

**Reducing HIV prevalence among young people:
A review of the *UNGASS* prevalence goal and how it
should be monitored**

Dr. Mar Pujades Rodríguez and Prof. Richard Hayes

**London School of Hygiene and Tropical Medicine
London, UK**

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Abbreviations

AIDS	Acquired immuno-deficiency syndrome
ANC	Antenatal care
ART	Antiretroviral therapy
BD	Blood donors
DHS	Demographic and health survey
EIA	Enzyme-linked immunosorbent assay
FP	Family planning
HIV	Human immuno-deficiency virus
ICPD	International Conference on Population and Development
IDU	Injecting drug users
MSM	Men who have sex with men
MTCT	Mother-to-child transmission
SGS	Second Generation Surveillance
STARHS	Serologic testing algorithm for recent HIV seroconversions
STD	Sexually transmitted diseases
STI	Sexually transmitted infections
SWs	Sex workers
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNGASS	United Nations General Assembly Special Session
VCT	Voluntary counselling and testing
WHO	World Health Organization

Executive summary

At the United Nations General Assembly Special Session on HIV/AIDS (UNGASS), in June 2001, member states committed themselves to achieving a 25% reduction in HIV prevalence among young people aged 15 to 24 years by 2005 in the most affected countries, and by 2010 in all other countries.

The present review discusses the limitations of HIV prevalence estimates when used to track changes in the HIV epidemic in young people. In particular, it highlights important factors that need to be considered in interpreting prevalence data obtained from antenatal care (ANC) surveillance. The document suggests that, despite substantial efforts made in recent years to improve the quality and representativeness of sentinel surveillance systems and to develop adjustment methods that can be used to obtain more accurate estimates of HIV prevalence in the population, current estimates may not accurately reflect trends of infection in young people. Behavioural changes, such as delay in sexual debut and changes in patterns of contraceptive use, are shown to be important factors that need to be accounted for. In particular, increases in condom use among young people may affect observed trends of HIV infection from ANC surveillance in either direction, depending on the sector of the population that is more likely to use them (e.g. high or low risk groups). Furthermore, the combined effect of the discussed factors is difficult to predict and will be determined by the characteristics of the site and the stage of the HIV epidemic.

Results of the 2001 Mali Demographic and Health Survey (DHS), conducted to assess the feasibility and acceptability of performing HIV testing at the time of periodic DHS surveys, are encouraging. DHS surveys could supplement ANC surveillance as a source of HIV prevalence data in some countries in the future, potentially avoiding many of the biases associated with the latter. In the meantime, despite its limitations, ANC surveillance is likely to remain the primary tool for monitoring the HIV epidemic. To better interpret ANC prevalence estimates, this review recommends focusing on the 15-24 year age group, rather than the narrower 15-19 year, because of the substantial bias that may be associated with the latter age group. It also recommends to collecting and analysing information on the characteristics of ANC clinic users as well as behavioural data that may provide useful insights into the sources and direction of biases in HIV prevalence estimates.

1. Introduction

More than two decades have passed since the detection of the first cases of acquired immunodeficiency syndrome (AIDS). The HIV epidemic has continued to spread rapidly in many countries despite national and international efforts to control it. The World Health Organization (WHO) has recommended the use of HIV prevalence as an indicator to monitor the effectiveness of national AIDS control programmes. The present review has been prepared in order to support WHO in its HIV-related activities among youth. The terms of reference provided for this discussion paper call for a review of literature and experience concerning the use of HIV prevalence to measure trends in HIV infection among people aged 15 to 24 years. The review focuses on the degree to which data sources commonly used in HIV surveillance may provide reliable estimates of the extent of the epidemic in this population. In particular, the limitations of ANC clinic estimates are discussed in detail by examining how key factors influence their interpretation in different contexts. The alternative approaches that have been proposed to overcome those limitations are then reviewed. Special attention is given to settings with scarce resources, which are also those most affected by the HIV epidemic.

1.1 *Scale of the HIV epidemic among young people*

Overall, an estimated 5 million people became newly infected with HIV in 2001. More than half of these new infections occurred among young people aged 15 to 24 years. (UNICEF *et al.*, 2002) Surveys have shown that sexual activity is frequently initiated early in adolescence and this can result in relatively high prevalence rates of HIV infection. For example, a multicentre study in 4 African cities showed prevalence of HIV infection among 15 to 19 year olds of up to 23% in women and 3.7% in men in the general population. (Buvé *et al.*, 2001) For several reasons, young adults and children, in particular young women and girls are extremely vulnerable. Adolescence is a period characterised by an urge for experimentation. Misconceptions and limited knowledge concerning HIV infection and prevention methods may lead adolescents to engage in risky sexual behaviour. In addition, adolescence is a time when drug and alcohol abuse starts, and these practices have been shown to increase the risk of HIV infection directly, through unprotected sex or needle

exchange, or indirectly through involvement in sexual commerce. (Gossop *et al.*, 1995; Mbulaiteye *et al.*, 2000)

In most cases, young people lack the necessary skills to negotiate safer sex. Financial constraints and emotional dependence on adults makes them vulnerable to sexual abuse, exploitation and coercion. Furthermore, reproductive health services, including services for the diagnosis and treatment of sexually transmitted diseases, are often poorly accessed by adolescents because of concerns about privacy and unfriendly and judgmental attitudes of care providers.

1.2 UNGASS prevalence target

At the Special Session on AIDS in June 2001, member states of the United Nations General Assembly (*UNGASS*) committed themselves to achieve a number of goals in the fight against HIV/AIDS. Those goals had already been enunciated in the key actions for the further implementation of the Programme of Action of the International Conference on Population and Development (ICPD+5). One of those goals was working towards a reduction in HIV prevalence among young people aged 15 to 24 years in their respective countries. In particular, governments of the most affected countries agreed to attempt a 25% reduction in HIV prevalence in this group by 2005 whereas all other countries would attempt a global reduction by 2005 and a 25% reduction by 2010. Equally important was the commitment of donor countries and agencies to the achievement of this goal.

Progress towards achievement of these UNGASS goals by each country will be reviewed annually. To facilitate this annual review, the Joint United Nations Programme on HIV/AIDS (UNAIDS) has developed a set of indicators of programme impact to provide technical guidance on the information required and its interpretation. (UNAIDS, 2002) Standardising types of data and methods to measure the extent to which programme activities have succeeded in achieving the prevalence goal will be necessary to maximise comparability of the estimates obtained across countries and over time.

1.3 Objectives of this review

The present discussion paper has been prepared in order to make recommendations that will help in evaluating progress towards achievement of the agreed *UNGASS* prevalence goal. The aim of the review is to highlight and discuss important factors that have been shown to distort prevalence estimates of HIV infection and provide guidance for their interpretation. In particular, the main objectives of the review are:

- To consider alternative sources of data collection and biases associated with their use in monitoring the HIV epidemic
- To discuss the limitations of prevalence estimates of HIV obtained from commonly used surveillance systems
- To examine the quality of prevalence data currently collected
- To provide recommendations for the measurement and interpretation of trends in HIV prevalence

The paper is organised into 5 sections. Section 2 provides some background materials on the circumstances leading to the formulation of the *UNGASS* goal. Section 3 starts by reviewing the limitations of data sources available to monitor the HIV epidemic. It briefly considers the relative advantages and disadvantages of alternative sources of data collection, discussing the factors to be considered when interpreting estimates. Limitations of ANC estimates are then reviewed in more detail, and the different methods that have been proposed to generalise findings to the population as a whole are discussed. The section concludes by discussing the use of HIV prevalence estimates obtained from sentinel surveillance to interpret trends in the context of Second Generation Surveillance. Various criteria related to the quality of prevalence data currently collected and reported are presented in Section 4. Finally, Section 5 lists recommendations for action and research priorities in order to achieve a more efficient use of available data.

2. Rationale for the *UNGASS* goal

Fighting the HIV epidemic and its consequences requires large and sustained investments, which are unaffordable for many of the most affected countries. In order to sustain the interest of donors in HIV/AIDS control and to ensure a more efficient use of funds, it is extremely important to assess the impact of National AIDS Control Programmes and of specific HIV-related interventions on the progress of the HIV epidemic. This helps in identifying effective interventions as well as geographical areas where efforts should be concentrated.

The present section discusses the advantages and disadvantages of using incidence or prevalence to monitor the spread of the HIV epidemic as well as the choice of the target age groups and the geographical scope of the target.

2.1. *Prevalence or incidence?*

HIV incidence – the number of new cases of HIV infection – and the distribution of those new infections in the population are the most relevant data for monitoring purposes, as they reflect the current dynamics of the HIV epidemic and the effects of ongoing preventive interventions. (Wawer *et al.*, 1997; Rutherford *et al.*, 2000)

Nevertheless, HIV incidence is difficult to measure. Because HIV incidence rates are relatively low, even when prevalence is high, detecting enough recent infections to obtain robust incidence rates requires follow up of large cohorts of people. (Zaba and Slaymaker, 2002) As a result, longitudinal studies are costly, time consuming, logistically complicated and have therefore been limited to localised cohort studies. (McFarland *et al.*, 1999; Rutherford *et al.*, 2000; Zaba *et al.*, 2000) (Schwarcz *et al.*, 2001) In addition, several factors tend to decrease HIV incidence in prospective studies, resulting in the underestimation of true incidence rates in the population of interest. For ethical reasons, cohort participants are usually offered enhanced medical services, voluntary counselling and testing (VCT) and education on reproductive health issues. Those services may affect the behaviour of participants (Schwarcz *et al.*, 2001) and the resultant “intervention effects” will tend to decrease HIV incidence within the cohort and over time. (Batter *et al.*, 1994; Gregson *et al.*, 1998; McFarland *et al.*, 1999) Individual characteristics of persons who enrol and remain in

cohort studies usually differ from those of the population of interest. Resultant selection bias from loss to follow-up and / or from time-dependent changes in participation levels may also lead to lower HIV incidence estimates. Furthermore, in closed cohort studies the number of susceptible people will tend to decline over time, as individuals at higher risk become infected with HIV. (Schwarcz *et al.*, 2001) In particular, in cohorts of high-risk groups, susceptible individuals who are “more likely” to acquire HIV infection will get infected soon after the beginning of the follow-up, and the proportion of those “resistant” to HIV infection will increase over time.

HIV incidence can also be measured using the serologic testing algorithm for recent HIV seroconversion (STAHRS) or detuned assay. This method involves re-testing HIV-positive specimens by using a less sensitive enzyme-linked immunosorbent assay (EIA), which can only detect antibodies after a mean of 129 days post-seroconversion. (Janssen *et al.*, 1998) The main advantage of the STAHRS is that incidence of HIV infection can be estimated by using data from cross-sectional surveys.

Although current data suggest that STARHS over-estimates HIV incidence by 10% to 20%, consistent use of this assay over time would allow tracking trends in incidence. (Cleghorn *et al.*, 2002) Low levels of HIV antibody, such as those found in final stages of AIDS or in persons receiving antiretroviral therapy (ART) including a protease inhibitor early after infection, (Schwarcz *et al.*, 2001) may cause misclassification. However, young subjects are likely to have been recently infected and the proportion of people receiving early ART is negligible in developing countries.

Blinded quality assurance panels have been field tested in developing countries. (MEASURE, 2000) Unfortunately, although STAHRS is being tested for non-B subtypes of HIV, which are the most commonly found in African population, current assays are limited to type B clades. (MAP, 2002) Once STAHRS for non-B subtypes of HIV are developed and become available they might be used in research or surveillance to estimate HIV incidence. Nevertheless, it should be noted that the use of this assay will not remove the need to adjust for selection and coverage biases introduced by using a given data source (Remis *et al.*, 2002; Zaba and Slaymaker, 2002) and large sample sizes will be required as a result of the narrow “window period” in STAHRS (HIV incidence is estimated over a four-month period).

In contrast with incidence, prevalence of HIV infection – the combination of new and older cases of HIV infection – provides the best measure of the scale of the epidemic, allowing

planning for health and social services. Overall prevalence estimates, however, will be less useful to identify those groups in which new infections are currently occurring. (Schwarcz *et al.*, 2001)

In a prospective study in rural Uganda it was shown that the decline in HIV prevalence observed in the presence of a stable HIV incidence could be explained by HIV-related differentials in mortality and mobility. (Wawer *et al.*, 1997) In general, HIV prevalence depends upon the balance between incidence, HIV-associated mortality and migration. A decline in prevalence could be attributed to changes in any of these three factors. (Konde Lule, 1995; Kamali *et al.*, 2000; Fylkesnes *et al.*, 2001) Therefore, it is difficult to relate changes in adult HIV prevalence to changes in infection rates, since differential mortality and migration between HIV positive and negative subgroups may be responsible for those changes in prevalence rates. When sentinel groups – especially selected population groups such as ANC attenders – are monitored for HIV surveillance purposes, differentials in compliance and/or use of services between HIV infected and uninfected individuals will also affect the measured prevalence estimates and trends. (Zaba and Slaymaker, 2002)

Prevalence estimates restricted to younger age groups are more likely to reflect new infections with HIV and therefore incidence, since start of sexual activity would be recent at those young ages. As discussed in Section 3, prevalence of HIV infection in the younger age groups would also be less affected by differentials in mortality and fertility between HIV infected and uninfected individuals. These effects are shown to increase with time since infection and will be more evident at older ages. In contrast, migration among the youngest may be an important factor and can lead to bias in the estimated prevalence in the 15-24 year group.

