

**TRENDS AND DETERMINANTS OF HIV PREVALENCE IN ZAMBIA:
Evidence from surveys in selected communities**

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**The degree philosophiae doctor (PhD)
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Philosophiae Doctor (PhD) Thesis



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Dedicated to

My wife Lilian Banji Namulimbwe Mweetwa
Our children, Chipu Mpikwa Mweetwa & Kalinda Nachimena
My parents Timothy & Nchimunya Michelo
and
My grandmother Kalinda Nacheembo

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List of original papers

The thesis is based on the following papers referred to in the text with their roman numerals

- Paper I. Charles Michelo, Ingvild F Sandøy, Kumbutso Dzekedzeke, Seter Siziya, and Knut Fylkesnes (2006). Steep HIV prevalence declines among young people in selected Zambian communities: population-based observations (1995-2003) *BMC Public Health* 6:279
- Paper II. Charles Michelo, Ingvild Fossgard Sandøy, and Knut Fylkesnes (2006). Marked HIV prevalence declines in higher educated young people: evidence from population based surveys (1995-2003) in Zambia. *Aids* 2006; 20 (7): 103-8
- Paper III. Ingvild Fossgard Sandøy, Charles Michelo, Seter Siziya, and Knut Fylkesnes (2006). Changes in sexual Behaviour among young people associated with HIV prevalence decline in Zambia. (Submitted)
- Paper IV Charles Michelo, Ingvild Fossgard Sandøy, and Knut Fylkesnes (2006). Antenatal clinic HIV data found to underestimate actual prevalence declines: Evidence from Zambia. (Submitted)

List of Abbreviations

PBS	Population-based survey
ANC	Antenatal clinic
CSA	Census Standard Area
SEA	Standard Enumeration Area
HIV	Human Immuno-deficiency Virus
PSU	Primary Sampling Unit
SSU	Secondary Sampling Unit
OR	Odds Ratio
AOR	Adjusted Odds Ratio
CI	Confidence Interval
MoH	Ministry of Health
GRZ	Government Republic of Zambia
WHO	World Health Organisation
UNAIDS	United Nations Joint Programme on HIV/AIDS
CSO	Central Statistical Office, Zambia

Abstract

HIV epidemics continue to represent a public health threat worldwide, leading in causing deaths in sub-Saharan Africa. UNAIDS has largely relied on the ANC based sentinel surveillance system to estimate the magnitude, patterns and trends of the HIV/AIDS epidemic. Knowing the magnitude of the disease problem is cardinal in all surveillance systems. One way of understanding the distribution and determinants of the HIV infection is to carry out studies on trend and focus on both individual and group level characteristics. Disease trends provide information about the past and current spread, and may be extremely useful in predicting future patterns of the disease, which in turn is important in adjusting public health policy and interventions. Establishing a functioning surveillance system is the best way to do this. However, although extensive work has been carried out on the epidemiology of individual risk factors of HIV in Zambia, work on patterns and trends of infection with focus on behaviour and exposures, has been limited. Furthermore, of the available work, a large proportion of it has not been guided by conceptual frameworks from data collection, analysis to interpretation of key associations between variables. Employing a framework forms a strong validity foundation on the interpretation of associations between variables. The aim of this thesis was to examine trends of HIV infection, explore factors that are associated with the transmission of HIV, evaluate magnitude and direction of potential biases associated with such surveys as well as to investigate whether antenatal (ANC)-based HIV prevalence can be extrapolated to the prevalence trend of men and women in the general population. In achieving these objectives, the proximate-determinants conceptual framework was applied as a guide.

In Zambia the HIV epidemic has been predominantly monitored using cross-sectional surveys that include both ANC-based sentinel surveillance and population based surveys (PBS). The ANC-based surveillance system was established in 1990 with a few sites, and was conducted thereafter in 1994, 1998, 2002 and in 2004. In Kapiri Mposhi and Chelstone, a series of cross-sectional surveys on HIV prevalence and risk factors were also conducted in 1995, 1999 and 2003 among randomly selected men and women. The data used in this thesis stem from the respondents in 1995 (n=3158), 1999 (n=3731) and 2003 (n=4751) aged 15-59 years who had completed the questionnaire and had a validated saliva test result for HIV. However, Chelstone was the only site that had both

ANC-based and population-based HIV prevalence estimates from the same population consistently. Thus, when investigating to what extent ANC-based estimates pick HIV prevalence trends among men and women, only ANC data from Chelstone (n=450, n=810, n=786 respectively) was validated with appropriate population-based data.

In general prevalence declined in all age groups but the decline was most convincing in young people aged 15-24 years. In this age group, prevalence declined by 59.2% (P<0.001) among rural females, by 44.6% (P<0.001) in rural males, by 47% (P<0.001) in urban females and by 57.3% (P=0.001) among urban males. It was further observed that these HIV prevalence declines were concentrated in groups with higher education. In 2003, young people with higher education had lower odds of infection than in 1995 in both urban [men: AOR 0.29(95%CI 0.14-0.60); women: AOR 0.38(95%CI 0.19-0.79)] and rural groups [men: AOR 0.16(95%CI 0.11-0.25), women: AOR 0.10(95%CI 0.01-7.34)]. Furthermore, urban young people who attended school for ≥ 11 years, reported increased use of condoms during the last casual sex (AOR 2.96 95%CI 1.93-4.52) over the period. Similarly, young people with higher education less often reported any casual sexual partners in the last twelve months (AOR 0.33; 95%CI 0.19-0.56) than groups with lower education. In addition, there were substantial delays in childbearing observed in this group in both the rural and urban areas. The most significant cause for non-participation was absence in men, but refusal to provide saliva remained <10% in all survey rounds in both sexes. The group of participants reporting to be highly mobile was used as sentinel of HIV infection for men who were absent. However, it was observed that even in these mobile groups there were significant prevalence declines in urban men and less prominently in the rural men. Notwithstanding the presence of selection biases due to non-response, they are unlikely to be an important factor explaining the sharp HIV prevalence declines among young people.

ANC-based data understated HIV prevalence for the general population. ANC-derived prevalence in Chelstone only declined by 20% (25.0% to 19.9%; P=0.101) in age group 15-24 years and was stable overall. In sharp contrast, population-based HIV prevalence declined by 44% (P<0.001) and by 27% (P<0.001) in age group 15-24 and 15-49 years respectively among women only. These declines were concentrated among higher educated women (P<0.001). Furthermore, in age group 15-19 years, the proportion of women ever given birth declined by 57% (AOR 0.43 95%CI 0.26-0.68) over the period.

The observed declines among young people were consistent with behaviour change. The observed parallel between HIV prevalence declines and behaviour change is a positive sign indicating that prevention programs in Zambia are bearing fruit. The concentration of the declines in young people with higher education suggests that the declines are due to behaviour change rather than increased mortality. Therefore, the power of educational attainment in reducing the HIV incidence by modifying people's behaviour should not be under-estimated. In addition, the stable risk among groups with less education might also indicate limitations in reaching some groups in the past. Lastly but not the least, the under-estimation of declines observed among ANC attendees requires further research.

1. INTRODUCTION

1.1 Historic synopsis and virological description

It is now the third decade since the Human Immuno-deficiency Virus (HIV) was first detected and described in human populations, yet the epidemic continues to represent a colossal public health threat worldwide, with 38.6 million people estimated to be living with the virus by the end of 2005(1, 2). It remains one of the leading causes of adult mortality in Africa and is among the top ten leading causes of Disability Adjusted Life Years (DALY) losses globally (3, 4). However, research efforts have dramatically increased the level of knowledge regarding its transmission and associated determinants of the infection since the epidemic started (2, 5, 6).

HIV, a retrovirus of the lentivirus subfamily, is closely related to the Simian Immuno-deficiency virus (SIV) whose hosts are largely primates (Mangabey monkeys) (5, 7). In human beings, HIV infection results when the viral particle attaches itself to CD4 T-lymphocyte receptors and eventually destroys the lymphocyte (8). Two types of HIV infection exist, the HIV-1, which has a ubiquitous distribution, and the HIV-2 mainly occurring in West Africa (7, 9, 10). HIV-1 has three distinct phylogenetic strains, namely M (Main), New (N, or non-M, non-O), and outlier (type O) (10). Further HIV-1 global sampling has revealed several genetic sub-types of the M group designated as A-K (11). Subtypes A, C, D, F, G, H, J, K, N and O are all distributed in Central Africa though, subtype A and C are the predominant types. Although it is not very clear whether the diverse phylogenetic differences that exist among the various forms of HIV-1 strains have similar divergent transmissibility potentials, these diverse phylogenetics might partly explain some of the emerging global and regional HIV infection patterns (12-15). The impact of this genetic diversity of HIV-1 in public health necessitates surveillance strategies that also systematically sample and characterise representative and predominant strains from populations whilst concomitantly monitoring proximate indicators and any other factors that may be associated with the infection (13). This background is critically important whilst estimating the magnitude of the HIV epidemic.

