Investigating trends in HIV transmission and risk factors in Zambia

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List of papers

The thesis is based on the following papers:

Paper I
Sandøy IF, Kvåle G, Michelo C, Fylkesnes K. Antenatal clinic-based HIV prevalence in Zambia: Declining trends but sharp local contrasts in young women. Tropical Medicine and International Health 2006, June: 11 (6); 917–928.

Paper II
Sandøy IF, Michelo C, Siziya S, Fylkesnes K. Associations between sexual behaviour change among young people and decline in HIV prevalence in Zambia. BMC Public Health 2007, Apr 23; 7(1):60.

Paper III
Sandøy IF, Siziya S, Fylkesnes K. Lost opportunities in HIV prevention: programmes miss places where exposures are highest. BMC Public Health 2008, Jan 24; 8:31.

Paper IV
Sandøy IF, Dzekedzeke K, Fylkesnes K. Prevalence and correlates of concurrent sexual partnerships in Zambia. (Submitted)

List of abbreviations

ABC	Prevention approaches emphasizing abstinence, being faithful, and condom use at risky sex
ACASI	Audio computer-assisted self-interview
AIDS	Acquired Immunodefiency Syndrome
ANC	Antenatal clinic
AOR	Age-adjusted odds ratio
ARV	Anti-retroviral drug
CASI	Computer-assisted self-interview
CBO	Community-based organization
CI	Confidence interval
CSA	Census supervisory area
CSO	Central Statistical Office
DHMT	District Health Management Team
DHS	Demographic and Health Survey
HAART	Highly active antiretroviral treatment
HBC	Home-based care
HIV	Human Immunodeficiency Virus
IDU	Injecting drug user
MSM	Men who have sex with men
NGO	Non-governmental organization
NUFU	Norwegian Council for Higher Education's Programme for Development Research and Education
OR	Odds ratio
PBS	Population-based survey
PEPFAR	The U.S. President's Emergency Plan for AIDS Relief
PLACE	Priorities for Local AIDS-Control Efforts
PLWHA	People living with HIV/AIDS
PMTCT	Prevention of mother-to-child transmission
PSU	Primary sampling unit
RR	Relative risk/Risk ratio
SBS	Sexual Behaviour Survey
SEA	Standard enumeration area
SD	Standard deviation
STI/STD	Sexually transmitted infection/disease
TB	Tuberculosis
VCT	Voluntary counselling and testing

Abstract

The objective of HIV surveillance is to document trends in HIV prevalence and transmission risk in order to make informed policies and to guide prevention and care/treatment programmes. Zambia established a comprehensive HIV surveillance system in 1994 that provides data on prevalence trends in both urban and rural areas based on over 20 sentinel sites using data from antenatal clinic (ANC) attendees. Furthermore, population-based HIV surveys have been conducted regularly since 1995 in selected communities to validate the representative profile of pregnant women and to measure the trends in HIV prevalence and transmission risks concomitantly. Since then, repeated national sexual behaviour surveys and one nationally representative HIV survey among adults have been conducted. This national survey from 2002 revealed that the HIV prevalence among adults in Zambia was 15.6% (23.1% in urban areas and 10.8% in rural areas).

The objective of this thesis is to examine trends in HIV prevalence and sexual behaviours that are likely to have had an impact on HIV infection in Zambia since the mid 1990s. The discussion of the associations between HIV, risk behaviours and underlying sociodemographic factors builds on the proximate determinants framework and takes into account the importance of the epidemiological context.

A significant declining trend in HIV prevalence among pregnant urban women and a modest decline among rural women was found in the data from the 22 antenatal sites that were part of the ANC-based HIV surveillance system throughout the period 1994 to 2002 in Zambia. The decline was clearest among urban women aged 15-24 with higher education, and it is likely that this drop reflected a reduction in incidence of infection. However, individual sites showed diverging trends. This could be a sign of different epidemic stages, but also differences in intensity and effectiveness of HIV prevention in these areas as well as cultural or structural factors affecting transmission.

Both national data and data from selected communities revealed a shift towards safer sexual behaviour in Zambia since the mid 1990s with a decrease in the proportion of people reporting multiple or concurrent partners and early sexual activity, and an increase in condom use with casual partners. A parallel increase in age of the first birth for women strengthens the credibility of the reported behaviour changes. Logistic regression analyses showed that the

same indicators probably contributed to the decline in HIV prevalence observed among sexually active young people between 1995 and 2003 in selected urban and rural areas. The changes in reported sexual behaviour were clearest among young urban people who had completed more than secondary education. Groups with higher education appeared also with the most marked decline in HIV prevalence. Although there are many sources of potential bias, these consistent trends are likely signs of real behaviour changes that have contributed to the decline in incidence indicated by the drop in the prevalence among young people.

Higher socioeconomic status and education were associated with having more sexual partners before the HIV epidemic in Africa, probably due to a combination of factors that promote sexual networking, such as higher mobility, urban residence and financial ability. Early surveys showed higher levels of HIV prevalence among wealthy and educated groups. Both in Zambia and several other sub-Saharan countries this pattern has now reversed. Multiple sexual partners, low condom use and HIV infection have become associated with lower socioeconomic status. As knowledge about risk factors becomes available, people of higher socioeconomic status will usually possess the resources and self-efficacy to change their behaviour and avoid disease. In groups with fewer resources such changes usually occur more slowly.

When a substantial proportion of a population has multiple concurrent sexual partners this can lead to rapid and widespread transmission of sexually transmitted infections, including HIV, in the population as large groups of people are connected at stages during which the infectiousness of the disease is high. Mathematical models have demonstrated that this can have a major impact on the growth of an epidemic in its early phases. There are no data on the prevalence of concurrent sexual partnerships in Zambia from the early 1980s when the HIV epidemic probably took off, but data from the period 1998 to 2003 showed a decline in concurrency among both urban and rural men. The fact that a decline was observed in groups with different educational attainment makes it plausible that a certain decrease in the prevalence of concurrency had already taken place by 1998 in higher socioeconomic groups.

The observed behavioural changes in Zambia could be due to successful HIV prevention campaigns, but may also reflect changes in risk due to the visible effects of the epidemic in the communities. There has not been a national system for monitoring and evaluation of HIV prevention programs in the past in Zambia, and thus it is not possible to determine the contribution of specific programs to HIV prevalence decline. Empirical data have revealed

that the effect of interventions on HIV incidence depends on the epidemiological context; i.e. the same intervention can have different impacts in different communities depending on the distribution of risk factors, sexual behaviour, stage of the epidemic, HIV prevalence/incidence in the target population, prevalence of other STIs, and sexual mixing between high-risk groups and other population groups. There is a need for a combination of research approaches - in addition to the established HIV surveillance systems - to obtain this information.

In countries with high prevalence of HIV in the general population, high risk groups can be an important source of new infections although a lot of the transmission takes place among individuals perceived to have low risk. However, it may be harder to identify high-risk/core groups than in low prevalence settings as the risk of HIV transmission is high in the general population too. One hypothesis is that focusing on high risk places such as venues where people meet new sexual partners would be more effective in reducing the transmission rate of HIV at the community level rather than targeting interventions just at the perceived high risk groups. So-called PLACE-assessments of venues where people meet new sexual partners in two cities in Zambia revealed a high level of unprotected sex among people who were socializing there, but also a high likelihood of using condoms if they were available in the venue or nearby. There was a lack of the signs of current preventive campaigns targeting these high-risk venues, and the assessment identified opportunities for prevention that potentially could have a significant impact on the serious epidemics in these urban settings.

Despite signs of improvements, Zambia still suffers from an extensive HIV epidemic with high incidence rates. It is of critical importance to further strengthen the prevention of new infections. This represents a particular challenge when priorities seem to be shifting from prevention to antiretroviral treatment.

1 Introduction

1.1 HIV surveillance systems

The objective of HIV surveillance is to document trends in HIV prevalence and risk behaviours, and not to identify causes of differential risks [1]. UNAIDS and WHO recommend that HIV prevalence is monitored in the general population in countries with a generalized epidemic (HIV prevalence higher than 1%) [2]. In most countries this is done by using data from pregnant women attending antenatal care. It is more difficult to find sentinel groups of men that are easily accessible and reasonable representative. Countries with compulsory national military service for men have the opportunity to monitor prevalence among recruits, and as most recruits are young they can be used to assess incidence in young men (prevalence among young people approximates incidence as the time since sexual debut is short and mortality is low). This has been done in Thailand [3, 4].

To obtain data on the prevalence in the general population, the best method is to conduct population-based cohort studies or surveys. A cohort study would allow direct incidence measurement, but continuous follow-up of the same population over a long period of time requires a lot of resources, especially in a population with high mobility. If the aim is to obtain nationally representative trend data, a cohort study with participants spread around a country would most likely be so expensive and demanding that it is unfeasible, especially in resource-limited settings.

Population-based surveys are sometimes conducted in the catchment area of an antenatal site to validate the HIV data from pregnant women. Most of these studies have found that the prevalence among pregnant women is relatively representative of the prevalence for men and women in the general population [5-9].

In recent years many countries with generalized epidemics have conducted nationally representative population-based surveys with HIV testing: the so-called Demographic and Health Survey plus (DHS+). The first countries in sub-Saharan Africa that conducted DHS+ were Zambia and Mali, and they only linked data on HIV infection to gender, age-category, region and rural/urban residence, but not to more detailed sociodemographic or behavioural information due to concerns about anonymity. Countries that have carried out such surveys more recently have, however, allowed more information to be linked to the HIV result [1],

and this makes it possible to assess risk factors and HIV prevalence in different population subgroups.

WHO and UNAIDS now recommend that HIV surveillance includes some behavioural data from the general population so as to be able to assess whether behaviour changes can explain HIV prevalence trends and to monitor the effect of prevention programs [2]. Such behavioural information cannot, however, be used to predict the epidemic as there is no straightforward relationship between risky behaviour and HIV incidence [10]. The behaviours monitored should capture the risk of exposure and transmission of HIV infection [1]. Ideally the behavioural information and HIV prevalence should be measured in the same population [10], and some argue that behavioural questions should be included in the antenatal surveillance system [1]. However, others express a fear that including such intimate questions will lower the attendance at the antenatal clinics and introduce bias.

The number of HIV infected children in a country is usually estimated from the HIV prevalence among pregnant women, assuming that 40% of infants are infected during pregnancy, perinatally or through breast-feeding if no measures are in place to prevent transmission [11, 12]. With increasing access to PMTCT, this transmission rate is likely to decrease.

The Estimation and Projection Package is a computer model developed by the UNAIDS Reference group on Estimates, Modelling and Projections that estimates the HIV prevalence of generalized epidemics using data from sentinel surveillance sites. The program fits models to data from different subepidemics and creates a national model based on these [13]. These estimates are published every year in the UNAIDS' Aids Epidemic Update.

As very few developing countries have working systems for the enumeration of the number of persons on antiretroviral treatment, reporting of AIDS cases, or vital registration, including cause of death [14], the UNAIDS has also developed Spectrum Projection Package. This is a model for estimating the number of infected individuals by age and sex, HIV-related mortality and the number of orphans resulting from the HIV epidemic, based on the estimated adult prevalence. Spectrum projections build on certain assumptions about the age and sex distribution of HIV infection, effects of HIV on fertility, life expectancy with and without HIV, probability of mother-to child transmission, child survival, and the effect of treatment [15, 16]. The Spectrum Projection Package also allows future projections of the epidemic to

be made from trend data. The estimates and projections obtained are used for planning of interventions, resource allocation and for advocacy. Comparisons of direct measurements of prevalence, mortality and number of orphans from empirical studies with the model-based estimates show that the estimates are usually accurate enough for medium-term planning, but more problematic to use in short-term planning [17].

1.2 Proximate determinants and the importance of the epidemiological context

The prevalence and incidence of HIV depends on three biological determinants; risk of exposure to infection of susceptible individuals, the probability of transmission at exposure, and the duration of the infectious period of the disease. The consequences of a change in one of them depends on the two other variables. The prevalence of HIV in a population affects the risk of HIV exposure. Thus there is a feedback loop. The biological determinants can be affected by a number of behavioural and biological variables which are called proximate determinants. These proximate determinants work through the biological determinants to influence the risk of HIV infection on an individual or group level and are themselves affected by underlying determinants like changes in the socioeconomic context or intervention programs [18]. If all the proximate determinants of HIV infection are measured and adjusted for in a study, the association between underlying determinants and HIV should be non-significant [19]. This framework is useful both in the collection, analysis and interpretation of HIV related data [18].

The effect of interventions on HIV incidence depends on the epidemiological context, i.e. the distribution of risk factors, primary transmission modes, sexual behaviour, the stage of the epidemic, incidence in different population subgroups, HIV prevalence in the target population, prevalence of other STIs, the stage of the epidemics of other STIs in the community, and sexual mixing between high-risk groups and other population groups. Assessment of these factors is advisable before launching an intervention [20, 21]. Different mathematical modelling packages have been developed in which information on the epidemiological context can be entered and the potential impact of a specific intervention can be predicted [20].

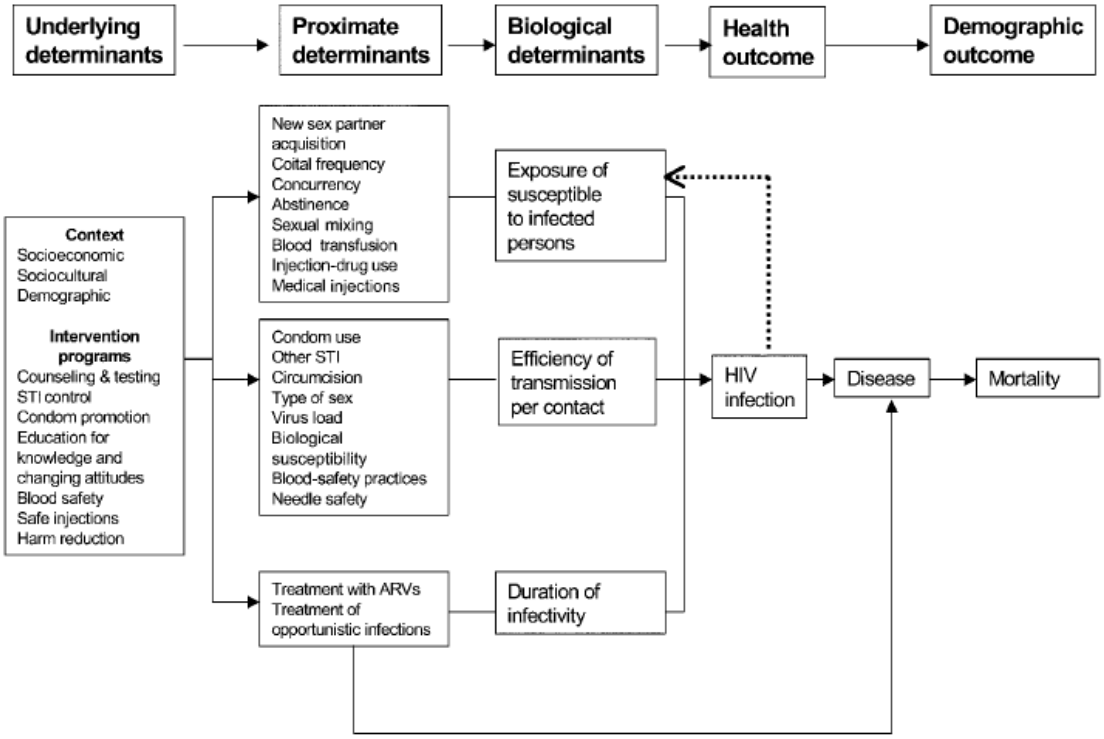


Figure 1: The proximate-determinants conceptual framework for factors affecting the risk of sexual transmission of HIV (Source: Boerma & Weir, 2005).

1.3 Prevention approaches

HIV can be transmitted through all bodily fluids. The relative importance of the different modes of transmission varies between different countries, but ignoring one of the pathways in an HIV prevention programme carries the risk that this pathway will emerge as important. The following is a summary of evidence for the efficacy (impact of an intervention on the study population) and/or effectiveness (impact in the real world) of different approaches.

1.3.1 Preventing blood-borne transmission

1.3.1.1 Blood supply safety: With voluntary low-risk blood donors, routine screening of all blood donated, and the avoidance of unnecessary transfusions, the risk of HIV transmission can be almost completely removed [22]. These steps have been implemented in most developed countries, but not in all developing countries [23-26].

1.3.1.2 Harm reduction for injection drug users (IDUs): Drug substitution programs have been shown to reduce injecting drug use and sharing of needles, but the evidence for reduced HIV incidence is currently weak [27, 28]. Several studies have found that needle and syringe exchange programs also reduce needle sharing among IDUs [29], but the evidence for decreased incidence of HIV is less clear with many studies being indeterminate [30-32].

1.3.1.3 Protective routines among health workers: All body fluids should be treated as potentially infectious and health workers should wear gloves and masks when appropriate, and dispose of waste safely to reduce the risk of HIV transmission in health care facilities [22].

1.3.1.4 Post-exposure prophylaxis: There have been no randomized controlled trials studying the efficacy of post-exposure prophylaxis, but one case control study and several animal studies indicate that antiretroviral drugs reduce the risk of HIV transmission after accidental needle-stick exposure to blood from HIV-positive patients [33].

1.3.2 Preventing Sexual Transmission

1.3.2.1 Information and education to achieve behaviour change: A number of school-based education programs in Africa have been effective in increasing HIV-related knowledge [34-37], delaying sexual debut [34, 36-38], reducing the number of sexual partners [34, 37], and increasing condom use [34, 37, 38], but none of these have been able to show an effect on HIV incidence [34, 37]. A review of systematic studies of mass communication programs (including TV, radio, posters, brochures and dramas) found that there were diverging impacts on condom use and abstinence, but in more than 50% of the studies knowledge about HIV increased and there was a moderate reduction in high risk behaviours like multiple sexual partners and casual sex. However, almost all the reviewed studies were of weak design with no randomization or appropriate comparison group, and it was not possible to extract what components were vital for the success of a programme [39].

PEPFAR (The U.S. President's Emergency Plan for AIDS Relief) is selectively financing abstinence-only interventions (encouraging primary and secondary abstinence as the only option to prevent HIV infection) targeting young people based on the idea that talking to young people about safer sex and condom use could increase promiscuity. Programs that

promote safer sex among young people have lost their funding from USAID [40]. There is, however, little scientific evidence to support the belief that abstinence-only interventions are effective. A systematic review of randomized or quasi-randomized trials of abstinence-only programs in the US found that there was no long-term effect on HIV risk assessed on the basis of self-reported sexual behaviour (including sexual debut and frequency of sex) or diagnosed STIs [41, 42]. A similar review of studies from developing countries also found very little evidence of behaviour change [43].

Reviews of "abstinence-plus" interventions from North-America (promoting abstinence as the best way to prevent HIV infection, but including information about condom use and other safer sex options) showed that more than half had both short-term and long-term effects on sexual behaviours like abstinence, condom use, or unprotected sex, but there were no effects on STIs [44]. More general meta-analyses of behavioural and social HIV prevention interventions targeting sexually experienced young people and heterosexual adults in the US found modest reductions in unprotected sex, and in addition decreased incidence of STIs among heterosexual adults. Most of these interventions included information on safer sex and abstinence, and technical, personal and interpersonal skills training. However, the follow-up time was generally short and long-term effects are therefore uncertain [45, 46]. Another meta-analysis examined interventions that included an eroticizing safer sex component (emphasizing pleasurable aspects of sex) and found indications that this element contributed to higher condom use compared to the findings of other meta-analyses of safer sex interventions, but the meta-analysis did not systematically compare similar interventions with and without an eroticizing component [47]. Training of interpersonal skills and focusing on younger age-groups or those at the highest risk were elements that were found to be important for achieving reductions in unprotected anal sex among men who have sex with men (MSM) in yet another meta-analysis from the US [48].

A limitation of all these reviews and meta-analyses is that the interventions included were very different in content, length, implementation, study methodology, target group and comparison group, and thus it is difficult to accurately assess which components were essential to achieve success [44-47]. One study that compared a safer sex intervention to an abstinence-plus intervention, found reduced unprotected sex among adolescents with sexual experience in the first intervention group, but no long-term effect of the latter intervention [49]. To be able to draw more general conclusions about the relative effectiveness of these

different programs there is a need for more trials that compare abstinence-only, abstinence-plus and safer sex approaches [42, 44].

1.3.2.2 Condom promotion, distribution and information about condom use: Condoms offer at least 90% effective protection against HIV transmission when used correctly and consistently [50]. Mathematical models have shown that consistent condom use practiced by a small group of people has a greater effect on the risk of acquiring HIV in a population than inconsistent use by many [51]. Condom distribution and information about condom use increases condom use, and has not been shown to increase other risk behaviours [52]. It is uncertain whether subsidizing condoms rather than giving them free of charge is the most successful strategy to increase use in the general population, but making them affordable seems to be important [53, 54]. Female condoms are equally effective as male condoms in preventing STIs, but more expensive [55]. Promotion of female condoms among sex workers was in one study found to give only a slight increase in overall consistent condom use, but male condoms were substituted for female ones, leading to a considerable increase in the cost of the prevention programme [56].

1.3.2.3 Screening and treatment of other STIs: Syndromic treatment of STIs and increased treatment seeking in the population have been shown to reduce the incidence of HIV and STIs in settings with a high prevalence of treatable STIs and moderate levels of HSV-2 infection (which is a life-long infection). The intervention seems to be most effective in the early stages of an HIV epidemic [57-60], but may also have an effect in a generalized epidemic where risk behaviours are prevalent and if combined with periodic presumptive treatment of sex workers and their clients [61]. It is important, however, to identify the relative contribution of treatable STIs in the target population before introducing syndromic treatment [59].

Some studies have found an effect of regular STI screening or presumptive treatment of sex workers combined with condom provision on HIV [62] and STI incidence [62-65] among sex workers [62-65] and their clients [63]. Very few of these studies, however, used control groups or randomized designs.

1.3.2.4 Male circumcision: Male circumcision reduces the risk of female-to-male HIV transmission through vaginal intercourse by approximately 50-60% according to three randomized controlled trials from South-Africa, Kenya and Uganda [66-68]. Circumcision also reduced the prevalence of self-reported genital ulcer in the Ugandan trial, but not

discharge or dysuria, suggesting a reduced incidence of other STIs, with the exception of gonorrhoea and chlamydia [68]. The South-African trial found an alarming increase in risky sexual behaviour in the intervention group [66], whereas the other two trials, which included intensive health education sessions, did not find that circumcision lead to any behavioural disinhibition in the trial periods of approximately 2 years [67, 68]. However, risky sexual behaviour decreased in the control group in Kenya, but not in the intervention group [67].

1.3.3 Peer-education

Peer education programs among youth have been popular in many countries as peers of the same sex have been found to be the most important source of information about sex-related issues among young people, and it is believed that such programs are cost-effective. Several studies have found that youth peer educators themselves often experience such programs as empowering [69-71]. Some peer education studies comparing the intervention group with control groups with no intervention have found increased knowledge related to HIV and intentions to abstain from sex or to use condoms [72], some show effects on actual sexual behaviour [49, 72], but there are also studies that show no beneficial effects on the target group [70]. In addition, evidence of impact on HIV incidence is lacking. A review comparing peer- vs. adult-led health education in schools found indications that peers were more successful in achieving behaviour change related to smoking and alcohol use than adults [73]. There is, however, a lack of randomized controlled trials that show that peers are more successful than adult educators in achieving reductions in risky sexual behaviour among young people [49, 74]. One randomized study from the US among adolescents found no difference in the impact on reported sexual behaviour of adult and peer educators [49].

Many peer-education programs among sex workers have achieved increased condom use with clients [75, 76], and some have also lead to reductions in HIV and STI transmission [77]. It seems that increasing condom use with non-paying regular partners is more difficult [75]. However, many of the successful programs have also included establishment of specific health clinics for sex workers [77], and it is often difficult to distinguish the separate effects of this and of peer education.

Training negotiation skills, condom distribution and increasing group solidarity are probably the main important components of sex worker peer education [76, 78]. Programs that have

been successful have also taken into consideration the high mobility among sex workers by continually training new peer educators [77]. Those who are trained should ideally be charismatic, experienced sex workers and well-known to their peers [76]. A study from Malawi found that when sex workers who had been trained as peer educators moved to a new establishment, they met with negative attitudes if they tried to educate their new colleagues [75].

Peer education programs among IDUs may get through to hard-to-reach groups of drug users who are not easily caught by other programs and at times when high risk behaviours take place [79]. Studies have found that such programs seem to be effective in reducing sharing of syringes [80, 81], especially among the peer educators themselves [80], but many of the studies have failed to find any effects on risky sexual behaviour and condom use compared to ordinary health education interventions [81, 82]. The conclusions are, however, limited by the weak designs of many of these studies, with small sample sizes and non-randomized allocation to the intervention arm.

1.3.4 Voluntary counselling and testing

Voluntary counselling and HIV testing has in many studies resulted in a drop in risk behaviours among those who are found to be HIV positive, but it is unclear whether VCT leads to a favourable behaviour change among those who test negative [83-85]. A study in Kenya, Tanzania and Trinidad, using the "US Centers for Disease Control and Prevention's client-centred HIV-1 Counselling Model" which encourages clients to come for several counselling sessions, found a reduction in reported unprotected sex with non-primary partners among those who were tested HIV-negative too [86]. However, reports indicate that in many settings the time spent on counselling is considerable shorter than what this counselling model recommends, usually being limited to one short post-test counselling session. Post-test counselling for those who are tested negative is particularly liable to be cut down (with no or minimal talk of protective measures) [87]. A recent study from Zimbabwe found an increase in number of partners after VCT among individuals who tested negative, highlighting the importance of thorough and proper counselling [84]. There is also no evidence yet of effects of VCT on HIV incidence in developing countries [88].

There are indications that changes in risky behaviour are more marked among persons who actively seek VCT-services themselves than among individuals who accept an invitation for VCT as part of a study [85]. This could imply that opt-out strategies or routine HIV testing of all who attend health clinics will not be as effective as voluntary approaches in achieving safer sexual behaviour among those who are tested. Thus the potential population impact of introducing routine-testing in settings other than in antenatal care, where it is a prerequisite to reduce transmission of infection from mother to child, may be small. Therefore it must be weighed against possible detrimental effects for the individuals who are tested, such as break-up of marriage and social isolation [89, 90].

1.3.5 Prevention of Mother-to-Child Transmission

1.3.5.1 Contraceptives: Avoiding unwanted pregnancy among HIV-positive mothers prevents vertical transmission of the infection [91].

1.3.5.2 Antiretroviral drugs: Antiretroviral drugs (ARVs) (one or a combination) administered before, during and after birth reduce transmission of HIV infection by 33-63% [92].

1.3.5.3 Caesarean delivery: Elective caesarean section significantly reduces (by >50%) the risk of mother-to-child HIV transmission compared to vaginal delivery [93-95].

1.3.5.4 Breastfeeding alternatives: The HIV virus can be transmitted through breast milk. In developed countries HIV-infected mothers are told to give their children substitutes instead of breast milk. In developing countries this is often not a feasible option due to lack of safe drinking water, high costs related to replacement feeding and sociocultural problems associated with not breast-feeding. Studies have shown that exclusive breast-feeding in the first six months is safer than mixed feeding with both breast milk and substitutes. Although the transmission risk of HIV with exclusive breastfeeding may be higher than with formula-feeding, the overall mortality seems to be lower [96-98]. The current recommendations from WHO are thus exclusive breastfeeding for all HIV-infected mothers the first 6 months unless replacement feeding is “acceptable, feasible, affordable, sustainable and safe” [99].

1.3.6 Preventive impact of antiretroviral treatment

In addition to preventing vertical transmission of HIV from mother to child, antiretroviral treatment can theoretically contribute to a decline in HIV incidence as reduced viral load among those on treatment reduces transmission risks. Introduction of ARVs can also motivate more people to get tested, and if knowledge of HIV status leads to safer behaviour (see earlier discussion), this could also reduce HIV transmission. These factors can, however, be counteracted by the longer survival of those who are HIV infected (which results in longer period of infectiousness) and potential behavioural disinhibition among both HIV negative and HIV positive persons if HIV is no longer perceived as a serious disease [100-102]. Several studies from developed countries have found an increase in risk behaviours among men who have sex with men (MSM) and in the general population after the introduction of HAART [100, 101, 103]. A meta-analysis found an association between unprotected sex and the belief that HAART prevented HIV transmission or being less worried about engaging in unsafe sex as antiretroviral drugs were available. However, there was no relationship between receiving HAART and increased unprotected sex [104]. Studies from developing countries have not found evidence for increased sexual risk behaviour among HAART users either. On the contrary, there is evidence for increased consistent condom use. It is, however, too early to draw a conclusion due to a low number of studies and weak study designs [105]. Mathematical models predicting the impact of ARV introduction on HIV incidence diverge in their conclusions depending on the assumptions made about likely behaviour changes and transmission of drug resistant virus strains [106].

1.4 The HIV epidemic in Zambia

The first case of HIV in Zambia was registered in 1984 [107]. It soon became clear that Zambia was already experiencing a very serious HIV epidemic as a survey from the University Teaching Hospital in Lusaka in 1985 found HIV prevalences of 8.7% among pregnant women, 18.4% among blood donors and 19% among hospital staff [108]. Retrospective analyses of serum from cerebral malaria patients in Ndola revealed a prevalence of 3% in 1982-83 (1 out of 39 patients) and 16% in 1986-87 (3 out of 19) [109]. Based on studies of the impact of HIV on adult mortality, Kumbutso Dzekedzeke et al. suggest that the HIV epidemic in Zambia was probably already big enough to significantly

influence adult mortality in the late 1960s. This hypothesis is based on the finding that the natural mortality advantage of women disappeared already in the period 1969-1980, and the crossover of the mortality curves for men and women has gradually shifted to younger ages since then [110].

In the first decade after HIV was discovered, the HIV prevalence in Zambia was only estimated based on data from population subgroups like pregnant women, STI clinic patients and blood donors [111]. The first population-based survey with HIV testing was conducted in 1995, and it found an HIV prevalence in the 15-39 years age group of 26.0% in Chelston (urban), Lusaka, and 16.4% in rural Kapiri Mposhi. These prevalences matched quite well with available ANC data from the same areas (23.9% and 12.5% respectively in 1994) [112]. This survey was followed-up in 1999 and 2003 in the same areas and revealed a declining prevalence among young people; from 6.9% to 3.2% among urban men aged 15-24, from 22.5% to 12.5% for young urban females, from 5.7% to 3.2% for young rural males and from 16.1% to 6.8% for rural females of the same age. As changes in prevalence among young adults can be used as a proxy of incidence changes in the same group, this is interpreted as a sign that the HIV epidemic in these selected communities in Zambia is declining [113]. The only national survey to include HIV testing to date was the DHS+ in 2001/2002 which found a prevalence of HIV of 15.6%; 10.8% in rural areas and 23.2% in urban areas [114].

At the start of the HIV epidemic in sub-Saharan Africa, including Zambia, higher educated groups were the hardest hit [5, 108, 115, 116]. However, in the repeated population-based surveys the prevalence decline was clearest among young people with higher education, especially in the urban area, whereas among respondents with little education there was no significant change [117].

The main mode of HIV transmission in Zambia is heterosexual intercourse [108] and mother-to-child transmission. It is estimated that 30,000 newborns are infected every year through vertical transmission [118].

1.5 Responses to the HIV epidemic in Zambia

The first major political response to the HIV epidemic in Zambia was the establishment of the National AIDS Prevention and Control Program and the National AIDS Surveillance

Committee in 1986. In 1987 an emergency plan was launched to ensure safe blood and blood product supplies. With the First Medium Term Plan (1988-92) AIDS coordinators were appointed at the provincial and district levels. The Second Medium Term Plan (1993-98) merged the AIDS, STD, TB and leprosy programs (to become NASTLP) and announced an "expanded multisectoral response" involving all ministries, public institutions, the private sector, churches and civil society. It included information and education, including HIV/AIDS-related topics in the school curriculum, condom social marketing, workplace programs, STI control (based on syndromic management), and VCT [118].

The health care system in Zambia was decentralized in the early/mid 1990s to increase local control over health services and shift resources towards primary health care. As a part of this Health Reform, vertical programs were to be avoided. However, as many districts lacked enough competent personnel, they were not able to implement and integrate all the health programs properly [119]. This had detrimental effects on the NASTLP which did not function properly for several years.

President Kenneth Kaunda announced in 1987 that his son had died of AIDS, but apart from that the government tried to keep prevalence figures secret for several years in fear that it might make it more difficult to obtain international loans. Most of the deaths were attributed to other diseases [120]. HIV/AIDS was not declared to be a national emergency until 2004.

When the Medium Term Plan was assessed in 1998/99 the conclusion was that it had not been adjusted to address the relevant problems of different subpopulations and that it lacked an evaluation mechanism, high-level political leadership and strategic management. As a response to this criticism the National HIV/AIDS/STD/TB Council (NAC) was established in 2000 and became operational in 2002 [118]. The NAC replaced the NASTLP in an effort to give the coordinating body more authority. Such a body had been recommended by WHO already in 1992 [121], but the government hesitated in the sense that the NASTLP was put under the Ministry of Health. The aim of the NAC is to coordinate all national initiatives in the fight against HIV. It is autonomous, but receives advice from the cabinet. Representatives from the government, NGOs, religious and traditional leaders, media, youth, the private sector, and people living with HIV/AIDS, are all part of the council [118]. A Directorate of Monitoring, Evaluation and Research has very recently been established with the aim to create one national system for monitoring and evaluation. Indicators at all levels (input, output, outcome and impact) have been defined and measurement systems are on the way of

being established. The information will be registered in a data base that will be made available for interested parties and research institutions [122].

Evaluation of the impact of individual programs/campaigns is often difficult when several interventions take place at the same time. Many different programs and campaigns in Zambia have used mass media such as radio, TV, newspapers, posters, brochures and dramas to spread information about HIV. A study of the effects of a radio drama in Bemba about a family facing AIDS, with 39 episodes broadcast over 9 months in 1991 and 1992, found that the level of knowledge about HIV increased during this period, but it was not related to exposure to the radio drama [123]. A more recent study evaluating the effects of a Zambian media information campaign called "Helping Each other Act Responsibly Together" (HEART) which targeted young people and promoted primary and secondary abstinence or consistent condom use, found that viewing the campaign on TV was associated with reporting abstinence or condom use in the past 12 months. However, those who had seen the campaign were also more likely to have more than primary education, live in an urban area and to belong to a household with TV. Therefore it is possible that socioeconomic status and residence may have confounded the results although the authors adjusted for these factors in the analyses [124].

There have been very few preventive interventions in Zambia targeting sex workers. A joint initiative from several NGOs lead to the founding of the organization Tasintha in 1992, with the aim to offer health education and vocational skills training to sex workers to give them opportunity to find other kinds of employment. The activities of this NGO have been focused in Lusaka, Kapiri Mposhi (urban), Kafue and Chirundu [118]. In 1999, Corridors of Hope (COH), a joint initiative between four NGOs, was launched to target female sex workers, long distance truck drivers and uniformed personnel in border areas and other towns where the risk of HIV infection was high. Initially the project had activities in Chirundu, Kapiri Mposhi, Kasumbalesa and Livingstone, but later expanded to 10 sites (adding Kazungula, Ndola, Nakonde, Chipata, Katete and Lusaka). The focus of the programme was on behaviour change communication, free treatment of STIs at dedicated clinics, and VCT. The project initially offered STI services to sex workers and long-distance truck drivers only, but later decided to open the services to the whole community to effectively reduce STI prevalence among sex workers and all client groups. The work was carried out in collaboration with the District Health Management Teams (DHMT), District AIDS Task Forces and other local partners.

The STI prevalence among patients at the project's STI-clinics declined during this 6-year period. However, the project period ended in 2006. The intention was that the DHMTs would take over the responsibility for the services, but the resources available to do this are meagre [125, 126].

ARV treatment started at two sites in Lusaka and Ndola in 2002, but this only gave 0.1% of people with advanced HIV infection in Zambia access to ARVs [127]. In 2005 Zambia introduced free ARV treatment for all who need them on paper. By December 2006 35% of those in need received this treatment, and it was estimated that 15% of HIV-infected pregnant women received ARVs for prevention of mother-to-child transmission (PMTCT) [128]. The government has also established a Social Welfare Scheme in response to the growing number of orphans and vulnerable children, but it only reaches 10% of the target population [129]. Support programs for widows/widowers have been run by some churches [130].

Zambian non-governmental organizations (NGOs) and community-based organizations (CBOs) have taken active part in the response to the epidemic, but they usually have limited coverage. Home-based care (HBC) has been offered primarily by religious organizations and NGOs, and government facilities have only had a limited role. The current HBC programs reach less than 20% of people living with HIV/AIDS [130].

1.6 Thesis focus

The focus of this thesis is to examine trends in HIV prevalence and sexual behaviours that are likely to have had an impact on HIV infection in Zambia since the mid 1990s. The observations of reduction in certain risk behaviours in some groups but not in others, may indicate impact of previous prevention programs, but even more importantly, reveal current challenges in prevention. In discussing the associations between HIV and risk behaviours this thesis builds on the proximate determinants framework as it operationalizes how proximate determinants relate to sociodemographic and economic contexts and how interventions can work to reduce HIV incidence and prevalence. The discussion also emphasizes the importance of the epidemiological context.

2 Aims and objectives

2.1 Overall objective

To generate knowledge on the driving factors of HIV transmission and structural factors and interventions that can reduce spread in Zambia.

2.2 Specific objectives

i) Describe geographical differentials in HIV prevalence trends among pregnant women in Zambia (Paper I);

ii) Assess trends in sexual behaviour among young people since the mid 1990s (Paper II);

iii) Assess differential changes in risk exposure over time by educational attainment (Paper II);

iv) Estimate the prevalence of concurrent partnerships, and assess the determinants of partnership concurrency and the likelihood that concurrency has been important in driving the HIV epidemic in Zambia (Paper IV).

v) Determine the presence of and opportunities for HIV prevention campaigns in places with a high risk of HIV transmission in two cities in Zambia (Paper III);

3 Methods

3.1 Study area and population

It is estimated that the population of Zambia is approximately 12 million people, and 35% live in urban areas [131, 132]. The annual population growth rate is around 2%, and 45% of the population is below 15 years of age. The total fertility rate in 2000 was 6.0 per woman [131]. UNAIDS estimates that the life expectancy for men and women in Zambia currently is 40 [132], but according to estimates based on childhood and adult mortality data it is probably even lower (37.5 for men and 34.7 for women in 2000) [133].

68% of the population in 2004 fell below the poverty line, which meant they could not afford to cover their basic nutritional and non-food requirements. The poverty level was higher in rural than in urban areas. More than 60% of the population could only afford 1-2 meals per day [134].

Zambia has 9 provinces and 72 districts. The antenatal surveillance system (paper I) and the Sexual Behaviour Surveys (paper IV) contain data from all 9 provinces. Paper II is based on data from Kapiri Mposhi district in Central Province and Chelston township in Lusaka province. The city of Livingstone in the Southern Province and Chelston township in Lusaka province are the focus of paper III.

3.2 Design, sampling and data collection

The papers in this thesis are based on the following data materials:

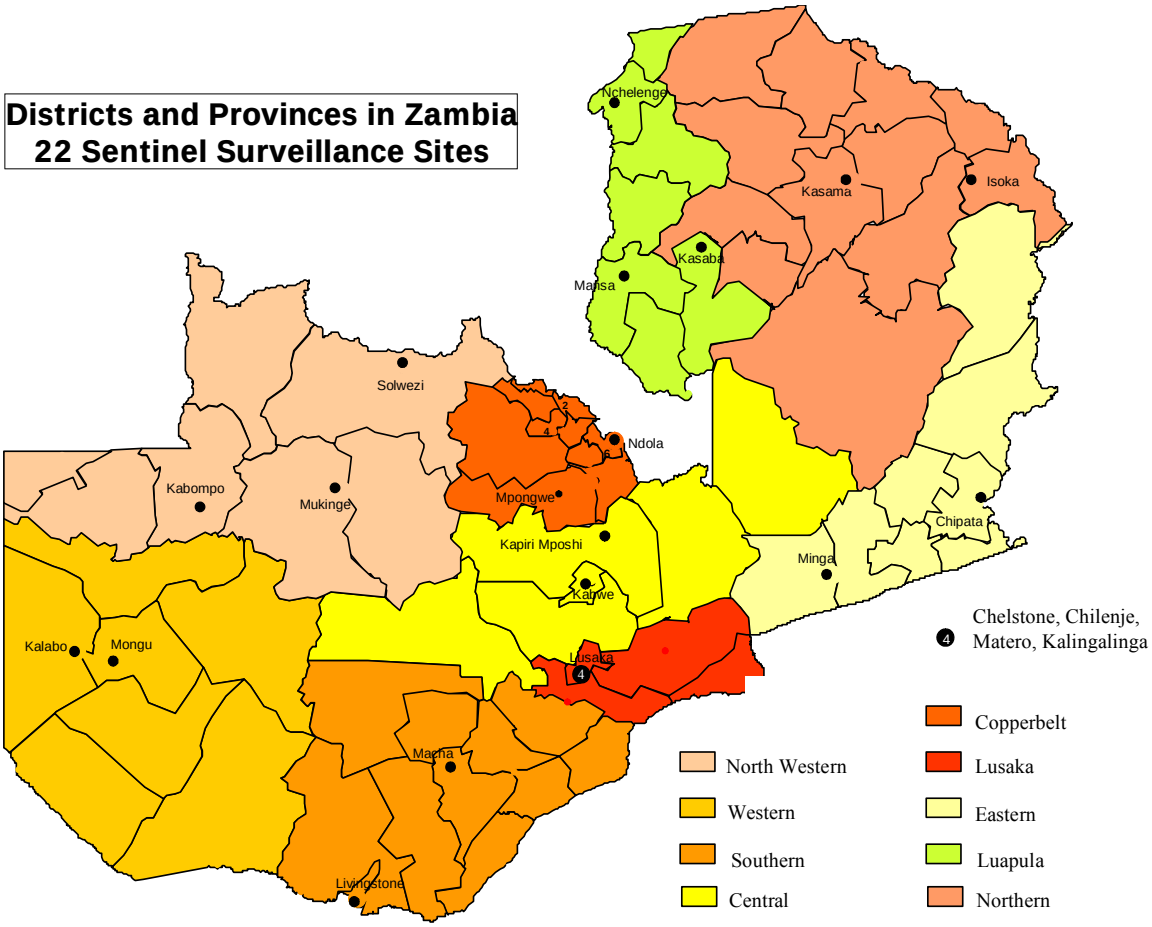
1. National antenatal HIV sentinel surveillance data from 1994, 1998 and 2002 (paper I)
2. Population-based survey data from Kapiri Mposhi and Chelston from 1995, 1999 and 2003 (paper II)
3. Data from a PLACE-study in Lusaka and Livingstone in 2005 (paper III)
4. The Zambia Sexual Behaviour Surveys 1998, 2000 and 2003 (paper IV)

3.2.1 National antenatal sentinel surveillance data

The Zambia antenatal clinic HIV sentinel surveillance system was established in 1990 and has gradually been expanded. It is the main system for surveillance of HIV prevalence trends in the general population. Just a few sites were included in the first years, and only location, HIV test result and a couple of other variables were recorded. From 1994 the participants have also been interviewed about socio-demographic characteristics. The sentinel surveillances in 1994, 1998, 2002 and 2004 covered at least one mainly rural and one mainly urban site in each province, in total over 20 sites [5, 112, 115, 135]. As more than 90% of women in Zambia attend ANC-clinics at least once during pregnancy, the system provides a good basis for studies of transmission trends [136-138].

In the data collection periods of the antenatal sentinel surveillance pregnant women attending the antenatal clinic for the first time during the pregnancy are consecutively enrolled in the surveys until the target number of 500 at each site is reached (the target number is higher for some of the urban sites: Livingstone, Chelston, Kapiri Mposhi and Ndola). The data collection is performed within a maximum of 4 months [5, 112, 115]. 27 sites were included in 1994, 22 in 1998 and 24 in 2002. The data from 2004 were not available at the time of analysis. Paper I is based on data from the 22 sites that were part of all three surveys in the period 1994-2002, as we wished to study trends over time.

Serum left over from blood drawn for syphilis screening of the pregnant women who are enrolled in the surveys is tested unlinked and anonymously using the Capillus HIV-1/HIV-2 rapid test at the ANC clinics after all identifiers have been removed. Wellcozyme HIV Recombinant HIV-1 is used to retest all positive samples and 5% (10% in 2002) of the negative samples at two national laboratories. When results from tests one and two are discordant, Bionor HIV-1&2 is employed, and this third result is considered final. In cases where false negative results have been discovered, 50% of all negative samples from the particular site have been re-tested with Wellcozyme [5, 112, 115, 139].



The 22 Sentinel Surveillance Sites that were part of the 1994, 1998 and 2002 rounds

3.2.2 Population-based survey data from Kapiri Mposhi and Chelston

In paper II, in which we studied trends in sexual behaviour among young people in Zambia, we used data from a selected urban community, Chelston, Lusaka, and a rural community, Kapiri Mposhi district, from 1995, 1999 and 2003. The study in 1995 was the first population-based survey with both interviews and HIV testing in Zambia and was conducted to validate the data from pregnant women in the same areas. The study population was selected using a stratified random cluster sampling method based on the Standard Enumeration Area-system employed by the Central Statistical Office. Ten of 24 urban clusters in Chelston and five out of 26 clusters in rural Kapiri Mposhi were selected. The survey was repeated in the same clusters in 1999 and 2003, and in addition the number of rural clusters was doubled to be able to detect small changes. Within the sampled clusters all households were included, and all household members who were 15 years or older and were found at home were asked to

participate in a structured interview and let their saliva be tested anonymously for HIV [5]. (Anyone who was said to live in the house or spent the previous night there was defined as a household member.) High mobility among the respondents made it difficult to study incidence between the surveys; hence prevalence among young people was used as a proxy of incidence as mortality is low in this group [5, 112, 117, 140, 141]. In paper II we only analysed data for the age group 15-24.

