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Ethiopia's Progress towards the Millennium Development Goals (MDGs) for HIV/AIDS

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Acronyms

AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Clinic
ART	Anti-Retroviral Therapy
ARV	Anti-Retroviral
DALYs	Disability-Adjusted Life Years
DHS	Demographic and Health Survey
EDHS	Ethiopia Demographic and Health Survey
EHSDP	Ethiopian Health Sector Development Program
EPP	Estimation and Projection Package
GDP	Gross Domestic Product
GNP	Gross National Product
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
LDC	Least Developed Country
MDG	Millennium Development Goal
MOH	Ministry of Health
NBE	National Bank of Ethiopia
OIs	Opportunistic Infections
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PLWHA	People Living With HIV/AIDS
PPP	Purchasing Power Parity
PRSP	Poverty Reduction Strategy Paper
QALYs	Quality-Adjusted Life Years
SMART	Specific, Measurable, Achievable and Time bounded
STD	Sexually Transmitted Disease
STI	Sexually Transmitted Infection
TB	Tuberculosis
UNAIDS	Joint United Nations Program on HIV/AIDS
UNGASS	United Nations General Assembly Special Session
WHO	World Health Organization

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Abstract

Objective: The objective of the study is to project HIV/AIDS incidence and prevalence in Ethiopia for the year 2015 based on 2005 Ethiopian Demographic and Health Survey data (EDHS 2005) and other relevant data sets obtained from various research institutions with a view to assess the impact of HIV/AIDS and poverty on the likelihood of meeting Goal 6, Target 7 of the millennium development goals (MDGs).

Methods: Econometric and bio-statistical analyses are performed based on descriptive, cross-sectional (2005) and longitudinal (1980 to 2015) data sets. The methods of study are mostly quantitative (descriptive statistics, graphical methods, multiple linear regression including time series analyses). A few qualitative methods have been employed to supplement results of quantitative approaches. HIV/AIDS incidence and prevalence of the years 1980 to 2015 have been estimated and projected. Multivariate analyses are done using socio-economic, demographic and health related variables affecting Ethiopians' economic and health conditions.

Variables: For the years 1996 to 2005, the impact of the HIV/AIDS epidemic on the Ethiopian GDP is estimated using predictor variables such as infant mortality rate, observed HIV/AIDS incidence, population size, dependency rate, health sector expenditure, gross national investment, life expectancy and others dropped by the elimination process. The effects of economic and health indicators (GDP, infant mortality rates, AIDS cases, health sector expenditures and crude birth rate) on life expectancy have been also analysed separately.

Results and conclusion: Based on EDHS 2005, the prevalence of HIV/AIDS among the adult Ethiopian population is estimated to be 1.5 % for 2005 (raging 0.9 -5%) and projected to be 3% (ranging 2.8 - 3.8%) for 2015. It is also projected that new infection will be observed up until 2015 that will further exacerbate the prevailing vicious circle of poverty in the country. As a result, Ethiopia will not be able to meet the MDGs for HIV/AIDS by the year 2015 unless drastic measures are taken to improve the intervention levels, the quality of health services and the poverty in areas severely affected by the epidemic. The study has also shown that the factors most responsible for the observed failure to meet the MDGs is the absence of effective strategy on how to address the lack of basic health services and the abject poverty among the general population. Thus, there is a dire need for coherent and clear strategy in which the spread of HIV/AIDS can be curbed more effectively. HIV/AIDS programs must be integrated with poverty eradication and education. Further recommendation is made for implementation of government-led participatory monitoring and evaluation as well as SMART intervention programmes funded adequately by the national government along with empowering the people most severely affected by the spread of HIV/AIDS, poverty and illiteracy.

Key words: Millennium Development Goals, Ethiopian Gross Domestic Products, Human Development Index, poverty and development, HIV/AIDS prevalence, HIV incidence, life expectancy at birth.

JEL I10, I18, O10

1 Introduction

In September 2000 the United Nations General Assembly, representing 189 countries, unanimously adopted the Millennium Declaration – resulting in 8 goals, 18 targets and 48 indicators known as the Millennium Development Goals. The eight Millennium Development Goals (MDGs) range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education – all by the target date of 2015[1]. Out of the eight MDGs, goal 6 aims at combating HIV/AIDS, malaria and other diseases. The target for HIV/AIDS (target 7) is to have halted and begun the reversal of the spread of HIV/AIDS by 2015[1]. This paper investigates the level of the HIV/AIDS problem in Ethiopia by evaluating the progress of the country towards attaining the MDG target 7.

2 Background and Literature Review

2.1 Human Development Index (HDI) and Poverty

The World Bank has accepted poverty as encompassing not only materials deprivation (measured by an appropriate concept of income or consumption) but also low achievements in education and health[2]. The United Nations Development Programme (UNDP) considers income level, adult education and life expectancy with further refinement to determine human development index (HDI) used for analysing poverty and development. As to UNDP, the determination of HDI 'looks beyond Gross Domestic Products (GDP) to a broader definition of well-being'[3]. UNDP's new approach of HDI "provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and enrolment at the primary, secondary and tertiary level) and having a decent standard of living (measured by purchasing power parity, PPP, income)."[3] This approach has brought about a shift in paradigm and it is in use since 1990 to measure development level.

While "HDI measures the average progress of a country in human development, Human Poverty Index for developing countries (HPI-1), focuses on the proportion of people below a threshold level in the same dimensions of human development as the HDI- living a long

and healthy life, having access to education, and a decent standard of living. By looking beyond income deprivation, the HPI-1 represents a multi-dimensional alternative to the $1 a day (PPP US$) poverty measure".[3] The HPI-1 measures severe deprivation in health by the proportion of people who are not expected to survive age 40. Education is measured by the adult illiteracy rate; and a decent standard of living is measured by the unweighted average of people without access to an improved water source and the proportion of children under age 5 who are underweight for their age.[3]

Most of basic indicators in Ethiopia show that the health status of the population is worse than the average for Sub-Saharan African countries[6].In 2004, Ethiopia was 170th out of 177 countries (.357 HDI), 153rd out of 177 countries in life expectancy (47.8 years), 163rd out of 172 countries in combined measurement of primary, secondary and tertiary gross enrolment ratio (36.0) and 166th out of 172 countries in GDP per capita (756 PPPUS$).[4]

2.2 HIV/AIDS Impacts on Development and Survival

The poverty conditions in Ethiopia are fuelled by HIV/AIDS. MOH has estimated that children orphaned by HIV/AIDS were 720,000 in 2003[5]. Because of death due to AIDS, life expectancy gains have been brought down from 53 to 46 in 2001. The US census Bureau estimates that life expectancy in the country will decline to about 42 years as a result of AIDS by the year 2020, which would have been 55 without AIDS[6]. Moreover, in Ethiopia vast majority live under conditions of poverty. Out of the total Ethiopians, 80.7% gets less than 2$ (two USD) per day[4]. It is also known that the debilitating and dehumanising HIV/AIDS is eroding the productive labour force and productivity of the country. The prevalence and incidence of HIV/AIDS are aggravated by the poverty. In general, Ethiopia is one of the least developed nations on earth; with the emergence of HIV/AIDS, the poor socio-economic status of the country has been further compounded.

In 1994, at the Programme of Action of the International Conference on Population and Development, the UN officially recognized that HIV/AIDS was a global health and development threat[7]. Specifically, "AIDS has the potential to create severe economic impacts in many African countries. The two major economic effects are a reduction in the labour supply and increased costs. The economic effects of AIDS will be felt first by individuals and their families, then ripple outwards to firms and businesses and the macro-economy."[2] In response, a country's' over all poverty worsens the lives and weakens the coping capacities of HIV/AIDS infected/affected persons and households.

In general, HIV/AIDS is no longer considered in an isolated manner. It is an integral part of socio-economic, socio-cultural and political component of the total development.[8] Now, it is also a development problem that threatens human welfare, socio-economic advances, productivity, social cohesion, and even national security. HIV/AIDS reaches into every corner of society, affecting parents, children and youth, teachers and health workers, rich and poor[8]. In a nutshell, it is affecting every walk of life of citizens.

