THE EFFECT OF HIV/AIDS ON MORTALITY AND INSURANCE PACKAGES OF HIV/AIDS INFECTED INDIVIDUALS.

I46/68446/2013

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JULY 2014

DECLARATION

I hereby declare that this work has not been presented in any University or any other forum for an award in any degree.

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DEDICATION

I am dedicating this study to my parents and brothers for their great support during the reign of this study.

ACKNOWLEDGEMENT

Foremost; I thank God for the wisdom, knowledge and ability to write this project. I am also grateful to my supervisor MRS Idah Orowe for her professional guidance, time and patience in reading through my drafts and suggesting workable alternatives. I also would like to acknowledge the support of the staff of NACC for providing necessary materials and data for this study.

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ABSTRACT

This study is an investigation into the effect of HIV/AIDS on mortality and insurance package in Kenya. The effect of HIV/AIDS on mortality is considered by analysis of 2010 data from KENYA HIV AND AIDS MONITORING & EVALUAT ION ANNUAL REPORT 2008. This analysis is supplemented by applying a combination of two states Markov model, actuarial calculation of premiums and survival probabilities with addition force of mortality. The study finds that HIV/AIDS is related to increase in mortality with an adverse increase to children aged below 15 years. The study also comes up with premiums payable for whole life insurance of a HIV infected adult in Kenya and premium payable for maternity cover for HIV infected women that cover for baby formulae for the first six months before weaning.

CHAPTER ONE

1.1 Introduction

Human immunodeficiency virus infection/ acquired immunodeficiency syndrome (HIV/AIDS) is a disease of human immune system caused by human immunodeficiency virus (HIV). The term HIV/AIDS represent the entire range of diseases caused by HIV virus from early infection to the late stage symptoms.

HIV/AIDS was first recognized by the united state centre of disease control and prevention in 1981. HIV probably started to spread in Kenya in the late 1970s or early 1980s. Although HIV prevalence was very low in Kenya during the early 1980s, the prevalence increased in 1990s and early 2000s. The National AIDS and STDs Control Programme estimated that by June 2000, adult HIV prevalence had increased to 13.5% (NASCOP 2000). In urban areas prevalence was estimated to be 17 to 18%. That meant that there are about 470,000 HIV-infected adults in urban areas. HIV prevalence in rural areas was increasing rapidly. In 2000 it was estimated at 12 to 13%.This suggested that there were about 1.5 million HIV-infected adults living in rural areas. Over three decades since the first AIDS case was described in Kenya, HIV/AIDS still remains a huge problem for the country in its efforts for social and economic development.

According to the Kenya demographic and health survey (KDHS) it is estimated that 7.4% of adults' aged between 15 and 49 are infected with HIV virus another 60,000 age 50 and over, and approximately 100,000 children with the rate of women (8.8%) infected nearly doubling the rate of men (5.5%). Urban populations have higher adult HIV prevalence (10%) than rural populations (6%).

. In 2011, an estimated 49,126 people in Kenya died of AIDS-related causes.

The AIDS death toll in 2010 represents a nearly two-thirds drop from the peak in AIDS deaths in 2002–2004, when an estimated 130,000 people died each year. Peak mortality followed peak HIV incidence in Kenya by roughly a decade, which one would expect given the roughly 10-year life expectancy of a newly infected individual in the pre-ART era.

The fact that HIV/AIDS affect the reproductive and generation in the country we need to come up with was to eradicate the HIV/AIDS epidemic by realizing the adverse effect of the epidemic on mortality rate in Kenya would enable the government and the citizens of the country to undertake the necessary precaution and steps to eradicate the epidemic

. it has also being proven that with necessary health care of an already HIV/AIDS infected person one can be able to live with the HIV/AIDS virus for more than 10years by coming up with health insurance package for the infected it would enable them acquire the much needed health care and reduce the mortality rates in Kenya

1.2 DEFINITIONS

1.2.1Mortality

It is the state or condition of being subject to death. It can also be defined as the relative death in a specific population.

1.2.2 INSURANCE COVERAGE IN KENYA

1.2.2.1 HEALTH INSURANCE IN KENYA

They are two forms of health insurance provided in Kenya.

- Public system

- Private system

1.2.2.1.1 PUBLIC SYSTEM

This system is mainly funded by the government. In Kenya the primary provider of health care is National Health Insurance Fund (NHIF). NHIF was established in 1966 as a department within the ministry of health, by an Act of parliament. This has been reviewed over the years and it is now governed by ACT NO. 9 of 1998 - National Hospital Insurance Fund Act. NHIF is a non-profit organization whose main purpose is provision of better healthcare for its members.

Any Kenyan nationality aged between 18 and 65 from both formal and informal sector is viable to register with NHIF. For those in formal sector it’s compulsory to register while those in informal sectors it’s voluntary. According to Kenya national health account 2009-2010 Kenya spent 122.9 billion on health with Ksh. 25.03 billion going towards HIV/AIDS.

1.2.2.1.2 PRIVATE SYSTEM

This system includes private insurance provider thus is where the insured individual pays premium depending on the expected benefits. Membership of this system is exclusively voluntary and it is a profit based organization. As of 2010 they were 44 licensed insurance firm with 21 of them been health insurance provider. The private system is of two forms:

- Individual health insurance

It’s where an individual personally purchases health insurance for himself.

- Company based health insurance

This is where an employer purchases the health insurance for his employees. Majority of companies in Kenya offer health insurance for its employees as an incentive.

In the past it was extremely difficult for a HIV infected to obtain a medical cover .the HIV and Aids Prevention and Control Act of 2006. The Act provides that patients have a right to be treated for HIV and Aids, including access to medical cover. It prohibits insurance companies and employers from forcing people to undergo HIV and Aids tests. "Every health institution and health management organization or medical insurance provider shall facilitate access to health care services to persons with HIV without discrimination," says the Act. This has enabled more Kenyans who are HIV infected to obtain medical cover.

