.36*	
District													
Gaborone (ref.)													
Francistown													0.49

Variable	model1	model2	model3	model4	model5	model6	model7	model8	model9	model10	model11	model12	model13
Lobatse													0.35
selibe phikwe													0.52
orapa													0.18
jwaneng													0.55
sowa													0.21
southern- ngwaketse													1.31
southern- borolong													0.55
southern ngwaketse west													0.68
south east													1.48
kweneng east													0.72
kweneng west													0.33
kgatleng													1.04
central- serowe/palapye													1.10
central -mahalapye													0.79
central -bobirwa													1.18
central-letlhakane													0.72
central -tutume													0.96
north east													1.08
ngamiland east													0.66
ngamiland west													0.51
ngamiland-chobe													0.23
ghanzi													(omitted)
kgalagadi- south													(omitted)
kgalagadi north													(omitted)

Variable	model1	model2	model3	model4	model5	model6	model7	model8	model9	model10	model11	model12	model13
Residence													
City/town (ref.)													
Urban Village						1.37	1.11	0.76	1.15	1.31	0.67	1.43	0.70
Rural						1.35	1.12	0.77	1.13	1.32	0.68	1.42	0.73
Child's sex													
Female (ref.)													
Male						1.37***	1.37***	1.37***	1.37***	1.37***	1.37***	1.37***	1.40***
Child's age(months)													
age						1.07***	1.07***	1.07***	1.07***	1.07***	1.07***	1.07***	1.07***
age^2						1.00***	1.00***	1.00***	1.00***	1.00***	1.00***	1.00***	1.00***
Interactions													
bothparents*grandparent(ref.)													
motheronly*grandparent						1.89**	1.87**	1.85*	1.92**	1.91**	1.87**	1.86*	1.86*
fatheronly*grandparent						1.67	1.68*	1.67	1.71*	1.71*	1.67	1.69*	1.70*
noparents*grandparent						0.71	0.70	0.70	0.71	0.70	0.70	0.70	0.68
Cross level interactions													
HH.SE*c.Professionals													
Second* Professionals												1.19*	1.33**
Middle*Professionals												1.29***	1.47**
Fourth*Professionals												1.16	1.32*
Richest*Professionals												1.12	1.29
Intercept	4.47	0.86	0.68**	3.52	6.36	3.36	1.06	0.38**	6.60	13.99	0.63	2.20	124.46
N	2531	2531	2531	2531	2531	2531	2531	2531	2531	2531	2531	2531	2531
ll	-1528.67	-1529.65	-1529.88	-1528.95	-1530.48	-1443.76	-1442.49	-1443.17	-1441.01	-1440.60	-1442.70	-1438.29	-1426.76

Variable	model1	model2	model3	model4	model5	model6	model7	model8	model9	model10	model11	model12	model13
df_m	9	3	3	3	3	31	31	30	32	33	31	35	53
chi2	22	20	20	22	19	192	195	193	198	199	194	203	226
aic	3077.35	3067.30	3067.76	3065.90	3068.97	2951.52	2948.97	2948.34	2948.01	2949.19	2949.40	2948.57	2961.52

The results shown are odd ratios. Legend: * p<.1; ** p<.05; *** p<.01 Model12 best fit the data. Although model9 had the lowest AIC, household size and district wealth status were collinear.

APPENDIX 5E. Final random intercept models for stunting in MLwiN

	model1		model2		model3	
	Coef.	SE.	Coef.	SE.	Coef.	SE.
Fixed Part						
cons	-1.586	0.270	0.205	1.195	1.035	1.278
Community variables						
Household size			-0.402	0.330	-0.481	0.331
Percent professionals			-0.088	0.044	-0.257	0.101
Region						
North (ref.)						
South			0.290	0.248	0.255	0.248
West			0.424	0.220	0.411	0.218
East & North East			0.499	0.282	0.582	0.292
Central			0.372	0.205	0.411	0.206
Residence						
City/town (ref.)						
Urban Village			0.131	0.481	0.397	0.496
Rural			0.126	0.475	0.386	0.488
Household variables						
Parent (s) in a household						
both parents (ref.)						
mother only	0.062	0.153	0.054	0.154	0.051	0.153
father only	-0.013	0.200	-0.010	0.200	-0.001	0.200
no parents	0.435	0.180	0.422	0.181	0.422	0.180
Other household members						
grandparent	-0.258	0.241	-0.258	0.242	-0.263	0.241
aunt	-0.299	0.133	-0.305	0.133	-0.314	0.132
uncle	0.150	0.160	0.148	0.160	0.151	0.160
other relative	-0.349	0.192	-0.363	0.192	-0.345	0.191
not related	0.365	0.183	0.372	0.183	0.369	0.182
HH. Socio-economic status						
Poorest (ref.)						
Second	0.139	0.141	0.110	0.152	-0.867	0.622
Middle	-0.223	0.173	-0.220	0.196	-1.655	0.606
Fourth	-0.563	0.187	-0.572	0.215	-1.280	0.665
Richest	-0.866	0.211	-0.879	0.252	-1.329	0.713
Household size (persons)						
2-3 persons (ref.)						
4-6 persons	-0.054	0.193	-0.069	0.193	-0.062	0.193
7+ persons	0.070	0.218	0.073	0.219	0.085	0.219
No.of under fives						
One (ref.)						
Two	0.162	0.131	0.155	0.130	0.158	0.130
Three-Four	0.229	0.169	0.239	0.169	0.246	0.168
Five-Six	0.737	0.514	0.811	0.516	0.837	0.514

	model1		model2		model3	
	Coef.	SE.	Coef.	SE.	Coef.	SE.
Individual variables						
Child's sex						
Female (ref.)						
Male	0.366	0.103	0.358	0.103	0.357	0.103
Child's age(months)						
age	0.077	0.013	0.077	0.013	0.077	0.013
age^2	-0.002	0.000	-0.002	0.000	-0.002	0.000
Interactions						
bothparents*grandparent(ref.)						
motheronly*grandparent	0.716	0.366	0.705	0.368	0.700	0.367
fatheronly*grandparent	0.519	0.360	0.520	0.360	0.525	0.359
noparents*grandparent	-0.521	0.388	-0.519	0.388	-0.511	0.387
Cross level interactions						
Poor*Professionals						
Second* Professionals					0.212	0.127
Middle*Professionals					0.287	0.118
Fourth*Professionals					0.170	0.124
Richest*Professionals					0.143	0.123
Random Part						
Level 3: ea						
cons/cons	0.120	0.073	0.125	0.073	0.103	0.070
Level 2: HHId						
cons/cons	0.734	0.163	0.706	0.161	0.697	0.160
Level 1: ChildId						
bcons.1/bcons.1	1.000		1.000		1.000	
Units: HHId	1804		1804		1804	
Units: ChildId	2531		2531		2531	
Units: ea	298		298		298	

Model1=Individual+ Household variables. Model2=Model1+Community variables.Model3=Model2+Cross-level interaction (HH.SE* Professionals). These models were estimated in MLwiN in order to test improvement between the models using the Wald test. Model 3 best fit the data, and it is the final model for the analysis in chapter five.