In summary, although incidence is the best indicator of the spread of HIV infection, prevalence, particularly that measured among young age groups, is easier to measure accurately and may be used to monitor recent changes in the epidemic, provided that sample size requirements are met and that sufficient information on demographic characteristics of the individuals surveyed is collected in order to interpret the results.

2.2. Choice of age group

The UNGASS has proposed to monitor trends in HIV prevalence among young people aged 15 to 24 years as an indicator of the ability of national AIDS control programmes to control the HIV epidemic. Every year, new cohorts of young and uninfected subjects join the group of sexually active individuals. As young people represent a high proportion of the population in developing countries, (Zaba *et al.*, 2000) reducing the rate of infection in this group would have an important influence on the overall course of the epidemic.

Several factors imply that people aged less than 25 years are the most sensitive group to monitor recent changes in the HIV epidemic. First, their rates of HIV infection are among the highest observed. (Zaba *et al.*, 2000; Laga *et al.*, 2001) An overall low prevalence may still exist in the presence of high incidence among adolescents. This was the case among ANC attenders in Kinshasa where prevalence among women aged fewer than 25 years increased over time despite an overall stable prevalence of HIV infection. (Batter *et al.*, 1994) Second, HIV infections in this group are more likely to have occurred recently and, therefore, prevalence among the young will reflect recent incidence or rates of new infections. In contrast, HIV prevalence in older women represents the cumulative net effect of infection and attrition over a longer period of time and is, therefore, less able to detect recent changes. (Changalucha *et al.*, 2002) Because adults already have a high prevalence, changes in incidence of infection in older age groups would take longer to be reflected in lower prevalence. (Konde Lule, 1995) Third, young people tend to respond more rapidly and are more sensitive to behavioural interventions, since it is easier to adopt new patterns of behaviour before they are established than to change habits that have been acquired in the past. (Gregson *et al.*, 1998; Kilian *et al.*, 1999; Zaba *et al.*, 2000) This means that analysing trends of HIV prevalence in young people may be a sensitive way of monitoring the impact of infection in the population.

The focus in the 15-19 year group, as opposed to younger age groups, derives from the assumption that sexual transmission predominates in young people and that sexual infection is uncommon before the age of 15. However, HIV infected in a 15-19 year old may have been acquired before the age of 15 years through different mechanisms: mother-to-child transmission (MTCT), parenteral transmission (eg. transfusion of contaminated blood or blood products or unsafe injections) or in the course of early sexual activity. The need for HIV seroprevalence data on young people below 15 years will depend on two main factors: the relative importance of those mechanisms of transmission and the probability that people

infected at such young ages are captured by surveillance systems at older ages (eg. 16-year-old pregnant women infected by 14 years attending ANC clinics).

MTCT of HIV infection in developing countries remains high due to absence of prevention programmes with ART and to the almost universal practice of breastfeeding for periods as long as 18 to 24 months. It has been estimated that 800,000 children were newly infected with HIV in 2001, almost all of them through MTCT. (UNAIDS, 2002) Survival of children infected with vertically acquired HIV infection is marked by two periods of very high mortality: infancy, because of the failure of the immature immune system to protect against HIV, and after age 9, due to opportunistic infections and progression to AIDS. (The UNAIDS Reference Group on Estimates, 2002) Despite the lack of information on long term survival of those infected children, it is assumed that by age 15 all HIV-positive children will have died or will be at an advanced stage of disease.

Early in the HIV epidemic it was estimated that, world-wide, between 5% and 10% of all HIV infections were acquired through transfusion of contaminated blood and blood products. (UNAIDS, 1997) Following the widespread introduction of blood screening for HIV this proportion is believed to have decreased substantially. However, few data are available concerning the relative importance of either transfusion or some nosocomial mechanisms (e.g. medical injections) in the transmission of HIV infection.

Although a substantial proportion of individuals under the age of 15 years are virgins, youth in many countries become sexually active at these early ages (e.g. Bangladesh or India). Where sexual activity starts early, the need for HIV seroprevalence data among younger adolescents would be potentially greater. Nevertheless, measuring HIV prevalence in young adolescents involves issues such as obtaining parental consent and ensuring confidentiality that can only be fulfilled in the context of research studies (e.g. randomised controlled trials targeting youth). In addition, behavioural information from individuals in this age group and in both in- and out-of-school youth (because of the substantial differences in health status and behaviour in these two groups) can be collected and analysed, but this information is likely to be very unreliable in such young people.

In summary, prevalence of HIV infection is generally very low below 15 years and it is difficult to measure. The UNGASS target of 15 to 24 years seems then to be reasonable.

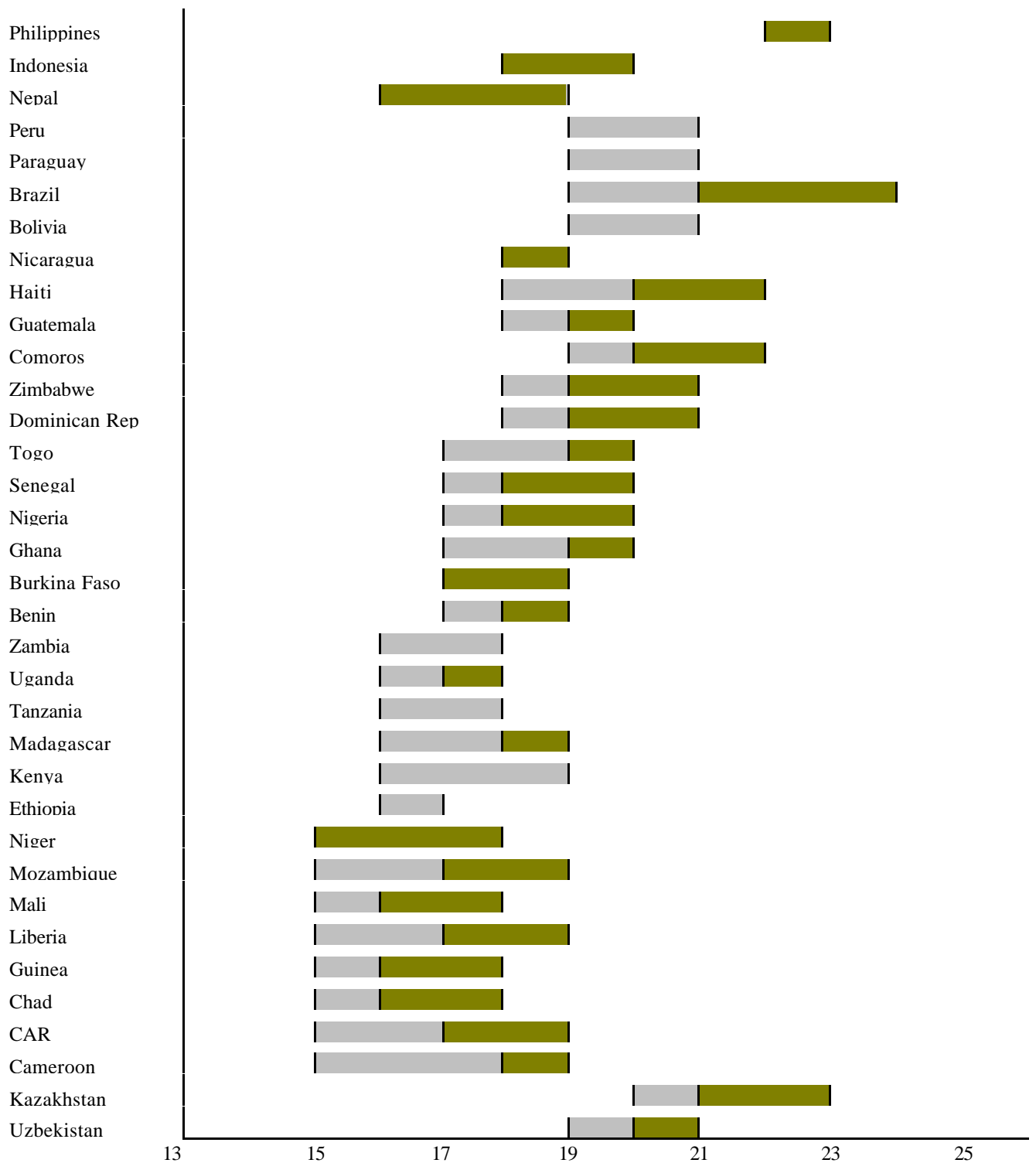
Prevalence in younger age groups, in particular 15 to 19 years olds, reflects incidence more closely than prevalence in older individuals, because recent HIV infection is not so strongly associated with increased mortality as infections acquired in the more distant past. (Kilian *et al.*, 1999; Fylkesnes *et al.*, 2001) The effects of HIV decreasing fertility will also be less important at those young ages, (Zaba *et al.*, 2000; Changalucha *et al.*, 2002) and this is especially important in the context of ANC surveillance in low contraceptive use countries. The effects of HIV infection on fertility and mortality will be discussed in detail in Section 3.

A decrease in HIV incidence would result in a temporal shift in the peak prevalence age from younger to older age groups, as the cohort of women who became infected in the past becomes older. (Taha *et al.*, 1998) Since data routinely collected by surveillance systems is unlinked, identifying women attending clinics at subsequent pregnancies is not possible and, therefore, observed trends in prevalence might just reflect such shifts of HIV-infected women from one age group to the next instead of true changes in incidence. (Bunnell *et al.*, 1999)

Nevertheless, despite the higher sensitivity of younger age groups in reflecting recent infections, the appropriate choice of age category to target may vary from country to country. In general, there is a wide variation in the proportion of subjects sexually active across age groups. Figure 1 shows median ages at first sex, first marriage and first birth in women of different countries. In countries in which sexual debut starts late the 15-19 age-group would not be an appropriate target group.

It is important to note that measures of prevalence among people aged less than 15 years and among those aged 15 to 19 years may be difficult to interpret. It is known that the length of exposure to sexual activity and the risk of transmission, which is related to the HIV prevalence in the general population and to the level of sexual mixing between high-risk groups and the general population and between age-groups, determine the prevalence of HIV infection among the sexually active population. It is also known that ANC clinics provide the most frequently reported estimates of prevalence worldwide. Given that the composition of the group of pregnant women aged 15 to 19 years is strongly affected by changes in age at sexual debut, the prevalence in this group may not adequately reflect trends in prevalence in adolescents in the population at large. (Zaba *et al.*, 2000) Furthermore, sufficiently large sample sizes required to obtain robust age-specific prevalence estimates are not always available for these younger age-groups.

Figure 1: Median ages at first sex, first marriage & first birth in women.



Source: DHS

In summary, although prevalence of HIV infection in the 15-19 year age category might be the most sensitive group to use, this may not be appropriate in some countries depending on the average age at sexual debut (e.g. it may be more appropriate the 20-24 age group). In addition, specific problems related to the use of ANC data, which will be discussed in detail in Section 3, imply that it is better to use a broader age group (15-24 years).

2.3. Geographical scope

At the end of 2001, the HIV-1 epidemic was generalised in most countries of sub-Saharan Africa. In 16 of these countries, the reported overall adult HIV prevalence exceeded 10% by the end of 1999. The Caribbean is the second most severely affected region in the world. By contrast, most South and Central American countries report low national prevalence estimates of HIV infection, the HIV epidemics being mainly concentrated in specific sub-groups of the population such as men who have sex with men, sex workers or injecting drug users. In Asia, only 3 countries have generalised epidemics: Thailand, Cambodia and Myanmar. However, some areas of India are also reporting prevalence of HIV infection over 4% among pregnant women, and concentrated epidemics among injecting drug users and sex workers are present in some provinces of China and Indonesia. (UNAIDS and WHO, 2001)

The UNAIDS Report on the HIV/AIDS epidemic, which was presented at the 2002 International AIDS Conference, includes a table showing prevalence estimates for pregnant women aged 15 to 24 years in countries where the overall adult HIV prevalence, as estimated at the end of 2001, is higher than 5%. It is important to note that, although this table provides an indication of countries where the HIV epidemic is particularly serious, it also lists countries such as Angola, Liberia or Sierra Leone, in which health activity has been disrupted as a result of civil conflicts. The consequence of this disruption is that no recent seroprevalence data are available and that it may be difficult to obtain reliable prevalence estimates for these countries during the next few years. In contrast, the table does not include countries such as Uganda where estimated infection rates remain high, despite tremendous efforts to control the epidemic and an observed declining prevalence of HIV infection.