The HIV testing for the surveys was based on saliva. The participants were informed that it would only be used for research purposes. In the first survey all the saliva samples were tested using Gacelisa HIV 1&2. In addition 450 randomly selected saliva samples from the survey were tested with Bionor HIV-1&2, and the two tests showed 99.8% agreement [115, 140]. In the 1999 and 2003 surveys only Bionor HIV-1&2 for saliva was used. Respondents who expressed a wish to know their HIV status were also tested using serum, and this provided an extra opportunity for validation. In cases where saliva and serum results were discordant, the serum result was considered final. In all the three surveys, 10% of both negative and positive samples were re-tested by a different person.

3.2.3 PLACE-study in Lusaka and Livingstone

Both Lusaka and Livingstone are cities with high HIV prevalence. We wished to study places within these cities with a high risk of HIV transmission. The study focused on areas of the two cities from which we had data about HIV prevalence. In Chelston, Lusaka, both ANC and population-based surveys have been conducted every fourth year since the mid 1990s. In Livingstone, data from pregnant women attending the health clinics in Maramba, Dambwa and New Boma are pooled and used in the ANC surveillance system, and we decided to include all these 3 areas in the assessment. According to the 2000 population census Chelston had a population of 33,700 and the three townships in Livingstone had a total population of 41,800 people.

In the first phase of the study local people encountered in the streets, health personnel, taxi drivers, shop staff and bar workers who knew the selected communities were asked to name places where local people met new sexual partners. The target number of informants in the first phase was 200 in Chelston and 400 in Livingstone (as we covered a bigger geographical area there). In the second part of the study the interviewers tried to visit all the sites that had

been mentioned (78 places in the study area in Lusaka and 147 in Livingstone). In all the places that were found, one person who knew the site well was interviewed about what activities took place there and the availability of condoms and educational materials. This was preferably the owner or manager of the venue or one of the staff, but if none of these were available, a patron was interviewed instead. The last part of the study consisted of interviews with individuals who were socializing at selected venues about their sexual behaviour and about partnership establishment at the site. All sites mentioned by more than 10 informants in the first phase and a random sample of 30% of the other sites (with probability of selection proportional to the estimated number of guests on an average night) were selected for such interviews. In these sites the interviewers asked individuals standing along two diagonal lines connecting the four corners of the room for an interview.

In addition the interviewers recorded observations from the venues they visited and concerns which were repeatedly mentioned in venues. We also interviewed one nurse, one counsellor and 1-2 peer educators at the health clinics and staff of NGOs which ran HIV preventive activities in these townships about HIV preventive initiatives. All the interviews were performed between September and December 2005.

3.2.4 The Zambia Sexual Behaviour Surveys

The data in the study of concurrency were collected as part of the Zambia Sexual Behaviour Surveys (ZSBS) 1998, 2000 and 2003. The latest ZSBS was conducted in 2005, but the data set has not yet been made available at the time of writing. The sampling frame in 1998 and 2000 originated from the 1990 Census of Population, Housing and Agriculture. 312 primary sampling units covering the whole country, corresponding to the Census Supervisory Areas (CSAs), were drawn, and among these, 80 CSAs were randomly selected. Both rural and urban areas in all provinces were included. The sampling frame in 2003 was updated using the 2000 Census and 20 extra clusters were added (giving 100 clusters in 2003). For all the three surveys all household listings were updated prior to the main fieldwork, and a sample of 20 households in the urban clusters and 30 households in the rural clusters were selected. All men and women aged 15-49 years that had been living in or had slept in the selected households the night before the interview, were eligible for interview [142-144].

The target number in 1998 and 2000 was 2,000 households with 2,000 women, and 2,000 men. In 2003 the target number was increased to 2,500 households with the equivalent number of men and women. The surveys consisted of questionnaires on knowledge, attitudes, and sexual behaviour related to HIV/AIDS and STIs, but no biological testing [142-144]. As the questions varied between the surveys, we could only compare the probability of reporting more than one ongoing relationship in 1998 and 2003, and the probability of overlaps between the three last partnerships in 2000 and 2003. The denominator for both parameters was the total number of men and women in the study populations.

3.3 Statistical procedures

We used SPSS version 13-0 when analyzing the data for paper I and III and Stata Intercooled version 9, adjusting for cluster design, in paper II and IV. In paper I and II the different surveys and educational groups were compared using logistic regression. In paper IV the different surveys and subgroups were compared using log-binomial regression. More information about the statistical procedures can be found in the individual papers.

3.4 Ethical considerations

The protocol for the antenatal clinic-based sentinel surveillance system was approved by the National AIDS Research Committee in 1990. All HIV testing was done unlinked and anonymously [112] according to the principles of WHO/UNAIDS' "Guidelines for Conducting HIV Sentinel Serosurveys among Pregnant Women and Other Groups" [145]. The pregnant women were not informed that some of the blood drawn for syphilis testing would be used for HIV surveillance purposes, and they were not asked to consent before answering questions about sociodemographic background, contraceptive use and condom use as this information is regarded as part of routine interviews at the ANC clinics. The HIV result was linked to this information, but the name of the woman or other personal identifiers were not recorded. As the HIV results were unlinked and anonymous, women who would like to know their HIV status had to go though regular VCT and take another blood test.

The protocol for the population-based survey (paper II) was approved by the National AIDS Research Committee for the two first surveys and by the University of Zambia Research Ethics Committee for the survey in 2003. The latter also granted ethical approval to the PLACE-study and the Sexual Behaviour Surveys.

Informed consent was required of all respondents. A statement explaining the purposes of the surveys was read to the participants. In the population-based surveys in Chelston and Kapiri Mposhi, a letter of introduction with more information about the survey and contact details of the primary investigators was also available for the respondents if they requested more information. The consent was obtained orally for all the surveys, except for the Chelston/Kapiri Mposhi-survey in 2003 for which written consent was required. In 2003 consent from parents was also required to interview young people below 18 years. In the PLACE-study we only interviewed adults above the age of 18 years. All interviews were anonymous, and the informants were assured that the information would not be linked to them or the venue where they were interviewed.

All participants in the population-based surveys in Chelston and Kapiri Mposhi were offered voluntary counselling and testing free of charge using blood specimens as required by the national guidelines for HIV testing [141]. The interviewers in these surveys and the PLACE-study, distributed condoms to those who were interested, and in Chelston and Kapiri Mposhi the counsellors carried painkillers and malaria drugs that were given free of charge to people who needed them.

4 Results

4.1 Paper I: "Antenatal clinic-based HIV prevalence in Zambia: Declining trends but sharp local contrasts in young women"

The aim of the first paper was to describe geographical variation in HIV prevalence trends in Zambia in the period 1994–2002 based on antenatal clinic data. In addition, we assessed the effects of residence, educational level and age on prevalence trends and potential interaction between these variables.

The HIV prevalence among pregnant women attending antenatal clinics in urban areas in Zambia declined during the period 1994-2002 both in the age groups 15-49 (from 28.5% to 25.5%) and 15-24 (from 28.0% to 21.8%). Among rural pregnant women the prevalence declined only non-significantly.

Out of the 22 antenatal sites from which there were at least three sets of data we observed an increase in prevalence among 15-24 year olds in 4 sites (Kalabo, Kapiri Mposhi, Kashikishi and Kabompo), a decline in 13 (Chelston, Macha, Chilenje, Matero, Kabwe, Chipata, Kasama, Isoka, Kasaba, Ndola, Ibenga, Solwesi, Mukinge) and a stable prevalence in 5 (Mongu, Livingstone, Kalingalinga, Minga, Mansa).

There was an association between increasing number of pregnancies and lower prevalence of HIV infection in all age groups among urban residents, and among 15-19 year old rural residents. The questionnaire in 1994 did not include number of births, only number of pregnancies. But the data from 1998 and 2002 showed that women (aged 15-49) who had been through several deliveries had a lower risk of HIV infection compared to nulliparae women. Young women aged 15-24 also had a significantly lower risk of being HIV infected with higher parity.

In both urban and rural areas the HIV prevalence increased steadily with increasing level of education. However, in the age group 15-24 all educational groups experienced a fall in risk of HIV from 1994 to 2002, and the decline was clearest among urban residents with the longest education. We found that the decline was also visible for urban women aged 15-49 with higher education. In contrast to this the prevalence increased among rural women aged 15-49 with 10 or more years of school in the same period. This interaction between educational attainment and urban/rural residence was strongest in the age group 15-49, but

was also observed in the group aged 15-24. Even in sites in which there was an overall declining prevalence trend among 15-24 years olds, we found that the risk of infection among women with high educational attainment, compared to women with limited school attendance, increased among rural respondents, whereas it declined among urban respondents.

4.2 Paper II: "Associations between sexual behaviour change among young people and decline in HIV prevalence in Zambia"

Data from the population-based surveys from Chelston and Kapiri Mposhi have shown declines in HIV prevalence among young people, especially in high-educated groups. In paper II we studied trends in key sexual behaviour indicators among 15–24 year-olds from 1995 to 2003, including the associations between sexual behaviour change and education. Based on logistic regression we also assessed which behaviour changes that may have contributed to the reduction in HIV prevalence among sexually active young urban men and women.

Respondents with little education were more likely to have had more than one partner in the previous year, than those with more than 9 years of schooling, except among rural women. The proportion with more than one partner in the previous year declined significantly for urban males and rural females.

Urban men were the most likely to report condom use "ever", "at the last sexual intercourse" and "at the last casual sexual intercourse", followed by urban women. The biggest increase in condom use was also found in the urban area. Among young rural men there was no change. Respondents with higher education were more likely to report condom use at both their last sexual intercourse and their last casual sexual encounter prior to the survey than the least educated. Condom use also increased more among high-education groups.

Among single higher educated women (≥10 years of school) and married urban higher educated women, the proportion that had given birth declined, but among women with only primary education or less and married rural women with higher education there were no significant changes. Throughout the period fewer urban than rural young women reported giving birth. Single women who had previously born children had an approximately double risk of acquiring HIV infection compared to those who had never born a child, whereas for married women there was no significant difference.

The median age at sexual debut increased among rural men and urban women with higher education. Sexual experience was less common among urban than among rural men and women, and among those with more than 9 years of schooling compared to the least educated. Interestingly, the proportions reporting early sexual debut varied between 1999 and 2003 within the same age-cohorts of rural men and urban women. In 1999, 15% of urban female and 42% of rural male 15-19 year-olds reported sex before age 15, but 4 years later, in 2003, 5% of urban female and 24% of rural male 19-23 year-olds reported the same. Among young people who claimed to be virgins, up to 8% of were in fact HIV positive in 1999, and none of these reported having received a blood transfusion.

In logistic regression analyses, the reported number of sexual partners during the year immediately prior to the survey and condom use, were factors that reduced the association between HIV and survey year among sexually active young urban men and women.

4.3 Paper III: "Lost opportunities in HIV prevention: programmes miss places where exposures are highest"

High risk groups may contribute disproportionately to the spread of HIV, and have thus been targets of interventions in many countries. In areas where the HIV prevalence in the general population is high, high risk groups may be difficult to accurately define. Interventions targeting specific groups may cause stigmatisation of already-marginalized individuals. It is possible that HIV prevention that focuses on high risk places may be more effective and less stigmatizing. The objective of the PLACE-study we conducted in Lusaka and Livingstone was to assess risk behaviour patterns, signs of current preventive interventions and apparent gaps in places where the risk of HIV transmission was high in communities with high HIV prevalence.

In the first phase of the PLACE-study 275 informants in Lusaka and 434 in Livingstone were asked where people met new sexual partners. Most of the places identified in Lusaka were bars or restaurants, whereas in Livingstone the majority were sherbeens (informal drinking places operating without a license to serve alcohol), bars and restaurants.

Very few venues had ever had HIV preventive activities like meetings or distribution of pamphlets, and less than 20% had ever exhibited HIV-related posters. Only a third of the

venues always had condoms available, whereas as many as 26% of the venues in Lusaka and 43% in Livingstone never had condoms. However, respondents in most of the venues claimed that it was possible to obtain condoms within 10 minutes of the venue.

In a selected sample of the venues 432 persons in Lusaka and 676 in Livingstone were asked for an interview about their sexual behaviour. Almost all (>99%) of the respondents were local. The majority of respondents reported having met a sexual partner in the venue where they were interviewed. This happened in the last week prior to the survey for almost all the women in Livingstone and half in Lusaka. Among the female respondents 50% in Lusaka and 87% in Livingstone had received money in exchange for sex in the previous 3 months. Both men and women admitted having a high number of partners in the last month preceding the survey (median 3 for men, 3 for women in Livingstone and 2 for women in Lusaka), and the majority of these partners were new.

Condom use with all new partners in the last month prior to the survey was reported by a high proportion (77%) of men and women in Lusaka, but only 44% of men and 34% of women in Livingstone. Not having a condom at hand, trusting the partner, dislike of condoms, and conviction that condoms can break, were the most common reasons mentioned for not using one. Among women who had received gifts for sex recently 85% in Lusaka reported using a condom with the last client, but only 54% in Livingstone. We also found that the trust in the protective effect of condoms against HIV was reasonably high (68%) among male respondents in Lusaka, but only 40-45% of the women in Lusaka and the respondents in Livingstone were convinced of the same. The majority of women said that their partner had brought the last condom that they used. In Livingstone individuals who socialized in places where condoms were declared to always be available where more likely to report condom use with partners met in that venue ($p=0.001$). Among men who were sceptical to the protective efficacy of condoms, availability had a big impact on the probability of condom use. In Lusaka reported condom availability in a venue was not related to condom use among the guests.

There was a wish among the respondents in both cities to see peer educators in places where people socialize. According to the peer educators and NGO-representatives interviewed about HIV prevention, several youth peer educators had been trained in both Lusaka and Livingstone during the previous 2-3 years, but only a handful were still involved. For example, only one out of 20 peer educators trained 2 years earlier in Chelston, Lusaka, was

still active. The others had quit due to lack of incentives, follow-up, material or mental support, or fringe benefits. Those who were still active rarely left their office, and none of the peer programs targeted places where people met sexual partners. The only programme targeting sex workers in Livingstone in 2005 was an NGO-initiative (Corridors of Hope). In 2006, however, they closed down all their activities in the city. There were no active initiatives aimed at sex workers in Chelston at the time of the survey.

4.4 Paper IV: "Prevalence and correlates of concurrent sexual partnerships in Zambia"

A high proportion of concurrent sexual partnerships in a population can lead to rapid spread of sexually transmitted infections, especially during the early stages of an epidemic. Models have shown that this is the case for HIV too. Paper IV is the first study on the prevalence of partnership concurrency in Zambia. We used data from the Sexual Behaviour Surveys from the period 1998-2003, to examine how the prevalence of concurrency changed during this 5-year period. We also assessed which personal and partnership characteristics were associated with having more than one ongoing sexual relationship.

5.8% of young rural men and 7.1% of young urban men reported having more than one ongoing relationship in 1998, but these proportions declined to 3.5% and 1.9% in 2003. Among older men aged 25-49 17.8% and 9.0% in 1998 and 11.9% and 8.2% in 2003 respectively reported the same. Only 0-2% of women admitted concurrent partnerships, but there was a non-significant increase from 1998 to 2003 in the proportion of young urban women who reported concurrency. The mean number of partners at the time of the interview was 1.10 in 1998 and 1.07 in 2003 among adults aged 15-49 who reported at least one partner, and the concurrency index *k* was 0.17 in 1998 and 0.13 in 2003 (k= proportion of partnerships that are concurrent). During the same period condom use with the previous non-cohabiting partner became more common among respondents who reported having more than one ongoing sexual relationship.

For young men there was no significant difference between those with only primary education and those with more in reporting ≥2 ongoing relationships, but among older urban men those who had completed secondary or higher education were less likely to report concurrency. The proportion with concurrent partners tended to decline during this 5 year period among young men of all educational levels and older rural men with little education.

The proportions reporting overlapping relationships and more than one ongoing relationship differed somewhat in 2003, but the prevalence of overlapping relationships also declined from 2000 to 2003 among older and young rural men and women, but was rather stable among urban respondents.

In uni-variate log-binomial regression analyses we found that for adult men aged 15-49 increasing age, being married or cohabiting, young age at sexual debut and first marriage, long duration of marriage, absence from home and living with the spouse were associated with having concurrent sexual partners. Other predictors for urban men were little schooling and a younger age of the last non-cohabiting sexual partner. In multivariate analysis early sexual debut, long duration of marriage and absence from home were all significantly associated with concurrency for rural men, and for urban men absence from home increased the likelihood of having concurrent partners, whereas having completed secondary or higher education made it less likely. For women aged 15-49, young age at sexual debut and a small age difference to the spouse were associated with increased probability of having concurrent partners in uni-variate analyses, but in the multivariate analyses only age difference to the spouse was significantly associated with concurrency.

5 Discussion

5.1 Methodological issues

5.1.1 Design and sampling

The four papers in this thesis are all based upon cross-sectional surveys, two of them population-based and two facility- or venue-based. The main limitation of cross-sectional studies is that we cannot assess causal relationships, only associations. The best observational method to assess causal relationships would be a prospective cohort study. This study design also allows calculation of disease incidence, and it is possible to assess how incidence is affected by changes in behaviour in different population sub-groups. A prospective cohort study is, however, very expensive to conduct as it requires frequent data collection rounds, big samples and meticulous follow-up of all study participants to avoid bias. Therefore cross-sectional surveys are usually preferred for HIV surveillance.

There are now indirect ways of estimating incidence that can be used in surveys using the HIV antigen, RNA detection or HIV antibody-tests with different sensitivities to identify early infections [146, 147]. These methods are, however, so expensive that most surveillance systems still rely on estimating incidence from prevalence among young people (aged 15-24). It is recommended to use this age-group rather than the narrower 15-19 age-group as the prevalence in this latter group is more sensitive to changes in age at sexual debut and uncertainties in age reporting [9]. Mortality below age 25 is low, and any changes in the HIV prevalence in this group are therefore primarily a result of changes in incidence or migration. When the prevalence among young pregnant women is used as a proxy of incidence one assumes that the HIV-associated reduction in fertility is small. In countries with low use of contraceptives, HIV prevalence among ANC-women who are pregnant for the first and second time can also be used as a proxy of incidence, as these women have probably only recently become sexually active. Estimates based on these women may better reflect short-term trends than age-based estimates [9]. This is the case if there is an increase in age at sexual debut over time, but no change in the risk behaviour of the sexually active individuals, leading only to a delay in infection [10, 148, 149]. A third way to estimate incidence from repeated surveys is mathematical modelling.

Surveys among pregnant women are recommended for surveillance of the HIV epidemic in the general population as this surveillance system utilizes existing health care structures and thus is not very costly. Pregnant women are assumed to be relatively representative of the general population, but this is not always the case. In particular they may not be representative of men. But as Zambia does not have national military service, there is no easily accessible sentinel group of men that can be utilized. Due to the uncertainty related to the representativeness of pregnant women, the data obtained from ANC surveillance are used to assess prevalence trends rather than the exact prevalence in the general population. This is based on the assumption that the relationship between the prevalence among pregnant women and the general population remains relatively stable over time.

Among the reasons for establishing the population-based surveys in Chelston and Kapiri Mposhi was the need to validate the prevalence data from the antenatal clinics. With three rounds of data collection for both the ANC surveys and the population-based surveys it was possible to compare trends in HIV prevalence in the general population with trends among women attending antenatal care. The conclusion was that in 1994-1995 ANC-data slightly underestimated the overall HIV prevalence in the general population of men and women aged 15-49, matched quite well in 1998-1999, but overestimated the prevalence in 2002-2003. The reason for this was that the prevalence declined in the population, but that this change was less visible among pregnant women. In Chelston the prevalence declined by 32% in the general population aged 15-49 but was stable among pregnant women of the same age [8]. It is, however, not possible to properly assess whether this pattern of differential declines for pregnant women and the general population applies to the whole country since these population-based surveys had limited geographical coverage.

In a cross-sectional study it is not possible to say that certain behaviours caused HIV infection. HIV-positive individuals may have changed their behaviour after they acquired the infection, and this may affect the association seen between infection and for example condom use or number of partners. Repeated cross-sectional surveys of the same population can give indications of whether changes in prevalence are preceded by changes in behaviour and thus give indications of causal associations. But if there are substantial changes in the study populations due to migration or differential non-response, any observed changes can be caused by changes in the composition of the sample. And if the surveys are far apart in time, it is more difficult to judge which changes preceded the others.

In paper II we observed a reduction of sexual risk behaviour among young people that was associated with a parallel decline in HIV prevalence in the same subgroups. With a 4-year interval between the surveys we cannot accurately assess whether the changes took place at the same time, or whether the behaviour changes preceded the HIV decline, making a casual association more likely. The study sample changed due to both in- and out-migration, and this may in addition have confounded our observations, but analyses of data from the same surveys showed that the prevalence declined among the mobile groups too [113]. As mortality is low among young people we find it likely that reduced risk taking is at least partly responsible for the decreased prevalence in this group. This assumption is strengthened by the fact that both the decline in risk behaviours and HIV prevalence were greatest among urban men and women with higher education.

In both paper III and IV we examined behaviours that we believe are important for the risk of acquiring HIV infection, but we do not have data on HIV prevalence in the same groups. The Sexual Behaviour Surveys are intended to supplement the prevalence data from the antenatal surveillance system with data on behaviour trends, but as the samples in the two survey types are very different, it is not straight-forward to draw conclusions about associations, and particularly not about causal links. Anyway, based on results from other studies we can assume that both high numbers of concurrent partners [150-155] and low level of condom use [50] are likely to have contributed strongly to the HIV epidemic in the early phases in Zambia. We can also assume that declines in concurrent partnerships and increases in condom use during high risk sex are partly responsible for the decline in HIV prevalence in young age groups seen in urban antenatal clinic data and the population-based surveys from Chelston and Kapiri Mposhi.

In paper III we only have data from one point in time. It is therefore impossible to say whether any of the differences we found in the data in Lusaka and Livingstone could explain the different courses of the epidemic in the two cities. Population-based and antenatal data from Chelston show that the prevalence has declined among young people from 1994 to 2003 [8, 113, 117], whereas antenatal data from Livingstone show a high and stable prevalence during the same period [135]. We found few signs of HIV preventive programs in the venues at the time of the study, but both cities may have had intensive and good campaigns in such venues previously. Unfortunately we do not have detailed information about this and cannot

assess whether any such programs have influenced the current level of condom use and attitudes to condoms as protection against HIV.

The intention of the PLACE-method is to make rapid assessments of the current situation and provide recommendations for the future based on these assessments. We found that among respondents in Livingstone condom use with new sexual partners was alarmingly low and scepticism to condoms prevalent. If we are correct in our assumption that individuals who socialize in venues where people meet sexual partners are at a much higher risk of acquiring HIV than the rest of the population, if the level of condom use is low, programs that manage to change attitudes to condoms and increase condom use among individuals who socialize in these venues could have a significant impact on the incidence of HIV in this group. To prove that this is really the case, however, we would have to conduct a randomized community trial. The population impact of such programs would probably depend on the size of this subpopulation. However, we did not collect data to assess this.

5.1.2 Bias

The validity of a test or an instrument is its ability to measure what it is intended to measure. The validity of a questionnaire is how close the information that is collected is to the truth. Reliability refers to the tendency of a test/instrument to obtain consistent results on repeated testing or measurement [156]. Both validity and reliability can suffer due to bias.

5.1.2.1 Selection and participation bias

The antenatal clinics that are part of the HIV surveillance system in many countries have been selected for convenient reasons, like laboratory facilities and the interest of the personnel in surveillance, and thus many of them are in urban areas [1]. The so-called rural clinics are often in reality periurban and have been selected due to the need to collect a rather large number of samples within a short period of time [13, 157]. This can give over-estimations as the prevalence in urban and periurban areas is usually higher than in rural areas. With the establishment of the sentinel surveillance system in Zambia at least two sites were selected from each province, one from the provincial capital and one assumed to be a typical rural community in that province, but taking into consideration the expected sample size that could be obtained within 4 months. Fortunately, the Zambia DHS + found a national prevalence in

2001/2002 of 15.6% among men and women which matched well with the standardized ANC-based estimate of 16.9% from 2002 [114]. This indicates that the selected ANC sites in Zambia are rather representative of the national adult population, although that can be said to be partly a result of chance and qualified guess-work.

During surveillance rounds at the antenatal clinics the pregnant women are not informed that they are enrolled in a survey as the surveillance is seen as part of routine care and the information collected does not contain personal identifiers. The argument for this procedure is that if the women were informed and asked to consent, refusals could create selection bias. Thus there are no refusals among the ANC attendees that are enrolled in the surveillance rounds. However, as the women may choose not to answer some of the questions that the nurses ask them related to sociodemographic background, contraceptives and condom use, some of the variables recorded will have missing responses. The ethical aspects of this practice of not requiring informed consent can certainly be discussed. Although the questionnaires and the blood samples are only marked with a number, it is theoretically possible for those who work in the laboratory to trace the result back to a woman as the syphilis result is routinely recorded under the woman's name. Thus rumours about their HIV status can spread while the women do not even know that they have been tested. Although avoiding selection bias is important in surveillance, it is likely that if the protocol for the ANC surveillance had been sent to an ethical committee today, the procedures might have been changed, as the importance of informed consent is increasingly being emphasized.

In some countries certain subpopulations, like those who are well-off, attend private clinics that are not part of the surveillance system, and this creates selection bias. However, in Zambia more than 90% of women attend public clinics, so this has so far not been a problem. Another factor that can give selection bias is high contraceptive use. This seems to be a growing problem in Zambia as both national data and paper II show that the use of contraceptives is increasing [138] and the proportion of young women who are sexually active is decreasing [158], especially among those with higher education, leading to postponement of childbearing. Those who still become pregnant at a young age are more likely to engage in higher risk sex and seem to be at an increasingly higher risk of HIV compared to others of the same age.

In some of the antenatal sites (Kasama, Kabompo, Kapiri Mposhi), substantial shifts in outreach took place from 1994 to 1998 due to changes in the organisation of the ANC

services [159]. The proportion of urban vs. rural residents varied in these sites, and this may partially explain the observed increase in the proportion of HIV infected ANC attendees from 1994 to 2002 in Kapiri Mposhi and from 1994 to 1998 in Kabompo. The subsequent prevalence fall in Kabompo in 2002 may have reflected an actual reduction as there were no changes in the distribution of rural and urban residents in this period. As the population-based surveys from Kapiri Mposhi conducted approximately in the same period showed a decline in prevalence among young rural women [5, 113], we have doubts about the representativeness of the ANC respondents and the consistency of the classification of urban and rural residence at this particular site.

Population-based surveys can provide biased estimates if there is a problem with non-response. Non-response due to absence at the time of the visit of the interviewer may lead to both under-estimation (if those who are absent are at higher risk of acquiring HIV, e.g. if they have unprotected sex with sex workers) and over-estimation (if those absent are at lower risk, e.g. attending school). Refusals can also lead to both. Responders in a sexual behaviour survey are willing to disclose information about their sexual life and may be less sexually inhibited than refusers. This may mean that they are more sexually experienced, but it could also mean that they have less to hide. In order to assess differences between responders and non-responders some studies have compared people participating in a survey who are willing to answer questions related to sexual activities and those who are not, but the latter group may be different from people who are unwilling to participate in surveys at all [160]. Non-response can particularly bias the results if the outcome of interest has a low prevalence [161].

Another problem in population-based surveys is that groups living on the margins of society and who are not members of ordinary households will not be captured in a survey based on household sampling. This will not be reflected in the non-response rate [156, 162], but constitutes an important loss of information as such individuals may have more partners than the average respondent and may thus be important drivers of the epidemic [163].

In the population-based surveys from Chelston and Kapiri Mposhi, 16% of all the eligible respondents in 1995, 28% in 1999 and 20% in 2003 were absent from home at the time of visit of the interviewer team despite two call-backs. In all the three surveys men were approximately twice as likely to be absent as women. Only 1-2% refused to be interviewed and less than 10% refused to let their saliva be tested [5, 112, 113, 117]. The refusal rates were similar for men and women. Of the eligible respondents in the Zambia Sexual Behaviour

Surveys 95% of the women and 92% of the men were interviewed in 1998, 88% and 85% in 2000, and 87% and 85% in 2003, respectively [142-144]. The response rates were thus relatively high, although the proportion of men who were absent in 1999 in the Chelston/Kapiri-survey was a little problematic. However, as the most common reasons for being absent among men were work or school we believe that it did not affect our prevalence estimates much. Those away for work might have been at higher risk of HIV, but those absent due to school attendance were likely to be at lower risk of infection.

It is important that the sampling of any study is done in a systematic and predetermined way. Randomization procedures reduce the risk of selection bias. If the respondents in a study have unequal probability of being selected, the results should be weighted to compensate for this. In the PLACE-study we randomly selected venues where individual guests were to be interviewed. The method used to sample the individuals themselves was systematic, but not randomized. The group of people gathered in the venues was dynamic, with persons coming and leaving all the time. The interviewers tried to behave as anonymously as possible to avoid scaring people off. However, in small venues they were still noticeable, and the presence of the interviewers might have made some people leave the venue prematurely or at least stay as far away from them as possible. The approach chosen for sampling of participants was the most practical one to avoid creating too much fuss (and has been used in many other PLACE-studies [164]). The interviewers moved systematically around the venue along two imagined diagonal lines to interview people who were staying close to the counter, in the middle of the room and in the corners. This was important as people who prefer different locations in a bar or a night club may also demonstrate different behaviours in other aspects of life. However, despite this systematic procedure, in a crowd of people it was easy for reluctant individuals to withdraw as the interviewers approached. This makes it more difficult to assess selection bias when using convenience rather than random sampling. However, the response rate among those who were asked for an interview was high, and we thus believe that we obtained a relatively representative sample of venue guests.

5.1.2.2 Information bias

Information bias due to measurement errors can lead to differential misclassification (related to the value of other outcome or exposure variables) or non-differential misclassification of

risks. Differential misclassification is especially feared, as it can distort measured associations in both directions, whereas non-differential misclassification tends to reduce the strength of an association [165]. An example of a possible differential information bias is that knowledge of one's own HIV status can affect the level of risk behaviours reported. A person who knows that he/she is HIV positive may have made an effort to remember past events that could explain how transmission could occur and may therefore be able to report previous behaviours more accurately than someone who is not infected or has never been tested. An infected person may, conversely, also intentionally underreport risk behaviours to avoid being blamed for inflicting the infection upon him/herself. However, in Zambia where only 13.4% of adults had ever been tested for HIV in 2005 [158], knowledge of one's own HIV status is not likely to be an important source of bias, except when symptoms of disease cause suspicions of HIV infection.

In paper IV we found information bias related to our concurrency parameters. Respondents in the Sexual Behaviour Survey in 2003 were asked questions about the last three sexual partnerships, including whether the relationships were ongoing and when the respondents had sex with these partners for the first and the last time. Based on the responses given we estimated the proportions with more than one ongoing relationship and the proportion with overlaps between the last three partners. We found that these two proportions differed. There was no systematic pattern in which of the parameters that gave the highest concurrency level. However, there was a non-significant tendency among men that the proportion with overlaps between the last three partners was higher than the proportion reporting more than one ongoing relationship, whereas the opposite was the case for women. Other studies have also found such inconsistencies when more than one parameter has been used to measure concurrency [166-168]. Missing responses did not explain the differences found in our study. However, it is more likely that difficulties in recalling exact dates or the correct order of events played a role, or that one relationship may have ended in the same month as the next one started, without being concurrent but that they were misclassified as such, or the respondent may have had sex with a partner although the relationship was regarded as officially over [166]. To reduce such information bias the interviewers could have pointed out inconsistencies to the respondents, asked for clarifications and helped the respondents to remember the exact timing of events by providing memory cues. It is also possible that using other data collection methods, like computer assisted self-interviews (CASI) could have lead to more accurate reporting.

The reporting of "hard" (objective and easily measurable) outcomes is usually less associated with differential information bias than "soft" outcomes. Information on previous births can be viewed as "harder" than reports of ever engaging in sex as this information is easier to validate. Self-presentation bias and memory bias are two important types of information bias that we will discuss more in detail:

5.1.2.2.1 Self-presentation bias

Issues related to sexuality are regarded as very personal and intimate, and culturally inappropriate sexual behaviour is associated with stigmatization. Self-presentation bias and social desirability may reduce the truthfulness of self-reports. Stigmatized behaviours are especially prone to be underreported. Many studies have found that particularly women tend to underreport their sexual activities [169, 170], whereas young men in some studies overreport sexual experience or number of partners [171]. This is probably linked to differences in gender-ideals of sexual skills, premarital sexual experience and perceptions of what is normal sexual urge among men and women.

Misreporting of age is common in many countries where people do not know their date of birth, and overreporting of age 20 is common in young age groups. The youngest pregnant women may report to be older than they are if there have been public campaigns discouraging teenage pregnancy [9].

Although there are biases in the data that are collected, it is possible to analyse trends in sexual behaviour if the biases do not change over time. It is also possible to compare different populations if the magnitude and the direction of the biases are the same [1, 169]. However, if attitudes to female sexuality become more liberal, this may give less under-reporting of specific sexual activities among women. On the other hand, it is likely that as the messages of HIV campaigns encouraging delayed sexual debut and abstinence before marriage become better known, people will report behaviour that is more in line with what is assumed to be socially desirable and the self-presentation bias may increase over time. This could also cause differential bias of the association between risk behaviours and education if e.g. educated individuals are more prone to report increased condom use compared to the low-educated to conform to what is perceived to be desirable behaviour.

In paper II we found that the proportion reporting early sexual debut changed from 1999 to 2003 within the young cohorts of rural men and urban women. The Demographic and Health

Surveys, Sexual Behaviour Surveys and studies from other countries show a similar pattern indicating under-reporting or inconsistent reporting [172-174]. This can be interpreted as a sign of increased self-presentation bias.

In paper IV the non-significant increase from 1998 to 2003 in the proportion of young urban women who reported more than one ongoing relationship could indicate that young urban women had become more truthful in reporting their sexual behaviour, especially as the proportion of men reporting concurrency declined during the same period.

Ensuring privacy in the interview setting is essential to reduce report bias. Some respondents will also prefer to be interviewed in a familiar place [175], but if interviews are carried out with other people nearby, it is important to make sure that nobody else can hear or see the responses. Convincing the participants that their answers will be kept anonymous, that all the personal information that can identify them will be deleted or kept apart from their responses, and that everything they say will remain confidential between the interviewer and themselves, will also reduce information bias, but does usually not remove it.

Different data collection methods have been developed to reduce report bias. In countries with a low level of literacy such as Zambia, interviewer-administered questionnaires have traditionally been employed. This method provides an opportunity for the interviewer to explain questions, discover inconsistencies in responses and probe about these. The respondents may perceive the interviewer/researcher as more credible when they can observe his/her face and name-badge than when they are only asked to fill out a self-administered questionnaire [160, 175]. Good rapport between the interviewer and the respondent and exhibiting a non-condemning attitude can reduce self-presentation bias. The interviewers should be trained to ask questions in the same way to all participants (using the same words and tone of voice). It can also be an advantage if the respondents can identify themselves with the interviewer, e.g. if the interviewers are of the same gender and age (or slightly older) and come from the same socio-demographic background [175]. However, a disadvantage with the method is that some respondents will be worried about confidentiality and privacy if it is possible that the responses can be heard by others. Some may also be embarrassed to talk about sexuality in face-to-face with another person.

The interviews in all the studies which the papers in this thesis are based on used interviewer-administered questionnaires. To minimize report bias confidentiality was stressed at the start

of the interviews, and the interviewers explained that all personal identifiers would be removed before analysis of the data. In the PLACE-study the respondents were not asked to give their name. The interviewers were trained to ask questions in a polite and sympathetic way, and not to skip questions. In the studies in paper II and III there were both male and female interviewers, so if a respondent had a special preference for an interviewer of a specific gender, this was complied with. In all these studies the interviews were conducted with other people close by (in a home, health clinic or social venue), and therefore the interviewer would in some instances conduct the interview outside the home or the venue, for example under a nearby tree, to ensure that nobody else could hear what was said. The interviews started with the least sensitive questions, and the most sensitive ones were asked at the very end when good rapport hopefully had been established.

There are several alternative approaches to interview-administered questionnaires. In developed countries where adult literacy is high, a self-administered paper questionnaire is a commonly used tool. Participants must be given space to ensure privacy when filling it in, and in order to convince the participant of his/her anonymity, there should only be a number on the questionnaire to identify the respondent, not the full name. The disadvantage with self-administered questionnaires is that they require form literacy too (ability to follow branching and skip instructions as intended) [176]. In addition, inconsistent responses are more prevalent than in interviewer-administered questionnaires as the respondent may not realize that contradictory responses are given.

Literate respondents may also be asked to record sexual activities in a diary over a shorter period of time. This can give more accurate frequency estimates of sexual intercourse and condom use [160], but the quality of the data depends on the respondent remembering and being motivated to write events down in the diary.

Questionnaires can be self-administered using computers (computer-assisted self-interview = CASI) or PDAs too. This has been shown to be feasible even in groups with little computer-experience [177, 178]. Sound has been added in some studies to allow respondents to hear the questions in headphones before answering (so-called audio-CASI = ACASI). This can improve the understanding of the questions in less literate parts of the population and makes it possible to standardize the way the questions are read [179]. Illiterate respondents can be instructed to press coloured buttons [178]. Computer-assisted questionnaires can be constructed to automatically make skips where appropriate and to discover inconsistent

responses. Such functions can reduce errors and the number of missing responses compared to self-administered questionnaires [177, 179]. Several studies have shown that these methods give increased reporting of stigma-related behaviours compared to face-to-face interviews [179-182], whereas other studies have found unpredictable reporting patterns, more missing responses and increased inconsistency in reported behaviours [178, 182, 183]. It may be easier to convince people that the interview is anonymous and confidential when they do not have to talk to another person. But the beneficial effect is smaller among those with little education [177, 183, 184]. Compared to an interviewer-administered questionnaire a multi-site study also found ACASI to be more time-consuming in populations with little computer-experience [178].

Using computer-technology is, however, often not technically or financially feasible in low-resource settings. There can be cultural barriers too. A study in Kenya found that using computers for ACASI in a survey among adolescents contributed to hostility and rumours about Satanism in the local community as many of the residents had never seen computers before [183]. Informal confidential voting is an alternative method developed to be used in such circumstances. The interviewer reads a question and the respondent ticks off the appropriate response on a piece of paper behind a screen. The respondent puts this piece of paper in a wooden box through a narrow slot, and as the box is locked with keys kept by the study supervisor, the interviewer will not be able to discover what the participant has answered [185]. Gregson et al have found that this method increased reporting of risk behaviours in comparison to face-to-face interviews. However, the method is time-consuming, gives more missing responses and is less useful with non-literate respondents [185, 186].

According to the Demographic and Health Survey 2001/2002 61% of women and 82% of men in Zambia are literate [138]. As a substantial proportion of the adult population is illiterate, the mentioned alternatives to interviewer-administered questionnaires could potentially increase non-response tremendously. Most studies that are conducted in Zambia use interviewer-administered questionnaires for this reason. Considering that Zambia is a low-resource country where the majority of the population has no computer-experience and electricity is often not available, the most feasible alternative in studies of sexual behaviour would be informal confidential voting, but low literacy could still be a major problem.

5.1.2.2.2 Memory bias

In retrospective studies the accuracy of reporting depends on the memory of the respondents. The report of recent events will usually be more precise than events that are further back in time. Important events are often reported as more recent than they actually are [160, 187, 188], and many people find it hard to remember exact dates of events unless they associate them with important life-events. Events that are associated with strong emotions are also more precisely remembered [160]. Reporting of sexual behaviours for a short time period is usually more precise than longer recalls, but this period may not be representative of the respondent's sex life. The finding in paper II that the proportion reporting early sexual activity changed over time within the same age-cohort could be a sign of memory bias as the recall period from sexual debut increases with age. However, sexual milestones like debut tend to more accurately remembered than other behaviours [160].

Studies have also shown that the accuracy of recall depends on the frequency that a specific behaviour takes place. High frequency behaviour is often underreported whereas low-frequency behaviour may be overreported. The more accurately respondents are asked to report behaviours in time or frequency, the more errors are made. Ever/never-responses are therefore the most reliable. And when time passes, people may not remember specific events, but make a guess based on what they perceived to be the general pattern at the time and what fits with their self-image [189]. A person with a sex life characterised by routines has less problems reconstructing sexual events than someone with many partners and changing routines [160]. Condom use at the previous casual sexual intercourse (one of the indicators in paper II) is a typical behaviour that is easily overreported. Some of the respondents who were asked this question had probably not engaged in casual sex for some time and therefore they may not have remembered exactly whether they actually used a condom. Feeling uncertain, respondents may have chosen to report that they used a condom if they knew that this happened at least sometimes and if reporting this fitted better with what they perceived to be ideal.

To reduce memory bias interviewers can assist respondents by helping them relate events to important milestones in life or to other events which are well-known to many people, such as elections, draughts or harvests.

5.1.2.3 Control of validity and reliability

Very few of the behaviours discussed in this thesis can be validated biomedically in a simple way. Some studies collect urine and vaginal swabs from women to find traces of sperm indicating sexual intercourse during the last 48 hours [156]. However, this requires a lot of resources, is rather intrusive, and was not at all worth the effort in the study paper II is based on where the interest was in sexual activity over a longer period of time. In studies where tests for HIV and STIs are conducted, self-reported behaviour can be correlated to the prevalence of these sexually transmitted infections [156, 160]. In paper II we found that up to 8% of the young respondents who claimed to be virgins were HIV positive, and none of these had received blood transfusion. Vertical transmission is unlikely as ARVs were introduced only recently in Zambia, and the median survival period for untreated children infected at birth is 2 years [190]. They could of course have been infected through injections, but there is convincing evidence that the dominant form of HIV transmission among adults in Zambia and sub-Saharan Africa is through heterosexual intercourse [191-196]. Other studies have also found HIV infection, STIs and current pregnancy among young people who denied having sex [169, 192, 197]. This may indicate underreporting of sexual experience among young people. Alternatively, some of these young people who claim to be virgins may have been raped/forced to have sex or be victims of incest and deny sexual activity as they have not participated voluntarily. A Kenyan study found that half the adolescent girls who denied sexual experience, reported having been forced to have sex [182]. According to the Zambia Sexual Behaviour Survey 2005 10% of women aged 15-19 years have been forced to have sex against their own will [158].

The reliability of participants' responses can be checked by conducting the interview twice using different interviewing methods or different interviewers. However, this requires extra time and resources and was therefore not done in any of the surveys that this thesis is based upon.

We found internal inconsistencies in the responses of some of the participants in the studies. For example some reported never having sex, but still had used a condom during the last sexual intercourse. This could arise both from lack of honesty from the participant, errors made when the interviewer filled in the questionnaire, or errors made during data entry (but the latter is unlikely as we employed double entry). When we found such inconsistencies we considered the response indicating the highest risk behaviour to be true and recoded the other

responses. Most responders were, however, consistent, and the finding that both the proportions that had ever had sex and that had ever given birth declined, increased the credibility of these self-reports. (The first behaviour is often seen as undesirable for those who are unmarried whereas the second is more likely to be associated with respect and difficult to hide.)

Comparing the number of partners reported by men and women is also a way of controlling the internal validity of a study. It is possible that under-reporting among women (and perhaps over-reporting among men) may partly explain the difference between the proportions of men and women reporting multiple partners in paper II. However, it is also possible that many of the men had sex with women outside the age-range of the survey, with women living elsewhere or with sex workers who constituted a small group of women not included in the survey [156]. One study found that there was a better match between the number of life-time partners reported by men and women in the group who reported 1-20 partners in total than in the group who reported more than 20 partners, indicating that the discrepancy between the number of partners reported by men and women was explained by the inclusion of a group of men with more than 20 partners and the likely exclusion of a smaller group of women with even more partners [163].

Direct observation can also be used to validate some responses, as long as it does not imply invading on people's privacy. In the PLACE-study the interviewers suspected that some women underreported intentions to engage in transactional sex as they clearly behaved as if they were looking for men to spend the night with, but did not admit that this was the case. Observations did, however, reveal that the information on presence of condoms was reliable; most of the places which claimed that condoms were always available and most of the men who said they had brought a condom, could verify it.

Despite all the possible biases described, we still believe that the observed declines in various sexual risk behaviours seen both locally in Kapiri Mposhi and Chelston and nationally in the Sexual Behaviour Surveys are real due to the parallel decline in HIV prevalence in the young subgroups where the behaviour change was clearest and mortality was low [113, 117].

5.2 Findings

5.2.1 Trends in HIV prevalence

According to the antenatal clinic data from the period 1994 to 2002 in Zambia there was a significant decline in HIV prevalence among pregnant urban women and a non-significant modest decline among rural women. The decrease in prevalence among young urban women aged 15-24, probably reflected a reduction in incidence during this period. The falling prevalence among women aged 15-49 may have been due both to a decrease in incidence and increased mortality.

When looking closer we found contrasting trends at the community (site) level. In many sites the HIV prevalence was clearly declining, but in others it was stable or even increased in some few. This could indicate different epidemic stages as the infection has spread at an uneven rate around the country. It is likely that it is also partly due to differences in intensity and effectiveness of preventive interventions both in the past and currently. The early HIV preventive campaigns focused on urban areas as the prevalence there was higher. Probably as a result of this the difference in HIV risk between urban and rural residents aged 15-24 shrank from 1994 to 2002.