APPENDIX 5F. An equation from the fitted random effects model in MLwiN

$$\text{Stunt2}_{ijk} \sim \text{Binomial}(\text{cons}_{ijk}, \pi_{ijk})$$

$$\begin{aligned}\text{logit}(\pi_{ijk}) = {} & \beta_{0jk}\text{cons} + 0.051(0.153)\text{motheronly}_{ijk} + \text{-}0.001(0.199)\text{fatheronly}_{ijk} + 0.422(0.180)\text{noparents}_{ijk} + \\ & \text{-}0.263(0.241)\text{grand present in hh}_{ijk} + \text{-}0.313(0.132)\text{aunt present in hh}_{ijk} + 0.151(0.160)\text{unclchipre}_{ijk} + \\ & \text{-}0.345(0.191)\text{rela present in hh}_{ijk} + 0.369(0.182)\text{notrel present in hh}_{ijk} + \text{-}0.867(0.621)\text{Second}_{jk} + \\ & \text{-}1.655(0.606)\text{Middle}_{jk} + \text{-}1.280(0.664)\text{Fourth}_{jk} + \text{-}1.329(0.713)\text{Richest}_{jk} + \text{-}0.062(0.193)\text{4-6 persons}_{jk} + \\ & 0.085(0.219)\text{7+ persons}_{jk} + 0.158(0.130)\text{Two}_{jk} + 0.246(0.168)\text{ThreeFour}_{jk} + 0.837(0.514)\text{FiveSix}_{jk} + \\ & 0.255(0.248)\text{\_Iregion\_2}_{jk} + 0.411(0.218)\text{\_Iregion\_3}_{jk} + 0.582(0.292)\text{\_Iregion\_4}_{jk} + 0.411(0.206)\text{\_Iregion\_5}_{jk} + \\ & 0.396(0.496)\text{Urban Village}_{jk} + 0.386(0.488)\text{Rural}_{jk} + 0.357(0.103)\text{male}_{ijk} + 0.077(0.013)\text{agemos}_{ijk} + \\ & \text{-}0.002(0.000)\text{agemosquare}_{ijk} + 0.700(0.367)\text{mograndint}_{ijk} + 0.525(0.359)\text{fagrandint}_{ijk} + \\ & \text{-}0.511(0.387)\text{nopgrandint}_{ijk} + \text{-}0.480(0.331)\text{Hhsize\_distr}_{jk} + \text{-}0.257(0.101)\text{Professionals}_{jk} + \\ & 0.212(0.127)\text{Second.Professionals}_{jk} + 0.287(0.118)\text{Middle.Professionals}_{jk} + \\ & 0.170(0.124)\text{Fourth.Professionals}_{jk} + 0.143(0.123)\text{Richest.Professionals}_{jk}\end{aligned}$$

$$\beta_{0jk} = 1.035(1.278) + v_{0k} + u_{0jk}$$

$$\begin{bmatrix} v_{0k} \end{bmatrix} \sim \text{N}(0,\ \Omega_v)\ :\ \Omega_v = \begin{bmatrix} 0.103(0.069) \end{bmatrix}$$

$$\begin{bmatrix} u_{0jk} \end{bmatrix} \sim \text{N}(0,\ \Omega_u)\ :\ \Omega_u = \begin{bmatrix} 0.695(0.160) \end{bmatrix}$$

$$\text{var}(\text{Stunt2}_{ijk}|\pi_{ijk}) = \pi_{ijk}(1 - \pi_{ijk})/\text{cons}_{ijk}$$

(2531 of 2715 cases in use)

$$\text{Stunt2}_{ijk} \sim \text{Binomial}(\text{cons}_{ijk}, \pi_{ijk})$$

$$\begin{aligned}\text{logit}(\pi_{ijk}) = {} & \beta_{0jk}\text{cons} + \beta_1\text{motheronly}_{ijk} + \beta_2\text{fatheronly}_{ijk} + \beta_3\text{noparents}_{ijk} + \beta_4\text{grand present in hh}_{ijk} + \\ & \beta_5\text{aunt present in hh}_{ijk} + \beta_6\text{unclchipre}_{ijk} + \beta_7\text{rela present in hh}_{ijk} + \beta_8\text{notrel present in hh}_{ijk} + \beta_9\text{Second}_{jk} + \\ & \beta_{10}\text{Middle}_{jk} + \beta_{11}\text{Fourth}_{jk} + \beta_{12}\text{Richest}_{jk} + \beta_{13}\text{4-6 persons}_{jk} + \beta_{14}\text{7+ persons}_{jk} + \beta_{15}\text{Two}_{jk} + \beta_{16}\text{ThreeFour}_{jk} + \\ & \beta_{17}\text{FiveSix}_{jk} + \beta_{18}\text{\_Iregion\_2}_{jk} + \beta_{19}\text{\_Iregion\_3}_{jk} + \beta_{20}\text{\_Iregion\_4}_{jk} + \beta_{21}\text{\_Iregion\_5}_{jk} + \beta_{22}\text{Urban Village}_{jk} + \\ & \beta_{23}\text{Rural}_{jk} + \beta_{24}\text{male}_{ijk} + \beta_{25}\text{agemos}_{ijk} + \beta_{26}\text{agemosquare}_{ijk} + \beta_{27}\text{mograndint}_{ijk} + \beta_{28}\text{fagrandint}_{ijk} + \\ & \beta_{29}\text{nopgrandint}_{ijk} + \beta_{30}\text{Hhsize\_distr}_{jk} + \beta_{31}\text{Professionals}_{jk} + \beta_{32}\text{Second.Professionals}_{jk} + \\ & \beta_{33}\text{Middle.Professionals}_{jk} + \beta_{34}\text{Fourth.Professionals}_{jk} + \beta_{35}\text{Richest.Professionals}_{jk}\end{aligned}$$