3. Approaches to monitoring

As mentioned in previous sections, obtaining regular measures of HIV infection is essential in order to monitor and evaluate the success of national AIDS control programmes, for advocacy and to justify and promote national and international HIV/AIDS control efforts. (UNAIDS, 2000; WHO, 2001) Such data are also important for planning, targeting and evaluating interventions. (Schwartlander *et al.*, 1999)

Given the long incubation period between HIV infection and the development of AIDS, a surveillance system restricted to AIDS case reporting is not effective for measuring the extent of the HIV epidemic. (Walker *et al.*, 2001) Biological data on HIV infection, as measured by serological tests, are therefore necessary in order to monitor the spread of HIV infection. The use of standard indicators and data collection procedures allows monitoring of the spread of the HIV epidemic in a given country as well as comparisons between different populations over time. As we will see in later sections, an optimal use of HIV infection data, as well as appropriate interpretation of estimates based on these data, require measures to be reported separately by individual characteristics that are determinants of the risk of HIV transmission.

3.1 Sources of prevalence data

Two main methods of data collection are used in HIV surveillance: repeated seroprevalence surveys in the general population or in particular high-risk groups, such as sex workers (SWs) or injecting drug users (IDU), and sentinel surveillance. Sentinel surveillance uses blood samples that have been drawn for other purposes (eg. screening for syphilis among pregnant women attending ANC services).

In generalised epidemics, where HIV prevalence is consistently over 1% in the general population, either population-based surveys or sentinel surveillance among ANC attenders may be used to obtain estimates of HIV prevalence. Although other population groups such as family planning (FP) and VCT attenders and blood donors (BD) can also be monitored for surveillance purposes, they are currently not widely used and studied and are, therefore, less

internationally comparable. Different contexts might provide additional unexpected opportunities for HIV surveillance, as is the case for routine health check-ups organised among military conscripts in Thailand. (Nopkesorn *et al.*, 1993)

In 1998, WHO proposed the use of HIV sentinel surveillance as the primary approach to monitoring the extent and trends of the HIV epidemic. (Walker *et al.*, 2001) UNAIDS has recommended two prevalence indicators to monitor the HIV epidemic: HIV prevalence in pregnant women attending ANC, the main indicator for generalised epidemics, and HIV prevalence in sub-populations at high-risk such as IDUs or patients with STIs, which is particularly important in concentrated epidemics. (Zaba and Slaymaker, 2002)

In this section, we briefly discuss the advantages and limitations of HIV prevalence estimates obtained from each of the data sources mentioned above and the extent to which they can be generalised to broader populations. In general, processes such as increased urbanisation, migration and education are likely to influence patterns of spread of HIV epidemics. Increasing income differentials may contribute to greater heterogeneity in rates of sexual partner change and lead to more assortative mixing patterns. (Gregson *et al.*, 2002) The direction and magnitude of bias associated with the use of each of these data sources may, therefore, vary over time and in different contexts.

Sentinel surveillance among ANC attenders and its limitations will be discussed in detail in Section 3.2. The present section reviews other sources of data in terms of their appropriateness to provide estimates of HIV prevalence among young people.

- ***Population-based randomised HIV serosurveys***

The main advantages of this type of survey are, firstly, that random selection of participants helps to provide a representative sample of the population; and, secondly, that they provide HIV prevalence estimates for both men and women. Their usefulness in helping to identify biases in surveillance systems and in interpreting estimates from such studies will be discussed in Section 3.2.2

Despite these advantages, community-based serosurveys are uncommon for financial, logistical and ethical reasons. Informed consent is needed and response bias resulting from

high refusal rates can be important. In addition, high-risk groups (eg. SWs) and highly mobile groups (eg. young men) tend to be under-represented at the time of these surveys and this may lead to underestimation of the HIV prevalence in the population.

- ***VCT services***

Because seeking HIV testing is a voluntary decision, data from VCT services are particularly susceptible to participation bias. As attitudes and behaviours towards acceptability of those testing services are culturally and socially variable, the direction and magnitude of these participation biases are unpredictable (Meda *et al.*, 1999) and likely to change over time and as the HIV epidemic matures. Thus, changes in test-seeking behaviour as well as changes in underlying prevalence in the target population may influence trends in HIV prevalence measured in people testing for HIV. (McFarland *et al.*, 1999) The proportion of young people using VCT services will also vary substantially from place to place and is usually low (less than 10%). {Godfrey-Faussett, 2002 #409}

Falls in HIV prevalence might be explained in different ways depending on the setting. For example, they could result from high-risk persons seeking HIV screening earlier than others or from increases in the proportion of people seeking HIV screening who come from low prevalence areas (e.g. rural sites). (Konde Lule, 1995)

In summary, VCT prevalence data cannot be recommended as an indicator of HIV prevalence in the general population.

- ***Blood donors***

In recent years, data from routine screening of blood for transfusion has not been used as an indicator of HIV prevalence in the general population and UNAIDS Guidelines do not recommend the use of this information for epidemic monitoring purposes.

The existence of standard procedures for recruitment, screening practices for BD, the degree of representativeness of reporting sites, and the proportion of BD aged 15 to 24 years old will determine the extent to which BD information may be used in the context of HIV surveillance for this age group.

Procedures for recruitment of BD vary in different countries. BD can be divided into three categories according to the main recruitment method used: voluntary non-remunerated donors, family or replacement donors and commercial or professional donors. (Sedyaningsih-Mamahit *et al.*, 2002) The likelihood and direction of biases introduced by using HIV prevalence in BD as a surrogate for the whole population will vary between these categories. Professional donors are likely to be the least representative of the general population if higher-risk groups seek financial compensation associated with the donation of blood.

In order to determine whether BD HIV data can be used as a proxy for HIV prevalence in the general adult population, data on HIV prevalence from BD in 50 countries with generalised epidemics were compared with prevalence estimates in adults published by UNAIDS/WHO. (Sedyaningsih-Mamahit *et al.*, 2002) In countries where HIV prevalence estimates in BD were similar to the UNAIDS estimates, the majority of donations came from family or replacement donors. In contrast, voluntary BD were the main source of donors where BD estimates were lower than the corresponding UNAIDS prevalence estimates, possibly because such countries implemented self-deferral of at-risk individuals and informed donors of their HIV status. The authors concluded that only replacement donors should be considered as an additional source of information on HIV prevalence, but could not replace the need for HIV sentinel surveillance in more representative population groups.

Where potential donors are effectively screened for behavioural traits that put them at high risk of HIV infection or if they are informed about their HIV status and asked not to donate again if positive, new and repeat donors are likely to be subject to different biases. (Zaba and Slaymaker, 2002) Moreover, as a result of this progressive exclusion of known HIV-infected individuals, HIV prevalence among BD may tend to under-estimate general population prevalence. Caution is therefore needed when interpreting decreasing trends in HIV prevalence among the BD population, since they may reflect increasing participation bias over time. (Downs *et al.*, 2002)

HIV prevalence among BD can be computed separately for men and women, and this allows the estimation of sex ratios for HIV prevalence. These sex ratios could be used to estimate male-to-female adjustment factors to calibrate the relationship between prevalence in ANC clinics and prevalence in men and women in the general population. (Walker *et al.*, 2001) However, caution is needed where BD services systematically exclude certain sectors of the

population. A common exclusion criterion adopted by many services is that of individuals under 45kg in weight and/or those with a haemoglobin level of less than 12 g/dl. In most developing countries, the strict application of this screening criterion would result in exclusion of a large proportion of women but very few men from the BD population. Too few women donors will imply imprecise BD estimates for females, particularly if such estimates are further stratified by age. Under these circumstances, HIV-specific sex ratios obtained from BD data may be biased towards lower rates of HIV infection in women, because of the indirect association between HIV infection and anaemia (e.g. through higher frequency of other infections such as malaria), although such biases may be less important in younger age groups in which acquisition of HIV infection is relatively recent.

A further issue is the overall representativeness of BD data. Not all health units are able to perform blood transfusions and continuity in the activity of those units that do may be compromised by shortage in supplies of medical materials (e.g. transfusion equipment or HIV tests). Where supplies are scarce, blood transfusions may be restricted to the most favoured socio-economic sectors of the population. These factors in combination with continuity and completeness of reporting of BD data, will also influence the bias introduced when using HIV estimates from BD.

Finally, information on age-specific HIV prevalence is rarely available from BD, as only overall prevalence rates are included in surveillance reports.

In summary, although information on BD is not recommended as a proxy measure for HIV prevalence in the general population, it may be useful as an indicator of recent trends in prevalence among low-risk groups in countries in which most donations come from family or replacement donors and where the proportion of those BD aged 15 to 24 years is substantial, particularly if exclusion criterion are not applied. In these countries, such data may also provide evidence of differentials by sex and geographical area. (Zaba and Slaymaker, 2002) However, in order to interpret prevalence estimates and trends, it is extremely important that reports always include additional information such as country standards for pre- and post-donation procedures, proportion of hospitals screened and their location (e.g. rural vs. urban areas), proportion of donated blood actually tested and basic demographic information about the donors (e.g. age and sex).

- ***FP attenders***

HIV prevalence estimates obtained from users of FP services may complement the information obtained from ANC sentinel surveillance. This is particularly important for high contraceptive use countries, where a large proportion of the population currently sexually active will be excluded from a surveillance system exclusively based on ANC data.

In the United States and Puerto Rico information from abortion and family planning clinics has been analysed in recent years. (Sweeney *et al.*, 1992) Median HIV rates were higher in clinics offering prenatal services and lower in abortion and FP clinics in the same cities. HIV studies among family planning clinic attenders have also been performed in some developing countries, such as Tanzania (Kapiga *et al.*, 1998) and Thailand. (Xu *et al.*, 2002) Unfortunately no comparative studies with adjacent ANC clinics have been carried out.

Although FP HIV estimates will be subjected to bias derived from the selection of sentinel sites and self-selection of attenders using those services, analysis of trends observed in this population will contribute to the interpretation of trends from ANC surveillance in countries where use of FP methods is common.

Comparative studies of HIV prevalence in FP attenders and the general population are necessary to identify bias in prevalence estimates from such services. Obtaining information on the age distribution of FP attenders and identifying demographic factors influencing attendance of such services would help to assess the usefulness of monitoring FP HIV trends in the context of HIV surveillance of young people.

- ***STD clinic attenders***

Few sentinel systems provide any data on HIV prevalence in men, but such data are provided by surveillance among STD clinic attenders. HIV prevalence measured among STD patients will overestimate prevalence in the general population because those patients represent a high-risk group. Furthermore, interpreting HIV prevalence among STD clients is difficult because trends of HIV prevalence in this population may be biased due to changes in treatment seeking for STD or changes in the incidence or aetiology of STD. The magnitude of such bias is likely to differ in men and women.

Reported data on STI usually come from selected governmental STD clinics. Apart from the quality, completeness and continuity of reporting from these sites, patterns of health seeking behaviour and differentials in characteristics related to HIV transmission between sentinel STD clinic users and those opting for other alternatives (i.e. private clinics or pharmacies, self-treatment) will influence the estimated indicators.

In addition, some studies suggest that, over time, the proportion of individuals at highest risk make up a decreasing fraction of the subgroup of persons testing for HIV. Thus, in a retrospective cohort study in four STD clinics in Miami, HIV seroprevalence for all tests fell from 12% to 10%, while the seroprevalence among persons tested for the first time remained unchanged and the seroprevalence among persons who had tested negative in the past increased from 2.1% to 3.7%. (Peterman *et al.*, 1995) The authors explained that these apparently contradictory trends arose partly because previously tested HIV-negative persons were re-tested while previously tested HIV-positive persons were not.

Among young people, a further limitation related to the use of data from STD clinics is the limitations in access to or use of STD services, which may also introduce bias in our estimates of HIV prevalence.