1.2.2.2 LIFE INSURANCE COVERAGE

life insurance is a contract between an insured (policy holder) and insurer(firm) , where insurer promises to pay a designated beneficiary a sum of money (benefits) in exchange of premiums, upon death of the insured. The premiums are paid regularly or in lump sum. Modern life insurance policy where established in the early 18th century the first company to offer life insurance was the amicable society for a perpetual assurance office in 1706.

There are four types of life insurance policies in Kenya

- **Endowment policy**-under this policy an individual has dual benefits. In the event that he dies in the time, the sum insured is paid out the family members or to the beneficiaries. should the person live beyond the stipulated time period in the policy the premiums are refunded back together with capital gain

- **Term life policy**: this policy is taken up by an individual and the insurer agree that insured shall pay a certain premium in the event he or she dies in certain number of years from the date, the beneficiaries shall receive a certain amount of money.
- **Whole life policy**: this is different from the term life policy in that it doesn't have a timeline assigned to it. Under the policy, the individual continues enjoying the benefits of the policy the individual continues enjoying the benefits of the policy until such a time of his or her demise.
- **Money back policy**: under this policy the individual receive periodic payment of the sum to be periodic payment of the sum to be paid out in the event of the demise of the person. In the case of the death within the policy, the beneficiaries receive the full sum insured

1.3 STATEMENT OF PROBLEM

The HIV/AIDS epidemic has been a major source of death in Kenya greatly affecting the current and future productive generation of Kenya. The death rate has been caused by high cost of medical coverage for a HIV /AIDS infected individual. There is a need to come up with a comprehensive health insurance package that offer special needs required by a HIV infected individual that are not necessary to the uninfected person. This project tries to analyze the effect of mortality rate and premiums chargeable for insurance policy of a HIV/AIDS infected person in Kenya.

1.4 OBJECTIVE OF THE STUDY

MAIN OBJECTIVE

This study's main objective is to show the impact of HIV/AIDS on mortality and insurance packages for an infected person.

SPECIFIC OBJECTIVE

1. To determine a comprehensive maternity health insurance package for a HIV/AIDS infected person.

2. To estimate premiums payable by a HIV/AIDS infected individual on whole life policy.

3. To compare the survival probabilities of a HIV/AIDS infected person and that of a person who is not infected.

1.5 SIGNIFICANCE OF THE STUDY

HIV/AIDS being a global epidemic with no cure or vaccination so far has a become a living nightmare to the whole world especially sub Saharan Africa where it is most prevalent .Kenya has a prevalence rate of 7.4 which is extremely high compared to developed countries the fact. By coming up with whole life policy for the HIV/AIDS infected it would lessen the burden of the families of the infected once they loved one passes on. The benefits of the policy would take care of the orphaned children and reduce the number of strict children and the school dropout in the country. The benefits would lessen the dependency level of relief help for the orphaned children.

By undertaking a comprehensive maternity cover for the infected mother would lessen the burden of buying baby formulae which is extremely expensive in the country. It would also allow babies born from infected mothers obtain the necessary nutrients required by babies since they cannot be breastfeed by their mother due to the risk of mother to child transmission through breastfeeding

The insurance of the HIV/AIDS infected would generate income for the insurance firms in the country since some people who are infected with the virus can afford to uptake the policy but are restricted by the harsh condition speculated by the insurance companies.

CHAPTER TWO

2.0 LITERATURE REVIEW

In this chapter we review the available literature on impact of HIV/AIDS on mortality rate and insuring of the HIV/AIDS infected individuals. We start by looking at the impact of HIV/AIDS on mortality. Cohen et al (2012) showed the impact of influenza-related mortality among adults aged 25–54 years with AIDS in South Africa and the United States of America. In the study they compared influenza-related mortality rates in young adults (aged 25–54 years) with AIDS in South Africa and the United States during the pre-HAART era. Furthermore, they evaluated trends in influenza-related mortality rates in young adults with AIDS after the widespread introduction of HAART in the United States and compared estimates with those from reference population groups in South Africa. They applied the indirect statistical regression methods to quantify the increase in mortality rates for broad disease categories occurring during influenza activity periods, which they termed as excess mortality. This method was used due to the fact mortality burden of influenza could not be measured directly, because many influenza-related deaths are not coded as such in death certificates. The study evaluated influenza-related excess mortality both among adults with AIDS in South Africa and the United States in the pre-HAART era and in the United States during the HAART era. Their data suggested that in the absence of HAART, adults aged 25–54 years with AIDS experienced a substantially elevated risk of influenza-associated death, higher than that in the general population of the same age and that in adults aged ≥65 years. This was consistent with the overall dramatic increase in total risk of death in patients with AIDS.

John Richardson (2007) studied the effect of excess body fat on mortality within the UK. The effect of obesity on mortality rates was considered through an analysis of current actuarial, epidemiological and demographic research. Health surveys from the UK were then used to investigate the change in the distribution of the UK population's body mass over the last 25 years. After a discussion of the issues raised by this research the analysis were supplemented by applying a Cox proportional hazards model to UK-specific data (Health and Lifestyle Survey, 1985) to provide an analysis of the effect of obesity on life expectancy, for people of various ages. The analysis found out that overweight and obesity was related to increased mortality in men and women. It also found that the increased risk decreases with age and that overweight would not seriously affect life expectancy in women. 35 year-old obese men were found to live on average 4 years less than men with healthy body fat levels. The equivalent figure for women was 1 year.

Richardson also suggested that Life insurance would mostly be directly affected. It was probable that the life insured population had a lower prevalence of overweight and obesity than the general population due to the following reasons;

- Underwriting filtered out obese individuals through the charging of higher premiums or the refusal of companies to write business for obese individuals.
- Insured lives tended to be from higher social economic groups than the general population.

There was also inherent long term risk involved in general insurance as a result of bodily injury claims any effect on mortality rates related to body fat would affect claims awards in the area. For instance class action suits could be initiated against fast food restaurants for mis-selling food as healthy, regular diet.The implications of this are that the following organizations might be at risk: fast food companies, food manufacturers, marketing agencies, advertising agencies, medical profession, school authorities, employers and directors and officers.