It has been suggested that to assess trends properly in HIV prevalence among pregnant women only sites with at least three observations from a 3-6 year period should be included, and statistical tests for trends should be conducted separately for each site [198, 199]. To be able to conclude in which direction the trend is moving, the three data points should show a consistent trend [198]. Based on these criteria UNAIDS conclude that there is no evidence of a decline in prevalence overall in the antenatal data from Zambia, only among 15-24 years old urban women and 15-19 year old rural women [200]. However, this approach does not take into account that antenatal attendees can be rural residents although the clinic they attend is situated in an urban area and vice versa. The relative balance of urban and rural residents attending the clinic during a data collection round may change, and this may create changes in the HIV prevalence at the site although there are no real changes in the prevalence among urban and rural pregnant women in the area. We saw examples of this in the data from Kapiri Mposhi and Kabompo. For this reason we found it more appropriate to stratify the pooled urban/rural analyses by the residence of the participants, rather than by location of the clinic.

With this approach we found a decline in prevalence among urban pregnant women aged 15-24 and 15-49.

Antenatal prevalence figures indicate relatively recent infections in all age groups as fertility is reduced with longstanding HIV infection [9]. Many studies have shown that the prevalence among young pregnant women aged 15-19 tends to overestimate the prevalence among young women in the general population, but that the prevalence among older pregnant women is more representative or may underestimate the prevalence in the corresponding age groups of women in population-based surveys [5-9]. The overestimation in the youngest age group is most likely due to the fact that a high proportion of women of this age have not yet become sexually active and therefore are at lower risk of HIV than women who have had sex and become pregnant. As we observed in paper II that an increasing proportion of young women seem to delay the first pregnancy through postponement of sexual debut and increased contraceptive use, including condom use, those who do become pregnant are probably becoming an atypical group, especially among the more educated women [6]. Thus it seems that ANC-data fail to detect the steep prevalence decline seen among young people in the general population in Chelston [8]. In order to better reflect the prevalence in the general population one solution may be to adjust the prevalence estimates from antenatal clinics for age at sexual debut and contraceptive use in populations with high use of modern contraceptives [6] or for the relative fertility risk for HIV positive, compared to HIV negative women, as shown to be valid in mature epidemics where modern contraceptives are not highly diffused [201].

As the prevalence trend among young pregnant women in Chelston is similar to the trend among young urban women in the national ANC-data, we think it is plausible that the decline observed nationally among young urban pregnant women reflects an even sharper declining prevalence among young urban men and women in Zambia. This hypothesis is strengthened by the fact that national population-based data show a decline in the reported number of partners for men and women and increased condom use with casual partners among women [172]. Currently there are no nationally representative population-based data on HIV prevalence trends. The only nationally representative population-based survey with HIV testing conducted in Zambia was the Demographic and Health Survey 2001/2002 (DHS+). Another population-based Demographic and Health Survey is planned for 2008, and this will finally make it possible to assess changes among both men and women on a national level

during the period 2002-2008. Comparing the DHS+ data with a new round of ANC surveillance can reveal whether there have been parallel changes in the ANC- and population-based prevalence estimates after 2001. If this is found, it will increase the likelihood that there were parallel changes on a national level in the 8 preceding years too.

There are only a few other countries in sub-Saharan Africa that have evidence of declining prevalence trends from national data. In many countries the HIV surveillance system has had limited coverage, no documentation of the survey methods, little quality control and/or the sites that have been part of the surveys have varied from round to round [202-204]. Kenya, Ethiopia and Tanzania have all improved their surveillance systems since 2000 and now have a broader coverage also of rural sites and have incorporated quality control mechanisms [204-206]. The inclusion of more rural sites has lead to a drop in the estimated national prevalence, in for example Kenya and Ethiopia, that should not be mistaken for a real decline [198, 206]. Prevalence trends since the 1990s in countries like Ethiopia, Niger, Burkina Faso, and the Gambia can only be followed for a few sites [207-210], and the national trends for the last decade are unknown. In Zimbabwe data from 2000 to 2004 from pregnant women show a decline in HIV prevalence both in urban and rural areas and in all provinces, overall from 32.1% in 2000 to 23.9% in 2004 [202]. In Kenya the prevalence in some urban sites declined from 1999 to 2003, but in rural sites there were no clear changes [206]. The same seems to have been the case for the Rwandan sites which were included in at least three surveys between 1998 and 2003 [211]. Data from urban antenatal sites in Uganda that have been part of the sentinel surveillance system since the early 1990s, have also shown a significantly declining trend [212]. However, data from many other countries in sub-Saharan Africa, e.g. Senegal and Malawi, indicate stable prevalence levels [199, 213-215].

5.2.2 Sexual behaviour changes

In paper II we reported that fewer sexual partners, increased use of a condom at the previous sexual intercourse and a decline in the proportion of women that had ever given birth seemed to contribute to the decline in HIV prevalence among sexually active young adults between 1995 and 2003 in two selected communities in Zambia. Slaymaker and Buckner found a decline in the proportion reporting more than one partner in the previous year and no condom use during the most recent sexual intercourse with this partner in the Demographic and Health

Surveys and Sexual Behaviour Surveys between 1996 and 2003 [172], and we found that the prevalence of concurrency among Zambian men declined in the five year period we studied in paper IV. It thus seems that there has been a trend towards safer sexual behaviour on a national level too.

The observed changes may be caused by the fact that most people in Zambia know someone who is infected with HIV, and this may have made them realize that HIV is a real danger, that can also infect them [216]. The shift towards safer behaviour may also be due to successful HIV prevention campaigns. However, most of the preventive activities have been focused on urban areas, and English has been the main language used in media campaigns, although local languages have been used to a certain extent. The relative lack of preventive campaigns in rural areas and the dominant use of English may partially explain why condom use is lower and the proportion with multiple partners has changed less than in rural than in urban areas [113, 158].

5.2.3 The role of concurrency

Mathematical models indicate that concurrent partnerships can give rapid and widespread transmission of sexually transmitted infections, including HIV, as several people are connected simultaneously. If a person with many concurrent partners is infected with HIV, he or she can transmit the virus to several others during the primary stage when infectiousness is high [150, 151]. This is estimated to have a huge impact on the growth of an epidemic, especially in the early phases when the prevalence may increase exponentially with the average number of concurrent partnerships per partnership in the population (=k) if the level of condom use is low [150]. Empirical studies have concurrency is associated with higher risk of STIs [152-155].

We do not have data about the prevalence of concurrent sexual partnerships in Zambia from the early 1980s when the HIV epidemic probably grew very rapidly. In the data from the period 1998 to 2003 we found a lower level of concurrency than what was reported in a study from five African cities in 1997/1998 [217]. However, compared with the sexual behaviour changes seen in paper II from 1995, it is plausible that a decline in the prevalence of concurrency had already taken place by 1998. Based on the shape of the projected epidemic

curve for the 1970s and 80 which shows a rapidly growing prevalence in Zambia [110, 218, 219], it is plausible that concurrency played a substantial role during these decades.

5.2.4 Condom effectiveness and acceptability

The role of condom promotion in HIV prevention is a much debated topic. In Thailand and Cambodia 100% condom use programs which included distribution of condoms, enforcing condom use among sex workers and their clients, public awareness campaigns, and management of STIs through frequent compulsory medical checks of sex workers, were probably vital in restricting the epidemic at a point when the prevalence of HIV in the general population was still rather low. As a likely side-effect of the programs the proportion of men engaging in sex with commercial sex workers also declined, and this may have contributed to the falling prevalence too [3, 4, 220-224]. In Thailand the programme was implemented nationally in 1991, and the HIV prevalence among army conscripts declined from 10.4-12.5% in 1991-1993 to 6.7% in 1995 and HIV incidence declined fivefold [3, 4, 222, 223]. The HIV prevalence in the general population in Cambodia declined from 3.2% in 1997 to 0.9% in 2006 [200, 225] after the introduction of the campaign in 1998.

But the role of condom promotion in huge heterosexual epidemics is not clear. In Uganda the HIV prevention campaigns focused mainly on abstinence and faithfulness during the first decade. Condom promotion was only integrated as part of the strategy in the mid 1990s and could therefore only have made a minor contribution to the decline in prevalence observed in Uganda during the early 1990s [226, 227]. It is, however, possible that condom use played a more important role in Zambia (see paper II) and Zimbabwe [228]. There is, anyhow, no doubt that condoms are essential to protect clients of commercial sex workers, the uninfected partner in a discordant couple and other sexual partners of HIV infected people who may not even know that they are infected. As only around 10-15% of people in sub-Saharan Africa know their HIV status [84, 158], couples who have not been recently tested for HIV and know for sure that they are concordant, should ideally use condoms consistently, at least in heavily affected countries.

Condom use has been opposed by many religious communities as they have argued that it will lead to more promiscuous behaviour, but a meta-analysis by Smoak et al. [52] demonstrated that this was not the case. The Catholic church opposes contraceptives in general, including

condoms [229], even for HIV discordant couples [230]. Other religious leaders support the belief that condoms that are distributed in Africa are infected with HIV as a part of a European/North-American conspiracy aiming to wipe out African men and women [231]. In the fight against condoms there are groups within the Catholic church that have spent a lot of energy on emphasizing the limitations of condoms and the potential for HIV transmission despite consistent use [229]. They refer to laboratory studies that show that small particles can pass through pores in the condoms [232]. Some also refer to studies where an association between ever using a condom and HIV infection has been found and take this as evidence of the dangers of condom use [232]. They ignore the possibility that ever having used a condom may be a marker of more general high risk behaviour or that people may have started using condoms in response to the high HIV prevalence [233].

As no randomised controlled trials of consistent condom use among discordant couples have ever been conducted (as this would be unethical), the estimates of the protective effect of condoms stem from observational studies of discordant couples who are encouraged to use condom and followed-up over time [234, 235]. A meta-analysis concluded that correct use of condoms gives at least 90% protection against HIV transmission [50]. But as these discordant couples are repeatedly encouraged to use condom consistently, they are also likely to underreport unprotected sex, and thus the effectiveness of condoms may be underestimated. A Zambian study of discordant couples who received VCT found that at least 50% of the acts of unprotected sex in the follow-up period were not reported [236]. On the other hand, discordant couples who consistently use condoms may not be directly comparable to couples who do not use them despite being encouraged to do so. The latter group is more likely to engage in other risk behaviours too [83, 235, 237]. Anyhow, the most common causes of HIV transmission despite condom use are breakage, slippage and incorrect use, which are related to knowledge and experience, and the risk of these will thus diminish with user experience [50, 238].

In societies where religious leaders are influential opinion-makers, the narrow focus on the uncertainties related to condom use is probably contributing to the scepticism to condoms that we observed in the PLACE-study. We found that the male partner's attitude to condoms was more important in determining condom use than the attitude of the woman. Beliefs that condoms reduce sexual pleasure and male potency have been found to be widespread in male-dominated societies [138, 142, 239, 240]. Many also believe that it is possible to see who is

infected and that infection thus can be avoided just by selecting partners who look healthy [240]. Anyway, we also found that easy availability of condoms in a venue could partly compensate for sceptical attitudes to the protective effect of condoms. In such cases the motivation to make an effort to get hold of condoms was probably low, but these men may have felt some uncertainty related to the matter as they seemed willing to use condoms if they were easily obtainable. The vital role of availability is probably also related to alcohol consumption coinciding with socializing at bars, night clubs and restaurants. Drinking makes people more impulsive and less worried about risks. Any barriers to obtaining condoms are therefore essential to minimize.

5.2.5 Effects of educational attainment and poverty

Socioeconomic status is usually measured based on one or a combination of the following parameters: education, income/wealth and occupation. These parameters are frequently regarded as indicators of the same and are used interchangeably as higher educated people often work in white-collar occupations and have a high income, whereas illiterate people are usually poor and have jobs that do not require specific skills. But the three measures do not always overlap in their effects on health [241]. Education provides knowledge and life skills and influences work opportunities. Income influences nutrition, housing, schooling and enables people to pay for health care services [242]. It also affects the ability to control life circumstances and participate in society [243, 244]. Being employed is related to prestige, travelling, and access to work-place prevention and treatment programmes. There is also a reciprocal effect between health and employment as people who are able to get a job are usually healthier than individuals who do not ("healthy worker"-effect).

Some studies have found that the socioeconomic status of a household seems to be more affected by the educational attainment and income of the husband in the family than the wife [245]. High socioeconomic status and education were associated with having more sexual partners before the HIV epidemic in Africa and many other parts of the world [5, 115, 116, 246]. This was probably due to more travelling, urban residence and ability to financially support more girl-friends among wealthy and educated groups. Travelling and urban residence are both linked to reduced social control and more opportunities to meet new sexual partners [5, 115, 116, 247]. Early surveys showed higher levels of HIV prevalence among

wealthy and educated people [115, 116, 248]. Studies from several sub-Saharan countries show that this pattern has reversed, and that HIV infection now is associated with lower socioeconomic status [116, 117, 249, 250].

It is a general pattern that as knowledge about risk factors becomes available, people of higher socioeconomic status are more likely to possess resources like knowledge, health awareness, economic and political power, a strong social network, self-confidence and self-efficacy to change their behaviour and avoid disease [5, 251, 252]. The finding from a population-based survey from Botswana that 48% of adults had been tested for HIV, and that higher education, good self-perceived health and good access to healthcare increased the likelihood of having had a test [253], probably illustrates how educated people make use of available technology and services to protect their health although their risk of disease is lower than among other groups. For people from lower socioeconomic backgrounds, the lack of the mentioned characteristics put them at risk of several different harmful factors (e.g. bad living conditions, unhealthy or limited food lacking essential vitamins and proteins, unsafe work environment, stress), and thus at risk of several diseases simultaneously [254]. It is possible that poor people have increased biological susceptibility to HIV as malnutrition leads to reduced immunity and increased risk of infection with other STIs, which again increases the risk of HIV transmission [255].

The number of problems poor people may face can create feelings of helplessness and fatalism, i.e. low belief in the ability to influence their own health [241]. According to the Theory of diffusion of innovation, groups with less resources are likely to change their behaviour if the community perception of what is desirable behaviour changes, but such changes will usually occur more slowly than in higher socioeconomic populations [256, 257]. It is not completely clear whether it is education in itself that causes these differences in the tendency to change behaviour in response to the dissemination of health promoting messages, or whether education is also a proxy for special characteristics of people who continue beyond secondary school, such as patience, endurance, ability to be motivated by long-term goals, and ability to postpone reward [258, 259].

We found that already in 1995 young men and women with higher education in Kapiri Mposhi and Chelston reported more than one partner in the previous year less frequently than those who were less educated, and that the proportion with multiple partners in addition declined more among those with higher education from 1995 to 2003. Combined with the

finding that the proportion reporting concurrency in the SBS-data declined from 1998 to 2003 both among those with little and more education, it seems likely that the process of change in sexual behaviour among those with the highest educational attainment started earlier than the mid 1990s. According to the Theory of diffusion of innovation they would be expected to adapt to the messages of HIV preventive campaigns more swiftly than other groups.

Health promotion campaigns that are not specifically targeted at poor people often increase the differences between different socioeconomic groups, as the most resourceful are more likely to follow the advice given [242]. Some argue that risk behaviour is only a proxy of poor health and a result of low socioeconomic status and powerlessness, and that although campaigns may succeed in making poor people change their behaviour, the higher socioeconomic groups will still have better health than the poor as they manage to adopt the protective strategies available at any time more consistently than people with less resources [258, 260].

HIV prevention programs all over the world mainly focus on individual risk factors such as high number of sexual partners, casual sex, unprotected sex and early sexual debut. There are several reasons why these messages may not be absorbed by all. Prevention campaigns that only use mass media will not reach those who cannot read and do not have radio or television. If the messages are only given in the official language, it is difficult for people who only speak a local language to understand the meaning. But more importantly, the ABC-approach (encouraging abstinence, being faithful and condom use) does not address more fundamental social causes that may lead to these high risk sexual behaviours. Poor people may not have the means to act on the messages they are exposed to, even if they understand them. As the majority of the population in many developing countries is struggling to survive from day to day, the risk of contracting HIV and dying in 10 years may seem of less immediate importance [261]. A woman may realize that she is at risk of becoming infected when having unprotected sex with a man in exchange for gifts or money, but she may be willing or have to accept to take this risk to be able to buy food for her children. In such desperate circumstances it will be difficult for a woman to negotiate condom use if the man is unwilling, and condoms may be unaffordable. Poverty may also force men to migrate to find work and thus live away from their wives and families for long periods of time. Such separations make it more difficult to be faithful to one partner, and migration of workers creates business for the sex industry.

The health care services accessible to poor people are often random and of low quality, and there are many barriers preventing them from visiting modern health clinics: long distances, problems with transport, unaffordable consultation fees, and negative experiences with health personnel who may ask for extra "fees" (bribes) because of their own low salaries [262, 263]. This combined with limited access to affordable antiretroviral treatment - removing the incentives to be tested for HIV - probably contribute to the low uptake of VCT services in many developing countries. When very few women know their HIV status, or there is poor access to antiretroviral prophylaxis during labour and birth, and breast-milk substitutes are unaffordable, the rate of HIV transmission from mother to child will be high. In addition, communities with low levels of education and in which the majority of the population is struggling to survive, may not be as able as more resourceful communities to mobilise and join their forces to fight HIV [262].

To change established behaviours, a person needs a certain degree of self-confidence in his/her own ability to change. Education often strengthens self-efficacy and can empower women and other vulnerable groups to stand up for their rights and be able to refuse sex or demand condom use. People who have no education may fail to change their behaviour or oppose pressures from others because of lack of belief in their own ability to initiate changes. Interventions targeting poor and vulnerable groups should therefore also include assertiveness and communication training [264, 265]. Poor countries that have relatively high life expectancies considering their low gross national product (e.g. Costa Rica, Cuba, Jamaica and Sri Lanka) seem to be characterized by an emphasis on education, particularly of women, and a good primary health care system [241].

5.2.6 Targeting interventions in generalized epidemics

A major part of the HIV transmission in countries with a relatively low HIV prevalence in the general population is estimated to occur from high risk/core groups (e.g. sex workers) to bridging populations (e.g. male clients) to the general population (e.g. low risk female partners) [266]. However, high risk or so-called core groups can be an important source of new infections even in countries with a high HIV prevalence in the general population, and have therefore been the focus of many HIV interventions in sub-Saharan Africa [267-269]. In a study from rural Zimbabwe 20% of male infections were estimated to arise from sexual

contact with sex workers [267]. Using mathematical models Boily et al found that core group interventions could significantly decrease the HIV incidence in epidemics with a low reproductive potential, whereas in epidemics with a higher basic reproductive number it was essential to add interventions targeting the general population early in the epidemic [270].

There are also empirical studies which have been demonstrated that interventions like syndromic management, presumptive or prophylactic treatment of STIs, dedicated STI clinics, peer education and condom distribution targeted at sex workers have been successful in achieving increased condom use [4, 64, 65, 75, 77, 271-275] and reduced incidence of STIs [3, 4, 63-65, 77, 271] and HIV [3, 4, 62, 276] in this high risk group, and some have also found reduced prevalence of STIs [63] and/or HIV [3, 4] among their clients. Very few of these trials have, however, had randomized designs and comparable control groups. A study of the cost-effectiveness of syndromic management and periodic presumptive treatment of sexually transmitted infections among female sex workers in South Africa found that these interventions were reasonable cost-effective ($78 per DALY averted) at the current HIV prevalence level of 11% in the general population and approximately 50% among female sex workers. However, in order to substantially reduce the HIV epidemic, these interventions should have been initiated at a much earlier stage. Alternatively the clients of sex workers would also need to be treated and the STI services for the general population improved [61]. Increased condom use will, however, prevent both HIV and STI transmission and is likely to be even more effective [266].

There are only a few studies which evaluate the long-term effect of such targeted interventions. A study from Kenya of behaviour among female sex workers one year after an intervention consisting of counselling and STI screening had ended found that the total number of partners and the frequency of unprotected sexual encounters with casual clients had increased, but not back to pre-intervention levels. However, at the same time condom use continued to increase, probably due to sustained peer-led community meetings and condom distribution [275].

A problem with core group interventions, is that many women who engage in transactional sex in sub-Saharan Africa do not regard themselves and are not seen by the rest of the community as commercial sex workers [277-279]. They may have another main source of income such as sale of fish, agricultural products or other goods, or work in a bar, and only occasionally engage in transactional sex [279, 280]. Some of these women may also be

looking for more committing relationships and may hope that the gift-giving is a part of courtship. Thus they may not perceive interventions specifically targeted at sex workers as relevant for themselves, although they also may have a high partner turnover, many concurrent partners and seldom use condoms [277, 278]. There is therefore a need for broader approaches. Targeting places rather than specific groups will probably be less stigmatizing, and interventions targeting all venues where people meet sexual partners are likely to reach women who engage in sex work only periodically too. Such interventions may also be perceived as more relevant by the regular non-paying partners of sex workers. Several studies have shown that condom use tends to be lower in such relationships despite interventions [64], and a study from Benin found a much higher prevalence of HIV among the boyfriends of sex workers than among clients [281].

Although it is well known that bars, night clubs, guest houses and restaurants are venues where people may initiate sexual relationships, many other studies from sub-Saharan Africa have also found few HIV interventions and condoms in such places [164, 282-284]. PLACE-studies conducted in East London, South Africa, in 2000 and 2003 showed an increase in condom use and reduction in the number of recent partners during the 3 year period. These recorded behavioural changes could possibly be related to a community-based intervention which targeted these types of venues and distributed condoms [285]. The effect of such interventions on the HIV incidence in the general population is, however, still uncertain. A recent study from Zimbabwe of a community-based intervention mainly targeting high risk groups (including peer education among sex workers and their clients at beer halls and workplaces, syndromic management of STIs, HIV education and condom distribution) found more consistent condom use with casual partners and reduced HIV incidence among men who attended programme meetings, but no extra effect on the HIV incidence in the general population in an already declining epidemic. The authors mention that it is possible that it takes more than 3 years to observe impacts at the population level, and that the dramatic economic decline in Zimbabwe during the study period might have disrupted the intervention. Studies from other areas will be needed before one can draw a conclusion about the effectiveness of interventions targeting high risk places more in general [286].

6 Implications for policy

There are encouraging indications that the HIV prevalence has declined in Zambia, but these changes are modest in rural populations and limited in groups with little education [113, 117]. The pattern of prevalence change matches well with signs of shifts towards safer sexual behaviour. Innovations in prevention are needed to reach groups with little education based on research on effective sexual behaviour-change campaigns among population groups who have not yet responded in terms of risk reduction. However, as mentioned in previous sections, although individual-focused approaches clearly have potential to influence the epidemic, as long as the fundamental social causes of risk behaviours remain unchanged, the traditional HIV prevention approaches may be of limited relevance to the large proportion of Zambia's population that is struggling to survive from one day to the next.

Interventions that can have an effect on important underlying barriers to behaviour change, such as poverty are, for example: providing free access to education for all, ensuring that all employees receive at least a minimum salary, establishing some sort of social security system that ensures that sick, elderly and unemployed persons have enough to survive on, and free access to basic medical services for all. Basic education is theoretically free of charge today, but some indirect expenses (uniforms, books, Parent-Teacher Association fee) still prevent many children from attending school. Zambia has been granted debt relief by the G8, the World Bank and the International Monetary Fund [287], and resources have recently become available that could be invested in schemes like this.

In sub-Saharan Africa women are more likely to be infected than men (between 20%-40% higher prevalence) and they are infected at an early age [288]. Interventions that aim at altering fundamental social causes, also need to address the specific needs of women. Empowerment of women has been suggested as an important risk reduction strategy, e.g. to be able to refuse sex or to negotiate safe sexual practices with male partners. Our findings suggest that providing education, both primary and secondary, is paramount. Another approach which is often suggested is to strengthen women's economic autonomy through e.g. microfinance initiatives combined with vocational skills training which allow women or other vulnerable groups to learn specific skills and take up loans to establish their own businesses [289, 290]. Women who have engaged in transactional sex to make ends meet can thus find other ways to support themselves. As women's activities as a result of such programs simply

become more visible, experience has shown that they may also become less vulnerable to suppression from male family members [291].

Our assessment of HIV prevention needs in Lusaka and Livingstone revealed that simple structural factors like condom availability have an effect on the likelihood of condom use in high-risk settings. This could easily be addressed by making sure that condoms are available in toilets of social venues and in rooms of guest houses and hotels where people could obtain them out of public sight when they need them. Another finding from the PLACE-study was that there is still a high demand for information and learning opportunities related to facts about HIV transmission among people who engage in risky sexual behaviour, although surveys show that there is a high level of knowledge about HIV in Zambia [158]. Despite a lack of strong evidence for the superior effectiveness of youth peer education over other health education strategies, we believe that a peer education programme targeting places where the risk of HIV transmission is high would be a cost-effective, acceptable and an efficient way of spreading awareness about the risk of HIV transmission. However, experiences from previous peer education programs in Lusaka and Livingstone showed that even such relatively low-cost interventions need a minimum of resources to be successful. Young people who are struggling to make ends meet will probably be more motivated to do voluntary work if their expenses are covered and they receive some technical and material support (e.g. leaflets). The peer educators themselves stated that a small incentive like transport money or a lunch allowance when they did outreach activities, opportunity to meet with other peer educators regularly, and involvement in decision-making related to prevention and health services for young people at the clinics, might be enough to keep them going.

In countries with major HIV epidemics but limited resources there is a potential that scaling up treatment programs can result in less resources for prevention. Concerns have been raised about this in several African countries [227, 292]. It is clear that prevention is considerably more cost-effective than treatment in reducing the long-term population impacts of HIV [293, 294], but not offering people access to life-saving drugs may seem unethical. More money has been made available for HIV-programs internationally in recent years from e.g. the Global Fund and PEPFAR, and this has made it possible to scale up treatment. Currently many countries in Africa have established a policy to offer ARVs free of charge to those who need them, but the coverage is below 50% in most countries, and the access to free drugs is usually very low in rural areas. There are also major concerns related to the sustainability of some

these programs. PEPFAR officially ends in 2008 and it is not yet clear what will happen after this date. A major part of the health resources in several sub-Saharan countries is already being spent on HIV infected people [293]. There is a great fear that African governments will be forced to take over the costs of ARVs and to move resources from HIV prevention programs to pay for the treatment.

7 Research challenges

The ANC-based data show that there are many diverse HIV subepidemics in Zambia. We need to understand the local contexts of these subepidemics to be able to plan sensible and effective interventions. The epidemiological context, i.e. epidemic stage, transmission patterns, the level of risky behaviours in different subpopulations, underlying sociodemographic contexts, and important cultural factors, must be assessed for each geographical area. This means that population-based surveys, PLACE-assessments and qualitative studies should be conducted in many new areas in order to better guide interventions. Conducting population-based surveys in the catchment area of other ANC-sites than Chelston and Kapiri Mposhi, would make it possible to further assess whether antenatal data are relatively representative of the prevalence in the general adult population. PLACE-assessments would help identify places where the risk of HIV transmission is particularly high and that need to be specifically targeted.

It is of course not feasible to conduct studies of the epidemiological context in all communities before carrying out interventions. However, doing comprehensive assessments in both rural and urban areas where antenatal data show increasing or stable trends will create knowledge of regional variation in factors that are important for the effect of interventions. This is likely to be more relevant than global or national recommendations about suitable interventions.

The validity and usefulness of future surveillance of HIV can be improved by combining population-based surveys and antenatal data. Both surveillance methods have strengths and potential biases. As population-based surveys are very costly to conduct it is more realistic to continue to follow the prevalence among pregnant women and to conduct national population-based surveys with HIV testing every 4-5 years. For this to be meaningful it does of course require that pregnant women continue to be relatively representative of the general population. The next national population-based survey with HIV testing (e.g. DHS+) should link socio-demographic and behavioural information to the HIV result, to be able to assess the prevalence and risks in different subpopulations. As mentioned previously, if behavioural and HIV prevalence data are available from the same population in at least two surveys which are 3-6 years apart, it is possible to assess associations between behaviour changes and HIV prevalence changes. A new round of the DHS+ should also include indirect measurement of incidence using sensitive HIV-tests that identify new cases in the “window period”. Future

HIV survey interviews should include questions about personal history of ARV-treatment too since a high number of people receive ARVs and this affects survival.

To assess the importance of core groups and bridging populations in the current epidemic it would be useful to conduct a study on sexual networking in Zambia. Such a study could also give better estimates of the prevalence of concurrency, and contribute to a better understanding of the factors and dynamics that put young women at such a high risk of HIV infection shortly after their sexual debut. The most plausible hypothesis for this is currently that young women engage in sexual relationships with older men and are infected by them [149, 197, 295, 296]. Studies of sexual networks could possibly in addition provide information on the interconnectedness of different socioeconomic groups. This would indicate whether the differences in prevalence levels found between socioeconomic groups are primarily due to persons with higher socioeconomic status simply engaging in less unprotected sex, or whether the most important reason is that wealthy/educated and poor/low-educated people belong mainly to distinct sexual networks with different prevalences of HIV.

There is a need for more research on barriers to behaviour change among poor and non-educated people. Quantitative studies can assess associations between social and economic factors and behaviour. To address this question it would also be useful to conduct qualitative studies of differences in the perception of HIV risk and attitudes to protective precautions in different socioeconomic groups.

There is little exact knowledge on which prevention programs in Zambia that have been effective and which have not. With the establishment of the Directorate of Monitoring, Evaluation and Research at the National HIV/AIDS/STI/TB Council and a database of outcome data from HIV-related programs, it will hopefully be possible in the future to identify what elements are important for the success of HIV prevention programs. Thus the resources that are available for HIV prevention can be spent as optimally as possible.

8 Conclusions

Analysis of data from pregnant women showed a decline in HIV prevalence in urban areas in Zambia since 1994, but also a sharp geographical variation in trends. The prevalence of HIV increased among 15-24 year olds in 4 sites, declined in 13 and was stable in 5. These geographical differentials are partly a result of changes in outreach in some sites, but probably also reflect different epidemic stages and differences in effectiveness of past and current preventive interventions.

Previous work has shown that the HIV prevalence is declining among young people in selected urban and rural communities in Zambia. We have indications that this decline was preceded by reductions in risky sexual behaviours such as multiple partnerships, unprotected sex with casual partners and increase in age at sexual debut. The combination of increased age at first sex and increased condom use was reflected in a higher age at first birth for women. All in all this could indicate that prevention campaigns have been effective, but it may also reflect that people have changed their behaviour in response to the observed impact of HIV in their own community. Both the declines in HIV prevalence and in risky sexual behaviours are strongest among young people with secondary education and above.

The proportion of the sexually active population who had concurrent partnerships in the period 1998-2003 declined both in urban and rural areas. Considering that there have been changes in other sexual behaviours since the early 1990s, we believe that the level of concurrency was previously much higher and may have contributed to the sharp increase in HIV prevalence in Zambia in the 1980s.

A survey of risk behaviours and HIV prevention coverage in venues where people met new sexual partners in two cities in Zambia found a high level of unprotected sex and few signs of HIV prevention targeting these places. As interventions that target places rather than specific groups would reach both men and women who engage in transactional sex and others who have a high partner turnover, it is likely that such interventions can have an impact on the epidemic in the general population in high prevalence settings. Simple structural measures as ensuring that condoms are easily available can effectively reduce the frequency of unprotected sex.

The observed prevalence declines give reason for some optimism, but there are heavy remaining challenges ahead. Firstly, the prevalence is still very high and has strong impacts on mortality and life expectancy (life expectancy has declined from 48 to 38 for men and 42 to 35 for women). Secondly, there have been limited changes in the sexual behaviour of rural and low-educated groups. Thirdly, there is a need to obtain more information about the epidemiological context in many geographical areas of Zambia where antenatal data indicate increasing or stable epidemics to inform preventive policies. And fourthly, more systematic targeting of prevention in Zambia at high risk groups and high risk places is needed.

It is possible that rural populations and groups with low educational attainment merely are slower in adopting less risky behaviours in response to HIV preventive messages than urban and educated groups. However, it is also possible that underlying social conditions constitute barriers to behaviour change among poor and low-educated people. A third possibility is that HIV preventive programmes in the past for some reason did not reach the less educated.

Zambia has had a relatively good surveillance system for monitoring the HIV epidemic since 1994 with data on prevalence trends from over 20 antenatal sites representing both urban and rural areas. Population-based surveys have also been established to validate the representativeness of pregnant women. In addition repeated national sexual behaviour surveys give indications on what behaviour changes might have contributed to national prevalence trends. There has, however, not been a system for monitoring and evaluation of programmes until very recently, and therefore there is limited knowledge on what programs have actually contributed to the reduction of the epidemic. Now that such a system has been established, it will offer the opportunity for future studies of effectiveness of programmes with relevance to sub-population groups and different epidemiological contexts. Ideally, programme evaluations should include measurement of HIV prevalence/incidence, not just behaviour and knowledge, as the impact of changes in behavioural outcomes is not straightforward to predict [20].

Zambia depends heavily on donor funding of the national HIV programme, and preconditions set by different donors are often in conflict with national strategies and priority settings. Experiences from various countries indicate difficulties in keeping up the focus on prevention when the scaling up of access to antiretroviral medicines is given the highest priority by donors. However, it is important to have a long-term perspective when planning prevention

and treatment programs, and to ensure that interventions are sustainable. Investment in local capacity building in prevention, research and health management is essential.

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Papers I-IV & Appendix

Paper I

Sandøy IF, Kvåle G, Michelo C, Fylkesnes K.
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Antenatal clinic-based HIV prevalence in Zambia: Declining trends but sharp local contrasts in young women

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Objects: To describe regional variation in HIV prevalence trends in the period 1994-2002 and to assess the effects on prevalence trends of residence, educational level and age, and potential interaction between these variables.

Methods: The data were from the national HIV sentinel surveillance system comprising information collected using interviews and unlinked anonymous testing of blood among pregnant women attending antenatal clinics in 22 sites in 1994, 1998 and 2002.

Results: There was a decline in HIV prevalence in the age-group 15-24 years in the period 1994-2002 both in rural (by 11%) and urban (by 26%) areas. The decline was strongest among highly educated women. However, this overall decline masked striking differences at community (site) levels with clearly declining epidemics in many sites contrasted by increasing epidemics in some and stability in others. Urban/rural residence, age, educational attainment, marital status and parity were factors closely associated with HIV infection. Having born many children was associated with lower risk of being infected by HIV, even in the age group 15-24.

Conclusions: The HIV prevalence decline in young women is likely to reflect a drop in incidence during the period. However, there were sharp geographical contrasts in trends. Such local contrasts probably indicate differences in effectiveness of preventive interventions. Understanding factors and mechanisms explaining the differences will be of critical importance to better guide preventive interventions.

Key words: HIV, Zambia, prevalence, trends, sentinel surveillance, regional variation

Abbreviated running title: Local contrasts in HIV prevalence trends in Zambia

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Introduction

National estimates of HIV prevalence from Sub-Saharan Africa show sharp contrasts between the countries. The HIV prevalence among pregnant women in 2003 was estimated to be 37.7% in Botswana, 22% in Namibia and 1.0% in Senegal. However, the country estimates may disguise huge regional differences within the countries (Asamoah-Odei et al., 2004).

Generally, urban areas have been more severely affected than rural areas (Asamoah-Odei et al., 2004). This is also the case in Zambia (Fylkesnes et al., 2001). Now, twenty years after the first HIV case was detected, however, the picture appears more complex. In many urban and rural areas a decline in prevalence has been observed, whereas in other areas the epidemic is still growing. A plausible explanation is that different areas of the country have reached different stages of the epidemic due to cultural and economic factors and differences in preventive efforts.

An antenatal clinic (ANC)-based sentinel surveillance system is still the main instrument employed to estimate HIV transmission trends. In Zambia, the sentinel surveillance system was established in 1990 and has gradually expanded. The surveillance has been performed repeatedly at over 20 sites from 1994 with all provinces represented. As more than 90% of women in Zambia attend ANC-clinics at least once during pregnancy, the system provides a good basis for studies of transmission trends (Central Board of Health (Zambia), 1997, Central Statistical Office (Zambia), 2003, University of Zambia, 1993).

The main aim of this study is to describe the HIV-epidemic in the period 1994-2002 in Zambia based on sentinel surveillance data from pregnant women. We will focus on regional variation in prevalence trends in all women aged 15-49 and in the age group 15-24. The study seeks to assess the relationship between HIV-prevalence and educational

background, urban/rural residence, marital status and parity. Since previous data have indicated different trends according to urban/rural residence, educational attainment and age, we also aim to examine further possible interaction between these factors.

Methods

National ANC-based sentinel surveillance

The first epidemiological HIV sentinel surveillance among ANC attendees in Zambia was performed in 1990. Just a few sites were included in the first years, and only location, test results and a couple of other variables were recorded. From 1994 the participants were interviewed about socio-demographic characteristics. At the same time there was an extension to 27 sites in order to cover urban and rural sites in all provinces (Fylkesnes et al., 2001, Fylkesnes et al., 1998, Fylkesnes et al., 1997). The survey was repeated in 22 of these sites in 1998 and in 24 in 2002. As the aim of this article is to study trends over time, the analyses include only the 22 sites that were part of all these three surveys. In some of the sites (Kasama, Kabompo, Kapiri Mposhi), substantial change in outreach was observed from 1994 to 1998 due to changes in the organisation of the ANC services. This may have resulted in differences in the populations from which the pregnant women were sampled (HIV Sentinel Surveillance Team, 1999).

Pregnant women attending the antenatal clinic for the first time during their pregnancy were enrolled consecutively in the surveys. The data collection was performed within a maximum of 4 months. 500 participants was the target number for each site, except in Livingstone, Chelstone, Kapiri Mposhi and Ndola, where a higher number was enrolled (Fylkesnes et al., 2001, Fylkesnes et al., 1998, Fylkesnes et al., 1997).

The sentinel surveillances in 1994, 1998 and 2002 covered at least one mainly rural and one mainly urban site in each province. All sites did, however, include both urban and rural residents and results are presented separately for these groups. As Lusaka is a purely urban province, the respondents who attended the ANC clinics in Lusaka and stated that they were rural residents (70 out of 1796 respondents in 1994, 290 of 2260 in 1998 and 200 of 2922 in 2002) must have been visitors. As we do not know their place of residence, they were excluded when calculating HIV prevalence by province (but are included in the overall prevalence).

Serum from blood samples drawn for syphilis screening was tested unlinked and anonymously using Capillus HIV-1/HIV-2 rapid test (Cambridge Biotechnology, Galway, Ireland) at the ANC clinics. All positive samples and 5% (10% in 2002) of the negative samples were re-tested at two national laboratories using Wellcozyme HIV Recombinant HIV-1 (Murex, Johannesburg, South Africa). A third test, Bionor HIV-1&2 (Bionor AS, Norway), was employed on the samples with discordant results from tests one and two, and this third result was considered final. If false negative results were discovered, 50% of all negative samples from the particular site were re-tested with Wellcozym. In one site the random retesting of negative samples with Wellcozyme in 2002 gave 10 positives out of the initial negative Capillus-tests. The remaining 50% of the samples with negative test results were consequently also re-tested, first with Wellcozyme and, in addition with Bionor if the results were discordant (Fylkesnes et al., 2001, Fylkesnes et al., 1998, Fylkesnes et al., 1997, Central Board of Health [Zambia], 2002).

Data analysis

The data were double entered in EpiInfo (Centre for Disease Control and Prevention, Atlanta, Georgia, USA). We performed the analyses mainly using the Statistical Package for Social Sciences (SPSS for Windows 13.0; SPSS, Chicago, Illinois, USA). Interactions between variables were tested using STATA 8.0 for Windows (Stata Corporation, Lakeway Drive, TX, USA). The analyses were restricted to women aged 15-49. In addition we did analyses for 15-24 years olds separately in order to detect any recent changes among the young.

We calculated age-adjusted odds ratios (AOR) with 95% confidence intervals to test the relationship between prevalence and province, age, different educational groups, urban/rural residence, marital status and parity. The age-adjustment was performed using a categorical age variable (15-19, 20-24, 25-29, 30-39, 40-49) for the age group 15-49 and a continuous age variable for the age group 15-24. We performed separate analysis for subgroups of the material (based on urban-rural residence, surveillance year, educational level and age) (not shown), as well as pooled multivariate analyses of AOR for the whole material – only stratified by residence (Table 2). In addition we checked for interactions between the effects of time trend, urban/rural residence, number of school years (0-6, 7-9, >=10) and age (15-19, 20-29, 30-49) using the likelihood ratio test. Only significant interactions (p-value <0.05) are reported.

Ethical aspects

The protocol for the antenatal clinic based sentinel surveillance system was approved by the National AIDS Research Committee in 1990. All HIV testing is done unlinked and anonymously (Fylkesnes et al., 1998) according to the principles of WHO/UNAIDS'

"Guidelines for Conducting HIV Sentinel Serosurveys among Pregnant Women and Other Groups" (UNAIDS/WHO, 2003).

Results

The HIV prevalence among urban residents dropped during the period 1994-2002 both in the total material, aged 15-49 (28.5% to 25.5%) and for the age group 15-24 (28.0% to 21.8%) (Table 1). Among rural residents the overall prevalence declined from 12.3% to 11.1% and from 11.4% to 10.1% in the two groups, respectively. The age-adjusted odds ratio of HIV infection among urban versus rural respondents was stable at about 2.7-2.8 for women aged 15-49. In the age group 15-24 the urban-rural odds ratio decreased from 2.9 in 1994 to 2.4 in 2002 due to a more prominent urban decline.

Regionally we found significant declines for both urban and rural residents in the Northern province, and among urban residents in the North-Western province (Table 1). In contrast, there was a significant increase in HIV prevalence among rural respondents of the Central province aged 15-49 (13.2% to 22.0%) and 15-24 (13.4% to 23.8%). Among 15-24 years old respondents from Lusaka, urban areas of the North-Western provinces, and from both urban and rural areas of the Northern province, the prevalence was significantly lower in 2002 than in 1994. Otherwise there were few significant changes for this age group, but we found a general tendency of decline in most of the other provinces as well.

The HIV prevalence was highest in the age group 25-29 (26.6% overall), and lowest in the age group 40-49 (9.6% overall). However, when adjustment was made for marital status, educational attainment, number of pregnancies and surveillance year, we found the lowest risk in the age group 15-19. Both among urban and rural residents the odds ratio of

HIV infection increased from the age group 15-19 to the age group 25-29, and then dropped.

Divorced and widowed women had significantly higher risk of HIV than currently married women, in urban as well as rural areas (Table 2). But after stratifying by age, the difference between divorced and married women could only be found above age 25. Rural single women had a somewhat higher risk of being HIV infected than women who were married, but when adjusting for age, education and pregnancies the difference was not significant (Table 2). Among women aged 15-24 we found the same pattern of relative risk for urban widows, but no overall increased risk for those who were divorced or single women.

We found an association between reduced risk and high number of pregnancies in all age groups among urban residents (Table 2), and among 15-19 year olds in both urban and rural areas. Rural girls aged 15-19 who had been pregnant more than twice (excluding the current pregnancy), had an AOR of HIV infection of 0.5 (95% CI 0.14-1.53) in 2002 compared to girls of the same age who were pregnant for the first time. The interview in 1994 did not include questions about number of births, only number of pregnancies. But the data from 1998 and 2002 showed that women who had gone through 5 or more births, when compared to nulliparae women, had an AOR of HIV infection of 0.3 (95% CI 0.23-0.32). Women aged 15-24 also had a declining risk with higher parity (AOR 0.5 (95% CI 0.41-0.62) in 2002 for young urban women with more than 2 previous births). In the age group 15-19 there was no significant difference in risk by parity.

The average number of births was higher for HIV-negative than for HIV-positive women. The difference increased primarily after the age of 25, but there was a significant difference also among 20-24 year olds (average number of births 1.3 [95% CI 1.29-1.35] for HIV-negative vs. 1.1 [95% CI 1.11-1.22] for HIV-positive in 2002).

In both urban and rural areas the HIV risk increased steadily with rising number of years of school attendance (Table 2). In urban areas there was a steady increase in risk of HIV infection by educational level in 1994 and 1998. In 2002, however, urban women with 8-9 years of school had a higher risk than those with 10 or more. The same trend could be found in the data for women aged 15-24 (Table 3). Table 3 shows that in the age group 15-24 all educational groups experienced a fall in risk of HIV from 1994 to 2002. The decline was clearest among urban residents with the longest education. We found that it was also evident for urban women aged 15-49. As a contrast to this, rural women aged 15-49 with 10 or more years of school experienced a rise in prevalence in the same period (from 22.4% to 25.3%).

This interaction between educational attainment and urban/rural residence was strongest in the age group 15-49, but was also observed in the group 15-24. Even when analysing separately the sites that had an overall declining prevalence trend in the age group 15-24, we found that the relative risk of women with high educational attainment compared to women with limited school attendance, increased from 1.3 in 1994 to 3.8 in 2002 among rural respondents, whereas it declined from 1.5 to 1.1 among urban respondents. There was also interaction between age and residence, with a smaller difference in HIV risk between urban and rural residents among young (15-24) than among older respondents.

In addition, we found interaction between age, residence and time as the urban-rural odds ratio of HIV declined during the period among the young, but not among older individuals. We also found interaction between age, educational attainment and time in urban areas reflecting that the decline in prevalence was strongest among young highly educated urban women.

We observed an increase in prevalence among 15-24 year olds in 4 sites (Kalabo, Kapiri Mposhi, Kashikishi and Kabompo), a decline in 13 (Chelstone, Macha, Chilenje, Matero, Kabwe, Chipata, Kasama, Isoka, Kasaba, Ndola, Ibenga, Solwesi, Mukinge) and a stable prevalence in 5 (Mongu, Livingstone, Kalingalinga, Minga, Mansa) out of the 22 sites from which there are at least three sets of data. Time trends in prevalence for selected sites are shown in Figure 2.