3.2 ANC sentinel surveillance

Several characteristics make HIV surveillance based on antenatal clinics the most widely used source of seroprevalence information in countries with generalised epidemics. (Carpenter *et al.*, 1997; Gregson *et al.*, 1998; Glynn *et al.*, 2001) Pregnant women attending ANC clinics often give blood for syphilis screening, making residual specimens available for HIV testing. (Kigadye *et al.*, 1993) These specimens are tested after the elimination of all personal identifying information. In contrast with named testing, anonymous unlinked testing requires no counselling and individual informed consent and ensures anonymity of HIV results. It is therefore a practical and relatively cheap method, which involves little disruption to the normal ANC services and reduces the risk of participation bias to a minimum. Because of its simplicity, it can easily be conducted in resource limited settings. (WHO, 2001)

Although ANC attenders are a relatively representative population (especially in high fertility countries in which the use of contraceptive methods is uncommon) data from ANC clinics may not be representative of all adult women. ANC sentinel surveillance contributes data only from recently sexually active women, who have easy access to, and use, governmental health care facilities and who are fecund and not using effective contraception. (Schwartlander *et al.*, 1999; Walker *et al.*, 2001)

Important factors that may introduce bias into the prevalence estimated from ANC clinics will be discussed in the following sections. They have been divided into several categories: factors related to the particularities of the national sentinel systems, those related to patterns of use of ANC services, patterns of migration and mobility in the areas covered by the sentinel sites and those determined by biological, social or behavioural factors associated with HIV infection. Some of these factors do not affect the interpretation of ANC estimates exclusively, and should also be considered when analysing indicators coming from other sources.

3.2.1 Limitations of surveillance systems

This section discusses the main limitations associated with the use of sentinel ANC surveillance as a source of HIV prevalence data.

- ***Selection of sentinel sites***

Ensuring that the geographical spread and type of facilities included in HIV surveillance systems reflect those facilities commonly used by the population is essential to minimise selection bias. Studies have observed large differences in HIV prevalence in various provinces and districts within the same country. Thus, the median HIV prevalence among women attending ANC clinics in 22 districts in Botswana ranged from 25.8% to 55.8%. (Masupu *et al.*, 2002) In general, districts with higher population density have higher HIV rates (Shaikh *et al.*, 2002) and HIV prevalence in urban areas is much higher than in rural areas. (Killewo *et al.*, 1990; Barongo *et al.*, 1992; Mnyika *et al.*, 1994; Fylkesnes *et al.*, 1997; Saphonn *et al.*, 2002) Population-based studies in Uganda and Tanzania have shown how HIV prevalence differs greatly according to location (eg. trading centres, intermediate trading

villages and rural villages). (Wawer *et al.*, 1991; Grosskurth *et al.*, 1995) Even within urban areas, large differences in HIV prevalence have been observed. (Fylkesnes *et al.*, 1997; Fontanet *et al.*, 1998)

Differences in prevalence between neighbouring areas or regions may be due to differences in sexual behaviour or in traditional practices that may influence the probability of HIV transmission (eg. circumcision or level of education), or may suggest an earlier introduction of the HIV epidemic in some of them. (Kwesigabo *et al.*, 1996) Therefore, an HIV surveillance system mainly restricted to urban sites is unlikely to represent prevalence in the general population in developing countries, where the majority of people live in rural areas. Furthermore, the probability that a blood specimen is collected from a pregnant woman at the time of her pregnancy is also higher for women attending urban ANC clinics than for those attending rural clinics. In a random sample of Malawian women who gave birth in the previous year and who had accessed ANC services, the proportion of women who had blood drawn ranged from 65% in urban areas to 32% in semi-urban areas. (Eckert *et al.*, 2002) Although African countries most severely affected by the HIV epidemic have increased the number of sentinel sites included in their surveillance systems and provide a fairly broad coverage in urban areas, rural sites still remain under-represented. (Schwartlander *et al.*, 1999)

A final related issue is the question of the overall representativeness of sentinel sites. In many countries sentinel clinics were initially chosen as an early warning system. They were located in areas believed to be at higher risk for HIV transmission or showing higher HIV prevalence. (Schwartlander *et al.*, 1999) The extent to which those countries have been able to expand the numbers of sites to other locations – eg. provinces, districts, rural and urban areas – will determine the degree of representativeness of their respective sentinel surveillance systems.

In summary, the number and choice of sentinel sites and how they relate to the population that they represent are critical to the interpretation of HIV estimates. A good surveillance system needs to provide coverage of a reasonably wide range of sentinel clinics, in both urban and rural areas, to ensure representativeness. Reporting detailed information about the location of sentinel ANC clinics and about key demographic characteristics of both

population covered and clinic users (i.e. place of residence and education) by national surveillance systems is helpful in interpreting HIV prevalence estimates and trends.

Although sentinel surveillance sites are never likely to be fully representative of the national population, they may still give valuable data on trends. However, trends may also be misleading (e.g. if prevalence of HIV infection is only falling in urban areas and ANC surveillance is weighted towards these areas).

- ***Serologic methods for HIV testing***

Training and turnover of laboratory personnel and supervisors as well as the choice of serologic kits to detect HIV may account for differences in prevalence between and within countries and over time. This is especially true because of the great variations in the specificity of HIV kits when they are used on African sera. (Fabiani *et al.*, 2001)

In this respect, WHO guidelines recommend limiting the number of HIV tests used in each country and advise that the surveillance co-ordinator should document all the test technologies and algorithms that are used. (UNAIDS *et al.*, 2001)

- ***Continuity in testing and reporting***

Continuity and completeness in carrying out the serological tests and reporting their outcome are also critical in order to provide representative estimates and track changes in HIV prevalence over time. Military conflicts, which cause disruption in the normal activity of certain countries, as well as financial difficulties, are some factors that cause irregularity in surveillance reporting.

- ***Routine data collection***

Specimens are generally anonymised but linked to basic data that are collected routinely in ANC services. As a result, reported surveillance data often lack key elements that might help to interpret estimated prevalence of HIV infection. Although unique identifiers could be used to detect duplication of samples (after anonymization) and to facilitate data linkage of infected women who attend clinics at subsequent pregnancies, this does not seem feasible in most settings. Information on sexual behaviour, such as age at sexual debut, could help to interpret observed trends in HIV prevalence infection. However, asking sensitive questions

in the context of routine ANC visits may be inappropriate and needs careful consideration. Concerns over confidentiality related to collection of this type of information by local health staff could have a negative impact in mother and child health programmes uptake.

3.2.2 Selection bias

Use of ANC clinics as the source of information for prevalence estimates generally implies restricting the population observed to women who have been recently sexually active and who were not using FP methods consistently (or for whom the FP method chosen was not effective). The present section discusses the biases introduced as a result of this choice as well as bias related to coverage and utilisation patterns of ANC clinics.

- ***Selection for sexual activity***

Table 1 summarises information from studies comparing ANC HIV prevalence data with prevalence estimates obtained in population-based surveys conducted in the same areas. In general, prevalence from ANC clinics overestimates prevalence of HIV infection among the younger age groups, whereas it underestimates the prevalence in older age groups. The main reason for these differences is that women in the 15 to 19 year-old group are less representative of their age group, because of the high proportion of virgins and women with limited sexual experience. (Zaba *et al.*, 2000; Glynn *et al.*, 2001; Chagalucha *et al.*, 2002) Many of those young women not seen in ANC clinics will never have been sexually active, while those sexually active who are pregnant may also have been exposed to risk of HIV infection. In general, the later the age at sexual debut the more atypical are pregnant women of younger age and, therefore, the higher the degree of overestimation of ANC estimates will be. (Gregson *et al.*, 2002)

In the absence of changes in the risk of infection among people becoming sexually active, tracking age-specific prevalence among the youngest age groups over time may be misleading when substantial changes occur in the average age of sexual debut. The later the age at sexual debut, the later will be the cross-over point at which fertility reduction effects of HIV cancel out the selection effects due to sexual activity (e.g. not only will HIV prevalence

Table 1: Comparison of HIV prevalence by groups of age in women in ANC clinics and in the general population

Data source	Year	Sample	Sample size (15-24 yr)	Age-group				Comments	Source
				15-19	20-24	15-24	15-49		
Fort Portal, Uganda	1995	Pop-based (W)	221	12.3	30.3	20.3	26.0	Pop-based (two-stage cluster sampling method). > 85% pregnant attend ANC	(Kilian <i>et al.</i> , 1999)
		Pop-based (M)	170	0	16.3	7.6	18.1		
		ANC	296	11.5	25.7	18.2	18.4		
Chelston, Zambia (U)	1994-1996	Pop-based (W)	702	12.3	35.4	22.5	29.9	12 months difference between data collection. Sentinel survey used serum-based HIV testing & pop-based survey used saliva. Age group 15-39	(Fylkesnes <i>et al.</i> , 1998)
		Pop-based (M)	434	4.5	10.7	6.9	18.3		
		ANC	307	17.1	26.0	22.8	26.1		
Kapiri Mposhi district, Zambia (R)	1994-1996	Pop-based (W)	236	8.2	24.6	16.1	17.4		
		Pop-based (M)	176	5.5	5.8	5.7	15.9		
		ANC	252	12.4	12.2	12.3	12.6		
Addis Ababa, Ethiopia	1994 1996	Pop-based (W)	373	3.5	9.1	4.3	5.5	24 months difference between ANC & population-based data. High refusal rate among 15-49 years olds: blood given by 59.7% of women in the population survey.	(Fontanet <i>et al.</i> , 1998)
		Pop-based (M)	468	1.8	4.5	3.0	6.2		
		ANC	608	-	-	20.7	17.8		
Yaounde, Cameroon (U)	1997-1998 1998	Pop-based (W)	475	3.4	9.3	6.3	7.8		
		Pop-based (M)	397	0	1.4	0.8	4.1		
		ANC	836	5.9	4.9	5.3	5.6		
Kisumu, Kenya (U)	1997-1998 1998	Pop-based (W)	594	23.0	38.3	30.2	30.1	12 months difference between ANC and population-based surveys.	(Glynn <i>et al.</i> , 2001)
		Pop-based (M)	298	3.5	12.3	8.1	19.8		
		ANC	1026	22.2	36.6	30.0	30.6		
Ndola, Zambia (U)	1997-1998 1998	Pop-based (W)	617	15.4	41.8	28.4	31.9		
		Pop-based (M)	245	3.7	13.2	9.0	23.2		
		ANC	610	15.4	31.7	24.9	27.3		
5 provinces, Cambodia, (R)	1993?	Pop-based (W)	332	-	-	0.8	0.9	Unspecified time difference between ANC and population-based surveys.	(Saphonn <i>et al.</i> , 2002)
		Pop-based (M)	-	-	-	-	-		
		ANC	518	-	-	2.7	2.3		
5 provinces, Cambodia, (U)	1993?	Pop-based (W)	387	-	-	1.0	1.6		
		Pop-based (M)	-	-	-	-	-		
		ANC	510	-	-	1.3	1.5		

Mwanza, Tanzania (R)	1991-1992 1991-1993	Pop-based (W)	2544	1.8	6.1	4.1	4.7	Direct standardisation using age distribution of general population survey yields age-adjusted HIV prevalence of 3.2% for ANC.	(Changalucha <i>et al.</i> , 2002)
		Pop-based (M)	2098	0.2	3.2	1.7	3.8		
		ANC	1210	2.2	4.6	3.6	3.6		
Manicaland, Zimbabwe	1998-2000	Pop-based (W)	2268	7.0	26.4	15.7	25.5	High contraceptive use setting. 15-44 yr	(Gregson <i>et al.</i> , 2002)
		Pop-based (M)	2155	1.1	8.4	4.9	18.6		
		ANC	684	13.4	21.6	18.4	21.1		
Mwanza, Tanzania (U)	1990-1991	Pop-based (W)	245	10.6	19.7	15.5	15.6	76% of eligible participated in population survey. Coverage of ANC clinic was 60%	(Kigadye <i>et al.</i> , 1993)
		Pop-based (M)	222	2.1	7.9	5.4	8.5		
		ANC	976	-	-	10.7	11.7		
Bukoba, Tanzania	1987-1990	Pop-based (W)	127	-	-	27.6	29.2	Approximately 30 months difference between population-based and ANC surveys. Age adjusted estimates.	(Kwesigabo <i>et al.</i> , 1996)
		Pop-based (M)	90	-	-	11.1	17.1		
		ANC	665	21.8	25.1	23.2	22.8		

W=Women; M=Men; U=Urban; R=Rural

in pregnant teenagers be higher than in non-pregnant teenagers, this relationship could be observed at ages 20 to 22 or so). In general, changes in the age distribution of young ANC attenders related to changes in age at sexual debut would tend to exaggerate peaks and falls in the measured prevalence and may even induce changes in the direction of trends. (Zaba, 2001) Nevertheless, a stable prevalence in pregnant women aged 15 to 24 years for about 5 years can be considered as an indicator of stable incidence, since in this time all the individuals included in the 15 to 19 years age category would be entirely replaced by other women. (Zaba *et al.*, 2000)

Finally, women not currently sexually active will also include some widows or divorced / separated women (especially in older age groups) and these women will also be underrepresented in ANC clinics. Some studies have observed a higher HIV seroprevalence among these two groups of women. (Barongo *et al.*, 1992)

- ***Level of contraceptive use***

The direction of the association between HIV infection and contraceptive use varies in different contexts and according to the type of contraceptive primarily used (e.g. barrier and non-barrier methods). It is therefore necessary to clearly separate the effects of using different contraceptives in interpreting HIV prevalence data from ANC.