1.2 Estimation of HIV magnitude- Surveillance

One way of understanding the distribution and determinants of the HIV infection is to carry out studies on trend and focus on both individual and group level characteristics. Disease trends provide information about the past and current spread, and may be extremely useful in predicting future patterns of the disease, which in turn is important in adjusting public health policy and interventions (16). Establishing a functioning surveillance system is the best way to do this. Surveillance is the continued observation of all aspects of the occurrence and spread of the disease, which is necessary for its prevention and control (16). Knowing the magnitude of the disease problem is cardinal in all surveillance systems. Among other things, the aim of any disease surveillance is to study the natural history and the epidemiology (17, 18). This helps to describe critical determinants that are necessary for the understanding of its spread, control and prevention (16, 19). Secondly, surveillance aims at providing baseline information that is useful to assess impact of prevention and control strategies (20).

Globally the magnitude of the HIV epidemic has been estimated through cross-sectional surveys among antenatal clinic (ANC) women and selected population groups. Recently more nationally representative surveys such as the Demographic and Health Surveys (DHS) have been conducted. In some countries, trends of HIV infection in selected cohorts of population sub-groups such as commercial sex workers (CSW), intra-venous drug users (IDU), men who have sex with men (MSM), truck drivers and military personnel are also available. Prospective cohort studies have been applied in several countries but are very costly and often not entirely representative of persons at highest risk of infection (21). Obtaining samples that are representative of the population has been desirable but often difficult to achieve, hence a pragmatic approach of utilising consistent sampling frames among cohorts has been designed so as to detect important changes over time (21, 22). The World Health Organisation (23) and the Joint United Nation programme on HIV/AIDS (UNAIDS) has largely relied on the antenatal clinic (ANC) based surveillance system to estimate the magnitude, patterns and trends of the HIV/AIDS epidemic (1, 23-25). Ensuring accuracy and maintaining quality in surveillance is and has been cardinal and

HIV surveillance laboratory services have continued to be critically essential in this regard.

Epidemiological surveillance, when carried out correctly, can provide more extensive description and analyses of the determinants of the HIV infection. However, Boerma and Weir (2005) argue that there are still many research issues that remain unresolved before we can fully comprehend the distribution and determinants of the HIV infection in most affected populations, like in sub-Saharan Africa, especially on how best to measure some of the underlying factors (26). The description of the critical areas where the main challenges have been observed is described in the next section.

1.3 Research Gaps

In the recent past, extensive work has been carried out on the epidemiology of individual risk factors with focus on behaviour and exposures. However, a large proportion of this work has not been guided by conceptual frameworks that could have helped not only in data collection, but also in the analysis and interpretation of key associations between variables. Against this background, it is now argued and proposed that the proximate-determinants conceptual framework, that integrates both demographic and epidemiological approaches, be employed in the study of social and biological variables associated with the HIV infection (26). It is further argued that employing a framework, forms a strong validity foundation on the interpretation of associations between variables. The synopsis of the thesis focus is given in the following section.

1.4 Thesis focus

The present thesis has been under-taken with a view to attempt to describe key distribution and determinants of HIV infection in Zambia by examining the available ANC- and population-based surveillance data from selected communities in Zambia collected between 1994 and 2003. In doing so, a modified proximate-determinants conceptual framework described by Boerma and Weir was employed (26). The thesis describes the declining trend of HIV infection in the general population (paper I). A risk factor analysis of HIV infection with focus on socio-demographic characteristics led to a detailed

description of marked HIV prevalence decline seen among higher educated younger people in both sexes (Paper II). Educational attainment forms a core representation of the underlying determinants that are often used to define a “socio-economic context”. In order to understand possible explanations for the declining HIV prevalence among young people, sexual behaviour patterns also were examined. The concentration of sexual behaviour changes among higher educated young people corroborated well with parallel HIV decline in this group (Paper III). Since HIV prevalence among pregnant women attending antenatal clinics (ANCs) remains the principal data source of infection patterns in the general population in sub-Saharan Africa in many countries, the comparability of ANC-based with population-based HIV data in one source urban population was also examined. The ANC-based estimates substantially underestimated declines in HIV prevalence in the general population (Paper IV).

1.5 The Proximate-determinant conceptual framework

In the 1950s, Davis and Blake, advocated for the use of conceptual frameworks in comparative studies and introduced the concept of intermediary variables as plausible “*modi operandi*” for any social factors influencing fertility patterns in human populations (27). This concept has been further advanced and based on that original concept, Bongaarts introduced the term “proximate determinants” in place of intermediary variables in the prevailing fertility studies and discussions of the time (28-30). The “proximate-determinants model” proposed by Boerma and Weir, was based on these model concept developments from earlier work (Figure 1).

The critical feature of the proximate-determinants framework is the identification and categorisation of proximate determinants, which can either be biological or behavioural or indeed both(26). These proximate determinants are linked with contextual factors and intervention programs on the left (underlying determinants) and biological determinants on the right and this interaction have a health outcome, which in this thesis was HIV prevalence. The underlying determinants comprise the contextual variables (socio-economic, cultural, environmental and demographic factors) as well as intervention programs. These must operate through proximate determinants in order to influence a biological

outcome. This distinction between underlying and proximate determinants is uniquely important concept because it has been noted that regression models that put these factors together produce bizarre findings, which are difficult to understand(26, 31). Therefore separation of these pathways is a concept that must improve modelling and understanding of the both the hierarchical and non-hierarchical associations. The biological determinants in this model are social and biological factors that affect the probability of getting infected with HIV. In other words, they influence the reproductive number, that is the average number of secondary cases that result from a single new infection (16). For this to take effect, it will depend on many biological parameters. These are generally referred to as biological determinants in this model and are largely grouped as factors that change the rate of exposure, efficiency of transmission during exposure as well as the duration of infectivity during the exposure period(26). It is clear that measuring these factors directly is not easy but they can be estimated from the proximate determinants. What is clear is that reducing any of these biological factors to zero will stop transmission. This means modifying the proximate determinants should have impact on transmission. For example, increasing condom use to 100% should theoretically stop transmission. These pathways are however, not as easy as portrayed here but it clearly shows that proximate determinants are key in this transmission pathway. Therefore the understanding of patterns of HIV infection must revolve around understanding the interactions that have to do with proximate determinants(32). The health outcome, in this case HIV infection, is also linked to the posterior pathways in a “feedback mechanism” which estimates the probability of exposure of susceptible persons to infected individuals. This will largely be dictated by transmission networks and has been suggested to be the key differentiating feature between infection patterns in heterosexual transmission and other types. This cyclic feature is peculiar to infectious disease epidemiology and is what predominantly differentiates this model to earlier models in fertility studies(26).

Although this model description does not take in account all possible complex and multi-level interactions that could possibly go on between underlying, proximate, biological and main health outcome, it is a useful descriptive, analytical and interpretative tool for HIV infection patterns in its present form. In

this thesis, age, sex, residence, employment, marital status, travel patterns, religion as well as education were the key underlying determinants (Paper I and Paper II). Sexual behaviour patterns were used as proximate determinants and HIV sero-status defined the health outcome (paper IV).

1.6 Background to the ZamCoreEpi project

In Zambia, a diagnosis of the first case of AIDS was made in 1985 at the University Teaching Hospital (UTH), in Lusaka(33). By 2005, it was estimated that up to about 1,100, 000 people were living with HIV and more than 100,000 registered deaths due to AIDS alone, one third of which comprised children(1). In this country, the HIV epidemic has been monitored using both ANC-based and population-based surveillance systems. The Zambia core HIV epidemiology survey system was established to provide a comprehensive database over time regarding the HIV epidemic. Presently, available and accessible data are from the following sources:

- a) ANC-based surveillance – 1993 (10 sites), 1994 (27 sites), 1998 (22 sites), 2002 (24 sites) and 2004 (24 sites). The aim has been to repeat the surveys every second year.
- b) Population-based surveys in selected rural (Kapiri Mposhi) and urban (Chelstone) areas were conducted in 1995/6, 1998/9 and 2003.

