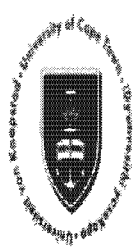

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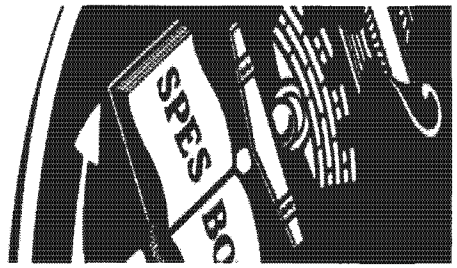

The Impact of a Pro-Male Circumcision (MC) Approach towards an HIV/AIDS Prevention Strategy in Botswana

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Submission Date:	29th July 2009
Year of registration:	Second/Final Year
Degree:	Masters of Commerce (MCom)
Degree Code:	CMO14
Programme:	Masters in Applied Economics
Stream:	Applications in Development
Course Code:	ECO5066W
Course Name:	Half Dissertation
Course Weighting:	90 Credits (50% of Final Degree Result)
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Contents

Abstract

This paper investigates how the emergence of male circumcision (MC) as part of a broader HIV prevention strategy will impact on Botswana's HIV/AIDS epidemic. Although is been more then two decades since Botswana's first case of HIV was diagnosed, HIV/AIDS is still the country's major development challenge. The government has played a key role in providing comprehensive treatment and care interventions and although prevention has always been the government's most important priority, the success of this has been limited. If Botswana is to succeed in decreasing the magnitude of the HIV/AIDS epidemic in future generations there is a paramount need for more effective prevention interventions. Evidence of the preventative impact of MC presents a major opportunity to address this need. Botswana's government has recognized this opportunity and has begun a scale-up of the MC service in the country's health sector. Qualitative methods and quantitative methods show that the current pro-MC approach towards HIV prevention strategy in Botswana could have a positive impact on the country's HIV/AIDS epidemic. However, the possible unintended effects of the scale-up of MC on behaviour should be considered carefully. Great care should be taken in ensuring that there is clarity amongst circumcised men, as well as the general public, on the 'limited' preventative impact of MC to deter behavioural disinhibition from taking place.

Introduction

Botswana is estimated to have the second highest proportion of HIV positive adults in the world. The United Nations (UN) and the World Health Organization (WHO) estimate that 23.9 percent of adults between the ages of 15 and 49 in Botswana were infected with HIV in 2007 (UNAIDS/WHO, 2008:4). This presents a major development challenge, and it is unsurprising that the government has declared the AIDS epidemic to be a national emergency. It has been over twenty years since the first case of HIV/AIDS was diagnosed in Botswana yet new infections continue to take place. The government has responded through comprehensive treatment, care and prevention interventions but it is clear that more effective prevention interventions are needed to curb the spread of HIV. Male circumcision (MC) has recently emerged as a tool that can be used as part of a broader HIV prevention strategy. Recent findings of randomized controlled trials indicate that MC reduces the risk of HIV transmission from women to men by up to 60 percent (Auvert et al, 2005, Bailey et al, 2007 and Gray et al, 2007). It is against this backdrop that Botswana's Ministry of Health plans to introduce MC as a HIV prevention intervention.

This paper explores MC and the progression of Botswana's HIV/AIDS epidemic. The research methodology entailed modelling the HIV epidemic in Botswana, investigating how different the epidemic would have been if higher rates of MC had been available since the mid 1980s and how different the epidemic will be with higher rates of MC going-forward, reviewing recent literature, analysing relevant socio-economic data sets for information about MC and its acceptability, and interviewing government officials about the emerging policy on MC.

Chapter 1 provides background on Botswana's economy looking at economic performance and the structure of the economy. The HIV/AIDS epidemic is identified as one of Botswana's major development challenges.

Chapter 2 investigates Botswana's HIV/AIDS epidemic using two publicly available models to estimate HIV prevalence and related demographic trends. The Estimation Projection Package (EPP) is used to estimate the size of Botswana's HIV/AIDS

epidemic over time. The Spectrum model is then employed to estimate the impact that the HIV/AIDS epidemic has had on Botswana's population. (These estimates are later compared with the ASSA2003 model – see Chapter 5). This chapter also includes a discussion on the drivers of the HIV/AIDS epidemic in Botswana and the government's policy responses to the epidemic.

Chapter 3 discusses the use of MC as an HIV prevention tool outlining the findings of three randomized controlled trials. The chapter also reviews the findings from two studies conducted in South Africa and Botswana that support the claim that MC is a cost-effective HIV prevention tool. This chapter discusses how these findings present an opportunity for Botswana to curb the spread of HIV but highlights that the findings need to be treated with extreme caution.

Chapter 4 explores the social and economic factors that could influence the effectiveness of the MC intervention. Firstly, in order to determine the scope for the MC intervention, the current MC prevalence is estimated using the 2004 Botswana AIDS Impact Survey (BAIS) II. Secondly, the cultural role of MC is investigated, looking at the history of MC in Botswana. Anthropology research is identified to uncover the changes that took place in the 19th and 20th century that have shaped the cultural importance of MC in Botswana today. Thirdly, the current willingness of men to be circumcised if the service was offered in a hospital-setting is assessed based on the findings of a major acceptability study. Finally, the chapter assesses the acceptability of MC in the public sector (which will be central to the MC rollout) and implications for financing this and other HIV/AIDS interventions.

Chapter 5 models the impact of MC on the HIV/AIDS epidemic in Botswana. It begins with a review of existing studies of the potential impact of a rollout of MC from 2008. The chapter then turns to an analysis, using the ASSA2003 model, of what impact MC would have had on Botswana's HIV epidemic if a high MC prevalence had existed when the HIV/AIDS epidemic started unfolding in the early 1980s. This analysis considers different scenarios and compares the HIV estimates derived using ASSA2003 with those derived using EPP and Spectrum. This is followed by another analysis, using the Male Circumcision model (MCM), to estimate the impact of MC going forward. This analysis considers different scenarios that may occur as a result

of the scale-up of MC in Botswana.

Finally chapter 6 draws conclusions and makes recommendations based on the findings from the research.

1. Botswana: Economy, Challenges and Threats

The Republic of Botswana is a landlocked country in Southern African with a land surface of 582 000 square kilometres of which more than two thirds is covered in the thick desert-sands of the Kalahari Desert (see Figure 1.1). Botswana has a population over 1.8 million, more than half of which is urbanised (see Table 1.1). It is bordered by South Africa, Namibia, Angola, Zimbabwe and Zambia. Botswana has celebrated over 40 years of independence having achieved independence from Britain in 1966. The country became a British Protectorate in 1885 and was known as Bechuanaland prior to independence. At independence Botswana was overwhelming poor and the largely rural economy depended heavily on the agricultural sector (Central Statistics Office (CSO), 2005:3).

Fig. 1.1: Geographical Map of Botswana[1]

[1] http://www.lib.utexas.edu/maps/botswana.html

1.1 Economic Performance

Despite having a weak economy at independence, Botswana has managed to achieve strong economic growth in the decades that followed independence – largely as a result of the discovery of diamonds in the 1960s. Table 1.1 reports key economic trends between 1980 and 2008

Table 1.1: Key Economic Trends in Botswana: 1980-2008

	1980 - 1989	1990 - 1999	2000 - 2006	2007 - 2008
GDP annual percentage change (constant prices)	11.3%	6.1%	5.7%	2.9%
GDP, US$ (current prices)	1 554,700,000	4 548,000,000	8 288,000,000	13 042,253,070
GDP per capita, US$ (current prices)	1426.8	3165.9	5237.2	8183.125
Population (millions)	1.1	1.4	1.6	1.8

Source: International Monetary Fund and the Central Statistics Office[2]

Botswana's real Gross Domestic Product (GDP) grew by an average 11.3 percent in the 1980s, 6.1 percent in the 1990s and less than 6 percent from 2000 to 2006. In 2007 GDP per capita had risen to over US$6,000 and Botswana was ranked 57 out of 180 countries in the world GDP per capita rankings[3]. The growth in GDP per capita is impressive considering that at independence Botswana was one of the poorest countries in Africa with a GDP per capita of only US$70 (World Bank, 2009a, 1).

Despite this history of sustained growth – which catapulted Botswana into the ranks of a middle-income country – it still faces the challenges of poverty, inequality, unemployment and the need to diversify its economy. Poverty remains of central concern with almost half of the population estimated to be living below the national poverty line. This is exacerbated by Botswana's skewed distribution of income; the country has a Gini coefficient of 0.60[4] (United Nations Development Programme (UNDP), 2009:1). Contributing to these challenges, the economy does not create enough jobs for all job seekers, especially the youth; the government estimates that the unemployment rate is around 15 percent (UNDP, 2009: 1). Lastly, the government

[2] 1980 to 2006 obtained from the IMF and 2007 to 2008 obtained from the CSO
[3] Rankings found at: http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal)_per_capita
[4] The closer the Gini coefficient is to 1 the more unequal income distribution is in the country

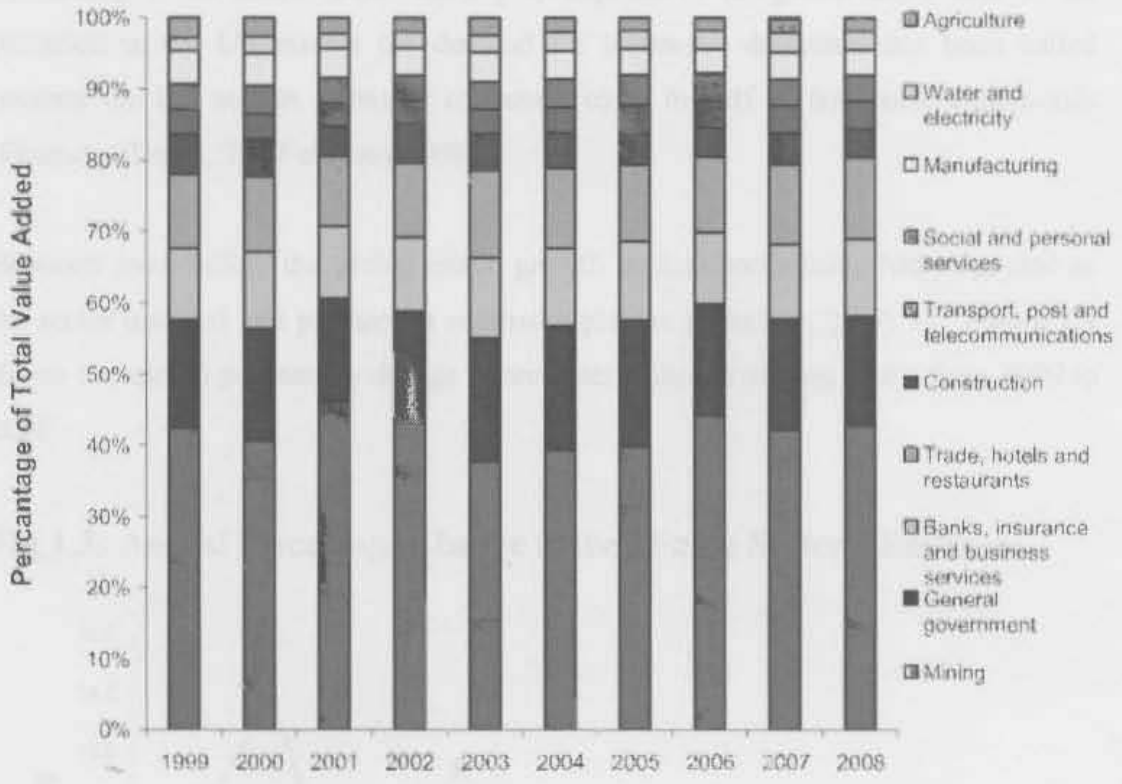
also faces the ongoing challenge of diversifying the economy from resource dependence and dealing with the after shocks of the 2008 global economic crisis.

Being a small open economy, Botswana has proved vulnerable to the recent global economic downturn. Between 2007 and 2008 real GDP growth was only 2.9 percent and the current account surplus had decreased to 7 percent of GDP. In order to understand the impact of the global crisis on Botswana's economy a brief description of the events that led to the crisis follows.

The global economic crisis began with the collapse of the United States (US) housing market and spread from housing into banking and other financial markets, and then into all parts of the real economy (Lin, 2008: 1). The crisis has its roots in the technology stock bubble which burst in the early 2000s, resulting in the US Federal Reserve Bank embarking on an expansionary monetary policy from 2002 to 2007 in order to minimize the duration and depth of the recession that would have followed (ibid: 2). Other developed countries similarly affected by the bursting of the technology stock bubble also embarked on expansionary monetary policies (ibid: 2). These policies averted a deeper recession by stimulating a boom in the housing markets which in turn stimulated further borrowing and consumption in the US – as well as rising commodity prices and exports from developing countries (ibid: 3). This boom, however, also turned out to be a bubble. When it burst, housing prices started to decrease, the US economy collapsed as home owners were unable to service their debts and consumption was halted. As the US economy is at the epicentre of the global economy, instability in the US markets led to instability in the entire global economy and growth slowed down everywhere.

The World Bank (2009b) expects developing countries to be impacted severely by the global crisis through decreased export revenues, lower foreign direct investment, lower remittances from abroad, and decreased commodity prices. A recent World Bank report classifies countries according to their exposure to the global crisis with respect to vulnerability to poverty (World Bank, 2009b). In this report Botswana is classified as being highly exposed to the global crisis. This is due to Botswana's open economy and reliance on mineral exports (see below).

Fig. 1.2: Total Value Added by Economic Sector in Botswana



Source: Data fro m the Central Statistics Office, chart by author

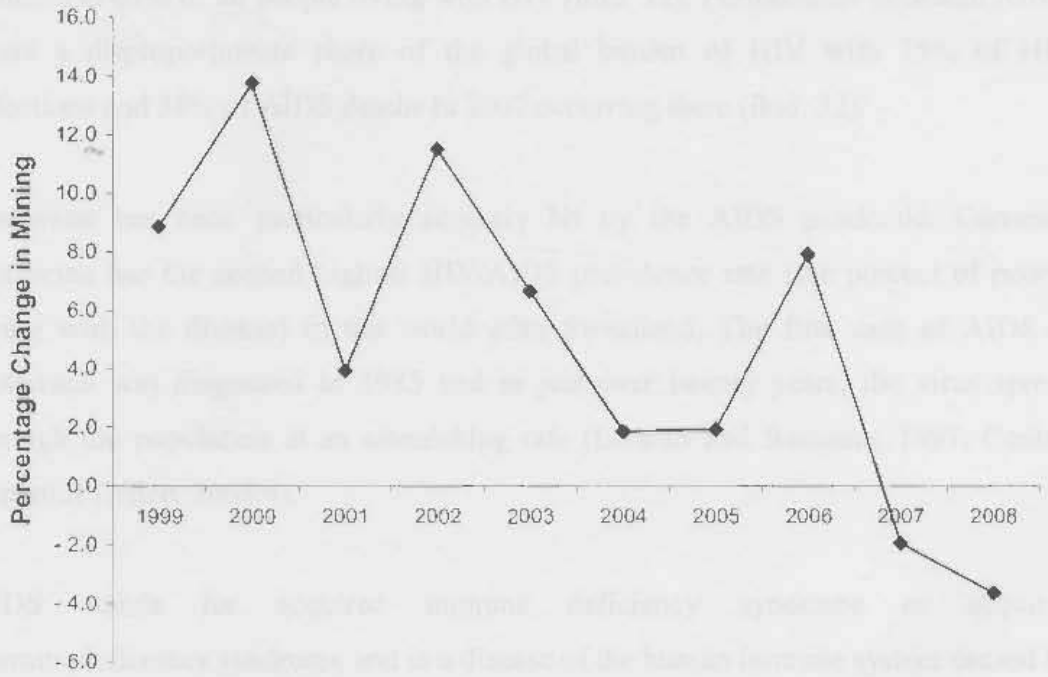
Diamond mining now contributes a significant proportion of Botswana's economy. Figure 1.2 shows the relative percentage that each sector contributes to total value added from 1999 to 2008. Total mining makes up over 40 percent of total value added in the economy and diamond mining makes up over 93 percent of total mining (International Monetary Fund, 2007:5). Botswana is the largest exporter of gemstone diamonds in the world, supplying over a quarter of the world's diamonds by value (Debswana, 2007). Apart from diamond mining, economic growth was also fuelled by beef exports, eco-tourism, and more recently, financial services (World Bank, 2009a: 1). The agricultural sector contributes about 3 percent to total value added whilst financial services contribute nearly 10 percent. Government activity also plays a key role in the economy, contributing over 15 percent to total value added.

Botswana's economic success has been bolstered by a stable democratic political system, good governance and macroeconomic stability (World Bank, 2009a, 1). Its

economic and political achievements have ensured that the country enjoys an international reputation of an African success story. However the strong reliance on the mining sector makes Botswana highly exposed to the global crisis. Due to the recession in the US market the demand for Botswana diamonds has been halted because the US market normally consumes close to half of the world's diamonds (Financial Times, 23rd February 2008).

However even before the global crisis, growth in diamond mining had stagnated as the sector matured and production reached a plateau (Thurlow, 2007: 1). Figure 1.3 shows the annual percentage change in revenues from the mining sector from 1999 to 2008.

Fig 1.3: Annual Percentage Change in the Mining Sector's Revenues



Source: Data fro m the Central Statistics Office, chart by author

In the past nine years the mining sector's revenues have trended downwards. Up until 2006 the downward trend could be explained by the maturity of diamond mining and the plateau in diamond mining production that Thurlow (2007) identified. However, from the 2006 output plummeted into negative territory owing to the global economic crisis. It is clear that the slowdown in diamond mining presents a real development

challenge in Botswana and the current economic crisis amplifies this challenge.

However, Botswana faces another, perhaps greater, development challenge: the HIV/AIDS epidemic.

1.2 The Onslaught of HIV/AIDS

HIV/AIDS is the leading cause of death in sub-Saharan Africa and is the biggest threat to the region's development. According to United Nations Programme on HIV/AIDS (UNAIDS) (2008) over 33.2 million people are estimated to be living with HIV globally. The bulk of the epidemic is in sub-Saharan Africa where over 22.5 million adults and children are estimated to be living with the virus. Although Sub-Saharan Africa constitutes only 10 percent of world's population, sub-Saharan Africa is home to 67% of all people living with HIV (ibid: 32). Furthermore Southern Africa bears a disproportionate share of the global burden of HIV with 35% of HIV infections and 38% of AIDS deaths in 2007 occurring there (ibid: 32).

Botswana has been particularly severely hit by the AIDS pandemic. Currently Botswana has the second highest HIV/AIDS prevalence rate (the percent of people living with the disease) in the world after Swaziland. The first case of AIDS in Botswana was diagnosed in 1985 and in just over twenty years, the virus spread through the population at an astonishing rate (Letamo and Bainame, 1997; Central Statistics Office, 2005:4).

AIDS stands for acquired immune deficiency syndrome or acquired immunodeficiency syndrome and is a disease of the human immune system caused by the human immunodeficiency virus (HIV). HIV reduces the effectiveness of the immune system thus weakening the body and making infected individuals more susceptible to opportunistic infections. HIV is transmitted through direct contact of a mucous membrane or the bloodstream with a body fluid containing HIV, such as blood, semen and vaginal fluid, and breast milk. Transmission of HIV can take place through sexual intercourse, blood transfusion (when blood is not properly screened for HIV), contaminated medical needles, exchange between mother and baby during

pregnancy, childbirth, or breastfeeding, or other exposure to bodily fluid containing HIV[5]. In Botswana the spread of HIV was fuelled by multi-partnered heterosexual activity, which in turn has been linked to the social power of men over women and lack of parental control over children (Letamo and Baitame, 1997).

Without the correct treatment, a person infected with HIV will eventually die. Although there is currently no cure for AIDS, life-prolonging antiretroviral treatment is available. Cohort studies done in Uganda, Tanzania and amongst South African miners found that it took an average of 11 years from the time of infection to death without treatment (Stover, Johnson, Zaba, Zwahlen, Dabis, and Ekpini, 2008:4). Since the AIDS epidemic started unfolding in the early 1980s, the increase in AIDS related-deaths led to a decrease in Botswana's life expectancy, from 60 years in 1980 to 50 years in 2007[6]. Apart from impacting negatively on human indicators such as life expectancy, AIDS deaths have also affected Botswana's economic performance. The extent of the impact of the HIV/AIDS epidemic on Botswana's economy is discussed next.

1.2.1 The Economic Impact of HIV/AIDS in Botswana

The HIV/AIDS has had significant impact on Botswana's economy through various interdependent effects that affect the overall performance of the economy. This section explores the economic impact of HIV/AIDS in Botswana starting with what economic theory predicts and then going on to review studies that estimate the economic impact of AIDS in Botswana.

[5] See Ferris and Navario for a full description on the epidemiology of HIV.
[6] http://ddp-ext.worldbank.org/ext/ddpreports/ViewSharedReport?REPORT_ID=9147andREQUEST_TYPE=VIEWADVANCED

1.2.1.1 What Economic Theory[7] Predicts

Economic theory predicts that HIV/AIDS will have a negative impact on an economy by reducing the labour supply through AIDS-related mortality of working aged adults, and by lowering productivity, through AIDS-related morbidity (Dixon, McDonald and Roberts 2002) Furthermore, HIV/AIDS could also lead to lower productivity whilst at work due to worry or illness or absenteeism by other workers needing to take care of a sick family member (Greener, 2002:50).

Dixon et al (2002) also argue that lower domestic productivity due to AIDS may lead to reduced exports whilst imports of expensive healthcare goods may increase. The decline in export earnings is expected to be more severe if strategic sectors of the economy are affected. This will lead to a situation where the balance of payments (the difference between export earnings and import expenditure) will come under pressure at the same time that government budgets come under pressure (ibid: 233). This may result in the government being unable meet debt repayments and thus requiring economic assistance from the international community. Increased expenditure by both government and firms on healthcare, training (to replace sick workers) and sick pay due to HIV/AIDS requires resources to be diverted away from other uses. Thus public and private investment and domestic saving (when income that would have otherwise been saved is spent on healthcare) is likely to decrease as a result of the HIV/AIDS pandemic (Greener: 202:51).

These mechanisms (i.e. decreased labour supply, decreased labour productivity, increased expenditure, decreased exports, increased imports and so on) of the macroeconomic impact of HIV/AIDS are referred to as the 'channels', through which the AIDS epidemic can be expected to reduce the growth rate of GDP below what it would have been without the HIV/AIDS epidemic (Greener, 2002:50). Apart from the lower economic growth, the population growth rate will also decrease as a result of the HIV/AIDS epidemic. Furthermore, the decreased population growth rate and the lower economic growth will result in smaller consumption growth and slower

[7]This section largely follows Chapter 7: *AIDS and the Macroeconomic Impact* in "State of the Art: AIDS and Economics" (Greener , 2002)

domestic market growth for firms compared to if they had been no HIV/AIDS epidemic.

Apart from its highly aggregated macroeconomic impact, HIV/AIDS also has an important microeconomic impact at the household-level. However different households are affected by the HIV/AIDS epidemic differently, depending on whether or not a household member is infected with HIV. If a household member is infected with HIV the impact of HIV/AIDS is more pronounced in families where the household member infected is a breadwinner. In that case households may be affected permanently though income loss if a breadwinner is unable to work due to sickness or death. Furthermore, households may also lose income temporarily if other household members also have to stop work in order to take care of a sick family member. Lastly, households may also be affected temporarily by additional expenditure that they may have to make on health care and eventually funeral costs. The net effect of these impacts on households will reduce the disposable income of affected households, and in the case where the household was already poor, the loss of disposable income may have a drastic impact on the welfare of the household. Therefore it is generally accepted that the HIV/AIDS will lead to increase in the proportion of households that are poor and that the short-term impacts on poverty will be worse than the long-term impacts (Greener, 2002:51).

Apart from households, the other microeconomic impact of HIV/AIDS is on the fiscal abilities of the government. The impact of HIV/AIDS on the government budget will affect government spending, especially on public health. This is a direct impact of HIV/AIDS but due to the aggregated economic impacts of HIV/AIDS, HIV/AIDS will also have indirect effects on the government budget, such as the increased need for poverty alleviation measures if the size of the economy decreases. HIV/AIDS healthcare expenditure and/or AIDS-related poverty alleviation expenditure incurred by the government will distort government revenue that would have been spent on other development programs. The effect of HIV/AIDS on the labour market may also increase government regulatory role in the labour market if for example skills need to be imported due to HIV/AIDS reducing key skills in the labour market (Greener, 2002:51).

It is, however, important to note that the economic impact of AIDS at the aggregated level is very difficult to measure (Greener, 2002:51). Furthermore, the HIV/AIDS epidemic is not the only development challenge facing Botswana and it is impossible to separate precisely the economic impact of the HIV/AIDS epidemic from the economic impact of other development challenges. This is why the microeconomic impact of HIV/AIDS on firms and households tends to be better documented than evidence on the macroeconomic impact of HIV/AIDS (ibid: 51). Also in order assess the macroeconomic impact of HIV/AIDS one needs to look beyond GDP (and GDP per capita[8]) as it is not a full measure of welfare and does not account for all the changes in socially productive economic activity as a result of HIV/AIDS.

1.2.1.2 Quantifying the Economic Impact of HIV/AIDS in Botswana

This section reviews some studies that have attempted to measure the economic impact of HIV/AIDS in Botswana.

