Trends in HIV Prevalence and Sexual Behaviour among Young People in Zambia: geographical and socio-economic differentials

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Dedication

To my wife Rachel and my children:
Natasha, Mwaji, Mapalo and Nkomba-Lasse.
I also dedicate these works to my late parents:
Phennis Katambi Kayeyi and Janice Billiot Mutabi Kayeyi

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Abstract

Introduction: Differences in the distribution of HIV between and within SSA countries is striking. Recent evidence indicates that HIV prevalence of young people, which is used as a proxy of HIV incidence, has been declining. There is convincing evidence that much of this decline is attributable to changing sexual behaviour. However, HIV epidemiological research has previously focused only on individual factors affecting sexual behaviour and HIV transmission, but recent evidence shows that neighbourhood factors play a significant role.

HIV prevalence in Zambia has been estimated at 14.3% among adults (15-49 years) and 6.6% among young people (15-24 years). The major factors believed to be driving the epidemic in Zambia have been extensively surveyed, e.g. early age at sexual debut, concurrent sexual partnerships, low condom use and age-mixing. As a result of the epidemic, multiple prevention programmes have been implemented that have targeted different risk groups and age-groups.

Overall objective: To assess trends and examine factors influencing the differential geographical distribution of HIV prevalence and risky sexual behaviours among young people in Zambia.

Methods: The empirical basis was from the national antenatal (ANC) sentinel surveillance system on HIV and syphilis, the Zambia Demographic and Health Survey (ZDHS), the Zambia Sexual Behaviour Survey (ZSBS), and a population-based HIV survey in selected urban and rural areas (Chelston and Kapiri Mposhi). A systematic review of peer-reviewed articles on HIV data from Zambia has also been included.

Results: ANC-based surveillance showed that HIV prevalence among young women has substantially declined during the period 1994 to 2008 (by 43% in urban and 17% in rural settings). Peer-reviewed articles were also in agreement with these findings; however, both the ANC-based data and the ZDHS data showed striking geographical variation in HIV prevalence in Zambia. Regarding factors affecting HIV infection, young women residing in low educational attainment neighbourhoods in selected communities were at higher risk of HIV infection than those in high educational attainment neighbourhoods. With regard to sexual risk behaviour, there were substantially declining trends between 2000 and 2009 for premarital sex (in both young men and women) and multiple partnerships (only young men). Condom use at last premarital sex remained stable among young people during the same period. Factors associated with lower risk of premarital sex included urban residence, high residential stability, and high comprehensive knowledge of HIV.

Conclusion: HIV prevalence among young pregnant women declined substantially during the 14-year period. Parallel decline probably occurred among men, but trend data are limited. The decline in HIV prevalence can probably be attributed to the change in sexual risk behaviour among young people. Both sexual risk taking and HIV prevalence are strongly associated with factors reflecting socio-economic status at both individual and neighbourhood levels.

Research publications

This PhD thesis is a synthesis of research work published in the following publications in peer-reviewed journals:

Paper I
Nkomba Kayeyi, Knut Fylkesnes, Charles Michelo, Mpundu Makasa, Ingvild Sandøy. Decline in HIV prevalence among young women in Zambia: National-level estimates of trends mask geographical socio-demographic differences. PLoS ONE 2012, April: **7** (4): e33652.

Paper II
Nkomba Kayeyi, Ingvild F Sandøy, Knut Fylkesnes. Effects of neighbourhood-level educational attainment on HIV prevalence among young women in Zambia. BMC Public Health 2009, August: **9**: 310

Paper III
Nkomba Kayeyi, Knut Fylkesnes, Nora Wiium, Ingvild F. Sandøy. Decline in sexual risk behaviour among young people in Zambia (2000–2009): Do neighbourhood contextual effects play a role? (Submitted: PloS ONE)

List of Acronyms

AIDS – Acquired Immune Deficiency Syndrome
ANC – Antenatal Clinic Sentinel Surveillance
AOR – age-adjusted odds ratio
aRR – age adjusted risk ratios
ART – Antiretroviral Therapy
CHAZ – Christian Health Association of Zambia
DBS – Dried Blood Spot
DHS – Demographic and Health Survey
DRC – Demographic Republic of Congo
Edu-sport – Educational sport
FHI – Family Health International
GCVL – Global Clinic Viral Laboratory
GPA – Global Programme on AIDS
HEART – Helping each-other Act Responsibly Together
HIV – Human Immunodeficiency Virus
ICT – Information and Communication Technology
IEC – Information, Education and Communication
MC – Male Circumcision
MCPs – Multiple Concurrent Partnerships
MDG – Millennium Development Goal
MoE – Ministry of Education
MoH – Ministry of Health
NASF – National HIV and AIDS Strategic Framework
NGO – Non-Governmental Organisation
NHS – National Health Strategic Plan
PBS – Population Based Survey
PEPFAR – President's Emergency Plan for AIDS Relief
PMTCT – Prevention of Mother-to-Child Transmission
PPAZ – Planned Parenthood Association of Zambia
SEA – Standard Enumeration Area
SEP – Socio-economic position
SES – Socio-economic status
SRH – Sexual and Reproductive Health
SSA – Sub-Saharan Africa
STI – Sexually Transmitted Infections
SPSS – Statistical Package for Social Scientists
TDRC – Tropical Diseases Research Centre
UNAIDS – Joint United Nations Programme of HIV/AIDS
UNGASS – United Nations General Assembly Special Session on HIV/AIDS
UNICEF – United Nations Children's Fund
WHO – World Health Organisation
ZSBS – Zambia Sexual Behaviour Survey
ZDHS – Zambia Demographic and Health Survey

1. Introduction

1.1 Geographical distribution of HIV in sub-Saharan Africa

Three decades after its discovery, the Human Immunodeficiency Virus (HIV) continues to have a severe direct and indirect impact on the world's population. Recent estimates from UNAIDS indicate that 34 million people live with the virus worldwide [1]. Substantial variations in the distribution of the epidemic exist across the world, from a high prevalence of >5% in sub-Saharan Africa (SSA) to a lower prevalence of 1% in the Caribbean and <1% in other parts of the world. Sub-Saharan Africa (SSA) has consistently been the region in the world with the highest number of persons living with HIV. The region accounts for 69% of the global HIV prevalence among adults [1] and nearly 92% of all HIV infections in children [2]. In 2011 alone, an estimated 1.2 million adults and children died of AIDS-related causes in the region [1].

Geographical differentials in the distribution of HIV infection in sub-Saharan Africa (SSA) and the rest of the world are also evident among young people aged 15-24 years. Figure 1 illustrates the absolute numbers of young people infected with HIV in different countries. Young people make up 5 million of the total estimate of those living with HIV globally, of which ~80% of are in SSA [2, 3]. High HIV prevalence in the general population of SSA means that young people who are sexually active have a high risk of exposure to HIV infection [4, 5]. HIV prevalence among young people in SSA is presently estimated at 1.3% for males and 3.1% for females. However, there are substantial differences in the risk of HIV infection among young people residing in what are known as the *"hyper-endemic"* countries of Southern Africa or high prevalence countries of Central and Eastern Africa, and those residing in the lower prevalence countries of Western Africa [2, 6].

Figure 1. Estimated number of young people aged 15-24 living with HIV
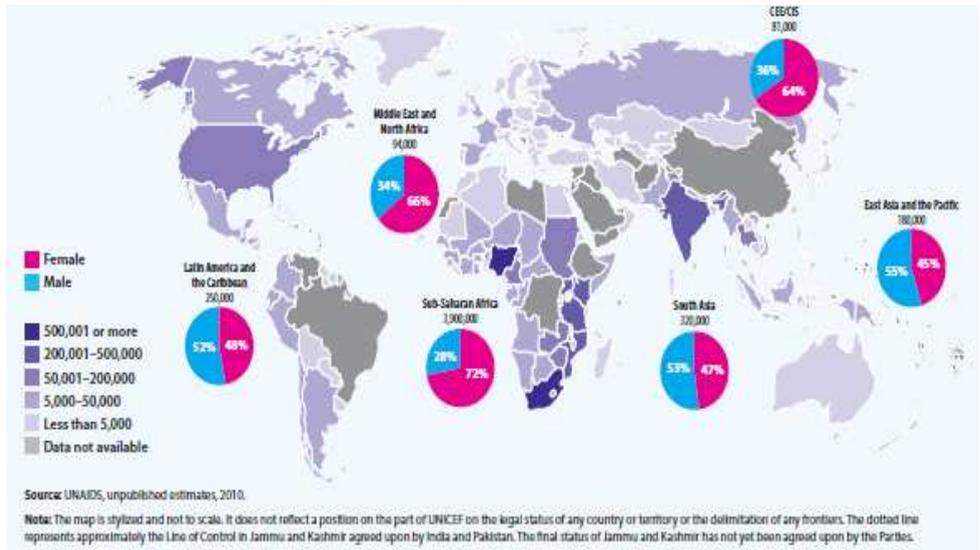
According to UNAIDS, HIV incidence has declined in 23 SSA countries between 2001 and 2011[1]. An estimated 14% decrease in HIV prevalence has been reported among young people between 2001 and 2009, and the incidence is estimated to have declined by 25%. The number of infected young people has dropped from 5.7 million in 2001 to 5.0 million in 2009 [2]. However, the transmission risk remains high, and in 2009 alone an estimated 890,000 young people were infected with HIV globally, which contributed to 41% of all new infections occuring that year. The majority of these new cases came from 20 SSA countries, that contributed 69% of all new HIV infections among young people in 2009, with Zambia being among the top 10 countries with the highest number of new infections [2, 3] (Table 1).

Table 1. Twenty sub-Saharan African countries with most new HIV infections among young people aged 15-24, 2009

Country	Total	
	Estimate	[low estimate – high estimate]
South Africa	160,000	[140,000 - 190,000]
Nigeria	120,000	[110,000 - 140,000]
Mozambique	49,000	[41,000 - 56,000]
Uganda	46,000	[38,000 - 53,000]
Kenya	42,000	[27,000 - 56,000]
United Republic of Tanzania	40,000	[31,000 - 52,000]
Zambia	27,000	[22,000 - 32,000]
Malawi	26,000	[18,000 - 33,000]
Cameroon	22,000	[18,000 - 25,000]
Zimbabwe	22,000	[14,000 - 31,000]
Lesotho	9,400	[7,900 - 11,000]
Ghana	8,300	[6,300 - 10,000]
Angola	8,000	[5,400 - 11,000]
Botswana	6,000	[4,300 - 8,800]
Chad	5,900	[3,700 - 21,000]
Swaziland	5,600	[4,600 - 6,600]
Côte d'Ivoire	5,200	[2,600 - 9,100]
Burundi	4,300	[3,200 - 5,100]
Togo	4,000	[2,300 - 5,800]
Rwanda	3,700	[1,400 - 6,600]
World	890,000	[810,000 - 970,000]

Source: UNAIDS unpublished estimates, 2010.

1.2 Surveillance systems for HIV and risky sexual behaviour

UNAIDS and WHO recommend that countries with a generalised HIV epidemic (HIV prevalence in the general population >1%) should institute a surveillance system to monitor the epidemic in the general population [7]. The purpose is to monitor HIV prevalence trends and sexual behaviour risk patterns [8]. All countries with generalised epidemics have established HIV monitoring systems since the early 1990s, using data from pregnant women attending antenatal care (ANC-based systems), where blood specimens collected for syphilis testing are tested unlinked and anonymously for HIV. However, ANC-based data are not necessarily representative of the general population.