The Norwegian Programme for Development, Research and Higher Education (NUFU) is a Norwegian programme for academic research and educational co-operation based on equal partnerships between institutions in the South and in Norway. During the period, there has been a NUFU-administered collaborative HIV surveillance project between the University of Zambia (Department of Community Medicine, School of Medicine and the Institute for Economic and Social Research-INESOR) and the Centre for International Health (CIH) at the University of Bergen (UiB), Norway. In addition the other collaborating organisations horizontally in Zambia were the Central Statistical Office (CSO) and the Ministry of Health through the National HIV/AIDS/STI Council (NAC). The ownership of the database is vested in the Central Statistical Office, which is mandated by an Act of Parliament of the Republic of Zambia regarding the storage, usage and dissemination of such information. In line with project objectives, the collaboration has a working group co-ordinating all activities

regarding the HIV epidemic using data from both the ZamCoreEpi and other sources such as the Demographic and Health Surveys (DHS) and Sexual Behaviour Surveys (Table 1).

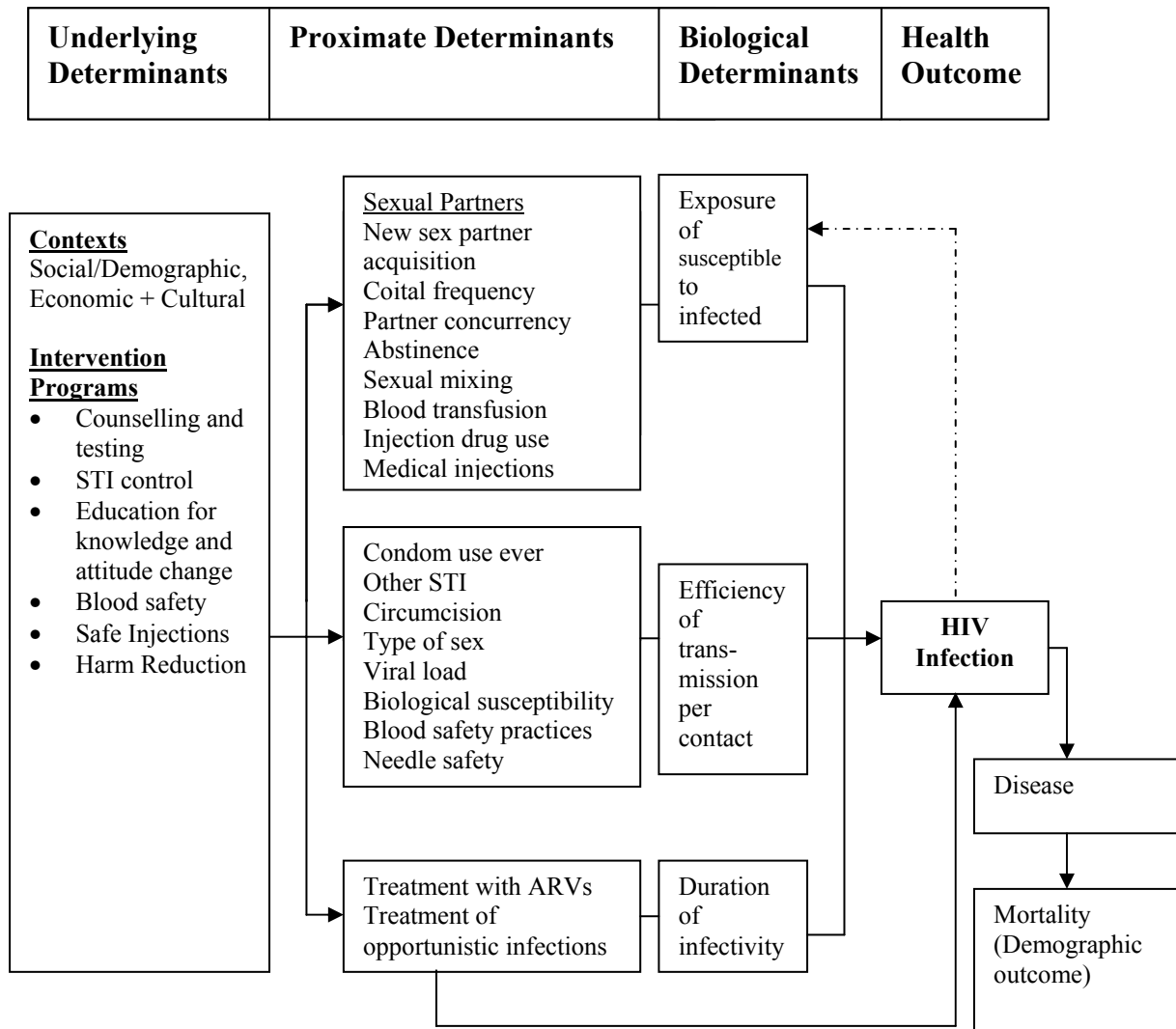
Table 1: Principal data sources on HIV infection in Zambia

Survey Type	Main Variables	Data Collection Period	Main Purpose
ANC-based Sentinel Surveillance	1. HIV test 2. Socio-demographic	Since 1990, 1993, more comprehensive from 1994, 1998, 2002 & 2004	Estimates on HIV & syphilis prevalence and trends
Population Based Surveys (focussed, open cohort in selected urban and rural populations)	1. HIV status 2. Mortality & morbidity; health status 3. Socio-demographic 4. Risk factors 5. Fertility and contraception etc	1995/1996 1998/1999 2003	1. Validation of ANC based estimates of HIV prevalence and trends 2. Risk explorations; Measure mortality by HIV status, fertility impact, health status, health care use etc.
National Survey on HIV	1. HIV 2. Place, age and sex	2002	Providing national prevalence estimates by sex and urban/rural residence
National Surveys on Risk	1. Socio-demographic 2. Risk Behaviour	1. DHS (1996, 1998, 2002; 2005 data collected) 2. Sexual Behaviour (1998, 2000, 2003, 2005)	1. Risk over time 2. Demographic parameters

1.7 Rationale

Many countries have established systems for providing information on the magnitude and trends of the HIV epidemic, but conceptual frameworks have often not guided this process(26). This often raises validity concerns regarding eventual conclusion arising from explaining both hierarchical and non-hierarchical association, which in turn has huge policy implications. There is urgent need therefore to explain the observed patterns and differential trends of the HIV epidemic using studies that employed conceptual frameworks from data collection, analysis to interpretation of the findings. In this thesis, the “Proximate-determinants framework” was employed in order to explain the observed patterns and differential trends of the HIV epidemic in the communities studied (Figure 1).

Figure 1: Proximate-determinants conceptual framework for factors affecting risk of sexual transmission of HIV, antiretrovirals (ARVs) and Sexually Transmitted Infections (STI); [Source: Journal of Infectious Diseases 2005:191(supplement) S61]



2. STUDY AIMS & OBJECTIVES

2.1 Overall objective

To examine trends of HIV infection and explore factors that may be associated with the transmission of HIV in subgroups of the population Zambia.

2.2 Specific Objectives

- 2.2.1 Describe the HIV prevalence trend among young people aged 15-24 years during the last 10 years, and describe the possible explanations for the changes (Papers I, II & III)
- 2.2.2 Study how educational attainment is associated with the likelihood being infected with HIV – and how this association might change over time in the general population (Paper II)
- 2.2.3 Examine how sexual behaviour changed in the general population between 1995 and 2003, and study how this was associated with educational attainment and HIV transmission (Paper I and III)
- 2.2.4 Compare and contrast ANC-based and population-based HIV prevalence derived from the same geographical area and, study the representativeness of ANC-based estimates in capturing the HIV prevalence trend in the general population (Paper IV)
- 2.2.5 Explore possible types, magnitude and direction of biases in the population based HIV surveys (Paper I, II, III, & IV)