The first study to measure the economic impact of HIV/AIDS in Botswana was conducted between 1999 and 2000 (Greener, Jefferies, Simphambe, 2000). This study was conducted through the Botswana Institute for Development Policy Analysis (BIDPA)[9]. It used a Solow[10]-type growth model that included two production sectors and two categories of labour. This approach extended Currington's (1993) earlier model that attempted to measure the effect of AIDS on growth of GDP and GDP per capita in Tanzania using a simple Solow-type growth model. The data in the BIDPA study included calibrated estimates and population projections based on the path that HIV was expected to take in the future. The study projected the size of the labour force and the subsequent effect of HIV/AIDS on aggregated output and output per capita as far as 2021. The study also projected the distribution of income among different groups and the long-term outlook for the fiscus. It found that HIV/AIDS

[8] As the population growth rate will decrease as a result of the HIV/AIDS epidemic GDP per capita may not necessarily decrease and therefore will not reflect the impact of HIV/AIDS on welfare.
[9] BIDPA is an agency mandated with analysing and monitoring Botswana economic prospects
[10] After Robert Solow who made major contributions to the theory of economic growth, including the Solow growth model

would reduce the annual growth rate of the economy in Botswana by an average of 1.5 percentage points, which would result in the economy being 31 percent smaller after 25 years than it would have been in the absence of AIDS. . The BIDPA study was set as a benchmark that has been followed by other studies that model the impact of HIV/AIDS.

MacFarlan and Sgherri (2001) drew on the BIDPA study by using a dual-economy equilibrium model. This study focused on the effect of HIV/AIDS on the long-term capacity of the economy considering different scenarios by looking at the key channels through which economic theory predicts that the HIV/AIDS pandemic is likely to affect the economic outlook in Botswana. These channels were firstly, the impact on the supply of labour and labour productivity, secondly the impact on saving and investment, and thirdly the impact on the banking sector (this sector was identified as a key strategic sector in Botswana's economy). MacFarlan and Sgherri (2001) assumed higher prevalence rates than those used in the BIDPA study and predicted that annual GDP growth (excluding mining) would fall by 3 to 4 percentage points on average over the decade until 2011 depending on what scenario was employed.

Following this, Greener (2004) conducted a study to model the economic impact of HIV/AIDS in Botswana looking particularly at the impact on households. The methodology followed in this study included the use of the estimates of the BIDPA model (Greener et al, 2000) on the macroeconomic impact of HIV/AIDS and household income and expenditure data from the Botswana Household Income and Expenditure Survey conducted in 1993/94. This approach enabled the author to look beyond the macroeconomic impact of HIV/AIDS and estimate the impact of HIV/AIDS on poverty and inequality. In order to assess the impact of HIV/AIDS at the household level, AIDS was assigned randomly to individuals in the population given the estimated infection level in the population. After the random allocation and given the structure of the households in Botswana, 49 percent of households in Botswana were estimated to be affected by HIV/AIDS (in that they have at least one infected household member) (ibid: 175).

This study then assumed that all infected household members die within 10 years and

the income and expenditure of each household member was recalculated given the resulting depleted household structure. This analysis took Botswana's employment structure into consideration and resulted in 26 percent of households losing income as a result of the death of an income earner. However, this analysis did not capture the total percentage of those affected by HIV/AIDS because of Botswana's high unemployment rate. This study assumed that the susceptibility to HIV infection was not related to employment status or skill level. Although this may not be entirely accurate (see Nattrass, 2009) this analysis predicted that many small households will be wiped out by AIDS. With approximately 6.9 percent of households disappearing completely over the 10-year period representing 1.9 percent of the total population, poverty levels were estimated to rise by 4 to 6 percent due to HIV/AIDS (ibid: 176).

The BIDPA study (Greener et al, 2000) was reviewed and updated in 2006 (Jefferies, 2006). This study extended the method used in the first BIDPA study. The macroeconomic stimulation model was improved by including an informal sector into the model and by including better estimates of the population growth rate and data on new life-prolonging highly active antiretroviral (HAART) treatment which was not available in Botswana at the time of the first study. Data on the HAART program was included because it ameliorates the economic impact of HIV/AIDS by restoring the health and productivity of those living with AIDS.

The broad conclusion of the study was that HIV/AIDS is continuing to have a substantially negative impact on the economy in Botswana (Jefferies, 2006). The provision of HAART was estimated to increase average annual economic growth by between 0.4 to 0.8 percent over the 20 year period due to a larger and healthier labour force and the reduced negative impact on productivity. However, even with the provision of antiretroviral treatment, HIV/AIDS was estimated to reduce economic growth by 1.2 percent a year, leading to an economy that was 23 percent smaller in 20 years (ibid: 111). The study also extended the analysis by including an analysis on the impact of AIDS on the government budget, households and firms. The study projected that in 2021 the total costs of HIV/AIDS will increase in real terms by about 60 percent and the share of government spending will rise by between 7 to 8 percent (ibid: 112-3). The study concluded that HIV/AIDS will have a negative impact of up

to 3 percentage points on poverty (ibid: 113-4). The majority of firms interviewed[11] in the study indicated that HIV/AIDS was having a negative impact on output and productivity. Interestingly, half the firms said that HIV/AIDS was not affecting their investment decisions primarily because other factors were of greater importance in determining investment decisions (ibid: 114).

Lastly, the most recent study was funded by the United Nations Development Programme (UNDP) to determine if the HIV/AIDS epidemic threatens to reverse Botswana's economic gains (Thurlow, 2007). This study used a dynamic and microstimulation model to link AIDS to growth, poverty and inequality. It concluded that HIV/AIDS reduces economic growth by 1.6 percent per year, increases the absolute poverty headcount by 1.5 percent and disproportionately hurts labour-intensive manufacturing (ibid: 25). Furthermore, the fiscal implications of dealing with the HIV/AIDS epidemic have meant that the government has had to divert some of its development funding to the dealing with the epidemic rather than, say, furthering economic diversification through labour-intensive manufacturing. Indeed, the study concluded that HIV/AIDS has undermined economic diversification by diverting spending towards HIV programmes.

1.3 Conclusion

The AIDS epidemic appears to be a pertinent threat to Botswana's economic development through its various impacts of the economy. The following chapter provides more detail on the HIV/AIDS epidemic in Botswana.

[11] A total of 24 firms were interviewed in the study.

2. HIV/AIDS in Botswana: Prevalence, Drivers, Responses and Impact

This chapter outlines the extent of the HIV epidemic, its identified drivers, related policy responses and demographic impacts. The main aim of the chapter is to provide information about the context of, and the critical need for, the new HIV/AIDS prevention intervention, notably MC.

2.1 Adult HIV Prevalence

Adult HIV prevalence is the most widely used indicator of HIV infection in a population. The adult HIV prevalence rate normally measures the percentage of people aged 15 to 49 (the most sexually active population group) who are estimated to be HIV positive. However, the adult HIV prevalence rate can also refer to the adult population aged 15 and above, so it is important to consider which definition is being used. In this paper, the adult HIV prevalence rate refers to the adult population aged 15 to 49. This will ensure that the modelled estimates for adult HIV prevalence presented here are comparable to those reported by the United Nations (UN) and Botswana's National AIDS Coordinating Authority (NACA). The following section describes how estimates of HIV adult prevalence in Botswana were obtained using the UNAIDS modelling packages.

2.1.1 The Estimation Projection Package

The Estimation Projection Package (EPP) is a differential equation model that is used by UNAIDS and the World Health Organisation (WHO) to estimate HIV prevalence rates amongst adults. EPP is publicly available tool designed to be easy to use by planners at country-level and is applicable across all countries[1]. The model is accompanied by a manual to assist the user when making projections[2]. It is a robust

[1] EPP 2007 R10 version is available from:
http://www.unaids.org/en/KnowledgeCentre/HIVData/Epidemiology/epi_software2007.asp.
[2] EPP manual for generalized epidemics available at:
http://data.unaids.org/pub/Manual/2007/epp_genepi_2007_en.pdf

and simple model that only requires information about HIV prevalence amongst pregnant women attending antenatal clinics (ANCs). The most recent (2007) version allows you to calibrate the HIV projections to any general population HIV prevalence survey and to conduct an uncertainty analysis. EPP uses four parameters to model the prevalence trend over time: the start year of the epidemic, the initial force of infection, the proportion of the population at risk of infection and the rate of replenishment of the population at risk when it is depleted by AIDS deaths. EPP generates thousands of epidemic curves randomly selecting values of these four parameters from plausible distributions. The curve that best fits the surveillance and survey data is then selected by the model[3].

2.1.2 HIV Prevalence Data

There are currently two sources for HIV prevalence data in Botswana, sentinel (ANC) data and a nationally representative AIDS impact survey. Both sentinel data and survey data are used to model the adult HIV prevalence trend over time.

HIV data from pregnant women is a biased sample of the general population because it comprises sexually active women who are not practicing safe sex (at least not all of the time!). This sample bias means that it is inappropriate to extrapolate from ANC data to the general population. Salomon and Murray (2001) identified the need to clarify the relationship between sentinel data from pregnant women and the epidemiology of HIV and AIDS in the general population. Mishra et al (2006) found that national survey data greatly enhances surveillance systems and the accuracy of national estimates in generalized epidemics because population-based surveys provide reliable, direct estimates of national and regional HIV seroprevalence among men and women irrespective of pregnancy status. For this reason, HIV prevalence data from a once off national survey of HIV prevalence (The Botswana AIDS Impact Survey (BAISII) from 2004) was also used in the modelling of the HIV epidemic by introducing it as part of the calibration exercise. By using the ANC data over time, and point estimates for population-wide HIV prevalence, one is able to get a more thorough and robust estimate of the Botswana HIV epidemic.

[3] Stover et al (2004)

2.1.2.1 Sentinel Prevalence Data

Sentinel ANC data measures HIV prevalence amongst pregnant women who receive antenatal care during pregnancy. Sentinel ANC data in Botswana are available from 1991 and the number of sites collecting this data has increased over the years to a total of 24 sites in 2007, 14 rural sites and 10 urban sites. These data are presented in Table 2.1. The table shows that from 2001 the availability of data increased significantly, although no data were recorded in 2004.

Table 2.1: Percentage of Pregnant Women Testing HIV Positive at Antenatal Clinics

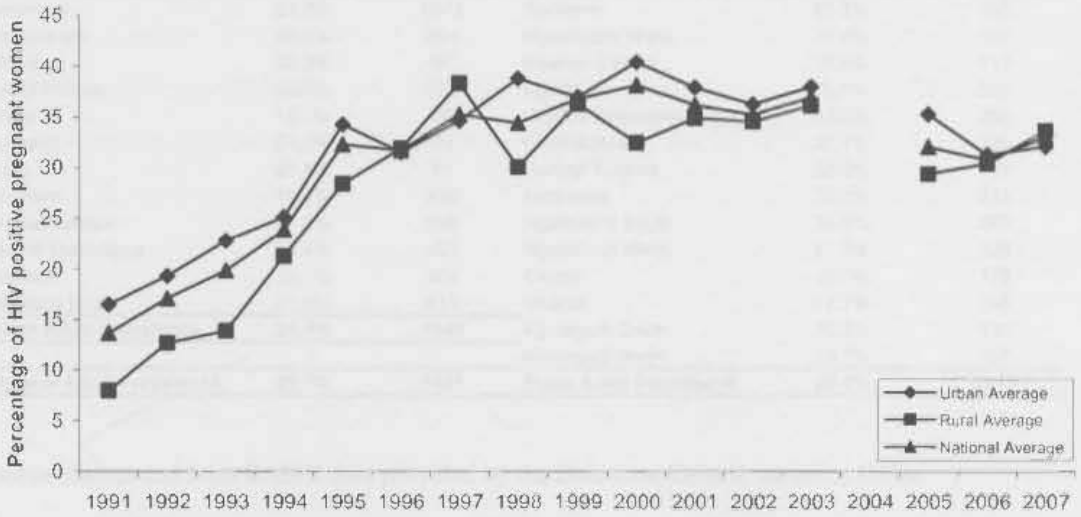
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Urban Sites (%)																	
Gaborone	17	14.9	19.2	27.8	28.7	31.3	34	39.1	37.1	36.2	38.6	38.2	44.8		34.4	35.3	33.2
Francistown	16	23.7	34.2	29.7	39.6	43.1	42.9	43	42.7	44.4	49.6	40.2	45.8		42.3	36.7	37.9
Southern				16		21.7		24.7		40.7	34	33.1	25.7		28.2	25	22.8
South East											32.1	26.5	27.9		32.1	27.6	26.7
Kweneng East						23.9		37.2		30.4	29.6	29.2	32.1		31.5	31.7	33.4
Mahalapye							28.2		32		31.9	39.8	37.4		36.2	29.9	30.4
Serowe Palapye			19.9		29.9		34.4		41.8		44.6	36.7	43.3		37.5	36.8	37.3
Lobatse			17.8		38.9		33.7		31.3		30.6	34.6	32.4		29	28.4	28.7
Selebi-Phikwe				27		37.8		49.9		50.3	50	48.1	52.2		46.5	41.1	49
Jwaneng															34.9	20	21.4
Rural Sites (%)																	
North East											40	42.4	40.4		34.9	35.4	38.8
Bobirwa District											44.3	45.3	49.3		29.8	37.6	42.9
Boteti											36.7	35.6	31.9		35.4	29	33.7
Gantsi			9.5		18.9			22.3			21.8	18.8			20.9	27	26.6
Chobe			18.3		37.9		38.3		50.8		38.3	42.9	47			42	45.6
Kgalagadi									21.8		28.5	28.3	28.9		26.2	19.1	31
Tutume				23.1		33.2		37.5		35.4	51.1	40.7	37.7		41.3	39.9	38.7
Kgalagadi West						30.1		26.5			25.3	28.7	27		27	28.1	23.9
Goodhope											33.1	26.5	40.9		20.8	23	26.5
Okavango											40.6	34.2	32.7		29.2	29.1	34.7
Hukuntsi											23.3	40	28.4		29.4	29.4	32.7
Ngami	8	12.7		19.4		32.5		33.5			35.8	40.7	38.4		27.3	35.4	39.7
Kgatleng								30.5		29.5		24.9	30.9		30.1	24.3	30.8
Mabutsane																26.4	25.3
Averages (%)																	
Urban Average	16.5	19.3	22.78	25.1	34.28	31.56	34.64	38.8	37	40.4	37.89	36.27	38		35.3	31.3	32.1
Rural Average	8	12.7	13.9	21.3	28.4	31.93	38.3	30.1	36.3	32.5	34.9	34.54	36.1		29.4	30.4	33.6
National Average	13.7	17.1	19.82	23.8	32.32	31.7	35.25	34.4	36.8	38.1	36.18	35.25	36.9		32	30.8	33

Source: Government of Botswana

In order to show the trend in the percentage of women reported to be HIV positive over the years, Figure 2.1 presents these data graphically, averaged[4] to show the urban, rural and national trend. This figure shows HIV infection increasing in 1990s and then flattening (perhaps even falling) during the 2000s.

[4] The sample size from each sentinel ANC site are not available and the sites where simply averaged across rural and urban sites irrespective of sample size.

Fig 2.1: Sentinel Antenatal Clinic (ANC) Data



Source: Government of Botswana, 2008

2.1.2.2 BAIS II Prevalence Data

A nationally representative survey, the Botswana AIDS Impact Survey (BAISII), was conducted in 2004 to measure HIV prevalence in the general population and to obtain data on the socio-economic, demographic, behavioural and biological factors associated with HIV infection. The raw data set from BAISII was obtained from the Central Statistics Office and was analysed using Stata 10 Data Analysis and Statistical software. A total of 15,161 of the BAIISII respondents (61% of the sample) agreed to provide a saliva sample for HIV testing. In order to calculate the adult HIV prevalence rate presented in Table 2.2 below, this sample was restricted to people aged of 15 and 49. These results show that urban, rural and national adult HIV prevalence was 24.4, 26.4 and 25.7 percent respectively in 2004.

Table 2.2: BAISII Adult (15 to 49 years) HIV Prevalence Estimates

Urban	Prevalence	Sample Size	Rural	Prevalence	Sample Size
Gaborone	21.2%	1042	Barolong	27.5%	102
Francistown	30.2%	394	Ngwaketse West	24.8%	121
Lobatse	23.3%	60	Kweneng West	20.5%	117
Selebi-Phikwe	33.9%	280	Kgatleng	20.1%	369
Orapa	19.7%	66	Central Bobonong	33.2%	265
Jwaneng	24.3%	74	Central Boteti	21.4%	126
Sowa	25.4%	71	Central Tutume	32.9%	517
Southern	18.2%	435	Northeast	28.6%	213
Central Serowe	27.2%	606	Ngamiland South	25.5%	377
Central Mahalapye	28.4%	402	Ngamiland North	21.6%	139
Southest	20.1%	303	Chobe	49.7%	179
Kweneng East	21.4%	813	Ghanzi	17.3%	156
Urban Adult Prevalence	**24.4%**	**4546**	Kgalagadi South	20.3%	133
			Kgalagadi North	25.7%	101
National Adult Prevalence	**25.7%**	**7461**	**Rural Adult Prevalence**	**26.4%**	**2915**

Source: Calculated from BAISII data provided by the Botswana Central Statistics Office

2.1.3 Modelling Adult HIV Prevalence using EPP

In modelling the HIV epidemic in Botswana using EPP, the 'generalised epidemic'[5] option was used and two different epidemics (urban and rural) were modelled. This enables us to explore how the trend in HIV in urban and rural areas differs and if and when the epidemic peaked in each of the rural and urban sub-populations.

Once the sub-populations have been selected, EPP requires you to define the National Epidemic Structure (Epi). This allows you to define or revise the structure of the national epidemic by selecting any special characteristics for each sub-population. For example if there was a known high-risk population like injecting drug users, female sex workers, her clients, or men who have sex with men in one of the sub-populations this function would allow you to define this special population. No such special characteristics where selected in this modelling exercise because there is no data or surveys on HIV prevalence for these risk groups and because it is generally accepted that the Botswana HIV epidemic is overwhelmingly heterosexual and general – as is indicated by the high HIV prevalence found in ANC sites.

[5] An epidemic that is firmly established in the general population versus a concentrated epidemic that HIV has spread rapidly in at least one defined sub-population, but is not well established in the general population.

EPP then requires you to define the adult population in each sub-population. According to the UN Population division in 2007 the adult population aged 15+ was 1,382,436 and 59 percent of the population lived in urban areas. Therefore the urban adult population was estimated to be 815,637 and the rural population 566,799. Furthermore, according to the UN Population Division in both rural and urban populations the proportion of males was 50 percent, the birth rate for adults was 5.71 percent, the survival rate to age 15 is 88.57 percent, the mortality rate for adults was 0.78 percent and the adult population growth rate was 3.53 percent. These default settings were accepted and left unchanged.

Once the urban and rural populations where defined, EPP requires you to enter the sentinel HIV prevalence data. The data from Table 2.1 were used and the sample size for each site, being unknown, was left at the default setting of 300[6]. The projection was then calibrated so that the overall trend was consistent with the BAISII results for 2004. Once all data was entered, EPP then estimated the adult HIV prevalence trend from 1980 to 2012.

2.1.4 Results

This section discusses the results from the modelling. It begins with the national trend, followed by the urban and rural trends (for people aged 15+). The urban, rural and national trends are then presented together and compared. The results are also compared to adult HIV prevalence projections (for those aged 15-49) published by United Nations[7] and Botswana's National AIDS Coordinating Agency[8]. However, before this could be done the results obtained using EPP were run through the Spectrum model[9] in order to obtain HIV prevalence estimates for people aged 15 to 49. Both the UN and the NACA use EPP and Spectrum to obtain their projections.

[6] In order to factor in the different population sizes that each ANC sites captures, a scenario using the BAISII sample sizes for each area was also conducted. However, the estimates obtained were very similar to the estimates obtained using the default sample size of 300. These estimates are available in Appendix 1.

[7] *Epidemiological Factsheet on HIV and AIDS* (UNAIDS/WHO, 2008)

[8] *HIV AIDS in Botswana: Estimated Trends and Implications Based on Surveillance and Modelling* (NACA, 2008)

[9] See section 2.4 for a detailed discussion about the Spectrum model

Therefore one would expect the projections to be comparable though not necessarily the same as different modelling strategies may have been employed.

2.1.4.1 The National, Rural, and Adult (15+) HIV Prevalence Trend estimated using EPP

Figure 2.2 shows the trend of national adult HIV prevalence (for those aged 15+) from 1980 to 2012. National adult HIV prevalence is estimated to have started increasing significantly from the mid 1980s and especially during the 1990s, rising to a peak 26 percent in 1999. In 2007 national HIV adult prevalence was estimated to have decreased to just less than 25 percent. EPP modelling projects that national adult HIV prevalence will stay constant at around 24 percent from 2007 to 2012.

Fig. 2.2: National Adult (15+) HIV Prevalence Trend

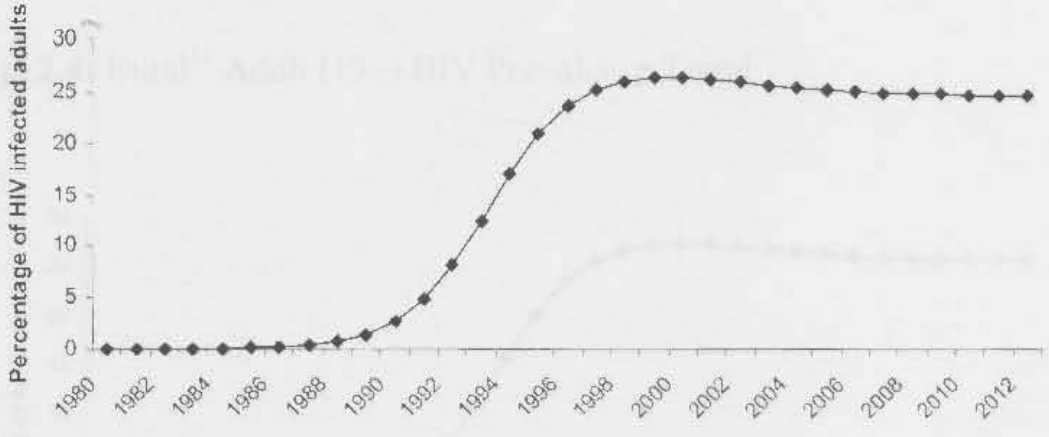


Figure 2.3 shows the trend in urban adult HIV prevalence (for those ages 15+) from 1980 to 2012. It shows a similar sharp upward trend in the late 1980s and into the 1990s, peaking at 26 percent in 1999 and subsequently decreasing to 24.5 percent in 2007. EPP projects that from 2007 to 2012 urban adult HIV prevalence will remain constant at just above 24 percent.

Fig. 2.3: Urban[10] Adult (15+) HIV Prevalence Trend

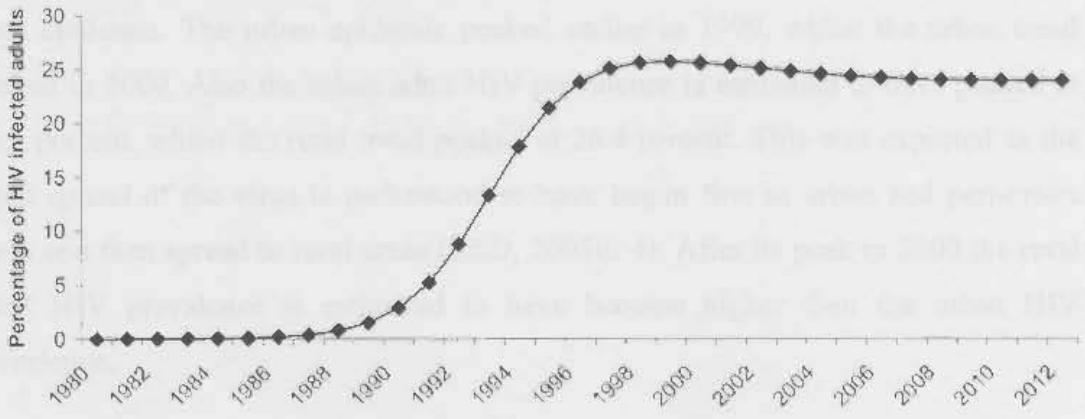
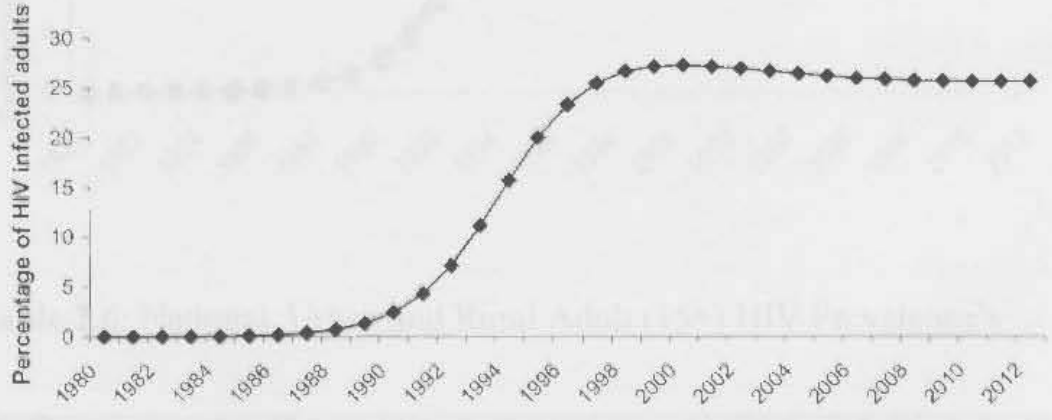


Figure 2.4 shows the trend in rural adult HIV prevalence (for those aged 15+) from 1980 to 2012. It shows the same steep upward trend in the 1990s, peaking at 26 percent in 2000 and then declining to 25 percent in 2007. EPP estimates that from 2007 to 2012 rural adult HIV prevalence will remain stable at just under 25 percent.