Surveillance of the epidemic among men has been limited for a long time to case reports from STI clinics, blood donors [9] or VCT clients [10, 11]. However, some countries with compulsory national military service, e.g. Thailand, have been testing new recruits for HIV, which has enabled them to establish trend estimates for HIV prevalence among men [12, 13]. A few population-based surveys were conducted in the 1990s in ANC surveillance sites to test the representativeness of ANC-based estimates. The findings indicated a close match between estimates from ANC-data vs. pooled data of men and women in the general population [14-16].

More recently, many countries in SSA have estimated HIV prevalence in the general population in nationally representative population-based surveys, such as the Demographic and Health Survey (DHS). The first countries to conduct HIV testing in the DHS were Zambia and Mali in 2001. Over the years, many countries have conducted DHS with the HIV testing module included. In the initial surveys in Zambia and Mali, the only characteristics that could be linked to HIV data were gender, age-category, region and rural/urban residence because of concerns about the risk of breaching confidentiality and anonymity of the participants. Later surveys based on a new protocol linked household and individual characteristics to HIV data, without compromising the anonymity of the participants, creating an opportunity to assess the association between HIV prevalence and the socio-demographic and behavioural characteristics [17, 18].

Population-based cohort studies allow direct measurements of new infections based on a follow-up of the same population over a long period of time. However, such a study is very expensive since it requires a close follow-up of participants to minimise attrition, which otherwise can be large in highly mobile populations and can introduce substantial selection bias [19, 20]. There are also laboratory techniques for estimating HIV incidence based on the assessment of biological assays for HIV antigens and antibody measurements, and which distinguish recent from established HIV infections [20-22].

However, these methods of estimating incidence rates are also very expensive and logistically difficult to conduct on a large population [20].

Another and more feasible method for estimating HIV incidence is mathematical modelling. The UNAIDS reference group on HIV/AIDS have developed a computer software programme for this purpose called the Spectrum Projection Package [20]. These models are built on specific assumptions regarding the age and sex distribution of HIV infection (or on actual estimations of the distribution from national surveys when such have been conducted), effects of HIV on fertility, life expectancy with and without HIV, probability of mother-to-child transmission, child survival and the effects of treatment of survival [23, 24]. The quality and accuracy of the estimates from Spectrum models depend on the quality and accuracy of the data introduced. This package allows estimation of HIV trends and makes future projections of the epidemic [25].

1.3 Neighbourhood effects on health and HIV

Early HIV/AIDS research focused primarily on individual-level determinants of infection, but evidence suggests that studying the influence of individual characteristics alone, i.e. demographic, biological, personality or behavioural factors, can only explain a small part of the complex set of factors that contribute to poor health [26, 27]. Renewed interest in neighbourhood factors as determinants of health was prompted by the recognition in the 1980s and early 1990s that *place* was important to health and has widened the spectrum of research in epidemiology. According to Diez-Roux, "*there are several factors that have converged to stimulate a revival of interest in area or neighbourhood health effects, and chief among them has been a rekindling of interest in the social determinants of health and the recognition that social influences on health operate through many different processes, one of which may be the type of areas or neighbourhoods in which people live…*" [27]. According to Bronfenbrenner's ecological model of human development, individuals exist

within a context and their behaviour are moulded through socialisation and by experiences in their environment around them [28, 29]. Therefore, epidemiological research has recently incorporated the study of neighbourhoods to infectious diseases because they represent an *"intersection of social networks and physical spatial locations through which infectious diseases spread"* [26].

Recent epidemiological and public health studies have examined the association between neighbourhood characteristics, including socio-economic position (SEP), and a variety of health outcomes, for instance HIV and AIDS [26, 30, 31], perinatal health [32], mortality [33], health behaviour [34], cardiovascular disease [35], and disability [36]. Recognition of neighbourhoods in HIV research comes from the realization that HIV vulnerability patterns may be conceptualised at multiple levels. Poundstone et al. [26] have suggested 2 mechanisms by which neighbourhood-level characteristics can shape the HIV patterns in a population, calling them *direct* and *indirect* mechanisms. *"Direct mechanisms are those that affect the probability of a person coming into contact with someone infected with HIV, for instance, through residential segregation and social isolation of marginalized populations. Indirect mechanisms are those that increase the population's vulnerability to HIV transmission, e.g. poor socio-economic conditions, high unemployment, or the proliferation of illicit drug markets"* [26]. Neighbourhood studies have assessed the effects of characteristics such as poverty, income, residential segregation and physical environment on HIV/AIDS transmission. An example in sub-Saharan Africa is the Mwanza study in Northern Tanzania, which assessed the impact of 4 neighbourhood characteristics on HIV transmission– social/economic activity, availability of bars, population mobility, and distance to the nearest-town [30]. Another example comes from a study using data from Ndola, Zambia, that examined the effect of neighbourhood socio-economic status (SES) characteristics on HIV infection among young women in Zambia

[31]. Both these studies showed that neighbourhood characteristics play a significant role in influencing risk of HIV infection.

1.4 The proximate-determinants framework

Boerma and Weir's (2005) proximate determinants framework of HIV infection is a logical explanatory sequence of how HIV transmission and infection occur in a population [37]. This framework was used in this study to guide the analysis. It posits that the underlying determinants operate through the proximate determinants and lead to HIV exposure, transmission and infection [37].

Underlying determinants	Proximate determinants	Biological determinants	Health outcome	Demographic outcome

Context
Socioeconomic
Sociocultural
Demographic

Intervention programs
Counseling & testing
STI control
Condom promotion
Education for knowledge and changing attitudes
Blood safety
Safe injections
Harm reduction

New sex partner acquisition
Coital frequency
Concurrency
Abstinence
Sexual mixing
Blood transfusion
Injection-drug use
Medical injections

Exposure of susceptible to infected persons

Condom use
Other STI
Circumcision
Type of sex
Virus load
Biological susceptibility
Blood-safety practices
Needle safety

Efficiency of transmission per contact

HIV infection

Disease

Mortality

Treatment with ARVs
Treatment of opportunistic infections

Duration of infectivity

According to Boerma and Weir (2005) *"statistical analyses of the determinants of HIV infection that indiscriminately include underlying and proximate determinants in the same model and do not take advantage of the multi-level data structure will produce estimates difficult to interpret"* [37]. Thus it is important to distinguish clearly between underlying and proximate factors, and carefully build on statistical models that allow assessment of the effects of underlying factors on HIV risk without overadjusting for the intermediary effects of risky sexual behaviour.

1.5 The HIV epidemic in Zambia

Zambia is located in Southern Africa, the epi-centre of the HIV epidemic in the world. HIV prevalence in Zambia in 2007 was estimated at 14.3% among adults aged 15-49 years and 13.5% among the whole population, including children [2, 38]. According to UNAIDS estimates, about 445,000 adult men, 560,000 women and about 95,000 children live with HIV[1]. Overall, HIV prevalence in urban areas (20%) is twice that in rural areas (10%), and provincial prevalence has ranged from <7% (in Northern and North-Western province) to >17% (in Lusaka, Central and Copperbelt provinces) [38]. Comparison of age-specific HIV prevalence in the 2001/2 and the 2007 ZDHSs indicates that a shift in peak prevalence from age-group 30-34 years to age-group 35-39 years among adult women, and from age-group 35-39 years to age-group 40-44 years among adult men [38]. This shift in the peak age-specific prevalence indicates maturing of the epidemic in Zambia because there are fewer young people getting infected with HIV, and mortality due to AIDS has also been reduced drastically due to antiretroviral therapy (ART). This means that HIV infected individuals are now living longer. However, young people aged 15-24 years make up 25% of the total population of 13 million in Zambia (Census 2010) [39]. The prevalence in this group was 6.5% in 2007. Young women had almost double the HIV prevalence of young men (8.5 versus 4.3%) [38].

1.5.1 Factors driving the HIV epidemic among young people in Zambia

Socio-demographic differences in HIV infection in Zambia have been attributed to many drivers; some of the key ones probably include the following:

(i) Early age at sexual debut

Sexual transmission is the most common mode of HIV transmission in generalised epidemics like that in Zambia. Unprotected early sexual activity

exposes young people to the risk of HIV infection because of the high prevalence in the general population [40]. The 1996, 2001/02 and 2007 ZDHSs showed that the median age at first sexual intercourse increased from 15.9 years to 17.9 years among men, and from 16.6 years to 17.2 years among women during this 11-year period. Young people in rural areas had lower age at first sex than those in urban areas in all these national surveys [38, 41-43]. According to the 2007 ZDHS, 4% of young women and 16% of young men aged 15-24 years had sexual intercourse before age 15, whilst ~59% of women and 51% of men had sexual intercourse before age 18. Highly educated young people had a higher age at first sex than less educated ones, and young people in the highest wealth quintile were more likely to delay sexual debut than those in the lowest quintile. The provinces recording high prevalence of early sexual debut included Western and North-Western provinces, and the lowest prevalence of early sex was recorded in Luapula and Lusaka provinces among young women, and Eastern and Luapula provinces among young men [38].

(ii) Concurrent sexual partners

Multiple concurrent partnerships (MCP) are likely to have been among the key drivers of HIV transmission in southern and eastern Africa [44-47]. MCP is defined as sexual partnerships in which one or more of the partners have other sexual partners while maintaining sexual relationships with the original partner [44]. It is said to contribute significantly to the spread of HIV infection in stable partnerships where condom use is very low [48]. According to the 2009 Zambia Sexual Behaviour Survey (ZSBS), an estimated 5% of young people in Zambia reported concurrent sexual partnerships in the past year. However, the prevalence varied by sex, with more males (11%) than females (0.9%) reporting concurrent partnerships. The trends in concurrent partnerships among young people significantly decreased from 2000 to 2009, for both young men (from 19 to 11%) and young women (from 2 to 0.9%) [48].

(iii) Condom use

Since the majority of HIV infections in Zambia occur through heterosexual transmission, condoms are the best alternative to abstinence in achieving reliable protection against HIV infection. Many studies have determined the prophylactic effectiveness of condoms against HIV infection, the results suggest that condoms are 90 to 95% effective in stopping HIV infection if used correctly and consistently [49-51]. Despite widespread knowledge of its effectiveness among young people, condom use has been quite low in Zambia [52]. ZDHS indicates that condom use at first sex was 24% among women and 22% among men in 2007 [38]. Condom use at first sex is symbolically important because it is the first exposure to risk of infection among young people who have not been at risk of vertical transmission of HIV. Furthermore, condom use at last premarital sex, which is used as a proxy for consistent condom use among young unmarried people, was 37% (39% for men and 33% for women) in 2009 [48]. However, young people who had sexual intercourse with a higher risk partner reported a slightly higher percentage of condom use (48% men and 38% women) because of the perception of high risk of infection [48]. Differences can also be seen in the geographical distribution of condom use among young people in the different provinces of Zambia; Lusaka province had the highest percentage reporting condom use with higher risk sexual partners among both young men (64%) and women (56%), and the lowest percentage was in Luapula province for both young men (28%) and women (22%) [38].

(iv) Age-mixing

Of particular concern in many sub-Saharan African countries has been the difference in HIV prevalence between young women and men, for which many reasons have been advanced. The risk of HIV is greater when young women engage in sexual intercourse early and are physiologically immature [53]. However, sexual relationships between younger women and older men

probably explain more of the difference in HIV prevalence between young men and women. Age-mixing or intergenerational relationships may facilitate transmission since young uninfected women can meet older men already infected with HIV [54, 55]. This can either be in marriage/stable relationships or outside stable sexual relationships. Studies from Cambodia and Zambia on the association between HIV infection and age difference between spouses gave similar results. In the former, for example, the likelihood of infection was 5.2 times higher if the age difference was 10 years compared to those spouses of the same age [56]. A study from selected communities in Zambia in 2003 showed a similar association by a factor of 4.7 (Chelston and Kapiri Mposhi population-based survey, unpublished data). Further evidence from a meta-analysis review of some Southern African studies has shown that for each year difference in age between young women and older men, the risk of infection of the women increased by 28% [57]. Some men seek out younger partners in the belief that young women are unlikely to be HIV infected [58-60]. A few men even engage in sexual relations with young women in the belief that it can cure their HIV infection [61, 62].