$$\beta_{0jk} = \beta_0 + v_{0k} + u_{0jk}$$

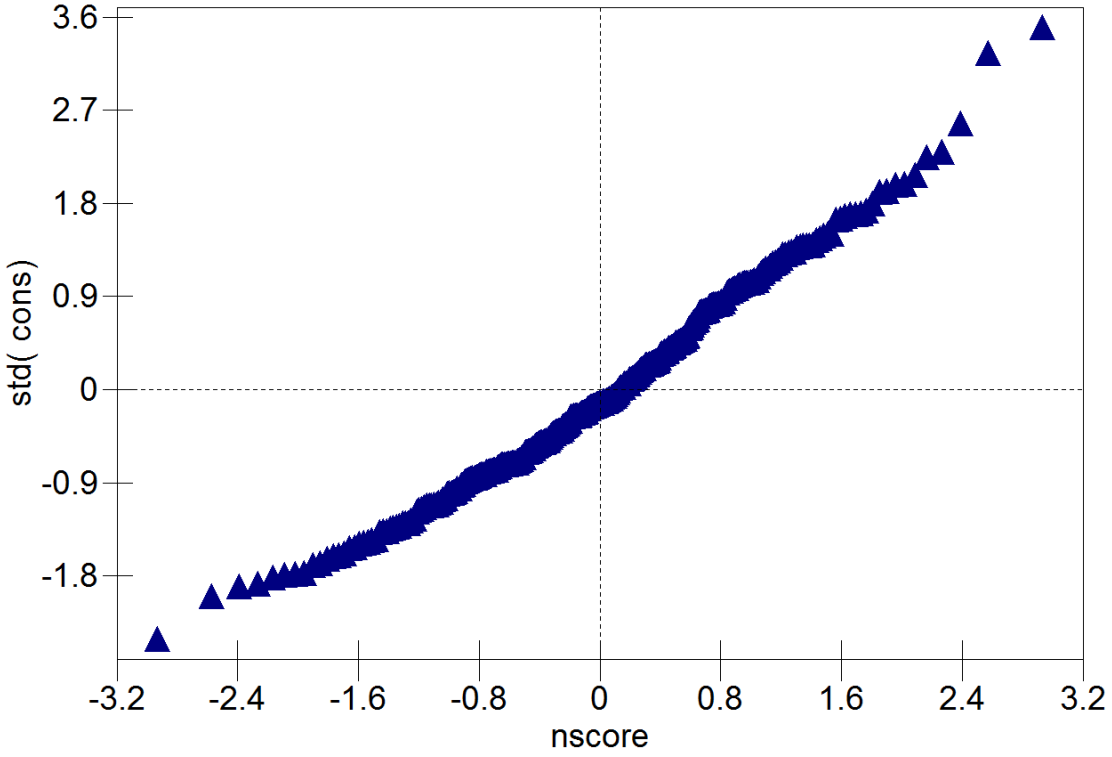
$$\begin{bmatrix} v_{0k} \end{bmatrix} \sim \text{N}(0,\ \Omega_v)\ :\ \Omega_v = \begin{bmatrix} \sigma^2_{v0} \end{bmatrix}$$

$$\begin{bmatrix} u_{0jk} \end{bmatrix} \sim \text{N}(0,\ \Omega_u)\ :\ \Omega_u = \begin{bmatrix} \sigma^2_{u0} \end{bmatrix}$$

$$\text{var}(\text{Stunt2}_{ijk}|\pi_{ijk}) = \pi_{ijk}(1 - \pi_{ijk})/\text{cons}_{ijk}$$

(2531 of 2715 cases in use)

APPENDIX 5G. Residual diagnostics



APPENDIX 5H. Ordered distribution of stunting and community variables by district