Fig. 2.4: Rural[11] Adult (15+) HIV Prevalence Trend



[10] Final fittings: r = 1.75, f0 = 0.41, t0 = 1980, phi = 94.13, Log Likelihood = 380.48

[11] Final fittings: r = 1.74, f0 = 0.39 , t0 = 1980, phi = 99.99 and Log Likelihood = 374.93

Figure 2.5 shows the estimated national, urban and rural adult HIV prevalence trends. In all three epidemics the trend shows a sharp upward trend in the late 1980s into the later 1990s. In that period the urban epidemic was estimated to be higher than the rural epidemic. The urban epidemic peaked earlier in 1999, whilst the urban trend peaked in 2000. Also the urban adult HIV prevalence is estimated to have peaked at 26.2 percent, whilst the rural trend peaked at 26.4 percent. This was expected as the rapid spread of the virus is understood to have begun first in urban and peri-urban areas and then spread to rural areas (CSO, 2005ii: 4). After its peak in 2000 the rural adult HIV prevalence is estimated to have become higher than the urban HIV prevalence.

Fig. 2.5: National, Urban and Rural Adult (15+) HIV Prevalence Trends

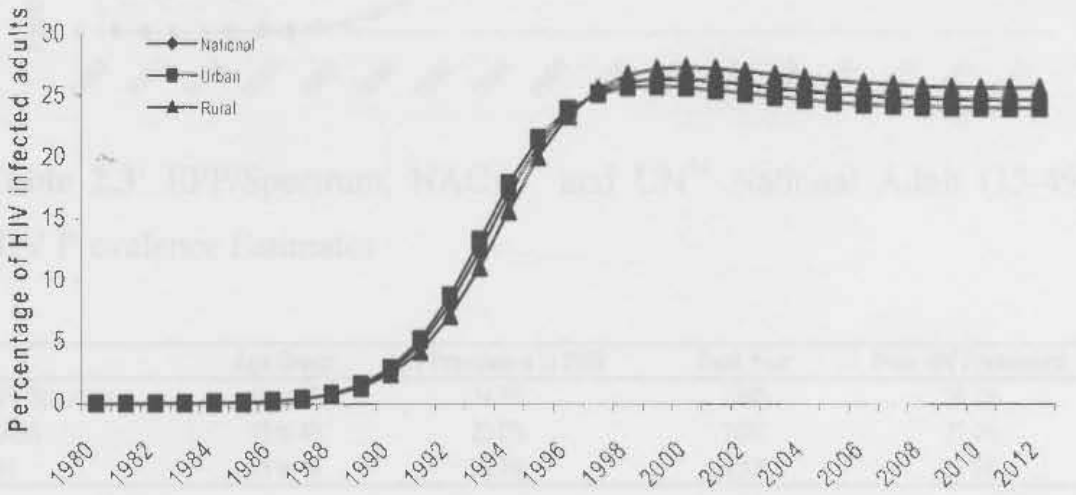


Table 2.6: National, Urban and Rural Adult (15+) HIV Prevalence's

	Age Group	HIV Prevalence in 2007	Peak Year	Peak HIV Prevalence
National	15 to 49	24.8%	1999	26.3%
Urban	15 to 49	24.1%	1999	25.7%
Rural	15 to 49	25.8%	2000	27.2%

2.1.4.2. The National Adult (15 – 49) HIV prevalence trend estimated using EPP and Spectrum[12]

Figure 2.6: National Adult (15-49) HIV prevalence trend

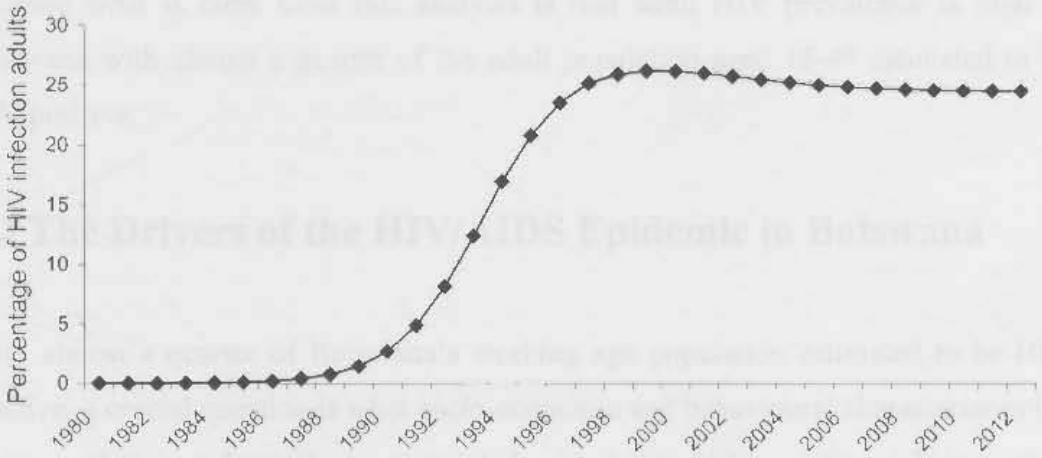


Table 2.3: EPP/Spectrum, NACA[13] and UN[14] National Adult (15-49) HIV Prevalence Estimates

	Age Group	HIV Prevalence in 2007	Peak Year	Peak HIV Prevalence
EPP/Spectrum	15 to 49	24.8%	1999	26.3%
NACA	15 to 49	23.0%	2001	27.0%
UN	15 to 49	23.9%	2000	27.0%

Figure 2.6 shows the national adult (15-49) prevalence trend using EPP and Spectrum. These results do not differ significantly from those obtained using EPP alone. More importantly, these estimates stand well when compared with the estimates published by NACA and the UN (see Table 2.3). In 2007 the NACA estimated a national adult prevalence of 23 percent, whilst the UN's estimate was just less than 24 percent. However all three estimates differ in terms of the peak of the national epidemic. Modelling done in this paper (called EPP in Table 2.3) estimated that the national

[12] Spectrum 3 (2007) version obtained at:
http://www.unaids.org/en/KnowledgeCentre/HIVData/Epidemiology/epi_software2007.asp
[13] NACA (2008)
[14] UNAIDS/WHO (2008)

epidemic peaked in 1999 at 26 percent; the NACA estimated that it peaked later in 2001 and the UN estimated that it peaked in 2000. However, both organisations estimated that at its peak, national adult HIV prevalence was 27 percent.

The estimates for adult HIV prevalence at a national, rural and urban level reveal that although the epidemic has peaked in both sub-populations, adult HIV prevalence remains high at just under 25 percent. Although modelling can never be completely accurate what is clear from this analysis is that adult HIV prevalence is high in Botswana with almost a quarter of the adult population aged 15-49 estimated to be HIV positive.

2.2 The Drivers of the HIV/AIDS Epidemic in Botswana

With almost a quarter of Botswana's working age population estimated to be HIV positive, a crucial question is what socio-economic and behavioural characteristics (or 'drivers of the epidemic') are associated with being HIV positive. This section reviews the relevant literature and reports relevant statistics from the BAISII data.

2.2.1. Behavioural Determinants of the HIV/AIDS Epidemic in Botswana

Macdonald (1996) argued that the rapid transmission of HIV in Botswana has been due to three main factors; the position of women in society, particularly their lack of power in negotiating sexual relationships (see also Letamo and Bainame, 1997); cultural attitudes to fertility; and social migration patterns. The government's National Strategic Framework (2005), however, identifies the four major categories of determinants which have contributed to the spread of HIV/AIDS as: stigma and denial, socio-cultural determinants, socio-economic determinants and demographic mobility. In order to understand the some of the behavioural determinants of HIV/AIDS in Botswana, some results from the BAISII that pertain to sexual behaviour are examined next.

Table 2.7: Sexual behavioural results from BAISII (2004)

Male and Female (15 to 48 years)	Mean	Std. Dev.	Obs	Range	Conf. Interval
Age when first had sex	18 years	3.30	8552	9 to 42 years	[18.24 -18.38]
Age when first married	25 years	6.48	4455	15 to 48 years	[25.31 - 25.69]
Number of current sexual partners	1 partner	0.58	7629	0 to 11 partners	[1.05 - 1.08]
Number of current sexual partners if more than 1	2 partners	1.19	617	2 to 11 partners	[2.37 - 2.55]
Number of sexual partners in the last 12 months	1 partner	1.23	7613	0 to 41 partners	[1.21 - 1.26]
Number of sexual partners in the last 12 months if more than 1	3 partners	2.86	948	2 to 41 partners	[2.68 - 3.05]
Male (15 to 49 years)	**Mean**	**Std. Dev.**	**Obs**	**Range**	**Conf. Interval**
Age when first had sex	18 years	3.85	3592	9 to 42 years	[18.48 - 18.74
Age when first married	28 years	6.33	1779	15 tp 48 years	[27.57 - 28.17]
Number of current sexual partners	1 partner	0.73	3354	0 to 11 partners	[1.11 - 1.16]
Number of current sexual partners if more than 1	3 partners	1.24	418	2 to 11 partners	[2.44 - 2.67]
Number of sexual partners in the last 12 months	1 partner	1.53	3344	0 to 41 partners	[1.33 - 1.43]
Number of sexual partners in the last 12 months if more than 1	3 partners	3.04	623	2 to 41 partners	[2.8 - 3.28]
Female (15 to 49 years)	**Mean**	**Std. Dev.**	**Obs**	**Range**	**Conf. Interval**
Age when first had sex	18 years	2.81	4860	9 to 35 years	[18.02 - 18.18]
Age when first married	24 years	6.09	2676	15 to 48 years	[23.7 - 24.16]
Number of current sexual partners	1 partner	0.41	3354	0 to 10 partners	[1.0 - 1.03]
Number of current sexual partners if more than 1	2 partners	1.07	199	2 to 10 partners	[2.12 - 2.43]
Number of sexual partners in the last 12 months	1 partner	0.77	4269	0 to 22 partners	[1.09 - 1.14]
Number of sexual partners in the last 12 months if more than 1	3 partners	2.37	325	2 to 22 partners	[2.28 - 2.8]

Source: Raw data from the Central Statistics Office analysed by the author

Table 2.7 shows some sexual behaviour results from BAISII, tabulated for men and women aged 15 to 49. The BAISII data shows that men and women on average have their first sexual encounter at the age of 18. However on average marriage takes place a lot later than the first sexual encounter, at around 28 years for men and 24 years for women. Thus most young Batswana are having sex before 20 years and are only getting married in their mid to late-20s. These findings are in line with global trends towards later marriage which has led to an increase in the prevalence of premarital sex (Wellings et al, 2006:1706). Premarital sex amongst young Batswana puts them at the risk of contracting HIV before they get married and thus could be an important driver of the epidemic

Furthermore, twelve percent of adults (regardless of marital status) reported to having three sexual partners on average in the last 12 months. Thus amongst sexually active people in Botswana a significant proportion may be having more than one sexual partner in a year (and hence are at an elevated risk of HIV infections).

The number of sexual partners in the last year is, however, less important than the number of concurrent sexual partners. The issue of concurrency in Africa is gaining

more attention amongst policy makers. It is becoming more accepted that in Africa men and women often have more than one partnership and that these can overlap for months and years (i.e. are concurrent) and that this pattern differs from the west were serial monogamy is more common (e.g. Halperin and Epstein, 2004: 4). Concurrent relationships have been found to be far more is more dangerous than serial monogamy because they link people up in a giant web of sexual relationships that create ideal conditions of the rapid spread of HIV (Epstein, 2007: 55).

The BAISII data shows that most females and males between the ages of 15 and 49 report having only one current sexual partner, however 8 percent of sexually active males and females aged 15 to 49 reported to having more than one current sexual partner. Of these respondents, men reported having more current sexual partners (three on average) than woman (two on average). These figures are, of course, difficult to interpret because they could either reflect low actual levels of concurrency, or they could reflect reporting bias in that respondents were aware that an AIDS impact survey was being conducted. The known implications of having more then one sexual partner could have led respondents, through 'social desirability bias', to underreport their number of current sexual partners. Even so, the data is consistent with global trends in sexual behaviour which shows that monogamy is the reported dominant pattern in most regions, and that the reporting of multiple sexual partnerships is more common in men than in women, and generally more common in developed countries than in developing countries (Wellings et al, 2006: 1706).

Polygamy used to be culturally acceptable and practiced in Botswana however the practice lost legitimacy in the early 1900s as many tribal leaders converted to Christianity. But while this led to the decline of polygamy, it apparently contributed to Batswana admitting to a much greater prevalence of concubines after the practice was abandoned (Schapera, 1943:41). Thus the lost culture of polygamy, which allowed men openly to take on more than one wife (with the consent of their current wife (or wives)), may have been *altered* into a perhaps more secretive practice of having more than one partner and whilst this practice is not publicly accepted it is nonetheless occurring. Apart from BAISII there is other evidence that suggests that multiple partnerships are taking place in Botswana. A recent study based on interviews with HIV positive women and men found that multiple sexual partnerships,

many of which are probably concurrent, were not uncommon among sexually active people living with HIV in Botswana (Kalichman et al, 2007). The probable existence of concurrent sexual partnerships amongst sexually active adults in Botswana may have created the ideal environment for the efficient spread of HIV.

2.2.2. The Biological Determinants of the HIV/AIDS Epidemic in Botswana

Stillwaggon (2002) argues that Africa was a 'fertile terrain' for the HIV virus to spread due to the supposed biomedical effects of socio-economic conditions in Africa that contribute to high rates of HIV transmission. Africa is poorest continent with the most countries at the bottom end of the income scale. The few exceptions like Botswana and South Africa have highly skewed income distributions with almost one-third of Botswana's population living on less than one dollar a day (ibid,:16). Poor living conditions in Africa have led to nutritional deficiencies amongst many Africans and although HIV is not a nutritional disease, the same health and hygiene considerations that contribute to morbidity and mortality from other infectious diseases may have contributed to the spread of HIV. As nutritional deficiencies decrease the effectiveness of the immune system this makes malnourished people more susceptible to infectious diseases, like sexually transmitted diseases (STDs) whose transmission is promoted by skin and mucosal weakness. STDs are a cofactor for HIV transmission, particularly STDs that result in genitourinary ulceration which are more common among malnourished people in Africa and elsewhere (ibid: 16).

Stillwaggon (2002) further argues that differences in sexual behaviour alone cannot explain the vast difference in HIV transmission between sub-Saharan Africa and most of the rest of the world. She thus concludes that a better understanding of the biological determinants of HIV transmission is necessary for effective preventative programs. The implication of this argument is that AIDS policy in very poor countries which relies only on behavioural modification is on the wrong track. Prevention programmes need to include a much broader health-promotion and poverty-reduction programmes that include improved nutrition, treatment for infectious diseases and health education (ibid:17).

Although Stillwaggon's argument has been criticised for failing to emphasise sexual behaviour or to recognise that in many African countries it is the richer people who are more likely to be HIV infected (Nattrass, 2009), she nevertheless has highlighted an important potential socio-economic pathway for HIV infection amongst poor people. Thus although sexual behaviour is undoubtedly an important driver of HIV infection in Botswana, biological determinants may also be an important part of explaining the rapid spread of HIV in Botswana.

2.3 Policy responses

This section investigates the government's policy responses to the treatment, care and prevention of HIV. There is no doubt that an efficient combination of treatment and prevention policies, bolstered by grassroots mobilization and effective treatment literacy campaigns, can prevent new infections, save lives and mitigate the impact of HIV/AIDS (Achmat and Simcock 2007:S11). Prevention, treatment and care are all an important part of AIDS policy in Botswana, as treatment can slow down the course of the virus and care can give dignity to the many Batswana that are living with HIV. However, there is no doubt that prevention is in principle preferable to treatment, but whether there are effective prevention policies is another matter.

Botswana has an AIDS policy that stresses prevention but also encompasses treatment and care. Botswana AIDS policy is documented in the National Strategic Framework (NSF) (2003-2009). The goals of the NSF are: (1) Prevention of HIV infection, (2) Provision of Care and Support, (3) Strengthened Management of the National Response to HIV/AIDS, (4) Psycho-social and Economic Impact Mitigation and (5) Provision of a strengthened Legal and Ethical Environment (Government of Botswana, 2008:15).

2.3.1 Early Responses to the AIDS Epidemic

The Government of Botswana started responding to the HIV epidemic as early as 1987, about two years after the first AIDS case was diagnosed. A one-year national emergency plan was set up in 1987, and this was followed by a series of 5-year

strategic plans (Allen and Heald, 2004:2). Programmes for disease surveillance and HIV/AIDS awareness where implemented, the awareness messages being implemented on the basis that they would cause behaviour change. The government's central message was one of prevention, adopting the slogan: "Preventing HIV is as easy as ABC, abstain, be faithful and condomise". The slogan was first adopted by the government in the late 1990s and can still be seen on billboards around the country.

Fig. 2.6: Roadside ABC sign in Botswana[15]

Despite the early awareness campaigns in the mid 1990s, HIV remained poorly understood and shrouded in stigma and silence at all levels of society a decade later (Allen and Heald, 2004:4). HIV prevalence in the meanwhile, climbed sharply upwards. Allen and Heald[16] (2004) argue that the failure of the early awareness

[15] http://www.avert.org/aids-picture.php?photo_id=466
[16] Heald worked in Botswana in the 1990's

campaigns was, ironically, due to the speed of the Government's response to the threat, as it required people to believe in the health promotion messages of the government before they had any experience of the disease in their own lives or communities. By contrast, Uganda's government response was later in the epidemic, so by the time that they acted, people understood the nature of the threat and were more open to changing their behaviour. For this reason, Allen and Heald argue that Uganda's epidemic did not reach the same heights of that in Botswana (ibid: 4).

2.3.2 Current Reponses to the AIDS Epidemic

In 1997 the Botswana government modified its AIDS policy, making the response to HIV/AIDS a multisectoral response that included major stakeholders from both the public and private sectors such as major private companies and all government organisations (Government of Botswana, 2008:6). The multisectoral response is coordinated by the National AIDS Coordinating Agency (NACA) whose job it is to bring together the major stakeholders in the AIDS response, whether in the public or private sectors. Central to Botswana's AIDS response is the provision of highly active antiretroviral therapy (HAART) through the public health system, as well as policy initiatives focussed on prevention of infection, prevention of mother to child transmission, expansion of counselling and testing facilities, caring for the sick, and support for orphans and vulnerable children (ibid: ix).

Currently, the government's HIV/AIDS awareness messages go beyond the *prevention only* message captured in the earlier "ABC" approach. The government is now attempting to address risky sexual behaviour that is still taking place despite the earlier prevention messages. The current HIV/AIDS awareness campaign does this by challenging traditional Setswana sayings or beliefs that pertain to sexual conduct. These traditional sayings imply that culture may have a role in the existence of the type of sexual behaviour that puts individuals at a greater risk of contracting HIV.

Fig 2.7: A bus displaying one of the current HIV/AIDS sexual behaviour awareness messages in Botswana

Figure 2.7 shows a bus at the main bus station in Gaborone (Botswana's Capital City) displaying the following message: A Setswana saying goes... "*'A man cannot be contained in one kraal' but he can spread HIV from one kraal to another*". Messages like these can be seen and heard throughout Botswana on different kinds of media such as, TV, radio and print media.

Botswana's leadership has obtained a good reputation for their response to the AIDS epidemic. Botswana's proactive approach certainly stands in sharp contrast with South Africa's tardy response to rolling out HAART. However, as Nattrass (2008) has shown using cross-country regression analysis, Botswana's performance in terms of HAART coverage is in line with what one would expect given its level of per capita GDP, institutional capacity etc (ibid:10). In other words, it may be exceptional in the Southern African region, but not when the global HAART rollout is considered.

2.3.3 HIV Care Policy

As the epidemic advanced in Botswana the health system became overburdened with terminally sick HIV patients. In 1995, the government of Botswana established a Community Home Based Care (CHBC) programme to complement the over stretched health system in caring for terminally ill patients and community mobilization was adopted. Members in the communities volunteered to care for AIDS patients from their homes. These volunteers would visit the terminally-ill patients at their homes and assist households with caring for the patient by feeding or bathing them, counselling the members of the household, or doing other chores such as collecting wood and water (Iliffe, 2006: 106). In order to provide a social net for AIDS orphans, the government started the Orphan Care Programme in 1999, providing food baskets, psychological counselling and facilitating the waivers of school fees for orphans. By 2007 the programme had registered over 50 000 orphans, all of whom are said to have been retained in the education system (Government of Botswana, 2008:22).

2.3.4 HIV Treatment Policy

In 2001 Botswana became the first African country to provide free HAART to its citizens when the national HAART programme known as *MASA* was introduced. The goals of the HAART program are to restore immunologic function and quality of life, and to increase life expectancy by decreasing morbidity and mortality due to HIV infection (Ministry of Health, 2008:41). This policy reinforced earlier efforts to provide HAART through the private sector. According to the Ministry of Health, by late 2007, over 90 000 people (over 82 percent of those with advanced HIV infection) were on treatment, 81 percent were in the public sector, 9 percent were outsourced to the private sector and 10 percent were enrolled directly in the private sector (Government of Botswana, 2008: 21, 25). In the 2009 Budget Speech earlier this year, the government reported that 114 406 AIDS patients are currently being provided with HAART (Gaolathe, 2009: 14).

2.3.5 HIV Prevention Policy

Prevention is the top priority of Botswana's national response to HIV/AIDS, but as will be discussed in the next section, it is important to consider the effectiveness of current prevention interventions. There are a number of different types of HIV prevention programs currently taking place in Botswana, these include: public education and awareness, condom distribution and education, targeting of high risk adult populations, improvement of blood safety and prevention of mother-to-child transmission (PMTCT) of HIV (Government of Botswana, 2008).

One of the ways that HIV can be transmitted is from a HIV positive mother to her unborn child, either through pregnancy, birth or breastfeeding. Administering a short course of antiretrovirals to pregnant HIV positive women greatly reduces the risk of transmission to the unborn child. HIV prevention drugs are available to pregnant women in Botswana through the PMTCT program. This program includes HIV screening during antenatal care, administering nevirapine and other antiretrovirals (ARVs) to mother and child, and providing alternatives to breastfeeding through a free formula program (Government of Botswana, 2008:57). The PMTCT programme was introduced in Botswana in 1999 and its main goal was to improve the survival and development of children by reducing HIV-related morbidity and mortality (Rakgoasi, 2005: 2). The government reports that the programme has managed to reduce mother-to-child transmission of the virus from infected females from about 40 percent to 4 percent (Khama, 2008:2) and the UN estimates that by 2007 just less than 95 percent of pregnant women living with HIV received ARVs for PMTCT (UN, 2008:13).

Other prevention programmes include the management of sexually transmitted infections (STIs), the routine testing of HIV and public sector distribution of condoms. The STI programme was established in 1989 to provide comprehensive syndromic management and treatment of STIs countrywide free of charge. As there is strong evidence supporting several biological mechanisms through which STIs facilitate HIV transmission by increasing both infectiousness and HIV susceptibility, the programme's main objective is to contribute to the reduction of HIV transmission through reduction of other STIs (Government of Botswana, 2008:20). Routine HIV Testing (RHT) was introduced in all health facilities in Botswana in January 2004 entailing routine but non-mandatory HIV testing to all public health centre clients. Its

main objectives are to make more people aware of their HIV status, facilitate supportive counselling, behavioural change, early assessment for HAART, early access to home based care and stigma reduction. The Ministry of Health reports that by September 2007 the percentage of people agreeing to be tested for HIV during routine testing was 93 percent (Government of Botswana, 2008:20).

According to U.S President's Emergency Plan for AIDS Relief (PEPFAR) the former President Festus Mogae called for the adding of MC as part of Botswana's HIV/AIDS prevention strategy. Following this, in November 2007 the Ministry of Health developed a five-year strategy aimed at reaching 80 percent coverage of the MC Service. PEPFAR has allocated funding for MC training and services and is working with Botswana's national Male Circumcision Reference Group and the Male Circumcision Technical Group to plan implementation. The Ministry of Health started to roll out the service in April 2009. This service will firstly target sexually active men (15-49); it will then extend to neonatal MC to insure sustainability in the long run (Hussein, personal communication, 5th January 2009).

Recent randomized clinical trials in Kenya, Uganda and South Africa found that MC provides up to 60 percent protection for men against acquiring HIV infection (Auvert et al, 2005, Bailey et al, 2007 and Gray et al, 2007). These findings present a real opportunity for Sub-Saharan countries to reduce HIV incidence (the number of new HIV infections). These findings will be discussed in more detail in a chapter 3. Before this is done; the demographic impact of HIV/AIDS on Botswana is modelled to assess the current impact of AIDS on the population and the limits of current prevention interventions.

2.4 The Demographic Impact of HIV/AIDS in Botswana

The following section models the demographic impact of AIDS in Botswana using the Spectrum model. It also motivates the need for new prevention interventions and notes the limitations of the Spectrum model.