According to the ZSBS, a decline from 16% of young women (aged 15–24 years) was reported in having sexual partners >10 years older in 2000 to 11% in 2009. However, young adolescent women aged 15-19 years (14%) had a higher likelihood of engaging in sexual relations with older men than women aged 20-24 years (10%) [48]. It is traditionally common and acceptable for young women to engage in relationships with older men in Zambia. These relationships could be marital, they may involve an exchange of money or gifts to cover basic needs or school fees and thus provide a means of survival, or they may receive luxury items or support for other living expenses [55, 63, 64]. This is known as transactional sex, which differs from commercial sex work (prostitution) in that it includes long-term and stable relationships, may be initiated with the hope that it may lead to marriage, are sometimes inter-generational relationships, and are often not caused by poverty and destitution,

as is often the case in commercial sex work. In fact, the influence of Western consumer culture and the degradation of traditional practices are seen as central to the increase of transactional sex in countries such as Zambia [65]. The ZSBS found that ~23% of men and 8% women reported transactional sex in Zambia in 2009, but not all of these involved age mixing [48]. When intergenerational and transactional sex are combined, age and economic asymmetries in sexual relationships– in addition to gender-based power differences– are believed to limit young women's ability to discuss safe sexual practices [63, 66]. Young women are still frequently unable to obtain condoms because female condoms are less common, and women who carry male condoms are stigmatised; thus young women may be unable to negotiate their use, or they are sometimes reluctant to use them in relationships with older partners [61].

(v) Socio-economic position, poverty, violence and alcohol abuse.

Other drivers that contribute to high HIV transmission in Zambia, especially among young people, are socio-economic position, poverty, violence and alcohol abuse. Socio-economic position (SEP) is the social standing or class of individuals or groups, and in most studies it is measured by proxy factors, such as education, wealth, income, employment and occupation. Social classes exist in society because of inequities in the distribution of wealth and resources, and access to services. HIV is a disease rooted in the social and economic inequities because these contribute to differential risk of exposure to and transmission of infection [67]. Educational attainment has been used by HIV studies in Zambia as a proxy for socio-economic position [68]. In earlier surveys, evidence indicated that highly educated individuals were at high risk of contracting HIV [69], but recent evidence suggest that HIV risk has reduced among highly educated individuals [68, 70, 71]. It is possible that young people in low socio-economic strata are at high risk of HIV infection [72], because they engage in more risky sexual behaviour such as early sexual debut, multiple partners and infrequent use of condoms [73, 74]. Other studies that have used wealth as a proxy for SEP have suggested that being wealthy can be a source of risk,

because wealth can increase the chances of mobility and this may result in encounters and relationships with multiple partners [75].

Poverty is another driver that is closely related to low socio-economic position, and the two cannot be discussed in isolation. The relationship between poverty and HIV infection is very complex, as evidence on this is still mixed [72, 76]. Some researchers have argued that poverty increases the risk and vulnerability to HIV infection [77]; whereas others argue that being rich may lead to risky sexual behaviour [69, 78]. It is important to note that HIV infection is not limited only to those who are poor or of low socio-economic position [72, 79], but the poor may be the most vulnerable to HIV infection because they often lack education, which affects knowledge about HIV and how to prevent it [80]. Poverty also pushes people to take drastic measures to extricate themselves. This may include migration from rural to urban areas, because the former in countries like Zambia lack schools and employment opportunities that could improve people's livelihood [81]. Migration, particularly among young people, may contribute to increased risk of HIV infection, because they are isolated from their local community and from the controls of traditional norms –cultural practices and social networks that could have prevented them from engaging in non-marital sex [81].

In Zambia, a large proportion of female–headed households fall into the lower socio-economic strata, which according to the 2007 ZDHS, accounts for ~24% of households [38]. Women in female-headed households have a higher risk of being infected with HIV than their counterparts in male headed households, with similar background characteristics [82]. This is because some of these women may engage in transactional sex or commercial sex work as a survival strategy for themselves and their dependents [74]. Young women in poor households may also have a high probability of engaging in intergenerational sexual relationships, often linked to transactional sex [74]. Furthermore, the

majority of young women who engage in commercial sex work come from poor households [83] and this puts them at a higher risk of HIV infection.

Many women are also subject to rape and sexual violence, which has been linked to HIV transmission [83, 84]. Forced sex is related to inequitable gender norms in many communities of Zambia [85, 86]. The likelihood of women getting infected with HIV through forced sexual encounters is greater because it can involve trauma and tissue tearing [55, 87]. The 2009 ZSBS revealed that forced sex was more common among young women than older women. About 10% of young women aged 15-19 years reported forced sex in the past year, while only 5% of women aged 20-24 years and 4 percent of those aged 25-49 years reported it [48]. In addition, violence and/or the fear of violence may prevent women from insisting on condom use or refusing unwanted sex.

Alcohol use has been linked to high risk sexual behaviour [88]. Alcohol raises sexual risks in many ways, including the interaction with risk-taking personality characteristics, drinking environments, expectations regarding the effects of alcohol on risk-taking, perceptions of risks and psychogenic effects of alcohol on decision making [89, 90]. The 2009 ZSBS indicated that among sexually active young people, 9% of men and 8% of women were drunk during their last sexual intercourse [48]. In another survey conducted in selected areas of Zambia on 1500 young people, 22% reported being drunk during their last sexual intercourse [91]. Alcohol clearly reduces young people's abilities to correctly use a condom during sexual intercourse, which consequently raises their risk of contracting HIV [92].

1.5.2 HIV prevention strategies focusing on young people in Zambia

HIV prevention strategies specifically targeting young people in Zambia have been outlined in the National HIV and AIDS Strategic Framework (NASF) 2011–2015 [93, 94]. The purpose of these preventive strategies is to increase HIV knowledge and change young people's sexual behaviour [93]. They have

been implemented by several programmes, with focus on the following broad areas: life skills education, youth-peer education, multi-media education campaigns, Edu-sport and theatre, abstinence only campaigns, young people-friendly health services, male circumcision and HIV treatment.

(i) Life skills education

The purpose of this programme has been to change positively young people's sexual behaviour by teaching them the necessary skills that would enable them to become autonomous decision-makers, problem-solvers, creative and critical thinkers with high self-esteem, as well as having good communication and interpersonal relations [95, 96]. The provision of life skills has been mainly through the education system and anti-AIDS clubs. The latter were clubs set up mainly in schools, with a goal of increasing HIV awareness among students through counselling and personal advisor support [97]. They were among the earliest responses to the epidemic in Zambia, the first club being established in 1987; by 1992 over 1,000 clubs had been formed in primary and secondary schools, and in some communities around the country [97]. The role of life skills in promoting healthy lifestyles among young people was recognised by the Ministry of Education (MoE) in 1996, when the education policy incorporated topics of sexuality, personal relationships and HIV/AIDS education to be integrated into the school curriculum [98]. With support from UNICEF, the MoE developed and distributed supplementary training materials on life skills for young people and teachers [98]. Evidence shows that school-based HIV prevention programmes can increase knowledge and promote safer sexual behaviour [99]. However, comprehensive knowledge of HIV among young people in Zambia remain lower than the UNAIDS set target of 80% [48, 95]. According to the NASF 2011–2015 report, only 1.1 million young people were provided with HIV-based life skills between 2006 and 2007, and only 11% of the targeted 2.4 million young people were reached in 2009 [93]. These statistics indicate low coverage of this programme [100]. Moreover, only 60%

of the schools in Zambia had teachers trained in teaching life skills in 2009 [95].

(ii) Youth peer-education

The Copperbelt Health Education project pioneered the introduction of the youth peer-education programme in Zambia in 1986 [101]. Its purpose was to actively involve young people in the provision of HIV and sexual and reproductive health (SRH) information and services, because in most cases they were viewed as passive clients. The programme involves training young people as peer-educators in HIV and SRH, after which these peer-educators teach other young people about HIV and SRH, and provide other services, such as counselling, condom distribution and referrals to youth-friendly health facilities. The services have been provided mostly in schools, in anti-AIDS clubs, and at youth-friendly health corners [101]. A number of non-governmental organisations (NGOs) have also been implementing peer-education services in some communities around Zambia, some examples include the Student Partnerships Worldwide (Restless Development) [102, 103], YouthNet [104], Planned Parenthood Association of Zambia (PPAZ) and the Christian Health Association of Zambia (CHAZ) [105]. Although national-level data on the coverage of the peer-education programme is scanty, in a study undertaken to assess 5 peer-education programmes in Zambia regarding the coverage and impact of the programmes, it was found that peer-education exposure was high (43%) [106]. There were indications that it increased the uptake of youth-friendly health services, and increased HIV knowledge and condom use among young people [73, 106].

(iii) Multi-media education.

Mass media reach a wide range of audience, and have been instrumental in transmitting important information. This information is most often given in English, but the 7 official local languages are also used. The prominent media used to communicate HIV prevention and SRH promotion information to

young people include posters, radio, television and ICT (Information and Communication Technology), such as mobile phones and internet. Examples of programmes on radio and television that educate young people about HIV, and parents and teachers on how they can help them prevent getting infected, are *"New Teen Generation"* and *"Your Health Matters"* [107]. However, little is known of their impact on young people's SRH behaviour in Zambia. One programme that has been evaluated is *"HEART"* (Helping Each other Act Responsibly Together), which has been using a combination of television spots, radio programmes, print stories and video drama to reach young people with abstinence, "return to abstinence", and condom use messages. Its evaluation showed that young people who viewed the programmes were 2 times more likely to report primary and secondary abstinence, and 2 times more likely to have ever used a condom than non-viewers [108]

ICT (i.e. internet and mobile phones) has also been used by different programmes to reach young people in Zambia with HIV and SRH education. Examples include e-Riding [103] and PPAZ, which have even established a free internet café at their Lusaka clinic to give young people better access to HIV and SRH information [105]. Furthermore, UNICEF Zambia has been using digital diaries (where affected persons give a televised account of their HIV status) to communicate behaviour change information and how to avoid HIV [109], but the impact of these programmes on young people has yet to be assessed.

(iv) Edu-Sport and Theatre

"Edu-sport" (abbreviation for "educational sport") is used to deliver educational messages about HIV and SRH through sport. Sports (football and netball) are common spare-time activities among young people in Zambia. Using sports is a good way of reaching out-of-school young people in low SEP communities. Since most edu-sport activities are organised by young people, it gives them a sense of involvement, and enables them to learn and teach other

young people about HIV and SRH. HIV prevention and SRH promotion messages are disseminated to the participants through messages printed on t-shirts and posters, and through drama. Examples include the "Grassroots Soccer" project, which uses football to reach young people [110], and the "Dunking AIDS Out" project, which uses peer coaches to engage young people in basketball [111]. An evaluation of edu-sports showed that the "Grassroots Soccer" project improved HIV knowledge, attitudes and practices among participants [105, 110].

Drama has been another approach of communicating information to young people. HIV messages reach both the audience and the actors themselves. The "Theatre for Community Action" project reached ~8,000 young people in 20 communities around Zambia in 2006 [111]. PPAZ and CHAZ have also used drama groups to promote HIV prevention and delay sexual debut at beer halls and other gatherings [105]. However, there is no documented evidence of how these programmes performed.