There was an increase in the proportion of HIV infected in the site Kapiri Mposhi. 13.2% of the women (15-49) were HIV positive in 1994, increasing to 16.5% in 1998 and 21.9% in 2002. There was also an increase in the proportion of infected respondents in Kabompo (North-Western province) from 1.9% in 1994 to 9.8% in 1998 and then a fall to 5.9% in 2002. At the same time the overall HIV prevalence estimates for the young declined in the North-Western province due to reduced prevalence in the sites in Solwesi and Mukinge. Among the sites with a clear decline in prevalence among 15-24 year olds, we found both sites with mainly rural residents (Isoka [Northern province], Kasaba [Luapula], Mukinge [North-Western province]) and sites with mainly urban residents (Chilenje and Matero [Lusaka] and Solwesi [North-Western province]).

Discussion

The ANC data from the period 1994 to 2002 revealed a modest decline in prevalence among pregnant women in Zambia. The overall reduction in prevalence among both urban and rural residents aged 15-24, is likely to reflect a fall in incidence rate during the period. Our analyses demonstrated that urban/rural residence, age, educational attainment, marital status and parity were important factors. The decline in trend was strongest among highly educated women of age 15-24, especially in urban areas. The overall declining trend, however, masked striking differences at community (site) levels showing clearly declining epidemics in many sites contrasted by increasing epidemics in some and stability in others. These sharp differentials could indicate differences in intensity and effectiveness of preventive interventions. Accordingly, efforts to better understand factors and mechanisms explaining these differentials in trends will be of critical importance to better guide preventive interventions.

Representativity

It is reasonable to assume that the representativity of ANC data varies at different stages of the HIV epidemic. Kwesigabo et al. (Kwesigabo et al., 2000) found that ANC data from the Kagera region (an area with high HIV prevalence) in Tanzania provided good trend estimates of the prevalence in the general population of men and women, but less good point estimates. Fylkesnes et al (Fylkesnes et al., 1998, Fylkesnes et al., 2001) found that ANC data at site level in Zambia (Chelstone) in 1994-1996 tended to underestimate the prevalence in the overall female population, but was representative in

1998-1999. The difference in 1994-96 was partly related to a lower level of education and a different age distribution among ANC attendees compared to the general population (Fylkesnes et al., 2001, Fylkesnes and Kasumba, 1998). The ANC estimates of trend were conservative in the sense that the population-based surveys showed more prominent declines (Fylkesnes et al., 2001). Interestingly, the estimates of the overall HIV prevalence for men and women aged 15-49 seen in the Zambian Demographic and Health Survey 2001-2002 (DHS+) (a nationally representative population-based survey) matched rather closely with the prevalence among pregnant women in 2002 (23.1% vs. 25.5% respectively in urban areas, and 10.8% vs. 11.1% in rural areas) (Central Statistical Office (Zambia), 2003, Dzekedzeke and Fylkesnes, 2006).

Reduced fertility of HIV positive women compared to HIV negative women is observed both in this study and in others (Hunter et al., 2003, Fylkesnes et al., 1998, Kwesigabo et al., 2000, Kilian et al., 1999). This provides a plausible explanation for the underestimation by the 2002 ANC data of the HIV prevalence in women in urban areas above the age of 24 and in rural areas above 29 compared to the estimates from the DHS+. A comparison with the DHS+ of younger age groups reveals an overestimation of the general female prevalence (Central Statistical Office (Zambia), 2003). As there is a notable proportion of young women in the general population who are not sexually active, estimates of prevalence in young women from ANC data are bound to overestimate the general prevalence level below age 25. In addition, as delay of first pregnancy is more common now than in the 1990s (Fylkesnes et al., 2001), young women who become pregnant despite of this are probably at a particularly high and increasing risk of HIV. This may also explain why we find that declining prevalence trends,

especially in young and highly educated females, are more evident in population-based than in ANC-based data (Fylkesnes et al., 2001, Michelo et al., 2006).

Estimates of incidence

The level of HIV prevalence depends on the balance between incidence, mortality and migration. No information on migration was collected in the ANC interviews, but previous population-based data indicate no significant association between migration and HIV in Zambia (Fylkesnes et al., 2001). The HIV prevalence among women in sub-Saharan Africa rises dramatically with age from the age of 15-19, which is the period in which the majority of young people become sexually active (Fylkesnes et al., 1998, Glynn et al., 2001). It is reasonable to assume that the HIV positive individuals at this age have been infected through heterosexual intercourse quite recently. Studies from sub-Saharan Africa have also demonstrated that women are mainly infected with HIV at a young age, whereas the proportion of men with HIV increases steadily up to the age of 50 (Glynn et al., 2001, Fylkesnes et al., 1998). As the HIV epidemic in Zambia was generalized and mature in the mid 1990s, any effects on fertility are likely to have been present already in 1994. It is possible that some of the decline in prevalence among women aged 15-49 is due to increased HIV related mortality from 1994 to 2002, but since it takes time for HIV to influence mortality in a cohort, changes in prevalence in the age group 15-24 primarily reflects similar changes in incidence among young people.

Urban/rural difference

It is interesting to note that the difference in HIV risk between urban and rural residents aged 15-49 was practically unchanged throughout the period from 1994 to 2002, whereas in the age group 15-24 this difference shrank. A possible explanation is that HIV-preventive work targeted at young people in the late 1990s was relatively more effective or concentrated in urban than in rural areas. Population-based surveys from Zambia show evidence of increased condom use in the urban population and higher age at first birth in young urban women, but not in the rural group (Fylkesnes et al., 2001, Central Statistical Office (Zambia), 2004, Central Statistical Office (Zambia), 2003, Central Board of Health (Zambia), 1997). These behavioural changes may have contributed to the reduced risk difference.

Prevalence trends at provincial and site level

The ANC data showed different HIV-trends in different provinces of Zambia. In many provinces the prevalence was stable, whereas in others there was a sharp rise or decline. The provincial estimates do however mask striking differences at community (site) levels. We found that the HIV prevalence among pregnant women in rural areas of the Central province first declined from 1994 to 1998 and then more than doubled from 1998 to 2002, also in the age group 15-24. When examining the data further, it was evident that this was due to an increase in prevalence among the ANC respondents in Kapiri Mposhi. Due to problems with the outreach of the ANC services in this particular sentinel site, there was at the same time a variation in the proportion of urban vs. rural residents. The

proportion of urban residents in Kapiri Mposhi varied: 12.2% in 1994, 60.6% in 1998 and 19.7% in 2002. As a contrast, population-based surveys conducted in the same site in approximately the same period (1995, 1999 and 2003), showed a decline in prevalence among young rural women from 1995 to 2003 (Fylkesnes et al., 2001) [unpublished data from 2003]. These conflicting results create doubts about the representativity of the ANC respondents and the consistency of the classification of urban and rural residence at this particular site.

In the Kabompo sentinel site in the North-Western province, there is also reason to believe that the apparent primary rise from 1994 to 1998 was due to a change of sample characteristics (more urban respondents), whereas the subsequent prevalence fall in 2002 may have reflected an actual reduction. The proportion of rural residents among the respondents in Kabompo decreased from 94% in 1994 to approximately 50% in 1998 and 2002.

The clearest examples of an increase in prevalence from 1994 to 2002 at site level (although not significant), can be found among 15-24 year old pregnant women in Kalabo (Western province) and Kashikishi (Luapula) (rose from 8.1% to 14.5% and from 13.7% to 18.4%, respectively).

Educational level

Studies from many countries have demonstrated a surprisingly repetitive pattern of increasing HIV prevalence with increasing levels of education (Fylkesnes et al., 2001, Fylkesnes et al., 1997, Kilian et al., 1999, Hargreaves and Glynn, 2002, Grosskurth et al.,

1995). Our data are consistent with this (Table 2). The epidemic was first introduced in groups with high socioeconomic status. This is probably explained by the association between high socioeconomic status, mobility and a high number of sexual partners in many countries before the HIV-epidemic, especially for men (Fylkesnes et al., 2001, Fylkesnes et al., 1997, Hargreaves and Glynn, 2002). For women, a husband with high education represents an additional risk. Highly educated women tend to marry men with an equivalent level of education, and their high risk of HIV is possibly more caused by their husbands' sexual risk behaviour than their own (Hargreaves and Glynn, 2002). When studying prevalence trends, we found, however, a decline among the urban women with high education. This is consistent with previous studies indicating that in areas where preventive interventions take place, a decline in prevalence is seen earlier among the more highly educated groups than among individuals with limited school attendance (Fylkesnes et al., 2001, Kilian et al., 1999). Individuals with high educational status are generally known to be more concerned about their health and are thus more prone to react to the messages of HIV prevention campaigns by changing their sexual risk behaviour (Kilian et al., 1999, Fylkesnes et al., 2001, Lagarde et al., 2001). As a result, we expect the association between HIV prevalence and education to disappear. Subsequently, as the incidence among educated people falls faster than among less educated, one expects to see a lower prevalence in the educated group, especially among the young (15-24). This has been observed both in population based data from Zambia (Fylkesnes et al., 2001) and ANC-based data from Uganda (Kilian et al., 1999).

We found significant interaction between the effects of urban/rural residence, time and number of school years, reflecting that the effect of high education differed in urban and

rural areas and over time. The interaction between the effects of educational level, age and time in urban areas reflects that the strongest decrease in HIV risk was found among urban women with high educational status.

Fylkesnes et al. (Fylkesnes et al., 1997) observed already in the ANC data from 1994 signs of a declining epidemic among young educated women, and we had expected to find an even clearer change in risk distribution between the different educational groups in these more recent data, especially in the age group 15-24. The changes we found after 1998 were rather small since almost all educational groups experienced a decline in risk (Table 3). However, population-based data from the same period show a decline in HIV prevalence with increasing educational level among men and women aged 15-24, both in urban and rural areas (Fylkesnes et al., 2001, Michelo et al., 2006).

There was one important exception to the prevalence decline mentioned above; rural pregnant women aged 15-49 with 10 years or more of schooling. They surprisingly experienced a clear increase in prevalence from 1994 to 2002, reaching the same level as urban women with the same educational attainment. At the same time, this group shrunk to less than half the size, indicating that there were fewer rural women with high educational status that became pregnant. It is probable that this is the result of a change in sexual behaviour. Delaying the first sexual intercourse (which is associated with lower risk of HIV (Buve et al., 2001a, Buve et al., 2001b, Ferry et al., 2001, Pettifor et al., 2004, Todd et al., 2001)) may be a strategy that is chosen by many women, especially those still in school, in response to the widespread risk of becoming infected. In this context we may assume that young women with 10 or more years of school who become

pregnant are not representative for this educational group. Possibly only a minority in the group is sexually active. This minority is at a particularly high risk as they have obtained their higher education in urban areas where HIV is more prevalent (Hargreaves and Glynn, 2002). The same mechanisms probably underlie the surprising finding that in sites with an overall declining prevalence trend rural women aged 15-24 with 10 or more years of school had a three-fold increased risk of HIV compared to the least educated. A problem with this theory is that we surprisingly do not find a corresponding reduction in the proportion of young pregnant urban women with higher education, but the HIV prevalence in this group declined. Population-based data from Zambia, however, show a significant decline in the proportion of both rural and urban young highly educated women who have ever given birth (but not in the lower educated group) (not yet published).

Marital status

Single pregnant women who took part in the sentinel surveillances tended to have a higher risk of being HIV infected than married pregnant women in 1994 and 1998. In 2002 the ANC data reveal a reduction in HIV prevalence among rural single women, thereby removing the heightened risk. This probably reflects the reduced risk behaviour observed in the Zambia Sexual Behaviour Surveys, especially among single women (Central Statistical Office (Zambia), 2004).

Divorced and widowed women had a significantly higher risk of being HIV positive than married women did, also after adjustment for age. One could speculate that disclosure of a positive HIV status to the husband might result in divorce, both due to the stigma

associated with HIV infection and to consequent doubts about the fidelity of either of the spouses. A meta-analysis by Medley et al. (Medley et al., 2004) did, however, show that divorce is not common after disclosure. Another possible explanation could be that divorced women have a higher number of extramarital partners than married women. As HIV is one of the leading causes of death in Zambia, a high prevalence among widows may be explained by transmission from their husbands.

Fertility

It is well documented that fertility is reduced with HIV infection (even in the asymptomatic stage) (Glynn et al., 2000, Lewis et al., 2004, Fabiani et al., 2003). Our finding of an association between high number of births and lower HIV risk among women 15-49 is probably a reflection of this (Table 2). The effects of HIV on fertility are likely to be primarily physiological as few infected women in sub-Saharan Africa know their HIV status. HIV positive women have higher risk of anovulation, amenorrhea, foetal loss, co-infection with other STDs. Further, reduced fertility may be related to the effect of HIV-associated illness of the woman and/or her male partner, and reduced frequency of sexual intercourse (Lewis et al., 2004, Ross et al., 1999). It is, however, surprising that we find the same pattern even in the age group 15-24. In the age group 15-19, we found a similar pattern by number of pregnancies. As both parameters reflect fertility, we use number of pregnancies as a proxy of fertility in the youngest age group. Many other studies on fertility and HIV have found higher fertility rates in HIV-positive women aged 15-19 compared to HIV-negative, and a reduced fertility only after age 20 (Lewis et al., 2004, Zaba et al., 2003, Ross et al., 2004, Hunter et al., 2003). As teenage girls who

become pregnant are per definition sexually active, they will have a higher risk of HIV than the average teenage girl (Ross et al., 2004, Zaba et al., 2003, Lewis et al., 2004, Hunter et al., 2003). At the same time it has been assumed that the HIV infection has not yet had a major effect on their physiological fertility. Most of these studies were population-based. As the fertility of HIV negative women will be underestimated by ANC-data (as some of them have never had sex), our results are even more surprising, and may suggest that HIV influences fertility physiologically even at the very early stages of infection. It is, however, also possible that couples with many children or many pregnancies at an early age belong to a socioeconomic group at lower risk than the average teenage population.

Indications of behaviour change

We believe that the reduced prevalence in the youngest age groups reflects incidence decline. Kilian et al found that a similar prevalence decline in young women in Uganda was best explained by changes in sexual behaviour (Kilian et al., 1999). Our ANC data do not include information on risk factors that could have provided us with clues to explain the observed changes in HIV prevalence. However, Fylkesnes et al (Fylkesnes et al., 2001) have previously reported increased condom use, reduction in number of partners and increased age at first birth in a population-based survey from Zambia. The Zambia Demographic and Health Surveys (1992, 1996, 2001/2002) and Sexual Behaviour Surveys (1998, 2000, 2003) provide information on sexual behaviour from nationally representative samples of men and women aged 15-49. These surveys seem to indicate that the age at first intercourse among Zambian women has increased from 1992

(University of Zambia, 1993) to 2003 (Central Statistical Office (Zambia), 2004). According to Slaymaker and Buckner (Slaymaker and Buckner, 2004), however, this might partly be an effect of increased reporting bias as there are no clear signs of a cohort effect. There seems, however, to have been significant reductions in the proportion of men and women who have had sex with more than one partner the last year and who did not use condom during the previous sexual encounter (Slaymaker and Buckner, 2004). The percentage of married men who reported non-regular partners decreased from 20% in 1998 (Central Statistical Office, 1999) to 9% in 2003 (Central Statistical Office (Zambia), 2004), indicating an expected reduced HIV risk of their wives. The percentage of women that used condom during the last sexual intercourse with a casual partner increased from 23.4% in 1998 to 44% in 2003 in urban areas and from 16.7% to 26% in rural areas (Central Statistical Office (Zambia), 2004, Central Statistical Office, 1999). Assessed together, these data and the reduction in prevalence observed in this study indicate that preventive efforts with a change of sexual habits have resulted in reduction of the incidence of new infections in most parts of Zambia covered by the sentinel surveillance system.

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Table 1: **HIV prevalence and age-adjusted odds ratio for changes in HIV prevalence by province and residence**

		Age 15-49						Age 15-24					
		Urban			Rural			Urban			Rural		
	Year	% HIV (n)	OR[3]	95% CI	% HIV (n)	OR[3]	95% CI	% HIV (n)	OR[4]	95% CI	% HIV (n)	OR[4]	95% CI
Total ***(22 sites)***	**1994**	28.5 (4836)	Ref.		12.3 (4914)	Ref.		28.0 (2771)	Ref.		11.4 (2753)	Ref.	
	1998	26.3 (6623)	**0.90**	**0.83-0.98**	11.7 (5172)	0.94	0.83-1.06	23.3 (3974)	**0.80**	**0.72-0.90**	11.3 (3042)	0.99	0.85-1.18
	2002	25.5 (7485)	**0.86**	**0.79-0.94**	11.1 (4436)	0.89	0.78-1.01	21.8 (4447)	**0.74**	**0.66-0.82**	10.6 (2471)	0.89	0.75-1.06
By province													
Western (2 sites)	**1994**	27.3	Ref.		13.8	Ref.		29.7	Ref.		11.9	Ref.	
	1998	26.0	0.94	0.70-1.26	15.6	1.16	0.76-1.77	26.7	0.87	0.59-1.29	15.1	1.28	0.72-2.28
	2002	28.0	1.04	0.79-1.36	13.0	0.94	0.58-1.52	27.2	0.92	0.64-1.31	12.0	1.02	0.52-2.03
Southern (2 sites)	**1994**	32.2	Ref.		9.9	Ref.		32.1	Ref.		8.6	Ref.	
	1998	32.5	1.01	0.80-1.29	8.5	0.84	0.55-1.29	30.0	0.91	0.66-1.25	8.2	0.96	0.54-1.72
	2002	32.3	1.01	0.78-1.30	8.0	0.79	0.52-1.21	30.6	0.91	0.64-1.28	6.5	0.76	0.41-1.43
Lusaka (4 sites)	**1994**	27.9	Ref.		-	-		27.6	Ref.		-	-	
	1998	27.9	1.00	0.87-1.16	-	-	-	22.6	**0.78**	**0.64-0.95**	-	-	-
	2002	27.8	1.00	0.87-1.14	-	-	-	22.2	**0.74**	**0.62-0.89**	-	-	-
Central (2 sites)	**1994**	30.0	Ref.		13.2	Ref.		28.3	Ref.		13.4	Ref.	
	1998	24.7	**0.76**	**0.60-0.97**	9.0	0.65	0.41-1.02	22.9	0.77	0.56-1.07	10.3	0.74	0.42-1.31
	2002	28.2	0.92	0.70-1.20	22.0	**1.85**	**1.31-2.62**	21.9	0.74	0.51-1.08	23.8	**2.01**	**1.28-3.15**
Eastern (2 sites)	**1994**	31.2	Ref.		10.3	Ref.		28.9	Ref.		7.9	Ref.	
	1998	28.2	0.87	0.64-1.17	13.3	1.33	0.92-1.92	24.3	0.90	0.59-1.37	13.1	**1.70**	**1.01-2.86**
	2002	27.3	0.83	0.62-1.10	10.3	1.00	0.67-1.49	22.5	0.78	0.52-1.17	7.8	0.97	0.53-1.75
Northern (2 sites)	**1994**	29.6	Ref.		13.5	Ref.		29.6	Ref.		13.5	Ref.	
	1998	17.3	**0.50**	**0.35-0.71**	10.3	**0.73**	**0.55-0.98**	14.4	**0.42**	**0.26-0.70**	9.2	**0.63**	**0.42-0.95**
	2002	19.0	**0.56**	**0.40-0.77**	3.1	**0.21**	**0.12-0.37**	13.6	**0.41**	**0.26-0.65**	3.4	**0.22**	**0.11-0.46**
Luapula (3 sites)	**1994**	29.0	Ref.		16.7	Ref.		29.4	Ref.		17.1	Ref.	
	1998	25.0	0.82	0.51-1.32	11.9	**0.68**	**0.55-0.83**	22.0	0.70	0.36-1.38	12.2	**0.69**	**0.52-0.91**
	2002	24.4	0.79	0.51-1.22	13.8	0.80	0.64-1.01	24.0	0.81	0.44-1.48	12.8	0.75	0.54-1.03
Copper-belt (2 sites)	**1994**	24.5	Ref.		12.2	Ref.		24.0	Ref.		12.9	Ref.	
	1998	27.9	1.20	0.98-1.46	9.6	0.76	0.47-1.24	26.1	1.13	0.87-1.48	7.5	0.54	0.29-1.02
	2002	23.4	0.94	0.77-1.15	13.4	1.11	0.75-1.64	21.1	0.87	0.66-1.14	11.3	0.85	0.51-1.41
North Western (3 sites)	**1994**	24.4	Ref.		7.5	Ref.		22.3	Ref.		6.9	Ref.	
	1998	19.7	0.76	0.52-1.11	8.6	1.16	0.79-1.70	16.8	0.68	0.39-1.19	7.3	1.08	0.63-1.88
	2002	13.9	**0.50**	**0.34-0.74**	6.9	0.91	0.62-1.33	11.6	**0.51**	**0.29-0.90**	4.2	0.61	0.34-1.12

[3] Adjusted for age as a categorical variable
[4] Adjusted for age as a continuous variable

Table 2: **Adjusted odds ratios[1] for HIV infection among women aged 15-49 attending ANC**

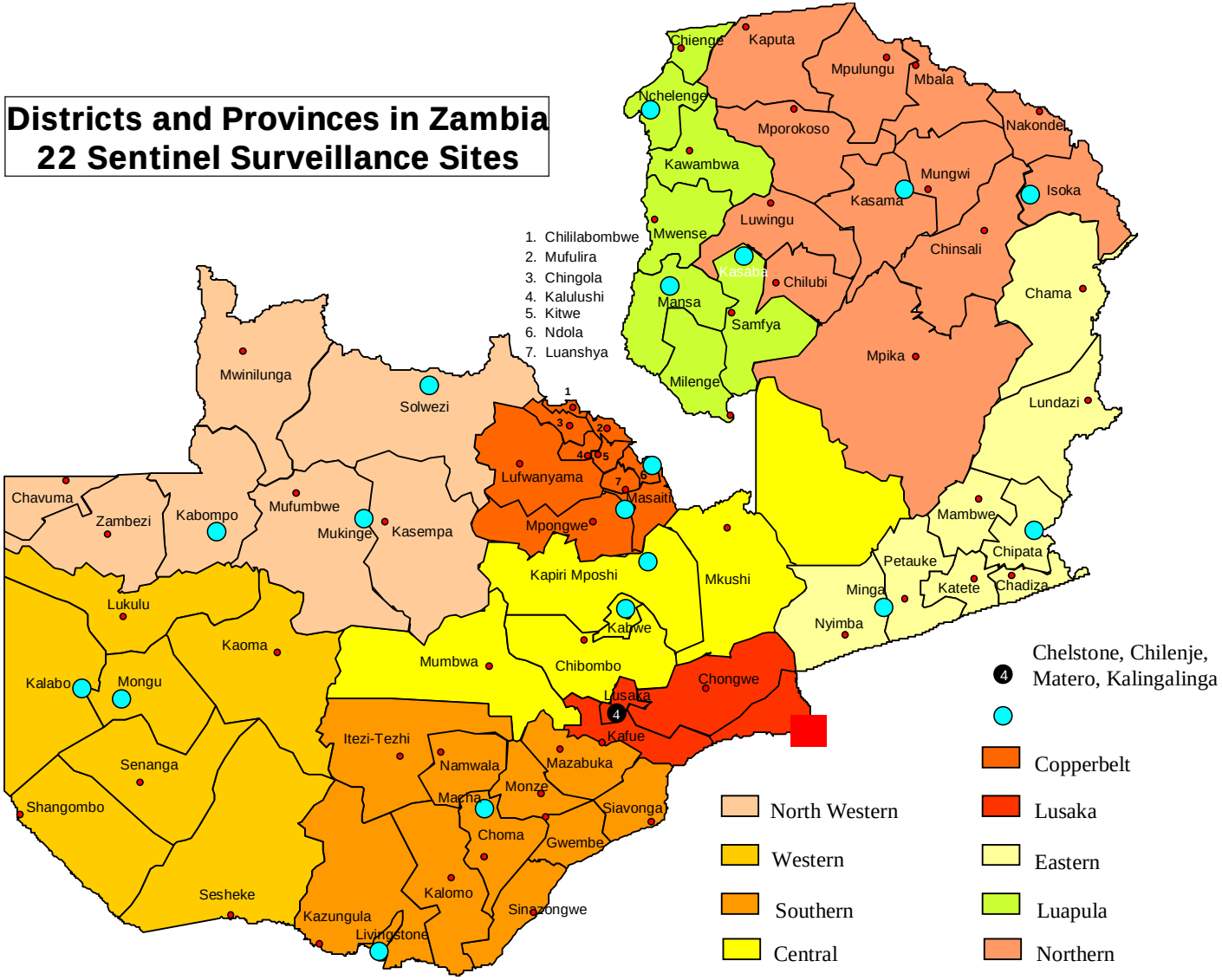
	Urban				Rural			
Variable	**% HIV**	**N**	**OR**	**95% CI**	**% HIV**	**N**	**OR**	**95% CI**
Year								
1994	28.7	4390	Ref.		12.8	4260	Ref.	
1998	26.3	6429	**0.88**	**0.81-0.96**	11.7	5044	0.91	0.80-1.03
2002	25.5	7344	**0.80**	**0.74-0.87**	11.1	4359	**0.84**	**0.73-0.96**
Age-group (categorical variable)								
15-19	17.1	4237	Ref.		8.2	3346	Ref.	
20-24	28.2	6463	**2.03**	**1.83-2.25**	13.3	4390	**1.79**	**1.52-2.11**
25-29	34.3	4011	**3.18**	**2.81-3.59**	15.9	2786	**2.72**	**2.23-3.31**
30-39	26.9	3206	**2.94**	**2.53-3.41**	10.5	2793	**2.06**	**1.62-2.62**
40-49	14.6	246	**1.78**	**1.21-2.61**	6.9	348	1.48	0.92-2.38
Marital status								
Married	26.4	15275	Ref.		11.6	12355	Ref.	
Single	25.5	2412	1.08	0.97-1.21	12.3	983	1.01	0.82-1.24
Divorced	31.7	369	**1.37**	**1.09-1.72**	18.1	249	**1.56**	**1.12-2.19**
Widowed	53.3	105	**3.29**	**2.22-4.88**	29.9	67	**3.33**	**1.94-5.71**
Years in school								
0-4	19.9	2012	Ref.		8.2	4174	Ref.	
5-6	22.6	2375	**1.18**	**1.02-1.37**	9.8	3097	**1.21**	**1.03-1.43**
7	25.5	5162	**1.33**	**1.17-1.51**	12.5	3658	**1.55**	**1.30-1.80**
8-9	29.0	4881	**1.55**	**1.36-1.76**	17.2	1956	**2.16**	**1.83-2.55**
10+	31.0	3733	**1.45**	**1.27-1.66**	23.5	778	**3.03**	**2.47-3.72**
No of pregnancies								
0	25.6	587	Ref.		10.6	180	Ref.	
1-2	26.0	9317	0.86	0.71-1.06	12.1	5962	1.02	0.62-1.67
3-4	31.2	4959	**0.75**	**0.61-0.94**	13.9	3648	0.83	0.50-1.39
5+	21.3	3300	**0.42**	**0.33-0.53**	9.6	3873	0.57	0.33-1.96

[1] Adjusted for all other variables included in the table (age, number of school years and pregnancies as categorical variables)

Table 3: **HIV prevalence and age-adjusted odds ratio for changes in HIV prevalence by educational level among women 15-24**

		Urban				Rural			
Years in school	**Year**	**% HIV**	**N**	**OR[1]**	**95% CI**	**% HIV**	**N**	**OR[6]**	**95% CI**
0-6	*1994*	23.0	648	Ref.		9.2	1266	Ref.	
	1998	20.7	997	0.88	0.69-1.12	8.9	1551	0.97	0.75-1.26
	2002	17.3	981	**0.72**	**0.56-0.93**	8.4	1297	0.93	0.71-1.22
7-9	*1994*	28.6	1534	Ref.		14.4	1032	Ref.	
	1998	23.6	2304	**0.80**	**0.69-0.93**	12.7	1328	0.88	0.69-1.12
	2002	23.3	2527	**0.80**	**0.69-0.92**	11.0	1041	**0.74**	**0.57-0.96**
10+	*1994*	35.0	449	Ref.		19.3	135	Ref.	
	1998	26.6	644	**0.67**	**0.51-0.87**	25.0	132	1.35	0.75-2.42
	2002	22.3	892	**0.53**	**0.41-0.68**	19.0	116	0.98	0.52-1.85

[1] Adjusted for age as a continuous variable


Districts and Provinces in Zambia
22 Sentinel Surveillance Sites
1. Chililabombwe
2. Mufulira
3. Chingola
4. Kalulushi
5. Kitwe
6. Ndola
7. Luanshya
Chienge
Kaputa
Mpulungu
Mbala
Nchelenge
Mporokoso
Nakonde
Kawambwa
Mungwi
Isoka
Kasama
Luwingu
Mwense
Chinsali
Kasaba
Chilubi
Mansa
Chama
Samfya
Mpika
Milenge
Lundazi
Mwinilunga
Solwezi
Lufwanyama
Masaiti
Chavuma
Zambezi
Kabompo
Mufumbwe
Mukinge
Kasempa
Mpongwe
Mambwe
Chipata
Petauke
Kapiri Mposhi
Mkushi
Minga
Katete
Chadiza
Nyimba
Lukulu
Kaoma
Kabwe
Mumbwa
Chibombo
Kalabo
Mongu
Chongwe
Lusaka
Kafue
Itezi-Tezhi
Namwala
Mazabuka
Senanga
Monze
Shangombo
Macha
Siavonga
Choma
Gwembe
Sesheke
Kalomo
Sinazongwe
Kazungula
Livingstone
Chelstone, Chilenje, Matero, Kalingalinga
North Western
Western
Southern
Central
Copperbelt
Lusaka
Eastern
Luapula
Northern

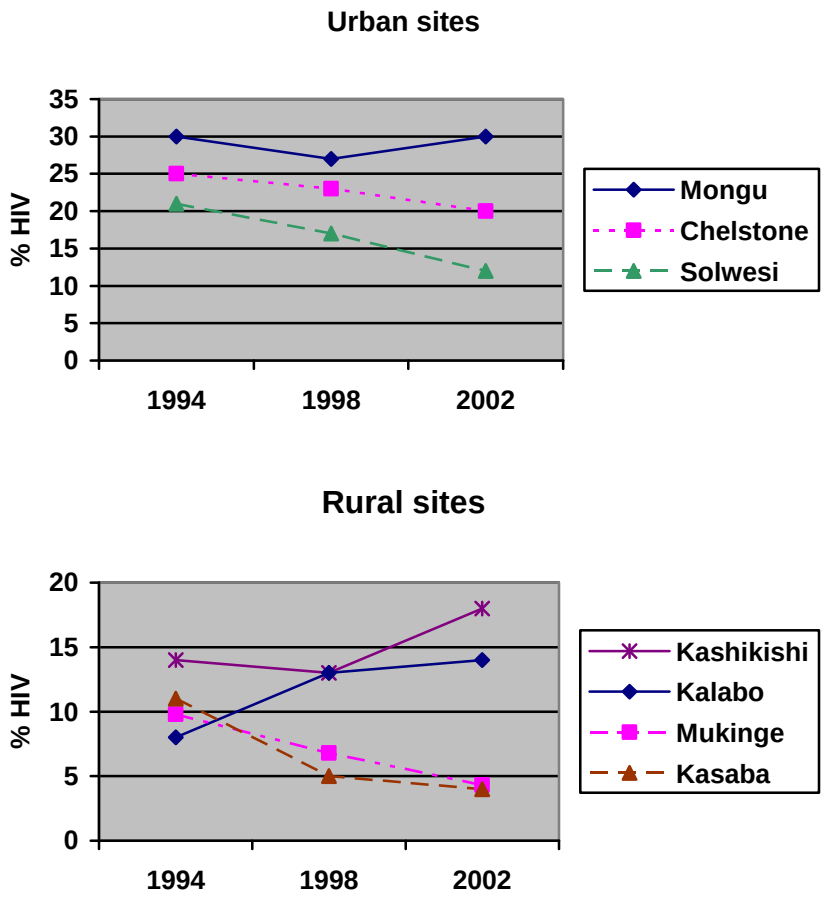


Figure 2: Examples of different trends in HIV prevalence among pregnant women aged 15-24 attending antenatal clinics in some rural and urban sites

Paper II

Sandøy IF, Michelo C, Siziya S, Fylkesnes K.

Associations between sexual behaviour change among young people and decline in HIV prevalence in Zambia.

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Research article

Associations between sexual behaviour change in young people and decline in HIV prevalence in Zambia

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Abstract

Background: Evidence suggests that HIV prevalence amongst young Zambians has declined recently, especially in higher-education groups. We studied trends in key sexual behaviour indicators among 15–24 year-olds from 1995 to 2003, including the associations between sexual behaviour change and education.

Methods: The data stem from a series of three population-based surveys conducted in 1995 (n = 1720), 1999 (n = 1946) and 2003 (n = 2637). Logistic regression and Extended Mantel Haenszel Chi Square for linear trends were used to compare the three surveys.

Results: Men and lower-education groups reported more than one sexual partner in the year immediately prior to the survey more frequently than did women and higher-education groups ($p < 0.01$), but these proportions declined regardless of sex and residence. Substantial delays in child-bearing were observed, particularly among higher-education and urban respondents. Condom use at least for casual sexual intercourse increased from 1995 to 2003; the level was highest among urban and higher-education groups. The number of women reporting frequent dry sex using traditional agents fell during the period. Participants from the rural area and those with less education reported more sexual experience than urban and higher-education participants in 2003. The reported number of sexual partners during the year immediately prior to the survey was a factor that reduced the association between HIV and survey times among sexually active young urban men and women.

Conclusion: High risk behaviours clearly decreased, especially in higher-educated and urban groups, and there is a probable association here with the decline in HIV prevalence in the study population. Fewer sexual partners and condom use were among the core factors involved for both sexes; and for women a further factor was delayed child-bearing.

Background

A number of studies from sub-Saharan Africa have recently reported declines in HIV prevalence among young people, which appear to be associated with changes in sexual behaviour [1-6]. Several previous studies have used mathematical models to examine the effect of behaviour changes on prevalence. The best method for obtaining indications of the effect of sexual behaviour change on the prevalence of HIV is, however, to study the inter-relation between changes in incidence and sexual behaviour within the same population; though if direct incidence measurement is not possible, prevalence among young people is commonly used as a proxy [7].

We previously reported sharp declines in HIV prevalence in selected urban and rural communities in Zambia between 1995 and 2003 on the basis of three serial cross-sectional population-based surveys [8,9]. In the 15–24 age group we found that HIV prevalence declined by 44% in the 8-year period (from 5.7% to 3.2%; $p = 0.143$) among rural males, by 58% (from 16.1% to 6.8%; $p < 0.001$) among rural females, by 54% (6.9% to 3.2%; $p = 0.005$) among urban males and by 44% (22.5% to 12.5%; $p < 0.001$) among urban females.

At the start of the HIV epidemic in sub-Saharan Africa, higher-educated groups were hit hardest [10-14], a fact attributed to more extensive travelling and greater numbers of sexual partners in this group [10,11,13]. More recent studies have, however, shown that the prevalence of HIV infection is decreasing among educated persons. In several countries the prevalence among young people with higher education is now lower than among the less educated, especially in urban areas [10,12,15,16]. We also reported particularly sharp declines in prevalence among young people with higher education (≥10 years of schooling) in the period 1995 to 2003 – 62% among urban females, 71% among urban males, 84% among rural males and 90% among rural females – whereas the prevalence was more stable among less educated respondents over the same period. Thus, from being at higher risk of HIV infection in 1995, young people with higher education were at lower risk by 2003 than those with little education [8,9].

In this study we investigated whether the observed decline in HIV prevalence among young people in selected communities in Zambia was likely to be due to behavioural changes. Furthermore, we examined how education was associated with changes in sexual behaviour.

Methods

The first population-based survey including data on HIV prevalence in Zambia was carried out in 1995 in Chelston (urban), Lusaka, and the Kapiri Mposhi district. The methods used in these surveys are described in detail elsewhere [8,10,17-19]. The study population was selected using a stratified random cluster sampling method. Ten urban clusters were selected in Chelston and five in rural Kapiri Mposhi. The survey was repeated in 1999 and 2003 using the same procedures except that the number of rural clusters was doubled in order to detect small changes. All households in the sampled clusters were included, and all household members aged ≥15 years who were found at home were asked to participate in a structured interview and to donate saliva for an anonymous HIV test [10]. This was an open cohort. It was possible to link individuals participating in two or more of the surveys, but the long periods between surveys and the high mobility of the respondents caused problems in studying incidence (small numbers and a highly selected group); hence we used prevalence among young people as a proxy of incidence. The data were double-entered in EpiInfo and validated.

Laboratory analysis

In the first survey all the saliva samples were tested using Gacelisa HIV 1&2 (Welcome Diagnostics). The Gacelisa saliva test was validated against serum tests on paired samples from 494 samples from antenatal clinic attendees, and the specificity and sensitivity of the saliva test was 100%. Four hundred and fifty randomly selected saliva samples from the survey were also tested with Bionor HIV-1&2 (BIONOR AS), and the two saliva tests showed 99.8% agreement [11,17]. In the two follow-up surveys only Bionor HIV-1&2 (BIONOR AS) for saliva was used [10]. Those respondents who wanted to know their results also had a serum test, and this provided an extra opportunity for validation. In cases where saliva and serum results were discordant, the serum result was considered final. In all the survey rounds, 10% of negative and 10% of positive samples were re-tested by a different person.

Data analysis

The analyses were performed using STATA version 9 and were restricted to adults aged 15–24 years. Data from the three cross-sectional surveys were compared using logistic regression, adjusting for the cluster effect and age, and Extended Mantel Haenszel Chi Square for linear trends (the latter analysis using http://www.openepi.com). Adjustment was made for age, which was considered as a continuous factor. The median age at sexual debut was calculated using survival analysis, and a log rank test for equality of survivor curves was used to compare the median ages in 1999 and 2003. (Questions about age at sexual debut, abstinence and current contraceptive use were not included in 1995, so we were only able to examine changes related to these variables between 1999 and 2003).

The total number of respondents was used as denominator when calculating the proportions for the following questions: 'ever had sex', 'sex by age 15', 'median age at debut', and 'ever given birth'. For questions about condom use, 'ever' and 'at last sexual intercourse prior to the survey', and about 'current contraceptive use', '≥2 partners during year prior to the survey', 'any casual partners during year prior to the survey', 'frequent dry sex with traditional agents', and 'self-reported experience of STI during year prior to the survey', the denominator was the number of sexually active respondents during the year prior to the survey. 'Condom use at last casual sexual intercourse' was calculated using the number of respondents who had had at least one casual partner in the course of the year prior to the survey as the denominator.

To allow comparisons to be made with our previously published analysis of prevalence changes by educational attainment in young people, the analyses were repeated with the same educational groups (0–7, 8–9 and ≥10 years of schooling) [8,9]. Analyses of the categories 'ever given birth' and 'any casual partner last year' were stratified by marital status. Logistic regression was performed with both survey time (stratified by educational level) and education (stratified by survey time) as exposure variables.

HIV prevalence declined significantly among sexually active young urban men and women and among rural women from 1995 to 2003 but not among rural men (AOR 0.51 [0.18–1.47]). To determine which behaviours contributed to the decline in HIV for urban men and women and rural women, we constructed a model based on the forward logistic regression of HIV risk by survey time, adjusted for age. We checked whether the following behaviour variables were confounders for the association between survey times and HIV among men and women: 'number of sexual partners last year' (continuous variable), 'any casual partners last year', and condom use 'ever' and 'at last sexual intercourse'. In addition we tested whether 'condom use at last casual sexual intercourse' and 'STI last year' were confounders among males; and for females we also tested the variables 'ever given birth' and 'frequent dry sex using traditional agents' (though not, in the case of women, 'condom use at last casual sexual intercourse' since <10% reported a casual partner). Variables that resulted in both a change in likelihood ratio chi square of > |3.84| ($p < 0.05$), and AOR for HIV comparing 2003 and 1995 closer to 1, were considered to be confounders. The confounder that gave the largest change in AOR was added to the model (by adjusting for this variable) before the process was repeated to look for additional confounders. Step by step, the model was thus expanded until no additional confounding could be detected.

Similarly, we tested how the association between survey time (2003 compared to 1995) and the odds of previous child bearing was affected when adjusting for 'condom use at last sexual intercourse', 'condom use ever', 'sexual activity last year' and 'current use of modern contraceptives' among young urban women. For rural women the proportion that had 'ever given birth' did not change significantly from 1995 to 2003 so these analyses were not performed for this group.

Ethical aspects

The protocol was approved by the National AIDS Research Committee for the two first surveys and by the University of Zambia Research Ethics Committee for the survey in 2003. All respondents were informed that the interview was anonymous and that the saliva-based HIV test would only be used for research purposes. Informed consent was required of all participants. Everyone was offered voluntary counselling and testing free of charge using blood specimens, as required by the national guidelines for HIV testing [19].

Results

Interview information (including sex, age and residence) was available from 1720 adults aged 15–24 years in 1995, 1946 in 1999 and 2637 in 2003. Saliva-based HIV test results were obtained from 1547 respondents in 1995, 1722 in 1999 and 2228 in 2003. In the whole sample the most common reason for not being interviewed was absence because of school, admission to hospital or temporary travel. Altogether, 16% were absent in 1995, 28% in 1999 and 20% in 2003. In all the three surveys, eligible men were approximately twice as likely to be absent as women; only 1–2% refused to be interviewed, and fewer than 10% refused to give saliva for testing [8,10,18]. The refusal rates were similar for men and women. There were no marked differences in non-response by age throughout the period, but an increase was observed in the median age of rural men successfully interviewed, from 26 in 1995 to 28 in 2003. The mean number of school years also increased somewhat for young urban male and female respondents (see Additional file 1).

The proportion of young respondents admitting to having had a casual partner or having had more than one partner during the year prior to the survey ranged between 39 and 52% among men and between 6 and 17% among women in both the rural and urban areas over the study period (Table 1). Fewer married than single young respondents had had casual partners, except among urban men (see Additional file 2). In addition, young people with little education were more likely to have had more than one partner during the year prior to the survey than those with more than 9 years of schooling, except among rural women (Figure 1). The proportion of respondents with

Table 1: Trends in HIV and key sexual behaviours among young people aged 15–24, 1995–2003.