2.4.1 Modelling the Demographic Impact of AIDS in Botswana using the Spectrum Model

Spectrum[17] is a publicly available computer program designed by UNAIDS Policy Initiative consisting of a number of models that analyze existing information to determine the future consequences of the HIV epidemic and the impact of HIV programs and policies. The Spectrum model is designed to answer a number of "what if" questions relevant to entities as small as local providers of primary health care services and as large as international development assistance agencies. These "what if" questions refer to factors that can be changed or influenced by public policy (Stover, 2007: 15). Like EPP, Spectrum is user-friendly and is designed to be used by policy makers. This model is accompanied by a manual that assists the user when making projections[18].

The AIDS Impact Model (AIM) is a program, within the range of Spectrum models, which projects the impact of the AIDS epidemic such as the number of people needing treatment, number of orphans; future number of HIV infections, AIDS cases, and the AIDS deaths. Spectrum requires assumptions about the epidemiology of HIV including the ratio of female to male HIV prevalence, the distribution of infection by age, the distribution of the time from infection until AIDS death, and the effect of HIV on fertility (Stover, 2004:2). Spectrum factors in country-specific demographic and AIDS policy data in order to make projections. The Spectrum model's 'Easy project' option was used which automatically factors in country specific demographic data. Spectrum uses a set of assumptions about the population and high risk groups. Default patterns have been developed for most input assumptions, these patterns are generally used in the UNAIDS estimates and projections (Stover, 2004: 2).

[17] Spectrum 3 (2007) version is available from:
http://www.unaids.org/en/KnowledgeCentre/HIVData/Epidemiology/epi_software2007.asp
[18] AIDS AIM user manual obtained: http://data.unaids.org/pub/Manual/2007/aim_manual_2007_en.pdf

Table 2.8: HAART and PMTCT inputs

Percentage of HIV positive mothers receiving prophylaxis to PMTCT

	None	SD NVP	Dual ART	Triple ART
1998	100	0	0	0
1999	93.4	6.6	0	0
2000	86.8	13.2	0	0
2001	80.2	19.8	0	0
2002	73.6	26.4	0	0
2003	67	33	0	0
2004	52.1	24.8	20.8	2.2
2005	37.2	16.7	41.4	4.5
2006	22.4	8.6	62.2	6.8
2007	7.6	0.4	83	9

Number of adults receiving ART

	First Line ART	Second Line ART
1998	0	0
1999	0	0
2000	932	0
2001	1865	0
2002	2797	14
2003	10264	82
2004	30600	849
2005	50044	1617
2006	79490	2384
2007	91780	2753

Percentage of children born to HIV positive mothers by type of feeding

	Mixed	Exclusive Breastfeeding	Replacement Feeding
1998	100	0	0
1999	93	1	6
2000	87	1	12
2001	81	1	18
2002	74	2	24
2003	67	3	30
2004	52	3	45
2005	36	4	60
2006	21	4	75
2007	5	5	90

Probablity of transmission of HIV from mother to child

Prophylaxis	Mixed	Exclusive Breastfeeding	Replacement Feeding
None	34	24	27
SD NVP	23	13	16
Dual ART	13	2.8	6
Triple ART	5	1.9	3

Number of children receiving ART and Co-trimoxazole

	ART	Co-trimoxazole
2004	2142	5474
2005	3503	8115
2006	5564	8830
2007	6251	9858

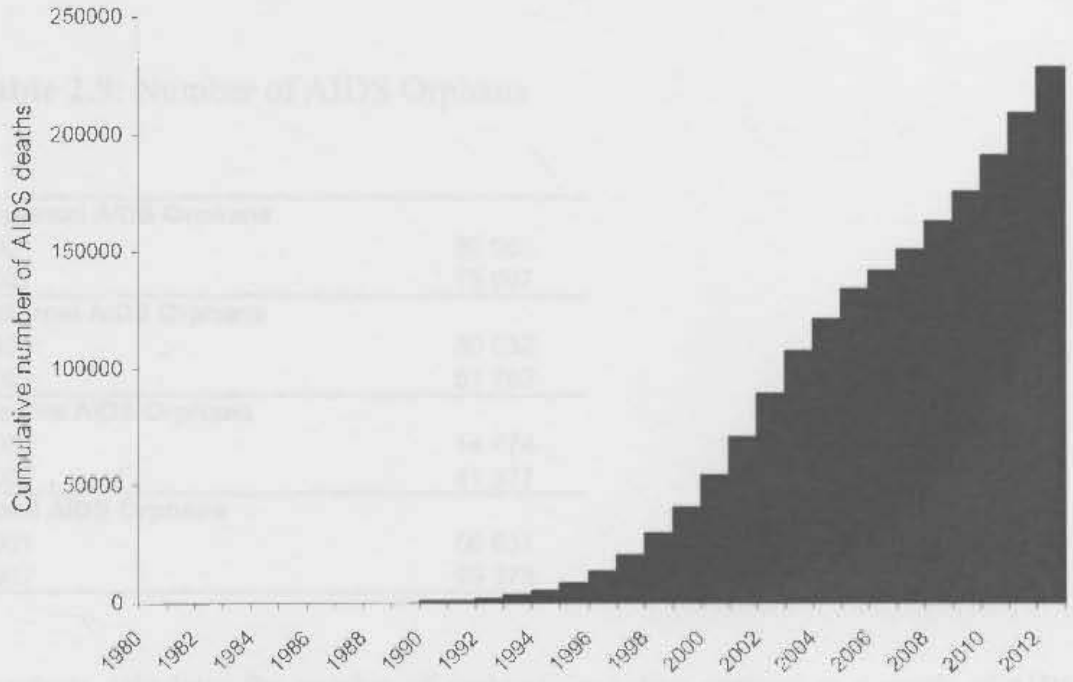
Source: Government of Botswana

For AIDS policy data, data reported by the Ministry of Health for both the HAART programme and the PMTCT programme were manually entered into Spectrum and is presented in Table 2.8. Spectrum also requires you to enter HIV prevalence data and the estimates obtained from the modelling done on EPP were used (see section 2.1). The results from the Spectrum model show how the HIV prevalence trend and its consequences change overtime due to HAART and PMTCT interventions.

2.4.2 Results

The first result from Spectrum that will de discussed is the number of AIDS deaths that have occurred in Botswana since the start of the epidemic. This is an important output as it shows the direct impact of HIV on the population, as HIV eventually leads to death and thus impacts the population's mortality levels.

Fig. 2.7: Cumulative number of AIDS deaths



AIDS deaths in Spectrum are calculated based on the survival patterns of HIV-infected adults, these survival patterns are based on the findings of cohort studies in developing countries. The Spectrum model assumes HIV infected people are subject to the same hazard of mortality from causes other than AIDS as are people who are not infected (Stover et al, 2008:3). Figure 2.7 shows the estimated cumulative number of AIDS deaths from 1980 to 2012. Spectrum estimates that by 2012 about a quarter of a million people in Botswana will have died because of HIV/AIDS. This represents over a tenth of the current population and three quarters of those dead will be adults of whom 54 percent will be female.

The large numbers of adult deaths have led to a growing number of children being orphaned in Botswana. These orphans are maternal, paternal or both (double) 'AIDS' orphans. Maternal orphans are children under the age of 18 that have lost their mother, paternal orphans are those who have lost their father and double orphans are children who have lost both parents (Government of Botswana, 2008:18). Table 2.9 shows the estimated number of AIDS orphans in 2001 and 2007. Please note that double orphans are also counted as both maternal and paternal orphans, thus the total

number of orphans is calculated as maternal orphans plus paternal orphans minus double orphans.

Table 2.9: Number of AIDS Orphans

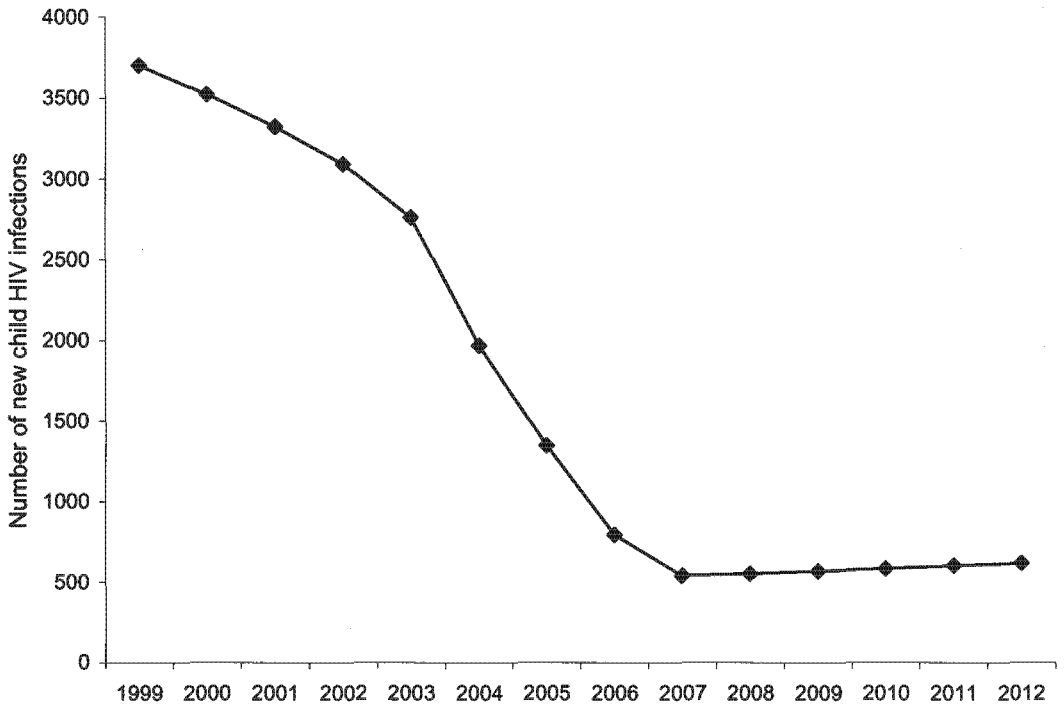
Maternal AIDS Orphans	
2001	39 062
2007	75 097
Paternal AIDS Orphans	
2001	30 032
2007	61 762
Double AIDS Orphans	
2001	14 474
2007	41 377
Total AIDS Orphans	
2001	56 631
2007	99 275

Spectrum calculates the number of orphans, including orphans as a result of AIDS from the pattern of mortality and fertility; this methodology has been confirmed by comparing the results with the findings of national surveys (Stover, 2004: 3). In 2001 just under 57 000 children are estimated to have lost one or both of their parents due to AIDS, in 2007 this number is estimated to have almost doubled to just less than 100 000 children.

The preventative impact of the current prevention interventions can be assessed by looking at the trend in HIV incidence (the number of new infections) over time. It is important to note that the only prevention intervention that can be included in Spectrum is the PMTCT intervention. No assumptions are made for the preventative impact of public awareness, education or condom distribution interventions.

Firstly, in order to assess the preventative impact of the PMTCT intervention, Figure 2.8 shows the estimated number of new child infections from 1999 to 2012. Secondly, in order to assess the trend in adult incidence from the start of the epidemic, Figure 2.9 shows the estimated adult incidence rate from 1980 to 2012.

Fig. 2.8: Number of New Child infections



In 1999 before the PMTCT intervention Botswana was experiencing close to 4000 new child infections per year. The PMTCT intervention is estimated to have led to a large decrease in the number of new child infections. In 2007, eight years after the intervention started, the number new child infections are estimated to have decreased to about 500 new child infections per year. Assuming that the PMTCT programme will remain unchanged going forward then the number of new infection is estimated to stay at around 500 new child infections each year.

Fig. 2.9.1: Adult incidence estimates

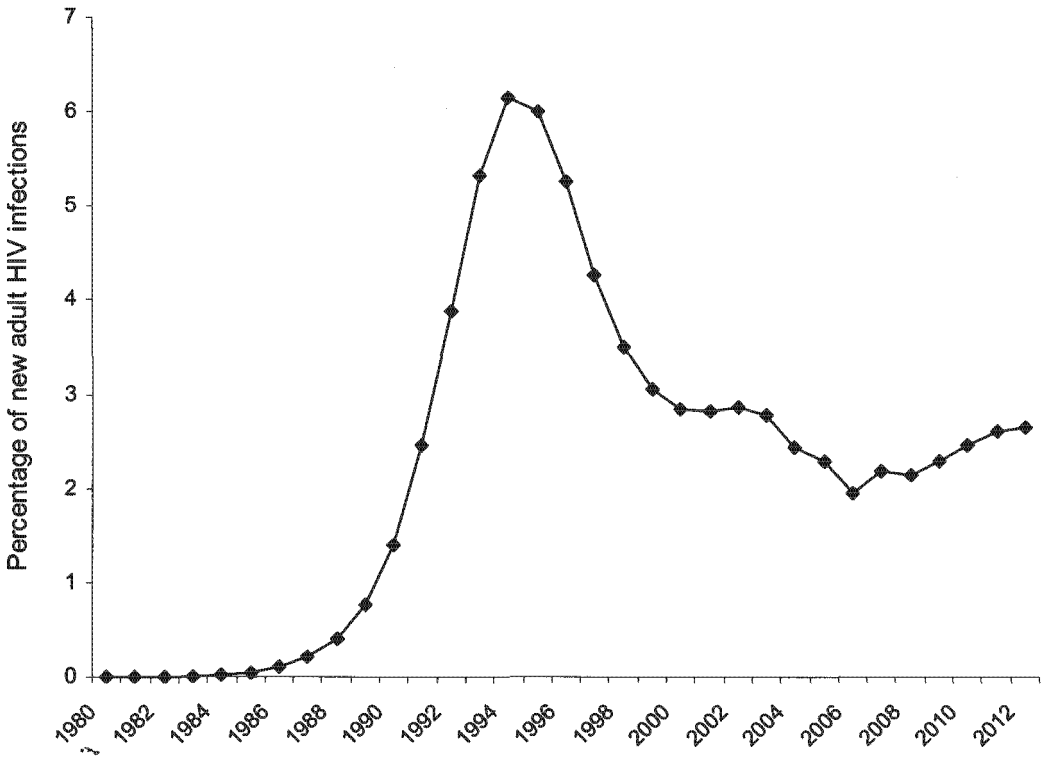
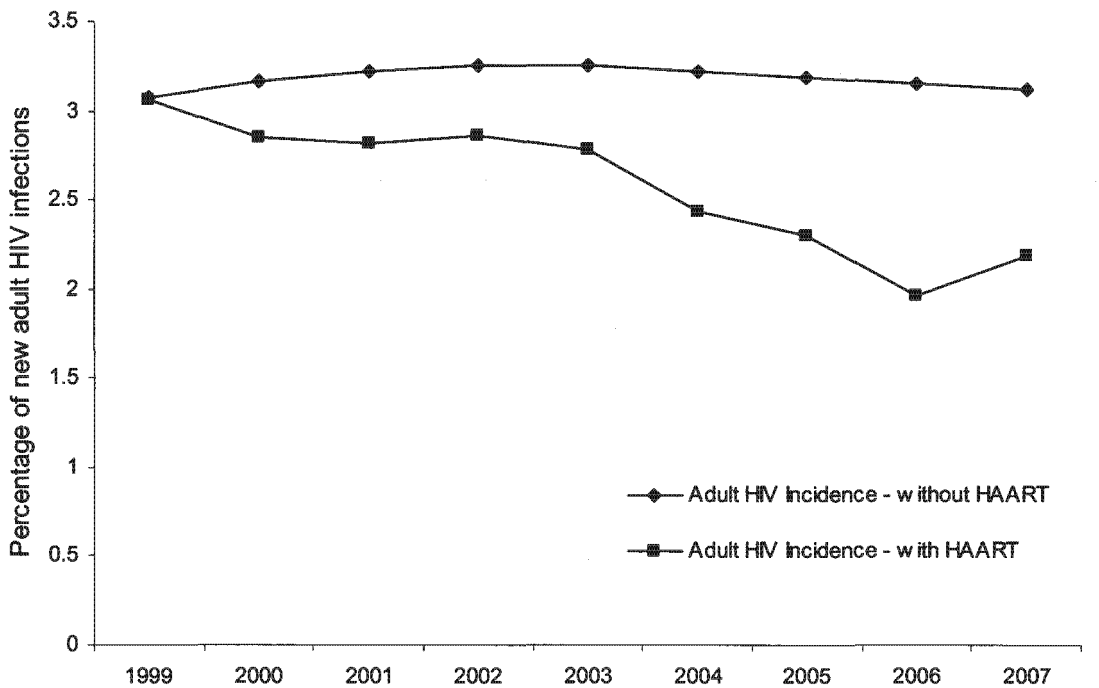


Figure 2.9.1 shows that adult incidence is estimated to have increase sharply in the early 1990s. In the mid-1990s the adult incidence rate is estimated to have peaked at just over 6 percent. In 2001 the adult incidence rate is estimated to have halved to 3 percent and by 2005 to have decreased further to about 2 percent, increasing to 2.5 percent in 2008. In the future the adult incidence rate is estimated to increase slightly from around 2.5 to just less than 3 percent.

Figure 2.9.2 shows the net preventative impact of HAART in the Spectrum model by displaying the adult incidence rate with HAART and the adult incidence rate without HAART. This figure shows that Spectrum estimates that HAART has led to a slight decrease in the adult incidence rate and that this impact increases overtime as the HAART programme reaches a higher coverage of people in need of HAART.

Fig. 2.9.2: Adult incidence estimates with and without HAART



It is not clear why Spectrum estimates an increase in the adult incidence rate going forward. Spectrum is, unfortunately, a bit of a 'black box model' in the sense that its assumptions and formula are not clear. In contrast the ASSA model which is introduced and employed in Chapter 5 (to model the impact of the MC intervention) is a more transparent model with clear assumptions and visible formulas that can easily be adjusted by the user. What is clear from the estimates obtained from the Spectrum model is that a large number of new adult infections are still taking place in Botswana despite current prevention and treatment programmes. This finding is in line with the recent conclusion by Stover, Fidzani, Molomo, Moeti and Musuka, (2008)[19] which states that:

"Botswana's PMTCT and treatment programs have achieved significant results in preventing new child infections and deaths among adults and children. The number of

[19] This study used surveillance, survey and program data to estimate past trends and current levels of HIV in Botswana and the effects of treatment and prevention programs

new adult infections continues at a high level. More effective prevention efforts are urgently needed" (ibid: 1).

2.5. Conclusion: HIV/AIDS in Botswana

This chapter employed UNAIDS modelling packages to sketch the demographic impact of the AIDS epidemic and point to the scale of the development challenge for Botswana. HIV infection is widespread in rural and urban populations. Close to a quarter of the adult population aged 15-49 is estimated to be infected with HIV. The government of Botswana has showed commitment to fighting the epidemic; however, the battle is far from being won. Although treatment and care are an important part of this fight, prevention will have to play a key role to achieving the much needed drop in HIV incidence. The population of Botswana has been affected significantly since the start of the epidemic. The AIDS epidemic will have claimed over a tenth of entire population in 2012, with over a quarter of a million AIDS deaths estimated. The AIDS epidemic is estimated to claim a greater proportion of adult lives and as a result a generation of children without a parent or both parents due to AIDS has been created in Botswana.

If HIV prevalence does not decrease dramatically in future, the AIDS epidemic will continue to exercise a severe impact on the population. Current prevention interventions may have assisted in reducing adult incidence which at its peak in the mid-1990s was estimated to be 6 percent. However, incidence is estimated to be high enough to maintain the adult prevalence rate (just over 24 percent) going forward. This means that the number of new infections in every year substitute for the number of lives lost due to AIDS in that year, thus maintaining the HIV prevalence rate. In short, there is a clear need for new effective HIV prevention interventions in Botswana. MC has been proved to reduce the risk of the probability of transmission of HIV for men during heterosexual intercourse. This intervention could potentially have the desired impact of curbing the number of new HIV infections significantly. The following chapter thus explores MC as prevention tool.

3. Male Circumcision as a HIV Prevention Tool

Male circumcision (MC) is a surgical procedure that removes all or part of the foreskin of the penis. MC is practiced as part of some religious rituals, traditional rituals performed as an initiation into manhood, or as a medical procedure. Worldwide the prevalence of MC is highly variable, depending on its acceptability and the religious, cultural, social and medical reasons for which it is performed. It estimated that 30 percent of all men worldwide are circumcised (Hankins, 2007: 63). This chapter explores the evidence that supports MC as a cost-effective HIV prevention strategy. It concludes by discussing the opportunity and limits that MC presents for Botswana as a HIV prevention tool.

3.1 The Evidence: Three Randomized Controlled Trials

Since the 1980s, over 30 observational studies have suggested a protective effect of MC on HIV acquisition in heterosexual men (Siegfried, Muller, Deeks, and Volmink, 2009:1). One study evaluated the relationships between MC prevalence, Muslim and Christian religion, and infectious diseases (of which HIV infection was one) using country-specific data from 118 developing countries. Results from the analysis showed that MC was associated with lower HIV prevalence in sub-Saharan Africa, independent of Muslim and Christian religion (Drain, Halperin, Hughes, Klausner and Bailey, 2006:1). These findings strengthened the reported biological link between MC and some sexually transmitted infectious diseases, including HIV. However it was the findings from three recent randomized controlled trials that confirmed this biological link.

The first randomised controlled trial took place in Orange Farm, South Africa from 2002 to 2004 (Auvert , Taljaard, Lagarde, Sobngwi-Tambekou and Sitta, 2005). A total of 3,274 uncircumcised men, aged 18–24, were randomized to a control or an intervention group. Like in the other two randomized controlled trials, only men in the intervention group were circumcised. This study found that at the end of the trial, HIV infection was higher amongst men in the control group, the reduction in the rate of transmission of HIV for circumcised men was found to be 60 percent. The study

concluded that since MC provides a degree of protection against acquiring HIV infection it may provide an important way of reducing the spread of HIV infection in sub-Saharan Africa (ibid: 1112).

The second randomized controlled trial took place in Kisumu, Kenya in 2005 (Bailey, Moses, Parker, Agot, Maclean, Krieger, Williams, Campbell, and Ndinya-Achola, 2007). The aim of this study was to determine whether MC had a protective effect against HIV infection, and to assess safety and changes in sexual behaviour related to this intervention. 2784 men aged 18 to 24 were randomly assigned into either an intervention group (which got circumcised) or a control group (which did not). The study was stopped early in December, 2006 after interim results showed significant efficacy for MC. The median length for follow-up from the beginning of the trial was 24 months. After adjusting for non-adherence to treatment and excluding four men found to be HIV positive at enrolment, the protective effect of MC was 60 percent. From these findings the study concluded that MC significantly reduces the risk of HIV acquisition in young men in Africa and where appropriate, voluntary, safe, and affordable circumcision services should be integrated with other HIV preventive interventions and provided as expeditiously as possible (ibid: 1).

The third randomized controlled trial took place in Rakai, Uganda. This study had the same goals as the trial in Kisumu, Kenya and these trials took place at the similar times (Gray, Kigozi, Serwadda, Makumbi, Watya, Nalugoda, Kiwanuka, Moulton, Chaudhary, Chen, Sewankambo, Wabwire-Mangen, Bacon, Williams, Opendi, Reynolds, Laeyendecker, Quinn, Wawer, 2007). 4996 uncircumcised, HIV-negative men aged 15–49 years were randomly assigned into an intervention group (which got circumcised) and a control group. The results of the study showed that HIV incidence was lower in the intervention group than it was in the control group in all socio-demographic, behavioural, and sexually transmitted disease symptom subgroups. The efficacy of the intervention was between 55 to 60 percent. From these findings the study concluded that MC can be recommended as a HIV prevention tool for men (ibid: 657).

The findings of the three randomized controlled trials confirmed the reported biological link between MC and HIV. Furthermore these trials were conducted in

Africa, thus providing strong evidence that MC helps prevent men in the general population from acquiring HIV from heterosexual sex in an African setting (Siegfried, Muller, Deeks, and Volmink, 2009:1). Against the backdrop of these findings the UN has called for the adding of a MC intervention in African countries facing large HIV/AIDS epidemics (UN, 2005).

3.2 The Cost-Effectiveness of MC as a HIV Prevention Tool

This section discusses the cost-effectiveness of MC and a HIV prevention tool. It begins by discussing the cost of a MC in an African setting and in the cost of MC in Botswana. This is followed by a review of two recent studies that use models to assess the cost-effectiveness of MC as a HIV prevention tool. The first study assesses the cost-effectiveness of MC in a South African setting, whilst the second study looks specifically at the cost-effectiveness of MC in Botswana.

In Africa one adult MC procedure is estimated to cost between US$30 and US$60 and a neonatal MC is estimated to cost about a third of the cost of the adult MC procedure (Weiss, Halperin, Bailey, Hayes, Schmidd, Hankins et al, 2008: 401). As part of the government's plan to scale-up the rollout of MC, a research study was conducted in late 2008 to estimate the overall cost and impact of a scaled-up program of safe MC in Botswana, including the cost-effectiveness of different scenarios (Bollinger, Stover, Musuka, Fidzani, Moeti, and Busang, 2009). As part of this study, a workshop was held in October 2008 with all the major stakeholders in order to ascertain the cost of MC program in Botswana. The findings on costs were as follows: the initial unit cost of an uncomplicated adult MC is estimated to be US$48 in the public sector, a neonatal MC is estimated to cost of $38[1] in the public sector, and both the adult and neonatal MC are estimated to cost of $60 and $48 respectively or 25 percent more than the public sector MC costs (ibid: 2). Apart from the unit costs of MC, the government plans to spend approximately US$2.3 million (or P14.4 million) over five years in order to generate demand for MC. It has also been agreed that approximately

[1]It was assumed to be 20% lower than the adult cost due to lower complication rates and lower costs for the instruments.