Bias introduced as a result of high hormonal contraceptive use might partly affect the bias in the opposite direction related to selection bias for sexual activity. In high hormonal contraceptive use populations, FP programmes are targeted mainly at married women, with “completed families”. The bulk of use will, therefore, occur in an older, low risk group. This will have the effect of lowering HIV prevalence among non-ANC attenders relative to ANC attenders at older ages. In contrast, in populations without active FP programmes (low hormonal contraceptive use populations), young users may tend to be the more sexually “adventurous” with unorthodox partnerships who are most determined to avoid pregnancy. These users may, then, be at high risk for HIV infection, in which case prevalence in non-ANC attenders would be higher than among pregnant women.

Some authors have hypothesised a role for hormonal contraception in enhancing the transmission of HIV infection. However, no clear or consistent pattern has been observed in

studies examining this association. Conflicting results have also been reported in studies of the effect of contraception on HIV shedding. (Stephenson, 1998)

Patterns of condom use will determine the effect of an increase in the proportion of individuals using condoms in HIV transmission and this effect could lead to artificial declines or increases in ANC prevalence estimates. Individuals who think they are at high risk of HIV infection will be more sensitive to promotion and marketing campaigns for condoms and more likely to adopt condom use to protect themselves or their partners as well as to avoid pregnancies. This would result in higher prevalence of infection in non-ANC users. In contrast, where condoms are used consistently as a preventive measure from the start of sexual activity, and only discontinued when the woman wishes to become pregnant, this will tend to lower prevalence among non-ANC users.

A mathematical model studying the population level effects of HIV on fertility showed that when condoms are widely used, ANC HIV prevalence tends to overestimate the prevalence in the general population and that ANC prevalence is more sensitive than community prevalence to the extent of condom use. (Gregson *et al.*, 2002) In the event of behavioural changes associated with the need to protect against infection in mature HIV epidemics, contraceptive use might increase. However, in most of sub-Saharan Africa, there are substantial practical and cultural obstacles to achieving high rates of use of condoms or other modern contraceptives. Condoms tend to be used more in casual rather than long-term childbearing relationships. Therefore, it is unrealistic to expect condom use to rise to very high levels and the increase in HIV prevalence associated with mature epidemics should be captured by ANC surveillance. However, if underlying community prevalence falls, due to successful condom promotion, ANC surveillance could fail to capture the full extent of the decreasing trend, since consistent condom-users will be under-represented in ANC clinics. (Gregson *et al.*, 2002) This is likely to be a particular problem in young people, who are less likely to be in long-term childbearing relationships.

In general, where contraceptive use is low, HIV prevalence from ANC surveillance in the youngest age groups overestimates prevalence in the general population due to selection bias for sexual activity. In high contraceptive use populations where young women take more effective measures to prevent both pregnancy and HIV infection, HIV prevalence in pregnant women of young age will over-represent women with higher risks for HIV-infection and this

over-representation would persist in older age groups. (Gregson *et al.*, 2002) ANC attenders would, therefore, be less representative of the general population in such countries. Where women with high-risk behaviour use contraceptive methods others than condoms to prevent pregnancy, ANC data will tend to under-estimate the prevalence of HIV infection in the general population.

- ***Coverage and utilisation patterns of ANC clinics***

The magnitude of the bias introduced by using HIV prevalence estimates from ANC surveillance to monitor the HIV epidemic in the general population will also depend on several factors related to utilisation of ANC facilities: i) the proportion of the theoretical population covered by the clinics who actually use those services; ii) the proportion of women who have blood drawn while attending ANC services; and iii) how pregnant women using ANC clinics and providing blood samples differ from those who do not. Demographic and Health Surveys (DHS) have shown that the proportion of women attending ANC services at some time during their pregnancy varies widely, ranging from 95% in Kenya to 26% in Bangladesh. (UNAIDS, 1998) Where attendance is high, as in Kenya, ANC users are likely to be representative of all pregnant women.

However, ANC attendance is lower in many areas and factors influencing ANC utilisation are likely to vary from place to place, and over time. (UNAIDS, 1998) For example, less than one-third of pregnant women in Cambodia receive ANC in government-supported clinics and deliver in a hospital (Saphonn *et al.*, 2002). DHS surveys provide information on key determinants of ANC attendance. Thus, ANC services seem to be used more frequently by women from urban than from rural areas, by those with more education compared to those with less and by younger women more than by those over 35. (UNAIDS, 1998) Patterns of use of ANC clinics may also change over time (e.g. provision of ART for prevention of MTCT may increase usage of governmental ANC clinics, especially by women at high risk).

In many countries, it is difficult to define the catchment population of a clinic. (Changalucha *et al.*, 2002) Large trading centres may “attract” clients from distant areas, who use the opportunity of a day at the market to also attend a particular ANC clinic. Population perceptions of different health facilities, in particular perceptions of the governmental ANC clinics included in the surveillance system, as well as the relative importance of the private

health sector and/or traditional medical practice will also play an important role in the patterns of use of different ANC clinics. The type of facility (private or public) is not routinely recorded by the DHS, and the balance is likely to vary in different countries and from place to place. (UNAIDS, 1998) The importance of the private sector might partly explain why more educated and unmarried women were less likely to attend their local clinic in a study in Zimbabwe. (Gregson *et al.*, 2002)

Referral patterns may also partly determine the size, distribution and overlap of catchment areas. Thus, in Uganda, smaller units routinely refer first pregnancies (primigravidae) to hospitals, and this gives the referral hospital a higher proportion of pregnant women below 20 years. (Konde Lule, 1995) Accessibility and availability of financial resources to travel to the referral centre will also determine the proportion and the individual characteristics of women attending the ANC facilities at the hospital. Opening of new health centres (Bunnell *et al.*, 1999) or improvements in transport infrastructure, which facilitate rural-urban mobility, may also alter patterns of use.

Finally, the demographic characteristics of the catchment population of health structures may vary over time. This will affect the interpretation of crude rates and ratios, which may need to be overcome by standardisation procedures.

In summary, sentinel surveillance provides a means of tracking a population in a systematic way over time, provided that the characteristics of the individuals attending these sentinel sites do not change over time. (2002) However, usage may change over time (e.g. provision of ART for prevention of MTCT may increase usage, especially by women at high risk of HIV infection). Representativeness of ANC attenders can be assessed by comparing basic demographic information and the parity and birth interval distribution of ANC attendees with women in the DHS giving birth in the last few years and examining how this changes over time. (Zaba *et al.*, 2000)

- ***Fertility and sub-fertility***

Fertility is the ability to produce live births. Levels of fertility vary substantially in different localities and according to demographic factors such as age. Population-based surveys in Uganda and Zambia as well as studies comparing data from ANC clinics with data in the

community have shown 20% to 50% lower fertility rates in women of all ages infected with HIV. (Fylkesnes *et al.*, 1998; Gray *et al.*, 1998; Ross *et al.*, 1999; Gregson *et al.*, 2002) In a multicentre study in 4 African cities, primiparous women infected with HIV had longer intervals between sexual debut and first birth, and multiparous infected women had longer birth intervals than uninfected women. (Glynn *et al.*, 2000) Low fertility in HIV positive women may, therefore, lead to the underestimation of the true HIV prevalence in the community, since infertile women are excluded and sub-fertile women are under-represented in those clinics.

The association between HIV and fertility is bi-directional and complex. HIV infection may reduce fertility directly by causing anovulation (Chirgwin *et al.*, 1996) or spontaneous abortion (Desgrees Du Lou *et al.*, 1998) or indirectly through association with other STD, and through other biological and behavioural factors. Later stages of HIV infection are likely to be associated with reduced coital frequency, anovulation, amenorrhoea and spontaneous abortion or stillbirths. (Carpenter *et al.*, 1997; Gray *et al.*, 1997; Gray *et al.*, 1998; Terceira *et al.*, 2001)

There is evidence for the role of HIV as a risk factor for spontaneous intrauterine mortality. (Desgrees Du Lou *et al.*, 1998; d'Ubaldo *et al.*, 1998) In a meta-analysis investigating the association between maternal HIV infection and perinatal outcome, women infected with HIV were four times more likely to have a spontaneous abortion or stillbirth than uninfected women. (Brocklehurst and French, 1998) However, the evidence is inconclusive and these findings should be interpreted with caution. (Ahdieh, 2001) Information on spontaneous abortion is rarely complete or reliable; not all cases are notified and not all women recognise the early foetal loss or attend health facilities. In addition, an increase in the proportion of spontaneous abortions and ectopic pregnancies after an HIV-positive test may be due to differences in ascertainment of outcomes (i.e more complete reporting for HIV-infected individuals followed prospectively). (de Vincenzi *et al.*, 1997) d'Ubaldo and colleagues have summarised the main hypotheses proposed to explain the association between HIV infection and spontaneous abortion (d'Ubaldo *et al.*, 1998). First, HIV has been identified in fetuses during the first weeks of pregnancy, suggesting that it can be transmitted across the placenta early in gestation. Presence of HIV infected monocyte/macrophages has also been demonstrated in the endometrial mucosa. These findings support the role of a direct effect of HIV on the placenta and/or on embryogenesis and this mechanism is likely to be more

important early after seroconversion and in the late stages of HIV infection. Second, thymic injury has been observed in foetal HIV-infected material, which supports the idea that immunosuppression related to HIV infection may also play an important role in inducing spontaneous abortion. The cumulative immunosuppressive effect of HIV infection and pregnancy may facilitate bacterial or viral infections of the villi. Later stages of infection are likely to be associated with this second mechanism.

The role of the HIV virus facilitating other infections, is supported by the findings of a prospective study of 765 pregnant women who were treated for malaria and STI and were attending a hospital in Kigali in their last 3 months of pregnancy. This study found that HIV infection increased the risk of prematurity by 62% and the risk of low birth weight (LBW) by 58%. (Leroy *et al.*, 1998) It also induced a lower placental weight. However, no significant association was noted between HIV serostatus and stillbirths or congenital malformations.

There is substantial evidence of the bi-directional relationship between HIV infection and other STI. HIV increases susceptibility to other STI (Dada *et al.*, 1998; McFarland *et al.*, 1999) or adversely influences the natural history and response to treatment of these infections, (Wald *et al.*, 1993; Augenbraun *et al.*, 1995), while STI act as co-factors in the sexual transmission of HIV. (Grosskurth *et al.*, 1995; Hayes *et al.*, 1995; Robinson *et al.*, 1997; Fleming and Wasserheit, 1999) STD are, therefore, more common in HIV infected than in uninfected individuals (O'Farrell, 1999; Do *et al.*, 2001; Schacker, 2001) and so women infected with HIV are also more likely to have a history of pelvic inflammatory disease. (Terceira *et al.*, 2001) In Africa, STI sequelae are thought to account for most cases of primary infertility. (Gregson *et al.*, 2002) In general, as the HIV epidemic matures, the prevalence of STD will tend to increase and, because of the effect of STD on fertility, fecundity will tend to decrease. (Gregson *et al.*, 2002) Part of the association between HIV and sub-fertility is explained by the more likely acquisition of HIV infection by women with lifestyles that also increase their risk of prior or subsequent infection with other STI. (Carpenter *et al.*, 1997) Sub-fertility prior to HIV infection may also contribute to the reduced fertility observed in HIV-infected women. In a population-based study in rural Uganda pre-existing sub-fertility accounted for approximately half of the infertility in infected women. (Ross *et al.*, 1999) Infertile women are likely to be at increased risk of HIV infection because they are frequently exposed to unstable marriages, or engage in extramarital relationships in order to prove their fertility. (Ross *et al.*, 1999; Gregson *et al.*,

2002) In some African societies, men reject infertile partners. In addition, lack of economic resources because of divorce or widowhood may increase a woman's chances of becoming involved in commercial sex. (Gregson *et al.*, 2002) This is corroborated by studies showing higher HIV seroprevalence among divorced, separated or widowed women. (Barongo *et al.*, 1992; Carpenter *et al.*, 1997; Gregson *et al.*, 2001; Boisson and Rodrigues, 2002)

Male partners of HIV-infected women may also be infected with HIV. HIV infection has been shown to be associated with a reduced production of spermatozoa and lower coital frequency because of illness affecting the partner and premature mortality of partners. These effects may contribute to reduce fertility in HIV positive women. (Setel, 1995; Carpenter *et al.*, 1997; Gray *et al.*, 1998; Ross *et al.*, 1999)