A study conducted by Population Division, United Nations Secretariat- UN/POP/MORT/2003/14 (2003) on the impact of HIV/AIDS on mortality. It indicated that in 2000-2005 the 38 affected countries in sub-Saharan Africa were expected to experience 14.8 million more deaths than they would have in the absence of AIDS. Among all 53 affected countries, the total number of excess deaths during that period was expected to amount to 19.8 million, implying that the countries of sub-Saharan Africa would account for 75 per cent of the excess deaths brought about by the epidemic in all the affected countries during 2000-2005, In the affected countries of Africa, the No-AIDS scenario projected a decline in the CDR throughout the projection horizon. With AIDS, the affected countries of Africa experienced an outright increase in the CDR from 1990-1995 to 2000-2005, but a decline was expected to resume in 2005-2010.

Due to the extremely high number of excess deaths in sub-Saharan Africa, life expectancy in the affected African countries as a whole was projected to fall to 45.3 years in 2000-2005. The widest difference in life expectancy between the projection with AIDS and the No-AIDS scenario was projected for 2010-2015, when life expectancy in the affected countries of Africa would be 11.3 years or 19 per cent lower than without AIDS. The impact of AIDS on life expectancy in the affected countries of Africa remains substantial during the rest of the projection period. In 2045-2050, AIDS would still be projected to produce a deficit of 7.8 years of life expectancy in that group of countries.

Even by taking into account the effect of AIDS, infant mortality for all 53 affected countries would decline from 70 deaths per 1000 births in 1990-1995 to 24 deaths per 1000 births in 2045-2050. The effect of AIDS on infant mortality was strongest in the affected countries of Africa, where in 2000-2005 AIDS was expected to cause infant mortality to be higher by 5 deaths per 1000 births than in the No-AIDS scenario. In all other regions the effect of AIDS on infant

mortality was small although, in relative terms, it was moderate on the already very low infant mortality of the two developed countries affected by the epidemic, implying that AIDS was likely to be responsible for a 5 to 6 per cent increase in their infant mortality after 2010.
For the group of all 53 affected countries, under-five mortality was projected to be 7.8 per cent higher in 2000-2005 than it would be without AIDS, compared to an excess of 2.2 per cent for infant mortality, and although the relative impact of AIDS was expected to increase to 13.3 per cent in 2045-2050, by that time under-five mortality would be projected to be nearly two-thirds lower than in 2000-2005 (33 deaths per 1000 births vs. 92 deaths per 1000 births).

Rodrigo (2012) outlined the advantages and disadvantage of micro insurance for HIV afflicted society in sub Saharan Africa .He used a combination of quantitative and qualitative analysis found that the introduction of micro-insurance product for the mitigation of HIV/AIDS for the assistance of the infected and their families is a complex method of development but found although the micro insurance was not a long term solution for HIV/AIDS. It lessened the economic, psychological and cultural implication of HIV/AIDS.

S. Haberman (1992) used the Markov chain as a tool for the calculation of life contingencies The transmission model advocated by the institute of actuaries AIDS working party is modified and simplified and then applied to derive explicit formulae for these standard life contingencies function .This investigation allows a thorough review of the properties of these function to be conducted and assist in calculation of premiums and reserve in the presence of HIV/AIDS.

CHAPTER THREE

3.0METHODOLOGY

3.1 THE GENERAL MARKOV MODEL

A major simplification occurs if the future development of a process can be predicted from its present state alone, without any reference to its past history i.e.

$$\mathbf{P}\left[\boldsymbol{X_t} \in \boldsymbol{A} \mid \boldsymbol{X_{S_1}} = \boldsymbol{X_1}, \boldsymbol{X_{S_2}} = \boldsymbol{X_2}, \cdots \boldsymbol{X_{S_n}} = \boldsymbol{X_n}, \boldsymbol{X_s} = \boldsymbol{X}\right]$$

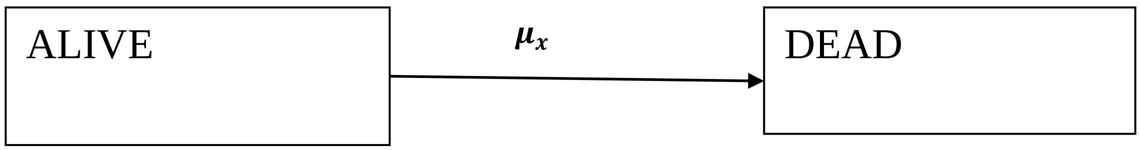
$$= \quad \mathbf{P}\left[\boldsymbol{X_t} \in \boldsymbol{A} \mid \boldsymbol{X_s} = \boldsymbol{X}\right]$$

For all times $s_1 < s_2 < \cdots\cdots < s_n < s < t$ all states that $X_1, X_2 \cdots\cdots X_n$ and X in S and all subsets A of S. This is the **MARKOV PROPERTY.**

The Markov model process can either be a two state model or a multistate model. Two state model is used for a modelling a one state of insured life while as a multistate model is used for modelling various state of insured life. While using the Markov model two problems arises with the main problem being estimating states probabilities and other process characteristics. It also assumes that the model parameter is given which is not mostly the case. The other problem being estimating the model parameter using the resulting characteristic for the process obtained from experimental data.

3.2 THE TWO STATE MARKOV MODEL

FIGURE1: An alive-dead model



The probability that a life alive at a given age will dead at any subsequent age is governed by the age dependent transition intensityμ_{x+t} $(t \geq 0)$.