(v) Abstinence-only approach
Abstinence-only promotion is another HIV prevention scheme that encourages primary and secondary abstinence as the only option to prevent HIV infection among young people [112]. For example, the "Safe from Harm" project initiated a parent-child communication programme in 2005 for adolescents aged 13-19 years to delay sexual debut [113]. Adolescents in this programme were better able to resist peer pressure for sex, and parents also reported increased communication with their children about HIV, but the effects on behaviour were not measured [113]. The "Family Matters" programme also used parent-child communication to conduct a pre-risk programme for young people aged 9-12 years to influence their behaviour intentions before they began having sex. Evaluation of this programme indicated that parents were willing and able to abrogate taboos and talk to young children about sex [114].

(vi) Young people – friendly health services

The young people friendly programme is a service that tries to get young people to use health services without fear of the health-providers judging them. The services provided in these facilities include peer-counselling on HIV and STIs, post-abortion care, family planning, HIV testing and counselling, life skills education, antenatal care, and distribution of condoms and IEC materials [105, 115]. The young people friendly programme was introduced in health facilities in 1996. In the National Health Strategic (NHS) plan for 2006–2010 and the NASF 2011–2015, it is stated that young people-friendly corners would be scaled up to more health facilities in Zambia, especially in rural areas [93, 116]. However, only 15% of them offered this service in 2006 [117].

(vii) Condom distribution.

Condom distribution has been an important HIV prevention intervention in Zambia since the early 1980s. Two major approaches have been used to promote and distribute condoms in Zambia, the first being through public health facilities. The Ministry of Health (MoH) has been ordering condoms through the Medical Stores of Zambia, and the condoms are distributed around the country in public health facilities, particularly in family planning units, youth-friendly corners, via peer educators, and in STI clinics–and they are free. Another condom distribution approach has been through NGOs, such as the Society for Family Health (SFH) [107]. SFH has been producing and distributing subsidized branded condoms (known as Maximum condoms) to distribution points in many districts, where they are sold cheaply to pharmacies, bars, night clubs, groceries and small shops, known as *"tuntembas"*. At the same time, SFH promotes the use of condoms through intensive mass media and interpersonal communication [107]. According to the 2010 UNGASS progress report, an estimated 14 million male condoms and 443,000 female condoms were distributed in 2008 alone, using mainly these two approaches [118]. However, coverage of condom distribution in Zambia is still low and even usage of condoms, especially among young people remains

low. In the 2011–2015 NASF, condom distribution and education were to be integrated into other prevention services, such as the male circumcision campaign.

(viii) Male circumcision (MC)

Male circumcision reduces by 60% the likelihood of men getting infected with HIV during unprotected sexual intercourse. Conclusive evidence comes from 3 randomised controlled trials in Uganda, Kenya and Rwanda [119-121]. Observational data in Zambia have been in line with this. The 2007 DHS showed that the North-Western province, which recorded the highest MC rate of 71%, had the lowest HIV prevalence in Zambia. In 2007, the national MC rate was estimated at 13% [38]. The same year, UNAIDS and WHO recommended male circumcision as an HIV prevention programme for countries with a generalised HIV epidemic [122]. In response, the government of Zambia, in collaboration with non-governmental organisations (NGOs), has embarked on a programme to increase the number of MCs in Zambia [123]. Acceptance of medical MC is high, both in traditionally circumcising and non-circumcising areas of Zambia, although there are barriers, information gaps and fears about MC, particularly in non-circumcising communities [66, 124]. But the goal is to circumcise 50% of Zambian men by 2020.

(ix) Treatment of HIV and scale-up of the ART programme in Zambia

The direct impact of HIV/AIDS in Zambia has been seen in high mortality [125] and morbidity among adults in the economically active age-group. Life expectancy at birth, which had improved substantially between 1950 and 1980 in many African countries, reduced to <50 years [126]. In Zambia, for instance, life expectancy at birth in the early 1990s had risen to over 50 years, but by 2000 it had fallen to 48 years or less [38, 41, 43, 127]. However, treatment of HIV through the use of anti-retroviral therapy (ARTs) has had a positive impact for individuals who had access to the drugs by extending their life span and improving their quality of life [128]. Using the new WHO guidelines of

putting people living with HIV on ART when CD4 counts fall below 350, Zambia had achieved near-universal coverage levels of between 70% and 80% by the end of 2010 [129-131].

1.6 Study Rationale

The significance of this project rests on the fact that HIV infection in Zambia has evident geographical and socio-economic variations, which has been attributed to different factors. To investigate those factors influencing HIV infection in Zambia, most studies have focused on individual-level factors and behaviour that contribute to increased risk of infection, such as those related to biological conditions, socio-demographic groupings, and patterns of sexual behaviour [26, 132]. Very few studies have included neighbourhood-level variables in their analyses [133]. Thus, studying individual-level factors alone may mean that we will not discover other factors that contribute to HIV infection. Certain characteristics of neighbourhoods, however, are associated with higher HIV prevalence [26].

The HIV prevention strategies implemented to curb the HIV epidemic in Zambia in the past few years seem to have had an effect on highly educated groups; a population-based study from Chelston and Kapiri Mposhi found a reduction in risky sexual behaviour of young educated people during 1995-2003 [134], probably contributing to an observed sharp decline in HIV prevalence in the same group [68]. National data from the antenatal HIV surveillance system for the period 1994-2002 also indicated that HIV prevalence declines was clearer among the more educated women [135]. However, the prevention strategies seem to have had less effect for less educated people, as the study from Chelston and Kapiri Mposhi found limited change in this group in reported risk behaviours such as having many sexual partners and unprotected sex [134]. Structural interventions might be more effective than individually focused campaigns in reducing the risk of HIV for groups with less resource. Thus, we were interested in examining whether

differences in community characteristics are associated with differences in sexual behaviour and HIV prevalence when individual characteristics are taken into account. We also wanted to assess trends in HIV prevalence in Zambia after 2002 in different socio-economic groups and geographical areas.

The analyses in this thesis are guided by the proximate determinants framework, and in 2 of the 3 papers we distinguish between individual and neighbourhood underlying factors. **Paper I** examines the links between trends in HIV prevalence and underlying sociodemographic and geographical factors in Zambia. **Paper II** deals with the association of underlying neighbourhood educational attainment, a proxy of socio-economic position, with HIV prevalence after adjusting for the effects of individual characteristics. **Paper III** places particular emphasis on the relationship between individual and neighbourhood underlying variables and 3 indicators of risky sexual behaviour: premarital sex, multiple partnerships and condom use at last premarital sex among young people. The focus in all the 3 papers is on young people since HIV infection in this group is, in most cases, recently acquired, and it is particularly important to monitor sexual behaviour patterns and HIV prevalence in this group to identify sub-groups, in which the incidence seems to be particularly high and needs to be targeted by prevention programmes.

2. Study Objectives

2.1 Main Objective

To assess trends and examine factors influencing the differential geographical distribution of HIV prevalence and risky sexual behaviour among young people in Zambia

2.2 Specific Objectives

   i. Examine geographical and sub-group differentials in HIV prevalence trends among men and women aged 15-24 years using available national data from 1994 to 2008 (**Paper I**);

   ii. Conduct a review of studies on HIV prevalence and incidence in the general population of Zambia (**Paper I**)

   iii. Investigate the effects of neighbourhood educational attainment on HIV prevalence among young women in selected urban and rural areas (**Paper II**);

   iv. Examine trends in premarital sex, multiple partnerships and condom use at last premarital sex among young people from 2000 to 2009 (**Paper III**);

   v. Assess the effects of individual and neighbourhood characteristics on premarital sex, multiple partnerships and condom use at last premarital sex among young people in 2000 and in 2009 (**Paper III**).

3. Research Methodology

3.1 Study area and population

Zambia is a landlocked country located in southern Africa that shares borders with the Democratic Republic of Congo (DRC), Tanzania, Malawi, Mozambique, Zimbabwe, Botswana, Namibia and Angola. Zambia has 10 provinces, which include: Central, Copperbelt, Eastern, Luapula, Lusaka, Northern, North-Western, Southern, Western and Muchinga (Muchinga province was created in 2011 and includes 5 districts previously part of Northern province and 1 district that was part of Eastern province) [136]. Zambia has over 72 districts [39].

Source: *ZDHS, 2007*

The country had an estimated population of 13.1 million people at the end of 2010, of which ~39% live in urban areas [39, 137]. The annual population growth rate is estimated to be 2.8% per annum [39, 137] and ~45% are <15 years of age [136]. The estimated total fertility rate in Zambia is 6.2 per woman [38] and life-expectancy is currently estimated by the Central Statistical Office at 51.2 years (49.2 years males and 53.4 years females) [138]. About 64% of the population live below the poverty line [139].

3.2 Design, sampling and data collection

The 3 papers are based on the following datasets:

i. National antenatal HIV sentinel surveillance data for 1994, 1998, 2002, 2004, 2006 and 2008 (**Paper I**).

ii. Zambia Demographic and Health Survey data for 2001 and 2007 (**Paper I**).

iii. Population-based survey data from Kapiri Mposhi and Chelston for 2003 (**Paper II**).

iv. Zambia Sexual Behaviour Surveys for 2000, 2003, 2005 and 2009 (**Paper III**).

3.2.1 National ANC-based Sentinel Surveillance

Zambia was the first country to establish (in 1994) a comprehensive ANC-based system by including a wide national coverage of sites, testing of both HIV and syphilis (seen as a marker of HIV), and a comprehensive set of demographic data including residence and educational attainment of the women [68]. This system was used in part as guidance for the "Second generation" HIV surveillance [7]. It is the main source of national HIV and syphilis trend data in Zambia. **Paper I** used the 22 sites that have consistently been part of the surveillance system since 1994, covering at least one rural and one urban site in the 9 "old" provinces. Women attending antenatal care for the first time in that pregnancy are enrolled sequentially during the data collection period (maximum duration 4 months), and socio-demographic data are

collected through routine interviews. The target sample of pregnant women was 500 in most sites, but in Ndola and the 4 sites in Lusaka (plus Livingstone and Kapiri Mposhi in 1994 and 1998) the target was 800. **Paper I** focused on young women aged 15-24 years, with a total sample size of 39,064 (5,542 in 1994, 7,106 in 1998, 7,092 in 2002, 6,606 in 2004, 6,575 in 2006 and 6,143 in 2008).

Blood specimens collected from eligible women were tested for both syphilis and HIV at the local health centre laboratories. HIV specimens were anonymous and unlinked to the women from whom they were collected. Capillus HIV-1/HIV-2 was the first test for screening for HIV in the 1994-2002 surveys, and all reactive specimens were re-tested using the confirmatory test Wellcozyme HIV. In the subsequent surveys, the Abbot Determine HIV1/HIV2 was used as a screening test, and all reactive specimens were re-tested using Murex ICE HIV. Specimens with discordant results were re-tested using a tie-breaker, viz. Bionor HIV1&2. Quality control of 10% (5% each in 1994 and 1998) of the negative specimens and all positive specimens was conducted using Wellcozyme HIV Recombinant HIV-1 in 1994, 1998, and 2002, and Abbot Determine in 2004, 2006 and 2008. When one of the negative specimens was positive, an additional 40-50% of the negative results were re-tested. If more false negatives were discovered, the entire batch of negative specimens was re-tested. Quality control and confirmatory testing was done at the Tropical Diseases Research Centre (TDRC) in Ndola and the University Teaching Hospital Virology Laboratory in Lusaka.