In addition, there is a strong association between HIV infection and changes in reproductive behaviour. In general, knowledge of HIV status may affect fertility by influencing desire for pregnancy, altering contraceptive use and breast-feeding practices and pregnancy termination because of concern about the possibility of transmitting the infection to infants. (UNAIDS, 1998; Bunnell *et al.*, 1999) For example, in a French cohort of 412 HIV-infected women, discovery of HIV infection led to a 5% to 20% decline in the proportion of women who were sexually active, to a lower incidence of pregnancy and live-births and to an increase of 54% in the proportion of pregnancies voluntarily interrupted. (de Vincenzi *et al.*, 1997) The local cultural context and socio-economic circumstances will determine the behavioural response to the HIV epidemic. (Setel, 1995; Gregson *et al.*, 2002) Cultural systems that support high levels of fertility are more susceptible to extensive HIV transmission. (Gregson *et al.*, 2002)

In sub-Saharan Africa, few people infected with HIV are likely to be aware of their condition until late stages of infection, when their own or their partner's health has deteriorated. (Zaba and Gregson, 1998) Therefore, it is unlikely that behaviour change will be more substantial among people infected with HIV than in the rest of the population. (Setel, 1995; Gregson *et al.*, 1997; Desgrees Du Lou *et al.*, 1998) In addition, studies aiming to measuring the impact of active HIV VCT on fertility rates, abortion and contraceptive use, have showed that, after disclosure of HIV results during pregnancy, most HIV-positive women are unwilling to inform sexual partners of their HIV serostatus. (Ryder *et al.*, 1991) These studies also noted that, among those who had informed their partner, compliance with counselling messages

was poor (e.g. low reported use of condoms and modern methods of contraception). (Desgrees-du-Lou *et al.*, 2001)

The effect of HIV on fertility increases with duration of infection, and since a large proportion of young HIV-infected women will be recently infected, the effect on fertility is likely to be lower in the 15-24 age-group. This is supported by the observation of a more rapid decline in fertility with age among HIV-infected women above 30 years. (Batter *et al.*, 1994) Zaba and colleagues reviewed the age-specific fertility rates from several African studies. (Zaba and Gregson, 1998) In general, among HIV-infected women, age-specific fertility rates are relatively high in women under 20 years, whereas at older ages fertility rates are markedly lower than in HIV-negative women. Differentials in fertility between HIV-infected and uninfected women seem to be greatest among women aged 20 to 29 years. (Gray *et al.*, 1998; Ross *et al.*, 1999)

It is important to note that, in countries where contraceptive use is common, the difference in HIV prevalence between pregnant and non-pregnant women (and ANC users and non-users) is likely to be narrower, because the group of non-pregnant women will not be dominated to the same extent by infertile women, but will also include a large proportion of fertile women who are contraceptive users. However, this may lead to other biases because contraceptive users may differ from non-users in HIV prevalence.

In low contraceptive use countries, the parity or birth order of a young pregnant woman may provide a more precise measure of sexual exposure than her age because the interval between sexual debut and first delivery is usually relatively short (See Fig.1). (Bunnell *et al.*, 1999) This is especially the case where there is wide variation in age at first sex or if initial sexual contacts are sporadic and infrequent. (Zaba, 2001)

- ***Stage of pregnancy***

Factors such as accessibility of ANC clinics, level of education or birth order are likely to influence the stage of pregnancy at which women attend ANC services for the first time. Although in sub-Saharan Africa the average median month of attendance is 5 months, in other geographical areas substantial proportions of women present much earlier. Medians of 2.5 to 6 months of gestation for the first ANC visit have been reported in different areas.

(UNAIDS, 1998) Where attendance is late in pregnancy, women who miscarry early will not be seen and this may lead to biased HIV prevalence estimates, because HIV seems to increase the likelihood of miscarriage. (Gray *et al.*, 1997) In most countries, nulliparous women are more likely to present to ANC services at an earlier stage of pregnancy than women expecting higher order births. (Zaba and Slaymaker, 2002)

Information about the stage of pregnancy at presentation to ANC clinics seems to be important in interpreting and comparing surveillance prevalence estimates of HIV infection. In a multicentre study in African urban sites, women attending ANC clinics at an earlier stage of pregnancy were more likely to be HIV-positive. (Glynn *et al.*, 2000) This is likely to reflect the inclusion of higher proportions of women infected with HIV who are at increased risk of experience foetal losses during their pregnancy.

The proportion of ANC attenders presenting at different stages of pregnancy should be considered when interpreting HIV prevalence estimates from ANC surveillance. The degree of underestimation of those estimates in relation to the true population prevalence is expected to be higher in areas where later attendance to ANC services is common.

3.2.3 Other limitations

- ***Exclusion of men***

Age-specific prevalence rates are generally higher among women than men aged less than 25 years (See Table 1) and higher in men than in women at ages 35 and above. This pattern is seen consistently regardless of the overall level of HIV prevalence and in both urban and rural areas. (Laga *et al.*, 2001) In particular, studies have observed extremely high levels of HIV infection in teenage women. (Wawer *et al.*, 1991; Barongo *et al.*, 1992; Auvert *et al.*, 2001; Laga *et al.*, 2001; Gregson *et al.*, 2002) Therefore, HIV prevalence estimated in young women cannot be extrapolated to the male population. (Fylkesnes *et al.*, 1998; Kilian *et al.*, 1999; MAP, 2002)

Physiological and behavioural factors are believed to contribute to the more rapid rise in HIV prevalence in young women. Studies of couples discordant for HIV infection have shown

that, in the absence of other co-factors such as STIs, men are two to three times more likely to transmit HIV to women than women to men. This difference is likely to be even larger in young girls in whom an immature reproductive tract is commonly associated with larger areas of cervical ectopy and sex may result in trauma to a less resistant vaginal epithelium. (Kapiga *et al.*, 1998) It is also plausible that susceptibility to HIV infection increases even further when vaginal or cervical trauma and bleeding are common, such as during forced sex or loss of virginity. (Laga *et al.*, 2001) In addition, higher levels of asymptomatic and untreated STIs (i.e. gonococcal or chlamydial infections) in women than men, common among the youngest age groups, would also contribute to increase the risk of HIV infection among young women. (Laga *et al.*, 2001)

Furthermore, sexual relationships between younger women and older men are frequent and older partners are more likely to be HIV infected, suggesting that young women are more likely to encounter an HIV-infected partner. (MAP, 2002) Thus, in a multicentre study, the reported median age difference between spouses was 6 to 7 years and, in Kisumu and Ndola, young married women had a higher risk of HIV infection if their husband was more than 3 years older than they were. (Ferry *et al.*, 2001; Glynn *et al.*, 2001; Buvé *et al.*, 2002) In rural Zimbabwe, the age difference between female and male sexual partners was the major behavioural determinant of the more rapid rise in HIV prevalence in young women than in men. (Gregson *et al.*, 2002) These patterns highlight the importance of also obtaining HIV prevalence information from older age groups, since HIV prevalence rates in older men will determine the risk of infection of younger women.

Sex is also more frequent for young women than for young men and young women are less likely than young men to use condoms. (MAP, 2002) The combination of these two factors will contribute to further increase the difference in HIV prevalence between young men and women.

The sex ratio in an HIV epidemic results from the relative importance of different modes of transmission (in particular, the proportion of infections among men who have sex with men and IDU (WHO, 1999)) and the stage of the epidemic. (Schwartlander *et al.*, 1999; WHO, 1999) Typically, in the early years, men account for a higher proportion of all infections. However, as the duration of the epidemic increases, the sex ratio of infection becomes more equal and may be reversed so that more women than men are infected.

In generalised epidemics it has been assumed that, overall, there are roughly equal numbers of men and women infected, although the ratio of infected men to infected women could easily vary by 5% or more in different countries. (Schwartlander *et al.*, 1999) Nevertheless, the sex ratio varies between age groups and according to age. Because of the factors mentioned above, more women than men in the 15 to 19 year old age group are infected. (Schwartlander *et al.*, 1999) Furthermore, the female / male HIV-1 prevalence ratio seems to be greater in urban areas and rural trading centres, where a relatively high proportion of women engage in commercial sex work. (Gregson and Garnett, 2000)

In summary, estimates from ANC attenders provide little information as to the patterns of spread within the male population. (Gregson *et al.*, 1998) Over-representation of the population prevalence by ANC HIV prevalence among young age groups is even greater for men than for women because men tend to be infected at an older age. (WHO, 2001) More data on the male-to-female ratio of HIV infection among young people are needed to obtain reliable prevalence estimates in young men.

- **Age**

Many of the behavioural factors that determine the risk of HIV infection vary with age, socio-economic status (education) and area of residence. Age also influences biological fertility and length of survival with HIV. (UNAIDS, 1998) Fertility and survival related to HIV infection will be discussed later in this section.

Approximately half of women of childbearing age fall within the 15 to 24 year age-group in both ANC and population-based surveys. However, there is considerable variation in the proportion of women aged 15 to 19 years relative to those aged 20 to 24 years. (Zaba *et al.*, 2000) The ratio of those aged 15 to 19 to those aged 20 to 24 years tends to be lower in ANC than in the general population, and this leads to overestimation of HIV prevalence from the population when ANC clinics are used as the source of surveillance data. (Zaba and Slaymaker, 2002)

Finally, misreporting of age by ANC clinic attenders is also possible. Age misreporting may be common where respondents do not know their exact birth date (although this seems less

likely among younger women) or where young pregnant women report an older age in order to conceal an early pregnancy. The effect of misreporting is more serious if narrow age groups are used, since these are more vulnerable to misclassification. (Zaba *et al.*, 2000) However, biases introduced through this mechanism are unlikely to change greatly over time, so this may be less important when looking at trends in HIV prevalence. (UNAIDS, 2000)

- ***Level of education***

Patterns of use of ANC clinics may differ according to the educational level of pregnant women and those patterns may also vary from place to place and over time. Thus, ANC attenders were more educated than non-attenders in Cambodia, (Saphonn *et al.*, 2002) whereas in Zambia, women with a higher level of education were under-represented in the ANC clinics relative to the general population because of their lower pregnancy rates. (Fylkesnes *et al.*, 1998) These lower pregnancy rates might be due to later sexual debut or to higher contraceptive use.

More educated young women tend to become sexually active later, (Fylkesnes *et al.*, 1998) and, therefore, young educated pregnant women will be a rather atypical group in certain contexts. In a study in Zimbabwe comparing rates of HIV infection in a population-based sample with those observed among ANC attenders, more educated women had lower risk of HIV infection than women with lower education in the general population, whereas in ANC attenders this pattern was inverted. (Gregson *et al.*, 2002)

In summary, because of the relationship between education and fertility, surveillance methods that are weighted towards certain educational categories may give a biased picture of the epidemic.

- ***Migration and mobility***

Different migration and/or mobility patterns among HIV infected and uninfected individuals living in a given area could introduce bias into estimated HIV prevalence rates. (Gregson *et al.*, 1998) For example, in rural Kenya it was observed that pregnant women from rural areas with husbands working in Nairobi often travel there during pregnancy to join their husbands and to attend ANC services and then return to their place of residence. (Jackson *et al.*, 1999) It is known that men are more likely to engage in high-risk practices while spending long

periods of time away from their families. Therefore, ANC attendance of women who are likely to have been infected by their partners at clinics located at their husbands' workplace would tend to artificially decrease HIV prevalence rates measured at ANC clinics in their rural place of residence, whilst inflating the urban ANC prevalence rates.

Including in regular surveillance reports information about the area of residence of ANC attenders would, therefore, be useful to provide an indication of selection effects due to population mobility.

3.2.4 Adjustment techniques

Comparative studies of HIV prevalence estimates between ANC attenders and women in the general population are useful as means to identify key factors responsible for the differences observed. Such studies have been used to derive correction factors that need be applied to sentinel surveillance data in order to obtain more accurate estimates of prevalence in the general population in different settings. Comparative studies, however, are affected by differential participation rates in HIV infected and uninfected women, problems in defining ANC catchment populations and time differences in the sampling of the two populations. (Zaba and Slaymaker, 2002)

Several other adjustment methods have been proposed to improve estimates of HIV prevalence among women. Some of these methods are based on changes in exposure to risk of pregnancy and HIV infection by age in women. Other methods have been proposed to extrapolate ANC prevalence estimates to men.

- ***Adjusting for age-differentials in prevalence of HIV infection***

Various methods have been proposed to adjust for differences between age distribution of ANC attenders and the general adult population using direct standardisation techniques. The standard age distribution has generally been taken as the country census population, (Fontanet *et al.*, 1998; Fylkesnes *et al.*, 1998) or a sub-Saharan African standard proposed by the UN Population Division (World Population Prospects, 1998 revision, volume II, sex and age) (Glynn *et al.*, 2001) or that of a general population survey (Changalucha *et al.*, 2002) in

the area. Although adjustment methods tend to further overestimate the prevalence of HIV infection in the 15-19 age group, such effect is at least partially counterbalanced by the greater weight that such methods give to the 20-24 age group (in which prevalence from ANC surveillance is closer to rates in the general population). Nevertheless, adjustment will not control for most of the sources of bias already discussed and adjusted age-specific estimates are likely to be biased.