3.2.1 ASSUMPTIONS

1. The probability that a life at any given age will be found in either state at any subsequent age depend only on the age involved and on state currently occupied. past events don't affect the probability of future event
2. For a short interval of time dt we have that

$${}_{dt}\boldsymbol{q}_{\boldsymbol{x+t}} \;=\; \boldsymbol{\mu}_{\boldsymbol{x+t}}\boldsymbol{dt} + \boldsymbol{0}(\boldsymbol{dt}) \text{ where } t \geq 0$$

In other the probability of dying in a very short time interval dt is equal to the transition intensity multiplied by the time interval plus a small correction term. This is equivalent to assuming that

$${}_{dt}\boldsymbol{q}_{\boldsymbol{x+t}} = \boldsymbol{\mu}_{\boldsymbol{x+t}}\boldsymbol{dt}$$

- $\boldsymbol{\mu}_{\boldsymbol{x+t}}$ is a constant μ for $0 \leq t \leq 1$

3.2.2 PROBABILITIES

Consider the survival probabilities ${}_{t+dt}p_x$ and condition on the state occupied at age x+t, i.e. we consider separately the survival probabilities from age x to age x+t and from age x+t to age x+t+dt.

By Markov assumption1 that nothing else affect the probabilities of death or survival at age x+t

$$\boldsymbol{{}_{t+dt}p_x = {}_tp_x \times p\left[Alive\ at\ x+t+dt \middle| Alive\ at\ x+t\right] +}$$

$$\boldsymbol{{}_tq_x \times p\left[Alive\ at\ x+t+dt \middle| Dead\ at\ x+t\right]}$$

$$\boldsymbol{= \left({}_tp_x \times {}_{dt}p_{x+t}\right) + \left({}_tq_x * 0\right)}$$

$$\boldsymbol{= {}_tp_x \times \left(1 - \mu_{x+t}dt + 0(dt)\right)}$$

The last equation is derived from assumption 2

$$\boldsymbol{\frac{\partial}{\partial t}\, {}_tp_x = \lim_{dt \to 0^+} \frac{{}_{t+dt}p_x - {}_tp_x}{dt}}$$

$$\boldsymbol{= {}_tp_x\mu_{x+t} + \lim_{dt \to 0^+} \frac{0(dt)}{dt}}$$

$$\boldsymbol{= {}_tp_x\mu_{x+t}}$$

This function is a Kolmogorav forward differential equation by dividing both sides by - ${}_tp_x$we have

$\boldsymbol{-\frac{\partial\ {}_tp_x}{{}_tp_x} = \mu_{x+t}}$ **, let** $\boldsymbol{y = -\ {}_tp_x}$

Hence

$$\frac{\partial y}{y} = \mu\, dt$$

$$y(t) = y(0) \times e^{-\int \mu dt}$$

We have that

$${}_t p_x = exp\left\{-\int_0^t \mu_{x+s} ds\right\}$$

3.3 STATISTICS

We suppose that we observe a total of N lives during some finite period of observation between the ages of x and x+1. Assuming that all N lives are identical and statistically identical; in reality there are no two lives that are identical. **Identical** refers to the fact that all lives follow the same stochastic model of living and dying hence the lives will have the same μ, but wont all die at the same time.

Definition
For i= 1, 2, 3…, N

x+a_i to be the age at which observation of the i th life start

x+b_i to be the age at which the observation of the i th life must cease if the life survives to that age.

x+b_i will be either x+1, or the age of the i th life when the investigation ends, whichever is smaller.

- Define a random variable D_i as follow:

$$\boldsymbol{D_i} = \begin{cases} \mathbf{1} & \text{If the i th life is observed to die} \\ \mathbf{0} & \text{If the ith life is not observed to die} \end{cases}$$

D_i is an example of an indicator random variable, it indicates occurrence of death

- Define a random variable T_i as follows

x+T_i= the age at which observation of the i th life end.

T_i and D_i are not independent:

D_i= 0 when T_i=b_i if no death has been observed, the life must have survived to x+b_i

D_i=1 when $a_i < T_i < b_i$ an observed death must have occurred between x+a_i and x+b_i.

- Define a random variable V_i this is the time spent under observation

$$\boldsymbol{V_i = T_i - a_i}$$

V_i is called the waiting time. It has a mixed distribution with probability mass at the point $b_i - a_i$.

3.4 MAXIMUM LIKELIHOOD ESTIMATOR

The probability function immediately furnishes the likelihood for μ:

L$(\boldsymbol{\mu}; \boldsymbol{d}, \boldsymbol{v}) = \boldsymbol{e^{-\mu v} \mu^d}$

The log of the likelihood is then

Log L= d log$\boldsymbol{\mu}$ –$\boldsymbol{\mu v}$

Differentiate with the respect to μ

$$\frac{d \log l}{d\mu} = \frac{d}{\mu} - v$$

By setting the equation to be equal to 0 and solving for μ yield the required maximum likelihood estimate

$$\hat{\mu} = \frac{d}{v}$$

The maximization of the likelihood can be confirmed by checking the sign of the second derivative of the log likelihood

$\frac{d^2 \log L}{d\mu^2} = -\frac{d}{\mu^2} < 0$ Hence maximum

The corresponding maximum likelihood estimator

$\hat{\mu} = \frac{D}{V}$

Where D and V are random variables denoting the number of deaths and total waiting time respectively.

3.5 ESTIMATING D_i and V_i

Since D_i = 0 if the life is not observed to die, we only need to consider the probability of death occurring (D_i=1) i.e.

E ($\boldsymbol{D_i}$) = $1\times\int_{\mathbf{0}}^{b_i-a_i}\ {}_{t}\boldsymbol{p}_{x+a_i}\boldsymbol{\mu}_{x+a_i+t}$

We assume constant transition intensity μ so as ${}_{t}\boldsymbol{p}_{x+a_i}=\boldsymbol{e}^{-\mu t}$

Hence

$$\mathbf{E}\ (\boldsymbol{D_i}) = \int_{\mathbf{0}}^{b_i-a_i} \boldsymbol{e}^{-\mu t}\boldsymbol{\mu}\ \boldsymbol{dt}$$

$$\mathbf{E}\ (\boldsymbol{V_i}) = \int_{\mathbf{0}}^{b_i-a_i} \boldsymbol{p}[\boldsymbol{life\ dies\ at\ time\ t}] \times \boldsymbol{t.dt} + (\boldsymbol{b_i} - \boldsymbol{a_i}) \times \boldsymbol{p}[\boldsymbol{life\ survives}]$$