The positive relationships between income and health are known facts but the establishments of clear quantitative relationships and indicators are not common. Brinkley (2003) made study and concluded that **"**causality between income and health is not yet fully understood nor is there a generally accepted unidirectional gradient even though a strong correlation has been observed between health and income as early as the mid-19th century"[9]. Brinkley also tried to address the macroeconomic effect that health has upon an economy. He used aggregate income (GNP) at constant prices and the "four well-known indicators of health (Life Expectancy, Infant Mortality, Death Rates, and Investment in Medical Research) as data variables to measure the direction of causality"[9]. Accordingly "causality flows only from improving health to rising incomes (or from poorer health to declining incomes). Decreasing death rates and infant mortality, extending life expectancy and increasing investment in medical research have played an important and significant role in increasing GNP."[9] In fact, Brinkley's result can not be directly applied to Ethiopia or to LDCs since he used it for the USA economy. In that sense, a sort of adapting to the realities of the Ethiopian condition is important.

HIV/AIDS as a general problem is a stress on the productive force of a nation. It deteriorates GNP of a country. In the least, it compromises the pace of growth that would have been realized without HIV/AIDS. In this sense, although a full recovery from all HIV/AIDS impacts can not be realized by ARV alone, huge gains will be attained in normalizing the growth of the nation's GNP. This holistic approach can be explained by

GNP= f (ARV), other things remaining the same, ---------- (2)

2.3 The Market for Anti Retroviral Drugs

Anti retroviral (ARV) drugs are not fully free market product. As learnt from the practical observations, the demand for and supply of ARV is highly related to assistance and subsidies, especially for the LDCs world. Normally, ARV is very expensive product. It is also related to the deteriorating purchasing power of the consumer emanated from the multi-dimensional effect of HIV/AIDS on the patients. Consequently, it is a highly subsidized item. Especially, it is highly subsidized on the demand side so that in most poor countries, the end users freely consume it. These subsidies have made ARV useful item for LDCs. These arguments are supported by the following conceptual frame work.

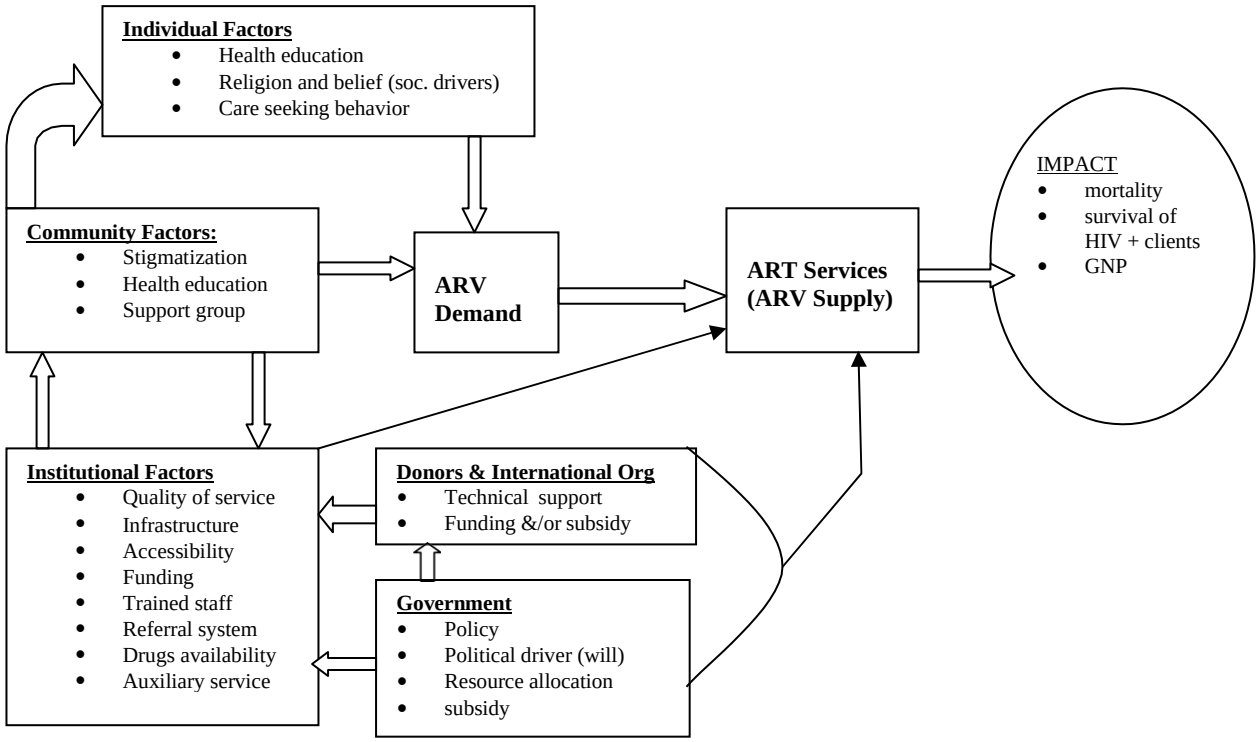

Fig. 1 Conceptual Framework of ARV Demand and Supply

As indicated by the diagram (Fig.1), the effects of individual, community and institutional factors shape the level of the demand for ARV. But, the upshots of these factors are reflected in terms of prices at market places. Thus, under competitive market system, the demand for goods and services is determined by the price which in turn determines the realized production of goods and services on the supply side as well.

From this conceptual framework, one can also develop mathematical functional or cause-effect relationships, which, at the end, simplify target-indicator setting jobs of planning and evaluation. Other things remaining the same, the functional relationships can be

Sa-Supply for ARV = f (Price of ARV) ---------- (3)

Da-Demand for ARV= f(development level of countries, price of ARV, supports and subsidy, number of people living with HIV/AIDS, progression to AIDS **)**----------**(4)**

Equations 3 & 4, assuming a linear relationship, can be $\mathbf{S_a=a_0+a_1P}$**---------- (5)**

$\mathbf{D_a= b_0 +b_1P+b_2D +b_3S+b_4rH}$**---------- (6)**

(Where P=price, D_a=demand for ARV, S_a=supply of ARV, D=development indicator, S=supports and subsidy, r= AIDS progression rate and H=people living with HIV/AIDS.)

By this approach, the equilibrium level will be $\mathbf{S_a=D_a}$**---------- (7)**

- $a_0+a_1P=b_0 +b_1P+b_2D +b_3S+b_4rH$
- $a_1P- b_1P = b_0 - a_0+b_1D +b_3S+b_4rH$
- $(a_1- b_1) P = b_0 - a_0+b_1D +b_3S+b_4rH$
- $P = [b_0 - a_0+b_1D +b_3S+b_{4R}H]/ (a_1- b_1)$
- $P = (b_0 - a_0)/ (a_1- b_1) +b_1D/(a_1- b_1) +b_3S/(a_1- b_1) +b_{4R}H/(a_1- b_1)$

Let $(b_0 - a_0)/ (a_1- b_1)=k_0$; $b_1/(a_1- b_1)=k_1$; $b_3/(a_1- b_1)=k_2$; $b_4/(a_1- b_1)=k_3$; then,

- $\mathbf{P =k_0 +k_1D +k_2S+k_3rH}$**---------- (8)**

Equation 8 can be used to arrive at equilibrium ARV price, demand and supply. It can be also applied for determining expenditure of the government on the consumption or demand side, as well as the income of ARV producers on the supply side. This final result (equation 8) can be used to re-allocate budget or national income, which can be clearly revealed by expenditure approach of GNP computation. From another viewpoint, the use and allocation of budget for ARV will have direct and significant effect on all of the

independent variables. As a result, **ceteris paribus**, one can conclude that income is dependent on the ARV: **GNP =f (ARV) ---------- (2)**
Equation 2 can be further interpreted like ARV users will return to productive lives so that GNP will be improving ultimately. Although their productivity will not be as high as their healthy conditions, there will be a very significant improvement comparatively.