Indicator	Year	Rural													
		M							F						
		%	N	Crude OR	95% CI	AOR	95% CI	P	%	N	Crude OR	95% CI	AOR	95% CI	P
HIV infection	1995	5.7	176	Ref.		Ref.		0.143	16.1	236	Ref.		Ref.		**<0.001**
	1999	7.5	268	1.42	0.66–3.05	1.45	0.66–3.17		10.3	380	**0.59**	**0.38–0.92**	**0.60**	**0.37–0.96**	
	2003	3.2	309	0.56	0.26–1.20	0.56	0.25–1.26		6.8	456	**0.38**	**0.19–0.78**	**0.36**	**0.19–0.67**	
Ever sex	1999	90	290	Ref.		Ref.			86	424	Ref.		Ref.		-
	2003	77	328	**0.37**	**0.24–0.58**	**0.32**	**0.18–0.56**		80	486	0.65	0.41–1.03	**0.53**	**0.32–0.89**	
Casual partner past year	1995	46	142	Ref.		Ref.		0.852	12	184	Ref.		Ref.		**0.023**
	1999	52	206	1.27	0.68–2.37	1.25	0.65–2.40		12	340	0.99	0.55–1.77	0.90	0.48–1.69	
	2003	48	191	1.07	0.70–1.64	1.08	0.69–1.69		7	343	**0.53**	**0.31–0.90**	**0.52**	**0.29–0.93**	
>2 sexual partners past 12 months	1995	50	147	Ref.		Ref.		0.491	10	189	Ref.		Ref.		0.056
	1999	51	206	1.03	0.74–1.43	1.02	0.72–1.42		10	340	1.03	0.54–1.95	0.95	0.49–1.85	
	2003	47	194	0.87	0.55–1.37	0.87	0.55–1.38		6	340	**0.56**	**0.34–0.92**	**0.56**	**0.33–0.96**	
Ever used condom	1995	54	147	Ref.		Ref.		0.891	26	189	Ref.		Ref.		0.098
	1999	60	207	1.25	0.73–2.14	1.32	0.74–2.36		36	338	1.57	0.82–3.02	1.59	0.85–3.00	
	2003	56	199	1.06	0.66–1.69	1.05	0.66–1.65		34	348	1.48	0.97–2.27	1.48	0.97–2.26	
Used condom at last sexual intercourse	1995	38	136	Ref.		Ref.		0.681	13	159	Ref.		Ref.		0.108
	1999	26	181	0.58	0.23–1.46	0.56	0.22–1.44		19	268	1.63	0.45–5.99	1.58	0.43–5.84	
	2003	35	133	0.91	0.48–1.73	0.93	0.49–1.77		19	248	1.67	0.86–3.24	1.69	0.87–3.29	
Used condom at last casual sexual intercourse	1995	27	62	Ref.		Ref.		0.571	9	23	Ref.		Ref.		**0.004**
	1999	14	110	**0.42**	**0.18–0.998**	0.43	0.18–1.05		2	40	0.27	0.04–1.91	0.26	0.04–1.83	
	2003	29	89	1.09	0.35–3.36	1.09	0.35–3.42		39	23	**6.75**	**2.15–21.2**	**6.31**	**1.50–26.5**	
Modern contraceptive use	1999	-	-	-	-	-	-		16	395	Ref.		Ref.		-
	2003	-	-	-	-	-	-		17	400	1.04	0.65–1.66	0.97	0.61–1.54	
Ever given birth	1995	-	-	-	-	-	-		54	257	Ref.		Ref.		0.114
	1999	-	-	-	-	-	-		61	411	1.32	0.69–2.53	1.61	0.74–3.51	
	2003	-	-	-	-	-	-		61	467	1.32	0.87–1.99	1.35	0.78–2.33	
Most often traditional agents before sex	1995	-	-			-		-	36	188	Ref.		Ref.		**<0.001**
	1999	-	-			-	-		20	381	**0.44**	**0.24–0.81**	**0.48**	**0.25–0.90**	
	2003	-	-			-	-		16	364	**0.34**	**0.16–0.71**	**0.33**	**0.15–0.72**	

Table 1: Trends in HIV and key sexual behaviours among young people aged 15–24, 1995–2003. *(Continued)*

Indicator	Year	Urban													
		M							F						
		%	N	Crude OR	95% CI	AOR	95% CI	P	%	N	Crude OR	95% CI	AOR	95% CI	P
HIV infection	1995	6.9	434	Ref.		Ref.		**0.005**	22.5	702	Ref.		Ref.		**<0.001**
	1999	7.4	432	1.07	0.67–1.72	1.01	0.61–1.66		18.3	641	**0.77**	**0.59–0.99**	**0.72**	**0.55–0.93**	
	2003	3.2	623	**0.45**	**0.28–0.70**	**0.40**	**0.25–0.66**		12.5	840	**0.49**	**0.36–0.66**	**0.43**	**0.33–0.57**	
Ever sex	1999	65	496	Ref.		Ref.		-	65	723	Ref.		Ref.		-
	2003	60	695	0.81	0.61–1.07	**0.70**	**0.52–0.96**		55	958	**0.65**	**0.50–0.83**	**0.54**	**0.42–0.68**	
Casual partner past year	1995	46	254	Ref.		Ref.		0.436	12	433	Ref.		Ref.		0.841
	1999	46	207	0.99	0.70–1.42	0.98	0.69–1.40		17	336	1.56	0.94–2.59	1.59	0.96–2.62	
	2003	43	244	0.87	0.63–1.20	0.86	0.63–1.17		11	363	0.93	0.66–1.30	1.00	0.73–1.37	
>=2 sexual partners past 12 months	1995	52	269	Ref.		Ref.		**0.003**	13	432	Ref.		Ref.		0.117
	1999	44	207	0.73	0.54–1.00	**0.68**	**0.48–0.99**		10	338	0.76	0.47–1.23	0.77	0.48–1.22	
	2003	39	243	0.59	0.48–0.72	**0.54**	**0.42–0.70**		10	359	0.71	0.42–1.19	0.80	0.51–1.26	
Ever used condom	1995	70	273	Ref.		Ref.		**<0.001**	59	445	Ref.		Ref.		**<0.001**
	1999	84	207	**2.22**	**1.53–3.24**	**1.82**	**1.23–2.68**		75	338	**2.09**	**1.27–3.43**	**2.08**	**1.27–3.40**	
	2003	84	263	**2.24**	**1.63–3.06**	**1.68**	**1.13–2.49**		81	387	**2.93**	**2.00–4.28**	**2.76**	**1.89–4.04**	
Used condom at last sexual intercourse	1995	53	247	Ref.		Ref.		**<0.002**	36	412	Ref.		Ref.		**<0.001**
	1999	26	255	**0.31**	**0.21–0.48**	**0.31**	**0.21–0.48**		25	425	**0.60**	**0.44–0.81**	**0.58**	**0.42–0.79**	
	2003	67	249	**1.80**	**1.04–3.11**	1.59	0.97–2.60		57	347	**2.34**	**1.45–3.79**	**2.43**	**1.51–3.93**	
Used condom at last casual sexual intercourse	1995	50	108	Ref.		Ref.		**0.023**	46	50	Ref.		Ref.		**<0.001**
	1999	65	94	**1.85**	**1.07–3.19**	**1.69**	**1.05–2.74**		53	57	1.30	0.62–2.76	1.29	0.60–2.78	
	2003	65	104	**1.89**	**1.10–3.23**	**1.68**	**1.00–2.82**		82	40	**5.53**	**2.89–10.6**	**5.80**	**2.88–11.7**	
Modern contraceptive use	1999	-	-	Ref.		Ref.			27	616	Ref.		Ref.		-
	2003	-	-	-	-	-	-		37	494	**1.64**	**1.13–2.37**	1.30	0.94–1.81	
Ever given birth	1995	-	-	Ref.		Ref.		-	39	772	Ref.		Ref.		**<0.001**
	1999	-	-	-	-	-	-		27	713	**0.57**	**0.44–0.75**	**0.43**	**0.31–0.61**	
	2003	-	-	-	-	-	-		26	834	**0.54**	**0.35–0.83**	**0.33**	**0.20–0.55**	
Most often traditional agents before sex	1995	-	-	Ref.		Ref.		-	20	429	Ref.		Ref.		**<0.001**
	1999	-	-	-	-	-	-		2	590	**0.09**	**0.03–0.24**	**0.10**	**0.04–0.29**	
	2003	-		-	-	-	-		5	427	**0.23**	**0.09–0.55**	**0.21**	**0.09–0.49**	

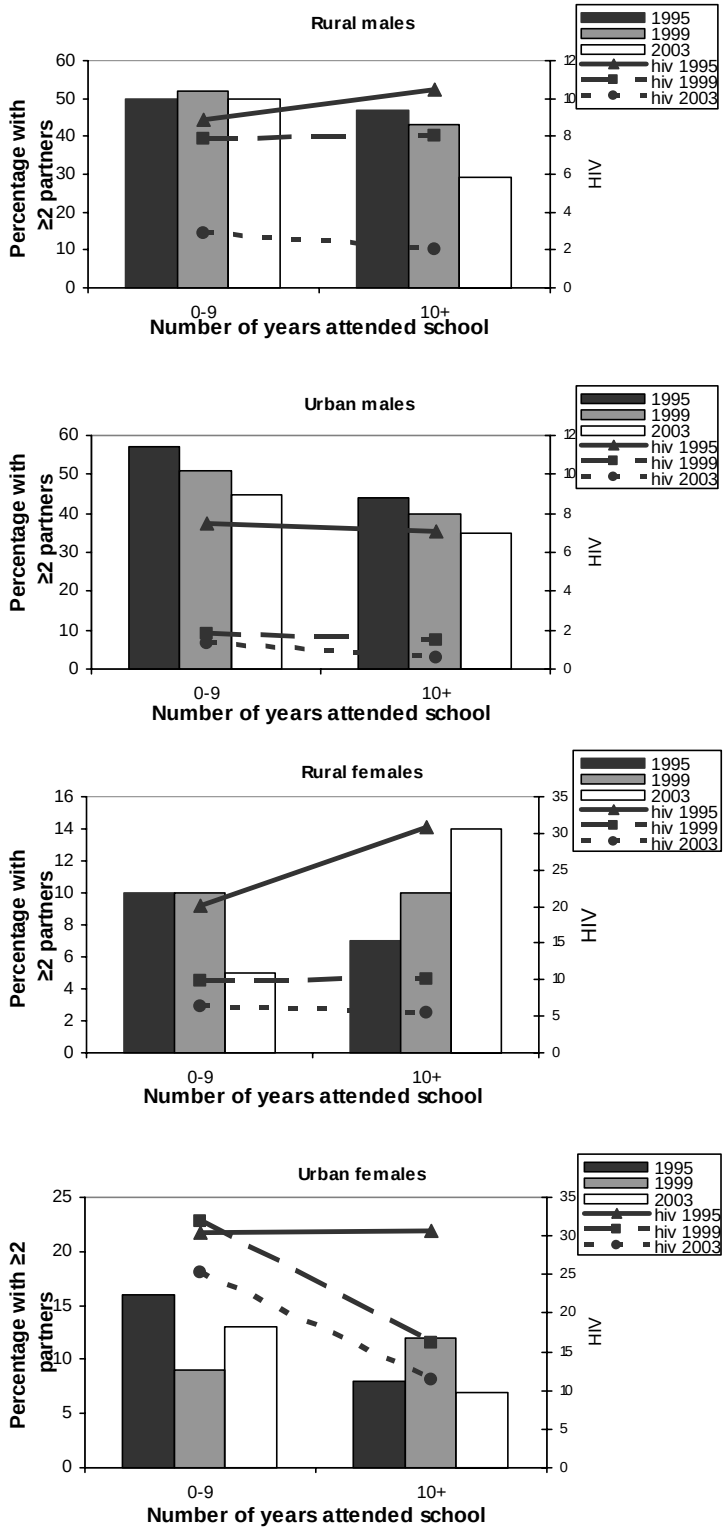

Figure 1
Proportion of sexually active men and women aged 15–24 with ≥2 sexual partners last 12 months and HIV prevalence among sexually active young people by educational attainment, 1995–2003.

more than one partner declined significantly for urban males and rural females (Table 1).

The proportions of 'condom use ever', 'condom use at last sexual intercourse' and 'condom use at last casual sexual intercourse', were highest among urban men, followed by urban women, and increased for all young adults. The most significant changes were found in the urban area, where 57% of young women reported using a condom at their last sexual intercourse in 2003 compared to 36% in 1995 (Table 1). For young rural men there was no increase. Young urban women used condoms more consistently with casual than with other partners, but for young urban men there was no difference. Individuals with higher education were more likely than the least educated to report condom use at both their last sexual intercourse prior to the survey (Table 2) and their last casual sexual encounter. Condom use also increased more significantly among high-education groups, especially educated rural women, who had lagged behind in 1995 (22% condom use at last intercourse in 1995 compared to 70% in 2003; p = 0.009). Among people with little education, condom use at last sexual intercourse was more common in the urban than the rural areas throughout the period surveyed (see Additional file 3).

In 1995, the proportion that had 'ever given birth' was higher among single women with higher education than among the less educated single women; however, the figure declined in the former group and remained stable in the latter up to 2003, resulting in a reversed relationship. Among married urban women with higher education the proportion that had given birth also declined, but among less educated married women and married rural women with higher education there were no significant changes (Table 3). Throughout the period, previous child-bearing was less common for young women in the urban than in the rural area. The declining proportion of women who had given birth among urban and higher-education groups was also observed among both HIV positive and HIV-negative women (Figure 2 and Additional file 4). (Note that for HIV positive rural women the sample was very small so the apparent increase in the proportion who had ever given birth was not significant.) Previous child-bearing was associated with an approximately double risk of acquiring HIV infection for single women. For married women, the risk of HIV was non-significantly higher or equal for those who had ever given birth compared to those who had not (see Additional file 5). 'Condom use at last sexual intercourse', 'condom use ever', 'no sexual activity during the last year', and 'current use of modern contraceptives' were all identified as confounding factors for the changes in the proportion of respondents who had 'ever given birth' among young urban women (see Additional file 6).

There was a marked reduction from 1995 to 2003 in the proportion of women who reported 'frequent dry sex using traditional agents' in both the urban and rural areas (Table 1). The practice was more common in the least educated groups throughout the period, but decreased for all educational levels (see Additional file 7 and 8). Use of modern contraceptives (condom, pill, injections, IUD) was more common among urban and among more highly educated females. It increased between 1999 and 2003 for rural and urban females with higher education and urban females with the lowest educational attainment (from 19% to 35% among urban women with 0–7 years of schooling) (see Additional file 9 and 10). Interestingly, in 1999, HIV prevalence among women currently using modern contraceptives was more than twice as high as among those who did not use modern contraceptives (AOR 2.49 [95% CI 1.47–4.21] for young urban females and AOR 2.57 [1.62–4.09] for young rural females), but in 2003 this association was not significant (AOR 0.92 [0.61–1.38] and AOR 0.77 [0.27–2.22], respectively).

Table 2: Proportions reporting condom use at last sexual intercourse by educational attainment among adults aged 15–24, 1995–2003. Urban and rural respondents have been pooled.

		Males						Females					
Year	**School years**	**%**	**N**	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	**N**	**Crude OR**	**95% CI**	**AOR**	**95% CI**
1995	***0–7***	31	142	Ref.		Ref		21	261	Ref.		Ref	
	8–9	50	118	**2.23**	**1.22–4.08**	**2.38**	**1.20–4.70**	32	173	**1.79**	**1.09–2.96**	**1.79**	**1.08–2.97**
	10+	63	122	**3.81**	**2.25–6.46**	**3.65**	**2.06–6.47**	41	133	**2.56**	**1.13–5.79**	**2.54**	**1.13–5.70**
1999	***0–7***	25	164	Ref.		Ref		21	349	Ref.		Ref	
	8–9	27	101	1.09	0.66–1.82	1.13	0.66–1.94	18	146	0.86	0.52–1.42	0.87	0.52–1.44
	10+	26	166	1.05	0.63–1.76	1.02	0.59–1.75	29	197	**1.54**	**1.08–2.19**	**1.57**	**1.09–2.25**
2003	***0–7***	28	109	Ref.		Ref		20	262	Ref.		Ref	
	8–9	50	72	**2.52**	**1.46–4.34**	**2.60**	**1.45–4.67**	45	112	**3.26**	**2.15–4.93**	**3.84**	**2.46–5.99**
	10+	73	201	**6.68**	**3.41–13.1**	**7.20**	**3.56–14.5**	64	219	**7.30**	**4.26–12.5**	**9.19**	**5.52–15.3**

Table 3: Changes in the proportion of women aged 15–24 reporting who had ever given birth by educational attainment, 1995–2003

Rural													
	Marital status	**Single**						**Married**					
School years	**Year**	**%**	**N**	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	**N**	**Crude OR**	**95% CI**	**AOR**	**95% CI**
0–7	*1995*	17	72	Ref.		Ref		82	99	Ref.		Ref	
	1999	17	94	1.03	0.43–2.44	1.38	0.72–2.66	79	214	0.83	0.26–2.66	1.02	0.26–3.94
	2003	18	94	1.10	0.44–2.77	1.47	0.66–3.29	86	229	1.42	0.68–2.94	1.40	0.71–2.77
8–9	*1995*	20	35	Ref.		Ref		95	19	Ref.		Ref	
	1999	26	31	1.39	0.88–2.19	**1.87**	**1.36–2.58**	86	29	0.35	0.04–2.78	0.19	0.01–2.72
	2003	24	49	1.30	0.57–2.95	2.53	0.99–6.44	89	28	0.46	0.08–2.72	0.17	0.02–1.25
10+	*1995*	29	7	Ref.		Ref		80	10	Ref.		Ref	
	1999	29	14	1	0.48–2.07	1.11	0.59–2.09	75	4	0.75	0.03–20.3	16.3	0.25–1056
	2003	14	36	**0.40**	**0.17–0.93**	**0.33**	**0.19–0.58**	89	9	2	0.12–32.5	3.97	0.29–54.9
Urban													
		Single						**Married**					
School years	**Year**	**%**	**N**	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	**N**	**Crude OR**	**95% CI**	**AOR**	**95% CI**
0–7	*1995*	15	197	Ref.		Ref		87	71	Ref.		Ref	
	1999	11	141	0.74	0.36–1.55	0.52	0.23–1.17	89	37	1.20	0.41–3.53	1.12	0.42–3.00
	2003	14	117	0.92	0.38–2.22	0.55	0.21–1.49	79	39	0.56	0.07–4.33	0.52	0.07–3.96
8–9	*1995*	27	187	Ref.		Ref		86	56	Ref.		Ref	
	1999	20	161	0.68	0.39–1.19	**0.40**	**0.19–0.86**	80	35	0.67	0.24–1.88	0.43	0.11–1.68
	2003	18	125	0.59	0.32–1.08	**0.33**	**0.13–0.85**	83	36	0.83	0.28–2.47	0.55	0.11–2.63
10+	*1995*	22	176	Ref.		Ref		86	44	Ref.		Ref	
	1999	12	284	**0.51**	**0.32–0.82**	0.57	0.31–1.03	74	31	0.45	0.17–1.20	0.41	0.15–1.10
	2003	11	432	**0.44**	**0.28–0.69**	**0.47**	**0.29–0.78**	75	61	**0.48**	**0.24–0.98**	**0.35**	**0.17–0.69**

When we distinguished between condoms and the three other modern contraceptive methods, we found that condom use was a risk factor for HIV infection among urban women in 1999, and use of IUDs, contraceptive pills or injections was a risk factor among rural women in 1999, but neither of these associations was significant in 2003.

There was a significant drop between 1999 and 2003 in the proportion of rural respondents and high-education urban respondents who reported ever having had sex (Table 1 and Additional file 11). The median age at sexual debut increased among higher-education groups of rural men and urban women (see Additional file 12). The proportion with sexual experience was lower among urban than among rural men and women, and lower for those with more than 9 years of schooling compared to the least educated (67% vs. 84% of women in the rural area in 2003; AOR 0.13: 0.07–0.26; other results not shown). Interestingly, comparisons of the proportions of reported early sexual debut between 1999 and 2003 showed significant differences among young rural men and urban women. In 1999, 15% of urban female and 42% of rural male 15–19 year-olds reported sex before age 15, but 4 years later, in 2003, 5% of urban female and 24% of rural male 19–23 year-olds reported the same (see Additional file 13). For older men and women the differences in reporting were not significant (see Additional file 14). We also found that up to 8% of young people who claimed to be virgins were in fact HIV positive in 1999, and none of these reported having received a blood transfusion (see Additional file 15).

The risk of acquiring HIV infection in 2003 compared to 1995 (AOR) among sexually active young people was

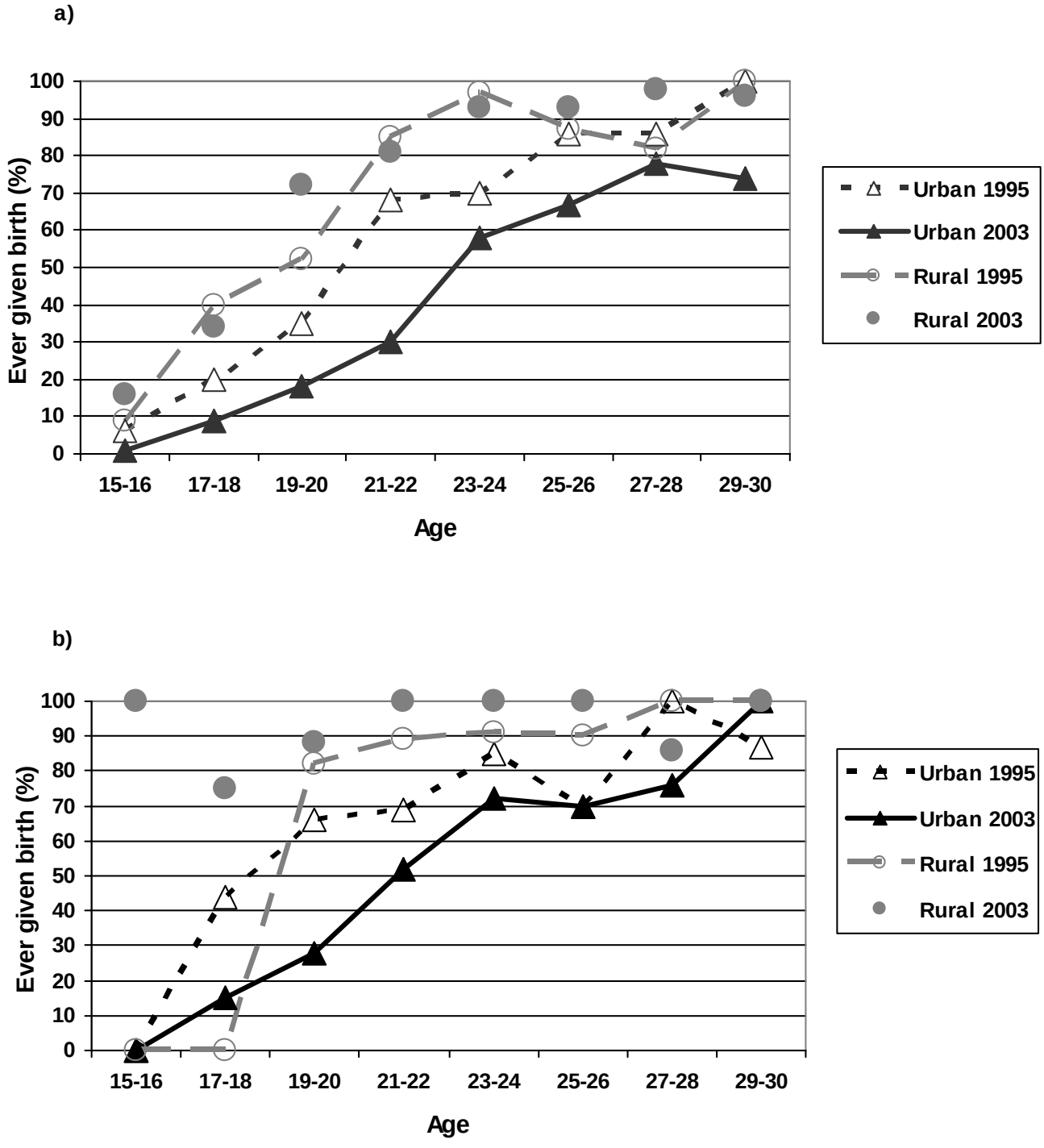

Figure 2
a: Proportion ever given birth among HIV-negative women. b: Proportion ever given birth among HIV-positive women.

0.55 [95%CI 0.31–0.96] for urban males, 0.35 [0.28–0.45] for urban females, and 0.27 [95%CI 0.11–0.68] for rural females. Using the survey time as exposure in modelling, we found that 'number of sexual partners during the past year', 'any casual partners during the past year', 'condom use at last sexual intercourse',' condom use at last casual sexual intercourse' and 'condom use ever' were all confounders for the association between HIV and survey time among sexually active young urban men. After adjustment for 'condom use at last casual sexual intercourse', there was no significant difference in the risk of HIV between 2003 and 1995 (Table 4). 'Ever given birth', 'number of sexual partners past year', 'any casual partners past year', 'condom use at last sexual intercourse', 'condom use last casual sexual intercourse', 'condom use ever' and 'frequent dry sex using traditional agents' were confounders for the association between HIV and survey time among sexually active young urban women. After adjusting the association between HIV and survey time for 'any casual partners past year' and 'ever given birth', the association between HIV and survey time was still significant, and no new confounders were found (Table 5). Among rural women, 'ever condom use' was the only confounder, and after adjusting for this variable the association between HIV and survey time was still significant (Table 6).

We also carried out similar modelling for higher-education groups only. We still found that the strongest confounder was 'condom use at last casual sexual intercourse' for urban men and 'condom use ever' for rural women. However, for urban women with higher education, all the same indicators were confounders as for all urban women, but 'frequent dry sex' was the strongest. For rural men, adjusting for 'any casual partners past year' and 'condom use at last sexual intercourse' changed the AOR from 0.24 [0.13–0.42] to 0.70 [0.49–0.99] (see Additional file 16).

Discussion

The findings showed a decline in high risk sexual behaviour and an increase in reported condom use among young adults aged 15–24 years. These changes were most prominent in the higher-education groups, and included fewer sexual partners and increased use of condoms at last sexual intercourse; and among women, delayed childbearing and less use of traditional agents before sex. We have already reported a marked decline in HIV prevalence, especially among young people with higher education, in the same surveys [8,9]. Our modelling of possible confounders of the association between survey time and HIV prevalence showed that differences in the above-mentioned indicators contributed to the decline in HIV prevalence among sexually active young people between 1995 and 2003. Mortality in young infected individuals is likely to be relatively low [2]. We have previously reported that migration did not have a significant impact on our results [9]. Overall, these findings provide convincing evidence that the substantial decrease in HIV prevalence among young people was associated with changes in sexual behaviour.

It is reasonable to believe that asking a woman whether she has ever given birth will yield more reliable answers than asking her whether she has ever had sex, as childbearing is associated with high respect in this society and is difficult to keep secret. The variable 'ever given birth' was associated with a doubling of the likelihood of HIV infection for single young women. Delays in first pregnancy may be interpreted as strong evidence for the use of an effective preventive strategy, such as abstinence, condom use, or avoidance of marriage to high risk partners. The finding that the proportion who had ever given birth declined among both HIV positive and HIV negative young urban women indicates that decreased fertility among young women was more likely to be due to behavioural change than to the physiological effect of HIV infection. We found that delayed child-bearing seemed to be

Table 4: Age-adjusted odds ratio (AOR) of risk of HIV by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for urban men aged 15–24

One by one behaviour indicator included			
Behaviour indicator	**Chi-square change**	**AOR**	**95% CI**
Number of sex partners past 12 months**	**-15.0**	**0.72**	**0.36–1.42**
Casual partner past year	**-20.59**	**0.66**	**0.27–1.64**
Condom use at last sexual intercourse	**-18.77**	**0.70**	**0.38–1.27**
Ever used condom	**-19.06**	**0.68**	**0.40–1.16**
Used condom at last casual sexual intercourse	**-21.07**	**1.12**	**0.71–1.77**
STI past year*	21.98	0.55	0.32–0.94

Notes: **Before adding the behaviour variables the Chi square was 22.19 and AOR 0.55 (0.31–0.96) in 2003 compared to 1995**. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents during the year prior to the survey. *The Chi square change was significant, but the AOR was unchanged. **The chief confounder in this step.

Table 5: Age-adjusted odds ratio (AOR) of risk of HIV by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for urban women aged 15–24

One by one behaviour indicator included				Two behaviour variables included				Three behaviour variables included			
Beh. indicator	**Chi-square change**	**AOR**	**95% CI**	**Beh. indicator**	**Chi-square change**	**AOR**	**95% CI**	**Beh. indicator**	**Chi-square change**	**AOR**	**95% CI**
Ever given birth	**-4.51**	**0.49**	**0.37–0.63**	Casual partner and ever given birth**	**-8.34**	**0.59**	**0.42–0.83**	-			
Number of sex partners past 12 months	**-26.97**	**0.52**	**0.38–0.70**	Casual partner and number of sex partners	-1.38	0.53	0.38–0.73	Casual partner, ever given birth and number of sexual partners	1.62	0.58	0.41–0.82
Casual partner past year**	**-27.25**	**0.54**	**0.39–0.75**	-				-			
Condom use at last sexual intercourse	**6.57**	**0.45**	**0.32–0.63**	Casual partner and condom use at last sexual intercourse	13.53	0.46	0.34–0.63	Casual partner, ever given birth and condom use at last sexual intercourse*	16.44	0.52	0.37–0.72
Ever used condom	**-18.06**	**0.50**	**0.37–0.68**	Casual partner and ever used condom	3.37	0.51	0.37–0.68	Casual partner, ever given birth and ever used condom*	4.32	0.56	0.41–0.76
Frequent dry sex	**-30.29**	**0.49**	**0.37–0.64**	Casual partner and frequent dry sex	**-8.85**	**0.54**	**0.38–0.77**	Casual partner, ever given birth and frequent dry sex#	-5.83	0.59	0.42–0.83

Notes: **Before adding the behaviour variables the Chi square was 53.88 and AOR 0.35 (0.28–0.45) in 2003 compared to 1995**. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents during the year prior to the survey.
*The Chi square change was significant, but the AOR was further from 1, which meant that adjusting for 'condom use at last sexual intercourse' or 'ever condom use' in addition to 'any casual partners past year' increased the strength of the association between HIV and survey time, rather than reducing it. # The Chi square change was significant, but the AOR was unchanged. **The chief confounder in this step.

Table 6: Age-adjusted odds ratio (AOR) of risk of HIV by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for rural women aged 15–24

One by one behaviour indicator included			
Beh. Indicator	**Chi-square change**	**AOR**	**95% CI**
Ever given birth	0.15	0.28	0.11–0.72
Number of sex partners past 12 months	-1.7	0.31	0.13–0.75
Casual partner past year	-0.62	0.30	0.12–0.72
Condom use at last sexual intercourse	-3.45	0.28	0.09–0.81
Ever used condom**	**-4.81**	**0.32**	**0.13–0.75**
Frequent dry sex	-1.9	0.26	0.11–0.63

Notes: **Before adding the behaviour variables the Chi square was 9.53 and AOR 0.27 (0.11–0.68) in 2003 compared to 1995**. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents during the year prior to the survey. **The chief confounder in this step.

due to a combination of abstinence, condom use and use of other contraceptives. It is possible that modern contraceptives were mainly used by women engaging in higher risk sexual behaviour in 1999 and that this explains the association with HIV; for as contraceptives rapidly became more common, as well as strongly associated with higher education, this association disappeared.

Fewer women than men reported having had more than one partner during the year prior to each of the three surveys. We also found that fewer men with higher education reported multiple partners in 2003 than in the previous surveys. Before the HIV epidemic in Africa, higher socioeconomic and educational status were associated with more sexual partners [10,11,13]. The finding in the baseline survey that more highly-educated young men and women less frequently reported more than one partner during the past year indicates that the process of change in sexual behaviour started earlier than the mid 1990s. This may be linked to the comprehensive HIV prevention campaigns that were launched in the early 1990s. As people with higher education are usually more concerned with their health, it is likely that they changed their behaviour in response to health-promoting messages [10,12,20].

Consistent condom use has been shown to be effective in protection against HIV transmission, but it also seems that condom use must reach a certain level to influence the HIV epidemic significantly [21,22]. Condom use at last sexual intercourse is often employed as a population-level indicator of frequency, but this has obvious limitations and may not give a representative picture of consistent condom use [23]. 'Condom use ever' is an indicator of acceptability. Both reported condom use 'at last sexual intercourse' and 'ever' increased, especially among urban respondents and people with higher education; these groups were already reporting higher use than rural and less educated respondents in 1995. This suggests that condom promotion has had limited success so far in reaching rural people and those with little education. The Sexual Behaviour Surveys of 2000, 2003 and 2005 also showed lower condom use in rural areas [24-26]. The resistance to condoms may arise from beliefs that they reduce sexual pleasure and male potency, or the belief that condoms are not effective in preventing HIV transmission [24,27,28]. Condom use has also been opposed by many religious communities. Individuals with casual partners during the past year were the only rural group that reported increased condom use; this trend was most evident among those few young women who admitted to this behaviour. A higher frequency of condom use in casual relationships is also reported by other studies from sub-Saharan Africa [29]. Young women with casual partners are probably more conscious of their own risk of becoming HIV infected, as casual sex is considered especially inappropriate for them and is condemned by society.

Frequent dry sex with traditional agents was associated with HIV infection among urban women. It has been believed that this practice increases the susceptibility of women to HIV by creating erosions in the mucous membrane. However, the evidence for increased susceptibility is insubstantial because most studies have, like ours, been cross-sectional, a design that precludes conclusions about causal relationships [30-32]. In any case, according to our results, this practice has become less common, with fewer women in all educational categories reporting it.

The differential HIV trends associated with the education levels of young people indicate that important changes in sexual behaviour have taken place among educated people. If people of different educational levels are part of the same social networks, distinct infection patterns reflect differences in risk exposure provided that the effects of differential mortality and migration are negligible. Thus we believe that most of the changes in reported behaviour observed between 1995 and 2003 are real. However, there are some signs of differential reporting bias in our study.

We found that controlling for less risky sexual behaviour substantially reduced the association between HIV and survey time among urban men, but less so among women; this may suggest that self-reports from men about sexual behaviour are more reliable. Studies suggest that respondents, especially women, tend to under-report the number of lifetime sexual partners [33]. Therefore, analyses of associations with, and changes in, self-reported sexual behaviour should be interpreted with caution. This also means that changes in the number of partners during the past year reported by women should be interpreted with extra caution. The finding that more highly educated rural women reported more partners in 2003 than in 1995, whereas all other groups reported fewer, could indicate less reporting bias in this group in 2003. We know that culturally inappropriate sexual behaviour is associated with stigmatization, and social desirability may create reporting bias. Another variable that is known to be associated with social desirability – but also with recall bias – is early sexual experience. Recall bias can be expected to assume greater importance among older age groups. We found indications of under-reporting of sexual experience among both males and females, in that some respondents claiming to be virgins were HIV positive whilst reporting no previous blood transfusions. There is convincing evidence that the dominant form of HIV transmission among adults in sub-Saharan Africa is through heterosexual intercourse [34-38], and other studies have also found HIV infection, STIs and current pregnancy among young people who denied having sex [29,33,37]. Except for individuals who strongly suspected that they were infected, it seems unlikely that respondents' actual HIV status affected the self-reporting in our study, since only 10% of respondents had ever been HIV tested. As the 1995 interview did not include questions about age at sexual debut, we can only compare changes between 1999 and 2003 on this variable, which makes the interpretations more vulnerable to error. We found no visible cohort effect, as could be expected if there had been a real change in age at first sexual intercourse, and the respondents were consistent from survey to survey as to the age at which they reported having had their sexual debut. Instead, we found that among the youngest respondents, fewer admitted having had sex by the age of 15 years in 2003 than in 1999. Analyses of data from the Demographic and Health Surveys, Sexual Behaviour Surveys and from other countries show a similar pattern indicating under-reporting [39-41]. It is probable that as HIV campaigns encouraging delayed sexual debut and abstinence before marriage reach the population, people will report behaviour assumed to be more socially desirable. Other lifetime sexual behaviours such as 'condom use ever' and 'ever given birth' are, however, less prone to recall and social desirability bias, and the reporting of both consistently increased (as might be expected given that the young age cohorts grew older between 1995 and 2003 [see Additional file 17 and 18]). Overall, it seems that bias in our study was mainly related to sexual debut and condom use at last sexual intercourse in 1999. The proportion who said they used a condom at their last sexual intercourse and at their last casual sexual intercourse increased over the 8 year period, but was much lower in 1999 than in 1995. While this is difficult to explain, such inconsistencies in the direction of change may indicate random variation between the surveys, changes in the sample due to migration, changes due to greater absence in 1999, reporting bias, or data entry errors. These inconsistencies are unlikely to be due to misunderstandings of the questions as they were formulated in the same way in all three surveys. However, we observed consistent trends or stability for most indicators, which increases the likelihood that these reflect real behaviour patterns.

The identification of confounding variables for the association between HIV and survey time builds on the assumption that the behaviours reported in 1995 and 2003 reflected the overall level of respondents' risk behaviour. Because we only use rather crude information about behaviour, this model remains quite simplistic. It is not possible in cross-sectional studies to establish whether behaviour change occurred before HIV infection in order for behaviour change to be associated with the HIV infection. Despite these important limitations we believe that since most young HIV infected individuals have been recently infected, the model provides clues to the behaviours that actually contributed to the decline in HIV. The analyses, when not stratifying by education (Tables 4, 5, 6) and when confining analysis to the higher-education groups, identified the same confounders, except that 'frequent dry sex' proved to be the most important for urban women with higher education. Considering the insubstantiality of the evidence for a link between dry sex and HIV infection, we are more inclined to believe that 'any casual partners' and 'ever given birth' were the key factors, as suggested by Table 5.

The data in this study stem from only one urban and one rural community. Generalisation to Zambia as a whole naturally requires further study. However, HIV prevalence levels in these communities are demonstrably comparable to the national urban and rural estimates, and national surveillance data among antenatal attendees have shown declines in prevalence in the 15–24 age-group [10,15,18,42]. Accordingly, these data might well contain important insights regarding overall national patterns of HIV-related behavioural responses.

Conclusion

We conclude that there is clear evidence of a shift towards safer sexual behaviour among men and women in these

communities, especially among young people with higher education. Moreover, these changes are likely to have contributed to the concomitant decline in HIV prevalence observed across the period. However, the results also pinpoint a need for much more effective preventive approaches, targeting rural and less educated people in particular.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

IFS analysed and interpreted the data and drafted the manuscript. CM supervised and coordinated the 2003 data collection and took an active part in interpreting the results and revising the manuscript. SS planned and coordinated the 2003 data collection and took an active part in interpreting the results and revising the manuscript. KF made substantial contributions to the conception and design of the surveys, coordinated and supervised the data collection in 1995 and 1999, planned the data collection in 2003, and took an active part in interpreting the results and revising the manuscript. All authors read and approved the final manuscript.

Additional material

Additional file 1

Additional table 1. Characteristics of respondents
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S1.doc]

Additional file 2

Additional table 2. Changes in the proportions reporting having any casual partner during the year prior to the survey by marital status, adults aged 15–24, 1995–2003
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S2.doc]

Additional file 3

Additional table 3. Changes in the proportions reporting condom use at last sexual intercourse by educational attainment among adults aged 15–24, 1995–2003
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S3.doc]

Additional file 4

Additional table 4. Changes in the proportions of HIV-negative women aged 15–24 who had ever given birth by educational attainment, 1995–2003
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S4.doc]

Additional file 5

Additional table 5. HIV prevalence by whether 'ever given birth', stratified by marital status. Women aged 15–24.
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S5.doc]

Additional file 6

Additional table 6. Age-adjusted odds ratio (AOR) of having given birth comparing 2003 and 1995 (2003 and 1999 for modern contraceptives) and adjusting for 'current use of modern contraceptives', 'used condom at last sexual intercourse' and abstinence among rural and urban women aged 15–24
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S6.doc]

Additional file 7

Additional table 7. Changes in the proportion of all women aged 15–24 who frequently use traditional agents before sex to make the vagina drier, by educational attainment, 1995–2003
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S7.doc]

Additional file 8

Additional table 8. Proportions of all women aged 15–24 who frequently use traditional agents before sex to make the vagina drier, by educational attainment, 1995–2003
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Additional file 9

Additional table 9. Changes in the proportions of females aged 15–24 reporting current use of modern contraceptives by educational attainment, 1995–2003
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S9.doc]

Additional file 10

Additional table 10. Changes in the proportions reporting current use of modern contraceptives by educational attainment among females aged 15–24, 1995–2003
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S10.doc]

Additional file 11

Additional table 11. Changes in the proportions reporting ever having sex by educational attainment among adults aged 15–24, 1995–2003
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Additional file 12

Additional table 12. Changes in the median reported age at sexual debut by educational attainment among adults aged 15–24, 1995–2003
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S12.doc]

Additional file 13

Additional figure 1. Percentages reporting having had sex by the age of 15 in 1999 and in 2003 based on the age groups of the respondents in 1999
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S13.doc]

Additional file 14

Additional table 13. Percentages reporting having had sex by the age of 15 in 1999 and in 2003 based on the age groups of the respondents in 1999.
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S14.doc]

Additional file 15

Additional table 14. HIV prevalence among young people aged 15–24 reporting 'ever' and 'never' sexual activity
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S15.doc]

Additional file 16

Additional table 15. Age-adjusted odds ratio (AOR) of risk of HIV infection by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for urban and rural men and women aged 15–24 with higher education (≥10 years of schooling)
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[http://www.biomedcentral.com/content/supplementary/1471-2458-7-60-S16.doc]

Additional file 17

Additional figure 2. Proportions who reported ever having used a condom in 1995, 1999 and 2003 based on the age groups of the respondents in 1995. The denominator is the number of sexually active respondents
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Additional file 18

Additional figure 3. Proportion of women reporting 'ever given birth' in 1995, 1999 and 2003 based on the age groups in 1995
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Additional table 1: Characteristics of respondents

Age 15-24													
		Rural						Urban					
		1995		1999		2003		1995		1999		2003	
			N		*N*		*N*		*N*		*N*		*N*
Sex distribution (%)	M	43.2	*197*	40.5	*290*	44.9	*432*	37.9	*479*	40.8	*1230*	42.1	*1675*
	F	56.8	*259*	59.5	*426*	55.1	*530*	62.1	*1264*	59.2	*1230*	57.9	*1675*
Mean age in years (95% CI)	M	19.9 (19.5-20.2)	*197*	19.6 (19.3-20.0)	*290*	19.7 (19.4-20.0)	*432*	18.9 (18.7-19.2)	*479*	19.3 (19.1-19.6)	*502*	19.5 (19.3-19.7)	*705*
	F	19.3 (18.9-19.6)	*259*	19.2 (18.9-19.4)	*426*	19.4 (19.2-19.7)	*530*	19.1 (18.9-19.3)	*785*	19.4 (19.2-19.6)	*728*	19.5 (19.3-19.6)	*970*
Median age in years (IQR)	M	20 (18-22)	*197*	20 (17-22)	*290*	20 (17.25-22)	*432*	19 (17-21)	*479*	19 (17-22)	*502*	19 (17-22)	*705*
	F	19 (17-22)	*259*	19 (17-22)	*426*	20 (17-22)	*530*	19 (17-22)	*785*	19 (17-22)	*728*	19 (17-22)	*970*
Mean number of school years (95% CI)	M	7.0 (6.6-7.5)	*195*	6.4 (6.0-6.7)	*290*	7.1 (6.7-7.5)	*326*	9.2 (9.0-9.4)	*477*	10.1 (9.9-10.3)	*496*	10.6 (10.4-10.8)	*696*
	F	6.3 (5.9-6.6)	*256*	5.4 (5.2-5.7)	*425*	5.7 (5.4-6.0)	*485*	8.4 (8.2-8.6)	*778*	9.2 (9.0-9.4)	*725*	9.9 (9.8-10.1)	*957*
Median number of school years (IQR)	M	7 (6-9)	*195*	7 (4-8)	*290*	7 (5-9)	*326*	9 (7-11)	*477*	10 (9-12)	*496*	11 (9-12)	*696*
	F	7 (5-8)	*256*	6 (4-7)	*425*	6 (4-8)	*485*	9 (7-10)	*778*	9 (7-12)	*725*	11 (8-12)	*957*

Additional table 2: Changes in the proportions reporting having any casual partner during the year prior to the survey by marital status, adults aged 15-24, 1995-2003

			Single						Married					
Residence		**Year**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Males**	*1995*	50	*106*	Ref.		Ref.		34	*35*	Ref.		Ref.	
		1999	60	*139*	1.48	0.64-3.42	1.49	0.67-3.32	39	*61*	1.24	0.63-2.43	1.21	0.64-2.30
		2003	55	*126*	1.21	0.66-2.23	1.21	0.66-2.22	35	*62*	1.05	0.47-2.39	1.09	0.49-2.45
	Females	*1995*	25	*51*	Ref.		Ref.		6	*126*	Ref.		Ref.	
		1999	32	*74*	1.40	0.77-2.56	1.21	0.66-2.22	4	*245*	0.69	0.32-1.52	0.63	0.28-1.42
		2003	14	*66*	**0.46**	**0.25-0.86**	**0.41**	**0.24-0.71**	5	*262*	0.71	0.30-1.69	0.73	0.30-1.80
Urban	**Males**	*1995*	46	*240*	Ref.		Ref.		50	*14*	Ref.		Ref.	
		1999	45	*195*	0.95	0.66-1.37	0.94	0.66-1.36	64	*11*	1.75	0.41-7.47	1.73	0.42-7.04
		2003	42	*229*	0.87	0.63-1.21	0.86	0.63-1.16	38	*13*	0.62	0.13-3.05	0.63	0.13-3.01
	Females	*1995*	17	*235*	Ref.		Ref.		4	*169*	Ref.		Ref.	
		1999	24	*218*	1.52	0.93-2.48	1.50	0.90-2.49	3	*104*	0.81	0.14-4.59	0.78	0.14-4.41
		2003	15	*221*	0.86	0.54-1.36	0.83	0.51-1.34	2	*130*	0.64	0.37-1.12	0.58	0.32-1.07

Additional table 3: Changes in the proportions reporting condom use at last sexual intercourse by educational attainment among adults aged 15-24, 1995-2003

	School years		0-7						8-9						10+					
Residence		**Year**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Males**	*1995*	23	*83*	Ref.		Ref.		58	*33*	Ref.		Ref.		63	*19*	Ref.		Ref.	
		1999	28	*134*	1.28	0.72-2.31	1.18	0.65-2.13	23	*31*	**0.21**	**0.06-0.80**	**0.21**	**0.06-0.79**	19	*16*	**0.13**	**0.06-0.32**	**0.13**	**0.05-0.31**
		2003	18	*74*	0.72	0.34-1.52	0.72	0.34-1.55	52	*27*	0.79	0.21-3.07	0.77	0.18-3.27	62	*32*	0.97	0.50-1.90	0.99	0.55-1.80
	Females	*1995*	9	*116*	Ref.		Ref.		21	*33*	Ref.		Ref.		22	*9*	Ref.		Ref.	
		1999	20	*223*	2.35	0.89-6.21	2.28	0.85-6.06	16	*38*	0.70	0.15-3.21	0.64	0.12-3.36	14	*7*	0.58	0.02-14.1	0.34	0.01-10.3
		2003	13	*189*	1.39	0.59-3.28	1.41	0.60-3.29	26	*39*	1.28	0.49-3.31	1.27	0.46-3.49	70	*20*	**8.17**	**3.25-20.5**	**11.3**	**2.11-60.8**
Urban	**Males**	*1995*	42	*59*	Ref.		Ref.		47	*85*	Ref.		Ref.		63	*103*	Ref.		Ref.	
		1999	13	*30*	**0.21**	**0.07-0.59**	**0.21**	**0.08-0.57**	29	*70*	0.45	0.20-1.02	0.51	0.22-1.19	27	*150*	**0.21**	**0.12-0.37**	**0.22**	**0.12-0.37**
		2003	51	*35*	1.44	0.45-4.60	1.40	0.48-4.08	49	*45*	1.08	0.64-1.81	0.85	0.50-1.46	75	*169*	1.71	0.95-3.08	1.65	0.91-3.00
	Females	*1995*	30	*145*	Ref.		Ref.		35	*140*	Ref.		Ref.		42	*124*	Ref.		Ref.	
		1999	23	*126*	0.69	0.38-1.25	0.63	0.33-1.19	19	*108*	**0.45**	**0.24-0.85**	**0.45**	**0.23-0.88**	29	*190*	**0.58**	**0.36-0.93**	**0.47**	**0.28-0.80**
		2003	38	*73*	1.43	0.64-3.18	1.58	0.74-3.37	55	*73*	2.25	1.48-3.43	**2.16**	**1.48-3.14**	64	*199*	**2.44**	**1.31-4.54**	**2.40**	**1.24-4.62**

Additional table 4: Changes in the proportions of HIV-negative women aged 15-24 who had ever given birth by educational attainment, 1995-2003

	School years		0-7						8-9						10+					
Residence		**Year**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Females**	*1995*	53	*148*	Ref.		Ref.		46	*35*	Ref.		Ref.		70	*10*	Ref.		Ref.	
		1999	60	*275*	1.37	0.58-3.24	1.67	0.67-4.13	49	*45*	1.14	0.47-2.73	1.19	0.43-3.28	33	*12*	0.21	0.04-1.06	0.67	0.17-2.70
		2003	67	*299*	**1.81**	**1.02-3.21**	**1.89**	**1.10-3.25**	44	*71*	0.92	0.42-2.00	0.79	0.24-2.62	22	*40*	**0.12**	**0.06-0.24**	**0.17**	**0.09-0.34**
Urban	**Females**	*1995*	31	*211*	Ref.		Ref.		36	*179*	Ref.		Ref.		28	*142*	Ref.		Ref.	
		1999	32	*139*	1.04	0.56-1.92	0.73	0.41-1.28	28	*142*	0.70	0.35-1.42	**0.39**	**0.17-0.90**	16	*235*	**0.48**	**0.30-0.75**	0.53	0.28-1.01
		2003	26	*118*	0.80	0.33-1.93	0.50	0.19-1.30	29	*121*	0.73	0.49-1.09	**0.36**	**0.16-0.83**	19	*397*	**0.61**	**0.38-0.99**	**0.56**	**0.33-0.96**

Additional table 5: HIV prevalence by whether 'ever given birth', stratified by marital status. Women aged 15-24.