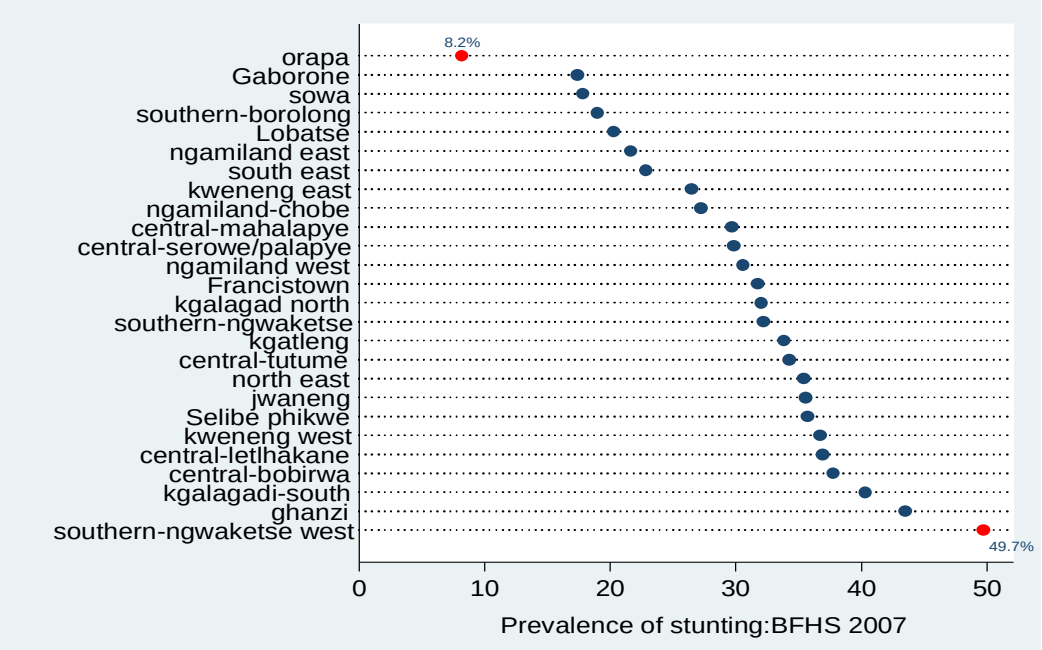


Figure 1: Stunting by district, BFHS 2007

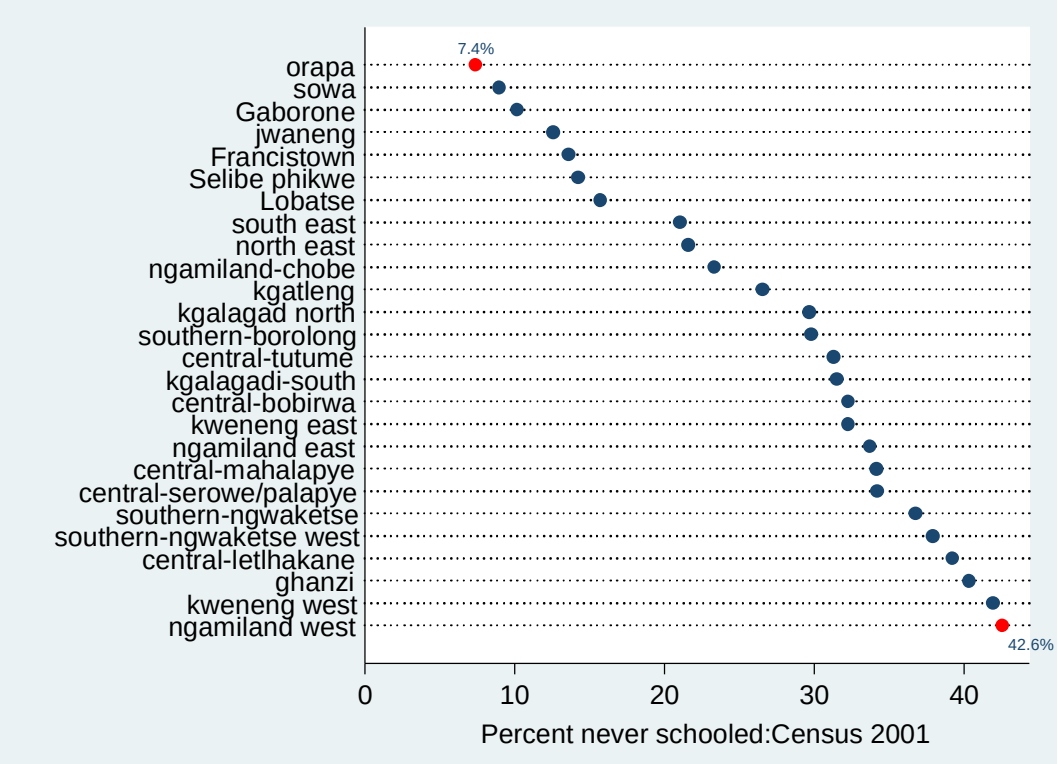


Figure 2: Per cent never schooled by district, Census 2001

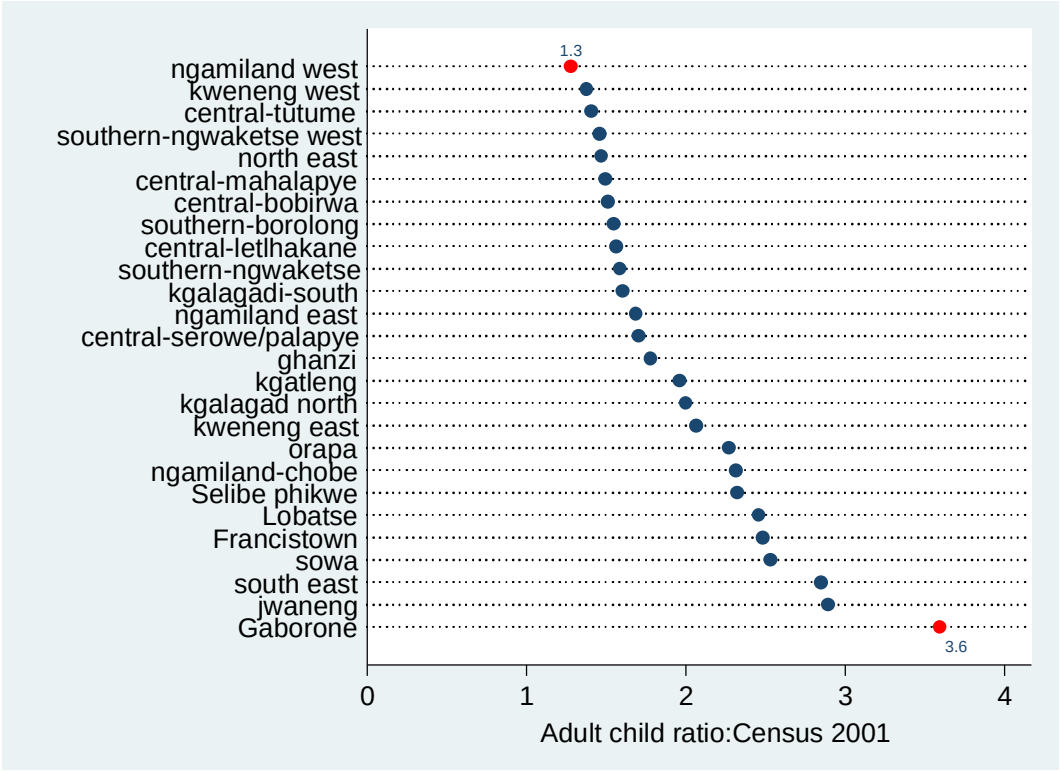


Figure 3: Adult to child ratio by district, Census 2001

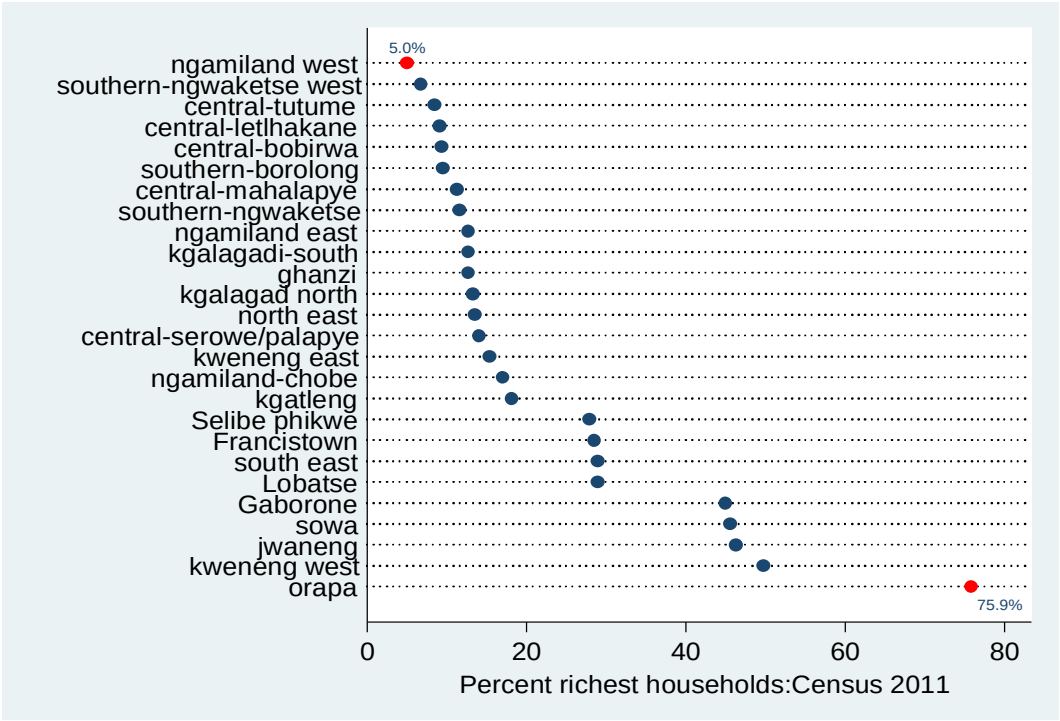


Figure 4: Per cent richest households by district, Census 2011

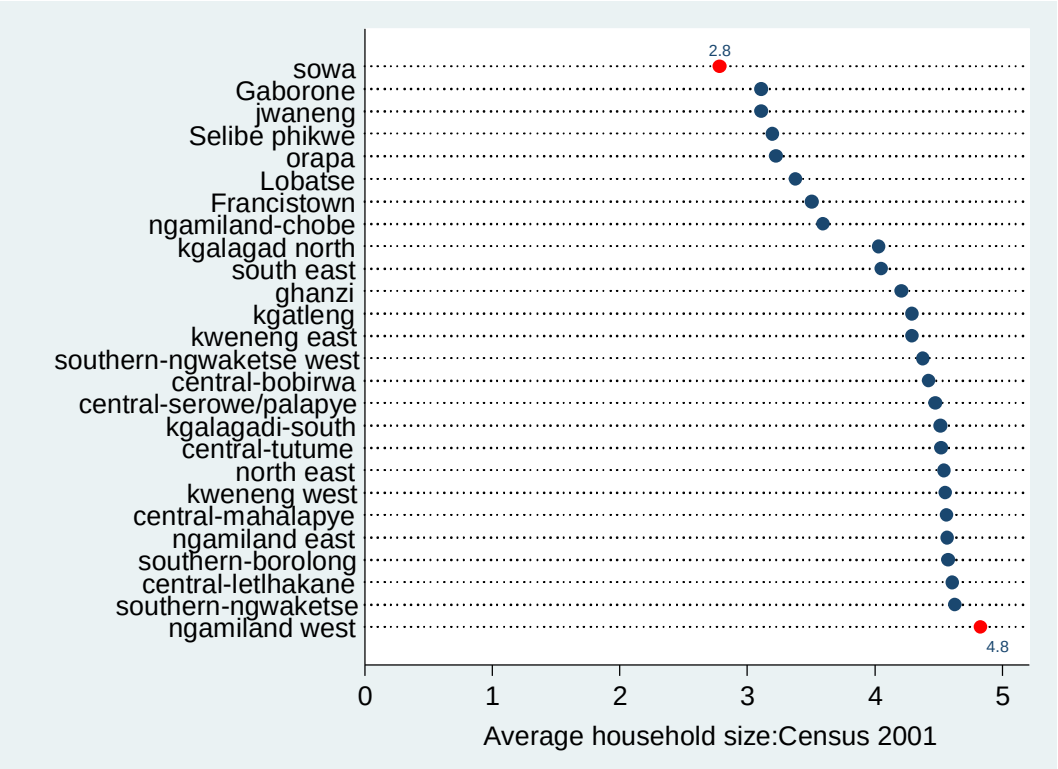


Figure 5: Average household size by district, Census 2001

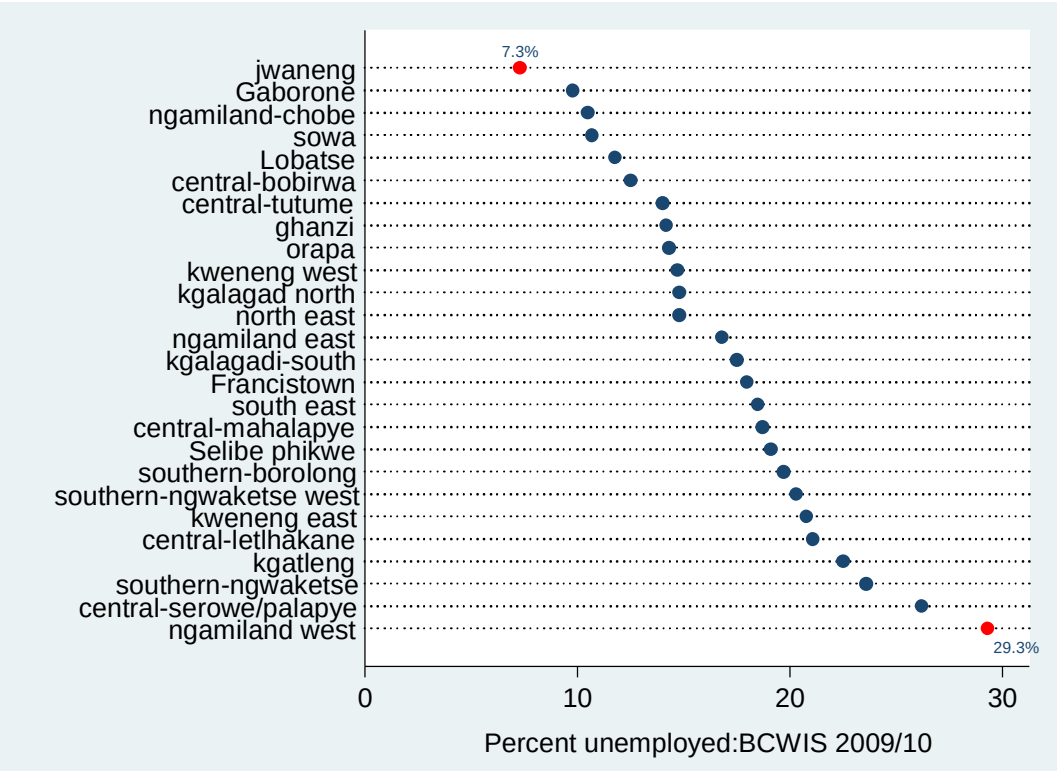


Figure 6: Per cent unemployed by district, BCWIS 2009/10