3. METHODS

3.1 Study area and population

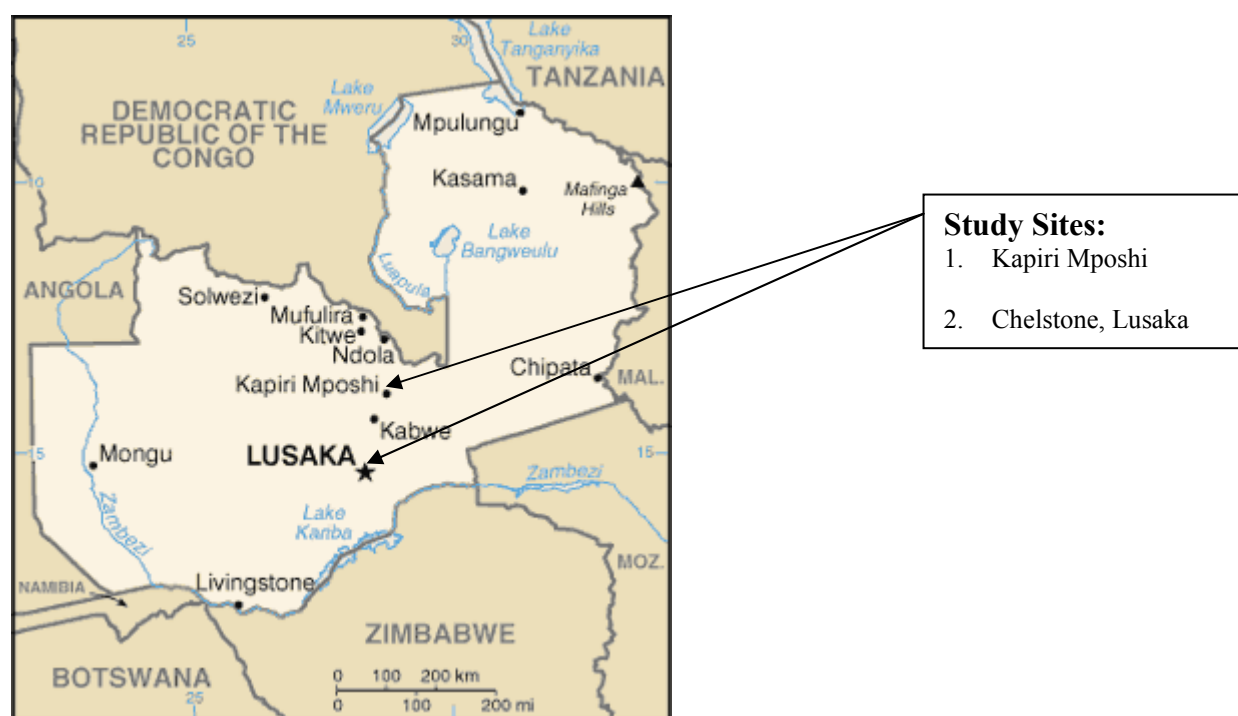


Figure 2. Map of Zambia

Zambia is a landlocked country situated in South Central Africa and shares borders with Tanzania, Malawi, Mozambique, Botswana, Zimbabwe, Namibia, Angola and Democratic Republic of Congo (Figure 2). Its population was 10.2 million in 2001 and is estimated to be approximately 11.5 million currently. Young people less than 16 years account for approximately 51% of the population. The high population growth in this country is largely due to high fertility rates, estimated to be 6.7 children per woman(34). Life expectancy at birth decreased from 54 years in the mid-1980s to 37 years in 1998 at the peak of HIV epidemic, but is estimated to be around 50 years now (males- 48, females-52)(35-37). Zambia's Gross Domestic Product (GDP) per capita is \$320, substantially lower than the average for Sub-Saharan Africa (\$480). The economy is based largely on copper and cobalt mining, which accounts for about 80% of the export earnings. Although mining is the main source of revenue for the country, approximately 75 percent of Zambia's population is engaged in subsistence farming. As a result, agriculture's vulnerability to weather fluctuations is partly given a reason why poverty levels (people living under one dollar a day) are as high as 73% (85% in some districts)(38, 39). The adult literacy rate is approximately 75%, 66% in urban & 37% in

rural areas have access to sanitation & safe water, and the prevalence of under-5 malnutrition (underweight) is estimated to be 23.5%(38, 39). The country is divided into eight geographical regions from which the nine administrative regions (provinces) and has a total of 72 districts. Kapiri Mposhi district is in Central Province and Chelstone is in Lusaka province.

In order to have a representative urban and rural population whose socio-demographic profile matched with typical respective urban and rural communities, Chelstone (urban) and Kapiri Mposhi (rural) were selected for the studies. Chelstone is a residential suburb in Lusaka, situated on the eastern part of the city. It has a high-density population and is typical of an urban suburb in Zambia. Kapiri Mposhi is an in-land port, situated approximately 192 kilometres north of Lusaka along the Great North road and it is the main link to the Copperbelt Province which shares a border with the Democratic Republic of Congo in the north. It is the gateway to Tanzania by both rail and road networks. It has a low population density, which is composed of urban, peri-urban and wide spread village based population.

3.2 Design, sampling and data collection

3.2.1 Population based surveillance design

Zambia is divided into statistical work areas called Census Supervisory Areas (CSAs), which in turn are divided into Standard Enumeration Areas (SEAs). On average, each CSA consists of about three SEAs. The first population-based HIV survey in Zambia was conducted in 1995 in Chelstone and Kapiri Mposhi and two follow-up surveys were later conducted. The sampling frame consisted of all CSAs and SEAs. The Primary Sampling Unit (PSU) consisted of 24 and 26 SEAs in Chelstone and Kapiri Mposhi respectively. The "measure of size" for the SEAs was determined by counting the number of households in each area based on the 1990 Census of Population household figures. Using William Cochran's definition of "probability proportional to measure of size", 10 SEAs were randomly selected in each respective site.(40). The Secondary Sampling Unit (SSU) was the household and it was sampled on a 100% basis,

corresponding to 1212 and 1111 households in the urban and rural areas respectively. In order to increase the number of rural sites in Kapiri Mposhi in 1999, 5 more typically rural SEAs were sampled adding another 463 households. The urban clusters were not followed. This meant that a total of 2786 households were followed.

In the sampled clusters, a personal structured interview was carried out with all eligible household members aged ≥ 15 years in order to collect information on education, socio-demographic characteristics and risk behaviours. The second part of the interview involved HIV testing using saliva. This was done after pre-test counselling with trained counsellors. Once collected, saliva specimens were stored in a central place and then transported once a week for testing at a national reference laboratory (University Teaching Hospital, Lusaka). This laboratory which was run with the help of Japanese International Co-operation Agency (JICA), is the main laboratory for the country and maintains strict quality assurance schedule. A two-test algorithm was employed. In 1995, all saliva samples were tested using Gacelisa HIV 1 & 2 (Welcome Diagnostics, Dartford, Kent, U.K.) and initially 450 randomly selected samples were tested using Bionor HIV- 1 & 2 (Bionor AS, Skien, Norway) magnetic particle assay following modifications for saliva. Agreement between the two test kits was 99.8%(41). The accuracy of Gacelisa was validated based on paired saliva and serum samples collected from 494 antenatal clinic attendees, and both sensitivity and specificity were 100%. In the 1999 and 2003 follow-up surveys, samples were tested using Bionor HIV 1 & 2 and we maintained the two-test strategy. In addition, 10% of negative and 10% of positive samples were periodically sampled and re-tested for exactness with initial results and a different and senior person from a different section of the reference laboratory, during all the survey rounds. In this country, HIV test disclosure of results requires that a blood test must have been conducted instead of saliva. Therefore, all respondents who wanted to know their results went through pre-test counselling with this information made available to them before their blood specimen was collected. When the result was ready, post-test counselling was also done. The testing with blood was also used as a validation strategy and quality assurance marker for the laboratory procedures during saliva testing.

The data used in this thesis stem from the respondents in 1995 (n=3158), 1999 (n=3731) and 2003 (n=4751) aged 15-59 years who had completed the questionnaire and had validated saliva test result for HIV.

3.2.2 Antenatal based surveillance design

ANC-based HIV surveys conducted in Chelstone and Kapiri Mposhi are part of the national ANC-based surveillance program. However, in the respective period, the catchment areas were redefined in Kapiri Mposhi in the follow-up surveys. In view of this change, it also meant that the population during follow-up was different from baseline, making trend analysis for this site difficult to interpret if carried out. Therefore, only the methodological procedures for surveillance in Chelstone are presented in this thesis.

The first epidemiological HIV sentinel surveillance among ANC attendees in Chelstone was conducted in 1990 as a pilot followed by another in 1993. However, the sample sizes in these surveys were small and lacked appropriate population-based data for validation. In 1994, the core antenatal based HIV surveillance for the whole country was established, repeated in 1998 and in 2002 and only data from these periods is presented (n=450, n=810, n=786 respectively). Pregnant women who were attending the antenatal clinic for the first time in the pregnancy were enrolled consecutively. Data was collected within a maximum of 4 months. The target number for enrolment in this site was 800 participants. Serum from residual blood samples drawn for syphilis screening was tested unlinked and anonymously using Capillus HIV-1/HIV-2 rapid test (Cambridge Biotechnology, Galway, Ireland) at the ANC clinic. Randomly selected negative samples (5% in 1994 and 1998, 10% in 2002) and all positive samples were re-tested at the national laboratory using Wellcozyme HIV Recombinant HIV-1 (Murex, Johannesburg, South Africa). A third test, Bionor HIV-1 & 2 (Bionor As, Skien, Norway), was employed on the samples with discordant results of tests one and two, and this third result was considered final.