2.4 The Epidemiology of HIV/AIDS

"Now, we are entering the third decade of what may be the most devastating epidemic in human history: HIV/AIDS"[11]. In addition to the 20 million people death of AIDS globally, most of the 40 million people now living with HIV are likely to die a decade or more prematurely[12]. Each day, 14,000 people —12,000 adults and 2,000 children —become infected with HIV. At least 95 per cent of these new infections occur in less developed countries with more than 50 percent afflict women and young adults.[12]

Projections by a research group led by WHO and UNAIDS indicate that the worldwide HIV infection rate will continue its rapid pace, producing 45 million new infections between 2002 and 2010[13]. In fact, 28 million (63 per cent) of these new infections could be prevented if existing HIV prevention strategies are substantially scaled up, and even more could be averted with the advent of new prevention technologies.[13] MOH report based on 2003 sentinel surveillance indicate 4.4% prevalence rate and 1.5 million persons living with HIV/AIDS (PLWHAs) in the country. In 2003, Ethiopia had an estimated 950,000 to 2.3 million PLWHAs, among the highest number in the world. An estimated 120,000 adults and children died from HIV/AIDS and 720,000 children younger than 17 years had been orphaned by HIV/AIDS at the end of 2003.[14]

In 2004, MOH indicated a continuous gradual increase in national prevalence between 1982 and 2003, but with some recent signs of stabilizing, particularly in urban areas, which indicates some behavioural change in the population.[15] In Ethiopia, the major mode of transmission for HIV is heterosexual sex, which accounts for 80% of the cases while 10% of the infections occur due to mother-to-child transmission. The highest prevalence (12%) is among people 15–24 years. Other vulnerable population groups include female sex

workers, unemployed people, long-distance truck drivers, migrant workers and internally displaced populations.[13,16] In estimating the prevalence and projecting corresponding values, other factors such as biological (gender, the sexual organ type, etc), social and other determinants need to be considered as well.[17]

2.5 HIV/AIDS Estimation and Projection Approaches

According to Tan (2000)[18] and Deikmann et al (2000)[10], the mode of transmission is one of the determinants in specifying models. For interrelationships between population dynamic and STDs (that has been used as an 'umbrella' term that includes HIV infections and other STDs) prevention programs were highlighted along with the social and economic impacts of STDs by Hinman and his colleagues[19].

In 1991, Shannon and his colleagues had undertaken studies on the area of HIV/AIDS models[20]. Chin had classified HIV/AIDS models in literature into three based on their complexity: the first two are empirical and extrapolation types while the third types (known by explanatory or deterministic type models) are the complexes ones.[21] "The simpler extrapolation models are designed for short term projections; the more complex models are for evaluating determinants of the HIV/AIDS pandemic and for hypothesis testing."[21]After reviewing these options, Chin developed the epidemiologic projection model (EPIMODEL). EPIMODEL is type II model used to estimate and project HIV/AIDS cases. It is a computer program for estimation and projection of adult AIDS cases and deaths, paediatric HIV/AIDS, and maternal AIDS orphans, and adult TB cases related to HIV infection. It is also used specifically to estimate and project adult AIDS cases in Sub-Saharan Africa.[21] Projections were also carried out by the Estimation and Projection Package (EPP), an updated computer package from EPIMODEL. Projected annual prevalence from EPIMODEL and EPP are usually used as input into the Demographic Projection Model (DemProj) and subsequently into the AIDS Impact Model (AIM) to provide socio-economic and demographic impact of HIV/AIDS which are some times considered HIV/AIDS epidemiologic projections. DemProj and AIM are also packages designed by The Futures Group International[22].

Shannon and his colleagues[20] had classified the models in the literature into three similar to Chin. They finally concluded to include spatial dimension for the simpler models to make them appropriate for areas under consideration. According to Shannon et al (1991)[27], the simpler models were also the approaches used by US Centre for Disease Prevention and Control (CDC) to determine AIDS cases that could be diagnosed after a year using the cases diagnosed each year. The assumptions of the procedure were:

If a(t)= number of AIDS cases diagnosed during year t; *i*(t)= number of newly infected in year t and d(x)= proportion of infected persons expected to develop AIDS after x year,

then $a(t)= \int_{i\#b}^{t} i(z).d(tz)$ ----------(9)

(z goes from the base year(b) to year t; the base year considered by the author was 1978). The number of AIDS cases, a(t), was determined from reporting to CDC, but d(x), the progression rate, was based on HIV infection/AIDS rate (applied on San Francisco homosexual). Three different possible infection curves were considered by these authors i.e. logistic, log-logistic and dampened exponential[20]. However, the CDC approach is in use still with other models aided by computer packages.

3 Objective and Hypothesis of the Study

The objective of this study is to project HIV/AIDS incidence and prevalence in Ethiopia with a view to assess the impact of HIV/AIDS on the likelihood of meeting Goal 6, Target 7 of the millennium development goals. The hypothesis of the study is Ethiopia will not realize the MDGs for HIV/AIDS given the existing development conditions and the observed HIV/AIDS prevalence.

4 Methods and Materials of the Study

4.1 Study Design

The study has both cross-sectional and time series analyses based on secondary data sources. Both descriptive and inferential statistical methods have been employed. In short, the study is quantitative with only little complementary qualitative information collected with the purpose of corroborating the quantitative analyses. The study design process is in short depicted by the following diagram (Fig. 2).

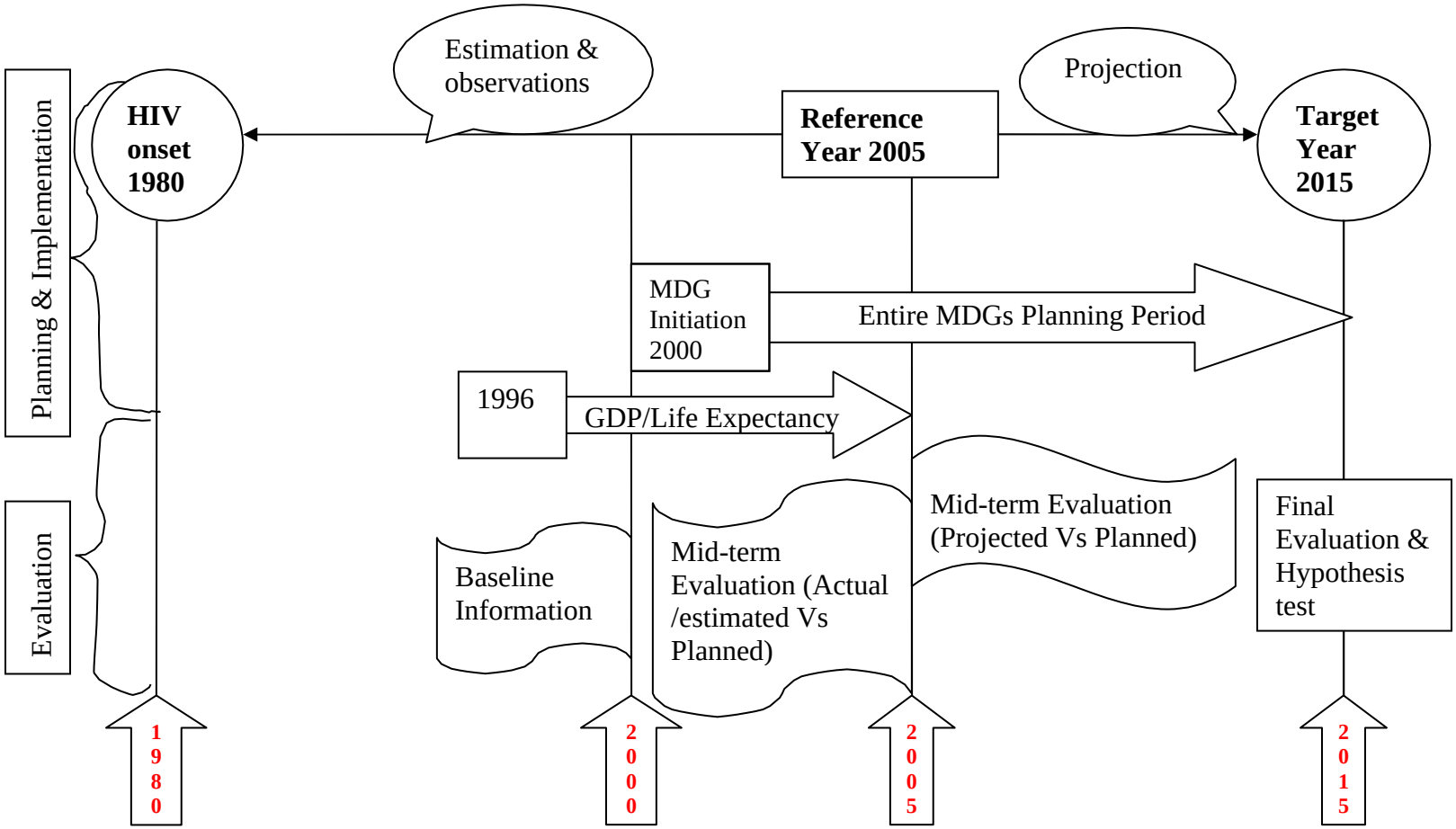

Fig. 2 Model Building, Planning and Evaluation Bases & Directions of the Study

As mid-term evaluations, the prevailing economic and HIV/AIDS conditions (actual and estimated) were compared with the expected performance as per the MDG targets of 2005. In the same way, the projections made based on these current conditions were inputs for the final year (2015) evaluation. This procedure enabled to evaluate the progress of the country towards the realization of the plans.