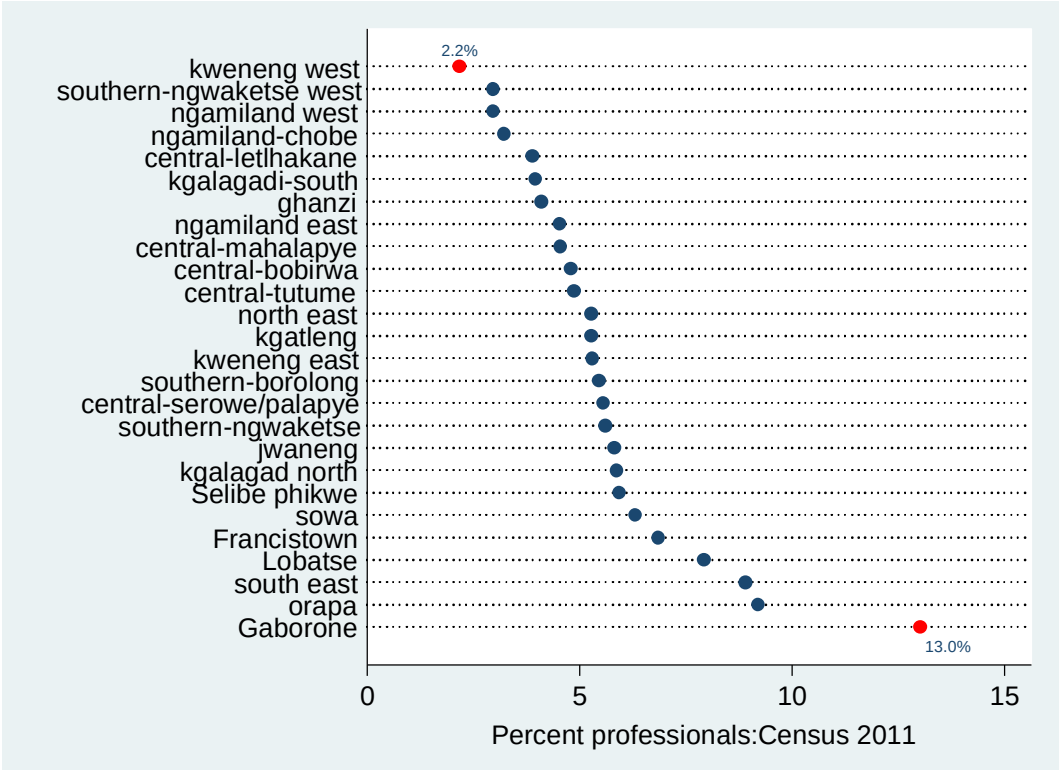


Figure 7: Per cent professionals by district, Census 2011

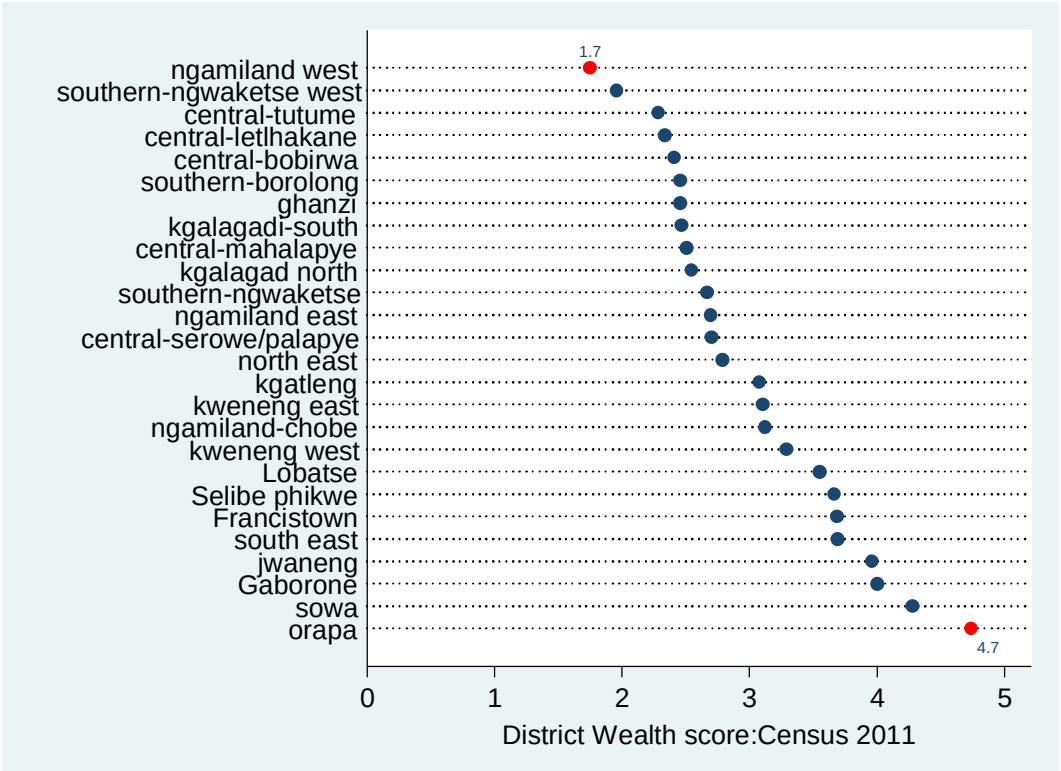


Figure 8: Wealth score by district, Census 2011

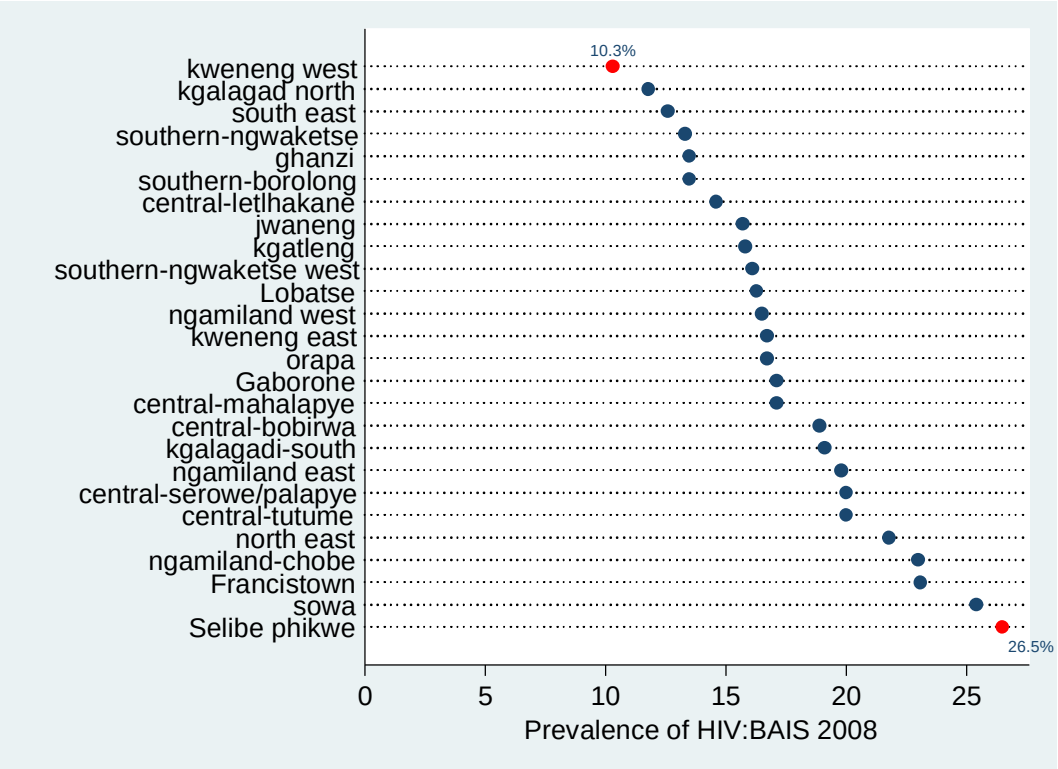


Figure 9: HIV prevalence rate by district, BAIS 2008

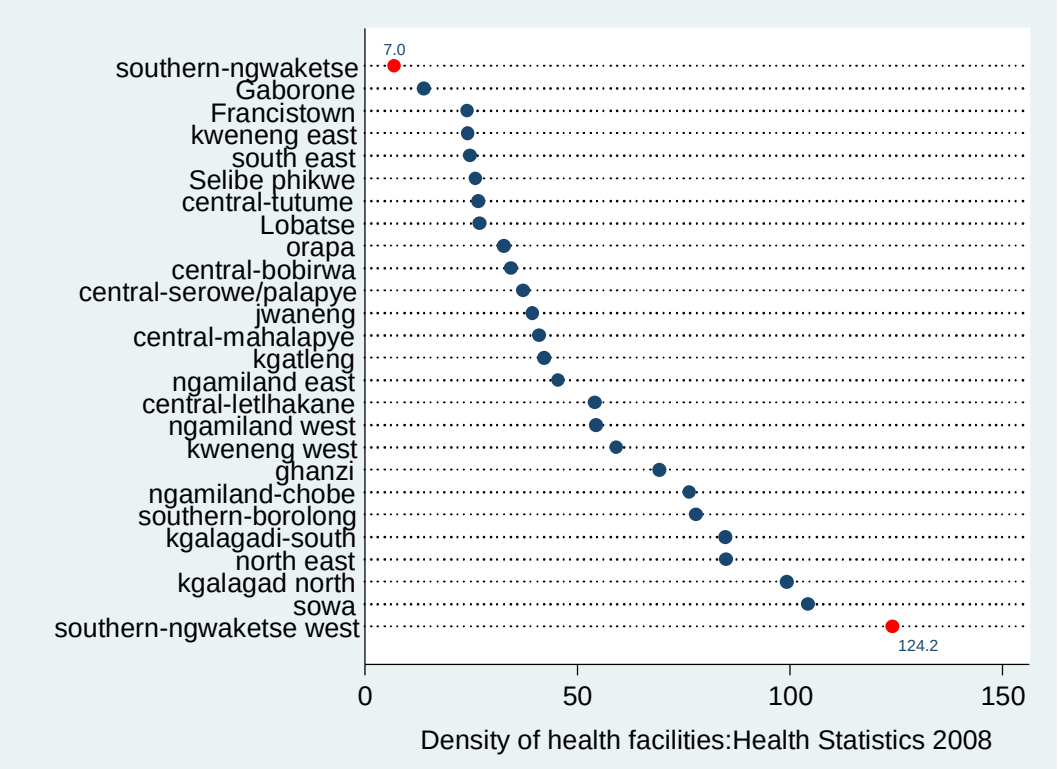


Figure 10: Density of health facilities by district, Health Statistics 2008

APPENDIX 5I. Proportion of child stunting by district according to household wealth quintiles, BFHS 2007

District	Wealth index (quintiles) Poorest (q1)	Second (q2)	Middle (q3)	Fourth (q4)	Richest (q5)