3.2.2 Zambia Demographic and Health Surveys (ZDHS)
ZDHS is a nationally representative population-based survey, and HIV testing was included in the 2001/2 and 2007 surveys [140-142]. A 2-stage cluster sampling procedure was followed using the 2000 Population Census as the sampling frame. About 320 clusters were selected, with probability proportional to size. All households were listed and systematic random sampling was used to select 25 households in each cluster, totalling to 8,000

households per survey. Women aged 15-49 years and men aged 15-59 years were eligible to participate in the surveys. In the 2001/2 round, men were only interviewed in one-third of the selected households. All selected men and women in these households were asked to consent to HIV testing. In the 2007 survey, men in all the selected households were eligible for interview, and all men and women in the selected households were eligible for HIV testing. Of the eligible men and women, 76% in 2001/2 and 77% in 2007 agreed to be tested. The total sample of young people who agreed to both an interview and an HIV test comprised 3,146 males (669 in 2001/2 and 2,477 in 2007) and 3,960 females (957 in 2001/2 and 3,003 in 2007) [38, 43].

In the 2001/2 survey, venous blood was obtained from participants as dried blood spots (DBS), whereas in the 2007 survey, capillary blood from finger pricks was used for the DBS [141]. Wellcozyme HIV-1&2 GACELISA was used to test for HIV antibodies in the 2001/2 survey. All positive specimens and 10% of the negative specimens were re-tested using Bionor HIV 1&2, and discordant specimens were tested by Western blot [140]. For the 2007 survey, screening was done with the ELISA test Vironostika® HIV Uni-Form II Plus O (Biomerieux) and all positive specimens were re-tested with a confirmatory ELISA test, Enzygnost Anti-HIV1/2 Plus. Discordant specimens were re-tested by Western blot [141]. In both surveys, 10% of the collected specimens (both positive and negative) were sent to the Global Clinical Viral Laboratory (GCVL) in Durban, South Africa, for external quality assessment [140-142].

In the 2001/2 survey, the HIV status data was not linked to household and individual characteristics of the survey respondents, in order to maintain their confidentiality and anonymity [140, 143]. However, the 2007 survey was based on a revised protocol that allowed HIV data to be linked to household and individual information, while maintaining the confidentiality and anonymity of the participants by scrambling the cluster and household numbers associated with each participant such that it was impossible to associate an individual data

record with a particular place and household [18]. HIV test results were linked to the questionnaire only through a barcode, after the identity codes had been scrambled and the files containing the original identity codes destroyed [17, 18].

3.2.3 Chelston and Kapiri Mposhi population – based study

The data in **Paper II** was from a population-based survey conducted in Chelston township of Lusaka and Kapiri Mposhi districts. It was first conducted in 1995 and later repeated in the same populations in 1999 and 2003 [16]. The focus of this analysis was the 2003 data set. Using stratified random cluster sampling, a total of 10 clusters corresponding to Standard Enumeration Areas (SEA) used in the Census frame were selected in each of the study sites. All persons in the selected clusters aged between 15-59 years were eligible to participate in the study. A total sample of 6,791 individuals were listed and 4,751 persons (i.e., 56% of whom were from Chelston and 44% from Kapiri Mposhi) were interviewed and consented to an HIV test (i.e., 70% of the eligible participants) [68, 71]. This study focused on young women aged 15-24 years, totalling 1,295 (840 from Chelston township and 435 from Kapiri Mposhi).

Only participants who consented to HIV testing provided saliva samples. The saliva samples were initially tested by a rapid BIONOR HIV 1 & 2 test. All reactive samples were re-tested by another rapid test, called GACELISA. The second test was used as a confirmation test of HIV-positive specimens. The 2 test kits gave a 99.8% agreement and had a sensitivity and specificity of 100% [68, 71]. Ten percent of the negative samples and 10% of the positive samples were sent to the national reference laboratory at the University Teaching Hospital in Lusaka for quality control.

3.2.4 Zambia Sexual Behaviour Survey

The data source for **Paper III** was the Zambia Sexual Behaviour Survey (ZSBS), which is a nationally representative population-based cross-sectional survey, conducted in 1998, 2000, 2003, 2005 and 2009. It had serially collected data on a number of HIV/AIDS/STIs indicators, such as knowledge, attitudes, sexual behaviour, and health-care seeking behaviour [48, 144-147]. The 1998 survey was based on WHO/GPA and the Family Health International (FHI) population surveillance questionnaire [144], whereas the 2000 questionnaire was made up of new sets of standard questions developed by an international consortium led by UNAIDS [145]. Over the years, adjustments have been made to the 2000 questionnaire to accommodate new indicators monitored by the international community, including PEPFAR, UNGASS, UNICEF, Global Fund, and WHO, through the MDGs [48]. Since the 1998 survey did not contain some of the questions included in the later surveys, it was excluded from the analysis [144].

A 3-stage probability sampling procedure was used in these surveys. The first stage involved selecting urban and rural clusters in every province [148], equal numbers of urban and rural clusters were selected and in all the 4 surveys [48, 144-147]. The second stage involved selecting 16 households (20 households in 2000) per urban cluster and 34 households (30 households in 2000) per rural cluster, which brought the total number of households sampled to 1,851 in 2000, 2,497 in 2003, 2,465 in 2005, and 2,500 in 2009. The final stage of the sampling procedure selected all adults in the chosen households, and a total number of 8,687 women aged 15-49 years and 7,803 men aged 15-59 years were interviewed in face-to-face interviews in the period under review (2000–2009) [48, 144-147]. However, the focus for this paper was young people aged 15-24 years, who comprised 3,630 women and 2,870 men.

3.3 Review of past studies on HIV prevalence and incidence

Published peer-reviewed articles on HIV prevalence and incidence in Zambia were identified through a computer search of the databases PubMed, Web-of-Science, EMBASE, Google-scholar, and African Journal on-line for **Paper I**. They identified 22 articles that met the criteria, i.e. the study must have: (a) been conducted in Zambia, (b) had original HIV data from a representative population, and (c) had HIV prevalence or HIV incidence estimates.

Table 2 HIV prevalence and incidence studies in Zambia before or in 2008

Sources	Year of data collection	References
ANC sentinel surveillance	1994	ANC Report (1994), Fylkesnes et al (1997), Fylkesnes et al (2001), Fabiani et al (2003), Sandøy et al (2006), Michelo et al (2008)
	1998	ANC Report (1998), Glynn et al (2001), Fabiani et al (2003), Fylkesnes et al (2001), Asamoah-Odei et al (2004), Sandøy et al (2006), Michelo et al (2008)
	2002	ANC Report (2002), Sandøy et al (2006), Dzekedzeke et al (2006), Michelo et al (2008)
	2004	ANC Report (2004)
	2006	ANC Report (2006)
	2008	ANC Report (2008)
Zambia demographic and health survey	2001/2	ZDHS Report(2001/2), Dzekedzeke et al (2006), Kandala el al (2008), Gouws et al (2008), Fortson (2008)
	2007	ZDHS Report (2007), Gouws et al (2008), Kandala el al (2011)
Other population-based studies		
Kapiri Mposhi	1995	Fylkesnes et al (1998), Fylkesnes et al(2001), Michelo et al (2006a), Michelo et al (2006b), Sandøy et al (2007)
	1999	Fylkesnes et al (2001),Michelo et al (2006a), Michelo et al (2006b), Sandøy et al (2007)
	2003	Michelo et al (2006a), Michelo et al (2006b), Sandøy et al (2007), Kayeyi et al (2009)
Chelston	1995	Fylkesnes et al (1998), Fylkesnes et al(2001), Michelo et al (2006a), Michelo et al (2006b), Sandøy et al (2007), Michelo et al (2008)
	1999	Fylkesnes et al (2001), Michelo et al (2006a), Michelo et al (2006b), Sandøy et al (2007), Michelo et al (2008)
	2003	Michelo et al (2006a), Michelo et al (2006b), Sandøy et al (2007), Michelo et al (2008), Kayeyi et al (2009)
Ndola	1997/8	Buve et al (2001), Glynn et al (2001)
PMTCT	2002/6	Stringer et al (2006)
Microbicide	2003/4	Ramjee et al (2008), Kapina et al (2010)

The articles found and used in this study were based on 6 data sources as shown in Table 2, namely; the ANC sentinel surveillance data [48, 144-147], the ZDHS data [38], the Chelstone and Kapiri Mposhi population-based surveys (PBS)[149-152], the Lusaka District Prevention of Mother to Child Transmission (PMTCT) Surveys [153], the Four Cities Multicentre Study in Ndola [154, 155], and the Microbicide Clinical Preparedness Study in Lusaka [156, 157].

3.4 Statistical analysis

3.4.1 Variables

A detailed description of the variables used in this thesis is given in the 3 papers. However, it is important to highlight that 2 different questions were used for the employment variable in **Paper III**. In the 2000 and 2003 ZSBS, respondents were asked for their main job or occupation, whereas in the 2005 and 2009 surveys, the question regarding the employment status of the respondents was used. It is clear that different aspects of employment were measured because different information seemed to have been captured.

3.4.2 Trend analysis

In **Paper I**, we estimated HIV prevalence trends of ANC sites and socio-demographic characteristics using the *chi-square* (χ^2) linear-by-linear trend test in SPSS 18. Similarly in **Paper III,** we used adjusted chi-square linear-by-linear trend test to determine whether a change in the sexual risk behaviour was statistically significant. Cluster effects were adjusted for using the stratified bootstrapping method in SPSS 18.

3.4.3 Single-level regression analysis

In **Paper I**, we used STATA 11.1 to estimate the age-adjusted risk ratios (aRR) for HIV infection for different survey years by province, age category and urban-rural residence using the *log-binomial regression of the generalized*

linear model. A detailed description of the statistical procedure has been presented in the paper.

3.4.4 Multi-level regression analysis

The term multi-level data refers to a hierarchical or nested data structure, such as repeated measures within subjects, or respondents within clusters, as in cluster sampling [158]. Multi-level analysis is used to examine relations between variables measured at different levels of the multi-level data structure [159]. In **Papers II** and **III**, we used multi-level mixed effects logistic regression (xtmelogit) models in STATA 11.1 to estimate fixed and random effects (however, only fixed effects models were reported in **Paper II**), since the sampling method used in these studies were stratified random cluster sampling. In this analysis, individual level data are analysed as fixed-effect models, and cluster-level data as random-effect models [159]. The fixed effects are presented as odds ratios, and random effects are presented as variances [159]. More details of the steps followed to build up the models have been presented in **Papers II** and **III**.

3.5 Ethical considerations

All the protocols for the studies used in the 3 papers were ethically scrutinised and approved. For the ANC HIV sentinel surveillance, approval was granted by the Ethics and Research sub-committee of the National AIDS Surveillance committee in 1990. The ZDHS, the Chelston-Kapiri Mposhi population-based survey and the ZSBS were approved by the Biomedical Ethical Review Committee of the University of Zambia. Further approval for the ZDHS was obtained from the Institutional Review Board of ORC Macro of the USA. In all the studies that included, HIV testing procedures were instituted to guarantee the requirements of unlinked anonymous HIV testing of blood or saliva. Furthermore, written or oral consent to participate in the surveys was sought, with participants being free to decline the interview or HIV testing (except in

the ANC sentinel surveillance where data collection was part of a routine care and was not announced to the participants). For respondents of <18 years of age, a parent or guardian was asked for permission to interview them and the respondents themselves were also asked to their assent. Anonymity and confidentiality was assured in all the studies.