80 percent of the MCs will take place in the public sector and with the remaining 20 percent being performed by private providers (ibid: 4).

A study by Kahn, Marseille, Auvert (2006) was conducted to assess the cost effectiveness of MC in a South African setting using data from the Orange Farm clinical trial. The objective of this study was to present the first cost-effectiveness analysis of the use of MC as an intervention to reduce the spread of HIV in sub-Saharan Africa. Cost-effectiveness was modelled for 1,000 MCs done within a general adult male population. Intervention costs included performing MC and treatment of adverse events. For Gauteng Province, assuming full coverage of the MC intervention, with a 2005 adult male prevalence of 25.6 percent, 1,000 MCs were estimated to have averted 308 infections over 20 years. This translates into a cost of $181 per infection averted, and a net savings (arising out of the cost of HIV disease management averted) of about $2.4 million. Cost-effectiveness was found to be sensitive to the costs of MC and of averted HIV treatment, the protective effect of MC, and HIV prevalence. The study found that cost-effectiveness improves by less than 10 percent when MC intervention coverage is 50 percent of full coverage (ibid: 2349). Furthermore modelling studies show MC to be not only cost-effective but also cost-saving; saving between US$100 and US$900 per infection averted in medium-to-high HIV prevalence settings, depending on the number of factors including the population incidence and the time horizon considered (Weiss et al, 2008: 401). Such models also predict that more rapid scale-up of MC would result in even higher cost effectiveness.

A recent study of the cost and impacts of the national MC draft strategy in Botswana used a MC model developed by the UN as part of the Decision-Makers' Program Planning Tool (DMPPT) of the Joint United Nations Program on HIV/AIDS (UNAIDS) and World Health Organization (WHO) (Bollinger et al, 2009). The study estimated that the cumulative cost of implementing a scaled-up MC program will be US$40 million by 2025, with the larger proportion of the cumulative cost of (US$23 million) being incurred earlier on in the scale-up (between 2008 and 2015) (ibid: 4). The study also estimated that if adult and neonatal MC is scaled-up to reach 80% coverage by 2012 this would result almost 70,000 new HIV infections averted by 2025 (ibid: 3).

In order to determine the cost-effectiveness of MC, the study then combined its estimates of the number of HIV infections averted with the estimates of cumulative costs to calculate the discounted net cost per infection averted. This resulted in the discounted net cost per HIV infection of $1,353 in the period between 2008 and 2015; this decreases to $642 when the discounted net cost per HIV infection is evaluated for the entire period (2008 -2025) (Bollinger et al, 2009: 5). The study also calculated net savings per infection averted as the savings due to future ART costs avoided minus the net circumcision costs. The study assumed a discounted lifetime cost of ART of US$11,258 and the net savings per infection averted was estimated to equal US$9,905 between 2008 and 2015 and US$10,616 when it was evaluated over the entire time period considered (ibid: 5).

3.3 The Opportunity for Botswana

The findings from the three randomized controlled trials and the cost-effectiveness studies summarised above present a real opportunity for Botswana. Not only does Botswana have a high heterosexual HIV incidence rate, but as will be shown in the next section, Botswana also has a low MC prevalence rate. Furthermore, although the findings from three randomized controlled trials are specific to female to male transmission, women may also benefit indirectly from MC. Women living in high prevalence settings with low MC prevalence may benefit after the intervention because if there is a reduction in HIV incidence among men who are circumcised then women will have a lower probability of encountering sexual partner with HIV infection (Hankins, 2007:62).

Botswana has recognised this opportunity. An interview with Dr. Fatima Hussein[2] a senior officer at the Department of HIV/AIDS Prevention and Care in the Ministry of Health revealed that a MC policy is being drafted and an assessment of the acceptability of MC in Botswana by the public and the health sector has taken place. This was followed by an ongoing assessment of the method that will be used to perform the surgical procedure. Currently an awareness campaign about the benefits of MC is taking place in Botswana through the media. This campaign encourages men

[2] Interview conducted on the 5th January 2009

to visit clinics for safe MC procedures. The Ministry of Health plans to circumcise 460,000 men in the next five years. Currently all primary and district hospitals are booking clients and performing the procedure. About 50 healthcare providers, including 27 doctors have undergone training on surgical circumcision. The Ministry of Health plans to use the country's well developed network of health care service to ensure that MC can be done in every village health post and hospital across the country (Southern Times, 17th May 2009).

3.4 The Possible Threat to Using MC as a Prevention Tool

Although MC could cause a significant decrease in Botswana's HIV prevalence rate, this intervention is a biological intervention that could have unintended effects on sexual behaviour. If circumcised men believe that being circumcised confers substantial or complete protection against HIV infection, they may engage in increased risk behaviour, commonly referred to as risk compensation or behavioural disinhibition (Mattson, Campbell, Bailey, Agot, Ndinya-Achola and Moses, 2008: 1). Significant risk compensation could reduce the protective effect of circumcision and possibly result in increased rather than decreased incidence of HIV (ibid: 1).

Evidence on behavioural disinhibition after MC is inconclusive. All three randomized controlled trials discussed earlier monitored the behaviour of the men in the intervention group before and after they were circumcised. In Kisumu, Kenya and in Rakai, Uganda the circumcised men did not show any behavioural disinhibition after they were circumcised (Bailey et al, 2007 and Gray et al, 2007). In the Orange farm trial sexual risk behaviour increased slightly amongst the men in the intervention group after they were circumcised (Auvert et al, 2005). Thus from the findings of the randomized controlled trials it is not clear whether or not MC will lead to behavioural disinhibition. However the risk of behavioural disinhibition needs to be considered seriously in the event that there is increased sexual risk behaviour due to MC as this could potentially reverse the gains of the MC policy.

Another possible threat to the using MC as a HIV/AIDS prevention tool is the possibility of men having sex before the wound has healed completely. Men that have

just been circumcised are at a higher risk of contracting HIV as HIV can be easily transmitted through the healing wound. Both this threat and the possibility of behaviour disinhibition need to be addressed sufficiently through straight-forward messages that ensure absolute clarity on the limits of MC as a HIV/AIDS prevention tool.

3.5 Conclusion: MC as an HIV Prevention Tool

There is now very strong evidence that MC causes a significant decrease, of up to 60 percent, in the probability of HIV transmission for men during heterosexual intercourse. The findings of the three randomized controlled trials have presented a real opportunity for Botswana to decrease HIV incidence going forward.

MC is a biological intervention that decreases the risk of transmission without requiring men to change their behaviour. The government has been urging people to adopt safer sexual behaviour since the beginning of the response to the AIDS epidemic in the late 1980s. However, the task of positively changing people's behaviour is a difficult one, and as the incidence rate indicates, there are still significant numbers of new infections taking place in Botswana. Thus although MC could reduce the number of new infections without requiring people to change their current sexual behaviour, if they mistakenly believe that it offers them complete protection against HIV, the mass-scale rollout of MC could have the unintended effect of causing an increase in risky sexual behaviour. In high HIV prevalence settings after men are offered MC, women may find it more difficult to negotiate safe sex with circumcised men who may mistakenly think that they can stop condom use and other safe sex measures. If such risk compensation takes place women will not be protected and the indirect benefits for MC for women will not materialise (Hankins, 2007:66)

Thus it is important that the MC awareness message is communicated unambiguously to the public to ensure that there are no misconceptions about the degree of protection that MC offers and the high risk of infection following the MC operation. The Ministry of Health plans to monitor and evaluate the MC program for possible

untoward effects, such as increases in unsafe or unprotected sex and increases in sexual violence (Hussein, personal communication, 5th January 2009). This monitoring will be in line with recommendations from a roundtable discussion convened by the Forum for Collaborative HIV Research in collaboration with the Bill and Miranda Gates Foundation, World Health Organization and UNAIDS held on the 8th of October in Washington, DC (see Kim, 2009)

The next chapter discusses the social context of MC in Botswana as this is crucial for the acceptability of the intervention. This is followed, in Chapter 5, by an exploration of the potential impact of MC on Botswana's AIDS epidemic by showing how much smaller the HIV/AIDS epidemic would have been if Botswana had had a higher rate of MC at the beginning of the epidemic. Chapter 5 will also show the impact of MC on the HIV/AIDS epidemic going forward.

4. Male Circumcision and Botswana: Prevalence, Cultural Role, Acceptability and Financing

This chapter investigates MC within Botswana in order to understand the impact that different factors may have on the success of the MC policy. Firstly, the current MC prevalence rate will be reported using data from the BAISII survey. Secondly, the cultural role of MC in Botswana will be investigated. Many African tribes have long used MC for traditional purposes, or have used it in the past, and Botswana is no an exception. In Botswana MC was initially performed as part of traditional ceremonies. This historical cultural legacy could potentially play a major role in shaping the public's perception of MC and therefore the success of the MC policy. Thirdly, whether MC can reach 80 percent coverage within five years as planned ultimately depends on the public's willingness to take up the service and the public health sector's ability to provide the service. For this reason, the chapter also investigates the acceptability of MC amongst the public and amongst the health sector professionals in the public health sector.

4.1 MC Prevalence in Botswana

According to the BAISII data, MC prevalence is low in Botswana. The survey asked male respondents over the age of 10 whether they had been circumcised[1] and of the 6762 men, 10 percent reported that they were. The results are tabulated in Table 4.1.

Table 4.1: MC prevalence results from BIAS II

MC Prevalence	10%
Sample Size	6762
Median Age	27 years

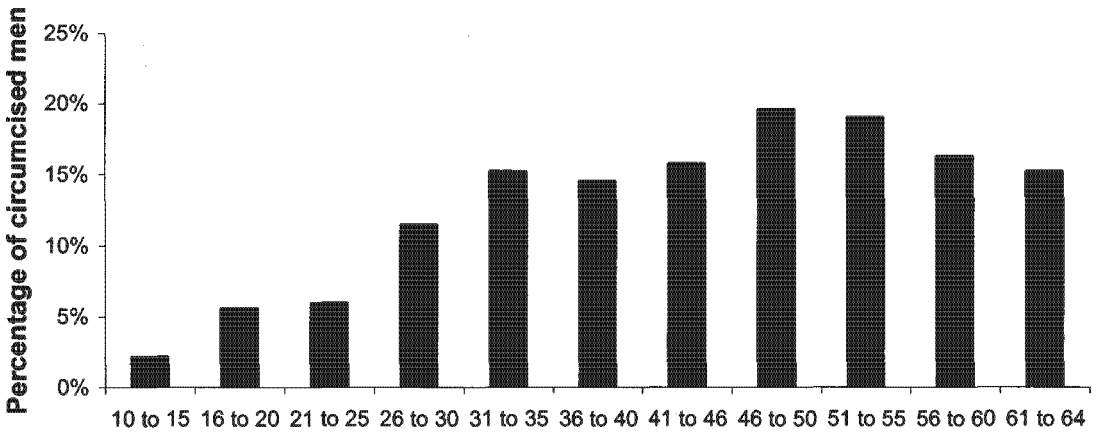
Source: Data fro m the Central Statistics Office, tabulated by author

Figure 4.1 shows the MC prevalence rate amongst different age groups from 10 to 64

[1] Section 4: Sexually Transmitted Diseases, Question 401

years. This figure shows that MC prevalence is higher amongst older males (i.e. older than 25).

Fig. 4.1: MC prevalence in different age groups according to BAISII



Source: Data fro m the Central Statistics Office, graph by author

4.2 The Cultural Role of MC in Botswana: a history

The history of MC in Botswana is profoundly structured by the historical changes that took place in the 19th and 20th century due to contact with Western civilization.

The majority of the natives of Botswana belong to what ethnologists and linguists term the Tswana cluster of the Sotho-speaking people (Schapera, 1938:1). Apart from the Tswana natives, Botswana is also inhabited by Bantu-speaking people like the Kalanga, who are from other groups and clusters. They are mainly allied with tribes in Angola and Zimbabwe (Schapera, 1938:1-2). Pre-colonial Botswana had frontiers instead of boundaries; bounded territories were a colonial invention creating clearly demarcated units of administration (Werbner, 2002:675). The making of colonial territory in Botswana left people who lived on borderlands on both sides of international boundaries, for example, the Kalanga were divided; some falling in Botswana, others in Zimbabwe (Werbner, 2002:675). Botswana is also inhabited by

'Bushmen' who are the country's earliest surviving inhabitants (Schapera, 1938:2). However despite the existence of other ethnic groups apart from the Tswana, Botswana is not ethnically diverse; the Tswana are the largest ethnic group, estimated to have a population share of 80 percent (Fearon, 2003:112). Furthermore, after independence a national unity consensus was established in order to assist a smooth transition to self-rule. Werbner (2002) termed this consensus the "One-Nation Consensus" and defined the process as follows:

> *"In terms of cultural difference, the One-Nation Consensus was assimilationist, favouring homogeneity, fostered through one official and one recognised language, respectively English and Tswana. Building one state was building one nation - the Tswana nation. The One-Nation Consensus - 'We are all Tswana' - was backed by the assimilationist policy of the ruling party. 'Tswanification', or Tswanalisation, to use the local terms for this majoritarian project of cultural nationalism, left virtually no space in the public sphere for the country's many non-Tswana cultures, unless recast in a Tswana image" (2002:677).*

This section investigates the cultural role of MC amongst the Tswana as they not only make up the majority of people but Tswana culture had been forged as the dominant culture in Botswana.

Within Botswana, the Tswana can be distinguished into eight different tribes. The five largest tribes are the Ngwato, the Tawana, the Ngwaketse, the Kwena, and the Kgatla, whilst the three smallest tribes are the Rolong, the Malete and the Tlokwa. Historically all natives belonging to a particular area acknowledged the supremacy of a Chief of its ruling community, each population would constitute a single political unit under his leadership and authority. Under the British Administration the general policy was to preserve as far as possible the tribal authority of the chiefs and the laws and customs of the people. However contact with Western civilization through European settlers, missionaries, traders and labour recruiters brought changes to Tswana life. Social anthropologist term this process 'acculturation' which means the changes produced in tribal life by the impact of Western civilization. (Schapera, 1943: 1-3).

Historically the system of age-regiments played a very prominent part in the public life of every Tswana tribe. These regiments were formed every few years, when all

the eligible girls and boys were initiated together (Schapera, 1938:104-105). Each age-regiment would be given a name and would be organized into a single body under the leadership of some member of the royal family; this organization gave members of the tribe a strong feeling of group solidarity. Age-regiments were also a way of organizing a labour force and regiments could be called upon by the chief at anytime to carry out certain work either for himself or in the interest of the tribe as a whole (Schapera, 1943:5). Historically the men's regiment also constituted the tribal army and fought its wars, but under British rule their role as the tribal army soon died away (Schapera, 1938:30).

Formerly the formation of men's regiments in all tribes was preceded by an elaborate series of rites, known as *bogwera* or *go rupa* which means "to circumcise" (the female ceremony is known as *bojale*) (Schapera, 1938:105). Thus for a man to belong to an age-regiment he needed to be initiated and circumcised with the rest of the men in the regiment The initiation ceremony included teachings on the tribe's history, traditions and values. These rites were among the most important ceremonial occasions in the life of the tribe as they marked the transition from boyhood to manhood. A man who had not passed through these rites was always regarded as a boy and was not allowed to sit in tribal meetings or take part in tribal discussions (Schapera, 1938:105). Belonging to a regiment insured a person's right as an *adult* and allowed him to get married, and weddings would be delayed until the boy and girl in question had been initiated into their regiments (Schapera, 1938:35)

However, in the early 1900s most of the Chiefs of the different Tswana tribes started abandoning the old traditional ceremonies of *bogwera* as they began converting to Christianity. Missionaries first came to the Tswana in 1816 and by 1870 they were established in all the larger tribes (Schapera, 1938:52). Once a chief had "reformed" and taken on Christian beliefs he would typically abolish or prohibit major ceremonies, including the initiation ceremony, that were considered incompatible with the principles of Christianity (Schapera, 1943:34). The missionaries regarded the whole series of rites to be most immoral and did all they could to stamp it out. Government officials also disapproved but did not actually interfere with legislation and it appears that it was primarily the chiefs who believed that the initiation ceremonies interfered with the advancement of European religion and education

(Schapera, 1943:34)

Among the Ngwato the last initiation ceremonies was held in 1876, among the Tawana the last ceremony took place between the 1906 and 1933, among the Ngwaketse the ceremonies were prohibited in 1902, the Kgatla abolished the ceremony in 1902 and Kwena ceremonies were completely prohibited in 1937 (Schapera, 1943:34-5). Among the three smaller tribes, the Malete and Tlokwa chiefs never prohibited the ceremonies which in 1943 were still practiced by their people, and among the Rolong the chief prohibited the compulsory initiation of youths who objected or whose parents objected, but neither that chief nor his successors tried to abolish the ceremony generally (Schapera, 1943:35). In short, apart from the three smaller tribes, all the five major tribes had abandoned the traditional initiation ceremonies by the early 20th century.

The prohibition of *bogwera* was very unpopular amongst some tribes and it was with great difficultly that the law was enforced as it affected the personal status of the individuals in the tribes (Schapera, 1943:35). This prohibition affected the status of individuals as adult members of the tribe and took away the personal identity that was created by belonging to an age-regiment. However, the chief's authority gave him the power to direct the process of change even if his subjects were not entirely in support of this change (Schapera, 1943:26).

Even within this process of change one major tribe, the Kgatla, continued to hold on to some aspects of the *bogwera* ceremony. Membership of a regiment continued, the regiments were formed with very little ceremony, the chief would simply call them at an appropriate occasion and tell them they were now men and give them their regiment name although this later grew into a more elaborate system. But, MC was completely abandoned (Schapera, 1938:107).

4.2.1 Traditional use of MC in Modern Times

In 1975 Chief Linchwe II, the deceased paramount chief of the Kgatla tribe, revived MC (Grant, 1984:7). In the early days of bogwera, the circumcision operation was performed by a traditional surgeon called "Rathipana" or "Father of the Little Knife"; his only requirement being that he was of Kgatla stock, fairly old and known for his skill and good fortune in castrating cattle (Schapera, 1978:7). Under Chief Linchwe II, the revived *bogwera* and practice of MC did not include the use of the Rathipana. Around 200 initiates took part in the 1975 revival of *bogwera* and the circumcision operations were carried out at the hospital in Mochudi (home of the Kgatla tribe). Ironically the hospital is part of the very mission that had been responsible for the abandonment of *bogwera* about 70 years earlier (Grant, 1984:8). All other aspects of the ritual were conducted in 'the bush' with the initiates moving into the village to complete the circumcision rites in a hospital setting. The initiates would filter into a camp in the village as they each got circumcised, here they would wait until the entire regiment was circumcised (Grant, 1984:14).

The *bogwera* ceremony took place in 1976 with over 300 initiates, the following ceremony was in 1980 with over 600 initiates, and lastly the largest ceremony took place in 1982 with over 927 initiates (Grant, 1984:8-10). This irregular character of the initiation ceremonies was not unusual. In its older form the *bogwera* ceremony did not take place every single year. For example in the 19th century, ceremonies took place in 1849, 1856, 1863, 1869, 1874 and so forth (Schapera, 1978:19).

At the 1982 ceremony 743 circumcision operations were carried out by a team of students from the Medical University of South Africa (MEDUNSA) in Pretoria. In previous years the operations had been carried out by doctors at the hospital in Mochudi and by private practitioners from nearby Gaborone. However, due to the growth in the number of initiates since the practice was revived, the hospital's two doctors could no longer provide an adequate service. It took the students three weeks to complete all the circumcision operations and each initiate paid P7.00 (approximately R8.50) for the procedure. During the period the hospital treated 452 outpatients from the initiates that needed post operative treatment. (Grant, 1984:14)

After 1982 the practice lost momentum among the Kgatla tribe – this time apparently because it was costly and time consuming. Chief Linchwe II said the whole process 'did not come cheap' as a lot of doctors where needed for the circumcisions and these doctors came at a substantial cost (BOTUSA News, November 2007).

In late 2008, the new paramount chief of the Kgatla Chief Kgafela stated at his inauguration that he was committed to reviving the practice of *bogwera* (The Sunday Standard, 25th May 2009). He stated that some NGOs had shown interest in assisting the Bakgatla with the revival of *bogwera* and that the negotiations between the Kgatla and these NGOs were in an advanced stage. As was the case with the earlier revival of the *bogwera* ceremony, the circumcision operations will be conducted in a hospital setting.

It thus seems likely that medical MC will continue as an integral part of the *bogwera* ceremony in the future. However, apart from the Kgatla, the likelihood of revival by any of the other four major tribes is regarded to be remote. In the case of the Ngwato and Ngwaketse the practice been so long abandoned in the late 19th century that attempts to revive it could only be an artificial absurdity (Grant, 1984:16).

4.3 The Acceptability of MC by the Public

Between 17 March and 17 June 2001 a major study on the acceptability of MC was conducted in Botswana by the Harvard-Botswana Partnership[2] to access the acceptability of neonatal circumcision as well MC in general. This study was based on a cross-sectional survey of 605 people in nine geographically representative locations in Botswana. Sites included two cities (Gaborone and Francistown), one town (Lobatse), and six villages (Maun, Ghansi, Serowe, Kanye, Ramotswa, and Bobonong). Twenty-nine different ethnicities from across the country were represented in the sample. Approximately 100 interviews were conducted in each of the cities and in the town, and approximately 50 interviews were conducted in each of

[2] Established in 1996, the Botswana–Harvard School of Public Health AIDS Initiative for HIV Research and Education (BHP) is a collaborative research and training initiative between the Government of the Republic of Botswana and the Harvard AIDS Institute. (http://www.hsph.harvard.edu/bhp/about_us/index.html)

the villages. Interviews were conducted by a team of three trained bilingual health educators, and were performed in either Setswana or in English according to the wishes of participants. The sample was drawn from community meeting places (known as *kgotlas*) and public markets. Interviewers systematically approached every second adult who passed by, alternating between approaching males and females. Participants were eligible if they were aged 18 years or older. Eligible respondents were asked if they were willing to participate in a health-related study.

The median age of the respondents was 29 years (range 18-74) of which 52 percent were male. Most respondents (57 percent) were single, 21 percent were married, 15 percent were cohabitating and the rest (7 percent) were separated, divorced or widowed. Most of the respondents were educated. Only 34 percent of the respondents had received no education, 31 percent had completed primary education, 53 had completed secondary education and 65 percent had completed tertiary education. The majority of the respondents were parents, 64 percent had one or more children and only 36 percent had no children.

Table 4.2: MC prevalence amongst male respondents in the Acceptability Study

MC prevalence	25%
Sample Size	315
Median Age	34yrs
Median age at circumcision	13yrs

Source: Kebaabetswe et al, 2003

Of the 315 males that were interviewed, 25 percent reported that they were circumcised (see Table 4.2). This MC prevalence is significantly different from the MC prevalence found in BAISII (10 percent). A suspected sample bias may explain this difference. The acceptability study only interviewed people aged 18 years and older, whilst the BAISII conducted individual questionnaires with people aged 10 years or older. Hence the median age of circumcised men in the acceptability study was 34 years compared to the median age of 27 years amongst circumcised in BAISII. Furthermore, a sample bias is indicated by the large majority who were parents and

the high education levels amongst the respondents. Thus it is possible that the different characteristics of the sample drawn in the acceptability study may explain why the findings on MC prevalence were significantly higher that the MC prevalence findings of BAISII reported earlier.

The interviews were conducted both before and after an informational session outlining the risk and benefits of MC. The interviews before and after the informational session were conducted with the same respondents. Before the informational session 68 percent responded that they would probably or definitely circumcise a male child if was offered free of charge in a hospital setting. The percentage increased to 89 percent after the informational session. Of the uncircumcised men, 61 percent said they would definitely or probably get circumcised if it was offered in a hospital setting. This increased to 81 percent after the informational session. Multivariate analysis revealed that those with children were more likely to favour MC than those without. Just over half of participants felt that the ideal age for MC is before 6 years and 90 percent of participants felt that MC should be performed in the hospital setting (Kebaabetswe et al, 2003).

It is not clear why the acceptability of MC was high even before the informational session; the majority of people cited the prevention of sexually transmitted diseases, including HIV, for favouring circumcision. Thus it appears that some of the respondents were aware of some of the benefits of MC prior to the informational session although the awareness campaign only began in 2009. Again this may be indicative of a sample bias. The main aim of the acceptability study was to assess acceptability for neonatal circumcision. This may explain the high proportion of parents amongst the respondents and why the multivariate analysis revealed that people with children were more likely to favour MC.

The study also reveals that MC had some cultural resonance. When the respondents were asked if MC was culturally acceptable, 50 percent said that it was, 34 percent were unsure and only 16 percent felt that MC was not culturally acceptable. This suggests that at some level, MC remains an acceptable aspect of cultural identity in Botswana. Indeed, 59 percent of the men who were circumcised listed culture or tradition as their reason for being circumcised whilst 41 percent listed disease

prevention as one of their reasons.