Gaborone	…..	0.20	0.35	0.15	0.13
Francistown	…..	0.38	0.25	0.23	0.26
Lobatse	…..	0.50	0.25	0.29	0.08
Selibe Phikwe	0.50	0.50	0.29	0.28	0.39
Orapa	…..	…..	…..	1.00	0.00
Jwaneng	…..	…..	0.60	0.50	0.11
Sowa	…..	…..	…..	0.20	0.16
Southern Ngwaketse	0.25	0.47	0.33	0.10	0.31
Southern Borolong	0.13	0.22	0.20	0.17	0.20
Southern Ngwaketse West	0.52	0.29	0.67		0.00
South East	…..	0.43	0.23	0.21	0.17
Kweneng East	0.35	0.31	0.25	0.18	0.17
Kweneng West	0.37	0.33	0.00	…..	…..
Kgatleng	0.38	0.43	0.11	0.44	0.15
Central Serowe/Palapye	0.25	0.39	0.26	0.33	0.10
Central Mahalapye	0.32	0.31	0.29	0.30	0.00
Central Bobirwa	0.45	0.24	0.44	0.00	0.50
Central Letlhakane	0.27	0.55	0.50	0.50	1.00
Central Tutume	0.33	0.33	0.24	0.33	0.33
North East	0.35	0.43	0.15	0.20	0.33
Ngamiland East	0.36	0.15	0.14	0.20	0.33
Ngamiland West	0.34	0.29	0.20	0.00	…..
Ngamiland Chobe	0.60	0.27	0.00	0.00	1.00
Ghanzi	0.47	0.35	0.44	0.50	0.00
Kgalagadi South	0.30	0.53	0.36	0.00	0.00
Kgalagadi North	0.33	0.00	…..	1.00	0.00

…..means no observations. Some of the districts do not have some of the wealth quintiles, eg. Gaborone, which is the capital city of Botswana doesn't have households in the poorest quintile (q1).