4. Results

4.1 Paper I

ANC surveillance results showed that HIV prevalence among young women aged 15-24 years decreased from 27.4 to 15.5% in urban sites and from 11.4 to 6.4% in rural sites. Of all the 22 sites (12 urban and 10 rural) assessed, there were statistically significant reduction in 14 of them. In 2 urban sites (Matero and Kalingalinga) and 2 rural sites (Minga and Ibenga) non-significant decline in HIV prevalence trends occurred, whereas in 4 rural sites (Kalabo, Kapiri Mposhi, Nchelenge and Kabompo) the prevalence fluctuated considerably during the same period. The declines in HIV prevalence were more prominent in urban than rural sites, and pooled HIV prevalence data from the rural sites showed that the decline had begun after 2004. It was also found that HIV prevalence declines were much steeper among young women with the highest educational attainment ($\geq$10 years of schooling) than those with no or low educational attainment (<4 years of schooling). Provincial HIV decline among young women in the ANC data differed significantly from 10 to 68% for women residing in urban areas and from stability to 86% decline for women residing in rural areas. The provinces that had a consistent significant decline over the years in question were Lusaka (urban), Eastern (urban) and Southern (both urban and rural).

According to the ZDHS 2001/2 and 2007, non-significant declines in HIV prevalence occurred among young women in the general population in both urban areas (from 15.2 to 12.5%, aRR 0.79 CI 0.58 – 1.08) and rural areas (from 7.8 to 6.4%, aRR 0.74 CI 0.52 – 1.07). However, a non-significant increase in HIV prevalence was observed among young men. There was a non-significant decrease in HIV prevalence among young women in most provinces in the ZDHS (except in the urban areas of Central, North-Western and Western provinces, rural areas of Central, Luapula and Lusaka provinces, where there was a non-significant increase, and the rural areas of Copperbelt and Eastern

provinces, where there was a significant decrease). A comparison of pregnant women and women in the general population showed that the direction and magnitude of change in HIV prevalence (between the years 2002 and 2008 for ANC and between 2001/02 and 2007 for ZDHS) were quite similar (28 vs. 21% among urban residents and 20 vs. 26% among rural residents).

All the reviewed articles that included HIV prevalence data at several time-points were in agreement that HIV prevalence trends were decreasing among young women in Zambia. Trend data for men at 3 time-points were only available from the Chelston/Kapiri Mposhi study, in which there was also a clearly declining trend among young men [71].

4.2   Paper II

HIV prevalence among young women aged 15-24 years was 12.5% in the selected urban neighbourhoods in Chelston and 6.8% in the selected rural neighbourhoods in Kapiri Mposhi in 2003. In both urban and rural areas, women in neighbourhoods with low average educational attainment had higher HIV prevalence than those living in neighbourhoods with high average educational attainment, 15.9 vs. 10.7% and 7.3 vs. 3.7%, respectively. The odds of infection in low vs. high educational attainment neighbourhoods was 3.4 times greater among rural women and 1.8 times higher among urban women, after adjusting for age and other individual-level underlying variables, including education. After adjustment for level of education in the neighbourhoods, the individual-level educational attainment differed by residence, i.e. a strong protective effect among urban women whereas it tended to be a risk factor among rural women (although not statistically significant).

Further analyses showed that women residing in low educational attainment neighbourhoods had a high risk of engaging in early sexual activities and to miss schooling, compared to those residing in neighbourhoods with high educational attainment. For the sexually active young women, the results

indicate that young women who resided in low educational attainment neighbourhoods more often engaged in sex before age 16, married early and gave birth early. The percentage reporting symptoms of sexually transmitted infections (STIs) was higher in neighbourhoods with low educational level, with a similar pattern being seen in both urban and rural neighbourhoods.

A comparison between urban and rural neighbourhoods also showed that young women in the latter neighbourhoods engaged in sexual intercourse earlier than those in the urban neighbourhoods, irrespective of the level of education in their neighbourhood. In terms of median reported life-time partners, women in rural neighbourhoods reported a higher number of partners compared to those in urban neighbourhoods.

4.3 Paper III

A decreasing trend in premarital sex was found among young men (from 54.4 to 45.1%, p<0.001) and young women (from 46.8 to 38.9%, p=0.003) between 2000 and 2009, trends also seen in most sub-groups. Multi-level analysis showed that the full models, comprising both individual and neighbourhood variables, explained 29 and 34% of the neighbourhood-level variance of premarital sex in 2000 and 2009, respectively. In these models, residing in an urban area (in both 2000 and 2009) and in neighbourhoods with high residential stability (in 2000), high comprehensive knowledge of HIV (in both 2000 and 2009) and high labour force participation (in 2009) were significantly associated with lower odds of premarital sex among young people. Increasing age, being in employment (in both 2000 and 2009), and being a protestant Christian (in 2000) were significantly associated with higher odds of premarital sex among young people.

The analyses showed that the prevalence of multiple partnerships among young men decreased significantly from 25.8 to 14.1% (p<0.001) between 2000 and 2009. This decline was also seen in almost all the subgroups of young men.

Among young women, the trends were not clear, but those reporting multiple partnerships were much lower than reported by young men. Multi-level full models for the year 2000 indicated that neighbourhood variance for multiple partnerships among young people was 29%, whereas in 2009, the neighbourhood variance for multiple partnerships among young people was extremely low. The covariates significantly associated with lower odds of multiple partnerships in the full models were:- being female (in both 2000 and 2009) and residing in neighbourhoods with high comprehensive knowledge of HIV (in 2009). Having secondary/higher educational attainment and being in employment were significantly associated (in 2000) with higher odds of multiple partnerships among young people.

Condom use at last premarital sex generally remained stable among young men between 2000 and 2009, whereas a non-significant decline was observed among young women (from 40.4 to 33.3%, p=0.247). Only females in neighbourhoods with medium residential stability had significantly decreased trends. Multi-level full models in the year 2000 explained 18% of the neighbourhood variability of condom use at last premarital sex among young people. However, in 2009, the neighbourhood variability of condom use among young people was extremely low. Residing in neighbourhoods with high educational attainment (in 2000), high residential stability (in 2009) and high comprehensive knowledge of HIV (in 2009) was significantly associated with higher odds of condom use at last premarital sex. Being a protestant Christian (in 2000) and residing in neighbourhoods with lower labour force participation (in 2000) was significantly associated with lower odds of condom use among young people.

5. Discussions

5.1 Methodology

5.1.1 Design and sampling

All 3 papers in this thesis are based on data collected from cross-sectional surveys, which have the advantage in their ability to generate large quantities of data in a short period of time. The data can be used for assessing health needs and planning appropriate health services. Cross-sectional studies give a snap-shot of the prevalence of HIV and sexual risk behaviour at just one time-point [160]. When data on HIV infection or sexual risk behaviour are collected using the same methodology at different time-points, trends can be established, as in **Paper I** and **Paper III**. However, since exposure and outcomes are measured at the same time, it is impossible to establish causal relationships [161], and also to state whether certain types of behaviour caused HIV infection or high HIV prevalence in Zambia caused sexual behaviour to change among young people.

The strength of our study lies in the fact that we used data collected by both the ANC sentinel surveillance and population-based surveys to examine overall trends and geographical distribution of HIV among young people in Zambia. These 2 data sources complement each other. The ANC sentinel surveillance system has sampled pregnant women from the same 22 sites over a 14-year period and can thus give estimates of HIV trends, which can be stratified by age-group and geographical location [7]. Population-based surveys, however, represent the whole population, including men, and can give more detailed information about social, economic, sexual behaviour and biomedical factors associated with HIV [162].

5.1.2 Validity of the study

The validity of the study depends on how well we could measure what was intended. In research, 2 main types of validity exist, internal and external validity. Internal validity refers to the accuracy of measuring what the study was designed to measure in the study population [161]. External validity refers to how generalizable the results are to the entire reference population or other populations [161, 163].

5.1.2.1 Internal Validity

Potential threats that might have affected the study have been grouped into 3 categories: selection biases, information biases and confounding. These threats may have arisen due to the sampling methods, the data collection instruments, and the observational study design. A detailed discussion of these challenges follows:

(i) Selection bias

By definition, selection bias is a systematic error in selecting a study group or groups, and can have a major impact on the internal validity of a study and the legitimacy of the conclusions [161, 163]. Such a bias is more likely to occur where study participants have not been randomly chosen. In our study, this bias was minimized because all participants in the ZDHS, the Chelstone and Kapiri Mposhi PBS and the ZSBS were randomly selected and a standardised selection procedure was followed in each survey round.

In relation to the assessment of HIV prevalence trends, changes in attendance at ANC due to changes in the quality or the outreach of services over time could have led to biases where this might have had an effect on the profile of women attending ANC in the selected sites [164, 165]. For example, selection bias may have occurred if those of high socio-economic position chose to attend ANC in private clinics where the quality of care is perceived as being higher, whereas those of low and middle socio-economic position attended

ANC clinics at public health centres. This situation is highly possible in urban areas of Central, Copperbelt, Lusaka, and Southern provinces of Zambia, where there are many private health centres. However, the evidence indicates that the majority of pregnant women attended public health centres in Zambia in 2007 [38], and therefore the impact of excluding private clinics in the ANC sentinel surveillance was probably minimal [166]. In contrast, studies in South Africa have shown that estimates from the ANC sentinel surveillance are to some extent biased where a large proportion of better-off pregnant women attend private clinics for their ANC services [166].

Another common source of selection bias, especially in population-based surveys, is the non-response bias. This occurs when individuals who do not respond to a call to participate in these studies are generally different from those who do respond [161, 163, 165]. To assess if non-response affected the HIV estimates from the ZDHS data, we did a sensitivity analysis in **Paper I** and the results indicated that even if those young people who refused to participate had double the HIV prevalence of those who participated, it would not have affected our findings substantially. These results are in agreement with the evaluation study of the DHS data from some sub-Saharan African countries, including Zambia, which show that the effect of non-participation in HIV testing on national estimates of HIV sero-prevalence tends to be very small and insignificant [18]. Furthermore, an assessment of the non-participants in the Chelston and Kapiri Mposhi PBS showed that most of them were young people attending boarding schools, and since young people in school were at lower risk of infection, it is likely that the prevalence of HIV among non-responders was quite low [71].

(ii) Information bias
Information bias occurs when research participants provide inaccurate information concerning diseases or exposures because they cannot recall certain events correctly or they adapt their answers to what they think is

desirable or socially acceptable in their community [167, 168]. The surveys that we analysed dealt with very sensitive information, so it is possible that there was some degree of information bias. Sex is typically a highly private matter, such that people feel embarrassed or threatened when asked to tell what they do or how many people they have had sex with [169, 170]. In countries like Zambia, topics to do with sex are not discussed openly between young people and adults, and indeed it is generally taboo for parents to discuss sex issues with their children [171].

The Zambian culture, like in many others in African, have strong restrictions against premarital sexual activities [171]. It is expected that young women remain sexually abstinent until marriage. If a young woman has sex, the man who *"takes away"* the young woman's virginity is customarily charged with what is known as *"chisungu"* (loss of virginity of a young girl). But in most cases, young women choose to remain silent about their loss of virginity because of the spectacle created by the traditional *"chisungu"* discussions and ceremony [171]. A young woman's loss of virginity before marriage is also considered a shame to the family [172]. In some cases, young women's reputation may be damaged by just a hint of sexual experience, and the situation is even worse if they are known to have had sex with many partners [173, 174]. Thus it is highly likely that some young women would deny being sexually active, especially if the interview was conducted in the presence of other people for fear of being stigmatised by their community. Thus it is possible that the finding that fewer young women than men reported multiple sexual partners in **Paper III** could be partly due to underreporting.