Hence

$$\mathbf{E}\ (\boldsymbol{V_i}) = \int_{\mathbf{0}}^{b_i-a_i} \boldsymbol{t}.\boldsymbol{e}^{-\mu t}.\boldsymbol{\mu}.\boldsymbol{dt} + (\boldsymbol{b_i} - \boldsymbol{a_i})\boldsymbol{e}^{-\mu(b_i-a_i)}$$

3.5 CALCULATION OF PROBABILITIES OF AN INFECTED PERSON

We have that

$$\boldsymbol{q_x} = {}_{t}\boldsymbol{p_x} \times \boldsymbol{\mu_{x+t}} \text{ If } \mathbf{0} \le \boldsymbol{t} < 1$$

A person who has been infected by HIV/AIDS endures an addition to the force of mortality. We let ${\mu^*}_{x+t}$ be the corresponding force of a life subjected to an addition to the force of mortality.

$$\boldsymbol{\mu^*}_{\boldsymbol{x+t}} = \boldsymbol{\mu_{x+t}} + \boldsymbol{k},$$

Where k, is the addition to the force of mortality.

Hence

$${}_{t}\boldsymbol{p}_{x}^{*} = \boldsymbol{exp}\left[-\int_{\mathbf{0}}^{\boldsymbol{t}} \boldsymbol{\mu^*}_{\boldsymbol{x+r}}\boldsymbol{dr}\right]$$

$$= \boldsymbol{exp}\left[-\int_{\boldsymbol{0}}^{\boldsymbol{t}}(\boldsymbol{\mu}_{\boldsymbol{x+r}} + \boldsymbol{k})\,\boldsymbol{dr}\right]$$

$$= \boldsymbol{e}^{-\boldsymbol{kt}}\ {}_{\boldsymbol{t}}\boldsymbol{p}_{\boldsymbol{x}}$$

Therefore

$$\boldsymbol{q}_{\boldsymbol{x}}^{*} = \boldsymbol{\mu}^{*}{}_{\boldsymbol{x+t}} \times\ {}_{\boldsymbol{t}}\boldsymbol{p}_{\boldsymbol{x}}^{*}$$

$$= \boldsymbol{e}^{-\boldsymbol{kt}}\ {}_{\boldsymbol{t}}\boldsymbol{p}_{\boldsymbol{x}} \times (\boldsymbol{\mu}_{\boldsymbol{x+t}} + \boldsymbol{k}),\ \boldsymbol{0} \leq \boldsymbol{t} < 1$$

3.6 CALCULATION OF PREMIUMS

Supposing premiums are paid monthly and in advance. It’s clear that

Present value of premiums = present value of benefits
With the assumption that no expenses are put into consideration and the policy are nonprofit.

$$\boldsymbol{p}\ddot{\boldsymbol{a}}_{\boldsymbol{n}\rceil} = \boldsymbol{c}\boldsymbol{v}^{\boldsymbol{t}}$$

Where **p** is the premium, **c** is the claim amount and **t** is the expected waiting time i.e. $\boldsymbol{E}(\boldsymbol{V}_{\boldsymbol{i}})$

We also assume the interest rate of insurance companies is a constant 12% per annum

CHAPTER FOUR

4.0 DATA ANALYSIS

4.1 DATA DESCRIPTION

The aim of the study is to model insurance packages and probabilities of a HIV infected person in Kenya. For this study we are going to use data for 2010 from the *KENYA HIV AND AIDS MONITORING & EVALUAT ION ANNUAL REPORT 2008.*

Table4. 1: population and annual death due to HIV/AIDS and transition intensities

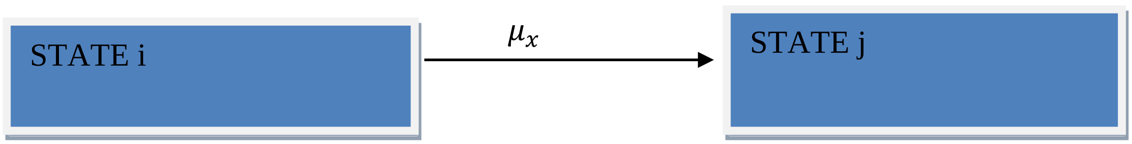
	0-14 YEARS	15 AND ABOVE YEARS
HIV POPULATION	157,813	1,558,449
NEW HIV INFECTION	29,698	127,905
ANNUAL AIDS DEATH	10,210	64,496
FORCE OF TRANSITION	0.064	0.041

Table 4. 2: Table for pregnancy, baby formulae and transition intensities.

No. of pregnant women	No. of HIV infected women	No. of HIV infected pregnant women	Cost of a packet of baby formulae	Duration of a packet	Number of packets required before weaning	No. of packets required before weaning	Total cost of baby formulae	Force of transition
1,529,000	913,434	130,082	Ksh. 840	2 days	180 days	90 packets	Ksh. 75,600	0.11285

4.2. TRANSITION PROBABILITY

A TWO STATE MODEL



To calculate the probability we use the formulae;

$$\boldsymbol{p_x = \exp\left[-\int_0^t \mu \, ds\right]}$$

And since our observation is within a year our integral boundaries will be from 0 to 1.

4.2.1 EXPECTATION OF D_i *and* V_i

<u>**Expectation of D_i**</u>

We redefine D_i,

$$D_i = \begin{cases} c & \textit{if the observed life dies} \\ 0 & \textit{if the observed life does not die} \end{cases}$$

Where c is the expected amount of claim for death

E (D_i) = c × $\int_0^{b_{i-a_i}} e^{-\mu t} \mu \, dt$

The observation period is 1 year hence,

E (D_i) = c $\times\int_0^1 e^{-\mu t}\mu\, dt$

But we know that

$$q_x = \int_0^1 e^{-\mu t}\mu\, dt$$

Hence

E (D_i) = cq_x but $q_x = 1 - p_x$

= c $[1 - p_x]$

<u>Expectation of V_i</u>

E (V_i) = $\int_0^{b_i - a_i} t.e^{-\mu t}.\mu.dt + (b_i - a_i)e^{-\mu(b_i - a_i)}$