4.4 The Acceptability of MC by Public Health Sector

The Botswana government plans to roll out MC from mid 2009 as a clinical intervention to be carried out on a public health sector. MC has been carried out in hospitals in the past but it was seen as an elective and not as a public health emergency. Through the Centres for Disease Control and Prevention's Global AIDS Program in Botswana (BOTUSA), an affiliate of the John Hopkins School has been awarded funds to conduct a needs assessment of Botswana's public health care's ability to expand and strengthen the provision of MC[3].

The Ministry of Health is committed to delivering a thorough MC service to the public which will include information about the risks and benefits of the procedure, counselling about the need to adopt and maintain safer sex practices, access to HIV testing, condom promotion and provision, and the management of sexually transmitted infections (Hussein, personal communication, 5th January 2008). Although the Ministry of Health is committed to do so, questions remain about the clinical managers who are going to oversee, supervise, manage, monitor and evaluate the intervention. In order for the MC intervention to be delivered efficiently it is important for the Ministry of Health to have 'buy-in' from the people tasked with rolling out MC.

In 2008 the Ministry of Health conducted a survey of hospital managers to ascertain their views on the acceptability of MC and on the challenges of rolling it out in the public sector. A total of 24 medical workers throughout Botswana were interviewed. Their positions in the hospital included: chief and principal medical officers, hospital superintendents, matrons and senior medical offices. The results from the survey were obtained from the Ministry of Health and key results are discussed next.

[3] http://research.hopkinsglobalhealth.org/Country.cfm?country_code=BC

Table 4.3: Hospital managers' views on MC in Botswana

Current reasons for conducting MC		*Common complications of MC*	
Medical Indications	31%	Bleeding	37%
Request by client	30%	Infection	22%
Cultural/social/religious	13%	Haematoma	10%
Cosmetic/fashion	11%	Reactions to local anaesthetic	7%
Prevent STIs/HIV	9%	Delayed healing	7%
Religious	4%	No response	7%
Hygiene	2%	Other	10%
Major constraint in running the MC service in health facilities		*Factors affecting rates of MC*	
Shortage of staff	47%	Culture	41%
Shortage of equipment and supplies	19%	Shortage of staff	36%
Not considered a priority	14%	Distance to facility	8%
Shortage of surgical facilities	8%	Cost	1%
Fear of pain	6%	Fear of unknown	1%
Lack of awareness	3%	Fear of complications	1%
Traditional beliefs in communities	3%	Other	2%
Most important factors that need to be changed to increase the provision health facility based MC		*Question*	*Yes*
Personnel to carry out MC	40%	Can the procedure take place in facilities other than hospitals?	83%
IEC on MC	34%	Can staff other than doctors perform the procedure?	79%
Drugs and equipment	13%	Will a policy of offering HIV testing affect the programme to increase rates of MC?	46%
Other issues	3%		

Source: Data from the Ministry of Health, table by author

Most hospital managers reported that MCs were typically demanded for medical or personal reasons, although a few noted that cultural, social and religious and cosmetic reasons contributed to the current demand for MC. Over half of hospital managers said the most common complications after MC operations were bleeding and infections. Fifty-seven percent of hospital managers felt that the major constraint to running the MC service in public health facilities is the shortage of staff, nineteen percent said it was the shortage of equipment and supplies, and only fourteen percent said it was because MC was not considered a priority. Forty-one percent of hospital managers said that the main factor affecting the current demand for MC is culture and only thirty-six percent said that it was the shortage of staff.

Forty percent of hospital managers identified the personnel that currently carry out MC as the most important factor that needs to be addressed to facilitate a national roll-out. About a third believed that the government needed to improve its information and education campaigns on MC to remove fear and misconceptions and to inform the

public about the benefits of MC. Thirteen percent of hospital managers felt that more drugs, equipment, minor theatres were needed to facilitate a national MC rollout.

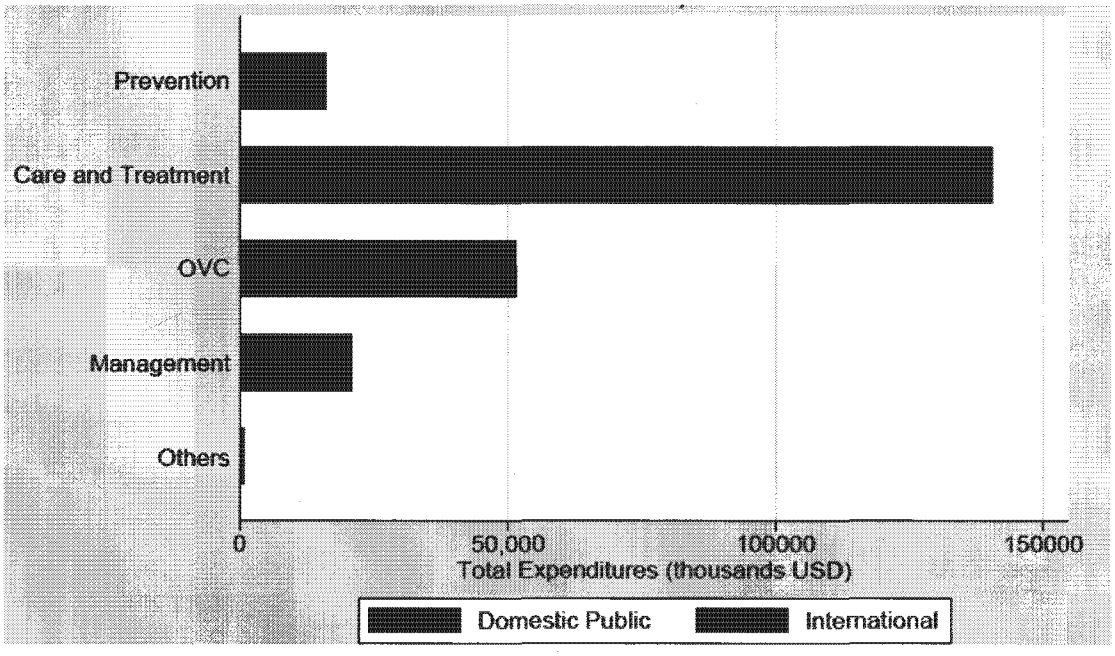
When the hospital managers were asked if the procedure could take place in facilities other than hospitals, 83 percent said that it could. The main reason given was that MC is an out-patient procedure and therefore could be carried out in clinics with minor theatres if doctors were available. Seventy-nine percent of hospital managers felt that staff other than doctors, notably nurses, could perform the MC procedure. The reasons given were that staff other than doctors could be trained to perform the MC because the procedure was relatively simple and because demand was large and growing.

When asked whether HIV tests should be offered prior to MC, almost half (46 percent) of hospital managers said that this would act as deterrent (because of the fear and stigma around HIV). However, 50 percent believed that it would have no effect because routine testing for HIV had been a standard practice in Botswana for over three years and was now accepted in the community.

4.5 The Financing of MC

Although there appears to be overwhelming evidence supporting MC as a cost-effective prevention strategy it is important to ask how this strategy will be financed in a country that is already overburdened with the cost of HIV care, treatment and prevention. Although Botswana is a recipient of funding from various NGOs and international donors like the Bill and Miranda Gates Foundation and PEPFAR, the majority of HIV/AIDS funding comes from the country's own resources. In 2007 alone, P1.4 billion (approximately R1.7 billion) was spent on HIV/AIDS programmes and almost 90 percent of this amount was covered by the government (Khama, 2008:2), this represents nearly 5 percent of the governments entire budget (Gaolathe, 2009:25).

Fig. 4.2: HIV/AIDS expenditure by finance source and spending category in 2007



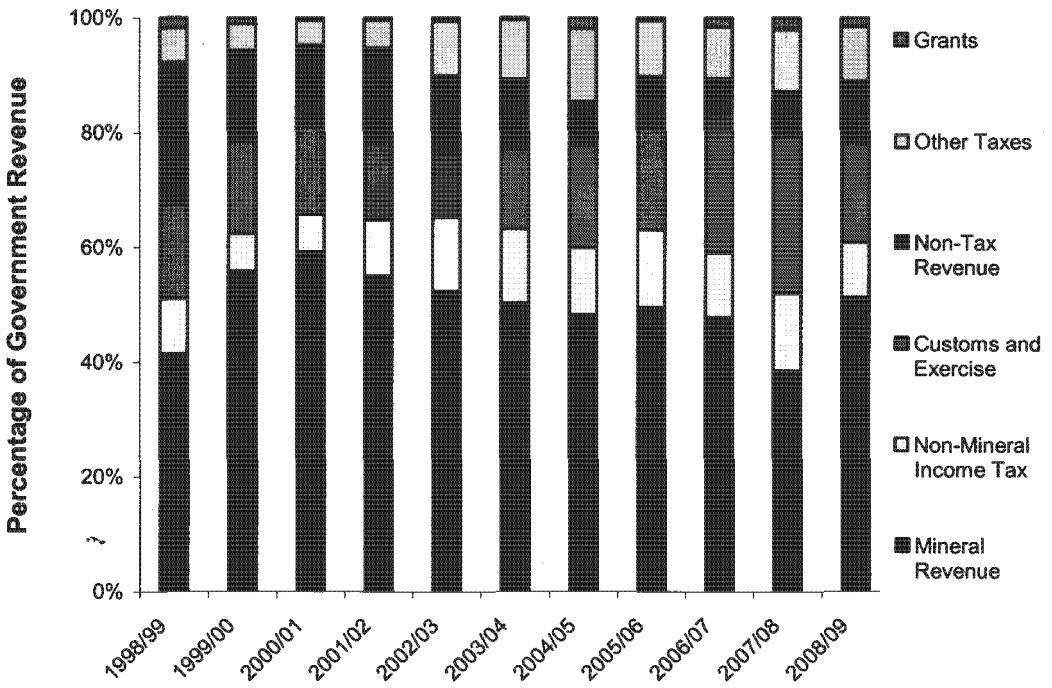
Source: UNAIDS

Figure 4.2 shows how HIV/AIDS expenditure was distributed across HIV prevention, care and treatment, orphans and vulnerable children (OVC), HIV/AIDS management and other expenditures. This figure also shows the proportion of the expenditure that was domestic (public sector) and the proportion that was paid through international funding. International funding includes resources from the Global Fund for HIV/AIDS, bilateral agreements and NGOs. Two things are clear from the table, firstly the largest proportion of Botswana's HIV/AIDS expenditure goes towards HIV/AIDS treatment and care. Secondly, the government or domestic public pays the largest share of almost all HIV/AIDS expenditures.

PEPFAR is currently providing the Ministry of Health with technical and financial support to assess what is needed to scale-up MC (PEPFAR, 2007). The UN through the WHO and UNAIDS Secretariat hired two consultants to assist the Ministry of Health to undertake necessary preparatory work for MC scale-up (UNAIDS, 2008b:

3). MC is a long term strategy and once the MC scale-up has been achieved it is likely that the government of Botswana will provide the largest share of the expenditure that is necessary to keep providing, maintaining and monitoring the MC intervention.

Fig. 4.3: The composition of government revenue



Source: Data fro m the Central Statistics Office, graph by author

In the past diamond revenues enabled the government to maintain high levels of spending on HIV/AIDS programs. Figure 4.3 shows the composition of government revenue from 1998 to the third quarter 2009. It is clear from this figure that mineral revenues make up the biggest proportion of government revenue, close to half in 2008/09. As stated in chapter 1, diamond revenues make up over 90 percent of all mineral revenue and are thus the government's most important source of revenue.

The global economic recession is now compromising the government's ability to spend on HIV/AIDS. In the 2009/10 budget the government said the demand for Botswana's diamonds is expected to decrease by 50 percent (Gaolathe, 2009). Depending on the length of the recession, the government may have to make tough

decisions about the allocation of HIV/AIDS funding. Earlier this year the government warned that it may have to cut or completely withdraw its HIV/AIDS funding, as the global economic crisis takes a toll on the vitally important diamond mining sector (Plusnews, 20th February 2009). Robson Dimbungu, chief programme planning officer of the NACA said their current budget will not sustain HIV/AIDS expenditure beyond 2016 and due to the uncertainty of future revenues there is an urgent need to scale up efforts to prevent further infections (Plusnews, 20th February 2009).

4.6 Conclusion: MC in Botswana

The investigation into MC in Botswana identified some of the main factors that could play an important role in the success of the MC intervention and the results are as follows. According to BAISII, MC is low in Botswana and about a tenth of all men are estimated to be circumcised. The current low MC prevalence rate gives the Ministry of Health a lot of scope to increase MC prevalence. There are large numbers of uncircumcised men and the demand for MC could increase dramatically after the current awareness campaign.

The cultural role of MC in Botswana is not entirely straight-forward. Historically the practice was abandoned in the 19th and 20th centuries by the majority of Tswana tribes, the practice was then revived by one major tribe in the 1970s but the revival lost momentum in the 1980s. The Kgatla tribe has stated a commitment to reviving the practice of MC. However despite MC supposedly being a lost tradition, 59 percent of circumcised men in the acceptability study stated culture as one of the reasons why they were circumcised and half of the all respondents said MC was culturally acceptable. Thus it appears that although MC is no longer practiced by Tswana tribes, MC still echoes some form of cultural association. This could positively impact on the Ministry of Health's education and awareness campaign. The association between culture and MC means that MC is not a completely new concept to Botswana. Furthermore if MC is considered to be culturally acceptable the public could be more willing to take up the service.

The acceptability of medical MC appears to be high in the general population and hospital managers appear to be supportive of a national MC rollout, although they warn about additional resource needs and point out that it is still being treated as an elective and not as a public health emergency.

The government pays the largest share of all HIV/AIDS expenditure with HIV treatment and care receiving the largest proportion of the HIV/AIDS budget. The economic recession could force the government to make tough decisions about its HIV/AIDS expenditure. However the prevention of new HIV infection is recognized as a crucial ingredient in the fight against HIV and MC is accepted as an effective prevention intervention.

5. Modelling the Impact of Male Circumcision

This chapter uses demographic modeling to explore the potential impact of MC in Botswana under two distinct scenarios. The first is the impact that MC would have had on Botswana's epidemic if Botswana had had a high MC prevalence at the start of the epidemic; the second is potential impact that MC may have going forward.

The chapter begins with a review of existing studies of the impact of MC in Botswana. This is followed by a description of the ASSA2003 Botswana Demographic model and a modelling exercise to show how much smaller the Botswana HIV epidemic would have been if the country had higher rates of MC to begin with. The ASSA2003 model was not designed to model the impact of a MC rollout. However, one can use the model to get a sense of what the likely impact of higher rates of MC would have been by adjusting the model's transmission probabilities accordingly. Using ASSA2003 has the additional advantage of enabling us to explore the potential for widespread behavioural disinhibition to negate the benefits of MC.

Once the ASSA2003 model has been employed, the chapter turns to a discussion of a recently released MC model (MCM) which projects the impact of MC from 2008 onwards (Bollinger, Plosky and Stover, 2008). This model is used to project the potential impact of the Botswana's MC scale-up considering the extent to which different levels of behavioural disinhibition amongst circumcised men (after the scale-up of MC) will reverse the potential gains of the MC scale-up.

5.1 A Review of Existing Studies

There are two prior studies of the potential impact of MC on the HIV epidemic in Botswana. The first by Nagelkerke, Moses, de Vlas and Bailey (2007) models the public health impact of a large-scale circumcision program for HIV prevention using the transmission probabilities drawn from the Orange Farm trial (discussed in Chapter 3). The study used two mathematical models, a random mixing model, and a compartmental model that distinguishes risk groups associated with sex work. In the

compartmental model, two scenarios were developed, one calculating HIV transmission and prevalence in a context similar to that of Botswana, and one similar to the Nyanza Province, in western Kenya.

Unsurprisingly, men were estimated to benefit from MC more than women, but prevalence amongst women was also reduced substantially. With 80 percent male circumcision uptake, the reductions in prevalence ranged from 45 to 67 percent in the two 'countries', and with 50 percent uptake, from 25 to 41 percent. These results were from the compartmental model which is relevant to Botswana's context. The models also showed that it would take over a decade for the intervention to reach its full effect. The paper concluded that large-scale uptake of MC services in African countries with high HIV prevalence, and where MC is not now routinely practised, could lead to substantial reductions in HIV transmission and prevalence over time among both men and women.

The second paper by Williams, Lloyd-Smith, Gouws, Hankins, Getz, Hangrove, de Zoysa, Dye and Auvert (2006) used dynamic simulation models to consider the impact of MC on the relative prevalence of HIV in men and women and in circumcised and uncircumcised men. It was found that in the next ten years MC could avert 2.0 million new infections and 0.3 million deaths in Sub-Saharan Africa. In the ten years after that MC could avert another 3.7 million new infections and 2.7 million deaths. It was also found that MC will reduce the proportion of infected people who are men from about 48 to 42 percent. With regards to Botswana, MC prevalence and HIV prevalence were assumed be 25 percent and 37 percent respectively. The models showed that the reduction in HIV incidence per year will be 1.17 percent or 10,660 new infections per year. This paper concluded that MC could substantially reduce the burden of HIV in Africa, especially in Southern Africa where the prevalence of MC is low and the prevalence of HIV is high.

5.2 The ASSA2003 Botswana Demographic Model

The Actuarial Society of South Africa (ASSA) model was developed to assess the demographic impact of AIDS in South Africa. In 2003 a tender was awarded to the

Centre of Actuarial Science Research (CARe) by the NACA and the United Nations Development Program (UNDP) to investigate the impact of HIV/AIDS on the population of Botswana. This led to two major outputs: the creation of a publicly available ASSA2003[1] model for Botswana which is similar to the South African ASSAlite2003 model and a paper modelling the demographic impact of AIDS in Botswana. The paper concluded that AIDS has had a serious demographic impact in Botswana with the total population projected to be 18% lower in 2021 than it would have been in the absence of AIDS. The model estimated that in 2004 adult HIV prevalence was 24 percent (Dorrington, Moultrie and Daniel, 2006: 5). This estimate is slightly lower then the estimate of 25 percent obtained from EPP (see chapter 2).

The ASSA 2003 model is a spreadsheet-based model programmed in VBA for Excel. It projects age-by-age and year-on-year changes in an initial population profile on the basis of the number of demographic, epidemiological and behavioural assumptions. The population is divided, by sex, into three distinct age groupings: young (up to age 13), adult (14-59) and old (60 and above). Different demographic, behavioural, and epidemiological assumptions are made for each group, which are used to project on a single-age, single-year basis. The adult group (assumed to be the sexually active population) is further subdivided into four risk groups differentiated by the level of exposure to the risk of contracting HIV through heterosexual activity. The model provides various detailed outputs, such as the numbers of people in each sex/risk group/HIV classification and in total, the number of people sick with AIDS, the number of deaths due to AIDS and HIV incidence and prevalence (Dorrington, Moultrie and Daniel, 2006: 21).

The ASSA2003 model was not created to model the impact of MC. But it has a clear set of assumptions that can be adjusted to approximate the reduced probability of transmission for men due to MC. The following section will discuss all the assumptions that were made to model the impact of MC in Botswana using the ASSA2003 model for Botswana. The current default assumptions and results that do not consider the MC intervention are discussed first in the 'No MC' scenario presented below. These results are then compared a 'high MC' coverage scenario.

[1] The ASSA2003 model available at: http://assaaids.eu1.rentasite.co.za/Other-Countries-3155.htm

5.2.1 Assumptions in the ASSA2003 Model for the Current Default Scenario (i.e. No MC Intervention)

Assumptions about the following interventions can be included in the ASSA2003 model: information and education campaigns (IEC) or social marketing, syndromic management of STDs, voluntary counselling and testing (VCT), mother-to-child transmission prevention (MTCTP) and antiretroviral treatment (ART). All the assumptions made for these interventions are available in Tables 5.1, 5.2 and 5.3[2]. In this section the current default scenario that does not include the MC intervention is modelled, the default scenario will later be compared to a high MC coverage scenario.

Table 5.1: ART and MCTCT rollout assumptions in the ASSA2003 model

	2000	2001	2002	2003	2004	2005	2006	2007	Subsequent years
MCTCT (% coverage)	0%	5%	15%	30%	63%	83%	88%	90%	90%
ART (% coverage)	10%	20%	35%	65%	85%	88%	90%	90%	90%

Table 5.2: IEC and STD assumptions in the ASSA2003 model

IEC assumptions	
Increase in condom usage with 100% roll-out	600%
STD assumptions	
Percent reduction in PRO-PRO, PRO-STD and STD-STD transmission probabilities, with 100% roll-out	15%
Percent reduction in STD-RSK transmission probabilities	10%
Percent reduction in RSK-RSK transmission probabilities	5%

Note: PRO, STD, RSK are the different population risk groups assumed by the ASSA2003 model depending on the models assumption on the varying degree of risk to contracting HIV. Thus these assumptions show the reduced risk of transmission between the different risk groups with the associated interventions

[2] These assumptions are the ASSA2003 model's default assumptions and are left unchanged in the current default scenario (that does not consider the impact of the MC intervention).

Table 5.3: VCT, MCTCT and ART assumptions in the ASSA2003 model

VCT assumptions	Not at risk	Uninfected and at risk	Stage 1 HIV	Stage 2 HIV	Stage 3 HIV	AIDS-sick, pre-HAART
Percentage of target group reached p.a. with 100% roll-out	5	6	6	6	6	6
Percent increase in VCT access with 100% ART roll-out	0	0	0	0	0	0
Reduction in amount of sex (%)	0	0	19	19	19	31
Reduction in percentage of sex acts that are unprotected	0	0	36	36	36	53
Rate of return to 'untested' state (%)	20	20	0	0	0	0
Percentage reduction in benefit from VCT per year	20	20	20	20	20	20

MCTCT assumptions		ART Assumptions	
VCT take-up rate	80%	Log reduction in viral load on ART	1.76
ART take-up rate	65%	Increase in transmissibility per log increase in viral lc	3
Formula milk take-up rate	50.25%	Percent reduction in AIDS morbidity on ART - adults	75%
Reduction in perinatal transmission from ART	47%	Percent reduction in AIDS morbidity on ART - childre	75%
Reduction in transmission through breast milk		Percent reduction in benefits from social marketing	0%
(for mother who takes ART & formula feeding)	100%	Relative transmissibility on ART	0.14
Percent of births that are live births	98.25%		

	Intial multiples (not allowing for the impact of VCT			*Current multiples (allowing for the cumulative impact of VCT)*	
Stage of HIV infection	Transmission efficiency	Condom Usage	Amont of sex	Condom no-usage	Amount of Sex
Stage 1	0.5	1	1	1	1
Stage 2	0.4	1	1	1	1
Stage 3	1.5	1	0.65	1	0.65
Stage 4	2.9	1	0.25	1	0.25
Stage 5	0.4	1	0.8	0.47	0.55
Stage 6	2.9	1	0.25	0.47	0.17

The main difference between modelling the demographic impact of AIDS using either the Spectrum or the ASSA2003 model is that the latter model allows you to make assumptions about more HIV/AIDS interventions. The Spectrum model only allows the user to make assumptions about the ART and MTCTP interventions, whilst the ASSA2003 model allows you to make additional assumptions on IEC, STD and VCT interventions. Chapter 1 described the HIV epidemic in Botswana using EPP and Spectrum. This chapter uses the ASSA2003 model. The following section compares the demographic outputs of both models in order to show the extent to which the projected outputs do or do not dove-tail with one another.

5.2.2. The Demographic Impact of HIV/AIDS in the ASSA2003 Model vs. the Spectrum Model

The first estimate of the demographic impact of HIV/AIDS on Botswana using the ASSA2003 model that will be compared to the estimate of the Spectrum model is the impact of HIV/AIDS on deaths in Botswana.

Fig. 5.1: The cumulative number AIDS Deaths in the ASSA2003 model and the Spectrum model

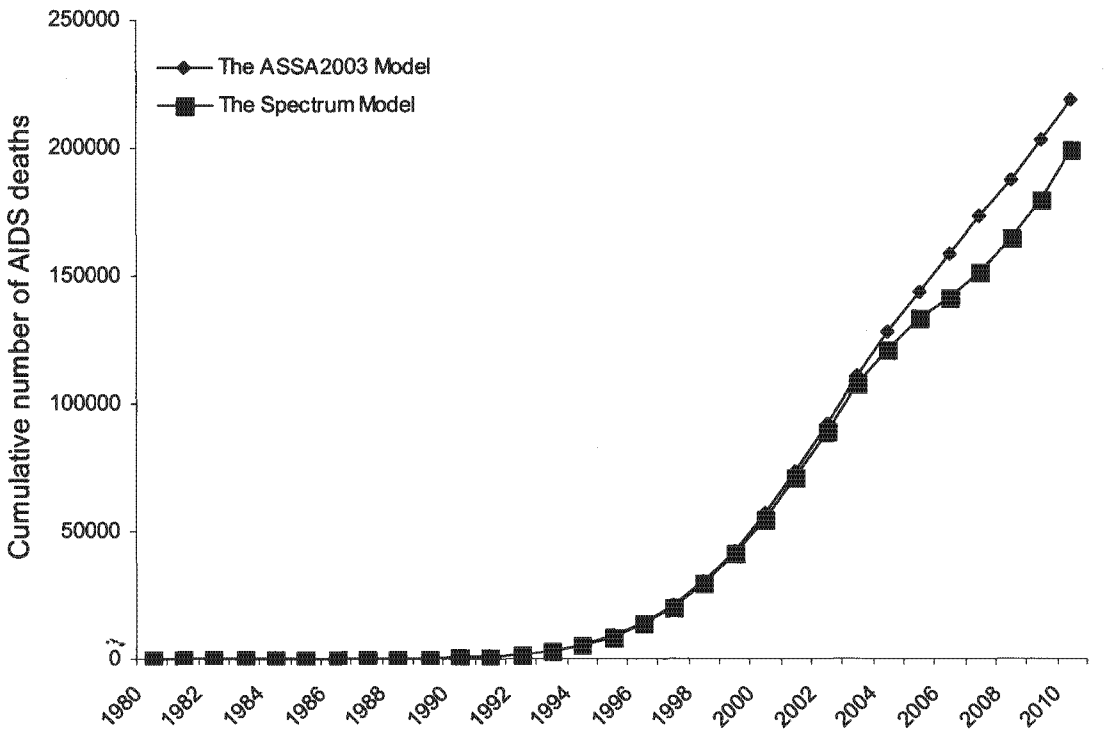


Figure 5.1 shows the estimated cumulative number of AIDS deaths in Botswana's population from 1980 to 2010 in ASSA2003 model and the Spectrum model. Both models estimate that in 2010 the cumulative number of AIDS deaths in Botswana will be over 200,000, however the ASSA2003 model estimates over 10,000 more deaths than the Spectrum model.