3.3 Statistical procedures

The main statistical methods employed were logistic regression, chi-square, trend tests and student's t-test. Statistical Package for Social Sciences Version 11.5 & 14 for Windows (SPSS, Chicago, Illinois, USA) and Intercooled Stata version 8 (College Station, Texas, USA) were used for overall statistical analysis. Epi-info version 6.04 (Centres for Disease Control and Prevention, Atlanta Georgia, USA) and OpenEpi (Atlanta Georgia, USA) were used for trend analyses. Stata was also used to calculate confidence limits of all odd ratios (OR) taking into account the cluster effect among the SEAs in the regression analysis (Paper I, II, III & IV). Educational level was measured using number of formal school years a respondent attained excluding night school and adult education years, (Paper I & II)(42). All analyses were stratified by age, sex and residence (rural vs. urban). Prevalence was standardised for age using the Zambian census (2000) as standard population (Paper I, II & IV). In multivariate logistic regression models, all results were adjusted for age as a continuous variable in the 15-24 years category and for age group in the 25-49 years category (grouped as 15-19, 20-24, 25-29, 30-39 and 40-49 years).

3.4 Ethical considerations

The National AIDS Research Committee approved the protocol for the ANC based surveillance system in 1990 and all HIV testing was done unlinked and anonymously as part of routine standard antenatal care in Zambia(43). The population based survey protocols received clearance from the National AIDS Research Council and the University of Zambia Research Ethics Committee (IRB00001131 of G0000774)(44, 45). The age for consent in Zambia is 16 years. In view of this, the parents or guardians gave consent for participation involving participants who were aged 15 years. The testing algorithm in both the population-based and the antenatal-based surveys complied with the WHO/UNAIDS guidelines for conducting such surveys.

4. RESULTS

4.1 Participation and distribution

Details of participation in the population-based surveys are summarised in Table 2. Overall, the most important cause of non-participation was absence, interview refusals or refusal to give a saliva sample for HIV testing (which was <10% in all surveys). The major reasons for absence were being away for business (fishing), at school, in hospital or travelled out temporarily for any other reason. The overall response rate for completing the interview and being tested for HIV among those aged 15-59 years was 77.4%, 64.5% and 72.3% in 1995, 1999 and 2003 respectively. In the ANC-based surveillance in Chelstone, sample sizes were 450, 810 and 786 in 1994, 1998 and 2002 respectively.

Table 2: Overall (Age group, ≥15 years) participation and response rates (percentages) of the population-based surveys conducted between 1995-2003 in selected rural and urban areas of Zambia

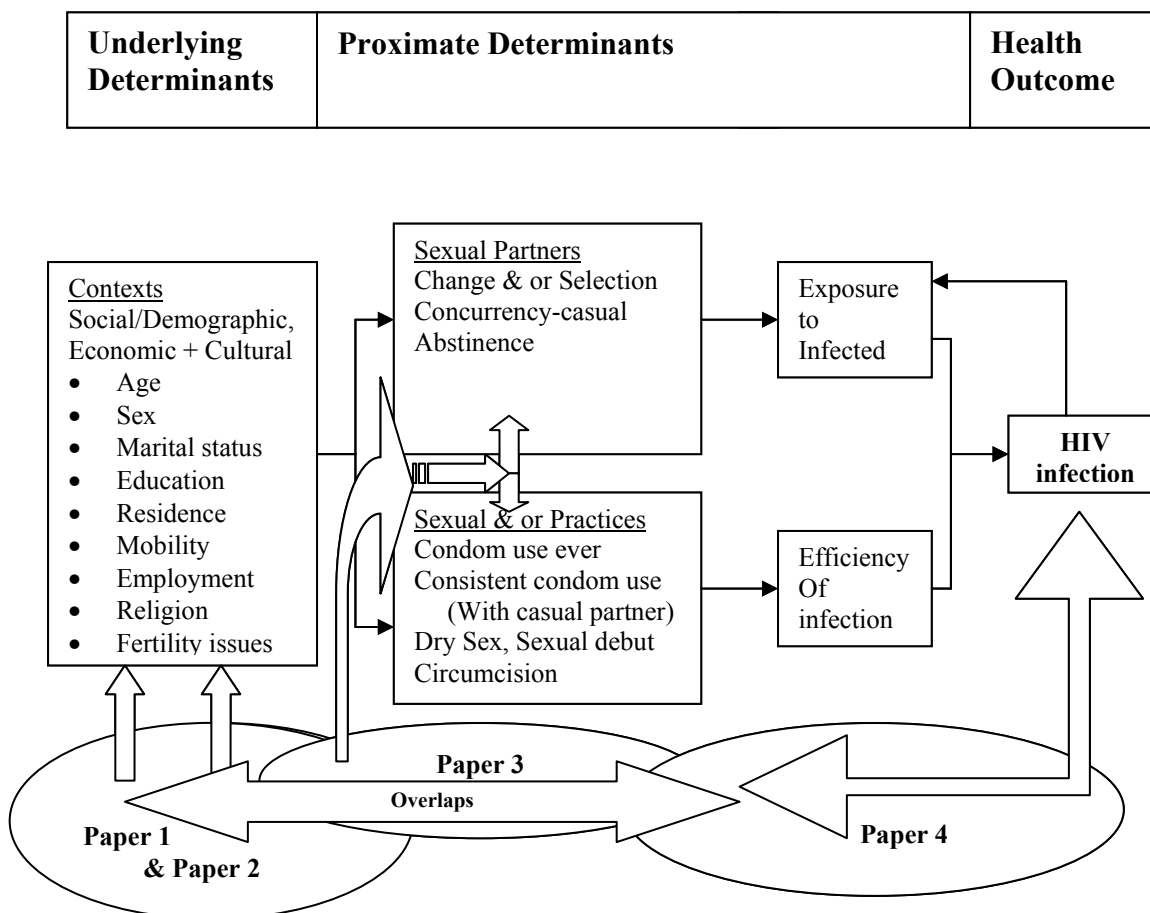
		1995	1999	2003
Listed		5847	6235	6791
Absent		927 (15.9%)	1763 (28.3%)	1346 (19.8%)
De facto eligible (found)		4920	4472	5445
Refused interview		108 (2.2%)	53 (1.2%)	185 (3.4%)
Interviewed		4812 (97.8%)	4419 (98.4%)	5260 (96.6%)
Saliva test	Accepted	4499 (93.5%)	4021 (91%)	4913 (93.4%)
	Refused	281(5.8%)	397 (9%)	347 (6.6%)
	Lost	32 (0.7%)	--	--
	Damaged or Mislabelled	162	264	162
Sample (Interviewed & tested, Less damaged/mislabelled) §		4337 (88.2%)	3757 (84%)	4751 (87.3%)
Final sample age 15-59 years		3158	3731	4751
Response (%) (Listed-[absent & refusals]/listed*100)		77.4%	64.5%	72.3%

Notes: 1. §Percentages in the final sample analysed represents proportion of participation out of the de facto eligible population. 2. Information by sex was incomplete in the file linking the listed and interviewed respondents. 3. Table adapted from Paper 1

4.2 Summary of results of individual papers

Figure 3 gives a schematic illustration of how the papers are linked with each other, and their main focus when viewed in the light of the proximate-determinant conceptual framework.

Figure 3: Proximate-determinants conceptual framework for factors affecting risk of HIV transmission based on observations from surveys in Zambia



4.2.1 Paper 1

Understanding the epidemiological HIV context is critical in building effective setting-specific preventive strategies. In this paper HIV prevalence patterns in men and women aged 15-59 years in Zambia are reported. Among rural groups aged 15-24 years, prevalence declined by 59.2% (15.7% to 6.4%, $P < 0.001$) in

females and by 44.6% (5.6% to 3.1%, $P < 0.001$) in males. In age-group 15-49 years, declines were less than 25%. In the urban groups aged 15-24, prevalence declined by 47% (23.4% to 12.4%, $P < 0.001$) among females and 57.3% (7.5% to 3.2%, $P = 0.001$) among males but were 32% and 27% in men and women aged 15-49, respectively. Although higher mobility was associated with increased likelihood of infection in men overall, AOR, 1.71(95%CI 1.34-2.19), prevalence declined in mobile groups also (AOR 0.52 95%CI 0.31-0.88). It was further observed that in young people, HIV prevalence declines were concentrated in higher educated groups. For example, in 2003, higher educated young people had lower odds of infection than in 1995 in both urban [men: AOR 0.29(95%CI 0.14-0.60); women: AOR 0.38(95%CI 0.19-0.79)] and rural groups [men: AOR 0.16(95%CI 0.11-0.25), women: AOR 0.10(95%CI 0.01-7.34)]. Furthermore, there were parallel and corroborative sexual behaviour changes observed in these groups and this was stronger in the urban area. Among urban young people with ≥ 11 school years, the reported use of a condom during the last casual sex among young people with increased from 42.7% to 67.3%, AOR 2.96 95%CI 1.93-4.52 between 1995 and 2003 in comparison with groups with 0-7 school years. Similarly, higher educated young people reported less number of casual sexual partners in the last twelve months than groups with 0-7 school years in 2003, AOR 0.33; 95%CI 0.19-0.56.