4.2 Sources of Information and Methods of Analyses

The main information source for the analysis was EDHS 2005. Complementary information was taken from national HIV/AIDS reports, review reports on Poverty Reduction Strategy Paper (PRSP) and MDGs, other national intervention reports of MOH and plan documents such as PASDEP (Plan for Accelerated and Sustained Development to End Poverty)[23] and economic data of National Bank of Ethiopia (NBE). In analyzing the data, regression analyses were employed. Projections of future values were carried out by the Estimation and Projection Package (EPP). The main estimation model of the EDHS based data analyses was specified using the logistic regression method. Multiple and multinomial logistic regressions were used since the response variables were categorized into three. The base of estimation was specified from

$$Y_{i=} \frac{e^{g(x)}}{1+e^{g(x)}} \text{ ----------(10)}$$

Or

$$Y_{i=} [1+e^{-g(x)}]^{-1} \text{ ----------(11)}$$

Where $g(x) = b_0+b_1 x_2+b_2 x_2+ \ldots + b_p x_p$ **for each of** Y_i, which is also a logit transformation of the logistic regression that produces a linear relationship. Therefore,

$$\ln(Yi)= g(x) = b_0+b_1 x_2+b_2 x_2+ \ldots + b_p x_p \text{ ----------(12)}$$

Y takes HIV positive, HIV negative and non respondents. The respondents who were not tested and refused to take test were merged together under the non respondents and considered as a third outcome variable. The number of non-respondents was so significant that the outcome variable could not be collapsed into only two (negative and positive) outcome variables. As a result, the outcome variables were HIV negative, HIV positive and not tested observations (non respondents). This multinomial logistic model was not applied using automated variable selection approach. Rather the results were obtained based on step by step backward and forward elimination methods.

As mentioned earlier, the base of estimation for EPP is specified from the epidemiologic projection model (EPIMODEL) which was designed based on a gamma curve defined by:

$$HIV_{inc} = t^{(p-1)} e^{-t/(p-1)} \text{ ----------(13)}$$

Where HIV incidence at time "t" is a function of the steepness of the curve's slope. This function has been reported to produce the curve that best fits a variety of countries with

well defined HIV/AIDS epidemics. Various gamma curves were modelled, but it was found that the default value (gamma=5) provided the best estimate of reported AIDS cases and prevalence data. Once a curve was developed for the population group (gamma 5), time points on the curve (x axis) were identified for both the origin of the epidemic and the epidemic's current location.[21]

4.3 Limitations of the Study

The study mainly depends on secondary sources. Along with inflexibility of non-primary data sources, the information sources that are specific to the country case in particular had various problems. Generally, there should be caution in the interpretation of the Ethiopian HIV surveillance data since health care infrastructure and surveillance systems are weak in the country (Vaillancourt, et al; 2003)[24]. "There were major gaps in HIV data collection in the 1990s limiting trend analyses. When trends are aggregated across sites for similar groups, they often represent different numbers of sites annually. Women who attend ANC services are not necessarily representative of the rest of the population."[24]

EDHS 2005 has also shown its own weaknesses. Naturally, population based surveys suffer from biases due to high non-response rate. The EDHS 2005 has shown high rate of non-respondents (more than 23%). Hence, it generated very low prevalence as compared to other date sources. The main issue that makes the EDHS unreliable is that those who refuse to take blood test are among HIV vulnerable groups; 76% of the non-respondents are within 19-49 years old which accounts for 78% of the reported prevalence.

5 Results

5.1 Time Series Analyses

Time series analyses have been performed on socio-economic indicators versus the observed prevalence and incidence in Ethiopia for the last ten years (1996-2005). Factors that were thought to affect GDP of the country were fertility, dependency ratio, crude birth rates, population, number of people per physician, number of people per nurse, HIV/AIDS incidence, HIV/AIDS prevalence, gross national investment (investgross) and infant mortality rate (imr). Of these variables, population, incidence, investment, health

expenditure, life expectancy and infant mortality rate are significant collectively in defining the model (Table 1). These variables are significant collectively since the F-test is showing the adequacy of the entire model and they have very high individual statistical significances. They are also practically important determinants in analysing the effects of health indicators on national income. Other independent variables have been found insignificant and hence dropped from the analysis by stepwise selection approach.

Table 1 Regression results of Ethiopian GDP over the years 1996-2005

```
. regress GDP population hexpend expectancy imr incidence investgross

      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  6,     3) =  159.44
       Model |  1.7888e+09     6   298128434           Prob > F      =  0.0008
    Residual |  5609672.71     3   1869890.9           R-squared     =  0.9969
-------------+------------------------------           Adj R-squared =  0.9906
       Total |  1.7944e+09     9   199375586           Root MSE      =  1367.4
------------------------------------------------------------------------------
         GDP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  population |  -29448.16   2648.142   -11.12   0.002    -37875.73   -21020.59
     hexpend |  -7776.783   1741.413    -4.47   0.021    -13318.74    -2234.83
  expectancy |   3706.075   1089.638     3.40   0.042     238.3614    7173.788
         imr |   1397.149   241.2247     5.79   0.010     629.4644    2164.833
   incidence |  -.2569687   .0428511    -6.00   0.009    -.3933401   -.1205972
 investgross |   114.4118   9.243581    12.38   0.001     84.99456     143.829
       _cons |    1283402   200423.3     6.40   0.008     645565.8     1921238
```

Therefore, the best fitted model: GDP= 1283402-29448.16 (population) +1397.149 (imr) -7776.783 (health expenditure)-.2569687 (incidence rate) + 114.4118 (gross investment) + 3706.075 (life expectancy) ---------- (14)

Since incidence as predictor variable has shown stronger effect on GDP than prevalence, incidence is included in the model. Initially, the model was tested when the prevalence, hospital-bed-day, number of persons per nurse, number of persons per physician, crude death rate and fertility rate were included but the model becomes unreliable entirely when these variables are included. As a result, all these variables have been dropped out from the model in the variable selection process. In fact, population is implicitly included in the other variables such as crude birth rate (cbr) and the numbers of persons per physician (physician) since the comparisons of the rates are with respect to the total population. As a result, only population is considered instead of cbr and physician. In the same way, incidence and prevalence have common values so that both cannot be considered simultaneously. As stated above, this approach avoids the potential collinearity problems.

The following graphs are output of multiple time series analyses. Both incidence (Fig.3) and prevalence (Fig.4) show that the observed changes over the last ten years (1996 to 2005) are of upward trends with a slight stability of incidence (Fig.4) at the end (2005).