Fig. 5.2: Number of new HIV infections in the ASSA2003 model and the Spectrum model

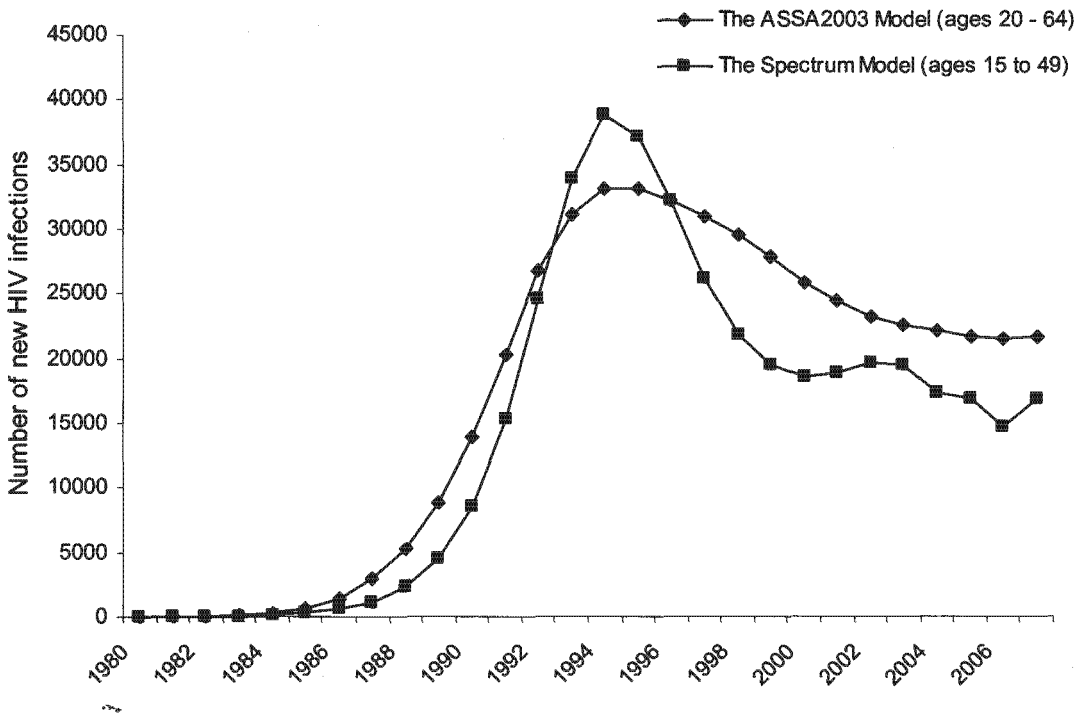


Figure 5.2 shows the estimated number of new HIV infections from 1980 to 2010 in the ASSA2003 model and the Spectrum model. Both models estimated that new HIV infections increased sharply in late-1980s into the mid-1990s. During this period the number of new HIV infections was estimated to be slightly higher in the ASSA2003 model. Both models estimate that the number new HIV infections peaked in the mid-1990s. However the Spectrum model estimates that at their peak, there were over 5,000 more new HIV infections than in the ASSA2003 model. Both models estimate that in the late-1990s the number of new HIV infections decreased. The Spectrum model estimates that that in the early 2000s the number of new HIV infections started increasing, whilst the ASSA2003 model estimates that the number of new HIV infections continued to decrease. In 2010, the ASSA2003 model estimates that the number of new HIV infections will be 2,500 lower than that estimated by the Spectrum model.

5.2.2. Factoring in the MC Intervention in the ASSA2003 Model

It is important to highlight, once again, that the ASSA2003 model is not explicitly designed to model a MC rollout. But one can estimate the extent that MC could have reduced the HIV epidemic by adjusting the default risk of transmission from females to males accordingly. But a consequence of this is that we cannot set a specific start date for a MC intervention (e.g. 2012 when the Ministry of Health intends to have reached its 80 percent coverage) and can only model the impact of MC as if it had taken place in 1980, i.e. the start of the epidemic. The modelling exercise thus simply demonstrates the power of MC to have affected the course of the epidemic assuming that there had been a MC prevention intervention reaching 80 percent of men, and having an 80 percent take up to begin with. It does not estimate the impact of a MC rollout from 2008/9 onwards

In order to model the impact of MC, the factor reduction in the probability of risk for female to male transmission after an initial MC intervention is assumed to be as follows[3]:

$$(1) \qquad \frac{(1-Y)(1-\Omega\Pi)+(1-(1-Y)(1-\Omega\Pi))(1-\delta)}{(1-Y)+Y(1-\delta)}$$

Where: Y is the prevalence rate of MC without the intervention, O is the proportion of men that have been offered free circumcision, d is the reduction in susceptibility to HIV in circumcised men, $\prod$ is the proportion of men agreeing to be circumcised.

[3] This formula was used by Johnson and Dorrington (2006) in their paper using the ASSA2002 Vaccine model for South Africa. This model was developed by adapting the C++ version of the ASSA2002 South Africa model in order to evaluate the impact of an AIDS vaccine in South Africa. In this model the effects of a vaccine were compared to the effect of a MC intervention and this formula was used to reduce the probabilities of transmission from females to males. Please note that Johnson and Dorrington are the designers of the ASSA models including the ASSA2003 model for Botswana.

Table 5.4: Assumptions used to calculate the factor reduction in the probability of risk for female to male transmission in formula (1)

MC Prevalence without intervention	Y	10%
MC coverage	Ω	80%
Reduction in susceptibility for circumcised men	d	60%
Proportion of men agreeing to be circumcised	p	80%

Table 5.4 shows the assumptions made in order to calculate the factor reduction in the probability of risk for female to male transmission of HIV. It is assumed that the MC prevalence without the intervention (***Y***) is 10 percent based on the findings of BAISII. The proportion of men that are being offered MC is (***O***) is 80 percent (the goal the Ministry of Health aims to reach). The reduction in susceptibility for circumcised men is 60 percent in line with the findings of the Orange Farm trial. The proportion of men agreeing to be circumcised is set at 80 percent. This is the percentage of men agreeing to be circumcised in the acceptability study (see chapter 4) after a brief informational session.

Given these assumptions the reduction in female to male probability of transmission of HIV is calculated as follows:

$$(1) \qquad \frac{(1-0.1)(1-((0.8)(0.8))+(1-(1-(0.1))(1-(0.8)(0.8))(1-0.6)}{(1-0.1)+(0.1)(1-0.6)}$$

According to this method the overall reduction in the probability of female to male transmission of HIV is ***63.23*** percent. This is larger than the reduction in HIV susceptibility for circumcised men because the intervention has a positive ripple-effect on the entire sexually active population. High MC prevalence after the intervention reduces the number of new male HIV infections and the overall male HIV prevalence. This in turn means that women are less likely to encounter HIV positive men and thus less likely to contract HIV themselves. If fewer women are likely to be HIV positive because more men are circumcised then men are also less likely to encounter HIV positive women. Thus a high MC coverage scenario has a greater overall reduction in the probability of female to male transmission of HIV

than just the reduction in the susceptibility for circumcised men.

Table 5.5: Default Scenario scenario (No MC intervention)

Female to male Prob of transmission		
Male PRO	Male STD	Male RSK
0.005	0.005	
0.005	0.005	0.003
	0.003	0.001

Table 5.6: High MC coverage (MC intervention)

Female to male Prob of transmission		
Male PRO	Male STD	Male RSK
0.001839	0.001839	
0.001839	0.001839	0.001103
	0.001103	0.000368

A factor reduction in female to male probability of transmission of HIV of 63.23 percent is used in the MC scenario to reduce the probability of transmission because of MC. Table 5.5 shows the ASSA2003 model's default assumption for the female to male probability of transmission in the different male risk groups. All these probabilities are reduced by 63.23 percent (see Table 5.6). One the designers of the ASSA2003 model, Leigh Johnson, warned of the shortcomings this method, saying: "...this approach probably understates the benefit of a MC program, particularly over the longer term (more than 10 years after the introduction of the MC intervention)" (personal communication, 25th September 2008). It may be that this method underestimates the size of the increasing ripple effect of the impact of high MC coverage on the probabilities of transmission in the long-run. Thus it is important to note that although this method will give us important insight into the potential impact that high MC coverage could have had in Botswana, it may also underestimate the long run impact of MC to some extent.

To consider the potential impact of MC at different levels of risk compensation six different scenarios were modelled. These scenarios were produced by adjusting the ASSA2003 model's assumptions on condom usage in the sexually active population and Table 5.7 shows the new assumptions on condom usage in the different scenarios.

Table 5.7: ASSA2003 Models assumptions on condom usage at different levels of behavioural disinhibition[4]

	Base Case			50% Decrease			40% Decrease			30% Decrease			20% Decrease			10% Decrease		
Age	PRO	STD	RSK	PRO	STD	RSK	PRO	STD	RSK	PRO	STD	RSK	PRO	STD	RSK	PRO	STD	RSK
14	72%	64%	56%	36%	32%	28%	43%	38%	33%	51%	45%	39%	58%	51%	44%	65%	58%	50%
15	72%	64%	56%	36%	32%	28%	43%	38%	33%	51%	45%	39%	58%	51%	44%	65%	58%	50%
16	72%	64%	56%	36%	32%	28%	43%	38%	33%	51%	45%	39%	58%	51%	44%	65%	58%	50%
17	72%	64%	56%	36%	32%	28%	43%	38%	33%	51%	45%	39%	58%	51%	44%	65%	58%	50%
18	72%	64%	56%	36%	32%	28%	43%	38%	33%	51%	45%	39%	58%	51%	44%	65%	58%	50%
19	72%	64%	56%	36%	32%	28%	43%	38%	33%	51%	45%	39%	58%	51%	44%	65%	58%	50%
20	71%	63%	55%	35%	31%	27%	43%	38%	33%	51%	44%	39%	58%	50%	44%	65%	57%	50%
21	71%	63%	55%	35%	31%	27%	43%	38%	33%	51%	44%	39%	58%	50%	44%	65%	57%	50%
22	71%	63%	55%	35%	31%	27%	43%	38%	33%	51%	44%	39%	58%	50%	44%	65%	57%	50%
23	71%	63%	55%	35%	31%	27%	43%	38%	33%	51%	44%	39%	58%	50%	44%	65%	57%	50%
24	71%	63%	55%	35%	31%	27%	43%	38%	33%	51%	44%	39%	58%	50%	44%	65%	57%	50%
25	70%	62%	54%	35%	31%	27%	42%	38%	33%	49%	44%	39%	56%	50%	44%	63%	57%	50%
26	70%	62%	54%	35%	31%	27%	42%	38%	33%	49%	44%	39%	56%	50%	44%	63%	57%	50%
27	70%	62%	54%	35%	31%	27%	42%	38%	33%	49%	44%	39%	56%	50%	44%	63%	57%	50%
28	70%	62%	54%	35%	31%	27%	42%	38%	33%	49%	44%	39%	56%	50%	44%	63%	57%	50%
29	70%	62%	54%	35%	31%	27%	42%	38%	33%	49%	44%	39%	56%	50%	44%	63%	57%	50%
30	61%	54%	47%	30%	27%	23%	37%	32%	28%	37%	38%	33%	49%	43%	38%	55%	49%	42%
31	61%	54%	47%	30%	27%	23%	37%	32%	28%	37%	38%	33%	49%	43%	38%	55%	49%	42%
32	61%	54%	47%	30%	27%	23%	37%	32%	28%	37%	38%	33%	49%	43%	38%	55%	49%	42%
33	61%	54%	47%	30%	27%	23%	37%	32%	28%	37%	38%	33%	49%	43%	38%	55%	49%	42%
34	61%	54%	47%	30%	27%	23%	37%	32%	28%	37%	38%	33%	49%	43%	38%	55%	49%	42%
35	53%	47%	41%	26%	23%	20%	32%	28%	24%	32%	33%	28%	42%	37%	32%	47%	42%	36%
36	53%	47%	41%	26%	23%	20%	32%	28%	24%	32%	33%	28%	42%	37%	32%	47%	42%	36%
37	53%	47%	41%	26%	23%	20%	32%	28%	24%	32%	33%	28%	42%	37%	32%	47%	42%	36%
38	53%	47%	41%	26%	23%	20%	32%	28%	24%	32%	33%	28%	42%	37%	32%	47%	42%	36%
39	53%	47%	41%	26%	23%	20%	32%	28%	24%	32%	33%	28%	42%	37%	32%	47%	42%	36%
40	47%	42%	36%	24%	21%	18%	28%	25%	22%	33%	29%	25%	38%	33%	29%	42%	37%	33%
41	47%	42%	36%	24%	21%	18%	28%	25%	22%	33%	29%	25%	38%	33%	29%	42%	37%	33%
42	47%	42%	36%	24%	21%	18%	28%	25%	22%	33%	29%	25%	38%	33%	29%	42%	37%	33%
43	47%	42%	36%	24%	21%	18%	28%	25%	22%	33%	29%	25%	38%	33%	29%	42%	37%	33%
44	47%	42%	36%	24%	21%	18%	28%	25%	22%	33%	29%	25%	38%	33%	29%	42%	37%	33%
45	41%	36%	31%	20%	18%	16%	25%	22%	22%	29%	25%	25%	33%	29%	29%	37%	33%	33%
46	41%	36%	31%	20%	18%	16%	25%	22%	22%	29%	25%	25%	33%	29%	29%	37%	33%	33%
47	41%	36%	31%	20%	18%	16%	25%	22%	22%	29%	25%	25%	33%	29%	29%	37%	33%	33%
48	41%	36%	31%	20%	18%	16%	25%	22%	22%	29%	25%	25%	33%	29%	29%	37%	33%	33%
49	41%	36%	31%	20%	18%	16%	25%	22%	22%	29%	25%	25%	33%	29%	29%	37%	33%	33%
50	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
51	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
52	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
53	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
54	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
55	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
56	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
57	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
58	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%
59	26%	23%	20%	13%	12%	10%	16%	14%	12%	18%	16%	14%	21%	18%	16%	24%	21%	18%

The 'base case' is the scenario where the MC intervention causes no change in condom usage and men continue to use condoms as they would have before the intervention. In this 'base case' scenario, condom usage is left as the ASSA2003 model's default assumption. The '50 percent decrease' is the scenario where 50 percent behavioural disinhibition takes place in the entire sexually active population and overall condom usage amongst all ages groups decreases by 50 percent. The '40 percent decrease' is the scenario where 40 percent behavioural disinhibition takes place in the entire sexually active population and overall condom usage amongst all ages groups decreases by 40 percent (with the same logic applying to the 30, 20 and 10 percent scenarios respectively).

[4] These are the final condom usages once the model has made projections after the initial condom usages are decreased by 50, 40, 30, 20 and 10 percent.

The scenario analysis is done for illustrative purposes to show that extreme, population wide (i.e. not just limited to circumcised men) behavioural disinhibition could reverse the gains of the MC interventions. The results are discussed next.

5.2.2 Results

The first result shows the impact of high MC coverage on adult HIV prevalence by comparing the MC 'base case' scenario to a scenario where the MC intervention is not introduced before the start of the epidemic. The second result shows the impact of the high MC coverage on HIV incidence at different levels of behavioural disinhibition.

Fig. 5.3: The impact of MC on adult HIV prevalence in Botswana

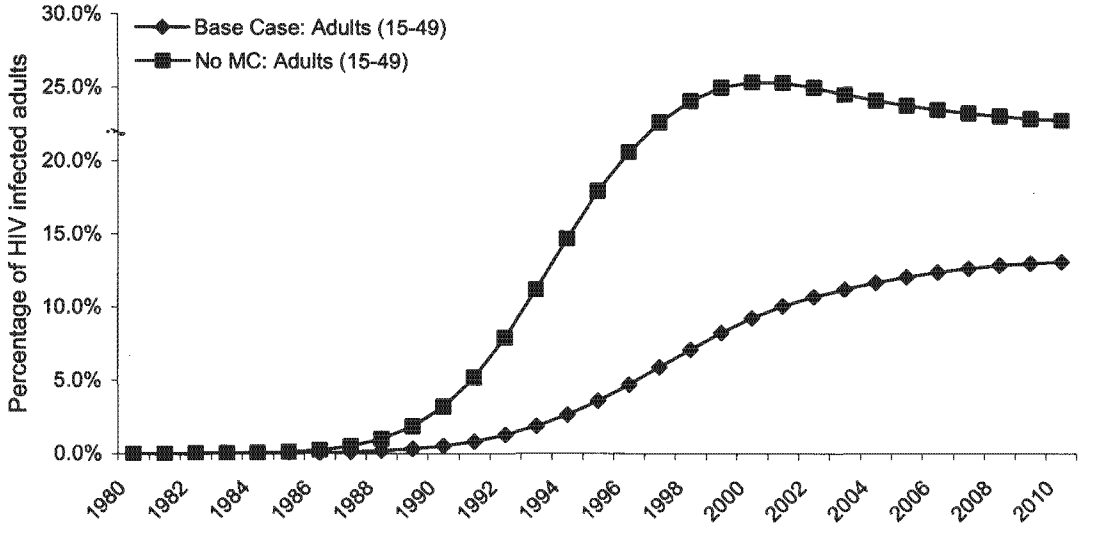


Figure 5.3 shows the potential impact of MC on adult HIV prevalence if Botswana had had a MC intervention program before the start of the epidemic reaching 80% of men. This figure also shows the current adult prevalence with no MC policy. The ASSA2003 model shows that such high MC coverage would have reduced adult HIV prevalence by more than 10 percentage points by 2008. The ASSA2003 model estimates that in 2008 Botswana's adult prevalence was just less than 25 percent but that with 80 coverage of a prior MC intervention in 1980, it would have been about 13 percent. Although the methodology used to obtain these results is crude, it does

demonstrate the potential for MC to affect an epidemic of the kind seen in Botswana. It is unfortunate that the planned MC intervention is occurring so late in the epidemic. MC will reduce new infections going forward, but the huge benefits that could have been gained if MC coverage had been higher in the past, are lost forever.

Although these results broadly support the use of MC as a HIV prevention tool in Botswana, it is vital to consider how the impact of MC could be compromised if the MC policy leads to behavioural disinhibition. The results from the scenario analysis considering different levels of behavioural disinhibition are discussed next.

Fig. 5.4: The impact of MC on HIV incidence at 50, 40, 30, 20 and 10 percent behavioural disinhibition

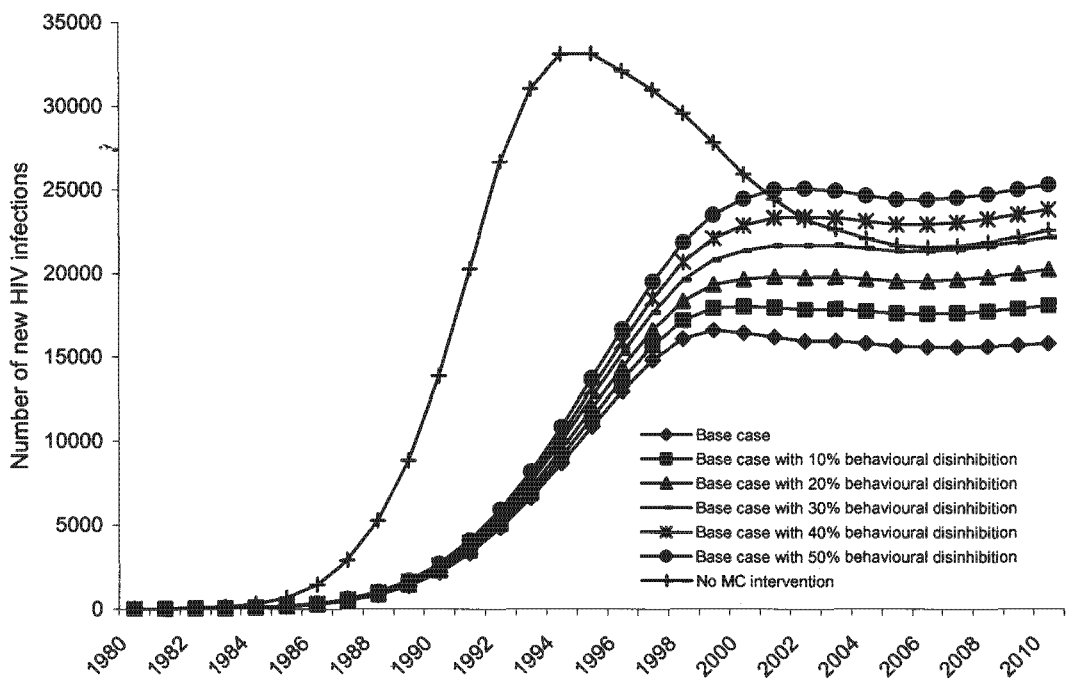


Figure 5.4 shows the impact of MC on the number of new infections at 0 to 50 percent behavioural disinhibition. The impact of MC on the number of new infections at different levels of behavioural disinhibition is compared to the number of new infections without high MC coverage. The results show that if a MC intervention had been introduced in 1980, reaching 80% of men (and 80% of these men had taken up

the offer)[5] – and if condom usage in the entire sexually active population had decreased by 30 percent as a consequence, then in 2008 the number of new infections would be the same as the current default scenario. If condom usage in the entire sexually active population decreases by more than 30 percent, then by 2008 the gains from high MC coverage would have been more than negated and HIV incidence would be higher than in the current default scenario. This analysis shows that widespread behavioural disinhibition is a real threat to the potential impact of MC in Botswana.

5.3 The Male Circumcision Model (MCM)

The MC model (MCM)[6] was developed by UNAIDS/WHO in order to support policy development and planning for scaling up services to provide safe MC. It is a publicly available model which is part of a larger toolkit developed by UNAIDS/WHO that provides countries with guidelines on comprehensive approaches to MC including the types of surgical procedures, as well key policy and cultural issues. The MCM addresses the following key policy areas: priority populations (all male adults, young adults, adolescents, newborns) and high risk groups, target coverage levels and rates of scale-up, service delivery modes (hospital, clinic, mobile van; public, private, NGO, and "other") and task shifting. The MCM is accompanied by a training manual that introduces users to the MC model and the basics of setting up the model and interpreting the results (Bollinger, Plosky and Stover, 2008).

The MCM contains two sub-models: The costing model and the impact model. As the costing of MC has already been discussed in Chapter 3, this section will only use the impact model to estimate the impact of MC going forward. Among other inputs, the MCM uses the cost of MC to estimate the impact of the epidemic using a transmission model that calculates new infections by age and sex as a function of the current force of infection, coverage levels, and speed of scale up (ibid: 4). Like the ASSA2003 model, the MCM is an Excel-based model. It is easy to use and has a clear set of assumptions which are discussed next.

[5] If the program reaches 80 percent coverage of MC and there is 80 percent acceptability of MC amongst men this infers that at the end of the program 64 percent of men would be circumcised

[6] The MCM is available from: http://futuresinstitute.org/pages/MaleCircumcision.aspx.

5.3.1 Assumptions in the MCM

The MCM requires country-specific data for demography inputs, sexual behaviour and HIV prevalence trends, as well as assumptions relating to the epidemiological and economic effectiveness of MC. All these assumptions are available in Appendix 2 (Table 5.8 to 5. 13). The MCM then requires you to fit this data and in order to do this the start year for the epidemic was assumed to be 1980. (See Table 5.14 in Appendix 2 for the model's fitted parameters for the initial force of infection)

Once the model has fitted the data it then requires you to make assumptions with regards to the MC program by specifying the priority population groups and target coverage levels. Ideally the MC scale-up should be assumed to begin in 2009 in line with the Ministry of Health's plans; however, even though the model is created to allow for this, it produces errors if the start year of the model is changed from the default year of 2008. It is not clear why this occurs and it appears to point to an error in the model's macro design with regards to setting the start year of the program. The priority populations are assumed to be adult males and all newborn children as the MC program plans to scale-up both adult and neonatal circumcision services. The percentage of the priority population to be covered by the MC program is assumed to be 80 percent, again in line with Ministry of Health's targets. The initial percentage of men circumcised at the start of the program is assumed to be 10 percent in line with the findings of the BAISII on MC prevalence. The pace of the scale-up of the MC, in terms of the number of men circumcised every year from 2008, is assumed to be s-shaped. Thus assuming that the number of MCs performed in each year of the MC program will initially rise slowly; increasing as the capacity to deliver the service increases over time and decreasing as the programs targets are reached. Lastly the MC model requires you to make assumptions about the costs of MC and how the delivery of the service will be distributed between the public the private sector. (All these assumptions are shown in Table 5.15 of Appendix 2 and were discussed in Chapter 3) The user costs are assumed to be zero as MC will be a free service to the public.