Young men are more likely to overstate their sexual encounters because of the masculine ideals of societies in Zambia, which covertly encourage them to have sexual experience before marriage [174]. There are, in most cases, no consequences or stigmatisation in young men losing their virginity [171, 175].

Even after marriage, multiple sexual partnerships are more commonly reported among men than women.

HIV prevention campaigns targeting young people have focused on messages of abstinence from sex until the *"right time,"* and on condom use for those who are sexually active. Since these messages are likely to influence what is regarded as "desired by society", it can lead to a social desirability bias since young people provide more *"socially desirable"* responses than in reality [176, 177]. For example, they may report consistent condom use when they only occasionally use condoms.

Recalling particular events in a participant's life is subject to error. For example, it would be difficult for participants to give the exact number of life-time partners if they have had many partners, but it is very easy if they have had only one or two partners. Furthermore, individuals identified as having a disease tend to be better at recalling events leading to the acquisition of that disease than those without the disease or symptoms [168]. HIV-positive participants, for instance, may be able to recall their sexual activity more accurately than non-infected participants or those who have not been tested, because they have made an effort to explain what events led to their HIV infection.

Reporting one's exact age has been a subject of error, especially in societies with less educated people. Age is an important variable in any survey and misreporting it might lead to distorted estimations [178-180]. Therefore, some surveys have developed ways to ensure that participants recall their age as accurately as possible. For example, in ZDHS and in ZSBS, the participants are not asked for their exact age, but for their age at their last birthday. Asking for age this way increases the accuracy of reporting [181]. Sometimes use of birth certificates, birth records or *"national registration cards"* are requested to ascertain the exact birthdays of the participants [181].

Another issue that might lead to information bias is the context within which the interview is conducted. For example, despite the data collection instruments used to collect sexual behaviour information in ZDHS and ZSBS being similar, the former surveys have tended to give over time higher estimated levels of risk behaviour than the latter. According to Slaymaker and Buckner (2004) [182], these differences might have been a result of ZDHS focusing on family formation and reproductive health, while ZSBS is more focused on HIV, which is a stigmatised disease. Another thing could be that the ZDHS questionnaire takes a long time to complete in comparison to that of the ZSBS, and thus responses in the former may be affected by fatigue among the participants [182].

Information bias can also take place if there are problems with the HIV tests, for instance, where there are false positives or false negative results. However, in all the HIV surveys from which we have used data, specimens that were positive according to the first test were retested with a different confirmatory test. Furthermore, there were additional internal and external quality controls for both positive and negative specimens in the ANC, ZDHS and the Chelston and Kapiri Mposhi surveys. These measures reduced the probability of false positives and false negatives.

In the 2000 and 2003 ZSBS surveys in **Paper III**, the variable employment was based on a question about one's main job or occupation, whereas in the 2005 and 2009 surveys, the question considered the work status of participants, apart from their occupation. It is possible that the differences in questions between the two periods (2000/2003 versus 2005/2009) contributed to the observed differences in **Paper III** on individual employment and neighbourhood labour force participation.

(iii) Confounding

Confounding occurs when an estimate of the association between an exposure and an outcome is mixed up with the real effect of another exposure on the same outcome because the 2 exposures are somehow correlated [161, 163]. Confounding might have occurred in all the 3 papers. In **Paper I**, the varying distribution of urban and rural women attending some ANC sites may have confounded the association between HIV prevalence at the site and time, since urban women are twice as likely to be HIV infected than rural women. In **Paper II**, when neighbourhood educational attainment and individual education were added to the same multivariate model, individual educational attainment– which was statistically significant in the bivariate analysis– lost its significant association with HIV infection (and the association changed from being protective to tending to be a risk factor) among rural young women. This indicates that the apparent association between individual education and HIV infection among rural women was due to a correlation between individual education and neighbourhood educational attainment, and between neighbourhood education attainment and HIV.

In **Paper III**, the inclusion of individual and neighbourhood characteristics in the full multivariate model for premarital sex in the year 2000 resulted in neighbourhood labour force participation losing its statistical significance. It is possible that neighbourhood labour force participation was a confounder in model III, and that the important association was the one with individual level employment status and premarital sex. Neighbourhood comprehensive knowledge (in 2000) lost statistical significance in the full multivariate models for multiple partnerships, which might have been a result of partial confounding by the rural-urban residence variable. Urban-rural residence seemed to be a confounder in relation to condom use at last premarital sex in 2000 since the significant association seen in model II disappeared when we adjusted for neighbourhood educational attainment and neighbourhood labour force participation. In contrast, after the urban-rural residence variable had

been added to the full multivariate models in 2009, neighbourhood comprehensive knowledge became a significant predictor of multiple partnerships and neighbourhood residential stability became significantly associated with condom use at last premarital sex. Such gains in statistical significance, also known as negative confounding, denote that the effect of confounding was biased towards the null hypothesis [183]. However, the potential threats of confounding in our study were dealt with statistically during the analyses by controlling for the effects of the confounder in the models.

5.1.2.2 External Validity

Potential threats to external validity of the results of this thesis relate to the selection process of the sample populations. If the sample is not representative of the general population, then the study results cannot be generalised to the whole population. ZDHS and ZSBS are population-based surveys based on randomly sampled households from a sampling frame encompassing the whole country [38], and findings from them are likely to be representative of household populations of Zambia when selection and other biases are minimal. However, both the ZDHS and the ZSBS exclude residents in institutions, such as army barracks, police camps, prisons and boarding schools within the selected clusters [38]. Since young people in these institutions may have a different risk of HIV infection and their sexual risk behaviour may also be different from those living in the selected households, this may affect the external validity of our findings. For the Chelston and Kapiri Mposhi study, although the sampling procedure used was random selection, the results of this study may only be representative of the communities where the study was conducted, despite the HIV prevalence estimates being comparable to the national estimates [16, 184].

In Zambia, the representativeness of ANC-based data has been investigated in 3 different ways, by comparing: (i) point estimates from population-based data and ANC-based data in the same site [16]; (ii) trends over time in population-

based data versus ANC-based data from the same site [185]; and (iii) ANC-based data with ZDHS data at the national level[142]. These validations have found that ANC and national estimates of HIV from the ZDHS were very similar. Furthermore, the magnitude and the direction of change from 2002 to 2008 in the ANC and from 2001/2 to 2007 for the ZDHS-based estimates were similar, as indicated in **Paper I**. However, the ANC trend estimates underestimated the decline in HIV prevalence in the general population in selected neighbourhoods of Zambia [185]. Despite the close match in HIV prevalence estimates between ANC and national representative population-based surveys, ANC estimates generally overestimate HIV prevalence among young people in the general population. This is because on average young pregnant women are more sexually active than young women and men in the general population, particularly in younger age groups, and their risk of infection is relatively high. In contrast, in **Paper III** we found that about half of single men and women in the general population were not sexually active. Evidence of this can be drawn from the ZSBS, which showed that in the general population less than half of young women were not sexually active.

Even though ANC sites were picked from all the 9 "old" provinces of Zambia, they cannot be automatically assumed to be representative of all areas of Zambia, since the sites were purposively selected and remote rural areas are under-represented because health centres in such areas are too small to give adequate sample size of women within a data collection period of 4 months [166]. The sites selected to represent rural sites are actually in peri-urban areas. Therefore pregnant women attending these health facilities may not be typical pregnant women living in rural areas. However, the fact that data collection was limited to 4 months could also have affected the representativeness of our study if there were seasonal variations in pregnancies.

5.1.2.3 Random errors and statistical power

We were unable to find significant changes in HIV prevalence at provincial-level between the 2001/2 and 2007 ZDHS **(Paper I)**, probably because of the low power of the statistical analysis, since the sample of young people who tested for HIV in the 2001/2002 survey was rather small. Similarly, in the multilevel mixed effects regression analyses of the Chelston-Kapiri Mposhi data (**Paper II**), the number of neighbourhoods was small and thus the power to detect between-cluster variation was limited, although a large sample size of participants were selected at individual-level, and therefore the random-effect estimates were not reported in **Paper II**. Some multi-level analysts have suggested that, as a rule of the thumb in detecting differences at neighbourhood-level, there should be at least 30 neighbourhood-level clusters [159, 186-189].

Another problem we encountered was the size of within-cluster samples in the ZSBS data (**Paper III**). Multi-level analysts have also suggested that if the within-cluster sample is <5 people, it might affect the detection of associations between the explanatory and independent variables [186-189]. However, if we were to remove clusters with <5 respondents from the analysis of multiple partnerships and condom use at last premarital sex, it would have resulted in a great reduction in the number of neighbourhood units. Thus we decided to keep them in the analyses, although it probably contributed in some cases to loss of statistical power in detecting between neighbourhood variance.

Furthermore, in **Paper III**, the inclusion of individual-level variables to the intercept-only models for premarital sex and multiple partnerships resulted in the total unexplained variance increasing instead of the usual reduction. At first glance this could have been interpreted as an error, but Snijder and Bosker (1999) [158] suggest that it means that individual-level variables are stronger predictors of the outcome variable than neighbourhood-level characteristics. A detailed discussion of this is given in **Paper III**.

5.2 Main findings

5.2.1 HIV prevalence and incidence trends among young people in Zambia

ANC surveillance data indicate that a substantial decrease in HIV prevalence occurred among young women in both urban and rural sites between 1994 and 2008. The PMTCT study in Lusaka [190] and the Chelston and Kapiri Mposhi study [71, 134, 184], which used different methodologies to estimate HIV prevalence trends in different communities of Zambia, produced similar findings. In addition, both the ANC surveillance and the Chelston and Kapiri Mposhi data are in agreement that reduction in HIV prevalence among young women has been steeper among urban residents than rural residents, although the difference in HIV prevalence among urban residents is twice that of rural residents. Similar patterns have been found in most other African countries [191, 192].

The decline in HIV prevalence among young women aged 15-24 years is likely to reflect a decline in incidence. Based on mathematical modelling of prevalence data from Zambia, UNAIDS has also concluded that HIV incidence has been decreasing in Zambia since 2001 [1]. We believe that this decline started in the mid-1990s, at least in urban areas. The decline in HIV incidence concurs with results from other sub-Saharan African countries [191-198].

Urban-rural differentials in HIV prevalence trends may indicate differences in the response to prevention campaigns, since many of them were more prominent in urban than rural areas because of better access to mass media (i.e., radio, television and newspapers) [107, 199]. It could also reflect differences in behavioural responses due to the observed effects of the HIV epidemic on morbidity and mortality being more visible in urban areas since the prevalence there is higher. It is also possible that these variations in trends could partially reflect that the epidemic has reached different stages in the different parts of Zambia [200].

Furthermore, the ANC surveillance data shows differences in HIV prevalence trends by educational attainment. HIV prevalence trends among young urban women, with >5 years of schooling decreased significantly, reaching almost at the same level as that of the less educated in 2008. A similar pattern was observed among young rural women with >7 years of schooling. The plausible explanation for this marked decline among the highly educated young women is that they have been quicker at adopting protective behaviour [70], which is in accordance with the Theory of Diffusion of Innovations [201].

Population-based surveys, such as the Demographic and Health Survey (DHS), are considered a gold standard in providing representative estimates of HIV prevalence [18, 166, 202-204] . So far only 2 DHS rounds, with an HIV testing module, have been conducted in Zambia. A comparison of the ZDHS 2001/2002 and the ZDHS 2007 indicate that there has been an insignificant reduction in HIV prevalence among young women. However, there was a slight increase in the estimated HIV prevalence among men of the same age group during the same period. The latter may be a result of random variations due to a small sample size rather than an actual increase in HIV prevalence. We had expected that the trend among men would be similar to that among women, as found in the population-based surveys in Chelstone and Kapiri Mposhi [71]. Another DHS will give us a better basis on which to assess the trend of HIV prevalence among young men.