		Single												Married									
		Rural						Urban						Rural						Urban			
		%	*N*	Crude OR	95% CI	AOR	95% CI	%	*N*	Crude OR	95% CI	AOR	95% CI	%	*N*	Crude OR	95% CI	AOR	95% CI	%	*N*	Crude OR	95% CI	AOR	95% CI
1995	***No***	8.0	*87*	Ref.		Ref.		11.8	*397*	Ref.		Ref.		22.2	*18*	Ref.		Ref.		23.8	*21*	Ref.		Ref.	
	Yes	20.0	*20*	2.86	0.91-8.98	1.24	0.37-4.19	29.4	*102*	**3.10**	**1.74-5.52**	**2.20**	**1.43-3.37**	20.2	*99*	0.89	0.34-2.32	0.60	0.22-1.63	41.3	*138*	2.25	0.62-8.20	1.64	0.34-7.85
1999	***No***	5.0	*100*	Ref.		Ref.		13.6	*441*	Ref.		Ref.		4.3	*47*	Ref.		Ref.		23.5	*17*	Ref.		Ref.	
	Yes	13.0	*23*	**2.85**	**1.37-5.93**	1.07	0.17-6.66	28.0	*75*	**2.47**	**1.59-3.84**	**1.68**	**1.05-2.71**	11.9	*176*	3.05	0.68-13.6	2.02	0.48-8.55	26.9	*78*	1.20	0.25-5.79	0.60	0.18-2.00
2003	***No***	0.7	*139*	Ref.		Ref.		9.4	*524*	Ref.		Ref.		3.1	*32*	Ref.		Ref.		24.0	*25*	Ref.		Ref.	
	Yes	17.6	*34*	**29.6**	**3.53-248**	**17.2**	**1.62-183**	18.0	*78*	**2.12**	**1.13-3.97**	1.71	0.92-3.20	8.3	*217*	2.80	0.68-11.6	2.23	0.54-9.21	22.6	*93*	0.92	0.38-2.22	0.90	0.37-2.17

Additional table 6: Age-adjusted odds ratio (AOR) of having given birth comparing 2003 and 1995 (2003 and 1999 for modern contraceptives) and adjusting for 'current use of modern contraceptives', 'used condom at last sexual intercourse' and abstinence among rural and urban women aged 15-24

a) Urban women

One by one behaviour indicator included					
Beh. Indicator		**Chi square**	**Chi-square change**	**AOR**	**95% CI**
Comparing 2003 and 1995	Condom use at last sexual intercourse	**109.69**	**18.86**	**0.46**	**0.27-0.76**
	Ever used condom	**126.72**	**35.89**	**0.54**	**0.30-0.96**
	Sexually active last year	**36.19**	**-54.64**	**0.51**	**0.32-0.84**
Comparing 2003 and 1999	Modern contraceptive use	**112.12**	**21.29**	**1.02**	**0.72-1.44**

Notes: Before adding behaviour variables Chi square was 90.83 and AOR for having given birth 0.33 (0.20-0.55) in 2003 compared to 1995 and 0.77 (0.53-1.11) in 2003 compared to 1999. If chi square >|3.84|, the added variable is a confounding variable. The denominator is the total number of women.

b)Rural women

		One by one behaviour indicator included			
Beh. Indicator		**Chi square**	**Chi-square change**	**AOR**	**95% CI**
Comparing 2003 and 1995	Condom use at last sexual intercourse*	40.51	-60.0	1.81	1.10-2.97
	Ever used condom*	74.83	-25.68	2.14	1.30-3.51
	Sexually active last year*	50.52	-49.99	1.71	0.99-2.94
Comparing 2003 and 1999	Modern contraceptive use	**105.87**	**5.36**	**0.98**	**0.53-1.79**

Notes: Before adding behaviour variables Chi square was 100.51 and AOR for having given birth 1.35 (0.78-2.33) in 2003 compared to 1995 and 0.84 (0.44-1.60) in 2003 compared to 1999. If chi square changed >|3.84|, the added variable is a confounding variable. The denominator is the total number of women. *The Chi square change is significant, but the AOR is further from 1, which means that adjusting for 'condom use at last sexual intercourse', 'ever condom use' or sexual activity last year increases the strength of the association between 'ever given birth' and survey time, rather than reducing it.

Additional table 7: Changes in the proportion of all women aged 15-24 who frequently use traditional agents before sex to make the vagina drier, by educational attainment, 1995-2003

	School years		0-7						8-9						10+					
Residence		**Year**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Females**	*1995*	41	*133*	Ref.		Ref.		28	*39*	Ref.		Ref.		13	*15*	Ref.		Ref.	
		1999	21	*312*	**0.39**	**0.26-0.60**	**0.42**	**0.27-0.63**	15	*55*	0.43	0.12-1.54	0.48	0.12-1.85	7	*14*	0.50	0.03-9.89	0.30	0.01-17.4
		2003	19	*291*	**0.33**	**0.18-0.62**	**0.32**	**0.17-0.60**	4	*47*	**0.11**	**0.01-0.96**	**0.11**	**0.01-0.87**	4	*26*	0.26	0.02-3.40	0.22	0.01-4.61
Urban	**Females**	*1995*	22	*163*	Ref.		Ref.		20	*134*	Ref.		Ref.		17	*128*	Ref.		Ref.	
		1999	4	*160*	**0.14**	**0.03-0.59**	**0.15**	**0.03-0.66**	4	*159*	**0.16**	**0.05-0.49**	**0.17**	**0.05-0.55**	0.4	*271*	**0.02**	**0.003-0.11**	**0.03**	**0.01-0.13**
		2003	12	*96*	0.50	0.17-1.48	0.47	0.17-1.27	7	*91*	**0.28**	**0.10-0.81**	**0.23**	**0.08-0.69**	2	*239*	**0.10**	**0.03-0.30**	**0.11**	**0.04-0.32**

Additional table 8: Proportions of all women aged 15-24 who frequently use traditional agents before sex to make the vagina drier, by educational attainment, 1995-2003

	Year		1995						1999						2003					
Residence		**School years**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Females**	0-7	41	*133*	Ref.		Ref.		21	*312*	Ref.		Ref.		19	*291*	Ref.		Ref.	
		8-9	28	*39*	0.57	0.27-1.21	0.57	0.26-1.22	15	*55*	0.63	0.17-2.41	0.60	0.17-2.09	4	*47*	0.20	0.02-1.63	0.18	0.02-1.34
		10+	13	*15*	0.23	0.04-1.32	0.21	0.03-1.34	7	*14*	**0.29**	**0.09-0.90**	0.29	0.08-1.05	4	*26*	**0.18**	**0.08-0.40**	**0.15**	**0.06-0.37**
Urban	**Females**	0-7	22	*163*	Ref.		Ref.		4	*160*	Ref.		Ref.		12	*96*	Ref.		Ref.	
		8-9	20	*134*	0.89	0.55-1.45	0.85	0.50-1.46	4	*159*	1.01	0.43-2.36	0.86	0.37-1.99	7	*91*	**0.49**	**0.28-0.87**	**0.44**	**0.21-0.91**
		10+	17	*128*	0.73	0.35-1.54	0.57	0.27-1.18	0.4	*271*	**0.10**	**0.01-0.96**	**0.07**	**0.01-0.69**	2	*239*	**0.15**	**0.06-0.39**	**0.12**	**0.05-0.28**

Additional table 9: Changes in the proportions of females aged 15-24 reporting current use of modern contraceptives by educational attainment, 1995-2003

	School years		0-7						8-9						10+					
Residence		**Year**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Females**	*1999*	15	*324*	Ref.		Ref.		27	*56*	Ref.		Ref.		20	*15*	Ref.		Ref.	
		2003	13	*309*	0.88	0.55-1.39	0.82	0.53-1.26	19	*57*	0.65	0.36-1.20	0.66	0.34-1.27	50	*34*	**4.00**	**2.15-7.43**	**3.13**	**1.51-6.49**
		1999	19	*167*	Ref.		Ref.		28	*169*	Ref.		Ref.		31	*280*	Ref.		Ref.	
Urban	**Females**	*2003*	35	*110*	2.23	0.92-5.40	1.86	0.84-4.14	32	*102*	1.24	0.78-1.97	0.90	0.58-1.38	40	*280*	**1.53**	**1.10-2.12**	1.26	0.95-1.69

Additional table 10: Changes in the proportions reporting current use of modern contraceptives by educational attainment among females aged 15-24, 1995-2003

Year		1999						2003					
Residence	**School years**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	*0-7*	15	*324*	Ref.		Ref.		13	*309*	Ref.		Ref.	
	8-9	27	*56*	**2.16**	**1.51-3.07**	**2.09**	**1.38-3.17**	19	*57*	1.61	0.90-2.86	1.68	0.97-2.92
	10+	20	*15*	1.47	0.78-2.78	1.62	0.84-3.15	50	*34*	**6.72**	**4.52-10.0**	**6.73**	**4.96-9.14**
Urban	*0-7*	19	*167*	Ref.		Ref.		35	*110*	Ref.		Ref.	
	8-9	28	*169*	**1.63**	**1.21-2.18**	**1.55**	**1.01-2.38**	32	*102*	0.91	0.42-1.97	0.81	0.37-1.75
	10+	31	*280*	**1.87**	**1.20-2.92**	1.55	0.98-2.45	40	*280*	1.28	0.62-2.63	1.05	0.58-1.89

Additional table 11: Changes in the proportions reporting ever having sex by educational attainment among adults aged 15-24, 1995-2003

	School years		0-7						8-9						10+					
Residence		**Year**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**	**%**	***N***	**Crude OR**	**95% CI**	**AOR**	**95% CI**
Rural	**Males**	*1999*	90	*202*	Ref.		Ref.		88	*59*	Ref.		Ref.		97	*29*	Ref.		Ref.	
		2003	79	*196*	**0.43**	**0.20-0.89**	**0.42**	**0.18-0.96**	78	*58*	**0.47**	**0.25-0.87**	**0.25**	**0.07-0.86**	72	*72*	0.09	0.01-1.05	**0.08**	**0.01-0.75**
	Females	*1999*	87	*342*	Ref.		Ref.		81	*64*	Ref.		Ref.		78	*18*	Ref.		Ref.	
		2003	84	*356*	0.79	0.47-1.34	0.65	0.35-1.22	69	*81*	**0.52**	**0.40-0.67**	**0.58**	**0.38-0.88**	67	*48*	0.57	0.28-1.15	0.33	0.09-1.18
Urban	**Males**	*1999*	60	*68*	Ref.		Ref.		57	*141*	Ref.		Ref.		70	*287*	Ref.		Ref.	
		2003	71	*73*	1.63	0.97-2.74	0.96	0.42-2.23	50	*143*	0.73	0.33-1.64	0.60	0.30-1.18	62	*477*	**0.69**	**0.53-0.89**	0.74	0.52-1.06
	Females	*1999*	66	*193*	Ref.		Ref.		65	*206*	Ref.		Ref.		65	*324*	Ref.		Ref.	
		2003	59	*193*	0.75	0.46-1.22	0.70	0.44-1.09	55	*198*	0.66	0.34-1.26	0.70	0.31-1.58	54	*564*	**0.61**	**0.47-0.80**	**0.51**	**0.38-0.69**

Additional table 12: Changes in the median reported age at sexual debut by educational attainment among adults aged 15-24, 1995-2003

	School years		0-7				8-9				*10+*			
Residence		**Year**	**Median**	**IQR**	***N***	**p-value**	**Median**	**IQR**	***N***	**p-value**	**Median**	**IQR**	***N***	**p-value**
Rural	**Males**	*1999*	15	14-17	*197*	0.03	15	14-18	*57*	**0.013**	16	15-17	*29*	**0.005**
		2003	16	15-16	*195*		17	15-18	*58*		18	16-21	*72*	
	Females	*1999*	15	15-17	*340*	0.45	17	16-19	*64*	0.73	17	16-19	*17*	0.26
		2003	16	15-17	*354*		17	15-19	*81*		19	17-20	*47*	
Urban	**Males**	*1999*	17	15-19	*66*	0.33	17	15-20	*134*	0.38	18	16-21	*279*	**0.06**
		2003	18	15-20	*73*		17	16-22	*143*		18	16-22	*473*	
	Females	*1999*	17	16-20	*184*	0.79	18	16-20	*200*	0.62	19	17-21	*306*	**0.005**
		2003	17	16-19	*192*		18	17-20	*198*		20	18-22	*554*	

Additional table 13: Percentages reporting having had sex by the age of 15 in 1999 and in 2003 based on the age groups of the respondents in 1999.

		Men						Women					
		1999		**2003**				**1999**		**2003**			
Rural	**Age in 1999**	**%**	***N***	**%**	***N***	**OR***	**95% CI**	**%**	***N***	**%**	***N***	**OR***	**95% CI**
	15-19	42	*113*	24	*156*	**0.45**	**0.25-0.83**	28	*176*	19	*233*	0.62	0.32-1.19
	20-24	26	*141*	17	*144*	0.58	0.34-1.02	18	*185*	21	*204*	1.19	0.74-1.90
	25-29	22	*120*	13	*151*	**0.50**	**0.29-0.86**	19	*174*	17	*147*	0.88	0.53-1.45
	30-34	23	*107*	15	*98*	0.59	0.22-1.59	15	*144*	17	*125*	1.18	0.64-2.19
	35-39	21	*87*	14	*88*	**0.61**	**0.37-0.98**	21	*112*	22	*96*	1.08	0.48-2.46
	40-44	13	*54*	13	*68*	1.02	0.35-2.96	17	*89*	16	*90*	0.91	0.49-1.69
	45-49	10	*60*	11	*45*	1.12	0.30-4.22	20	*54*	26	*58*	1.36	0.40-4.61
Urban	**15-19**	26	*111*	15	*284*	0.52	0.27-1.00	15	*157*	5	*332*	**0.28**	**0.12-0.65**
	20-24	16	*195*	12	*190*	0.69	0.39-1.20	5	*283*	4	*356*	0.79	0.38-1.63
	25-29	8	*131*	6	*147*	0.71	0.37-1.37	6	*265*	4	*245*	0.78	0.37-1.65
	30-34	10	*91*	9	*91*	0.88	0.45-1.73	4	*163*	3	*124*	0.87	0.21-3.69
	35-39	11	*56*	8	*71*	0.77	0.15-3.83	4	*140*	1	*115*	0.20	0.01-3.14
	40-44	12	*66*	6	*54*	0.43	0.18-1.04	8	*105*	5	*86*	0.59	0.20-1.74
	45-49	5	*60*	11	*46*	2.32	0.80-6.71	8	*51*	2	*45*	0.27	0.02-3.26

Notes: *The reference is 1999

Additional table 14: HIV prevalence among young people aged 15-24 reporting 'ever' and 'never' sexual activity

Year	Response	Urban												Rural											
		M						F						M						F					
		% HIV	*N*	Crude OR	95% CI	AOR	95% CI	% HIV	*N*	Crude OR	95% CI	AOR	95% CI	% HIV	*N*	Crude OR	95% CI	AOR	95% CI	% HIV	*N*	Crude OR	95% CI	AOR	95% CI
1999	***Never***	6.4	*155*	Ref.		Ref.		7.7	*220*	Ref.		Ref.		4.0	*25*	Ref.		Ref.		5.7	*53*	Ref.		Ref.	
	Ever	7.9	*277*	1.25	0.55-2.84	1.12	0.59-2.12	23.8	*421*	**3.72**	**1.83-7.56**	**2.54**	**1.38-4.67**	8.3	*241*	2.17	0.28-16.6	1.53	0.13-18.3	10.9	*329*	2.05	0.89-4.71	1.02	0.37-2.79
2003	***Never***	2.0	*244*	Ref.		Ref.		4.0	*370*	Ref.		Ref.		0	*68*	Ref.		Ref.		0	*89*	Ref.		Ref.	
	Ever	4.0	*377*	1.98	0.60-6.49	1.47	0.57-3.76	19.2	*468*	**5.63**	**3.99-7.96**	**4.55**	**2.90-7.14**	4.2	*240*	-	-	-	-	8.4	*367*	-	-	-	

Additional table 15: Age-adjusted odds ratio (AOR) of risk of HIV infection by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for urban and rural men and women aged 15-24 with higher education (≥10 years of schooling)

a)

Urban men aged 15-24 with 10+ years of school				
One by one behaviour indicator included				
Behaviour indicator	**Chi square**	**Chi-square change**	**AOR**	**95% CI**
Number of sex partners past 12 months	**8.94**	**-17.06**	**0.52**	**0.29-0.94**
Casual partner past year	**7.49**	**-18.51**	**0.53**	**0.26-1.08**
Condom use at last sex	**3.48**	**-22.52**	**0.45**	**0.23-0.88**
Ever used condom	**14.69**	**-11.31**	**0.49**	**0.28-0.85**
Condom use with last casual partner**	**3.48**	**-22.52**	**0.63**	**0.23-1.72**
STI last year	28.01	2.01	0.42	0.29-0.59

Notes: Before adding the behaviour variables the Chi square was 26.00 and AOR 0.41 (0.28-0.59) in 2003 compared to 1995. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year. . **The chief confounder in this step.

b)

Urban women aged 15-24 with 10+ years of school														
One by one behaviour indicator included					Two behaviour variables included					Three behaviour variables included				
Beh. indicator	**Chi-square**	**Chi-square change**	**AOR**	**95% CI**	**Beh. indicator**	**Chi-square**	**Chi-square change**	**AOR**	**95% CI**	**Beh. indicator**	**Chi-square**	**Chi-square change**	**AOR**	**95% CI**
Ever given birth	**22.35**	**-18.82**	**0.37**	**0.23-0.61**	Frequent dry sex and ever given birth	13.64	-1.78	0.51	0.31-0.84	Frequent dry sex and number of partners and ever given birth	4.95	-1.78	0.54	0.31-0.93
Number of sex partners past 12 months	**13.33**	**-27.84**	**0.42**	**0.24-0.73**	Frequent dry sex and number of partners**	**6.73**	**-8.69**	**0.50**	**0.29-0.86**	-				
Casual partner past year	**15.10**	**-26.07**	**0.40**	**0.22-0.70**	Frequent dry sex and casual partner last year	13.44	-1.98	0.48	0.27-0.83	Frequent dry sex and number of partners and casual partner	10.56	3.83	0.49	0.28-0.85
Condom use at last sex	**18.23**	**-22.94**	**0.39**	**0.25-0.61**	Frequent dry sex and condom use at last sex	**9.31**	**-6.11**	**0.46**	**0.31-0.70**	Frequent dry sex and number of partners and condom use at last sex	5.06	-1.67	0.49	0.33-0.73
Ever used condom	**14.49**	**-26.68**	**0.39**	**0.22-0.70**	Frequent dry sex and ever condom use	**6.82**	**-8.6**	**0.48**	**0.26-0.89**	Frequent dry sex and number of partners and ever condom use	5.58	-1.15	0.49	0.27-0.92
Frequent dry sex**	**15.42**	**-25.75**	**0.45**	**0.28-0.72**	-									

Notes: Before adding the behaviour variables the Chi square was 41.17 and AOR 0.27 (0.17-0.43) in 2003 compared to 1995**.** If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year.

c)

Rural men aged 15-24 with 10+ years of school									
One by one behaviour indicator included					Two behaviour variables included				
Beh. indicator	**Chi-square**	**Chi-square change**	**AOR**	**95% CI**	**Beh. indicator**	**Chi-square**	**Chi-square change**	**AOR**	**95% CI**
Number of sex partners past 12 months	**20.74**	**-172.99**	**0.35**	**0.13-0.90**	Casual partner last year and number of sexual partners*	29854.28	-39370	0.29	0.20-0.42
Casual partner past year**	**69224.28**	**69030.55**	**0.60**	**0.49-0.75**	-				
Condom use at last sex	**8022.54**	**7828.81**	**0.39**	**0.23-0.65**	Casual partner past year and condom use at last sex**	**-**	**-**	**0.70**	**0.49-0.99**
Ever used condom	**1704.62**	**1510.89**	**0.25**	**0.16-0.38**	Casual partner past year and ever condom use*	165481.25	96256.97	0.53	0.35-0.81
Condom use with last casual partner	-	-	-	-	Casual partner past year and condom use with last casual partner	-	-	-	-
STI past year	193.73	0	0.24	0.13-0.42	Casual partner past year and STI past year	69224.28	0	0.60	0.49-0.75

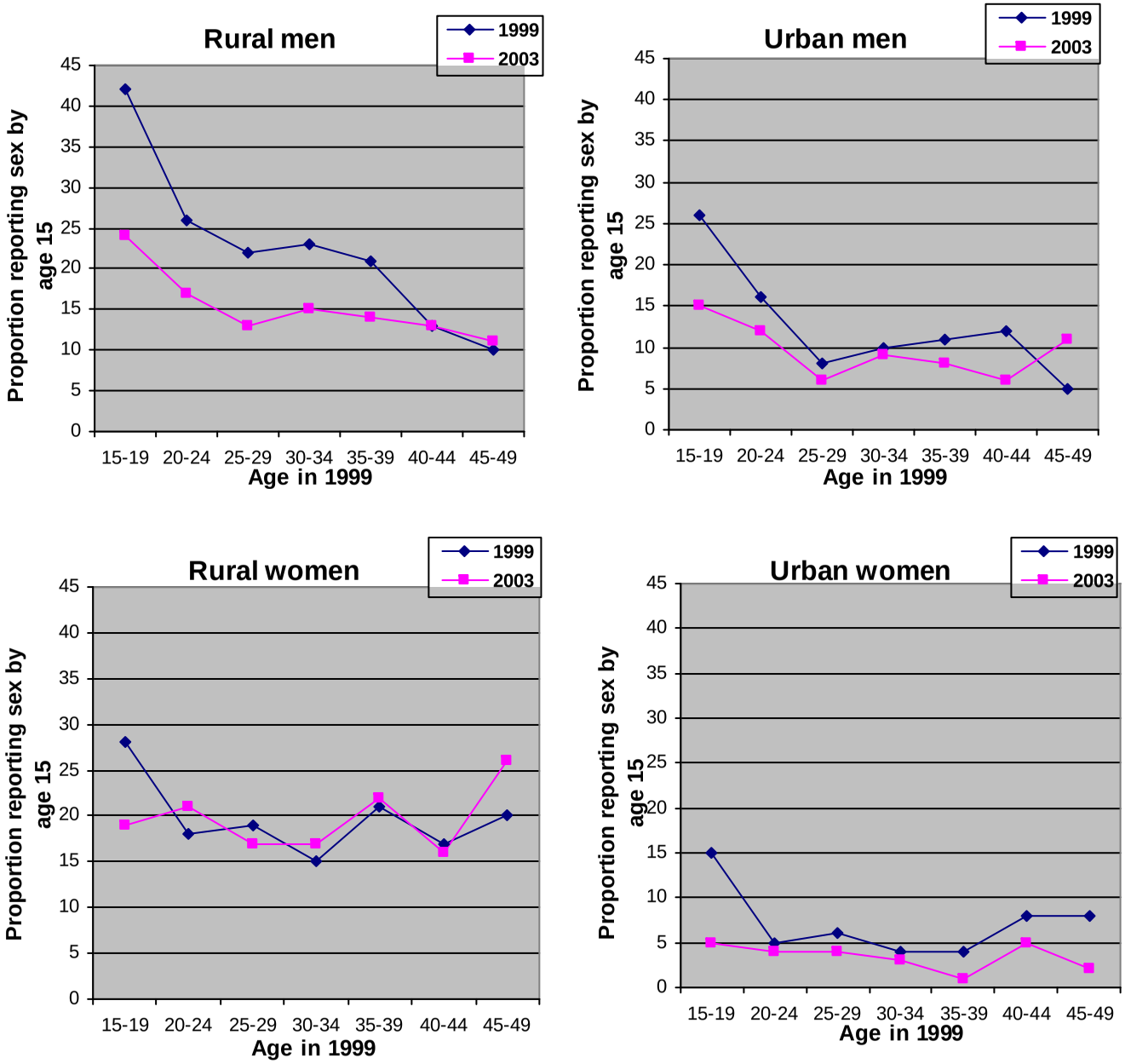
Notes: Before adding the behaviour variables the Chi square was 193.73 and AOR 0.24 (0.13-0.42) in 2003 compared to 1995. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year. *The Chi square change was significant, but the AOR was further from 1, which meant that adjusting for 'condom use at last sexual intercourse' or 'number of sexual partners past year' in addition to 'any casual partners past year' increased the strength of the association between HIV and survey time, rather than reducing it.

d)

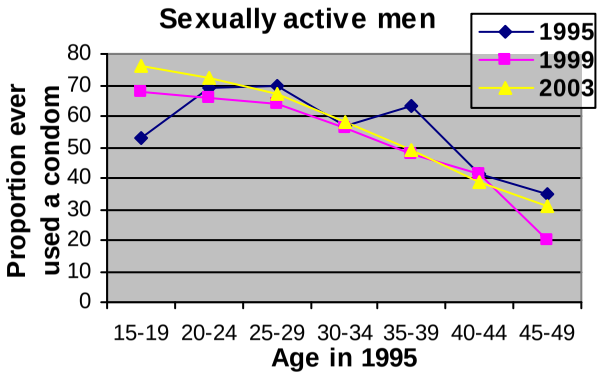
Rural women aged 15-24 with 10+ years of school				
One by one behaviour indicator included				
Beh. indicator	**Chi-square**	**Chi-square change**	**AOR**	**95% CI**
Ever given birth	**55.12**	**-18.87**	**0.20**	**0.02-1.64**
Number of sex partners last 12 months	**23.90**	**-50.09**	**0.22**	**0.04-1.16**
Casual partner last year	**28.01**	**-45.98**	**0.21**	**0.06-0.78**
Condom use at last sex	**-**			
Ever used condom**	**198.82**	**124.83**	**0.76**	**0.45-1.29**
Frequent dry sex	**41.94**	**-32.05**	**0.27**	**0.14-0.52**

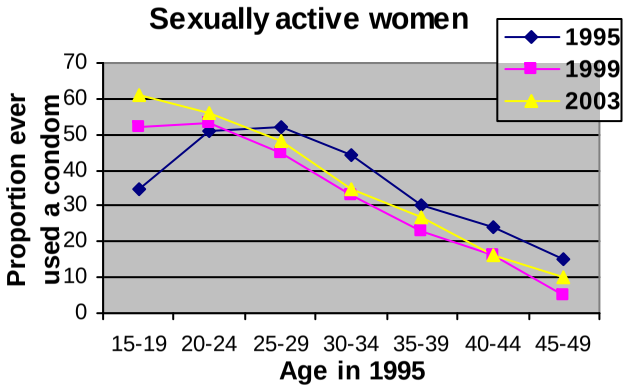
Notes: Before adding the behaviour variables the Chi square was 73.99 and AOR 0.18 (0.04-0.85) in 2003 compared to 1995. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year.

Additional figure 1: Percentages reporting having had sex by the age of 15 in 1999 and in 2003 based on the age groups of the respondents in 1999

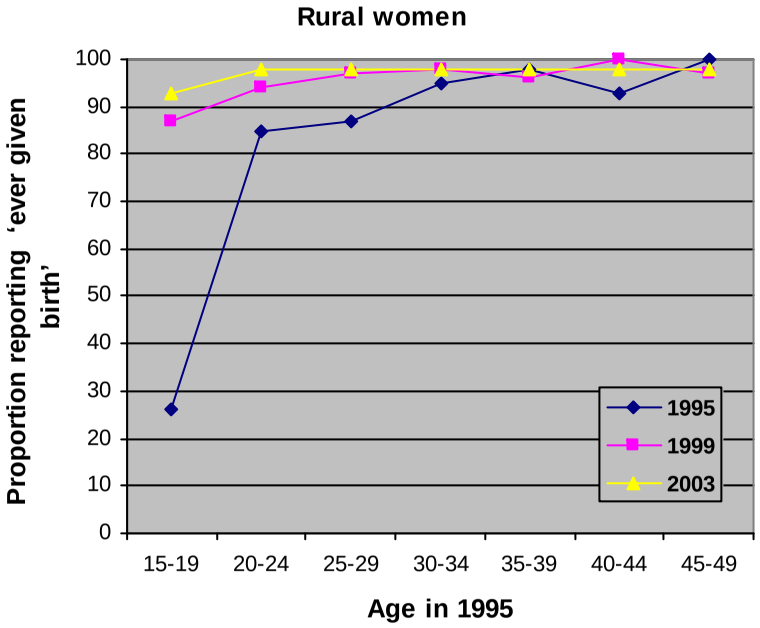


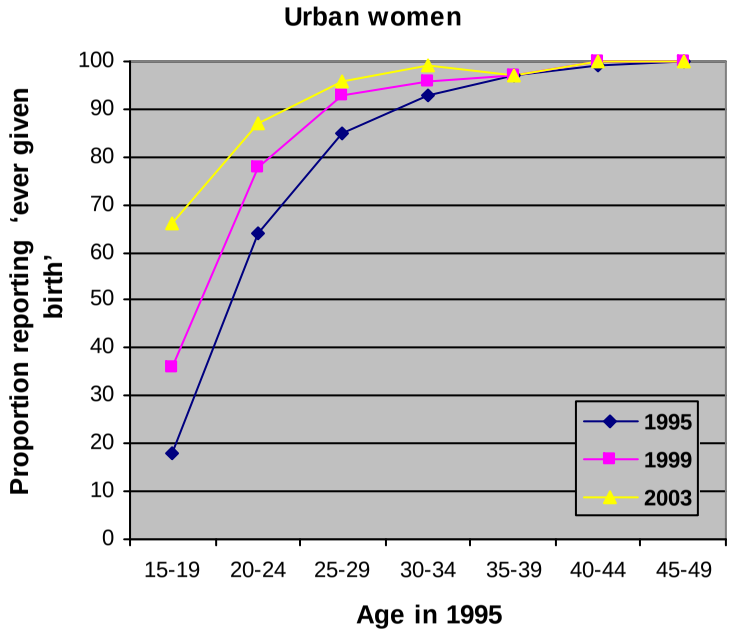
Additional figure 2: Proportions who reported ever having used a condom in 1995, 1999 and 2003 based on the age groups of the respondents in 1995. The denominator is the number of sexually active respondents





Additional figure 3: Proportion of women reporting 'ever given birth' in 1995, 1999 and 2003 based on the age groups in 1995





Paper III

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Lost opportunities in HIV prevention: programmes miss places where exposures are highest.
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Research article

Lost opportunities in HIV prevention: programmes miss places where exposures are highest

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Abstract

Background: Efforts at HIV prevention that focus on high risk places might be more effective and less stigmatizing than those targeting high risk groups. The objective of the present study was to assess risk behaviour patterns, signs of current preventive interventions and apparent gaps in places where the risk of HIV transmission is high and in communities with high HIV prevalence.

Methods: The PLACE method was used to collect data. Inhabitants of selected communities in Lusaka and Livingstone were interviewed about where people met new sexual partners. Signs of HIV preventive activities in these places were recorded. At selected venues, people were interviewed about their sexual behaviour. Peer educators and staff of NGOs were also interviewed.

Results: The places identified were mostly bars, restaurants or sherbeens, and fewer than 20% reported any HIV preventive activity such as meetings, pamphlets or posters. In 43% of places in Livingstone and 26% in Lusaka, condoms were never available. There were few active peer educators. Among the 432 persons in Lusaka and 676 in Livingstone who were invited for interview about sexual behaviour, consistent condom use was relatively high in Lusaka (77%) but low in Livingstone (44% of men and 34% of women). Having no condom available was the most common reason for not using one. Condom use in Livingstone was higher among individuals socializing in places where condoms always were available.

Conclusion: In the places studied we found a high prevalence of behaviours with a high potential for HIV transmission but few signs of HIV preventive interventions. Covering the gaps in prevention in these high exposure places should be given the highest priority.

Background

Many efforts at HIV prevention in sub-Saharan Africa have been aimed at high risk groups as these are believed to contribute disproportionately to the spread of the epidemic [1-3]. In countries with a relatively low HIV prevalence in the general population, much of the HIV transmission usually occurs from high risk/core groups (e.g. sex workers) to bridging populations (e.g. male clients) to the general population (e.g. low risk female partners). In settings with high prevalence in the general population, more transmission takes place among non-core individuals, but high risk groups can still be an important source of new infections [4-6]. In a study from rural Zimbabwe, 20% of infections among men in the

general population were estimated to be due to sexual contact with sex workers [1]. Several examples show that interventions such as syndromic management, presumptive or prophylactic treatment of STIs, dedicated STI clinics, peer education and condom distribution targeted at sex workers have been successful in achieving increased condom use [7-16] and reduced incidence of STIs [7-9,12,13,17,18] and HIV [8,18-20] in this high risk group, and some have also found reduced prevalence of STIs [17] and/or HIV [8,18] among their clients. Very few of these trials have, however, had randomized designs and comparable control groups. There is evidence that such interventions had an effect on the HIV incidence in the general population of Thailand [8,18] and Cambodia [21,22], but the potential impact on the population incidence in countries with much higher HIV prevalences, as in sub-Saharan Africa, is more uncertain [23]. A problem with interventions targeting specific groups is that they may cause stigmatisation of already-marginalized individuals. Furthermore, in many countries in Africa transactional sex and frequent partner changes are quite common among women who do not identify themselves as sex workers [1,24-26]. Using mathematical models, Boily et al. found that for epidemics with a high basic reproductive number, interventions targeting core groups should be supplemented by general population approaches early in the epidemic [5].

Weir et al. have proposed that prevention should be focused on places where exposure to HIV can be assumed to be very high and have described a method for identifying such places rapidly (called "Priorities for Local AIDS Control Efforts", abbreviated PLACE-method) [23]. The assumption is that in countries where the HIV prevalence is high, focusing on high risk places such as venues where people meet new sexual partners would be even more effective in reducing the HIV transmission rate than targeting interventions just at perceived high risk groups. It may also cause less stigmatisation [27]. Accordingly, studies of such high risk sites to assess the coverage and intensity of interventions are of particular importance. Studies of this type from sub-Saharan Africa have found few HIV interventions or condoms in such venues [23,28-30]. However, PLACE-studies conducted in East London, South Africa, in 2000 and 2003 showed an increase in condom use and a reduction in numbers of recent partners during a 3 year period, and this could possibly be related to a community-based intervention targeting high risk venues [31].

Despite numerous condom promotion campaigns in sub-Saharan Africa, condom use with non-regular partners for prevention of STIs, including HIV, is still relatively low (< 50%) [32-35]. An increase in condom use for casual sex has been observed in Zambia and Zimbabwe [34,36-38], together with other changes in sexual behaviour. This is probably related to the observed declines in HIV prevalence. However, the prevalence among young people (a proxy of incidence) in both these countries is still high. It seems that condom use must reach a certain level to have a major influence on the epidemic [6,8,33]. Several studies indicate that making condoms easily available in places where people meet sexual partners may be critical for increasing the probability that people will use them [28,39-42]. However, despite many condom promotion campaigns, condoms are seldom found in bars, discos or guest houses where people meet potential sexual partners [23,28-30].

A growing number of studies from southern Africa have revealed signs of decline in the HIV epidemic [37,38,43-48], but have also shown marked local differentials within countries [45,47,49]. An example from Zambia is the difference between trends appearing in two major cities, Livingstone and Lusaka. In Livingstone, HIV surveillance among antenatal clinic (ANC) attendees conducted since 1993 has shown a high and stable HIV prevalence of around 30% among women below the age of 25 years. In contrast, the HIV prevalence in Lusaka was very high in the early 1990s, but has declined during the past decade according to both ANC-based HIV surveillance and population-based surveys from Chelston township, i.e. from 22.5% in 1995 to 12.5% in 2003 in women in the general population aged 15–24 years [50,51]. Unfortunately, no system for monitoring the coverage and intensity of preventive interventions has been put in place until recently in either city, so there is insufficient information to explore the relationship between differentials in transmission trends and past preventive efforts. Although HIV prevention programs appear to have been successful in Chelston, it is vital to sustain the energy in both cities. We investigated signs of current preventive efforts and apparent gaps in places where people meet new partners in these two urban settings approximately 20 years after the first prevention programs were launched.

Methods

We wanted to study high risk places in Lusaka, the capital city of Zambia, and in Livingstone, a border city and the main tourist spot in Zambia, which are two urban communities where the HIV epidemic has developed differently. We selected townships in the two cities for which we have data about HIV prevalence over time. The ANC-based HIV surveillance in Livingstone includes data from the health clinics in Maramba, Dambwa and New Boma, and the results from these three clinics are pooled in the surveillance reports. In Lusaka, we chose Chelston as our study community as we have both population-based and ANC-based prevalence data from this township. According to the 2000 population census Chelston had a popu-

lation of 33,700 and the three townships in Livingstone had a total population of 41,800. Both cities have high unemployment rates, but we observed worse housing and sanitary conditions, indicating higher poverty levels, in the three study communities in Livingstone than in Chelston. Livingstone had many sherbeens (informal drinking places operating illegally without a license to serve alcohol), but none were found in Chelston.

The PLACE-method was used to collect the information. During the first phase of the study people who knew the selected communities well because they lived or worked there, such as young people encountered in the streets, health personnel, taxi drivers, shop staff and bar workers, were interviewed about places where local people meet new sexual partners. The informants were people that the interviewers met as they walked systematically through the study areas. The target number of informants during the first phase was 200 in Chelston and 400 in Livingstone as a bigger area would be covered in Livingstone. The study team also looked for places where people gathered and it seemed likely that new partnerships were formed.

During the second phase, the interviewers tried to find all the sites that had been mentioned. As informants in Livingstone, with just a few exceptions, only mentioned places in Maramba, Dambwa and the city centre, we decided to examine only venues in these areas. In Chelston, most of the places mentioned were within Chelston, and we only visited these. In those places that were found, one person who knew the site well (a bar worker or a regular guest) was interviewed about what activities occurred there and the availability of condoms and educational materials.

The last part of the study consisted of interviews on sexual behaviour and partnership establishment with a sample of individuals who socialized at selected venues. All sites mentioned by more than 10 informants during the first phase, and a random sample of 30% of the remaining sites were selected for interviews (with the probability of selection proportional to the estimated number of guests on an average night). The interviewers approached individuals who were standing along two imaginary diagonal lines connecting the four corners of the room, and tried to interview as many as possible in each venue visited.

We excluded churches and schools that had been identified in the first phase from the second and third phases of the study because the authorities were reluctant to distribute condoms, and we did not expect them openly to admit that people met sexual partners in schools or churches.

In addition, the interviewers recorded observations and concerns that were repeatedly mentioned in the venues. We also interviewed one nurse, one counsellor and 1–2 peer educators at three of the health clinics in the townships, and staff of the NGOs who ran HIV preventive activities in the study areas. All the interviews were performed between September and December 2005.

Statistical analysis

Statistical analyses were performed using SPSS version 13-0. The results of the interviews with people socializing in the venues were weighted by multiplying by the estimated number of guests at busy hours and dividing by the number of interviews conducted. We performed a chi-square test of independence to test for a relationship between number of partners in the last month and engaging in transactional sex among women. A p-value less than 0.05 indicated a significant association between the number of sexual partners and engaging in transactional sex.

Ethical aspects

We only interviewed adults 18 years or older. All interviews were anonymous and based on oral consent, and the informants were assured that the information they provided would not be linked to them or to the specific site. The protocol was approved by the Research Ethics Committee of the University of Zambia (Ref no. 012-08-05).

Results

During the first phase of the study, 275 informants in Lusaka and 434 in Livingstone were asked where people met new sexual partners. Seventy-eight places in Lusaka and 147 situated in Maramba, Dambwa and the city centre of Livingstone were identified. In Lusaka, most of the places were bars or restaurants. The rest were schools, night clubs, guest houses, churches, a cinema hall and a bus stop. In Livingstone, 50% of the places were sherbeens, 37% bars and restaurants, and the rest were guest houses and night clubs (Table 1). Approximately 40% of the venues were reported to have between 10–25 guests during busy hours, and another 40% of the venues had 26–50 guests.

HIV preventive activities in venues

HIV preventive activities such as meetings and distribution of pamphlets had taken place in fewer than 5% of the venues, and HIV-related posters had been present in 17% of the venues in Livingstone and 3% in Lusaka (Table 2). Only a third of the venues were reported always to have condoms available. When asked to produce condoms, the staff in 42% and 26% of the venues in Livingstone and Lusaka respectively could do so (Table 3). Condoms were never available in 26% of the venues in Lusaka and 43%

Table 1: Venues mentioned by informants during the first phase

		Lusaka		Livingstone	
		%	N (sites)	%	N (sites)
Type of place	Sherbeen	0	78	50	147
	Bar/restaurant	76		37	
	Night club	4		5	
	Guest house	3		7	
	School	5		0	
	Bus station	1		0	
	Church	10		0	
	Cinema hall	1		0	
Place verification	Venue found	82	78	78	147
	Venue found, but no venue representatives willing to be interviewed	3		1	
	Venue not found	0		12	
	Venue closed temporarily	3		0	
	Venue closed permanently	3		1	
	Venue not visited	10		10	

in Livingstone (Table 2). However, respondents in 84% of the venues in Lusaka and 63% in Livingstone stated that it was possible to find condoms within 10 minutes of the site.

Individuals socializing

During the third phase of the study 432 persons in Lusaka and 676 in Livingstone were invited for interview. The refusal rates were 2.8% in Lusaka and 2.5% in Livingstone. Eighty-five percent of the respondents in Lusaka

Table 2: Responses to interview with venue representatives (one per site)

			Lusaka		Livingstone	
			%	N (sites)	%	N (sites)
Staff or patron agreed to be interviewed			97	66	99	116
Men meet new female sexual partners here			72	64	82	115
Women meet new male sexual partners here			73	64	82	114
Men meet new male sexual partners here			11	64	0	114
Sex workers operate here			73	64	80	115
Among men who come to this venue	--- find new sexual partners here	None	28	61	21	114
		Some	35		73	
		Most	37		6	
	--- appear to be paying for sex	None	31	61	21	114
		Some	34		73	
		Most	35		7	
Among women who come to this venue	--- find new sexual partners here	None	33	61	19	113
		Some	30		70	
		Most	37		11	
	--- appear to be selling sex	None	32	62	19	113
		Some	28		69	
		Most	40		11	
HIV preventive activities that have taken place in venue[1]		Lectures/seminars	2	58	4	115
		Pamphlets/leaflets	3	58	3	115
		Posters	3	58	17	115
How often condoms available to guests in venue[1]		Always	28	58	31	114
		Sometimes	47		26	
		Never	26		43	
Condoms reported to be available in venue at time of interview[1]			29	58	44	115

N varies because of missing responses to some questions.

[1] Including only sherbeens, bars/restaurants, night clubs, guest houses

Table 3: Percentage of venues where interviewers observed condoms

		Lusaka		Livingstone	
		%	N (sites)	%	N (sites)
Condoms observed by interviewer		26	58	42	115
Percentage of venues[1] where condoms observed among ...	Venues where condoms said always to be available	75	16	94	35
	Venues where condoms said sometimes to be available	11	27	47	30
	Venues where condoms said never to be available	0	15	2	49

[1] Including only sherbeens, bars/restaurants, night clubs, guest houses

and 77% in Livingstone were males. Almost all (> 99%) were from the city where they were interviewed. The average ages were 21.1 (SD 3.3) and 24.9 (SD 5.6) years for females ($p < 0.001$) and 26.9 (SD 5.1) and 29.9 (SD 6.6) years for males ($p < 0.001$) in Lusaka and Livingstone, respectively, and the average numbers of years of school attendance were 11.6 (SD 1.7) and 9.9 (SD 2.2) for women ($p < 0.001$) and 11.5 (SD 2.5) and 11.4 (SD 2.4) for men.

High level of sexual risk behaviour

Half the men in both cities stated that they had come to the venues to meet a sexual partner. Among women, 66% in Livingstone and 8% in Lusaka reported such intentions, and 85% and 60% respectively reported ever having met a sexual partner in the venue where they were interviewed (Table 4). In 99% of the venues at least one person reported having previously met sexual partners in the place where he/she was interviewed. In Livingstone, 93% of women said this had happened during the previous week, whereas in Lusaka, 51% reported the same. Half the women interviewed in Lusaka and 87% in Livingstone had received money in exchange for sex during the 3 months prior to the survey, but the interviewers observed that more women were approaching men and seemed to be negotiating sex than admitted it. The median number of partners in the last month preceding the survey was 3 (IQR 2–4) for men in both cities, 3 (IQR 2–4) for women in Livingstone and 2 (IQR 1–3) for women in Lusaka. A high proportion of these partners were new for women in both Livingstone (77%) and Lusaka (50%). We also found that women who had had 3 or more sexual partners in the previous month were more likely to engage in transactional sex ($p < 0.001$).