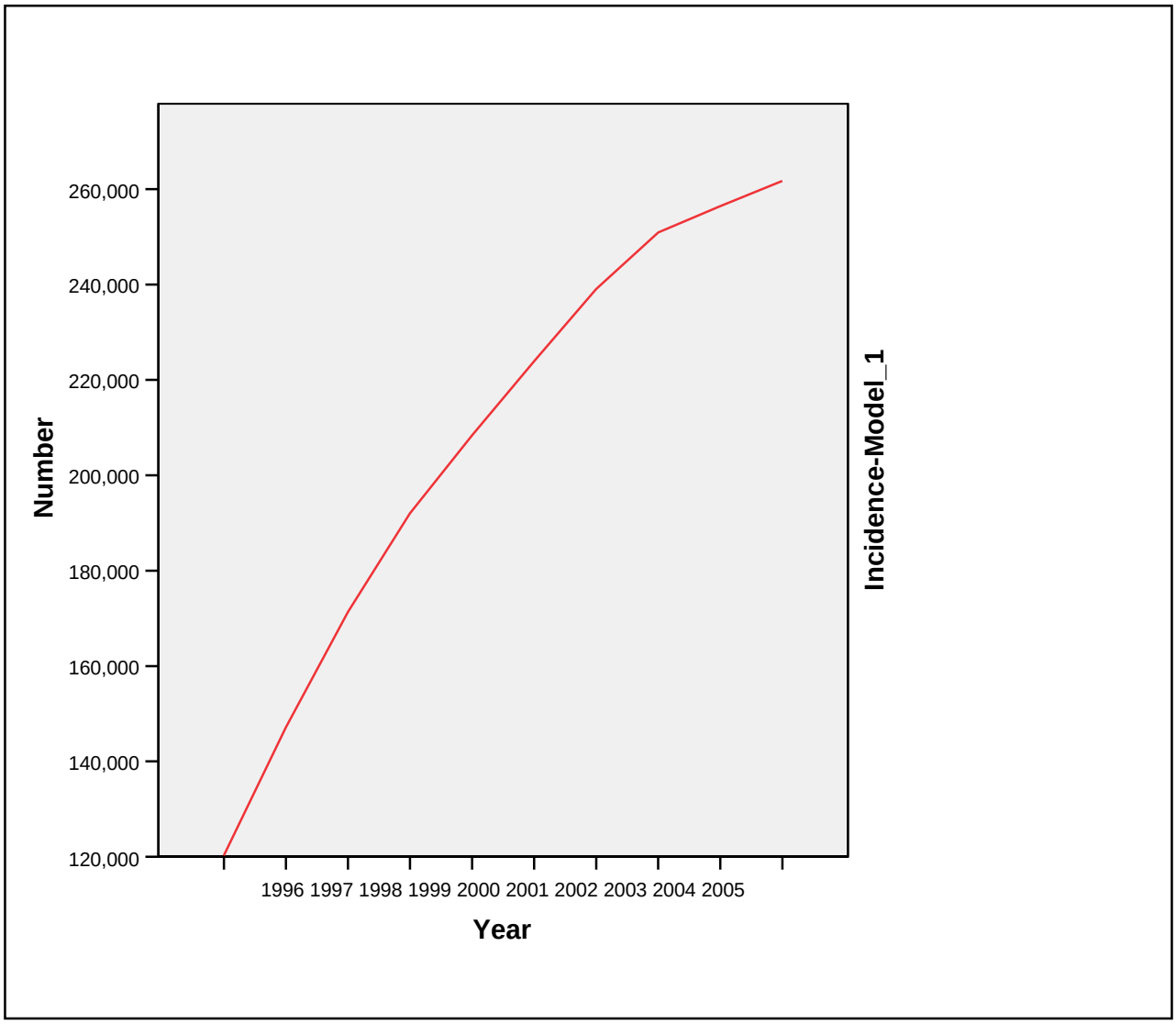

Fig. 3 Annual HIV Incidence in Ethiopia over the Years 1996 to 2005

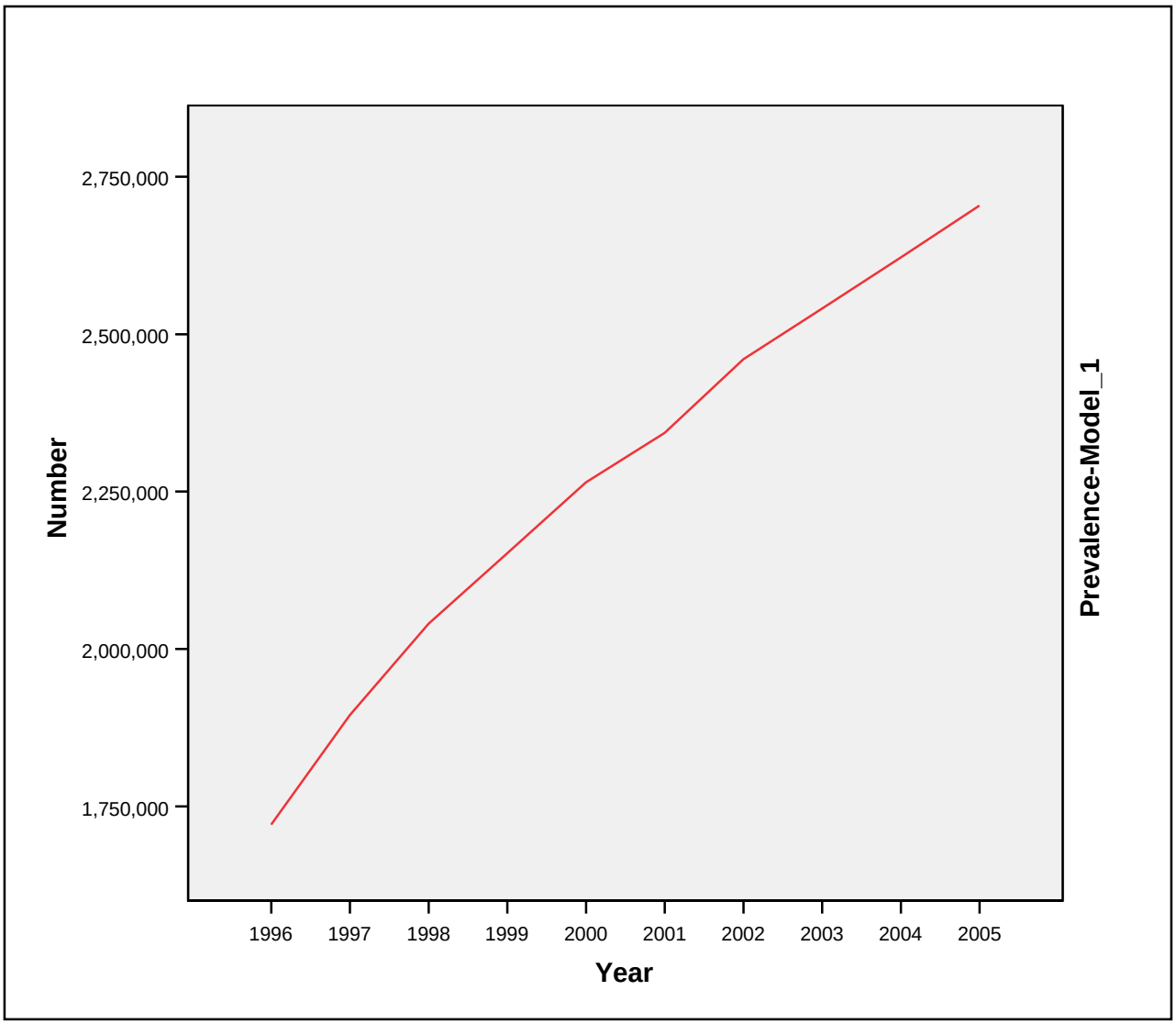

Fig. 4 HIV/AIDS Prevalence in Ethiopia over the Years 1996 to 2005

5.2 Multinomial Logistic Regression

Multinomial logistic regression analysis was used for analyzing the EDHS 2005 data set in order to identify key predictors of HIV status. The output of multinomial logistic regression is indicated on the following page (Table 3).