- ***Adjusting for fertility-differentials in exposure to HIV infection***

Zaba and colleagues suggest an adjustment method in which the HIV prevalence is determined separately for parous and nulliparous ANC attenders. Applying separate correction factors for fertile and infertile women allows adjustment for infertility, whereas birth interval data are used to allow for sub-fertility. (Zaba *et al.*, 2000) The method has been validated in low-contraceptive use sub-Saharan Africa. Correction factors were derived using data from rural Uganda and Mwanza town. The method was further validated in rural Mwanza, although this time without using data on birth interval. (Changalucha *et al.*, 2002) In this latter population, unadjusted HIV prevalence was lower in ANC attenders than in women from the general population (3.6% vs. 4.7%, $p=0.025$) whereas after adjusting HIV prevalence in the ANC attenders there was little difference between the two groups (4.6% vs. 4.7%). In these low contraceptive use populations results suggested that adjustment for infertility was more important than for sub-fertility.

In contrast, application of Zaba's adjustment method to high contraception populations such as Zimbabwe suggested that in some of these settings unadjusted overall ANC HIV prevalence might be used as a proxy measure for overall prevalence in the general female population and further testing is required. Although in theory Zaba's method could be applied separately by age group, small sample sizes might preclude this.

Nicoll and colleagues propose an attendance method of estimating female population HIV prevalence from ANC surveillance. This method uses relative inclusion ratios – fertility in HIV-infected compared with uninfected women – to adjust for the relative probability of ANC attendance and of HIV diagnosis of women infected with HIV. (Nicoll *et al.*, 1998) The type of information required to apply Nicoll's method (e.g. weighted fertility rates in HIV infected and uninfected women and estimated proportions of HIV-infected women in the

population by exposure category, and before and after diagnosis of HIV infection) complicates its use in many developing countries. (Changalucha *et al.*, 2002)

In summary, Zaba's method has been shown to be useful for adjustment of overall HIV prevalence estimates from ANC clinics in low contraceptive use countries. Because parity measures may help to identify transient trends in age-based estimates when age at sexual debut is changing, it is recommended that data should be collected on parity and previous birth interval. Nevertheless, the use of this method in young age groups is limited because of the small size of ANC samples available. In addition, analysing prevalence of HIV infection according to parity is a reliable guide to incidence in sexually active individuals but not necessarily to incidence of HIV in the population as a whole and age-based prevalence measures may reflect levels of infection in young women more appropriately.

- ***Extrapolating prevalence estimates to male partners***

Information on ratios of males to females with HIV infection is useful to adjust HIV prevalence from ANC surveillance in order to obtain estimates for men. However, sex ratios for HIV infection vary substantially in different age groups and with type and stage of the HIV epidemic. (Gregson and Garnett, 2000) In addition, obtaining HIV seroprevalence data from young men may be difficult. Men aged 15 to 19 years are frequently underrepresented in population-based studies because mobility and migration related to work, military service and schooling result in fewer residents. For example, in a cohort study in rural Uganda, there were 25% fewer men aged 15-19 than females. (Sewankambo *et al.*, 1994) In Addis Ababa, compliance in providing blood samples was only 37.5% among those aged 15-49 years. (Fontanet *et al.*, 1998) Higher non-response rates among men in surveys may pose a problem for adjustments.

Glynn and colleagues proposed a method using the child's father's age to estimate male HIV prevalence from ANC data. This method assumes equal HIV status in both partners. However, this approach did not provide accurate HIV age-specific prevalence estimates and was not useful for the youngest age group of men. (Glynn *et al.*, 2001) This may be partly explained by the substantial number of couples in which members have a discordant HIV status. (Zaba and Slaymaker, 2002) In addition, the results obtained in using this approach would be subject to similar bias to those in women.

3.2.5 Bias in estimated trends

Surveillance of HIV and AIDS generally aims at monitoring trends in infection from sequential cross-sectional surveys of the same population. (Fylkesnes *et al.*, 1997) We have already discussed the importance of following HIV prevalence trends over time for public health and policy planning reasons. However, trends in ANC prevalence may not represent true trends in the population. We have reviewed the main factors that could potentially introduce bias into estimates of HIV prevalence obtained from ANC clinics. Because the relative importance of those biases is likely to vary from place to place and over time, caution is needed in interpreting trends in those estimates. Thus, declining prevalence among younger women has been reported in various countries, such as Zambia (Fylkesnes *et al.*, 2001), Uganda (Kamali *et al.*, 2000) and Tanzania. (Kwesigabo *et al.*, 1998) However, in the light of the issues raised in previous sections, how should we interpret those trends?

The key factors that influence trends in HIV prevalence obtained from ANC surveillance and the potential mechanisms by which they could introduce bias in observed estimates are summarised in Table 2. Delayed onset of sexual activity and changes in the proportion of young women using different types of modern contraceptive methods seem to be critical in interpreting trends in prevalence of HIV infection. Changing patterns of presentation to ANC clinics could also result from other factors such as reduction in the number of pregnant women consistently seeking ANC services in governmental clinics or increased migration. Collecting information about the mentioned factors as well as from characteristics of clinic users is important in order to interpret our observations.

Finally, it is likely that the degree of representativeness of ANC data relative to the general population varies according to the stage of the HIV epidemic. (Fylkesnes *et al.*, 1998) In mature HIV epidemics, fertility differentials tend to increase because higher proportions of women have been infected with HIV for longer periods. Increasing fertility differentials would tend to produce more strongly biased ANC estimates. However, this effect will be less important in younger age groups. (Zaba and Gregson, 1998)

Table 2. Hypothesised direction of bias introduced by key factors on trends in HIV prevalence among 15-24 years olds ANC attenders

Factor	ANC attendance		HIV trends		Recommendations
	HIV+	HIV-	ANC	Gen. Pop.	
<i>Behavioural change</i>					
Delayed onset of sexual relations ¹	+	-	+	-	Collect data on age at sexual debut
Increased condoms use:					
- by high-risk groups	-	+/-	-	-	Collect data on patterns of condom use
- consistent use from start of sexual activity	+/-	-	+	-	
Increased hormonal contraceptive use	-	+/-	-	NC	Collect data on hormonal contraceptive use
<i>Bio-social</i>					
Increased widowhood	-	+/-	-	+	
Decreased fecundity due to low spermatogenesis in older partners	-	+/-	-	NC	
<i>Selection of sentinel sites</i>					
Increased number of rural sentinel sites	+/-	+	-	NC	Report detailed information about: clinic location, key demographic characteristics of clinic users and population covered
Discontinuity in testing & reporting	?	?	?	NC	Allocate and report clinic codes

+ Increase; - decrease; NC no change

¹Delayed sexual activity causes a decline in prevalence of HIV in young women in the general population and can cause a temporal rise in prevalence among pregnant women aged 15 to 19 years.

3.3 Interpreting trends in HIV prevalence

Levin and colleagues developed a mathematical model for the population dynamics of HIV/AIDS. (Levin *et al.*, 2001) During the epidemic phase of the disease, there are many susceptible hosts and the number of infections increases geometrically. At these early stages, transmission of HIV infection is likely to be concentrated in sub-populations (high-risk groups). Furthermore, the proportion of recent infections among both women and men infected with HIV will be higher and, therefore, the effects of HIV infection on fertility and mortality will be less evident. (Konde Lule, 1995; Jackson *et al.*, 1999; Zaba *et al.*, 2000) As a result, prevalence rates (e.g. from population-based surveys and ANC) will tend to rise even when incidence rates are very low. As the HIV epidemic progresses, incidence may decline or level off due to the saturation of the pool of susceptible hosts in high risk groups rather than to successful intervention or behavioural changes. A high proportion of those groups will be already infected and the proportion of recently infected individuals (who are potentially more infectious) in these high-risk groups will decrease leading to a fall in incidence. (Asiimwe-Okiror *et al.*, 1997; Wawer *et al.*, 1997) Furthermore, HIV spreads from high to low risk groups and those in the highest risk groups are the most likely to be infected by HIV and lost through mortality reducing the prevalence of infection.

In mature epidemics, fertility and mortality differentials increase, particularly at older ages. (Zaba and Gregson, 1998; Jackson *et al.*, 1999) In general, the peak prevalence in this phase will be concentrated in the younger age groups and an overall stable or declining prevalence may coexist with high or rising incidence rates of HIV. (Batter *et al.*, 1994) (Peterman *et al.*, 1995) The plateau in overall HIV prevalence is the result of a balance between incidence of and mortality associated with HIV infection. This was the case in a prospective community-based study in rural Uganda, where the combination of high HIV-related mortality and out-migration of individuals infected with HIV greatly exceeded the number of new HIV infections in each follow-up year. (Konde Lule, 1995; Wawer *et al.*, 1997)

Even among young people and in the absence of major changes in the age and sex structure of the population, reductions in HIV prevalence may mask a stable or increasing incidence of HIV because of the balance between incidence, mortality, migration and ageing. (Wawer *et al.*, 1997) Thus, although the effect of HIV on mortality would tend to be less strong in

younger age groups, its impact may still be important. In a prospective study in rural Uganda, 56% of 32 female HIV-related deaths occurred among women aged 15 to 29 years. (Sewankambo *et al.*, 1994) In Thailand, substantial increases in adult female mortality in Chiang Rai have been reported, particularly among 20-24 years old (a 10-fold increase between 1990 and 1996), with most of the increase due to excess deaths attributable to AIDS. (Bunnell *et al.*, 1999) In a cohort study in Uganda, the mortality rate among persons aged 15 to 24 years was over 18 times higher among HIV-infected individuals compared with those HIV-uninfected. (Wawer *et al.*, 1997)

Changes in the structure of the population may also occur and those changes may differ by HIV status. In a study in Zambia, the proportions of participants who had migrated out from the study area were 56% and 31% for urban and rural sites respectively. In addition, among urban men aged 15 to 19 years, there was a significant excess prevalence of HIV infection among in-migrants compared with out-migrants. (Fylkesnes *et al.*, 2001)

Furthermore, as discussed in previous sections, using different types of kits to detect HIV infection over time may account for an increase in test specificity, which may be translated into an apparent decline in the measured prevalence of HIV. This may be especially relevant in Africa where great variations in the specificity of kits have been observed. (Fabiani *et al.*, 2001)

Interpreting trends in HIV prevalence is therefore difficult and caution should be taken in interpreting declines in HIV seroprevalence, even in young people, since several contributing factors may account for those trends. (Jackson *et al.*, 1999) Declines in prevalence of HIV should not be interpreted in isolation from other sources and types of data (e.g. behavioural information), since changes may occur in the absence of behavioural changes.

Recently, UNAIDS and WHO have proposed the use of Second Generation Surveillance (SGS) in order to improve the understanding of the HIV epidemic. (Walker *et al.*, 2001) Second generation surveillance links trends in behavioural data and data on STD to trends observed from HIV serosurveillance of the same population, helping to interpret and validate the latter. For instance, incidence of self-reported or clinical STI can be used as proxy measures of the impact of HIV infection in men and as useful indicators of recent changes in

risk behaviour. (UNAIDS, 2000) Trends in reported STI may also provide evidence that supports or helps to explain observed trends from different surveillance sources.

Within the context of SGS, several countries have added an AIDS module in their Demographic and Health Surveys (DHS). (UNAIDS, 2000) That module includes some behavioural information (e.g. age at sexual debut). Changes reported in behavioural surveys may be attributable to some extent to changes over time in perceptions of acceptable and desirable responses to sensitive questions. It is thought that young people, especially those aged 15 to 19 years, may be prone to misreporting their sexual behaviour. (Fylkesnes *et al.*, 2001) Despite the risk of misreporting of sexual behaviour, analysing such data may help in interpreting observed trends in serosurveillance data.

3.4 Other sources of data

Different contexts may offer unexpected opportunities to conduct unlinked serological surveys of HIV infection in the general population or in particular groups. This is the case for some surveys that are currently carried out in many of the countries most affected by the HIV epidemic at more or less regular intervals (DHS, sexual behaviour surveys and UNICEF MICS).

DHS are nationally representative household surveys with sample sizes ranging from 5,000 to 30,000 households. Such surveys are conducted in over 50 countries approximately every 5 years and provide data on basic demographic, health and nutrition indicators. (MEASURE, 2002) Combining HIV serosurveys with DHS represents an opportunity to collect population-based information from men as well as women and from rural as well as urban areas. They would also allow comparative studies with information from other data sources in order to derive adjustment methods that can be applied to those data. However, ethical, logistical and financial issues call for a careful assessment of the feasibility and acceptability of this approach on a country-by-country basis. (MEASURE, 2000) Besides, completeness of coverage in such surveys may be reduced if samples are collected for HIV testing.