5.2.2 Sexual risk behaviour trends

The decline in HIV prevalence among young people may possibly be attributed to change in sexual risk behaviour [134, 184, 205-208], but there are many aspects of behavioural changes. In **Paper III**, premarital sex, multiple partnerships and condom use at last premarital sex did not change at the same rate. The prevalence of premarital sex decreased significantly between 2000 and 2009, with almost similar rates for young women and men. For multiple sexual partners, a significant decrease was only observed among young men.

These reductions in premarital sex and multiple partnerships indicate that young people have begun to adhere to the prevention messages by taking fewer risks. It is also possible that behavioural changes have occurred because young people have become more cautious as a result of the effects of the HIV epidemic on mortality and morbidity, which have been so evident around them [208-211].

Despite rigorous promotional efforts since the mid-1980s [107], our analyses indicated that condom use among young unmarried men and women has remained low and stable in Zambia. Knowledge of the male condom is almost universal in Zambia [38], but promoting its use has not been easy due to much opposition from religious groups and traditionalists. These groups have argued that condoms are a symbol of immorality, infidelity and women's uncontrolled sexuality [212, 213]. Cultural attitudes towards condoms may also be affecting condom use. Traditionally, sex is viewed as a procreative activity; therefore male potency and the pressure to have children usually override the concerns of contracting HIV and other STIs [214]. For this reason, condoms are more often used in short-term rather than long-term relationships, and in most cases it is not even consistent [215]. Despite these hurdles, the Ministry of Health and NGOs, with the support from donors, have continued to distribute millions of free and low-priced condoms around Zambia [64, 93, 116], but there are problems of making sure that condoms are readily available where people really need them; thus some studies have found that condoms were not regularly available in places where people meet high-risk partners [216].

5.2.3 Individual-level predictors of risky sexual behaviours

In **Paper III**, we found that higher age among young people was associated with a higher risk of pre-marital sex, multiple partnerships and condom use at last premarital sex. Women were less likely to report multiple partners in all survey rounds. A review of the DHS studies in 13 sub-Saharan Africa showed that the percentage of women reporting 2 or more partners was <5% in the

majority of these countries, and this has been constant over the years [217]. The probable reason for the under-reporting could be fear of being labelled or stigmatised as a prostitute if they report many sexual partners. This might also scare away potential suitors for marriage.

Furthermore, this study found that individual-level education was associated with higher risk (but not statistically significant) of premarital sex, multiple partnerships and condom use. These findings are a bit surprising considering that studies conducted in selected communities of Zambia have shown since the mid-1990 that individual-level education was associated with less risky sexual behaviour [68, 71, 134], and considering that national declines in HIV prevalence have been particularly clear among those with higher education attainment (**Paper I**). However, the proportion reporting multiple partnerships declined more markedly among educated men between 2000 and 2009, and as a result the association between education and multiple partners was not significant in 2009. This is in line with the Chelston and Kapiri Mposhi study, and studies conducted in Zimbabwe and other sub-Saharan African countries, which have found a higher probability of highly educated people reducing their sexual risk behaviours than those less well educated [70, 209, 211].

Young people with a job had a higher risk of premarital sex (in 2000 and 2009) and multiple partnerships (in 2000). This may be because they, especially young men, can afford to have many partners. All religious groups in Zambia are opposed to premarital sex and condom use, but it is difficult to explain the significant differences found between Protestant Christians and Catholic Christians, particularly the finding that Catholics were more likely to report condom use, since the Catholic Church is well known to oppose contraception.

Residing in urban areas was associated with a lower probability of engaging in premarital sex and higher odds of condom use. This is probably a result of high exposure to prevention messages through the mass-media, and from the

experience of seeing many friends and relatives getting sick and dying from AIDS-related illnesses.

5.2.4 Neighbourhood-level predictors of HIV infection and risk sexual behaviours

Places where people live affect their health status and health-related behaviour [218, 219]. In **Paper II**, we examined the association between HIV and the variable "neighbourhood educational attainment", a proxy of neighbourhood SEP. The appropriateness of using educational attainment as a proxy of SEP comes from the fact that educated people can easily get high paying jobs and are more empowered. SEP contributes to better health, since those with more resources can buy better food and afford better housing, live in safer environments, and have better access to healthcare information and healthcare [220]. Other indicators to measure the SEP of a neighbourhood are average level of income, wealth index, and employment status. Average neighbourhood income has been used in most developed countries to class neighbourhoods into different socio-economic strata [221], because it has been shown to be a better indicator of SEP [220]. However, average neighbourhood income is unreliable in countries like Zambia as it is very difficult to determine household income, hence the use of a proxy variable such as neighbourhood educational attainment to estimate SEP. In **Paper II**, we found that young women living in high socio-economic position (SEP) neighbourhoods had a lower risk of HIV infection than those in low SEP neighbourhoods, which is consistent with findings from a study conducted in Tanzania [222]. The finding in **Paper III** that neighbourhood educational attainment was strongly associated with high condom use in 2000, but that the statistical significant association disappeared in 2009, was thus surprising. The change in association seemed to be due to a dramatic drop in reported condom use at last premarital sex from 2005 to 2009 for young women living in neighbourhoods with high educational attainment. Since the decrease over time was insignificant according to the trend analysis, it is too early to conclude whether the low percentage reporting condom use in

2009 in this group reflected a real change or was due to some random changes in the sample.

The results in **Paper III** also point out that young people in neighbourhoods with high average length of residence had less premarital sex (in 2000) and higher condom use (in 2009). Similar associations have been reported in other studies [223]. According to the social capital theory, households living together in the same neighbourhood for a long time are more likely to build a sense of social responsibility, which increases social control on young people's behaviour [224, 225]. It is also possible that social cultural norms in the neighbourhoods where young people live may shape their behaviour if they have stayed in the same neighbourhood for a long time together. For example, in a study of determinants of high-risk sexual behaviour in sub-Saharan Africa, it was argued that involvement in multiple partnerships was prevalent in communities where these norms were accepted [47].

Most HIV prevention interventions have focused on increasing comprehensive knowledge of HIV, especially among young people [226, 227]. It is assumed that high comprehensive knowledge would make young people act responsibly to prevent HIV infection. This is in line with the findings in **Paper III**, i.e., that residing in neighbourhoods with high comprehensive knowledge of HIV resulted in less risk of premarital sex and multiple partnerships, and more condom use.

Labour force participation levels, the prevalence of full-time employment among adult women, and employment opportunities are associated with less sexual risk behaviour among young people [228-230]. In line with this, we found that labour force participation was associated with less premarital sex in 2009. The probable explanation is that most of these neighbourhoods comprise people who are highly educated, and are characterised by family stability, high levels of parental authority and control, availability of parental time and

supervision, and increased communication between the young people and parents [231]. Surprisingly, labour force participation was associated with lower condom use in 2000, a finding that is difficult to explain.

6. Conclusion and Recommendations

6.1 Conclusion

Marked geographical differences in HIV prevalence trends across Zambia were observed, which may be a sign that the epidemic has reached different stages in the different geographical areas, or there could be differences in the response to prevention interventions or the visible impacts of the epidemic. HIV prevalence trends among young women in both urban and rural areas decreased between 1994 and 2008, which may partially be a result of young women delaying sexual debut and having fewer sexual partners. Condom use at last premarital sex, on the other hand, has remained rather low and stable among young people, and thus will have contributed little to the change over time in HIV prevalence.

A review of studies that have been conducted on HIV prevalence and incidence also show a significant decline in prevalence among young women, but the results for men are mixed. The ZDHS (2001/2 and 2007) results for men did not agree with findings of a clear prevalence decline from the Chelston and Kapiri Mposhi study (1995–2003). These conflicting results warrant increased HIV infection surveillance among young men in Zambia.

Neighbourhood educational attainment was a strong predictor of HIV infection among young women in both urban and rural communities in the Chelston and Kapiri Mposhi study of 2003. There was a higher likelihood of young women in low SEP neighbourhoods being infected than those in high SEP neighbourhoods, which indicates that community factors contribute to young women's risk of HIV exposure.

The national survey on sexual behaviour (ZSBS) showed that individual-level factors such as education, employment and religion were strongly associated with a higher likelihood of premarital sex and/or multiple partnerships among

young people. Urban residence and the neighbourhood residential stability and comprehensive knowledge were strongly associated with a lower likelihood of premarital sex and a higher rate of condom use. These results suggest that both individual and neighbourhood characteristics influence sexual risk behaviour, and that it is useful to take into consideration neighbourhood variables when studying sexual risk behaviour related to HIV.

6.2 Recommendations

6.2.1 Policy Implication

The great geographical variation in HIV prevalence trends indicates a need to develop preventive strategies appropriate for different local contexts targeting different age groups and subgroups. The findings also support previous research, which underscores the HIV preventive potential in strengthening the educational system in Zambia, since educated individuals and young women living in neighbourhoods with high educational attainment are at a lower risk of infection. Policy makers should adopt an educational policy that compels parents to send their children to school, for at least the basic school level. This will only be achieved by enacting legislation that makes it illegal for parents not to send their children to school. For those who cannot afford to send their children to school, a bursary support system should be established. There is also need to build more secondary schools and rehabilitate old ones. The government policy of free education was a step in the right direction, but informal payments, such as "Parent-Teachers Association" (PTA), are a hindrance to school attendance.

The school curriculum should emphasize sexual and reproductive health topics that need to be introduced early so that young people can take control of their sexual lives by understanding the danger of early sex and how to protect themselves. Although there has not been a national programme to evaluate the life-skills training, local area programmes show an impact on young people. Therefore, this programme should be scaled up to include areas where it does

not exist, and should be strengthened in areas where it is weak. Since only few teachers have been trained in life-skills education in Zambia, this programme should be introduced in the teachers' curriculum so that all teachers in Zambia can become better equipped.

Our findings further indicate that prevention programmes targeting premarital sex and multiple partnerships are working and should be continued. But there is great need to re-strategise the campaigns on condom use, especially in rural areas. This is because we have shown a higher rate of condom use in urban areas. It is also important that policy-makers suggest policies that will ensure that condoms are available in places where people tend to meet sexual partners. Campaigns on condom use should also be integrated into other programmes; for example, the male circumcision and reproductive health programmes.

6.2.2 Research Implications

The national epidemiological efforts that are being conducted in Zambia to monitor the HIV epidemic, for example, the ANC and the population-based surveys, should be continued. A few changes could be made, such as moving the HIV testing module in the ZDHS to the ZSBS because the former is already a big survey that is dealing with a lot of demographic and reproductive health questions. Taking the HIV testing module to the ZSBS would improve the quality and efficiency of the data collection system. Furthermore, the selection of some clusters of a new ZSBS could be purposely done in some ANC sites so as to continue validation of the ANC sentinel surveillance, as in the Chelston and Kapiri Mposhi study.

Mixed methods research should be conducted for a better understanding of the geographical differential distribution of the HIV epidemic in Zambia. Furthermore, there is need to base such studies on sound theories at the design stage for purpose of providing reasonable explanations for the associations seen in these studies, especially at the neighbourhood level. There have been no

studies conducted in Zambia to test theories such as the Social Ecological model and the Social Capital theory.

To evaluate the education effect on HIV prevalence, the variable years in school has been used, but this does not take into consideration the aspects of school performance of the students or exposure to sexual and reproductive health education. Future research could look into what aspect of education influence changes in sexual behaviour.

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