But the observation time is 1 year hence $b_i = 1$ *and* $a_i = 0$

E (V_i) = $\int_0^1 t.e^{-\mu t}.\mu.dt + e^{-\mu}$

By application of integration by parts

$$\mu\int_0^1 t.e^{-\mu t}\, dt + e^{-\mu}$$

We have that

E (V_i) =$\mu\left\{\left[\frac{-te^{-\mu t}}{\mu}\right]_0^1 - -\int_0^1 \frac{e^{-\mu t}}{\mu}dt\right\} + e^{-\mu}$

$= \quad -e^{-\mu} + \int_0^1 e^{-\mu t}\, dt + e^{-\mu}$

$$= \int_0^1 e^{-\mu t}\, dt$$

$$= \frac{1}{\mu}\left[-e^{-\mu t}\right]_0^1$$

$$= \frac{1}{\mu}\left[1 - e^{-\mu}\right] \quad \text{but } e^{-\mu} = p_x$$

Therefore

$$\mathbf{E}\ (V_i) = \frac{1-p_x}{\mu}$$

4.3 WHOLE LIFE INSURANCE PREMIUM OF A 15+ INFECTED PERSON

A HIV infection – death model

$$\boxed{\text{HIV INFECTED}} \xrightarrow{\mu_x = 0.041} \boxed{\text{DEAD}}$$

$$p_x = \exp\left[-\int_0^t \mu\, ds\right]$$

$$= \exp\left[-\int_0^1 0.041\, ds\right]$$

$$= \exp\,[-0.041]$$

$= 0.9598$

E (D_I) = c [1-p_x]

=c [1-0.9598]

=250000×0.0402

= 10,042.72

E (V_i) = $\frac{1-p_x}{\mu}$

E (V_i) = $\frac{1-0.9598}{0.041}$

= 0.9805

Present value of claim

cv^t =E $(D_i)v^{E(V_i)}$

The rate of interest is 12% p.a

=10072.72×$[1.12]^{-0.9805}$

= 8986.55

Present value of premium = present value of claim

12p$\ddot{a}_{1]}^{(12)}$ = 8986.55 but $\ddot{a}_{1]}^{(12)} = \frac{1-V^n}{d^{(12)}}$

12p$\left[\frac{1-1.12^{-1}}{0.1128}\right]$ = 8986.55

11.3982p = 8986.55

P = 788.41

4.4 COMPREHENSIVE MATERNITY INSURANCE PACKAGE

As of April 2013 the government of Kenya instituted free maternity health care for all Kenyans who visit public hospital. This package is aimed on insuring exclusively the cost of baby formulae for babies who mother are HIV infected since breastfeeding is one form of MTCT. HIV infected mothers are advised against breastfeeding.

A HIV infected - pregnant HIV model

$$\boxed{\text{HIV INFECTED WOMEN}} \xrightarrow{\mu_x = 0.11285} \boxed{\text{PREGNANT HIV INFECT WOMEN}}$$

$$p_x = \exp\left[-\int_0^t \mu \, ds\right]$$

$$= \exp\left[-\int_0^1 0.11285 \, ds\right]$$

$$= \exp[-0.11285]$$

$$= 0.8933$$

E (D_i) = c [1- p_x]

= 75600[1-0.8933]

= 8066.52

$\text{E}\,(V_i) = \frac{1 - p_x}{\mu}$

$= \frac{0.1047}{0.11285}$

$= 0.9455$

Present value of claim

$cv^t = \text{E}\,(D_i)v^{E(V_i)}$

The rate of interest is 12% p.a

$=8066.52 \times [1.12]^{-0.9455}$

$= 7246.87$

Present value of premium = present value of claim

$12p\ddot{a}_{1]}^{(12)} = 7246.87$ but $\ddot{a}_{1]}^{(12)} = \frac{1-V^n}{d^{(12)}}$

$12p\left[\frac{1-1.12^{-1}}{0.1128}\right] = 7246.87$

$11.3982p = 7246.87$

$P = 647.06$

4.5 COMPARISION OF SURVIVAL PROBABILITIES OF AN UNINFECTED AND AN INFECTED PERSON

Assuming that an uninfected life is subject to probabilities of an ELT No.12 male life. A person who is HIV infected is subject to addition force of mortality.

In the case of 0-14 years they are subjected to a constant force of mortality of 0.064 while as those who are 15years and above are subject to addition force of 0.041

$$\boldsymbol{\mu^* = \mu + k},$$

Where k, is the addition to the force of mortality.

Hence

$$\boldsymbol{p_x^* = exp\left[-\int_0^t \mu^* dr\right]}$$

$$\boldsymbol{= exp\left[-\int_0^1 (\mu + k)\, dr\right]}$$

$$\boldsymbol{= exp\ [-(\mu + k)]}$$

$$\boldsymbol{q_x^* = 1 - p_x^*}$$

Table 4. 3: Probabilities table of a HIV infected and uninfected

AGE	p_x^h	q_x^h	μ_x^h	μ_x^i	p_x^i	q_x^i
0	.97551	.02449			.91503	.08497
1	.99843	.00157	.00210	.06610	.93603	.06397
2	.99901	.00099	.00134	.06534	.93675	.06325
3	.99931	.00069	.00079	.06479	.93726	.06274
4	.99938	.00062	.00063	.06463	.93714	.06286
5	.99943	.00057	.00059	.06459	.93745	.06255
6	.99948	.00052	.00054	.06454	.93749	.06251
7	.99952	.00048	.00050	.06450	.93754	.06246
8	.99956	.00044	.00046	.06446	.93757	.06243
9	.99959	.00041	.00048	.06448	.93755	.06245
10	.99961	.00039	.00040	.06440	.93763	.06237
11	.99962	.00038	.00039	.06439	.93764	.06236
12	.99962	.00038	.00038	.06438	.93765	.06235
13	.99959	.00039	.00039	.06439	.93764	.06236
14	.99953	.00043	.00043	.06443	.93760	.06240
15	.99941	.00059	.00052	.04152	.95933	.04067
16	.99922	.00078	.00067	.04167	.95919	.04081
17	.99901	.00099	.00089	.04189	.95898	.04102
18	.99888	.00112	.00107	.04207	.95880	.04120
19	.99883	.00117	.00115	.04215	.95873	.04127
20	.99881	.00119	.00119	.04219	.95868	.04132