There is, a detailed description on the association between educational attainment and HIV prevalence (Paper II) as well between sexual behaviour and HIV prevalence (Paper III).

4.2.2 Paper 2

In this region, higher educational attainment has been associated with a greater risk of HIV infection. In the earlier part of the HIV epidemic this increased risk was linked to socio-economic status and travel. Although economic and lifestyle changes that accompany educational attainment were associated with behaviours that increase the risk of HIV transmission, it was often anecdotally postulated that in any given population, this relationship may dissolve as the epidemic

spreads. This is because knowledge, concern for health and behaviour change may often be linked to educational level. In this paper change over-time in the association between educational attainment and HIV infection in the general population in Zambia is reported. There was a universal shift towards reduced risk of HIV infection in groups with higher than lower education in both sexes among urban young people, AOR 0.20(95%CI 0.05-0.73) in males and 0.33(95%CI 0.15-0.72) in females. A similar pattern was observed in rural young men, AOR 0.17(95%CI 0.05-0.59) but was less prominent and not statistically significant in rural females. In the age group 25-49 years, higher educated urban males had reduced risk in 2003, AOR 0.43 (95%CI 0.26-0.72) but this was less prominent in females.

4.2.3 Paper 3

The evidence that HIV prevalence in Zambia among young people, especially higher educated, had declined recently created enough ground to investigate the presence of parallel changes in key sexual behaviour indicators between 1995 and 2003 with focus on the age group 15-24. The evidence was strongest among urban participants with higher education. In this group, there were substantial delays in child-bearing (married women: AOR 0.35 95%CI 0.17-0.69; single women: AOR 0.47 95%CI 0.29-0.78). In addition, between 1995 and 2003, condom use at last casual sex increased and the likelihood of using condoms was higher among groups with ≥ 10 years of schooling (young men: AOR 7.2 95%CI 3.56-14.5; young women: AOR 9.19 95%CI 5.52-15.3) than groups with 0-7 years of school. The number of women reporting frequent dry sex using traditional agents dropped during the period. Number of sexual partners past year also reduced over the period and this was most prominent in urban males (AOR 0.54 95%CI 0.42-0.70). The clear reductions in high risk behaviours, especially in young higher-education and urban groups were associated with the HIV prevalence decline in the same population of young people. Fewer sexual partners and increased condom use were among the core factors involved in both sexes, and delayed childbearing was an additional factor among women.

4.2.4 Paper 4

HIV prevalence among pregnant women attending antenatal clinics remains the principal data source of infection trends in sub-Saharan Africa (46, 47). However, despite its usefulness, ANC-based HIV prevalence estimates have potential for multiple inherent selection biases, hence should be interpreted with a lot caution (48). Nonetheless, ANC-based HIV prevalence is often used to extrapolate prevalence trend in men and women when serial data is available. The extent, to which ANC-based estimates pick HIV prevalence trends among men and women in a high prevalence urban population, was examined. It was found that among ANC attendees, prevalence declined by 20% (25.0% to 19.9%; $P=0.101$) in age group 15-24 years and was stable overall. In contrast, in the general population, prevalence declined by 49% ($P<0.001$) and by 32% ($P<0.001$) in age group 15-24 and 15-49 respectively. Among women only, HIV prevalence declined by 44% (22.5% to 12.5%; $P<0.001$) and by 27% (29.6% to 21.7%; $P<0.001$) in age group 15-24 and 15-49 years respectively. In addition, prevalence substantially declined in higher educated women aged 15-24 years (20.7% to 8.5%, $P<0.001$) in the general population, but not among higher educated ANC attendees. In addition, higher educated young people in the general population showed significant postponement in ages at first birth in 2003. Among women with more than 11 school years, the proportion ever given birth in age group 15-24 years decreased from 33.1%, 22.2% to 19.2% ($p=0.002$) whereas the decline was marginal in groups with 0-7 school years. Furthermore, in age group 15-19 years, the proportion of women ever given birth declined by 57% (16.8%, 9.4% to 7.9%; OR 0.43 95%CI 0.26-0.68) during the respective periods.

5. DISCUSSION

In this section the key findings from papers I to IV are discussed briefly in light of the earlier stated main objectives and rationale of the studies. A more detailed discussion of the results on focussed areas is found in the individual papers attached to this thesis. As a prelude to the discussion, some key and salient methodological issues are considered of which the validity of the findings is the key element. Thereafter the main findings are discussed in detail from which some conclusions are drawn. Based on all these issues, the thesis is concluded with what is considered to be issues relevant for policy and future research challenges.

5.1 Methodological Issues

5.1.1 *Design*

Classification of principal research designs does not often include surveillance, although there is a relationship. Surveillance is generally defined as “a continuous and systematic process of collection, analysis, interpretation, and dissemination of descriptive information for monitoring health problems” which in this case were HIV infection and its possible determinants (16, 40). It is logical to remember that for surveillance to achieve its objective, data must be collected, analysed and interpreted using known research techniques. Therefore surveillance utilises research in order to achieve the intended objective. There are many different approaches employed when one wants to collect data for surveillance purposes. Broadly the principal approaches have been classified and are listed in the following categories: “notifiable-disease” reports, laboratory based reports, registries, surveys, information systems, sentinel events and record linkages (16, 49-53). Two of the approaches listed here namely surveys and sentinel events, were used to collect data for this thesis. It is thus further observed that “surveys” are designs used largely when answering a particular research question. In as far as surveillance is concerned the question being answered is “What is the magnitude, distribution and pattern” of a particular health problem, in this case HIV prevalence. In this regard, the studies in cited in this thesis qualify to be classified as “surveillance”. As typical of most surveillance systems, monitoring trends of the HIV infection was the cornerstone objective of this thesis.

Nonetheless, the discussion below is restricted to the principal survey design used in the thesis, namely population-based cross-sectional surveys. The major factor that is cited as a weakness for cross-sectional surveys, is its lack to offer causal inference (16). However, understanding cause-effect relationship is not the main objective of surveillance. Rather, the aim is usually to describe, estimate the magnitude and identify factors that may be associated with the health outcome. The overall aim of this thesis was “to examine trends of HIV infection and explore factors that may be associated with the transmission of HIV in subgroups of the population Zambia”. This was achieved by carrying out research over a period of time. Although the design employed in describing the HIV epidemic in these communities is justifiably suitable and the weakness related with cause-effect relationship does not apply, this design is often associated with both selection and measurement biases, and these are discussed later on in this section.

Against this background, WHO and UNAIDS has used sentinel surveillance among pregnant women attending antenatal clinics to monitor trends of the HIV epidemic (46). Although this is the case, questions have often been raised on how reliable this can be to monitor HIV prevalence in the general population of men and women. In fact, paper IV indicates that this method may actually underestimate declines of HIV prevalence in the general population as the epidemic matures. Periodic population-based estimates from appropriate populations are thus needed to offer the needed valid information on trends because coverage is improved and there is available data for both men and all women. However, population-based surveys too have limitations, one of which is the presence of potential for bias introduced due to non-response and exclusion from sampling frame (54).

5.1.2 Validity and sampling errors

According to James Buehler (1998), the criteria for valid interpretation of surveillance data is assessed by answering the following questions (55):

- a) What is the sensitivity of the design used,
- b) How representative is the sample

- c) What is the predictive value of the case definition (to what extent are reported cases real cases),
- d) How complete is the descriptive information (participation),
- e) How robust are the statistical procedures employed, and
- f) Is there evidence for high acceptability (high or acceptable response rates).

In addition to these criteria, it is currently argued that a conceptual framework in the whole process of data collection, analysis and interpretation of findings must also play a pivotal guiding role (26).