5.3.2 Results

Once all the assumptions have been made the MCM produces estimates of the impact of MC in Botswana and a number of results are available to the user. This section will discuss the results in the MCM with regard to the impact of MC on adult HIV prevalence. This is done through comparing the adult prevalence with and without the MC program. This section will also discuss the MCM's results for the impact of behavioural disinhibition. This is done through comparing the impact that different degrees of behavioural disinhibition have on the number of new HIV infections averted by the MC program. Like in the ASSA2003 model, behavioural disinhibition in the MCM is examined at the 50, 40, 30, 20 and 10 percent level. The risk compensation[7] assumption in the sexual behaviour assumptions (see Table 5.9) is adjusted accordingly in order to model the different scenarios of behavioural disinhibition. Risk compensation is assumed to occur only amongst circumcised men.

Fig. 5.5: The impact of MC on adult HIV prevalence in Botswana

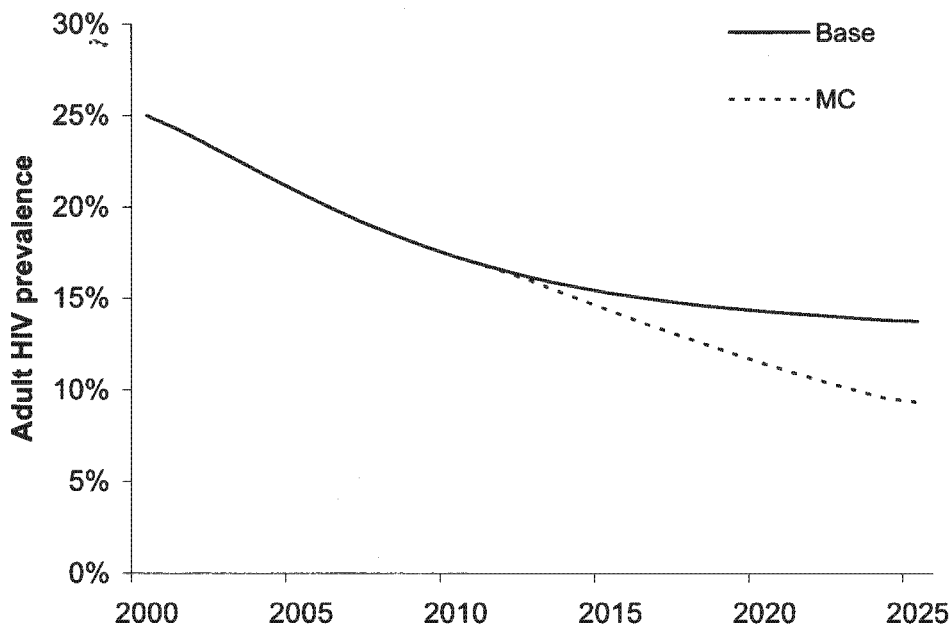


Figure 5.5 the impact of MC on Botswana's adult HIV prevalence. The results show that the MCM estimates that the current MC program will have a positive impact on the adult HIV prevalence rate going forward. It is interesting to note that according to

[7] Risk compensation is assumed to take place amongst all sexually active circumcised men after the scale-up of MC

Figure 5.5 the MCM assumes that even in the absence of MC, the adult HIV prevalence would be on a downward trend going forward as is shown by the base adult HIV prevalence line. In fact in 2008, in the absence of MC the MCM estimates that adult HIV prevalence was as low as 18 percent. It is not entirely clear why the MCM estimates a much lower adult HIV prevalence compared to the estimates obtained in EPP (see Chapter 3) and in the ASSA2003 model (see section 5.3). The MCM estimates that by 2015 the MC scale-up will result in adult prevalence that is almost one percentage point smaller than had the MC scale-up not taken place. This impact increases over time and by 2025 the MC scale-up will result in an adult HIV prevalence that is almost 5 percentage points lower than had the MC scale-up not taken place.

Fig. 5.6: The impact of MC on the number of infection averted at 50, 40, 30, 20 and 10 percent behavioural disinhibition

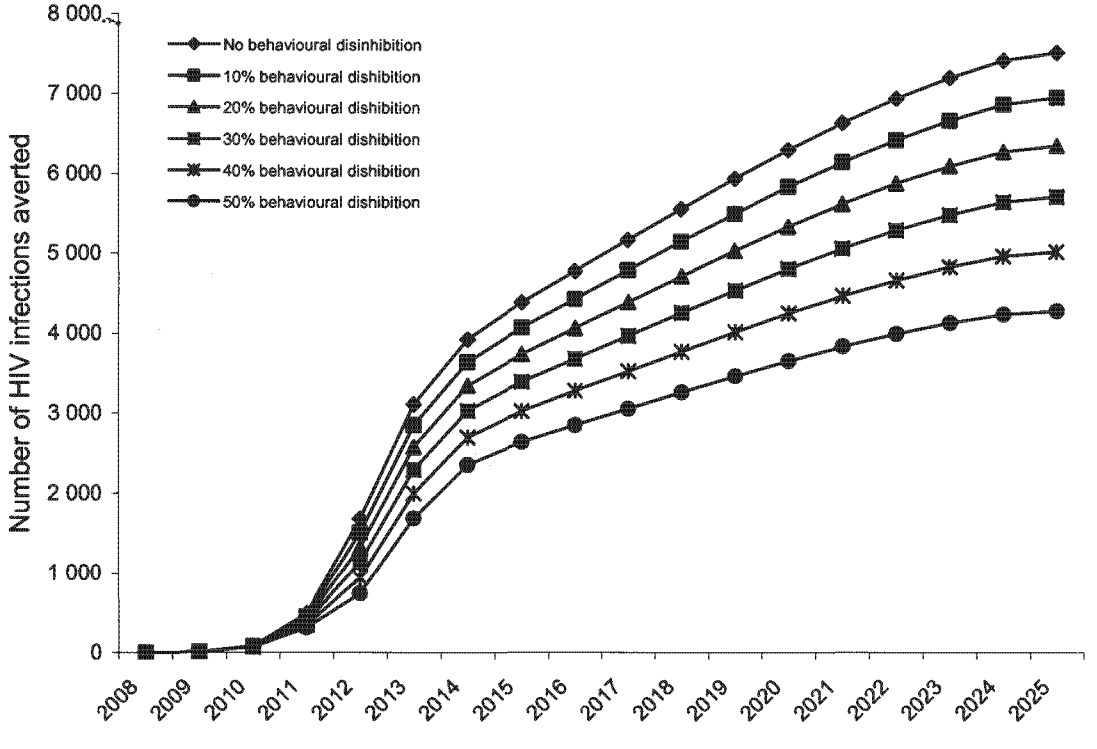


Figure 5.6 shows how a 50, 40, 30, 20 10 or 0 percent increase in behavioural disinhibition will impact the number of HIV infections averted as a result of the MC scale-up. The results of this analysis show that without behavioural disinhibition the

MC scale-up could avert 13,699 new infections by 2015 and this number increases to 63,419 by 2025. The analysis also illustrates that behavioural disinhibition may decrease the possible gains of the MC scale-up through decreasing the estimated number of HIV infections that could be averted through the MC scale-up. In the event that there is a 50% increase in behavioural disinhibition after the MC scale-up the number of infections that could have been averted (if there was no change in behavioural disinhibition) is halved, in this scenario the number of infections averted decreases to 7,803 and 36,736 in 2015 and 2025 respectively. Even in the event that behavioural disinhibition changes by just 10 percent, the number of infections that could be averted decreases to 12,593 and 58,718 in 2015 and 2025 respectively. Thus both the extreme and moderate scenario of behavioural disinhibition the MC scale-up is estimated to have a significantly decreased impact on the number of HIV infections averted.

5.4 Conclusion: Modelling the Impact of MC

The results from the ASSA2003 model as well as the MCM show that the use of MC as a HIV prevention tool could have a positive impact on Botswana's HIV prevalence and incidence rates. The results from the ASSA2003 model suggest that Botswana could have made the greatest gains from MC earlier in the epidemic when new HIV infections were rising rapidly. This finding is interesting in light of the discussion in Chapter 4 on the historical practice of MC amongst Tswana tribes and how contact with Western civilization, particularly Christian missionaries, led to a widespread abandonment of cultural practice of MC. Thus it seems fair to conclude that had this change not occurred Botswana's HIV/AIDS epidemic may have not reached its current proportions. However, the MCM shows that Botswana may still benefit significantly from MC through the current scale-up of MC in Botswana. Both models show that the impact of MC could be reversed significantly if wide-spread behavioural disinhibition occurs as a result of the policy. Therefore MC could have a positive impact on the magnitude Botswana's HIV/AIDS epidemic but its success will ultimately depend on sexual behaviour.

Langeni (2005) conducted a study in Botswana to determine the relationship between MC and STIs in Botswana. After behaviour was controlled for, the study found that

although MC appears to be significantly associated with a decreased risk for self-reported urethral discharge or genital ulcers, it is the man's sexual behaviour, irrespective of ethnicity or religion that plays a greater role in protection against self-reported symptoms of sexually transmitted diseases (2005:75). The findings of this study stress the paramount role that behaviour plays in aiding the spread of HIV. With the MC intervention there is the risk of behaviour disinhibition in the event that risk compensation occurs amongst circumcised men and in the broader population.

6. Recommendations

This paper drew on available studies and demographic modelling packages to argue that MC is a potentially powerful tool for HIV prevention, especially in Botswana where MC coverage is low. However in order for the MC intervention to be effective, the benefits of MC have to be communicated in ways that ensure that there is clarity amongst circumcised men – and the general population – that it does not offer complete protection against HIV and eases the transmission of HIV/AIDS whilst the wound is still healing. The aim of this communication should be to prevent 'behavioural disinhibition' and risky sexual behaviour following the operation from taking place. If these threats are not addressed sufficiently the effectiveness of MC could be undermined. The importance of these threats cannot be overstressed as the failure to address them could render the MC policy infective as a HIV/AIDS prevention tool.

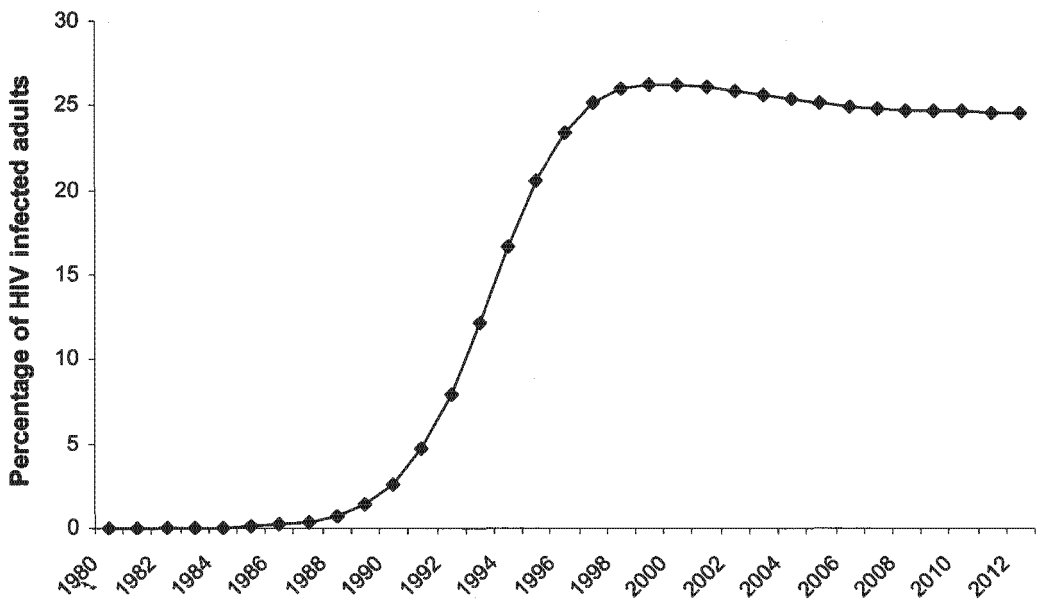
There appears to be strong support in Botswana for MC, but even so, a MC intervention has to be conducted with sensitivity as it could lead to unintended stigma amongst uncircumcised HIV-positive men. The current proposed policy is to concentrate on rolling out MC for HIV-negative men; HIV-positive men will only be offered the service if they explicitly request it and only after counselling (Hussein, personal communication, 5th January 2009). This approach may dissuade men from getting circumcised out of fear that they will be treated differently if they are HIV-positive. It may also result in an unwarranted assumption in the general population that all circumcised men are HIV-negative, thereby resulting in a decline in safe sex. Given the results of the modelling exercise reported in the previous chapter, this could erode the preventative benefits of MC. There is a clear need for ongoing research, monitoring and evaluation of the MC program, and on how it is perceived and how its risks and benefits are understood in the general population.

In 2003 the Ministry of Health mandated that all new mothers should be counselled about the benefits of MC but this mandate had not been implemented in the public health sector as of 2006 (Wilson and De Beyer, 2006) – and there are no signs of it being implemented as of June 2009 (the time of writing). The Ministry of Health

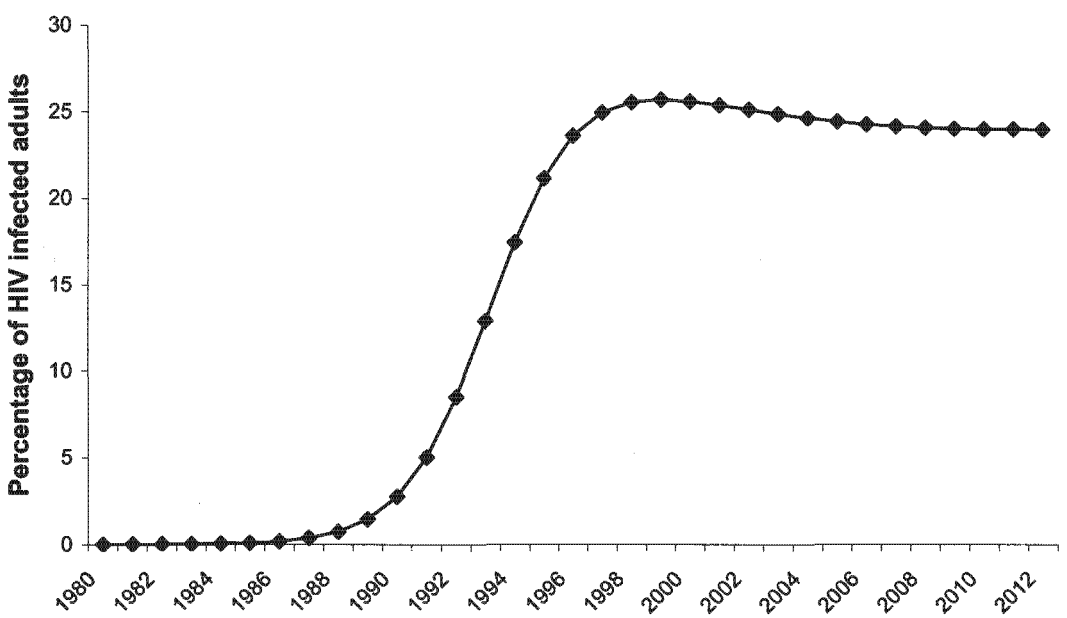
needs to speed its implementation. Neonatal MC is cheaper and simpler and the acceptability study revealed a high acceptance amongst parents.

Appendix 1

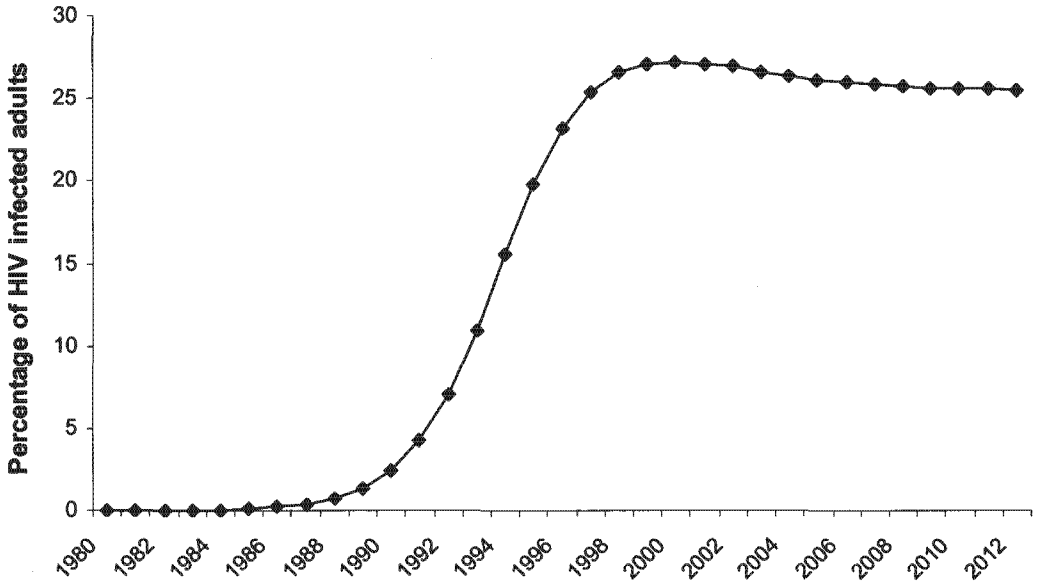
Graph 1: National Adult (15+) HIV prevalence estimates using the BAISII sample sizes for the sentinel ANC data in EPP



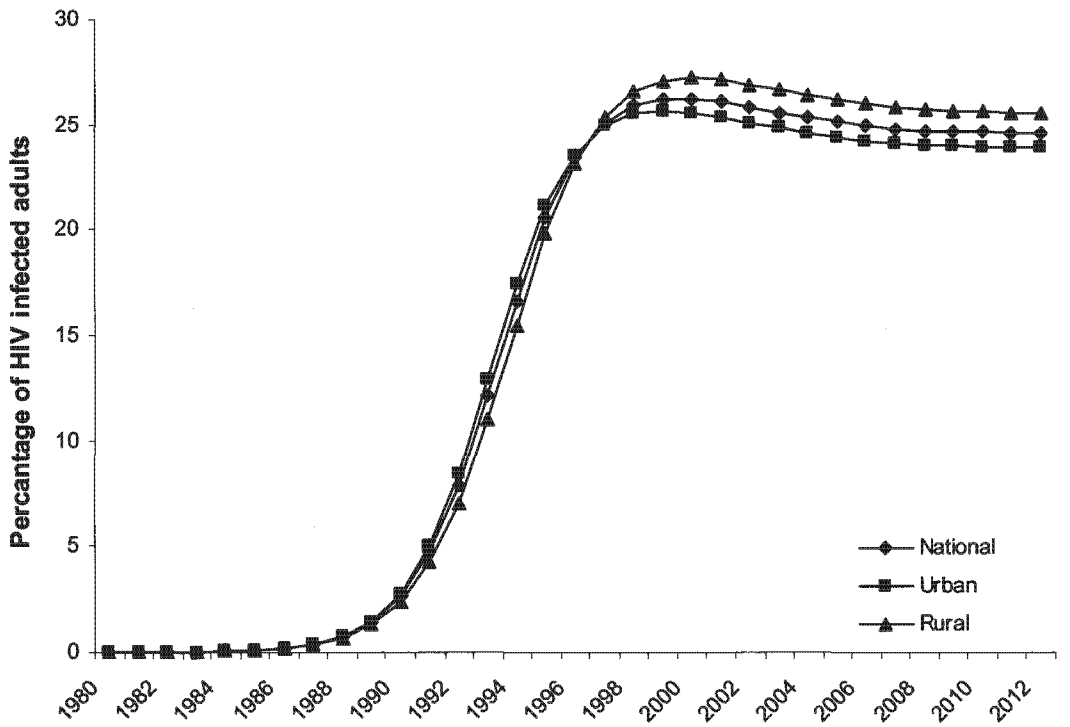
Graph 2: Urban Adult (15+) HIV prevalence estimates using the BAISII sample sizes for the sentinel ANC data in EPP



Graph 3: Rural Adult HIV (15+) prevalence estimates using the BAISII sample sizes for the sentinel ANC data in EPP



Graph 4: National, Urban and Rural Adult (15+) HIV prevalence estimates using the BAISII sample sizes for the sentinel ANC data in EPP



Appendix 2

Table 5.8: Demography assumptions[1]

Indicator	Value in 2008
Adult population (15-49)	1 077 908
Adult population growth rate	2.42%
Upper age limit of young age group	29
Male pop aged 15-29 as proportion of Males 15-49	0.6009
Male pop aged 15 as proportion of Males 15-49	0.0426
Male pop aged 49 as proportion of Males 15-49	0.0123
Female pop aged 15-29 as proportion of Females 15-49	0.6070
Male pop aged 15 as proportion of Males 15-29	0.0708
Male crude birth rate (per 1000 population aged 15-49)	49.9579
Crude death rate 15-29	0.35%
Crude death rate 30-49	1.45%
Proportion surviving to age 15	0.92
Proportion of adult population female	0.493
Current prevalence of male circumcision	10.2%
Adjusting the Population Projection	
Estimated adult population in 2008	1 077 071
Adjustment factor for 1961 population	0.79
Crude birth rate in 1945 (per 1000 population aged 15-49)	103.22

Table 5.9: Sexual behaviour assumptions[2]

Proportion of sexual partners by age of partner			
	Females 15-29	Females 30-49	Total Females
Males 15-29	0.21	0.22	0.43
Males 30-49	0.28	0.29	0.57
Total Males	0.49	0.51	1.00

Risk Compensation	
Percent of behavior change that is reversed when circumcised	0%
What population is affected by risk compensation?	All circumcised men

[1] Model's default assumptions which were accepted and left unchanged
[2] Model's default assumptions which were accepted and left unchanged

Table 5.10.1: HIV prevalence assumptions (and related populations)[3]

Population Survey	
Year of population survey	2004
Name of population survey	BAISII
HIV prevalence from population survey	
Male 15-29	10.7%
Male 30-49	34.4%
Female 15-29	25.1%
Female 30-49	35.8%
Population	
Male 15-29	328 308
Male 30-49	218 013
Female 15-29	322 697
Female 30-49	208 891

Table 5.10.2: HIV prevalence assumptions (Adult (15 -49))[4]

Year	%
1985	2.70%
1986	4.84%
1987	8.12%
1988	12.38%
1989	16.90%
1990	20.78%
1991	23.52%
1992	25.14%
1993	25.92%
1994	26.19%
1995	26.16%
1996	25.98%
1997	25.73%
1998	25.47%
1999	25.22%
2000	25.01%
2001	24.83%
2002	24.70%
2003	24.62%
2004	24.56%
2005	24.53%
2006	24.51%
2007	24.49%

[3] Model's default assumptions from the Botswana AIDS Impact Survey II which were accepted and left unchanged

[4] From the Spectrum model (see Chapter 2 section 2.4.2) no HAART scenario

Table 5.11: Effectiveness of MC assumptions[5]

Reduction in annual probability of infection when circumcised	
Female to male transmission	
- General population	60%
- High risk population	69%
- Other population 1	69%
- Other population 2	69%
- Other population 3	69%
Male to female transmission	0%

Calculated force of infection for those not circumcised	
Male 15-29	0.11
Female 15-29	2.05
Male 30-49	0.92
Female 30-49	2.25

Table 5.12: Epidemiology assumptions[6]

Probability of transmission from mother-to-child	0.32
Fertility reduction due to HIV	0.80
Parameters for the survival function	
alpha	3.5
beta	12.2

Years Since Infection	Proportion Dying from AIDS	Cumulative Proportion Dead
0	0.00	0.00
1	0.00	0.00
2	0.00	0.00
3	0.01	0.01
4	0.01	0.02
5	0.02	0.04
6	0.04	0.08
7	0.05	0.13
8	0.07	0.20
9	0.09	0.29
10	0.10	0.39
11	0.11	0.50
12	0.11	0.61
13	0.10	0.71
14	0.09	0.80
15	0.07	0.87
16	0.05	0.92
17	0.03	0.96
18	0.02	0.98
19	0.01	0.99
20	0.01	1.00

[5] Models default assumptions (derived from the relevant studies) which were accepted and left unchanged

[6] Model's default assumptions which were accepted and left unchanged

Table 5.13: Economic assumptions

Discount rate	3%
Discounted lifetime cost of ART	$7 400

Table 5.14: Initial force of infection parameters

Start year of the epidemic	1980
Initial force of infection	
Male, : rm1	0.11
Female, : rf1	2.05
Male, : rm2	0.92
Female, : rf2	2.25
Decline in r, alpha	5.35
Decline in r, alpha	4.42
Behavior change, e	29.40
Behavior change, e	0.95
Sum of squared errors	593.84

Table 5.15: Service delivery assumptions

		Cost per Client		Source
Service Delivery Mode	**% of MC**	**Adult**	**New Born**	
Public Hospital	80%	$37.07	$30.64	MC Costing Workbook Public Hospital
NGO Hospital	0%	$36.47	$29.43	MC Costing Workbook NGO Hospital
Private Clinic	20%	$36.12	$28.01	MC Costing Workbook Private Clinic
NGO Health Center	0%	$52.19	$38.49	MC Costing Workbook NGO Health Center
Annual Demand Creation Cost	**$ 500 000**			

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