21	.99882	.00118	.00119	.04219	.95869	.04131
22	.99886	.00114	.00116	.04216	.95871	.04129
23	.99892	.00108	.00112	.04212	.95875	.04125
24	.99898	.00102	.00105	.04205	.95882	.04118
25	.99901	.00099	.00100	.04200	.95887	.04113
26	.99902	.00098	.00098	.04198	.95889	.04111
27	.99900	.00100	.00099	.04199	.95888	.04112
28	.99896	.00104	.00102	.04202	.95885	.04115
29	.99891	.00109	.00106	.04206	.95881	.04119
30	.99885	.00115	.00112	.04212	.95875	.04125
31	.99879	.00121	.00118	.04218	.95870	.04130
32	.99872	.00128	.00125	.04225	.95863	.04137
33	.99864	.00136	.00132	.04232	.95856	.04144
34	.99855	.00145	.00140	.04240	.95849	.04151
35	.99845	.00155	.00150	.04250	.95839	.04161
36	.99833	.00167	.00161	.04261	.95828	.04172
37	.99819	.00181	.00174	.04274	.95816	.04184
38	.99804	.00196	.00189	.04289	.95802	.04192
39	.99786	.00214	.00205	.04305	.95786	.04214
40	.99765	.00235	.00224	.04324	.95768	.04232
41	.99741	.00259	.00246	.04346	.95747	.04253
42	.99713	.00287	.00273	.04373	.95721	.04279
43	.99681	.00319	.00303	.04403	.95692	.04308

44	.99644	.00356	.00337	.04437	.95660	.04340
45	.99601	.00399	.00377	.04477	.95622	.04378
46	.99552	.00448	.00423	.04523	.95578	.04422
47	.99495	.00505	.00476	.04576	.95527	.04473
48	.99430	.00570	.00538	.04638	.95468	.04532
49	.99356	.00644	.00607	.04707	.95402	.04598
50	.99272	.00728	.00687	.04787	.95326	.04674
51	.99177	.00823	.00777	.04877	.95240	.04760
52	.99070	.00930	.00878	.04978	.95144	.04856
53	.98949	.01051	.00993	.05093	.95035	.04965
54	.98816	.01184	.01121	.05221	.94913	.05087
55	.98669	.01331	.01263	.05363	.94778	.05222
56	.98508	.01492	.01420	.05520	.94629	.05371
57	.98332	.01668	.01590	.05690	.94469	.05531
58	.98141	.01859	.01776	.05876	.94293	.05707
59	.97935	.02065	.01978	.06078	.94103	.05897
60	.97713	.02287	.02197	.06297	.93897	.06103
61	.97475	.02525	.02433	.06533	.93676	.06324
62	.97222	.02778	.02684	.06784	.93441	.06559
63	.96951	.03049	.02953	.07053	.93190	.06810
64	.96661	.03339	.03243	.07343	.92920	.07080
65	.96352	.03648	.03553	.07653	.92632	.07268
66	.96022	.03978	.03884	.07984	.92326	.07674

67	.95668	.04332	.04239	.08339	.91999	.08001
68	.95288	.04712	.04622	.08722	.91647	.08353
69	.94878	.05122	.05036	.09136	.91269	.08731
70	.94434	.05566	.05487	.09587	.90858	.09142
71	.93953	.06047	.05976	.10076	.90415	.09585
72	.93430	.06570	.06509	.10609	.89934	.10066
73	.92861	.07139	.07092	.11192	.89411	.10589
74	.92241	.07759	.07730	.1183	.88843	.11157
75	.91566	.08434	.08432	.12532	.88221	.11779

Where

- p_x^h is the probability of an uninfected person age x surviving to age x+1
- q_x^h is the probability of an uninfected person age dying between age x and x+1
- μ_x^h is then force of mortality of an uninfected life at age x
- μ_x^i is then force of mortality of an infected life at age x
- p_x^i is the probability of an infected person age x surviving to age x+1
- q_x^i is the probability of an infected person age dying between age x and x+1