The questions above were used to assess to what extent the findings of this thesis are valid and useful. In the preceding sections, it has already been stated that population-based surveys certainly have design strength over other approaches when conducting surveillance because of wider coverage. This strength was complimented by employing laboratory-based testing algorithm done in accordance with WHO guidelines. A standard two-test algorithm was employed and was performed in a central laboratory which has a high quality assurance record, thereby increased the sensitivity of the design as well as the predictive value of cases. Furthermore, in line with recommendations from the Joint United Nations Programme on AIDS and the WHO HIV surveillance working group regarding the implementation of “second generation surveillance” approaches, information on socio-demographic characteristics, risk behaviours and other factors deemed to be important for the surveys was collected (23). In addition, information on participants who were not found in the subsequent surveys either due to out-migration, death or temporal absence for any reason was collected. As stated earlier, data collection was guided by a conceptual framework and this adds further strength to the whole process. This information was used to estimate the possible impact, magnitude and likely direction of bias due to non-response.

Notwithstanding the presence of selection biases due to non-response, they were unlikely to be an important factor explaining the sharp HIV prevalence declines among young people (Paper I & II)(56). The non-participation due to refusal to provide saliva remained low in all survey rounds, and was even significantly below refusal levels experienced in the Demography and Health Survey in

Zambia 2001/2002 when using blood as the basis for HIV testing (57). In fact, the demographic characteristics of respondents who refused saliva tests were similar with study participants and this pattern did not change over the period. Absence was the most significant cause of non-participation, particularly in men. Mobility and migration are said to be associated with HIV transmission in a few studies (58, 59). It is generally difficult to say something about the persons that were absent, but it is generally felt that this group may have a higher risk profile than respondents. In this regard, Paper II indicates that, highly mobile participants can be used as sentinel of HIV infection for men who were absent because of demographic and risk likelihood similarities. However, even in these mobile groups, there were significant prevalence declines in urban men and less prominent among the rural men, suggesting further that the declines reported among the respondents were not substantially affected by non-response bias (Paper II).

5.1.3 The theoretical framework

Theoretical frameworks should guide the analysis of hierarchical associations (26, 30). In this thesis, the proximate determinant conceptual framework was used to guide the analysis and assessing the plausibility of interpreting the main findings. In recognisance of the fact that socio-demographic and other contextual variables influences proximate determinants, which in turn dictate the likelihood of getting infected with HIV, it is logical to consider these pathways when looking for both hierarchical and non- hierarchical associations in multivariate analyses (30).

During the analysis, construction of regression models was based on this key theoretical consideration, hence, the possible pathways of associations were looked at step by step. Firstly, underlying factors' association with HIV was examined separately and association between some socio-demographic and economic factors was observed, of which educational attainment was prominent. In view of this finding, it followed that because education needs proximate determinants in order to exert its influence, there was an association between these factors. Educational attainment was thus associated with condom use, partner change or acquisition as well as sexual debut. Lastly but not the least,

because education was found to be associated with HIV prevalence and behaviour, it followed that behaviour must be associated with HIV infection. It must be noted that this last relationship was not the first step of the analysis but the last step in the interpretation. This is because measurement of behaviour is not easy due to the influence of biases of which social desirability, recall and measurement biases predominate. This being the case, any associations that has to do with behaviour variables, must be supported by other plausible associations in order to minimise the influence of biases when making final conclusions. This kind of reasoning was only made logical by employing a conceptual framework. Therefore, as can be expected, behaviour variables were not mixed with underlying factors in the models because this interaction was obvious from theoretical point of view (31). The statistical approach employed in this thesis is not only ideal for surveillance but is acceptably robust and were guided by a theoretical framework, thereby minimising any validity concerns that can result when statistical analysis is inappropriate or poorly designed.

5.2 Comments on main findings

5.2.1 HIV prevalence patterns

The steep HIV prevalence declines in young people, suggesting continuing declining incidence, was masked by modest overall declines. It is difficult to make conclusions regarding changes in older groups because of the effect of mortality and other dynamics associated with duration of infection. The declines in young people in this population have been reported earlier. Therefore, finding prevalence that is lowest in the final survey round suggests that acquisition of new infection has continued to decline. The reasons for this were not exhaustively investigated but it was clear that these declines were concentrated in higher educated and younger people, an indication of declining incidence. In this same group, a parallel change in behaviour was observed. The concentration of declines in higher educated groups suggests a plausible association with behavioural change. This is reasonable and is line with plausibility options when this is interpreted using the conceptual framework as a guide. Higher educated people have responded to prevention messages and this is manifested with their change in behaviour. In fact, the change in behaviour seem to have started way before 1995 because it was observed that higher educated younger people

reported ≤ 2 partners throughout this period. This is logical considering that prevention programmes in this country were intensified in the early 1990s. As expected it looks longer for the differences in HIV prevalence between different educational groups to become apparent. The changes in older groups are probably largely influenced by differential mortality rates.

5.2.2 *Bias Considerations*

Overall, low refusals in all the survey rounds suggest consistent acceptability. The most important reason for non-participation was absence in men. Investigating the HIV prevalence patterns among highly mobile groups as a sentinel for the groups absent during the survey introduces an innovative and simple, but reliable way of assessing the effect of non-participation bias. The declining prevalence in this group suggests that the declines seen in these populations are real changes. Moreover, if this bias was present in younger people, its effect was very minimal. This is so because, the difference in odds of infection by mobility was non-significant and the major reason for absence was being away at school, which has a protective effect. Rather, it is likely that the prevalence among young people could even have been over-estimated due to the fact that those not found because of school attendance are less likely to be infected (31). Notwithstanding the presence of selection biases due to non-response, they are unlikely to be an important factor explaining the sharp HIV prevalence declines among young people.

The application of the conceptual framework provided guided thinking on the plausibility of the findings. It is reasonable to think that if the impact of bias was huge, parallel changes in the proximate determinants would have been absent, making it difficult to explain what could have gone on in the underlying factors.

5.2.3 *Validation of ANC-based data*

Although selection biases due to non-response were unlikely to be an important factor explaining the sharp HIV prevalence declines among young people in general, ANC-based estimates substantially underestimated declines in HIV prevalence in the general population. This seemed to be partially explained by a combination of marked differentials in prevalence change by educational

attainment and changes in fertility related behaviours among young women. This raises questions as to how useful ANC-based surveys are in monitoring the HIV prevalence trends given the changing population dynamics. There is obviously need to have more research to explore this finding in order to offer answers to this question. In order to do this, there is be need to have more population-based surveys in different settings so as to assess this finding.

5.2.4 *Extrapolation of findings*

External validity is another critical challenge when data from selected communities are extrapolated to the whole population. Evidence supporting the interpretation that the HIV declines observed in these selected communities approximate well with those of the general population was clearly observed. Firstly, the prevalence levels of selected urban and rural communities matched with respective national estimates, and this was one of the criteria for selecting them (60). Secondly, national ANC-based estimates show declines among young women (44). Thirdly, we have previously reported that ANC-based trends underestimate declines in the general population (61). The main explanation for this reduced representativeness of ANC-based data was substantial delayed age at first birth (Paper III & IV).

6. IMPLICATION FOR POLICY AND RESEARCH

The findings presented and discussed in this thesis raise many policy and research related questions. The reasons as to why lower educated and rural groups have not been reached yet and the possible remedies for it, seems to be the most obvious policy challenge and may be viewed both in the short and long terms.

6.1 Considerations for policy

The low effectiveness of HIV preventive efforts so far has led to an important debate on perspectives and priorities in prevention. Firstly, it has been suggested that low effectiveness can to a great extent be explained by the failures in addressing structural factors that support risky behaviours, thereby affecting people's protective ability, e.g. poverty and sexual inequity. Secondly and in addition, it has also been suggested that the low impacts of prevention efforts could also be due to limited understanding of the local epidemiological context leading to failures in reaching targets and places where exposures are highest. Both these perspectives are of critical importance in HIV prevention. However, there is obvious need to tackle structural factors, but such changes take time, and the generation of proper knowledge on local epidemiological contexts is of critical importance for effective short-term efforts in prevention (62, 63).

Short Term Strategies

In the short term, it seems logical to focus on reaching groups who have not responded yet as well as focusing on places where the highest exposures to infection might be. There are many ways this can be achieved and some of these are suggested below.