Table 3 Multinomial logistic regression result of HIV status in Ethiopia from 2005 complex survey

Survey: Multinomial logistic regression

Number of strata	= 265	Number of obs	=	13696
Number of PSUs	= 535	Population size	=	1.369e+10
		Design df	=	270
		F(16, 255)	=	16.84
		Prob > F	=	0.0000

HIV status	Coef.	Linearized Std. Err.	t	P>|t|	[95%	Conf. Interval]
2 (Not tested)						
Gender	-.032589	.0673998	-0.48	0.629	-.1652851	.100107
Residence	.8162117	.1329709	6.14	0.000	.5544201	1.078003
Region	.041812	.0128836	3.25	0.001	.0164469	.0671771
Wealth index	-.0065136	.0275696	-0.24	0.813	-.0607923	.0477651
Mother Literacy	.0703597	.0782677	0.90	0.369	-.0837328	.2244523
Grade	.1442957	.0832847	1.73	0.084	-.0196743	.3082657
BMI	-.0150935	.0899967	-0.17	0.867	-.1922781	.162091
Age	-.0093437	.0702104	-0.13	0.894	-.1475732	.1288859
_cons	-1.813169	.131839	-13.75	0.000	-2.072732	-1.553606
3 (HIV positive)						
Gender	.0127448	.2386553	0.05	0.957	-.457117	.4826067
Residence	1.187683	.3690222	3.22	0.001	.4611562	1.91421
Region	.0510986	.0326299	1.57	0.119	-.0131427	.1153399
Wealth index	.1359769	.0712704	1.91	0.057	-.0043395	.2762932
Mother Literacy	.6395729	.3484042	1.84	0.067	-.0463615	1.325507
Grade	-.0707987	.2953289	-0.24	0.811	-.6522389	.5106415
BMI	.4402221	.3072964	1.43	0.153	-.1647796	1.045224
Age	-.9189365	.2694087	-3.41	0.001	-1.449345	-.3885276
_cons	-5.049654	.3974759	-12.70	0.000	-5.8322	-4.267108

(HIV status==1 is the base outcome) (This represents HIV negative results)

The measure of effect is the estimated regression coefficient. At the 5% level of significance, significant predictor variables are characterized by P-values that are smaller than 0.05, estimated regression coefficients that differ from 0 significantly and 95% confidence intervals of regression coefficients that do not contain 0. Accordingly, for Category 2 of HIV status (for respondents that are not tested for HIV), the variables residence and region are influential at the 5% level of significance. For Category 3 of HIV status (for respondents that are HIV-positive), the variables residence and age are influential at the 5% level of significance.

Table 3 shows that the effect of residential differences and age are significant determinants for the variations in HIV positive results. According to Hosmer and Lemeshow (2000)[25], for a 5% level of significance, the acceptance and rejection level is recommended to be as low as 0.25 rather than limiting at 0.05 to avoid rejection of important variables. According to this recommendation, wealth index and region are acceptable since the practical importance of these variables in the study is very high. Residence, age, region, BMI, mothers' literacy and wealth index are statistically significant at 0.05 significance levels while education level (grade) and gender are not significant individually since their p-values are more than 0.25. All the factors are collectively significant over the HIV positive results since the F-test showed the adequacy of the model at a 5% level of significance; all these factors considered in the model are practically important as well. Therefore, the model specified will be

$$\textbf{Probability (HIV status=HIV positive)} = \frac{e^{[-5.049654+.0127448(\text{gender}) + 1.187683(\text{residence}) + 0.0510986(\text{region}) + 0.1359769(\text{wealth index}) + 0.6395729(\text{mothers' literacy}) - 0.0707987(\text{grade}) + 0.4402221(\text{BMI}) - 0.9189365(\text{age})]}}{1+e^{[-5.049654+.0127448(\text{gender}) + 1.187683(\text{residence}) + 0.0510986(\text{region}) + 0.1359769(\text{wealth index}) + 0.6395729(\text{mothers' literacy}) - 0.0707987(\text{grade}) + 0.4402221(\text{BMI}) - 0.9189365(\text{age})]} + e^{\text{not tested}}} \quad \text{------ (15)}$$

In this way, one can calculate the probability of any person to be HIV positive as following (according formula 10):

HIV positive result =

$$\frac{e^{[-5.049654+0.0127448(\text{gender})+1.187683(\text{residence})+0.0510986(\text{region})+0.1359769(\text{wealth index})+0.6395729(\text{mothers' literacy})-0.0707987(\text{grade})+0.4402221(\text{BMI})-0.9189365(\text{age})]}}{1+e^{[-5.049654+.0127448(\text{gender})+1.187683(\text{residence})+0.0510986(\text{region})+0.1359769(\text{wealth index})+0.6395729(\text{mothers' literacy})-0.0707987(\text{grade})+0.4402221(\text{BMI})-0.9189365(\text{age})]}} \quad \text{----- (16)}$$

Or according to equation 16,

- $\{1+\exp[5.049654-.0127448(\text{gender})-1.187683(\text{residence})-0.0510986(\text{region})-0.1359769(\text{wealth index})-0.6395729(\text{mothers' literacy})+0.0707987(\text{grade})-0.4402221(\text{BMI})+0.9189365(\text{age})]\}^{-1}$ ---------- **(17)**
- **Predicted ln (odds of HIV positive)** = -5.049654+.0127448(gender) + 1.187683(residence) + 0.0510986(region) + 0.1359769(wealth index) + 0.6395729(mothers' literacy)-0.0707987(grade) + 0.4402221(BMI)-0.9189365(age) ---------- **(18)**

Equation 18 could be a binary logistic regression if positive and negative results were considered. But, rather than binary method adjustment for non respondents was preferred.

5.3 Non-respondents

Table 3 shows that the effect of residential differences (i.e. whether a person lives in an urban or a rural area) and regional differences are very significant for the non-respondent rate. Table 4 gives 0.2a+0.78b+0.02c=Nr. where a, b and c are non-respondents per age group (15-18, 19-49 and above 49 years old); while 0.2, 0.78 & 0.02 are the probabilities of HIV positive results of respective age groups taken from the actual age distribution, and Nr=the total additional number of positive results expected from non-respondents. Thus, if non-respondents were tested, there would be a probability to get 53 additional persons with HIV positive results; i.e. the prevalence could be (53+219) ÷14757=1.8%, which otherwise is 1.4% of total respondents (1.5% for adults of 15-49 years old).

Table 4 Non-respondents by age category

	HIV status			
Agecategory	1(-ve)	2(NoTest)	3(+ve)	Total
15-18 1	2,127	680 **(20)**	44 **(20)**	2,851
19-49 2	8,490	2,581 **(76)**	171 **(78)**	11,242
>49 3	518	142 **(4)**	4 **(2)**	664
Total	11,135	3,403 **(23)**	219	14,757
	Pearson chi2(4) =	6.1352	Pr = 0.189	

As these non respondents are among the widely reported risky age group, more positive results might have been registered if these persons had been tested. Thus, it is possible to say that the EDHS 2005 is biased due to the high number of non-respondents.

5.4 Projections

The graphs (Fig. 5, 6, 7 & 8) are generated from EPP. In the four figures, the three lines indicate results using the three assumptions considered for HIV/AIDS prevalence and incidence rates for the year 2015. The upper lines (the blues) are projection and estimation results under the assumptions of high prevalence and incidence rates. The red lines in the middle indicate estimations and projection results using the average level of incidence and prevalence levels assumed for the reference year (2005). In the same way, the green lines are results under the lower assumptions.

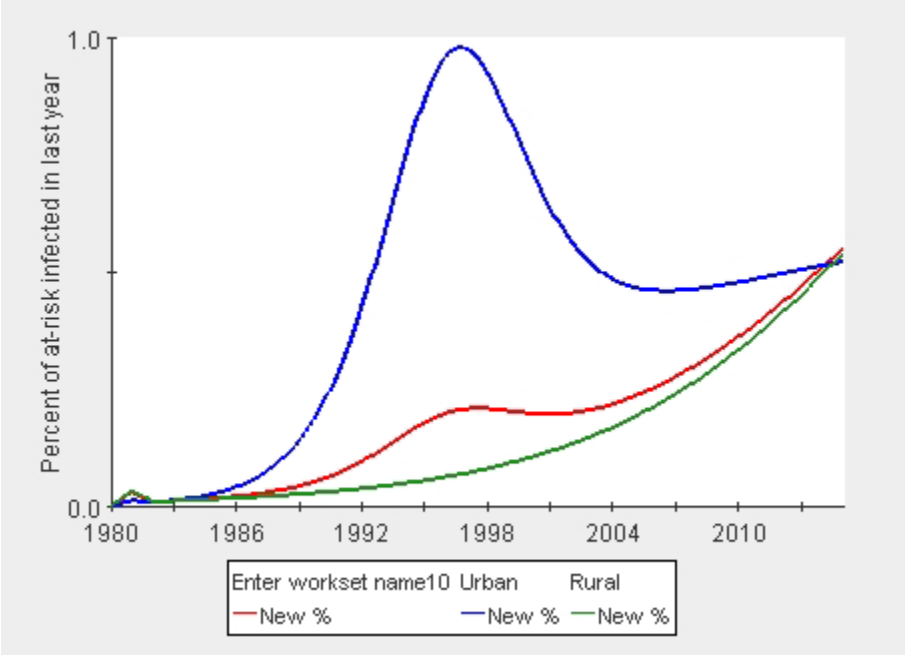

Fig. 5 Rates of HIV Incidence among Persons at Risk for the Years 1980-2015

Figure 5 shows the percentage of persons infected from risky group. It was as high as 1% for 1996. An average projected percentage of at-risk infected is 0.7 for 2015 under the medium assumption. As the estimate and projection for the lower assumption shows, the infection among persons at-risk steadily rises between 1980 and 2015. As a result, it is improbable to halt and reverse the effect of the epidemic at the end of the planning period under such results.