Condom use

More than 80% of men and women in Lusaka claimed to have used a condom both during the last sexual intercourse with a partner from the venue where they were interviewed and with the last new partner, whereas only half the women and approximately 60% of the men in Livingstone reported the same. The proportion of respondents who had used a condom with all new partners in the previous month was also much higher in Lusaka, and the same applied to condom use with clients for women who admitted receiving gifts for sex (Table 4). About three quarters of men and 67% of women with more than 9 years of schooling used a condom with the last new partner compared to 43% and 20% respectively with 0–7 years of education ($p < 0.001$). The proportions who reported not using a condom with the last new partner were 14% and 39% among men and 12% and 45% among women in Lusaka and Livingstone respectively. Not having a condom at hand, trusting the partner, dislike of condoms, and conviction that condoms can break, were the most common reasons mentioned. The majority (68%) of male respondents in Lusaka believed that condoms were very effective in preventing HIV, but the others were less convinced. Twenty-nine percent of men and 34% of women in Livingstone and 17% of men and 44% of women in Lusaka expressed low trust in the effectiveness of condoms.

The majority of women said that their partners had brought the last condom they used. More women in Livingstone than in Lusaka had a condom in their pocket when asked to show the interviewers one, whereas around a third of men in both cities could prove that they had brought a condom (Table 4). Women in Livingstone who had a condom with them were more likely to have used a condom with the last new partner than those who did not have a condom (OR 2.72; 95% CI 1.27–5.84). Condom use in Livingstone was also higher among individuals who socialized in places where condoms were declared always to be available and in places where condoms were observed by the interviewers ($p = 0.001$), and this was especially the case for men who were not convinced that condoms were effective in preventing HIV transmission. In Lusaka, reported condom availability was not associated with condom use (Figure 1).

Current HIV preventive programs in the townships

In both Lusaka and Livingstone, the local health clinics ran VCT and youth peer education programs. In addition, some NGOs ran such programs and distributed condoms. In both cities, a number of youth peer educators had been

Table 4: Responses from individuals socializing at places where people meet new sex partners

		Males				Females			
		Lusaka		Livingstone		Lusaka		Livingstone	
		%	N*	%	N*	%	N*	%	N*
Came to meet a sexual partner		53	229	51	413	8	61	66	138
Ever met a sexual partner here		68	358	63	508	60	62	85	149
Used a condom the last time had sex with a partner from this venue		85	234	64	315	81	37	52	126
Any new sexual partner last 4 weeks		76	354	78	500	70	62	87	149
Used a condom the last time had sex with one of these new partners		86	265	61	386	88	43	55	129
How often used condom with new partners during the previous 4 weeks	Always	77	258	44	378	77	43	34	125
	Sometimes	22		44		23		58	
	Never	1		13		0		8	
Have brought a condom		45	356	36	503	5	61	46	151
Condom shown if claimed to have brought		93	150	94	179	25	4	83	69
Condom shown (out of all)		39	366	33	517	2	65	37	154
Self-perceived risk of HIV	None	35	350	33	505	23	61	37	151
	Moderate	45		36		34		36	
	High	12		20		25		15	
	Very high	7		10		18		12	
Discussed with anyone in the last 6 months how to prevent becoming HIV infected		86	273	83	498	85	54	65	150
If yes, with whom?	Parents	8	235	2	413	2	46	3	97
	Grandparents	4		2		13		4	
	Brothers/sisters/cousin	38		15		15		20	
	Spouse	39		42		50		27	
	Friends	94		80		94		92	
	Peer educators	11		19		9		16	
	Health personnel	18		29		24		22	
Have received money in exchange for sex in the past 3 months (women)		-		-		50	62	87	150
Used a condom last time received money in exchange for sex (women)		-		-		85	27	54	127
Given money or gifts in exchange for sex in the past 3 months (men)		74	356	81	499	-		-	
Used a condom last time paid for sex (men)		92	264	69	405	-		-	
Had sex with man during the past 4 weeks (men)		0	348	0	494	-		-	

N varies because of missing responses to some questions.
*Individuals socializing at venues

trained during the previous 2–3 years, but only a handful were still active in the townships we studied. For example, 2 years after 20 peer educators were trained by one NGO in Lusaka, only one was still involved. Most of the peer educators had quit because of lack of incentives, follow-up, material or mental support, or fringe benefits such as reduction in fees at the health clinic from which they were working. Many of the peer educators were also frustrated that they were not involved in planning prevention and health care services for young people. Those peer educators who were still active worked primarily from their offices and rarely did outreach activities. None of the peer programs currently targeted places where people met sexual partners, and no other programs did this at the time of the survey. The posters and leaflets that were found in a few of the venues had been distributed by peer educators some time previously.

None of the clinics in the townships in our study currently had programs targeting sex workers, and only one NGO initiative, Corridors of Hope, targeted this group in Livingstone in 2005. They reported that they were offering

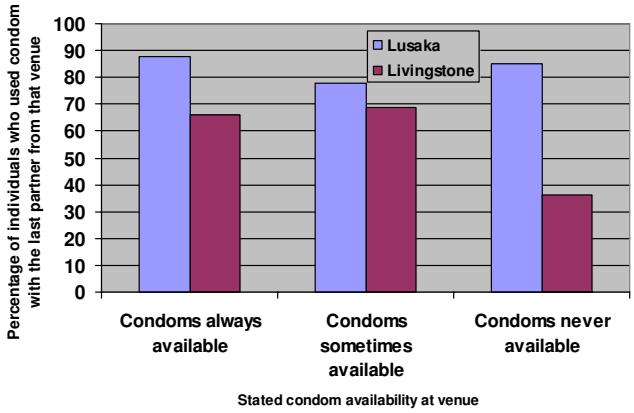

Figure 1
Condom use with the previous partner in relation to condom availability at the venue. Proportion reporting condom use with the previous sexual partner from a specific venue in relation to how often condoms were reported to be available at the same venue, men and women combined.

approximately 2000 sex workers in Livingstone free STI-services and VCT, promoting condom use, and training sex workers as peer educators (Program Director, Corridors of Hope (CoH), Family Health International). According to a survey conducted by CoH among female sex workers in 2003, 51% in Livingstone were registered with the program [52]. In 2006, however, they closed down all their activities in the city.

Discussion

This study successfully identified venues at which there was a high risk of HIV exposure among individuals socializing. Most of the guests interviewed reported having met a sexual partner in the venue where they were interviewed, and the median number of sexual partners reported during the month prior to the study was high. Our study revealed missed opportunities in prevention, as very few of these venues seemed ever to have been exposed to HIV preventive activities, and we found no current interventions that specifically targeted these high-risk venues. In comparison, similar PLACE-studies conducted in two other urban areas in Zambia, i.e. Mongu and Kapiri Mposhi, in 2005 found that one third and half the high-risk venues reported previous HIV prevention activities, respectively [53,54]. The current study also revealed major gaps related to recruitment, continuous training and follow-up of youth peer educators.

The respondents reported a higher median number of sexual partners in the previous month than men and women in the general population in Chelston, who reported a median of 1 for the previous year in 2003 [unpublished data]. The number was also higher than the median of 1 found among men and women in the PLACE-studies in Mongu and Kapiri Mposhi [53,54]. Reported condom use among respondents in both Lusaka and Livingstone was higher than has been reported with casual partners in the Sexual Behaviour Survey 2005 (50% in urban areas) [34] and in the PLACE-studies from Mongu and Kapiri Mposhi (< 25%) [53,54], and in Lusaka the level was slightly higher than in the population-based survey from Chelston (70%) [Unpublished data]. This may reflect the higher partner turnover in the current study.

The lack of association between condom availability and condom use in Lusaka may be partly because condoms were allegedly nearly always available nearby, and higher trust in the protective effect of condoms among men in Lusaka made them willing to walk further to obtain condoms when they needed them. Most women in both cities relied on their partner to have a condom, and considering that a higher percentage of women in Livingstone than in Lusaka had a condom in their pocket (37% vs. 2%), their attitude to condoms did not seem to be decisive. In both cities not having a condom at hand was the most usual reason given for not using one with the last new partner or the last paying partner. After decades of condom promotion campaigns, it is thought-provoking that so many of the respondents expressed low trust in the effectiveness of condoms. Influential religious and political leaders who have emphasized the theoretical risk of HIV transmission when using a condom may have contributed to this [55-57]. It is encouraging that making condoms readily available seemed partially to compensate for sceptical attitudes among men in Livingstone. Since many of those who are out socializing also consume alcohol, making them less cautious, and as sexual intercourse is often not planned, it is important to make it easy for people to protect themselves. Providing condoms at venues where people socialize is therefore a simple but potentially effective structural intervention for preventing HIV transmission. Condoms can easily be placed in toilets and in rooms of guest houses and hotels so that people can obtain them out of public sight.

Transactional sex was very common among respondents in both cities, especially in Livingstone, which might reflect the higher level of poverty there. Numerous studies from sub-Saharan Africa have shown that many women who engage in transactional sex do not identify themselves as commercial sex workers, nor are they seen as such by the rest of the community. Receiving money and gifts for sex may be among the few available ways for women to secure themselves and their families financially when other sources of income are not sufficient [24,25,58-62], but the women may also have some hope that such relationships will evolve to become more lasting, i.e. marriage. The desperate need for money and the

interest in a long-term relationship often put them in a weak position for negotiating condom use [24-26,59-61].

There have generally been very few preventive interventions in Zambia targeting sex workers with dedicated clinics and peer education, and Corridors of Hope, the only provider in Livingstone, has now closed down its activities. There is a need for political will to launch such interventions which have been shown to be effective in reducing HIV incidence among sex workers. A limitation of such programs is, however, that they may not reach women who only periodically engage in transactional sex, although they also may have a high partner turnover and many concurrent partners and may seldom use condoms [59]. Interventions targeting high risk places in addition to high risk groups are likely to reach a higher proportion of these women. This means that all venues where people meet sexual partners should be targeted, since women who perceive themselves as professional sex workers may operate in other establishments and other neighbourhoods than women who engage in transactional sex more infrequently [59]. There is currently a lack of strong evidence for the hypothesis that providing condoms and health educational materials in venues where people meet new sexual partners has an impact on HIV incidence in the general population. However, although no randomized field trials have been conducted that directly compare interventions targeting places with those targeting specific groups, it makes sense that approaches that also include women who engage in high risk behaviours only periodically, and their male partners, will be more effective against mature generalized epidemics.

Half the venues identified in Livingstone were sherbeens. In contrast, such places were non-existent in Chelston. This difference may reflect a different level of law enforcement in respect of alcohol regulations, or simply a different drinking culture. We do not have detailed data about the socioeconomic conditions in the townships we studied, but the available information from the Central Statistical Office is consistent with the observation of a high level of poverty in both cities.

We are convinced that we have a representative sample of venues where people meet sexual partners, as we tried to visit all the places mentioned and were able to find representatives willing to be interviewed in almost all of them. During the third phase, however, a convenient sampling method is used in all PLACE-studies. People who were reluctant to be interviewed could withdraw from the space near the interviewers. This means that although we recorded a very low refusal rate and tried to follow a predetermined sampling technique, we may not have interviewed a representative sample of the guests. The fact that some of the questions had a higher proportion of missing values than others, e.g. "Why did you come here today? – to meet a sexual partner?", could indicate partial refusals, but these questions did not appear to be more intimate than questions with a higher response rate. In any case, it is impossible to judge whether the successfully interviewed were engaging in greater or lesser risk behaviours than guests who were not interviewed. As in any study on sexual behaviour, it is also possible that the respondents were both under- and over-reporting certain behaviours. We found signs that some women who denied intentions to meet a sexual partner were not speaking the truth. Condom use may have been over-reported. However, the information that could be validated about condoms turned out to be reliable; in most of the places where the staff/patrons claimed that condoms were always available, and among most of the men who said they had brought a condom, this was verified.

The PLACE-method is intended for rapid assessment of the current situation and for making recommendations for the future based on such assessments, and not for drawing causal inferences. We only have data from one point in time, and it is therefore impossible to say whether any of the differences we found in the data in Lusaka and Livingstone could explain why the epidemics have had different courses in the two cities. Although few signs of HIV preventive programs were revealed at the time of the study, we cannot exclude the possibility that both cities may previously have been exposed to intensive campaigns against HIV in such venues.

Conclusion

Many missed HIV preventive opportunities were identified in places where exposure is highest. Covering this gap would probably have a high impact on a short term basis, and the need to establish a monitoring and evaluation system in this regard is urgent. The present findings are to be followed up in the areas studied through an intervention comprising condom distribution and peer education among young people. To curtail transmission further, however, we believe that interventions with more long-term perspectives are badly needed, for example offering social and economic support programs that target women being forced into sex work.

List of abbreviations used

ANC Antenatal clinic

HIV Human immunodeficiency virus

NGO Non-governmental organization

PLACE Priorities for Local AIDS Control Efforts

STI Sexually transmitted infection

Conflicts of interest

The author(s) declare that they have no competing interests.

Authors' contributions

IFS prepared the proposal, coordinated and supervised the survey, and conducted interviews with health personnel and peer educators, analysed the data, interpreted the findings and wrote the manuscript. SS helped develop the protocol, assisted in the supervision of data collection, and took active part in revising the manuscript. KF made substantial contributions to the conception of the survey and took active part in interpreting the results and revising the manuscript. All authors read and approved the final manuscript.

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Paper IV

Sandøy IF, Dzekedzeke K, Fylkesnes K.
Prevalence and correlates of concurrent sexual partnerships in Zambia.
(Submitted)

Prevalence and correlates of concurrent sexual partnerships in Zambia

Ingvild F. Sandøy[1], Kumbutso Dzekedzeke[12], Knut Fylkesnes[1]

Abstract

Background: Concurrent partnerships may cause more rapid spread of HIV in a population. We examined how the prevalence of parallel relationships changed in Zambia from 1998 to 2003.

Methods: The data were collected as part of the Sexual Behaviour Surveys (ZSBS) 1998, 2000 and 2003. We studied the prevalence and predictors of concurrent partnerships among men and women aged 15-49.

Results: Thirteen percent of rural and 8% of urban men reported more than one ongoing relationship in 1998, and these proportions declined to 8% and 6% respectively in 2003. The proportion of women reporting concurrent relationships was negligible. The most important predictors of concurrency were early sexual debut, absence from home and being married.

Conclusion: The prevalence of concurrent sexual partners declined during the period covered by the surveys. This is consistent with reductions in other risk behaviours and may have contributed to declines in HIV prevalence. It is likely that concurrency was much more common during the early phase of the HIV epidemic in Zambia.

Key words: HIV; heterosexual transmission; concurrent sexual partners; Zambia

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[2] Central Statistical Office, Zambia

Appendix

Questionnaires for the antenatal HIV surveillance

NATIONAL HIV/STD SENTINEL SURVEILLANCE

SITE:…….. *DATE:…… ID:……*

(Answer accordingly by ticking in the box or recording a valid response in the space provided)

1. Age (in years) ☐

2. Marital status

Married	1	☐
Single	2	☐
Divorced	3	☐
Widow	4	☐

3.

Polygamy	1	☐
Monogamy	2	☐

4. Residence

		URB	RUR
High	1	☐	☐
Medium	2	☐	☐
Low	3	☐	☐
Village	4	☐	☐
Sharity	5	☐	☐
Site and service	6	☐	☐

5. Main occupation

		RESP	SPOUSE
Commerc. farmer	01	☐	☐
Peasant farmer	02	☐	☐
Trader	03	☐	☐
Medical	04	☐	☐
Education	05	☐	☐
Truck driver	06	☐	☐
Executive	07	☐	☐
Clerical	08	☐	☐
Army	09	☐	☐
Engineer	10	☐	☐
Police/security	11	☐	☐
Student	12	☐	☐
Self employed	13	☐	☐
Unemployed	14	☐	☐
Housewife	15	☐	☐
Hotel/restaurant/bar	16	☐	☐
Domestic servant	17	☐	☐

6. Years in school (number) ☐
(of respondent only)

7. Educational level

		RESP	SPOUSE
None	1	☐	☐
Primary	2	☐	☐
Secondary J	3	☐	☐
Secondary S	4	☐	☐
College	5	☐	☐
University	6	☐	☐

8. Denomination

Catholic	1	☐
Pentecostal	2	☐
Apostolic	3	☐
Watchtower	4	☐
CMML	5	☐
Baptist	6	☐
Muslim	7	☐
Other	8	☐

9. Number of pregnancies ☐

10. Outcome of last pregnancy

Live birth	1	☐
Still birth	2	☐
Abortion	3	☐

11. Admitted in hospital last one year ☐

12. Experienced any of the following the last one year?

TB	1	☐
Rash	2	☐
Genital ulcer	3	☐
Herpes Zoster	4	☐
Vaginal discharge	5	☐
Other STD	6	☐
Sudden weight loss	7	☐

13. What type of contraceptive method have you ever used?

None	1	☐
Natural	2	☐
Traditional	3	☐
Pill	4	☐
Injectables	5	☐
Tubal ligation	6	☐
IUD	7	☐
Condom	8	☐

14. Have you ever used a condom to protect yourself against STD or AIDS? **YES** ☐ **NO** ☐

15. Did you use a condom the last sexual intercourse? ☐☐

16. Do you take alcoholic drinks? ☐☐

17. Do you go to public bars? ☐☐

ZAM ANC SURVEILLANCE ID: 9599

DATE: ..... **(Circle relevant codes or record a valid response in the space provided)**

1. **Age** (in years) ____

2. **Residence**
   Urban 1 Rural 2

3. **Have you ever been married or lived as married?**
   Yes 1 No 2

4. **If yes, are you now married?**
   Married 1
   Separated/divorced 2
   Widowed 3

5. **How old were you when you first got married?** ____

6. **Does your husband have another wife or wives?**
   Yes 1 No 2

7. **Employment status:**

	Self	Spouse
Unemployed	1	1
Farmer	2	2
Self employed	3	3
Employee	4	4
Employer	5	5
Still at school	6	6

8. **How many years did you go to school?** (number of years) ____

9. **What is your highest level of education, completed?**

	Self	Spouse
Less than primary	1	1
Primary	2	2
Secondary J	3	3
Secondary S	4	4
College/University	5	5

10. **Number of months pregnant** ____

11. **Number of pregnacies** ____

12. **How old were you when you first became pregnant?** (code 0 if none) ____

13. **How many children have you given birth to all in all** (code 0 if none) ____

14. **How many of these children are presently alive?** ____

15. **How many months since you last gave birth?** (number of months) ____

16. **How did the last pregnancy end?**
   Live birth 1
   Still birth 2
   Abortion 3

17. **Have any of your children died before the age of 5 years?** (code 0 if none. If the answer is yes, ask how many and code the number) ____

18. **How many children live with you permanently?** number ____

19. **Did you use any of the following contraceptive methods before this pregnancy?** (mention all)

None	Yes	No
Pill	1	2
Injections	1	2
IUD	1	2
Condom	1	2
Natural	1	2
Traditional	1	2

20. **How many times during the past 12 months were you admitted in hospital?** number ____

21. **Did you experience any of the following in the last 12 months?**

	Yes	No
Malaria	1	2
TB	1	2
Rash	1	2
Genital Ulcer	1	2
Vaginal Discharge	1	2
Any STD	1	2

22. **Have you ever used a condom to protect yourself against STD or AIDS?**
   Yes 1 No 2

23. **Did you use a condom during the last sexual intercourse?**
   Yes 1 No 2

24. **Is your usual or regular partner circumcised?**
   Yes 1 No 2

Questionnaire for the population-based surveys in Chelston and Kapiri Mposhi

ZAM CORE EPI: FOLLOW-UP SURVEY 2003

1. Cluster identification:

CSA SEA Rural/Urban

2. Housing identification:

Building Unit Household

3. Personal number:

---

4. AGE
5. SEX (Male=1, Female=2)
6. What is your mother Language?
(1=Bemba, 2= Kaonde, 3=Lozi, 4=Lunda, 5=Luvale, 6=Nyanja, 7=Tonga, 8=other)
7. For how long have you been living continuously in this household?
(if less than 1 year, code 0, else years)
8. Just before you moved here, did you live in a 1=Village, or 2=Lusaka, or 3=other city or town?
9. Marital status: Are you now
(1)Single, never married, (2) Single but engaged, (3) Living as married, (4) Married, (5)Widowed, (6) Separated/div.

<u>If single, never married, skip to Q 14</u>

10.For how long have you been married to this person?
(if less than 1 year, code 0, else years)
11. How old is this person (spouse)?
12. How old were you when you first got married?
13. Now think back to the past. Apart from this spouse, how many have you been married to/living with in your whole life?

14. For how many years did you go to school?
15. What is your highest level of education completed? (1=Never attended, 2=Grade 1-4, 3=Grade 5-7, 4=Grade 8-9, 5=Grade 10-12, 6=Higher)
16. Are you still in school?

Score for all yes/no Qs: Yes=1, No=2
17. Are you employed at present?
(1=Unemployed, 2=Unpaid family worker, 3=Self employed, 4=Employee, 5=Employer)

Does your household have
18. Electricity?
19. A radio?
20. A refrigerator?
21. A bicycle?
22. A plough?
23. A donkey?

24. What is your religion?
(1=None, 2=Catholic, 3=Liberal protestant, 4=Strict protestant, 5=Muslim, 6=other)

25. Have you during the past years been on regular trips where you have to stay away from home for several days or more?
(1=Never, 2=Sometimes, 3=Often, 4=Very often)
26. How would you say your health is at the moment? Is it (1 =) Very poor, (2 =) Poor, (3 =) Fair, (4=) Good, (5 =) Excellent

During the last one year, how many times did you visit
27. a traditional healer?
28. a spiritual healer?
29. private doctor/clinic?
30. the local health centre?
31. the hospital?

32. How many times were you admitted in hospital during the last one year?
33. If ever admitted in hospital, did you ever receive blood (transfusion)?
34. Are you on any type of medication?
(1=No, 2=Traditional, 3=Professional)
During the last one year, did you suffer from
35. Malaria
36. TB
37. Any STD (sexually transmitted disease)

Now I will ask you some few questions related to certain pains and problems, that might have bothered you the last 30 days. If you think the question applies to you and you have had the problem in the last 30 days, answer Yes. If not, answer No.

(Codes: Yes=1, No=2, Don't know=3)

38. Do you sleep badly? ☐
39. Do you cry more than usual? ☐
40. Do you find it difficult to enjoy your daily activities? ☐
41. Do you find it difficult to make decisions? ☐
42. Is your daily life suffering? ☐
43. Are you unable to play a useful part in life? ☐
44. Has the thought of ending your life been on your mind? ☐
45. Do you feel tired all the time? ☐
46. Do you often have headaches? ☐
47. Is your digestion poor? ☐

Do you agree or disagree with the following statements?: (Read and obtain a response for each statement: Code **1** when Agreeing, **2** when Disagreeing).

48. Condoms are safe preventing HIV/AIDS ☐
49. Most women don't like men to use condoms ☐
50. Condoms are embarrassing to obtain ☐
51. Using condoms shows responsibility ☐
52. Most men do not like using condoms ☐
53. Condoms are too expensive ☐
54. Using condoms is against my religion ☐

55. Have you ever had sexual relations? ☐

If no, skip to Q 67

56. At what age did you first have sex? ☐☐
57. Have you had sex the last 12 months? ☐
58. Have you ever used a condom? ☐
59. Did you use a condom last time you had sex? ☐

60. Is it easy to get a condom when needed? ☐

61. Did you have a regular sex partner during the last 12 months? ☐
62. Did you have sex with anyone else apart from your regular sex partner last year? ☐
63. If yes on Q62: Approximately how old was the last casual sex partner? ☐☐
64. Did you use a condom when you last had sex with a casual partner? ☐
65. With how many different people have you had sex in the last 12 months? (include spouse) ☐☐
66. How many different people have you had sex with in your life? ☐☐

67. Have you ever contracted any STD? ☐

If no, skip to Q 69

68. Did you tell your partner? ☐

Do you agree or disagree with the following statements: (Read and obtain a response for each statement, code **1** when Agreeing, **2** when Disagreeing)

69. I have less sexual partners at present compared to some years ago ☐
70. My friends have not changed their sexual behaviour despite the AIDS risk ☐
71. Some years ago I did not use condoms ☐
72. Most of my friends never use condoms ☐
73. I always use a condom nowadays ☐

74. In your situation, do you think that you are at risk of getting (catching) HIV? Would you say that
1= You are not at risk, or
2= the risk is moderate, or
3= the risk is high, or ☐
4= the risk is very high

75. How worried are you about actually being infected by HIV/AIDS?
1= Always worried, or
2= Sometimes worried, or
3= Seldom worried, or
4= Never worried ☐

Now I will ask you some hypothetical questions

76. If a member of your family became sick with the HIV/AIDS virus, would you be willing to care for him or her in your household? ☐

77. If you knew that a shopkeeper or food seller had the HIV/AIDS virus, would you buy fresh vegetables from him? ☐

78. If a female teacher has the HIV/AIDS virus but is not sick, should she be allowed to continue teaching in school? ☐

79. If a member of your family became infected with the AIDS virus, would you want it to remain a secret? ☐

<u>MALES ONLY:</u>

80. Have you been circumcised? ☐

81. How many wives do you have? ☐

<u>FEMALES ONLY:</u>

82. Have you ever given birth? ☐

83. Are you pregnant at present? ☐

If not given birth, skip to 91

84. How many have you given birth to all in all? ☐☐

85. How long is it since you last gave birth? ☐☐
(if less than 1 year, code 0, else years)

86. Do you want another child? ☐

87. How did the last pregnancy end?
(1=live, 2=still, 3=abortion) ☐

88. Did you visit any antenatal care services during last pregnancy? ☐

1= No; 2= Yes, traditional practitioner or midwife
3= Yes, clinic/hospital
4= Yes, Private clinic

89. Have any of your children died before the age of one? ☐
Code the number, if none, score 0.

90. Have any of your children died before the age of 5? ☐
Code the number, if none score 0.

91. <u>Do you use any of the following contraceptive methods currently</u>? ☐
(mention all)
1=Pill; 2=Injections; 3=IUD; 4=Condom;
5=Natural; 6=Traditional; 7=Any other;
8=None

92. Have you ever used a condom as your contraceptive method? ☐

93. Does your husband have other wives? ☐

94. Do you often use traditional agents like herbs or other agents for self-treatment when experiencing vaginal discharge or itching? ☐
(1=Most often, 2=Sometimes, 3=Never)

95. Do you often use traditional agents like herbs or a cloth before having sex? ☐
(1=most often, 2=sometimes, 3=never)

96. Is your usual (regular) male partner circumcised? ☐
Yes=1,No=2, don't know=3

<u>Do you agree or disagree with the following statement:</u> 1=agree, 2=disagree ☐

97. If my husband had a STD, I could either refuse to have sex with him or I would get him to use a condom? ☐

ALL RESPONDENTS
Inform on saliva samples; anonymity, consent; and on the voluntary option of being counselled and tested

98. Have you ever been HIV tested? ☐

99. If tested: Did you receive the test result? ☐

100. Would you like us to arrange for you to be HIV tested? ☐

101. Attendance
1=Completed (both interview and saliva)
2=Refused saliva
3=Refused interview
4=Refused both interview and saliva ☐
5=Not found

102. Number of interviewer ☐

103. Date: day:..... /month...../year.....

Questionnaires for the PLACE-study

Key informant interview

1. Study area *Chelstone =01* □
Livingstone =02 □

2. Interviewer no __ __

3. Key informant no __ __ __

4. Date __ __/__ __/__ __

5. Gender of informant
Male=01 □
Female=02 □

6. Type of key informant: Code __ __
Taxi driver = 01
Public transport driver = 02
NGO Staff = 03
Community leader/governm. official = 04
Health Personnel = 05
Police Officer = 06
Shop staff = 07
Bar worker = 08
Youth = 09
STD clinic patient = 10

Hello. I am working on a study that aims to identify places where health programs may be needed in this area. The study is run by the Department of Community Medicine at the University of Zambia and the Centre for International Health at the University of Bergen in Norway. I would like to ask you a few questions about places where people meet new sexual partners. We want to visit these places to find out whether they want a health program there. I just want you to name public places. I will not ask for your name and all that you tell me will be kept anonymous. The information will not be linked to you. If you do not want to participate, you may refuse.

7. Are you willing to participate
Yes =01 □
No =02 □

If no, end of interview

8. Age __ __

9. How many years have you attended school? __ __

10. Do you live in this township?
□ Yes =01

□ No, in another township in same town =02
□ No, elsewhere =03

11. Do you know any places where people socialize and go to meet new sexual partners or where men or women are paid to have sex?
Yes =01 □
No =02 □

12. Can you name and describe the location of these places?

Fill out place description form

Name of site _____	Address _____	How to find site _____	Type of place: Code __ __	Is this a place where people meet new sexual partners? Yes =01 No =02	Is this a place where sex workers operate? Yes =01 No =02

Sherbeen = 01
Bar/café/restaurant = 02
Nightclub/disco = 03
Hotel/guest house = 04
Stairwell = 05
Basement/roof = 06
School/college = 07
Bus station = 08

Truck stop/stand = 09
Taxi stand = 10
Street = 11
Market = 12
Park = 13
Church = 14
Garage = 15
Other = 16 (specify)

Site characteristics form

1. Study area Chelstone =01 □
Livingstone =02 □

2. Interviewer no __ __

3. Name of site _____

4. Mentioned by __ __ key informants

5. Correct address

_____

6. Place verification:

Place found =01 □

Place found,no willing respondent=02 □

Place not found =03 □

Place closed temporarily =04 □

Place closed permanently=05 □

7. Type of site: Code __ __
Sherbeen = 01
Bar/café/restaurant = 02
Nightclub/disco = 03
Hotel/guest house = 04
Stairwell = 05
Basement/roof = 06
School/college = 07
Bus station = 08
Truck stop/stand = 09
Taxi stand = 10
Street = 11
Market = 12
Park = 13
Church = 14
Garage = 15
Other = 16 (specify)

_____

8. Date __ __/__ __/__ __

9. Day of the week
Monday =01 □
Tuesday =02 □
Wednesday =03 □
Thursday =04 □
Friday =05 □
Saturday =06 □
Sunday =07 □

10. Time of day (24 hour)__ __:__ __

11. Number socializing at time of arrival

Men: __ __ __Women:__ __ __

12. Gender of respondent
Male =01 □
Female=02 □

13. Position of respondent (Do you work here?)
Staff =01 □ Patron =02 □

Hello. I am working on a study that aims to identify places where health programs may be needed in this area. The study is run by the Department of Community Medicine at the University of Zambia and the Centre for International Health at the University of Bergen in Norway. I would like to ask you a few questions about this place and people who attend it. I will not ask what your name is and all that you tell me will be anonymous. The information will not be linked to you. If you do not want to participate, you may refuse. We are asking people at several other places in the township the same questions. Your answers will not be reported separately for this place alone, but will be presented together with information from other sites.

14. Are you willing to be interviewed?
Yes =01 □
No =02 □

If no, end of interview

15. Age __ __

16. What activities take place here?
(Read list, one item at a time)

(Yes=01, No=02)	Y	N
a) Beer drinking	□	□
b) Spirits drinking	□	□
c) TV/video watching	□	□
d) Dancing	□	□
e) Music	□	□
f) Computer games/slot machines	□	□
g) Eating food	□	□
h) Striptease show	□	□

17. I have been told that people also meet new sexual partners here

a) Do men meet new female sexual partners here?
Yes =01 □ No =02 □

b) Do women meet new male sexual partners here?
Yes =01 □ No =02 □

c) Do men meet male sexual partners here?
Yes =01 □ No =02 □

18. Do female sex workers look for customers here?
Yes =01 □

No =02 □

Now I would like to talk about what kind of people come here during the busiest hours.

19. Among <u>men</u> who come here during the busiest times, how many do you think are:
(Coding: None=01, Some =02, Most=0

	None	Some	Most
a) Below age 18	□	□	□
b) Live within a 10 minute walk from here	□	□	□
c) Live outside this township	□	□	□
d) Come here at least once a week	□	□	□
e) Drink alcohol here	□	□	□
f) Find a new sexual partner here	□	□	□
g) Appear to be paying for sex (clients)	□	□	□

20. Among <u>women</u> who come here during the busiest times, how many do you think are:
(Coding: None=01, Some =02, Most=03)

	None	Some	Most
a) Below age 18	□	□	□
b) Live within a 10 minute walk from here	□	□	□
c) Live outside this township	□	□	□
d) Come here at least once a week	□	□	□
e) Drink alcohol here	□	□	□
f) Find a new sexual partner here	□	□	□
g) Appear to be selling sex	□	□	□

21. During a typical week in the last two months, what have been the busiest hours? Which days and at which time? *(Indicate with circle around mentioned hours)*

	06.00-11.00	11.00-17.00	17.00-22.00	22.00-06.00
Monday =1	1	2	3	4
Tuesday =2	1	2	3	4
Wednesday =3	1	2	3	4
Thursday =4	1	2	3	4
Friday =5	1	2	3	4
Saturday =6	1	2	3	4
Sunday =7	1	2	3	4

22. Approximately how many people come here during one of these busy hours?

<10	□ =01	201-250	□ =07
11-25	□ =02	251-300	□ =08
26-50	□ =03	301-350	□ =09
51-100	□ =04	351-400	□ =10
101-150	□ =05	401-500	□ =11
151-200	□ =06	>500	□ =12

23. a) Have there ever been any HIV/AIDS prevention activities at this place?

Yes =01 □ No =02 □

If yes: What types? *(Yes =01, No =02)*

	Yes	No
b) Lectures/seminars	□	□
c) Pamphlets/leaflets	□	□
d) Posters	□	□
e) Condom distribution	□	□
f) Other:_____		

24. In the last 12 months, how often have condoms been available here?

Always =01 □

Sometimes =02 □

Never =03 □

Don't know =04 □

25. a)Are there any condoms here today?

Yes =01 □
No =02 □

b)If yes: Can I see one? Yes =01 □
No =02 □

26. Is it possible for someone to find a condom within 10 minutes of leaving this place at night?

Yes =01 □
No =02 □
Don't know =03 □

27. Would you be willing to sell condoms here? Yes =01 □
No =02 □
Not applicable =03 □

28. May we come back at night in the next few weeks to interview some of the guests here about their sexual behaviour and condom use?

Yes =01 □ No =02 □

29. *Observation: HIV educational activities seen by interviewer at the site*

a) Number of HIV-posters __ __
b) Number of HIV-brochures at site __ __
c) Number of condoms visible __ __

Questionnaire for individuals socializing at sites

1. Study area *Chelstone =01* □
Livingstone =02 □

2. Interviewer gender and number *Male =01* □
Female=02 □
No. :__ __

3. Name of site _____

4. Date __ __/__ __/__ __

5. Day of the week

Monday □ *=01*
Tuesday □ *=02*
Wednesday □ *=03*
Thursday □ *=04*
Friday □ *=05*
Saturday □ *=06*
Sunday □ *=07*

6. Time of day (24 hour clock) *__ __:__ __*

7. Number socializing at time of arrival *Men:* *__ __ __*
Women:__ __ __

8. Consecutive interview number at site *__ __*

9. Gender of respondent

Male =01 □ *Female=02* □

Hello. I am working on a study that aims to identify places where health programs may be needed in this area. The study is run by the Department of Community Medicine at the University of Zambia and the Centre for International Health at the University of Bergen in Norway. I would like to ask you a few questions about your behaviour, including sexual behaviour. I will not ask what your name is and all that you tell me will be anonymous and confidential. The information will not be linked to you. If you do not want to participate, you may refuse. Your answers will be recorded in a form that only identifies you by a number. We are asking hundreds of other people the same questions, both here and at other places in the township.

10. Do you agree to be interviewed? Yes =01 □
No =02 □

If no, end of interview

11. How old are you? __ __

12. Are you still in school/college/university?

Yes =01 □

No =02 □

13. How many years have you attended school? __ __

14. Do you live in this township?

□ Yes =01

□ No, in another township in same town =02

□ No, elsewhere =03

15. How often do you come to this place?

Every day (=01) □

4-6 times per week (=02) □

2-3 times per week (=03) □

Once per week (=04) □

2-3 times per month (=05) □

Once per month (=06) □

Less than once a month (=07) □

This is my first visit (=08) □

16. Why did you come here today? *(Read options) (Coding:Yes=01, No=02)*

	Yes	No
a) To drink alcohol?	□	□
b) To socialize with friends?	□	□
c) To meet a sexual partner?	□	□

d) Other reason

_____

17. Have you ever met a new sexual partner here? Yes =01 □
No =02 □

18. When did you last meet a new sexual partner here?

Last 24 hours (=01) □

Last 7 days (=02) □

Last 4 weeks (=03) □

Last 3 months (=04) □

Last 6 months (=05) □

Last year (=06) □

Over a year ago (=07) □

Never (=08) □

19. The last time you had sex with this new partner that you met here, did you use a condom?

Yes =01 □

No =02 □

Don't remember =03 □

20. How many different people have you had sex with in the last 4 weeks? __ __

21. How many of these partners were …

a) from somewhere outside this city __ __

b) from this city __ __

c) from this township __ __

22. How many of these sexual partners were new for you in the last 4 weeks? __ __

23. The last time you had sex with one of these new partners, did you use a condom?

□ Yes =01

□ No =02

□ No new partners past 4 weeks =03

24. If no: Why did you not use a condom with your last new partner?
(Do NOT read options. Tick the ones mentioned.)

a) Partner protested □

b) Do not like condoms □

c) I trusted my partner □

d) I was afraid my partner would become suspicious of me □

e) Used another contraceptive □

f) Condoms are too expensive □

g) Did not have them at hand □

h) Condoms do not protect against STDs/HIV □

i) Condoms break □

j) Other _____

25. If yes, in the past 4 weeks, how often did you use a condom with new sexual partners?

Always =01 □

Sometimes =02 □

Never =03 □

No new partners in past 4 weeks=04 □

26. Where did you get the last condom you used?

□ Never used a condom=00
□ Shop =01
□ Pharmacy =02
□ Kiosk =03
□ Partner had condom =04
□ From a friend =05
□ Received free of charge =06
□ Bar/night club/restaurant/hotel =07
□ Other =08

27. a) Do you have a condom with you? □ Yes =01
□ No =02

b) If yes: May I see it? □ Yes =01
□ No =02

28. In your opinion, how effective are condoms in preventing STIs and HIV?

Very effective =01 □

Somewhat effective =02 □

Not very effective =03 □

Not effective at all =04 □

Don't know =05 □

29. In your situation, do you think that you are at risk of getting HIV? Would you say that

You are not at risk □ =01

The risk is moderate □ =02

The risk is high □ =03

The risk is very high □ =04

Women only:

30. Have you received money in exchange for sex in the past 3 months?

Yes =01 □

No =02 □

31. If yes: Where do you usually go to look for men?

i) _____

ii) _____

iii) _____

iv) _____

v) _____

32. Last time you received money in exchange for sex, did you use a condom?

Yes=01 □ No =02 □

33. If no: Why did you not use a condom? *(Do **NOT** read options. Tick the ones mentioned.)*

a) Partner protested □

b) Do not like condoms □

c) I trusted my partner □

d) I was afraid my partner would become suspicious of me □

e) Used another contraceptive □

f) Condoms are too expensive □

g) Did not have them at hand □

h) Condoms do not protect against STDs/HIV □

i) Condoms break □

j) Other _____

Men only:

34. Have you given money or gifts to anyone in exchange for sex in the past 3 months?

Yes =01 □ No =02 □

35. If yes: Did you use a condom the last time?

Yes =01 □ No =02 □

36. Have you had sex with a man in the past 4 weeks?

Yes=01 □ No =02 □

Questionnaires for the Sexual Behaviour Surveys

Excerpts from the individual questionnaire of the Zambia Sexual Behaviour Survey 1998

Section 3: Marriage & Cohabitation

Now I would like to ask you questions about marriage and cohabitation.

No.	Questions and filters	Coding categories	Skip to
Q301	Have you ever been married or lived together with a man/woman?	YES 1 NO 2	 →Q401
Q302	How old were you when you first married /started living with a partner?	YEARS. [__|__]	
Q303	Are you currently married or living together with a partner?	YES MARRIED 1 YES LIVING TOGETHER....2 NO 3	 →Q305 →Q401
Q304	FOR MARRIED RESPONDENTS ONLY: Does your husband/wife live with you or does he/she live somewhere else?	LIVES WITH ME .....1 LIVES SOMEWHERE ELSE 2	
Q305	How long have you been married / living together? WRITE 00 IF LESS THAN ONE YEAR	NUMBER OF YEARS [__|__] DON T KNOW . 98 NOT LIVING TOGETHER....95	
Q306	MEN: Do you have more than one wife/cohabiting partners? WOMEN: Does your husband have other wives/cohabiting partners?	YES 1 NO 2	 →Q308 for the only spouse/ partner
Q307	MEN: How many wives/cohabiting partners do you have? WOMEN: How many wives/cohabiting partner does your husband have?	NUMBER OF WIVES/PARTNERS [__|__]	

No.	Questions and filters	Spouse/ Partner 1	Spouse/ Partner 2	Spouse/ Partner 3	Spouse/ Partner 4	Spouse/ Partner 5
Q308	NUMBER OF SPOUSES/COHAB. PARTNERS (ASK Q309-312 FOR EACH PARTNER, STARTING WITH THE FIRST,ETC.) What is the first name of your spouse/partner?					
Q309	How old is (NAME)? IF DON T KNOW: RECORD 98	[__|__]	[__|__]	[__|__]	[__|__]	[__|__]
Q310	How many days did you have sex with (NAME) In the last week? In the last month? IF DON T KNOW: RECORD 98	[__|__] [__|__]	[__|__] [__|__]	[__|__] [__|__]	[__|__] [__|__]	[__|__] [__|__]
Q311	The last time you had sex with (NAME) did you/your partner use a condom?	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8
Q312	The last time you had sex with (NAME) did you/your partner practice dry sex , that is use methods to tighten the vagina?	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8
Q313	FOR THE FIRST INSTANCE FOR WHICH Q312 IS YES PROBE AND RECORD METHOD USED. What method did you/your partner use?	GO TO NEXT SPOUSE	GO TO NEXT SPOUSE	GO TO NEXT SPOUSE	GO TO NEXT SPOUSE	GO TO Q402

No.	Questions and Filters	Coding categories				
Q405	NUMBER OF <u>NON-COHABITING PARTNERS</u> (ASK Q406-Q416 FOR EACH PARTNER, STARTING WITH THE MOST RECENT) What is the first name of this partner? RECORD INITIAL	**Partner 1**	**Partner 2**	**Partner 3**	**Partner 4**	**Partner 5**
Q406	For how long have you had a sexual relationship with (NAME)?	ONCE ...1 < 1WK..2 < 1MO..3 < 6MO..4 <12 MO..5 12MO+..6 DK ...8	ONCE ...1 < 1WK..2 < 1MO..3 < 6MO..4 <12 MO..5 12MO+..6 DK ...8	ONCE ...1 < 1WK..2 < 1MO..3 < 6MO..4 <12 MO..5 12MO+..6 DK ...8	ONCE ...1 < 1WK..2 < 1MO..3 < 6MO..4 <12 MO..5 12MO+..6 DK ...8	ONCE ...1 < 1WK..2 < 1MO..3 < 6MO..4 <12 MO..5 12MO+..6 DK ...8
Q407	Is this relationship still ongoing or has it ended?	ON....1 END..2	ON....1 END..2	ON....1 END..2	ON....1 END..2	ON....1 END..2
Q408	How old is (NAME)? IF DON T KNOW: RECORD 98	[__|__]	[__|__]	[__|__]	[__|__]	[__|__]
Q409	Is (NAME) married?	YES 1 NO 2 DK ..8	YES 1 NO 2 DK 8	YES 1 NO 2 DK ..8	YES 1 NO 2 DK ..8	YES 1 NO 2 DK ..8
Q410	Does he/she live in the same village or town/city/ neighbourhood?	YES 1 NO 2 DK.. 8	YES 1 NO 2 DK ..8	YES 1 NO 2 DK ..8	YES 1 NO 2 DK..8	YES 1 NO 2 DK ..8
Q411	How many days did you have sex with (NAME) in the last 3 months? **(IF NONE ENTER 00)**	[__|__]	[__|__]	[__|__]	[__|__]	[__|__]
Q412	The last time you had sex with (NAME) did you use a condom?	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8
Q413	Did you/your partner practice dry sex , that is methods to tighten the vagina?	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8
Q414	The last time you had sex with (NAME) did you or your partner drink alcohol?	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8	YES 1 NO 2 DK 8
Q415	**The last time you had sex with (NAME), did you give or receive money or anything in return for sex?**	YES 1 NO 2 ↓ 501	YES 1 NO 2 ↓ 501	YES 1 NO 2 ↓ 501	YES 1 NO 2 ↓ 501	YES 1 NO 2 ↓ 501
Q416	How much money/what did you receive or give in kind? RECORD AMOUNT IN ZKWACHA/ ASK THE RESPONDENT TO CONVERT PAYMENT IN KIND INTO CASH	K_______ _________ (Specify)	K_______ _________ (Specify)	K_______ _________ (Specify)	K_______ _________ (Specify)	K_______ _________ (Specify)
		GO TO NEXT PARTNER	GO TO NEXT PARTNER	GO TO NEXT PARTNER	GO TO NEXT PARTNER	GO TO Q501

Excerpts from the individual questionnaire of the Zambia Sexual Behaviour Survey 2000

Section 2: Marriage and Cohabiting Partnerships

Now I would like to ask you some general questions about marriage and live-in partnerships.