- a) “100% condom prevention strategy”: The “100% condom strategy” with focus on female sex workers and their male clients has been tried and found to be useful in Asia. This strategy has also included screening and treatment of STIs. Campaigns to increase condom utilisation means making condoms available, accessible and affordable (64). Results from surveys in places where risks are exceptionally high showed limited signs of any preventive

efforts. Therefore, trying such a strategy to target risky places even in generalised epidemics is worthy considering

- b) *Re-packaging prevention messages*: The power of education restricted to the urban and more educated groups might indicate historical limitations of prevention efforts. This further suggests that there remain some unresolved challenges to prevention, one of which could be that messages have been predominantly urban and largely in English. In order to reach these groups, there is need to re-package prevention messages in languages and codes that are appropriate.
- c) *Sharpen under-utilised strategies e.g. Peer-education*: Reaching the groups that have not yet responded requires soul searching on what has not worked. Peer education seems to have worked in the urban areas and there is need therefore to sharpen it in order to meet the needs of rural groups who have not responded with similar pace (65-69).
- d) *Revitalise lost opportunities-Active STI surveillance and treatment*: Despite the declines reported, HIV prevalence in these communities and in the whole country is unacceptably high. There is evidence showing parallel presence of sexually transmitted infections in the same communities. There is need in the short term to develop “active surveillance” programs aiming at effective STI treatment and eradication, especially syphilis (70).

Long Term Strategies

- a) *Intensifying and prioritising primary prevention*: The parallel behaviour change associated with HIV prevalence declines among higher educated young people is a positive sign indicating that prevention works. Therefore primary prevention strategies should thus not be abandoned because they work. This is important because treatment efforts are gaining massive advocacy as a preventive strategy and can easily de-rail efforts given to primary prevention strategies. Combination of promoting abstinence, faithfulness to one partner and consistent condom use in casual sexual associations should continue to be given highest priority among all other strategies. Treatment efforts should largely be seen as adjuvant support for this mainstream primary prevention. In addition, there is therefore need to re-focus such strategies in order to target “sex work” as a long-term strategy. It

is worthy noting that interventions targeting sex workers were and are still neglected intervention approach in this country. This is further illustrated by the fact that unpublished results from surveys in places where risks are exceptionally high (predominantly sex work) showed limited presence of any preventive efforts. If sex work is targeted, there might be noticeable impacts on preventing the spread of HIV in this country.

- b) *Education as a tool for change*: HIV prevalence seen among young urban women may be suggesting that policies that aimed at increasing the proportion of female school enrolment and encouraging them to stay on at school bore fruit and need to be strengthened. The effect was strongest when the level of education gained was higher than basic education. The long term implication for this is that policy makers probably should consider making a huge stridal-jump from aiming at universal basic education to universal secondary education (“basic-education-plus”). If this is done, it is most likely that the high risk of infection seen in out-of-school adolescents in these studies could be curbed. This will not only arm these young people with requisite tools for behaviour change but also by just keeping them in school, will provide time they needed most to prepare for adulthood
- c) *Linkage with poverty reduction strategies*: There is evidence that poverty is a major developmental challenge (71). According to the World Bank, “the poor constitute the absolute majority of those living with HIV and AIDS, although AIDS does not only affect poor people”(72). In this thesis, poverty was manifested by the unchanging burden of HIV infection largely in lower educated and rural groups. It is not coincidence that this is the same group that lives in abject poverty in this country. This reveals how the core and complex problem of poverty is spatially linked to the HIV epidemic. It is possible that prevention messages, though given, remain “irrelevant and inoperable” because people are poor, creating an environment that promotes risky behaviours (71). It is further observed that less than 10% of the rural respondents had secondary school education compared to 44% in the urban area. This reflects how low the proportion of people with secondary education (estimated at 20%) is in this country where the majority of the poor people are rural based (38, 39). Therefore poverty reduction programs must be linked with strategies to increase educational attainment in order to be

effective against HIV infection. When people struggle to survive from day to day, they will not find it easy to take precautions against a disease that can make them sick ten years to come (38, 39, 71). To do this might mean employing multi-pronged approaches and this requires leadership, commitment and dependable management skill embedded in cross-cultural, cross-gender and cross-sector, and even cross-border initiatives.

6.2 Main Research challenges

a) *Validation of ANC-based estimates*

ANC-based estimates were found to understate the HIV prevalence changes in the general population, suggesting that regular population-based surveys in selected communities must be conducted alongside but at more sparse intervals than ANC-based surveys for improved measurement of the HIV infection monitoring given the changing population dynamics. However, if there is similar evidence and from different studies, this would have stronger corroborative evidence for external validity. Therefore there is need for further research in this area.

b) *Measurement of behaviour*

The significance of some proximate determinants after adjusting for underlying factors in the regression model suggests that the proximate determinants might not have been measured correctly or completely. This included both measurement of condom use and sexual activity and the potential for both recall and social desirability biases has already been alluded to. Therefore, there is need for triangulation of research approaches in order to explain the dynamics of behaviour change, and qualitative approaches are particularly needed.

c) *Building a research agenda on education and HIV*

Education along with income and occupation has been used repeatedly to define the social gradient of health. Generally individuals with lower income, less education and lower-status by occupation and or employment, have poorer health. The differential social gradient by either education or income exists in all countries irrespective of varying types of health insurance. This suggests there is an income-independent

contribution of education to health. In this thesis higher educated and predominantly urban respondents were found to have lower likelihood of HIV. Understanding how educational attainment contributes to behaviour change might be useful in HIV prevention programs aimed at less educated people. However, the specific mechanism by which education operates was beyond the scope of the thesis. There is therefore need to carry out research on possible mechanisms and dynamics by which education influences health and in particular HIV.

d) *Implementation of monitoring and evaluation programs*

It was noted earlier that there has been a lag in instituting monitoring and evaluation of programs in Zambia and in most other sub-Saharan African countries thereby making it difficult to evaluate programmes. Scaling up evaluation of HIV efforts should be seen as an investment with power to save lives over the medium to long term – through a continuous effort to develop a knowledge base to inform what approaches work and which do not. In this regard there is an urgent need for more investment in operational research in order to better understand how best a monitoring and evaluation system can be implemented and used in Zambia. In order to achieve this, there must be parallel and relevant capacity building at the University level as an on-going process.

e) *Triangulation of approaches*

Lastly but not the least, there is need for triangulation of qualitative and quantitative approaches in trying to generate knowledge on how and why different population groups respond. Sexual relationships between young females and older infected male partners still occur and there is need to understand the critical factors that fuel this behaviour. If employed, triangulation of research approaches would generate a critical understanding of the dynamics and possible reasons why cross-generational sexual relationships occur. Consequently relevant and strategic programs aimed at effectively breaking this cycle would be designed on the basis of this critical knowledge base. There are many other areas where it would be of critical importance to adopt this research approach, and the “cross-generational relationships” is just one of them.

7.0 CONCLUSION

The observed declines among young people are consistent with behaviour change and not the natural course of the HIV epidemic. This might be due to responses to preventive messages thereby influencing changes in behaviour. However, it is difficult to link these changes to any particular prevention program. The prevention programs in Zambia initiated in the early 1990s and re-enforced thereafter, were complex and integrated, but there is little or no documentation about their outcomes and impacts based on in-built individual systems of monitoring and evaluation. Assessment of program effectiveness requires a critical monitoring and evaluation of inputs and efforts taken to redress the program inequities of the past as well as the on-going processes linked to budgetary and implementation constraints, while keeping the current strategies focussed on reducing the magnitude and severity of the epidemic. Although there have been efforts to put a functioning monitoring and evaluation system in place, the process and momentum have been rather slow. The reasons for this are not clear and are beyond the scope of this thesis, but it seems logical to conclude that as long as prevention programs continue to operate individually, it will be difficult to pinpoint what works and in what contexts, thereby making evidence-driven adjustments less likely. However, although it is not easy to link these observed outcomes to particular interventions, the observed parallel between HIV prevalence declines and behaviour change is a positive sign indicating that prevention works. This observation suggests that although Zambia is still among the most affected countries in sub-Saharan Africa, some of its programs have had positive impact and the decline reported in this thesis is but one example of this. Therefore primary prevention strategies should thus not be abandoned because they work, but should instead continue to be given higher priority even more than treatment efforts. In contrast however, the stable risk among lower educated and predominantly rural groups is an indication of limitations in past prevention messages.

Lastly but not the least, the observed underestimation of actual HIV prevalence declines seen in ANC-based data have important implications for the interpretation of ANC-based HIV estimates and underscore the importance of population-based surveys. There is need for more research in this area. However, present finding suggest that there is an urgent need to increase efforts to have more population-based surveys in appropriately

selected communities in addition to ANC-based surveillance. This is this is likely to improve HIV infection monitoring given the changing population dynamics which may not be captured by ANC attendees.

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