Let us assume that X is the number of persons at-risk at the end of the period. From figures 5 and 7, we can learn that 0.7*X=50,000 ! >X=50,000÷0.7 ! >X =71,429 persons will be at risk of HIV incidence in 2015. Since 50,000 persons are projected to be newly infected by HIV by the year 2015 (Fig. 7, the incidence rate for the final year (year 2015) will be 50,000÷58,970,310=0.1% of the adult population of the country. The 58,970,310 is the total adult population projected for 2015 taken from EPP detail projections output. As this output shows, the total number of persons living with HIV/AIDS (the prevalence for 2015) will be close to 1.8 million.

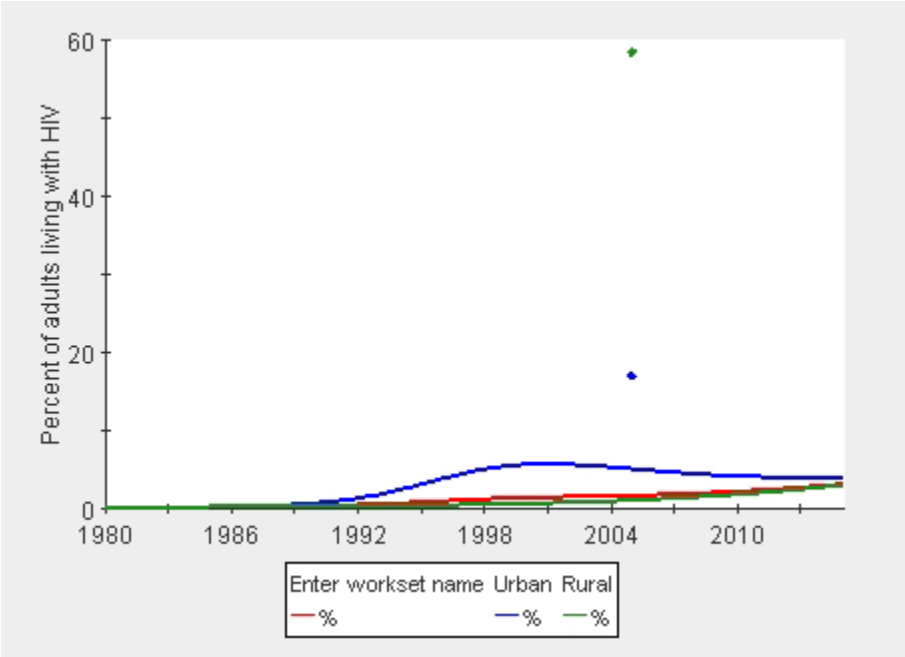

Fig. 6 HIV/AIDS Prevalence Rates, Estimations & Projections for 1980-2015

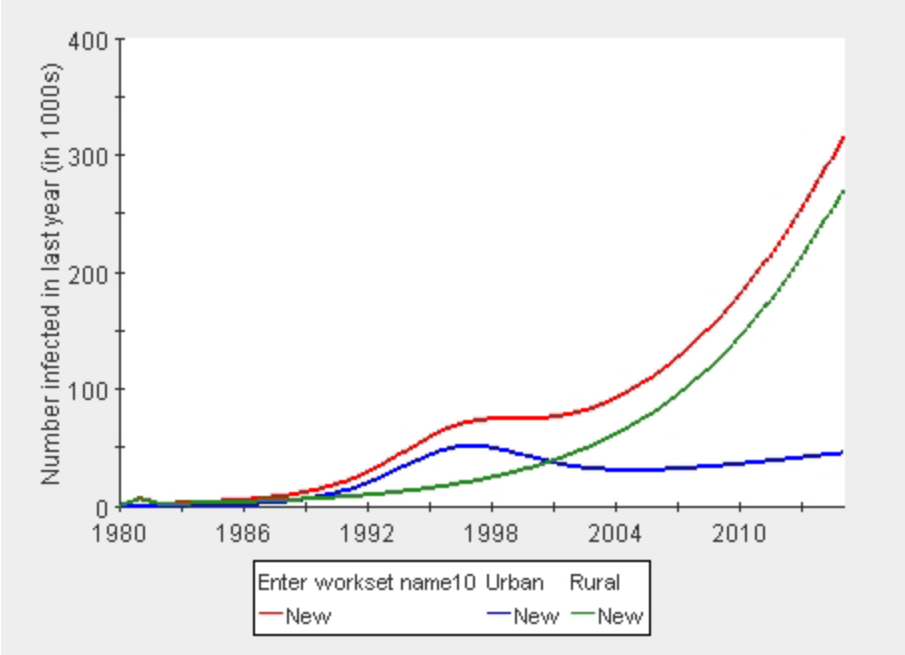

Fig. 7 Number of Persons Infected by HIV (Estimations & Projections for 1980-2015)

As can be learnt from all the above diagrams, the incidence rate is showing an increasing trend reaching its peak in 1996. Even the lowest prevalence/incidence assumption is producing increasing trends over the periods of considerations (1980 to 2015). Under the high assumption, it is also projected to increase steadily from 2005 onwards, after showing some decreasing rates of increases between 1998 and 2005. Under all the assumptions, therefore, the final year incidence will be significant. The probability of HIV infection among the risky group is projected to be close to 70% (Figure 5).Thus, 71,429 of the total adult population will be at risk in absolute numbers under the assumption mentioned before. The lower assumption (the green lines of the diagrams) will be realized if there are better interventions, improvements in poverty and changes in in other conditions for the remaining planning periods (2006 to 2015). In what ever assumptions, at the end of the plan (2015), there will be a significant amount of persons living with the virus and additional newly infected persons so that halting the epidemic is unrealistic for the target year. The cumulative prevalence for each year under consideration can be easily observed from Figure 8 below.

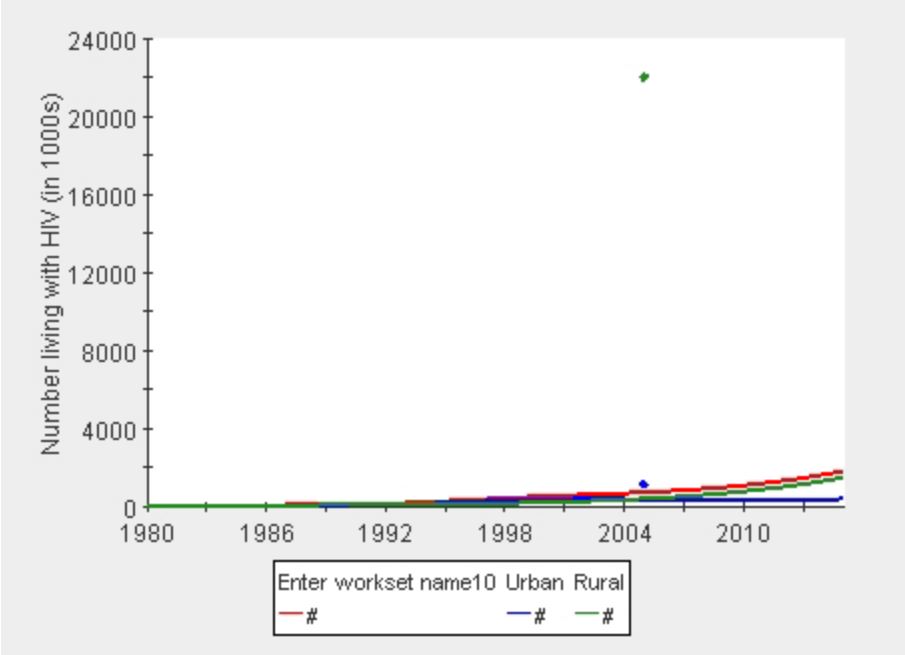

Fig. 8 PLWHAs in Ethiopia during the Years 1980-2015(Estimations & Projections)

The prevalence is projected to be 2.85% to 3.83% for 2015. Under the medium assumption, there will be 3% prevalence rate with the total of close to 1.8 million HIV positive adults. According to the average estimation, the number of adults who will be living with the virus will, therefore, increase by 183, 147 from year 2014 to 2015. This indicates a significant number of new HIV infections at the final year of the MDGs. In Figure 5, it is approximated that the probability for the incidence is near to 0.7% so that adults who will be exposed for newly infection for that year is 71,429. Figure 7 indicates that by the year 2015, a total of 50,000 persons will be newly infected. Thus, referring Figures 5, 6, 7 and 8, one can develop a two by two table for analysing the resulting epidemiologic effect for the target year 2015.