GLOSSARY

This section comprises a list of technical terms and concepts used in the thesis. Where applicable a distinction is made between how a term is theoretically, empirical used, and its relevance to the childrearing situation in Botswana.

Affinal	Affinal kin includes relations based on marriage and not blood such as in law families of the mother or father.
Anthropometry	A method that uses body measurements and is used to reflect measures of nutrition and socio-economic inequalities (Bronte-Tinkew and DeJong, 2004).
Batswana	Refers to citizens of Botswana; singular is Motswana.
Child	Is defined as a person under the age of five years.
Child well-being	Is measured by behavioural, emotional and cognitive outcomes.
Child health	Is defined within the context of physical health to describe stunting and diarrhoea in children aged less than 5 years.
Cohabiting	Is used synonymously with the term non-marital living together to describe unions in which partners live together but are not married.
Community	Is defined based on the composition of a neighbourhood (Leventhal and Brooks-Gunn, 2000), a social group or residential space such as district, village or census track (Madise et al., 1999, Griffiths et al., 2004, Kandala et al., 2011).
Conjugal	Refers to members of a family or household who are related by marriage.
Co-residence	Describes living arrangements, that is who else is in the household in addition to another household member e.g. grandmother co-resident with her grandchildren.
Currently married	Refers to formal unions -civil and customary marriages.
Diarrhoea	An indicator for short term illness, and indicates whether a child had loose stools in the two weeks preceding the survey or in the preceding 24 hours.
Domestic unit	A unit of accommodation for a family or household. There is sometimes more than one private household within a domestic unit or dwelling.

De jure household membership	Refers to usual household members.
De facto household membership	Refers to household members who are present at the time of the survey.
EA	Also known as primary sampling unit or cluster. For BFHS 2007 the EAs were established according to the 2001 Population and Housing census and were selected with probability to size and they represent geographical stratification along ecological and income categories across the 26 districts.
Family	The term family refers to a domestic group that is based on partnership, parenthood and kinship ties between its members; that is parents and their children. Husband and wife, co-residing partners, widowed or divorced persons without children also constitute a family (Clarke, 1965). For purposes of this research family refers to one or two parents with children, and with or without other relatives or non-related members.
Family complexity	Refers to the heterogeneity of the family membership. This involves a wider kin network beyond parents.
Family functioning	This includes family processes such as parenting practices (parental support, characteristics, relationship quality), and parental involvement in child care.
Family structure	Family structure characterises the family in terms of size, membership and family characteristics. The family structure presents characteristics which are common to all members of a family unit. The term is often used in the research on child well-being (Allan and Crow, 2001a).
Household (HH)	A household is a domestic group with one or more persons living together under the same roof or within the same housing unit, have shared cooking and other living arrangements (Simpson, 2012, Allan and Crow, 2001a). Households can be divided into two types: a family household, and non-family household (Sweet and Bumpass, 1987). A family household consist multiple-persons who are related to each other, living with or without non-

	related household members. A non-family household comprise one person or multiple-persons that are not related to each other.
Household change	A change in the size and composition of a household.
Household formation	Involves a new household forming or an extension of an existing household due to processes of marriage, union formation, childbearing, access of kin to live with, and financial independence of individual (s) to set up their own household.
Household dissolution	Involves the splitting or dissolving of a household due to deaths, divorce, out migration of household members or merging of a household with another one.
Household complexity	Refers to the heterogeneity of the household membership, which may involve non-nuclear members, more distant relatives and individuals not related to the household head (Bongaarts, 2001).
HH. composition	Refers to who is in the household. It reflects the characteristics of household members such as relationships between members, the resources and the number of persons with whom the resources are shared (Sweet and Bumpass, 1987). Household membership for BFHS 2007 analysis was operationalised from the relationship of the child to other household members. And the main categories identified are living with one parent (mother), living with one parent (father), living with two parents, living with no parents, and by the types of others living in the household, including a grandparent, aunt, uncle or other relatives/not related household members. The term household composition is used synonymously with household membership.
Household headship	In the DHS surveys a household head is the person who answers the survey; that is the reference person for collecting data about the household and establishing household relationships. Normally a household has one main person who is the household head. It is not always clear who the household head is, and there might be debates on how he/she is chosen? For the BFHS 2007, the head of household was reported by household members, and it is a person aged more than 12 years and who is listed first in the household roster. The following headships were established

	for the 2822 children in the BFHS 2007: biological parent (mother/father), grandparent, uncle, aunt, ambiguous, other relative and not related member.
Household structure	Household structure can be defined from a number of criteria reflecting the composition, relationships and characteristics of either the household or non-family household members. Household structure differs from household composition because here the characteristic of the household is usually common to all members of a domestic unit. For example a household maybe classified based on household headship and whether it is a nuclear or extended household. In addition household structure reflects the cohesion and degree of integration of individuals into family units (Vimard and Fassassi, 2006).
Index child	Is a unit of analysis, and relationships within a household are recast relative to this child. The term index child is used interchangeably with the term reference child in the thesis.
Living arrangement	The term is used synonymously with residential pattern to indicate the conditions under which children or other household members live. Compared to household composition, child living arrangements emphasise a different set of concern; that is often based on separation of families and child mobility due to labour migration of parents (Madhavan, 2004).
Moderator	The term moderator and not mediator is used in the conceptual frameworks, in the modelling and in the interpretation of the models. A moderator variable shows the interaction effects; it affects the strength and direction of the relationship between an independent variable X, and outcome variable, Y. While a mediators reflect the process through which an independent variable, X operates to influence the outcome variable, Y. That is a mediator variable illustrates the mechanism through which X and Y are related (Hayes, 2009, Fairchild and McQuillin, 2010, Bradley and Corwyn, 2002).
Motswana	A citizen from Botswana; plural is Batswana.

Malnutrition	Also referred to as undernutrition comprise length/height for age, weight for age, weight for length/height z scores and deficiencies of vital vitamins and minerals (Victora et al., 2010).
Single	Describes a marital status type in which a person has never married.
Stunting	An indicator for long term malnutrition among children 0-59 months, and it is represented by height for age z-score of below −2 standard deviation (SD) based on the World Health Organization international reference standard (WHO, 2013b)
Traditional family	A family in which children live with two parents who are either married or cohabiting.
Tswana	Refers to Botswana society; also known as Batswana.

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