No.	Questions and filters	Coding categories	Skip to
Q201	Have you *ever* been married or lived with a man/woman as if you were married?	YES.....1 NO 2	→GO TO Section 3
Q202	How old were you when you *first* married/started living with a man/woman?	AGE IN YEARS..... [__|__]	
Q203	Are you *currently* married or living together with a man/woman as if you are married?	YES, MARRIED.....1 YES, LIVING TOGETHER.....2 NO 3	→Q205 →GOTO Section 3
Q204	Does your husband/wife live with you or does he/she live somewhere else?	WITH RESPONDENT .....1 SOMEWHERE ELSE 2	
Q205	For how many years have you been married or living together as if you were married? (RECORD 00 IF LESS THAN ONE YEAR.)	YEARS..... [__|__]	
Q206	MEN: Do you have more than one wife or other partners who live with you? WOMEN: Does your husband have other wives or does he live with other partners?	YES.....1 NO 2	→GO TO Section 3
Q207	MEN: Altogether, how many wives or other partners live with you? WOMEN: Including yourself, how many wives or other partners live with your husband?	NO. OF WIVES/PARTNERS ..... [__|__]	

3. Sexual History and Behaviour

READ OUT:

I am going to ask some specific questions about sex and your sexual partner(s) in the last 12 months. I know it may be difficult to remember exactly, but I would like you to answer the questions to the best of your knowledge, as this information is very important for the survey. Again, this information is all completely private and anonymous and cannot be linked to you or any partner in any way.

I will begin by asking about your most recent sexual partner, but in case you have more than one partner, I will ask only about the last three partners you may have had in the past 12 months. This includes anyone you might have had sex with: husband, wife or wives, girlfriends, boyfriends, friends, casual partners etc.

No.	Questions and filters	Coding categories	Skip to
Q301	Have you *ever* had sexual intercourse?	YES....1 NO....2	 ➔Q401
Q302	At what age did you *first* have sex?	AGE IN YEARS.... [__|__]	
Q303	When was the *last time* you had sex? ENTER 00 IF LESS THAN A DAY. (COMPLETE ONLY ONE OF THE OPTIONS.)	DAYS AGO.... 1 [|] WEEKS AGO.... 2 [|] MONTHS AGO.... 3 [|] YEARS AGO.... 4 [|]	 ➔Q401

Please think about the last time you had sex, and I am going to ask you some questions about your sexual partners, beginning with the person with whom you had sex most recently. (ASK Q304-Q317, BEGINNING WITH MOST RECENT PARTNER.)

		Most recent partner	Next-to-last partner	Second-to-last partner
Q304	What is your relationship to this PARTNER (Partner 1- MOST RECENT PARTNER) (READ OUT) **IF ANSWER IS 1 OR 2, CHECK Q. 203**	HUSBAND/WIFE....1 LIVE-IN PARTNER....2 GIRLFRIEND / BOYFRIEND NOT LIVING WITH YOU..3 SOMEONE WHOM YOU PAID OR WHO PAID YOU FOR SEX....4 CASUAL ACQUAINTANCE...5 OTHER (SPECIFY)....6 ________	HUSBAND/WIFE....1 LIVE-IN PARTNER....2 GIRLFRIEND / BOYFRIEND NOT LIVING WITH YOU....3 SOMEONE WHOM YOU PAID OR WHO PAID YOU FOR SEX....4 CASUAL ACQUAINTANCE...5 OTHER (SPECIFY)....6 ________	HUSBAND/WIFE....1 LIVE-IN PARTNER....2 GIRLFRIEND / BOYFRIEND NOT LIVING WITH YOU....3 SOMEONE WHOM YOU PAID OR WHO PAID YOU FOR SEX....4 CASUAL ACQUAINTANCE...5 OTHER (SPECIFY)....6 ________
Q305	How old is this partner?	AGE.... [__|__] DON'T KNOW....98	AGE.... [__|__] DON'T KNOW....98	AGE.... [__|__] DON'T KNOW....98
Q306	At what place or event did you *first* talk to or get to know this partner?	OWN/FRIEND'S HOUSE....1 CHURCH....2 SCHOOL....3 WORK....4 WEDDING, FUNERAL/OTHER FAMILY EVENT....5 SPORTING EVENT....6 BAR/NIGHTCLUB....7 BROTHEL....8 OTHER (SPECIFY).... 9 ________	OWN/FRIEND'S HOUSE....1 CHURCH....2 SCHOOL....3 WORK....4 WEDDING, FUNERAL/OTHER FAMILY EVENT....5 SPORTING EVENT....6 BAR/NIGHTCLUB....7 BROTHEL....8 OTHER (SPECIFY).... 9 ________	OWN/FRIEND'S HOUSE....1 CHURCH....2 SCHOOL....3 WORK....4 WEDDING, FUNERAL/OTHER FAMILY EVENT....5 SPORTING EVENT....6 BAR/NIGHTCLUB....7 BROTHEL....8 OTHER (SPECIFY).... 9 ________

Q307	Where does this partner live? PROBE: Does he/she live in: (READOUT)	SAME HOUSEHOLD .....1 SAME VILLAGE OR NEIGHBORHOOD .....2 OTHER URBAN AREA.....3 OTHER RURAL AREA .....4 OTHER (SPECIFY)..... 5 _____ DON'T KNOW 9	SAME HOUSEHOLD .....1 SAME VILLAGE OR NEIGHBORHOOD .....2 OTHER URBAN AREA.....3 OTHER RURAL AREA .....4 OTHER (SPECIFY) ..... 5 _____ DON'T KNOW 9	SAME HOUSEHOLD .....1 SAME VILLAGE OR NEIGHBORHOOD .....2 OTHER URBAN AREA.....3 OTHER RURAL AREA .....4 OTHER (SPECIFY) ..... 5 _____ DON'T KNOW 9
Q308	When did you first have sex with this partner? ENTER 00 IF LESS THAN A DAY. (COMPLETEONLY ONE OPTION.)	DAYS..... 1 [__|__] WEEKS ..... 2 [__|__] MONTHS..... 3 [__|__] YEARS ..... 4 [__|__]	DAYS ..... 1 [__|__] WEEKS ..... 2 [__|__] MONTHS..... 3 [__|__] YEARS ..... 4 [__|__]	DAYS .....1 [__|__] WEEKS .....2 [__|__] MONTHS.....3 [__|__] YEARS.....4 [__|__]
Q309	Did you use a condom the first time you had sex with this partner?	Yes..... 1 No..... 2 DON'T KNOW 9	Yes..... 1 No..... 2 DON'T KNOW 9	Yes..... 1 No ..... 2 DON'T KNOW 9
Q310	When did you last have sex with this partner? (COMPLETE ONLY ONE OPTION.)	DAYS AGO..... 1 [__|__] WEEKS AGO..... 2 [__|__] MONTHS AGO ..... 3 [__|__] YEARS AGO ..... 4 [__|__] WAS A ONE-TIME SEXUAL CONTACT 5	DAYS AGO..... 1 [__|__] WEEKS AGO ..... 2 [__|__] MONTHS AGO..... 3 [__|__] YEARS AGO ..... 4 [__|__] WAS A ONE-TIME SEXUAL CONTACT 5	DAYS AGO .....1 [__|__] WEEKS AGO .....2 [__|__] MONTHS AGO.....3 [__|__] YEARS AGO .....4 [__|__] WAS A ONE-TIME SEXUAL CONTACT 5
Q311	The last time you had sex with this partner, did you or this partner use a condom?	YES..... 1 NO..... 2 **IF NO, SKIP TO Q313**	YES..... 1 NO..... 2 **IF NO, SKIP TO Q313**	YES..... 1 NO..... 2 **IF NO, SKIP TO Q313**

Q317	Now think about the partner you may have had sex with before the partner we just talked about. Was this sexual contact within the past 12 months?	YES..... 1 (IF YES, GO BACK TO 304 AND ASK ABOUT NEXT PARTNER) NO..... 2 **(IF NO, GO TO Q318)**	YES..... 1 (IF YES, GO BACK TO 304 AND ASK ABOUT NEXT PARTNER) NO..... 2 **(IF NO, GO TO Q318)**	GO TO Q318

Excerpts from the individual questionnaire of the Zambia Sexual Behaviour Survey 2003

Section 2: Marriage and Cohabiting Partnerships

READ OUT: Now I would like to ask you some general questions about marriage and live-in partnerships.

No.	Questions and filters	Coding categories	Skip to
Q201	Have you *ever* been married or lived with a man/woman as if you were married?	YES ..... 1 NO 2	→ SECTION 3
Q202	How old were you when you *first* married/started living with a man/woman?	AGE IN YEARS ..... [__|__]	
Q203	Are you *currently* married or living together with a man/woman as if you are married?	YES, MARRIED ..... 1 YES, LIVING TOGETHER ..... 2 NO 3	→ Q205 → Q206
Q204	What is your marital status now: are you widowed, divorced, or separated?	WIDOWED ..... 1 DIVORCED ..... 2 SEPARATED 3	→ Q209
Q205	Does your husband/wife live with you or does he/she live somewhere else?	WITH RESPONDENT ..... 1 SOMEWHERE ELSE 2	
Q206	MEN: Do you have more than one wife or other partners who live with you? WOMEN: Does your husband / live-in partner have other wives or does he live with other partners?	YES ..... 1 NO 2	→ Q208

No.	Questions and filters	Coding categories	Skip to
Q207	MEN: Altogether, how many wives or other partners live with you? WOMEN: Including yourself, how many wives or other partners live with your husband?	NO. OF WIVES/PARTNERS ..... [__|__]	

No.	Questions and filters	First or only spouse / live-in partner	Second spouse / live-in partner	Third spouse / live-in partner	Skip to
Q208	For how many years have you been married or living together as if you were married? FOR MEN WITH MORE THAN ONE WIFE/PARTNER: With your first wife/partner? Your second? Your third? (ENTER 00 IF LESS THAN ONE YEAR.)	YEARS ..... [__|__]	YEARS ..... [__|__]	YEARS ..... [__|__]	

No.			Skip to
Q208F	ONE SPOUSE/LIVE-IN PARTNER ? ☐→	MORE THAN ONE SPOUSE/ LIVE-IN PARTNER? ☐→	SECTION 3

No.	Questions and filters	Coding categories	Skip to
Q209	Have you been married or lived with a partner only once or more than once?	ONLY ONCE ..... 1 MORE THAN ONCE 2	

Section 3. Sexual History and Behaviour

No.	Questions and filters	Coding categories	Skip to
Q301	Now I would like to ask you some questions about sexual activity in order to gain a better understanding of some family life issues. How old were you when you first had sexual intercourse (if ever)?	NEVER .... 00 AGE IN YEARS .... [__|__] FIRST TIME WHEN STARTED LIVING WITH (FIRST) SPOUSE/PARTNER 95	→ Q332
Q302	Was your first sex partner older than you, younger than you, or about the same age? IF OLDER OR YOUNGER, ASK: By how many years was this sex partner older/younger than you?	OLDER .... 1 [|] YOUNGER .... 2 [__|__] SAME AGE .... 300 DON'T KNOW 998	
Q303	When was the *last time* you had sex? (COMPLETE ONLY ONE OPTION.) ENTER 00 IF LESS THAN 1 DAY ENTER 'MONTHS AGO' ONLY IF 11 MONTHS OR LESS. ENTER 'YEARS AGO' ONLY IF ONE OR MORE YEARS AGO.	DAYS AGO .... 1 [__|__] WEEKS AGO .... 2 [__|__] MONTHS AGO .... 3 [__|__] YEARS AGO .... 4 [__|__]	**IF ONE YEAR OR MORE, GO TO Q323F.**

READ OUT:
I am going to ask some specific questions about sex and your sexual partner(s) in the last 12 months. I know it may be difficult to remember exactly, but I would like you to answer the questions to the best of your knowledge, as this information is very important for the survey. Again, this information is all completely private and anonymous and cannot be linked to you or any partner in any way.

I will begin by asking about your most recent sexual partner, but in case you have more than one partner, I will ask only about the last three partners you may have had in the past 12 months. This includes anyone you might have had sex with: husband, wife or wives, girlfriends, boyfriends, friends, casual partners, someone you may have met at a bar, wedding, a special event, etc.

ASK Q304-Q321 FOR EACH SEXUAL PARTNER, BEGINNING WITH THE MOST RECENT.
COMPLETE ALL QUESTIONS FOR EACH PARTNER, ONE PARTNER AT A TIME.

		Partner 1 **Most recent partner**	**Partner 2** **Next-to-last partner**	**Partner 3** **Second-to-last partner**
Q304a	Is your relationship with this partner ongoing?	YES .... 1 NO .... 2 NOT SURE 8	YES .... 1 NO .... 2 NOT SURE 8	YES .... 1 NO .... 2 NOT SURE 8
Q304b	What is/was your relationship to this partner? (READ OUT CHOICES) **CHECK Q203 IF ANSWER IS 1 OR 2**	HUSBAND/WIFE .... 1 LIVE-IN PARTNER .... 2 GIRLFRIEND / BOYFRIEND NOT LIVING WITH YOU .. 3 SOMEONE WHOM YOU PAID OR WHO PAID YOU FOR SEX .... 4 CASUAL ACQUAINTANCE ... 5 SOMEONE ELSE .... 6 ______________ (SPECIFY)	HUSBAND/WIFE .... 1 LIVE-IN PARTNER .... 2 GIRLFRIEND / BOYFRIEND NOT LIVING WITH YOU .. 3 SOMEONE WHOM YOU PAID OR WHO PAID YOU FOR SEX .... 4 CASUAL ACQUAINTANCE ... 5 SOMEONE ELSE .... 6 ______________ (SPECIFY)	HUSBAND/WIFE .... 1 LIVE-IN PARTNER .... 2 GIRLFRIEND / BOYFRIEND NOT LIVING WITH YOU .. 3 SOMEONE WHOM YOU PAID OR WHO PAID YOU FOR SEX .... 4 CASUAL ACQUAINTANCE ... 5 SOMEONE ELSE .... 6 ______________ (SPECIFY)
Q305	How old is this partner?	AGE .... [__|__] DON'T KNOW 98	AGE .... [__|__] DON'T KNOW 98	AGE .... [__|__] DON'T KNOW 98

Q307	Where does this partner live? PROBE: Does he/she live in: (READ OUT CHOICES)	SAME HOUSEHOLD............1 SAME VILLAGE OR NEIGHBORHOOD ....2 OTHER URBAN AREA ....3 OTHER RURAL AREA ....4 OTHER (SPECIFY).............. 5 DON'T KNOW.......................8	SAME HOUSEHOLD............1 SAME VILLAGE OR NEIGHBORHOOD ....2 OTHER URBAN AREA ....3 OTHER RURAL AREA..........4 OTHER (SPECIFY).............. 5 DON'T KNOW.......................8	SAME HOUSEHOLD............1 SAME VILLAGE OR NEIGHBORHOOD...........2 OTHER URBAN AREA ....3 OTHER RURAL AREA...........4 OTHER (SPECIFY).............. 5 DON'T KNOW.......................8
Q308	How long has it been since the very first time you had sex with this partner?	DAYS AGO .... 1 [__|__] WEEKS AGO .... 2 [__|__] MONTHS AGO........... 3 [__|__]	DAYS AGO .... 1 [__|__] WEEKS AGO .... 2 [__|__] MONTHS AGO........... 3 [__|__]	DAYS AGO................. 1 [__|__] WEEKS AGO ....2 [__|__] MONTHS AGO...........3 [__|__]

		Partner 1 **Most recent partner**	Partner 2 **Next-to-last partner**	Partner 3 **Second-to-last partner**
	(COMPLETE ONLY ONE OPTION.)	YEARS AGO .... 4 [__|__]	YEARS AGO ....4 [__|__]	YEARS AGO ....4 [__|__]
Q309	Have you had sex with this partner more than once?	YES.......................................1 NO...2 **IF NO, GO TO Q312**	YES.......................................1 NO...2 **IF NO, GO TO Q312**	YES.......................................1 NO...2 **IF NO, GO TO Q312**
Q310	The first time you had sex with this partner, did you or this partner use a condom?	YES.......................................1 NO...2 DON'T KNOW...................... 8	YES.......................................1 NO...2 DON'T KNOW...................... 8	YES.......................................1 NO...2 DON'T KNOW...................... 8
Q311	How long has it been since the last (most recent) time you had sex with this partner? (COMPLETE ONLY ONE OPTION.)	DAYS AGO .... 1 [__|__] WEEKS AGO .... 2 [__|__] MONTHS AGO........... 3 [__|__] WAS A ONE-TIME SEXUAL CONTACT.........................400	DAYS AGO .... 1 [__|__] WEEKS AGO .... 2 [__|__] MONTHS AGO........... 3 [__|__] WAS A ONE-TIME SEXUAL CONTACT.........................400	DAYS AGO................. 1 [__|__] WEEKS AGO ....2 [__|__] MONTHS AGO...........3 [__|__] WAS A ONE-TIME SEXUAL CONTACT 400
Q312	The last time you had sex with this partner, did you or this partner use a condom?	YES..1 NO...2 DON'T KNOW..........................8 **IF NO OR DON'T KNOW, SKIP TO Q316a**	YES..1 NO...2 DON'T KNOW..........................8 **IF NO OR DON'T KNOW, SKIP TO Q316a**	YES..1 NO...2 DON'T KNOW..........................8 **IF NO OR DON'T KNOW, SKIP TO Q316a**

Q321	Now think about the partner you had sex with before the partner we just talked about. Was this sexual contact within the past 12 months?	YES..1 **(IF YES, GO BACK TO Q304 AND ASK ABOUT NEXT PARTNER)** NO...2 **(IF NO, GO TO Q323F)**	YES..1 **(IF YES, GO BACK TO Q304 AND ASK ABOUT NEXT PARTNER)** NO...2 **(IF NO, GO TO Q323F)**	**GO TO Q322**

Errata

Background for corrections

In the regression analyses of determinants of having more than one ongoing relationship in paper IV, I have now discovered that the variables "Age difference from first spouse", "Age difference from last non-cohabiting partner" and "Young at first sexual intercourse" had some missing values as many of the respondents had not responded to the questions that the parameters were derived from as the questions had not been relevant to them. To reduce the number of missing values, we could have given those who had never been married the value 0 years for the variable "Age difference from first spouse". Respondents who did not report any non-cohabiting partners among the last three partners in 2003 or no non-cohabiting partners during the past year in 1998, could gave been given the value 0 years for the variable "Age difference from last non-cohabiting partner". Respondents, who had a missing value for age at sexual debut but had reported age at first marriage, may be considered to have had their sexual debut at the age that they married. In addition, we could have included young respondents who were cohabiting in the married group, as we had done this in the analyses for the age group 15-49. If these changes to the four mentioned variables are made, it results in some changes in the results in the uni-variate and multivariate analyses (see the revised Tables 4 and 5). If the analyses are redone in this way several changes must also be made in the text. These are given below.

However, *although the wording of several paragraphs should be slightly changed, the interpretation of the findings remains the same*, and the only major change is that "Age difference from the last non-cohabiting partner" becomes more strongly associated with concurrency among both men and women.

In addition, we would like to clarify the difference between the two measures of concurrency used in paper IV. This results in the following changes in the text:

Page 43 should be:

The prevalence of overlapping relationships also declined from 2000 to 2003 among older and young rural men and women, but was rather stable among urban respondents.

In uni-variate log-binomial regression analyses we found that for adult men aged 15-49 increasing age, being married or cohabiting, young age at sexual debut and first marriage, long duration of marriage, age difference to spouse and the last non-cohabiting partner, absence from home and living with the spouse were associated with having concurrent sexual partners. Another predictor for urban men was little schooling. In multivariate analysis early sexual debut, long duration of marriage, age gap from the last non-cohabiting partner, and absence from home were all significantly associated with concurrency for rural men, and for urban men absence from home and age gap from the last non-cohabiting partner increased the likelihood of having concurrent partners, whereas having completed secondary or higher education made it less likely. For women aged 15-49, young age at sexual debut and a small age difference from the spouse were associated with increased probability of having concurrent partners in both the uni-variate analyses and multivariate analyses.

Page 51, second paragraph, first sentence should be:

In paper IV there was some information bias related to our concurrency parameters.

Page 51, line 18, after "overlaps between the last three partners", the following should replace the rest of the paragraph:

Whereas the first measure only refers to one point in time (the time of the interview), the second measure covers a longer period (the duration of the last three sexual partnerships). Thus it is not unexpected that these two proportions differed and that the proportion with overlaps between the last three partners among men tended to be higher than the proportion reporting more than one ongoing relationship. However, a person who reported that the last time he/she had sex with partner X was 2 months ago and that the first time he/she had sex with partner Y was 1 month ago, would not be categorized as having concurrent partners according to the measure based on overlaps between the last three partners, even though both relationships to partner X and Y could be "ongoing". This may not seem logical, but as the survey in 2000 did not include the question "Is your relationship with this partner ongoing?" and our aim was to compare the changes in concurrency over time, we did not incorporate the information on whether any of the relationships were still ongoing in 2003. This explains why the proportion with more than one ongoing relationship was higher than the proportion with overlaps between the last three partners among women in 2003. It is possible that there is additional measurement error related to the proportion with overlaps between the last three partners as difficulties in recalling exact dates or the correct order of events may have played a role. To reduce such information bias the interviewers could have helped the respondents to remember the exact timing of events by providing memory cues. It is also possible that using other data collection methods, like computer assisted self-interviews (CASI) could have lead to more accurate reporting.

Paper IV: page 157, last sentence of Results of abstract is corrected to:

The most important predictors of concurrency were early sexual debut and absence from home. Concurrency was associated with an age gap between the male and female partners.

Page 161, first paragraph of Data analysis, line 6, before "The denominator was… ", the following should be inserted:

Whereas the first measure only refers to one point in time (the time of the interview), the second measure covers a longer period (the duration of the last three sexual partnerships). A person who reported that the last time he/she had sex with partner X was 3 months ago and that the first time he/she had sex with partner Y was 3 months ago, would not be categorized as having concurrent partners according to the measure based on overlaps between the last three partners, even though both relationships to partner X and Y could be "ongoing". This may not seem logical, but as the survey in 2000 did not include the question "Is your relationship with this partner ongoing?" and our aim was to compare the changes in concurrency over time, we did not incorporate the information on whether any of the relationships were still ongoing in 2003.

Page 162, line 13, following "with spouse"", insert:

, and 0 years for the variable "Age difference from first spouse".

Page 162, line 14, the following should be inserted after ""Young at sexual debut"":

For the variable "Age difference from last non-cohabiting partner", respondents who did not report non-cohabiting partners among the last three partners in 2003 or no non-cohabiting partners during the past year in 1998, were given the value 0 years.

Page 164, first sentence of second paragraph should be:

The prevalence of overlapping relationships also declined from 2000 to 2003 among older and young rural men and women (the decline in the latter group was not significant).

Page 164, line 2 from the bottom, after "being married" insert: or cohabiting

Page 164, line 2 from the bottom, before "young age at sexual debut" insert: age gap from the last non-cohabiting partner

Page 165, line 2, after "addition," delete "increasing age difference from the last non-cohabiting sexual partner and"

Page 165, line 3, replace "were" with: was

Page 165, line 4 after "Living with the spouse", "was" should be replaced by: and age gap from the spouse were

Page 165, line 7, replace "or" with comma

Page 165, line 7 after "the spouse" insert: , and age gap from spouse and the last non-cohabiting partner,

Page 165, line 9, delete "and a younger wife were" and insert: was an

Page 165, line 11-12, replace "was an additional predictor" with: and increasing age gap from the last non-cohabiting partner were additional predictors.

Page 165, second paragraph should be:

In the multivariate analysis for young people, the most important predictors of having more than one ongoing relationship for men and urban women were age gap from the last non-cohabiting partner and absence from home. For young rural women, only a big age difference from the last non-cohabiting partner was significantly associated with concurrency in the multivariate analysis. For rural men aged 15-49, being married, long duration of marriage, age gap from the last non-cohabiting partner and absence from home were all significantly associated with having several ongoing relationships; and for urban men, the latter two variables also increased the likelihood of having concurrent partners, whereas having completed secondary or higher education reduced the likelihood. Among rural and urban females aged 15-49, young age at sexual debut and a small age difference from the spouse were significant predictors in the multivariate analysis, and among urban females long duration of marriage and absence in the last month were also important (Tables 4 and 5).

Page 166, second last sentence of the first paragraph of Discussion should be:

The most important predictors of concurrency were early sexual debut and absence from home. Concurrency was also strongly associated with having a younger non-cohabiting partner for men and an older non-cohabiting partner for women.

Page 166, from line 6 from the bottom, following "(Manhart et al., 2002)." the following should replace the rest of the paragraph:

We used one parameter that measured concurrency at one point in time and one that measured concurrency over a longer period (the duration of the last three partnerships). Both parameters can involve measurement error if respondents have difficulties in providing correct dates or are unwilling openly to admit involvement with several sexual partners at the same time (Adimora et al., 2004; Brewer et al., 2006; Manhart et al., 2002).

Page 170, line 7, replace "overall for 15-49 year olds" with: overall for men aged 15-49.

Page 170, the following should replace the second half of the paragraph from line 10 (after "additional partners."):

Living with the spouse was a risk factor of concurrency in the uni-variate analyses, but the association disappeared in the multivariate analyses, and thus probably only reflected that married men tended to live with their spouses. It seemed that after being married for a few years, some men were liable to seek variation with extramarital partners who were younger than themselves, i.e. concurrency was associated with having a younger extramarital partner for men and an older extramarital partner for young women. A big age gap from the spouse was also associated with concurrency among men in the uni-variate analyses, but the association disappeared when adjusting for age. This probably indicated that the finding in the uni-variate analyses only reflected that older men were likely to have both concurrent partners and younger wives. The finding of the opposite among women aged 15-49, i.e. that a big age difference from the spouse reduced the likelihood of having concurrent sexual partners, may reflect greater dependency on the husband in marriages with a considerable age gap between spouses resulting in more faithfulness.

Table 4: Percentage with more than one ongoing relationship, respondents aged 15-24 years; surveys from 1998 and 2003 have been pooled

						Uni-variate analyses			Age-adjusted			Multivariate analyses		
Residence	**Sex**	**Respondent characteristics**	**Categories**	**%**	**N**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**p**	**RR**	**95% CI**	**p**
Rural	Male	Age (continuous variable)				**1.18**	**1.06-1.31**	**0.002**				0.98	0.85-1.13	0.781
		Age	15-19	3.1	480	Ref.								
			20-24	6.1	460	**1.95**	**1.10-3.44**	**0.022**						
		Marital status	Single	3.4	742	Ref.			Ref.			Ref.		
			Married/cohabiting	9.9	182	**2.94**	**1.64-5.25**	**<0.001**	**2.04**	**1.04-4.03**	**0.039**	-		
		Educational level	Primary	4.4	608	Ref.			Ref.					
			Secondary/Higher	4.8	252	1.07	0.55-2.09	0.837	0.97	0.49-1.91	0.921			
		Young age at first sexual intercourse (<16)	No	2.9	614	Ref.			Ref.			Ref.		
			Yes	7.6	318	**2.57**	**1.46-4.54**	**0.001**	**2.50**	**1.43-4.36**	**0.001**	1.59	0.94-2.69	0.083
		Young age at first marriage (<20)	No	4.6	878	Ref.			Ref.					
			Yes	5.0	60	1.10	0.36-3.31	0.869	0.86	0.30-2.50	0.787			
		Age difference from first spouse				**0.84**	**0.75-0.92**	**<0.001**	0.91	0.81-1.04	0.160	1.05	0.90-1.22	0.559
		Age difference from last non-cohabiting partner				**0.79**	**0.72-0.88**	**<0.001**	**0.82**	**0.75-0.91**	**<0.001**	**0.78**	**0.70-0.88**	**<0.001**
		Absence last month	0 days	3.3	721	Ref.			Ref.			Ref.		
			1-7 days	9.2	163	**2.76**	**1.53-5.00**	**0.001**	**2.41**	**1.31-4.42**	**0.005**	**2.42**	**1.26-4.65**	**0.008**
			8-31 days	7.1	56	2.15	0.72-6.43	0.172	1.79	0.57-5.59	0.319	1.08	0.23-5.03	0.921
		Live with spouse	Yes	9.7	176	Ref.			Ref.			Ref.		
			No/no spouse	3.4	761	**0.35**	**0.19-0.65**	**0.001**	0.51	0.24-1.05	0.067	-	-	-
	Female	Age (continuous variable)				1.30	0.99-1.69	0.057				1.53	0.97-2.43	0.069
		Age	15-19	0.5	582	Ref.								
			20-24	0.8	596	1.63	0.38-6.95	0.511						
		Marital status	Single	0.4	500	Ref.			Ref.					
			Married/cohabiting	0.8	604	2.07	0.39-10.9	0.390	1.06	0.08-13.4	0.964			
		Educational level	Primary	1.1	748	Ref.			Ref.					
			Secondary/higher	0	228	-	-	-	-	-	-			
		Young age at first sexual intercourse (<16)	No	0.4	738	Ref.			Ref.			Ref.		
			Yes	1.2	402	3.06	0.74-12.7	0.124	3.48	0.86-14.1	0.081	3.16	0.79-12.6	0.103
		Young age at first marriage (<17)	No	0.8	922	Ref.			Ref.					
			Yes	0.4	248	0.53	0.07-4.22	0.550	0.49	0.06-4.00	0.509			
		Duration of marriage ≥8 years	No	0.6	1056	Ref.			Ref.					
			Yes	0	44	-	-	-	-	-	-			
		Age difference from first spouse				1.04	0.93-1.16	0.476	1.00	0.83-1.21	0.975			
		Age difference from last non-cohabiting partner				**1.30**	**1.05-1.61**	**0.017**	**1.36**	**1.07-1.72**	**0.012**	**1.39**	**1.08-1.79**	**0.012**
		Absence last month	0 days	0.7	969	Ref.			Ref.					
			1-7 days	0.6	160	0.87	0.10-7.47	0.895	0.80	0.10-6.63	0.834			
			8-31 days	0	46	-	-	-	-	-	-			
		Live with spouse	Yes	0.7	557	Ref.			Ref.					
			No/no spouse	0.5	610	0.68	0.15-3.09	0.623	1.13	0.13-9.82	0.913			

						Uni-variate analyses			Age-adjusted			Multivariate analyses		
Residence	**Sex**	**Respondent characteristics**	**Categories**	**%**	**N**	**RR**	**95% CI**	**p**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**P**
Urban	Male	Age (continuous variable)				**1.17**	**1.04-1.32**	**0.010**				0.96	0.80-1.15	0.659
		Age	15-19	2.4	333	Ref.								
			20-24	6.7	280	**2.82**	**1.19-6.68**	**0.018**						
		Marital status	Single	3.3	552	Ref.			Ref.					
			Married/cohabiting	8.3	48	2.56	0.76-8.55	0.128	1.67	0.41-6.86	0.475			
		Educational level	Primary	5.7	209	Ref.			Ref.			Ref.		
			Secondary/higher	3.6	393	0.62	0.30-1.28	0.196	0.53	0.25-1.12	0.095	0.49	0.18-1.30	0.149
		Young age at first sexual intercourse (<16)	No	2.7	414	Ref.			Ref.			Ref.		
			Yes	8.2	194	**3.10**	**1.60-6.03**	**0.001**	**3.15**	**1.61-6.15**	**0.001**	1.73	0.83-3.60	0.139
		Young age at first marriage (<20)	No	3.7	588	Ref.			Ref.			Ref.		
			Yes	20.0	25	**5.35**	**2.40-11.9**	**<0.001**	**4.18**	**1.72-10.2**	**0.002**	1.78	0.49-6.46	0.383
		Age difference from first spouse				0.80	0.64-1.01	0.058	0.88	0.68-1.15	0.352			
		Age difference from last non-cohabiting partner				**0.72**	**0.63-0.81**	**<0.001**	**0.72**	**0.61-0.84**	**<0.001**	**0.73**	**0.63-0.85**	**<0.001**
		Absence last month	0 days	2.1	467	Ref.			Ref.			Ref.		
			1-7 days	12.3	114	**5.74**	**2.70-12.2**	**<0.001**	**5.14**	**2.33-11.4**	**<0.001**	**4.17**	**1.98-8.80**	**<0.001**
			8-31 days	10.0	30	**4.67**	**1.76-12.4**	**0.002**	**4.45**	**1.67-11.9**	**0.003**	**3.14**	**0.52-18.9**	**0.210**
		Live with spouse	Yes	9.8	41	Ref.			Ref.					
			No/no spouse	4.0	572	0.41	0.13-1.32	0.136	0.63	0.17-2.30	0.481			
	Female	Age (continuous variable)				**1.27**	**1.09-1.48**	**0.002**				1.25	0.92-1.69	0.151
		Age	15-19	0.5	404	Ref.								
			20-24	2.5	402	**5.02**	**1.04-24.4**	**0.045**						
		Marital status	Single	1.0	479	Ref.			Ref.					
			Married/cohabiting	2.2	271	2.12	0.73-6.18	0.168	1.19	0.33-4.24	0.792			
		Educational level	Primary	1.5	336	Ref.			Ref.					
			Secondary/higher	1.6	444	1.06	0.37-3.03	0.914	1.05	0.37-2.91	0.933			
		Young age at first sexual intercourse (<16)	No	0.8	598	Ref.			Ref.			Ref.		
			Yes	3.0	199	**3.61**	**1.17-11.1**	**0.026**	**3.33**	**1.03-10.7**	**0.044**	1.34	0.25-7.33	0.733
		Young age at first marriage (<17)	No	1.0	698	Ref.			Ref.			Ref.		
			Yes	4.7	106	**4.70**	**1.84-12.0**	**0.001**	**4.09**	**1.61-10.4**	**0.003**	1.74	0.26-11.4	0.565
		Duration of marriage ≥8 years	No	1.4	737	Ref.			Ref.					
			Yes	0	10	-	-	-	-	-	-			
		Age difference from first spouse				1.03	0.96-1.11	0.380	0.99	0.90-1.09	0.797			
		Age difference from last non-cohabiting partner				**1.20**	**1.13-1.27**	**<0.001**	**1.24**	**1.18-1.31**	**<0.001**	**1.24**	**1.14-1.34**	**<0.001**
		Absence last month	0 days	1.1	642	Ref.			Ref.			Ref.		
			1-7 days	4.4	114	**4.02**	**1.49-10.9**	**0.006**	**3.42**	**1.26-9.32**	**0.016**	**4.80**	**1.31-17.5**	**0.018**
			8-31 days	0	47	-	-	-	-	-	-	-	-	-
		Live with spouse	Yes	0.8	242	Ref.			Ref.					
			No/no spouse	1.6	559	1.95	0.54-7.09	0.311	**3.76**	**1.09-13.0**	**0.037**			

Table 5: Percentage with more than one ongoing relationship, respondents aged 15-49 years; surveys from 1998 and 2003 have been pooled

						Uni-variate analyses			Age-adjusted			Multivariate analyses		
Residence	**Sex**	**Respondent characteristics**	**Categories**	**%**	**N**	**RR**	**95% CI**	**p**	**RR**	**95% CI**	**p**	**RR**	**95% CI**	**p**
Rural	Males	Age	15-19	3.3	480	Ref.						1.06	0.51-2.22	0.870
			20-24	6.1	460	**1.95**	**1.10-3.44**	**0.022**				Ref.		
			25-29	11.0	392	**3.51**	**2.18-5.65**	**<0.001**				1.00	0.62-1.61	0.994
			30-39	14.6	574	**4.68**	**2.82-7.78**	**<0.001**				0.80	0.48-1.32	0.378
			40-49	18.4	315	**5.89**	**3.41-10.2**	**<0.001**				0.87	0.48-1.55	0.628
		Marital status	Single	3.2	831	Ref.			Ref.			Ref.		
			Married/cohabiting	15.2	1300	**4.66**	**3.20-6.79**	**<0.001**	**3.26**	**1.91-5.58**	**<0.001**	**2.34**	**1.00-5.48**	**0.050**
		Educational level	Primary	10.9	1362	Ref.			Ref.					
			Secondary	10.3	590	0.95	0.70-1.28	0.712	0.92	0.67-1.26	0.595			
			Higher	8.7	46	0.79	0.30-2.10	0.643	0.55	0.21-1.45	0.227			
		Young age at first sexual intercourse (<16)	No	9.0	1444	Ref.			Ref.			Ref.		
			Yes	12.8	760	**1.42**	**1.10-1.83**	**0.007**	**1.43**	**1.11-1.84**	**0.005**	1.19	0.94-1.51	0.136
		Young age at first marriage (<20)	No	9.2	1937	Ref.			Ref.			Ref.		
			Yes	18.2	270	**1.97**	**1.55-2.51**	**<0.001**	**1.65**	**1.28-2.11**	**<0.001**	1.20	0.90-1.60	0.210
		Duration of marriage ≥8	No	6.3	1446	Ref.			Ref.			Ref.		
			Yes	19.8	672	**3.15**	**2.35-4.20**	**<0.001**	**2.21**	**1.45-3.34**	**<0.001**	**2.21**	**1.45-3.37**	**<0.001**
		Age difference from first spouse		-	-	**0.93**	**0.91-0.95**	**<0.001**	0.98	0.95-1.01	0.242			
		Age difference from last non-cohabiting partner		-	-	**0.90**	**0.89-0.92**	**<0.001**	**0.92**	**0.90-0.93**	**<0.001**	**0.91**	**0.90-0.93**	**<0.001**
		Absence last month	0 days	8.0	1667	Ref.			Ref.			Ref.		
			1-7 days	15.8	412	**1.96**	**1.49-2.59**	**<0.001**	**1.85**	**1.41-2.43**	**<0.001**	**1.70**	**1.28-2.25**	**<0.001**
			8-31 days	20.4	142	**2.54**	**1.76-3.66**	**<0.001**	**2.38**	**1.67-3.38**	**<0.001**	**1.88**	**1.32-2.68**	**<0.001**
		Live with spouse	Yes	15.4	1218	Ref.			Ref.			Ref.		
			No/no spouse	4.1	990	**0.27**	**0.20-0.36**	**<0.001**	**0.42**	**0.29-0.60**	**<0.001**	0.83	0.45-1.54	0.561

						Uni-variate analyses			Age-adjusted			Multivariate analyses		
Residence	**Sex**	**Respondent characteristics**	**Categories**	**%**	**N**	**RR**	**95% CI**	**p**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**P**
Rural	Females	Age	15-19	0.5	582	Ref.								
			20-24	0.8	596	1.63	0.38-6.94	0.511						
			25-29	0.8	484	1.60	0.35-7.42	0.546						
			30-39	1.0	626	1.86	0.54-6.38	0.324						
			40-49	1.0	384	2.02	0.46-8.79	0.348						
		Marital status	Single	0.5	560	Ref.			Ref.					
			Married/ cohabiting	1.0	1747	1.82	0.49-6.71	0.371	1.34	0.14-12.3	0.799			
		Educational level	Primary	1.1	1660	Ref.			Ref.					
			Secondary	0.7	418	0.63	0.20-1.95	0.420	0.65	0.20-2.12	0.470			
			Higher	0	21	-			-					
		Young age at first sexual intercourse (<16)	No	0.5	1662	Ref.			Ref.			Ref.		
			Yes	1.4	931	**2.58**	**1.07-6.22**	**0.035**	**2.60**	**1.09-6.22**	**0.032**	**2.98**	**1.14-7.83**	**0.026**
		Young age at first marriage (<17)	No	0.8	1932	Ref.			Ref.					
			Yes	1.0	711	1.27	0.52-3.06	0.598	1.20	0.49-2.95	0.694			
		Duration of marriage ≥8	No	0.6	1396	Ref.			Ref.					
			Yes	0.9	883	1.41	0.49-4.05	0.528	0.83	0.25-2.72	0.762			
		Age difference from first spouse				**0.93**	**0.91-0.95**	**<0.001**	0.98	0.95-1.01	0.242	**0.87**	**0.79-0.97**	**0.009**
		Age difference from last non-cohabiting partner				1.13	0.73-1.74	0.596	1.15	0.78-1.70	0.475			
		Absence last month	0 days	0.8	2145	Ref.			Ref.					
			1-7 days	1.0	397	1.27	0.33-4.85	0.725	1.23	0.33-4.64	0.758			
			8-31 days	0.8	123	1.03	0.13-8.30	0.981	1.01	0.12-8.18	0.996			
		Live with spouse	Yes	0.7	1620	Ref.			Ref.					
			No/no spouse	0.7	1025	0.92	0.38-2.21	0.856	1.03	0.35-3.07	0.953			

						Uni-variate analyses			Age-adjusted			Multivariate analyses		
Residence	**Sex**	**Respondent characteristics**	**Categories**	**%**	**N**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**P**
Urban	Males	Age	15-19	2.4	333	Ref.						Ref.		
			20-24	6.8	280	**2.82**	**1.20-6.68**	**0.018**				1.51	0.60-3.79	0.384
			25-29	9.5	241	**3.97**	**1.70-9.29**	**0.001**				0.79	0.31-2.02	0.622
			30-39	7.4	363	**3.10**	**1.37-7.00**	**0.007**				0.76	0.29-1.96	0.567
			40-49	9.3	216	**3.85**	**1.63-9.13**	**0.002**				1.01	0.40-2.57	0.978
		Marital status	Single	3.0	666	Ref.			Ref.			Ref.		
			Married/cohabiting	10.2	684	**3.41**	**1.75-6.64**	**<0.001**	**3.11**	**1.47-6.60**	**0.003**	2.43	0.39-15.0	0.340
		Educational level	Primary	10.3	419	Ref.			Ref.			Ref.		
			Secondary	6.0	807	**0.58**	**0.38-0.87**	**0.009**	**0.54**	**0.36-0.81**	**0.003**	**0.42**	**0.26-0.67**	**<0.001**
			Higher	1.7	181	**0.16**	**0.05-0.50**	**0.002**	**0.12**	**0.04-0.37**	**<0.001**	**0.10**	**0.03-0.30**	**<0.001**
		Young age at first sexual intercourse (<16)	No	5.5	1031	Ref.			Ref.			Ref.		
			Yes	10.2	393	**1.84**	**1.25-2.71**	**0.002**	**1.97**	**1.38-2.80**	**<0.001**	1.21	0.72-2.03	0.478
		Young age at first marriage (<20)	No	6.0	1338	Ref.			Ref.			Ref.		
			Yes	17.8	90	**2.94**	**1.76-4.90**	**<0.001**	**2.48**	**1.45-4.24**	**0.001**	0.71	0.32-1.57	0.401
		Duration of marriage ≥8	No	5.7	998	Ref.			Ref.					
			Yes	9.2	349	**1.61**	**1.02-2.54**	**0.043**	1.03	0.62-1.72	0.898			
		Age difference from first spouse				**0.94**	**0.91-0.97**	**<0.001**	0.97	0.92-1.02	0.170	1.00	0.93-1.08	0.961
		Age difference from last non-cohabiting partner				**0.86**	**0.84-0.89**	**<0.001**	**0.87**	**0.84-0.90**	**<0.001**	**0.84**	**0.81-0.87**	**<0.001**
		Absence last month	0 days	4.5	1021	Ref.			Ref.			Ref.		
			1-7 days	11.2	278	**2.48**	**1.59-3.85**	**<0.001**	**2.31**	**1.47-3.61**	**<0.001**	**2.34**	**1.40-3.92**	**0.001**
			8-31 days	15.3	131	**3.39**	**1.96-5.85**	**<0.001**	**2.97**	**1.68-5.22**	**<0.001**	1.96	0.88-4.35	0.099
		Live with spouse	Yes	10.0	653	Ref.			Ref.			Ref.		
			No/no spouse	3.8	772	**0.38**	**0.21-0.69**	**0.002**	**0.39**	**0.21-0.71**	**0.002**	0.60	0.10-3.69	0.580

						Uni-variate analyses			Age-adjusted			Multivariate analyses		
Residence	**Sex**	**Respondent characteristics**	**Categories**	**%**	**N**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**P**	**RR**	**95% CI**	**p**
Urban	Females	Age	15-19	0.5	404	Ref.						Ref.		
			20-24	2.5	402	**5.02**	**1.04-24.4**	**0.045**				2.57	0.46-14.4	0.283
			25-29	0.4	288	0.70	0.06-7.86	0.774				1.19	0.11-12.8	0.889
			30-39	0.8	384	1.58	0.26-9.59	0.620				2.14	0.24-19.2	0.497
			40-49	2.3	220	4.59	0.82-25.7	0.083				**100**	**6.95-1437**	**0.001**
		Marital status	Single	1.1	543	Ref.			Ref.					
			Married/cohabiting	1.3	898	1.21	0.51-2.84	0.662	0.91	0.32-2.61	0.868			
		Educational level	Primary	1.3	751	Ref.			Ref.					
			Secondary	1.4	715	1.05	0.47-2.36	0.905	1.12	0.50-2.51	0.778			
			Higher	0.7	141	0.53	0.07-4.04	0.542	0.50	0.06-3.97	0.515			
		Young age at first sexual intercourse (<16)	No	0.8	1139	Ref.			Ref.			Ref.		
			Yes	2.3	435	**2.85**	**1.22-6.66**	**0.016**	**2.72**	**1.13-6.51**	**0.025**	**3.82**	**1.53-9.54**	**0.004**
		Young age at first marriage (<17)	No	1.1	1391	Ref.			Ref.					
			Yes	2.0	300	1.85	0.85-4.06	0.122	1.67	0.73-3.81	0.220			
		Duration of marriage ≥8	No	1.4	958	Ref.			Ref.			Ref.		
			Yes	0.4	474	0.31	0.06-1.54	0.152	0.08	0.006-1.14	0.062	**0.01**	**0.00-0.44**	**0.015**
		Age difference from first spouse				0.91	0.82-1.01	0.063	**0.90**	**0.83-0.99**	**0.022**	**0.83**	**0.76-0.90**	**<0.001**
		Age difference from last non-cohabiting partner				**1.16**	**1.07-1.25**	**<0.000**	**1.18**	**1.10-1.27**	**<0.001**	1.08	0.86-1.35	0.528
		Absence last month	0 days	0.9	1280	Ref.			Ref.			Ref.		
			1-7 days	2.4	330	**2.59**	**1.04-6.43**	**0.041**	**2.47**	**0.95-6.39**	**0.063**	**4.87**	**1.83-13.0**	**0.002**
			8-31 days	1.2	83	1.29	0.15-10.9	0.818	1.22	0.14-10.6	0.859	-	-	-
		Live with spouse	Yes	0.7	824	Ref.			Ref.					
			No/no spouse	1.4	857	1.92	0.70-5.27	0.204	2.20	0.81-5.99	0.121			