Table 5 A 2X2 table of HIV incidence for 2015

Projected Exposure	**Projected HIV Incidence**		
	Infected	not-infected	Total
Exposed	50,000	21,429	71,429
Unexposed	133,147	58,765,734	58,898,881
Total	183,147	58,787,167	58,970,310

The following (Table 6) portrays incidence related estimations generated by STATA.

Table 6 Incidence rate estimation for 2015

```
                 |   Exposed   Unexposed  |      Total
-----------------+------------------------+-----------
           Cases |     50000      133147  |     183147
     Person-time |     71429    5.89e+07  |   5.90e+07
-----------------+------------------------+-----------
                 |                        |
  Incidence Rate |   .6999958    .0022606  |   .0031057
                 |                        |
                 |      Point estimate    |    [95% Conf. Interval]
                 |------------------------+------------------------
 Inc. rate diff. |         .6977352       |    .6915996    .7038708
 Inc. rate ratio |           309.65       |     306.477    312.8521 (exact)
 Attr. frac. ex. |         .9967705       |    .9967371    .9968036 (exact)
 Attr. frac. pop |         .2721231       |
                 +-------------------------------------------------
                     (midp)   Pr(k>=50000) =                 0.0000 (exact)
                     (midp) 2*Pr(k>=50000) =                 0.0000 (exact)
```

The above table shows that the 95% confidence interval for incidence rate difference (0.59, 0.70) does not contain 1. This shows that the incidence rates of the groups being compared are significantly different at the 5% level of significance. This is proving the difference of the incidence conditions among the exposed and unexposed groups, however, all the above results (Tables 5 &6) show similar direction. That is the probabilities and the cumulative incidence and prevalence of the epidemic are showing upward trends. Moreover, there will be a 0.31% of incidence rate by the year 2015. For that reasons, the problem related to HIV/AIDS in Ethiopia will be increasing rather than decreasing. Consequently, the problem of the epidemic is not to be reversed up until 2015 as far as there is incidence (new infection) for that target year.

6 Conclusion and Recommendations

6.1 Short Term

Poverty has revealed its debilitating power in every dimension of Ethiopians' daily lives and performances. The information unavailability, inaccessibility and unreliability are hampering research, evidence based planning and evaluation in Ethiopia. For instance, the inaccessibility of the raw data sets of ANC based surveillances has inhibited further comment on the main issues of this study. Access to the existing information needs

priority which otherwise will contribute for the sustainability of the vicious circle of the problem in the country.

The findings of population based studies, reports and data bases show low HIV/AIDS prevalence (though with wide differences across population groups and geographic locations) while ANC based data generated very high prevalence. The methodologies employed so far are, therefore, generating widely differing estimates that necessitate further refinements and careful considerations. Triangulations by space, data sources and methodologies are vital to sort out the observed disparities of estimates generated at different time and by the different methodologies. The apparent stability or decline in the prevalence over time has to be considered cautiously as well. The effect of AIDS death has to be considered too. Appropriate mixing of ANC based with population based surveys as well as wider primary data bases properly adapted to the specific conditions of the country are still crucial. Therefore, further efforts need to be made to get the real picture of the country, for designing realistic plans, to implement appropriate interventions in practice, to make down-to-earth evaluations of the implementation conditions and for informed decision makings.

6.2. Medium and Long Term

In Ethiopia, the budgetary allocation, the health sector performances and the current plan in general show very high dependencies on external sources. Thus, the country can not accomplish any extra ‘big commitments’ without ‘generous and sustained’ assistances from the rest of the world, under the existing conditions. Currently, for Ethiopia, planning for and solutions of the widespread economic and health problems (such as meeting HIV/AIDS target of the MDGs) seem insurmountable without external assistance. This dependency is expected to sustain unless extraordinary internal resource mobilizations and innovative policy changes are designed and implemented. Further local resource mobilization and international assistance will be needed for the realizations of such plans (MDGs). Conversely, foreign components of financing mechanisms make the planning system weak, unreliable and exposed for many exogenous factors. In other words, applicable plan and sustainable development are highly explained by the fiscal capacity

or fiscal space of the country. Therefore, refocusing on the internal financing and strengthening own resources base is the best strategy for sustainable solutions. For sustainable development, the country has to use and link the external resources to development purpose as well. Therefore, refocusing of relief efforts or resources towards development and sustainable results, and alleviating poverty need real considerations in the strategies.

In this study, the main initial assumptions were:

- No significant change in the socio-economic situation i.e. the same trend
- Stable political environments and consistent policy, and
- No medical break through that can change medical history of HIV/AIDS of today.

However, for the actual implementation of the MDGs, these assumptions need to be relaxed. In this regard, scale up of efforts and interventions are imperative. In a nutshell, more concerted and coordinated efforts need to be exerted; more resources (including human) have to be mobilized and allocated for the remaining periods; more awareness and practical behavioural changes, mainly among those who are at-risk, are vital. Improved medical interventions and technologies are required. To be specific, in the medium and long terms, the new infections could be prevented if existing HIV prevention strategies are substantially scaled up, and even more could be averted with the advent of new prevention technologies or biomedical interventions.

Thus, much more efforts, resources allocations, efficiencies and effectiveness in implementations of HIV/AIDS interventions are required for the road ahead. Moreover, inter and intra-sectoral mainstreaming of HIV/AIDS and multi-sectoral approaches need to be further strengthened for effective and sustainable responses on HIV/AIDS intervention strategies. Specifically, first, there is a real need for strategic approaches and resources allocation towards responsive awareness and education programs among the risked persons that enable them to value their lives and react practically in changing their behaviour. Secondly, improving socio-economic status of the people under abject poverty and participation of the vulnerable groups during the implementations is basically necessary. The participation and empowerment of those marginalized and infected/affected persons will bring about sense of ownerships for the programs that

concern them, a key for sustainability of any program. In other words, it will trigger ripple effect on the whole socio-economy changes. Thirdly, in short, it is noteworthy to mention that more healthy people means more productive citizen, which is in turn a base for earning more personal and aggregate income; and hence this ultimately leads to growth and development. Development guarantees sustainability for overall health and socio-economic gains. Thus project/programs, policies and practical implementations need to be geared towards poverty alleviation and development goal attainments. The vicious circle of poverty can be broken when there is significant change in productivity which is mainly the function of healthy citizens and enabling policy environments.

Further more, it must be recognized that the potential effect of the spread of the epidemic among the rural Ethiopians will be more devastating than urban areas in the future since the literacy level and magnitude is very low; the health seeking behaviour is not developed; and the access to infrastructures, even for the basic health services, is very low down in these rural areas comparatively. Attention for such growing dangers is very important in planning comprehensive interventions. The challenge of Ethiopia due to HIV/AIDS is multidimensional and affecting every walk of life. It is eroding the barely available resources and marginally accumulated development gains. It is worsening the prevailing poverty and development challenge of the country. The country is lagging behind MDG as far as HIV/AIDS is concerned. The solutions entail reconsideration of political commitments and policy environments. Otherwise, targets of the MDGs for the remaining years will remain as another ambition like the Alma Ata Declaration.

HIV/AIDS programs require integration with poverty alleviation and education programs. For the sustainable solution, there is a need for implementation of participatory and SMART intervention programmes that are funded adequately by the national government with empowering the people that are most severely affected by the spread of HIV/AIDS, poverty and illiteracy. Further work on improvement of the economic status and education levels of the population will have significant changes on the way to realize the MDGs in general and the targets for HIV/AIDS in this case. Self sufficiency of project/program beneficiaries through income generating activities can be mentioned as a simple short and medium term strategies to realize such objectives.

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