Probability –Age graph

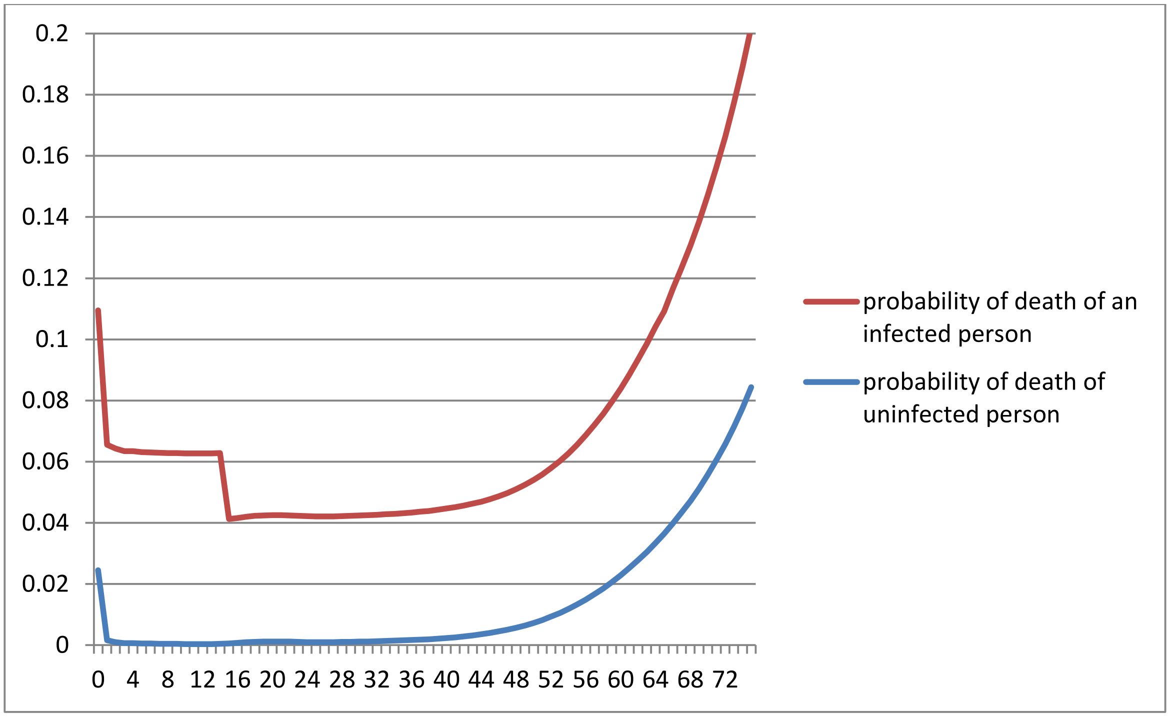


Figure 4. 1: Probability –Age graph

Age- Force of mortality graph

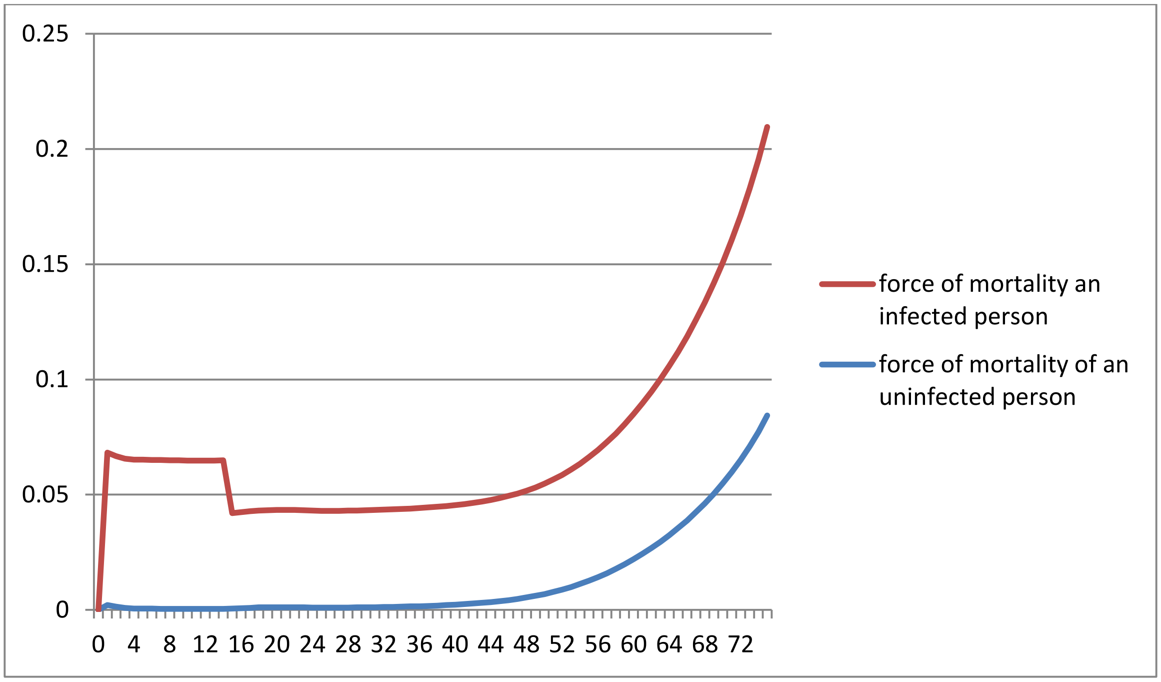


Figure 4. 2: Age- Force of mortality graph

CHAPTER FIVE

5.0 RECOMMENDATION AND CONCLUSIONS

5.1 ASSUMPTIONS OF THE STUDY

- That all HIV infected mothers don’t breast feed and all pregnant women attend ANC and are aware of their HIV status
- The whole life policy is undertaken at early stages of infection and not while in the final stages of infection. The insured party undertakes all intervention available to mitigate the effect of HIV on body functions
- That all HIV negative people in Kenya are subjected to life of ELT No.12 males.
- The insurance industry operates with a constant 12% interest rate.

5.2 LIMITATIONS

- The premiums are relatively high and the poor people in Kenya who are mainly affected in Kenya cannot afford to pay them.
- There is social stigmatization for mothers who do not breastfeed their children. As it’s taken as a sign of being HIV infected which can cause discrimination and being humiliated in the society.
- Constant transition intensity in ages within the children and adult group. The probability of dying due to AIDS differs for different age, social status and gender.

5.3 CONCLUSIONS

HIV/AIDS has an adverse effect on mortality in Kenya. The effect is more severe to those who are below the age of 15 whose main form of transmission of the HIV virus is through mother to child transmission. From *KENYA HIV AND AIDS MONITORING & EVALUAT ION ANNUAL REPORT 2008* majority of mothers who took ARV gave birth to children who were HIV negative but passed on the virus by breastfeeding the babies since the prices of baby formulae was high. The maternity insurance package would lessen the burden of buying baby formulae and ensure that the infant acquire the required nutrients.

The maternity insurance package would lessen the burden of buying baby formulae and ensure that the infant acquire the required nutrients.. The infected party would be able to rest assured that they loved ones are left with financial security and lessen the psychological burden of contemplating the future life of their loved ones once they pass on.

5.4 RECOMMENDATIONS

It's recommended that the following step should be undertaken to help lessen the burden of HIV;

- NHIF should come up with a policy specifically for covering maternity for HIV women since majority of HIV infected women cannot afford the proposed maternity cover in this study.
-

- Raise awareness on risk involved in breastfeeding by HIV infected women
- Introduce more life covers for the HIV infected.
- Educate the public on the need of undertaking insurance coverage
- Educate the public on the adverse effect of HIV/AIDS especially those in rural areas

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