Three different options have been proposed to combine HIV testing to household surveys: voluntary confidential HIV testing and unlinked anonymous HIV testing with or without

consent. The two first options may increase the likelihood of participation bias because of association with high refusal rates. In unlinked anonymous HIV testing few or no links with behavioural data are possible.

In 2001, serologic testing for HIV using fingerpick blood was added to the traditional DHS in Mali. The main objective was to assess the feasibility and acceptability of combining HIV testing to national surveys. Every man and every third woman interviewed were offered HIV testing. Informed consent was requested and individuals were referred for free counselling and testing services. Participation rates for DHS interview and for HIV testing are shown in Table 3. Overall participation rates for interview and HIV testing were 70% for men and 86% for women, with higher rates in rural than urban areas. (MAP, 2002; Pappas *et al.*, 2002) However, participation rates for HIV testing alone were higher than 80% in men and higher than 90% in women.

Table 3: Participation rates for DHS interview and HIV testing

	Acceptance rates			
	DHS 95/96	DHS+ 2001		
	<i>Total</i>	<i>Urban</i>	<i>Rural</i>	<i>Total (No.)</i>
Men				
DHS male interview	88.0%	74.5%	88.1%	83.8% (3,405)
HIV testing	-	80.0%	84.2%	83.0% (2,962)
Interview & testing	-	59.6%	74.2%	69.6%
Women				
DHS female interview	96.1%	92.4%	95.8%	94.9% (12,849)
HIV testing	-	89.9%	91.0%	90.7% (3,845)
Interview & testing	-	83.1%	87.2%	86.1%

Source: Ryan CA. Serosurveys in household samples – HIV seroprevalence in DHS+ Mali, West Africa, 2001. Barcelona MAP Symposium, July 2-4, 2002.

Results of the Mali DHS survey are encouraging. Three other countries are planning population-based HIV sero-surveys using different approaches. In Zambia, individual interviews will be linked to HIV test results. In the Dominican Republic the testing will be

performed using saliva specimens. HIV serological testing has also been added to the Youth Risk Behaviour Survey in Zimbabwe.

3.5 Sample size issues

Over-sampling of the younger age groups is needed to provide robust prevalence estimates in these sub-groups and, in particular, when trends need to be analysed over time. The size of the sample required will depend upon the magnitude of change that it is necessary to detect, the level of statistical confidence and power desired, time-intervals between surveys and the sub-group analyses that are judged important (e.g. youth living in urban and rural areas). (Fylkesnes *et al.*, 1997; Magnani *et al.*, 2002)

WHO has recommended testing specimens from at least 300 eligible women per participating clinic for populations with an expected HIV prevalence of 2 to 19%. (WHO, 1989) It should be noted that, in some areas, obtaining large samples of young people might be difficult, since young individuals are usually very mobile.

Table 4 shows the estimated sample sizes required to identify changes in prevalence over time for selected values of HIV prevalence with a power of 80% and 95% confidence.

Table 4: Sample size required to detect a specified decline in prevalence, with a power of 80% and 95% confidence, according to baseline prevalence

<i>Baseline</i>				
Prevalence (%)	Percentage reduction in HIV prevalence			
	20	25	30	35
1	34,962	22,376	15,539	10,158
5	6,738	2,676	2,868	2,013
10	3,210	2,055	1,355	974
15	2,098	1,108	876	601
20	1,446	926	615	452
25	1,111	747	462	344

Source: Smith PG, Morrow RH. Field trials of health interventions in developing countries: a tool box. Macmillan Press Ltd on behalf of the UNDP/World Bank/WHO, 1996

According to the above sample size calculations, a country such as Namibia with an estimated HIV prevalence of 20% (UNAIDS, 2002) would require testing approximately 930 pregnant women in the age range 15-24 years in order to detect a 25% decrease in the country prevalence of HIV infection.

4. Data availability

The Joint WHO/UNAIDS Working Group on Global Surveillance of HIV/AIDS and STIs produces country-specific estimates of HIV prevalence every two years. Current estimates are based on a new model that allows short-term projections of the course of the HIV/AIDS epidemic in countries. (The UNAIDS Reference Group on Estimates, 2002) This epidemiological model includes a very limited number of parameters. For specific risk groups the demography of the model is less well defined and should be interpreted with caution.

4.1 Current data sources

Guidelines on SGS for HIV (Surveillance, 2000) describe the main data collection methods to be used in surveillance and provide recommendations about the most appropriate populations to be monitored according to the stage of the HIV epidemic reached. The predominant source of HIV prevalence data in countries with generalised epidemics, especially in sub-Saharan Africa, is sentinel surveillance among pregnant women. (Gregson *et al.*, 1998; Zaba *et al.*, 2000; Zaba *et al.*, 2000) In contrast, monitoring in concentrated and low-prevalence epidemics is mainly done in vulnerable populations such as IDU, patients with STI and MSM. Few countries outside the highly industrialised would have sentinel surveillance among men who have sex with men. (Walker *et al.*, 2001)

Several workshops on surveillance systems have been organised recently to provide recommendations for improved national surveillance systems for HIV. (UNAIDS, 1998) Over the last few years, efforts have been made in several countries (e.g. Cameroon, Mozambique, Botswana, Kenya) to extend surveillance to both urban and semi-urban areas in most of their provinces. (International Programs Center, 2000) However, rural sites continue to be strongly under-represented.

Existence of “sampling frames” for choice of sentinel sites in the country (e.g. a listing of all ANC clinics, including private facilities) could be used for random sampling (e.g. the

probability proportional to size system used in South Africa) or for purposive sampling (e.g. stratification by geographical area). However, few countries are using these strategies.

4.2 Quality of data

The value of surveillance depends on the availability of data of adequate quality. Data from surveillance systems is the basis for estimates of HIV/AIDS prevalence and mortality produced by WHO and UNAIDS. (Walker *et al.*, 2001) The quality of HIV/AIDS sentinel surveillance systems was analysed in 167 countries, of which 55 had generalised HIV epidemics. The final rating for countries of high HIV prevalence is shown in table 5. Quality was defined according to the following criteria: frequency of data collection, timeliness of reporting, appropriateness of populations under surveillance, consistency of sites/locations and groups over time and coverage and representativeness of the system.

Table 5. Quality of surveillance system rating in countries with high HIV prevalence

Quality rating	Country		
Poorly or non-functioning system	Angola	Lesotho	Sierra Leone
	Congo	Liberia	Haiti
Some or most aspects of a fully implemented system	CAR	Namibia	Togo
	Ethiopia	Nigeria	Zambia
	Malawi	Rwanda	Zimbabwe
	Mozambique	Swaziland	
Fully implemented system	Botswana	Cameroon	South Africa
	Burkina Faso	Côte d'Ivoire	Tanzania
	Burundi	Kenya	

As expected, the analysis suggested that surveillance systems vary considerably in quality. Some countries with generalised epidemics such as Cambodia and Myanmar and the four most affected states of India do not provide the same level of coverage among rural areas. Coverage of surveillance systems does not always provide a complete picture of the course of the epidemic in all states or regions of some countries (e.g. China and India). It was observed that many systems have poor coverage of rural populations. For many of them, consistency of data over time is the major weakness. Because many countries have little data on which to

base HIV prevalence estimates it may be that some of these countries have many more people living with HIV/AIDS than are currently estimated.

4.3 Continuity in reporting

Surveillance information is used to estimate national prevalence to track the epidemic over time. Continuity and completeness in carrying out the serological tests and reporting their outcome is vital to ensure comparability within and between countries. Regularity of reporting by a large number of clinics located in both rural and urban areas of the country is essential to ensure representativeness. (Zaba and Slaymaker, 2002)

Surveillance reports are usually incomplete. (MEASURE, 2000) Madagascar and Lesotho, for instance, previously had good HIV surveillance systems, but, due to financial and other constraints, have not collected data recently. Other countries, such as Namibia and Zambia, only collect data every 2 years due to limited resources. (Walker *et al.*, 2001) Congo and Liberia have only now begun to collect data on HIV seroprevalence.

Since 1980, at least 28 of 53 African countries have been at war. During conflicts the risk of HIV is exacerbated by the stressful circumstances and danger related to war. Civilians are often subjected to human rights abuse, including sexual violence, and are left in conditions of poverty that may lead them to engage in commercial sex to survive. (Buvé *et al.*, 2002) In such countries, sentinel surveillance data are unavailable because of disruption of health activities. Even where attempts are made to conduct seroprevalence surveys in such contexts, uncontrolled movements of populations make results hard to interpret.

4.4 Information reported

In the context of HIV surveillance, two main factors limit the amount of information that can be collected. First, it is necessary to preserve anonymity of individuals and confidentiality of the information provided should be guaranteed. Second, a compromise has to be reached between the need for surveillance data and the additional burden placed on clinic staff.

In general, information included in surveillance reports is rather limited. Seroprevalence data from different clinics are aggregated and clinic names and information on their location is not clearly specified. The appropriateness of aggregating surveillance data was discussed in a meeting about HIV/AIDS surveillance organised by WHO. (WHO, 2001) One of the conclusions of the working groups was that aggregation of data from different sentinel sites in the same country could be misleading and mask increasing trends in HIV infection at regional or district level. It was recommended that, when aggregation is necessary to increase sample size or reduce sample periods, consistency in the sites selected over time should be ensured. Surveillance reports should also include range and median values of HIV prevalence to show variability and data on clinic attendance by site and disaggregation should not compromise the anonymity of individuals included in the surveillance sample.

South Africa is the only country in which the data on the number of women using the ANC facilities each year has been systematically compiled. (Zaba and Slaymaker, 2002) Other information usually excluded from surveillance reports are socio-demographic characteristics of clinic attenders (that can be related to characteristics of the catchment population), month of pregnancy at attendance, proportion of women seeking ANC services for their first pregnancy and data on parity and birth interval. Prevalence is usually reported in 5-year age-groups, as opposed to exact year of age.

5. Recommendations

The priorities highlighted by the Joint WHO/UNAIDS Working Group on Global Surveillance of HIV/AIDS and STIs in order to obtain more accurate country prevalence estimates and to analyse trends in prevalence over time are: i) to improve the coverage of sentinel surveillance, ii) to gain a clearer understanding of the biases introduced by using sentinel data and iii) to assess consistency with trends in behavioural data. (The UNAIDS Reference Group on Estimates, 2002)

Sustaining ongoing processes of change to improve the quality of surveillance systems and allocating sufficient resources to monitor the spread of the HIV epidemic are critical. In the context of the UNGASS prevalence goal, we made some specific recommendations aimed at improving the monitoring and interpretation of trends in HIV seroprevalence among young people. These recommendations have been divided into two categories, those designed to improve HIV surveillance systems and those identifying areas requiring further research.

5.1 Enhancement of national HIV surveillance systems

As already discussed, extrapolating prevalence data from young pregnant women attending ANC clinics to young men and women in the general population is problematic and is likely to lead to biased prevalence estimates of HIV infection in the latter. Improving the quality of data collected by national surveillance systems and making more efficient use of the data and funds available for those activities are critical to interpreting surveillance prevalence estimates accurately.

- ***Assessing the feasibility of achieving the UNGASS prevalence goal***

To provide a more realistic picture of what is feasible within the time frame proposed for achievement of the UNGASS prevalence goal, it is suggested that countries are grouped into categories depending on their baseline level of HIV prevalence (as shown in the Report on the global HIV/AIDS epidemic 2002). (UNAIDS, 2002) Mathematical modelling can then be used to

determine the level of reduction in incidence required in order to achieve a 25% reduction in prevalence among people aged 15 to 24 years, given a certain level of baseline HIV prevalence.

- ***Strengthening of national MCH programmes***

Supporting the activities of MCH programmes is vital to encourage attendance of pregnant women to and maintain adequate coverage of ANC services.

Young pregnant women expecting their first birth should be encouraged to attend ANC clinics early in pregnancy (during the first trimester of pregnancy), so as to increase the probability of detecting problems in the course of pregnancy (e.g. infection, abortion). Early attendance at ANC services should help to decrease maternal and child mortality in both infected and uninfected women. Although this could first lead to increase bias in time trends, in the long term, it would tend to decrease the likelihood of obtaining biased HIV prevalence estimates due to differentials in fertility associated with early spontaneous abortion.

- ***Improving sampling strategies***

Several factors are critical in considering the usefulness of surveillance data: degree of representativeness of the sentinel sites, continuity in reporting of those sites and quality of collected data. Although efforts should be made to increase the number of sentinel sites to provide good geographical coverage (e.g. several provinces and peri-urban and rural areas), this increase should not be achieved to the detriment of the quality of surveillance data, and quality of data should remain the priority. Where resources are limited, frequency of reporting could be lowered (e.g. 2-yearly instead of yearly).

In addition, it is recommended that the same sentinel sites provide surveillance data every year (or every 2 years), rather than analysing data coming from different sentinel clinics each year (or every 2 years), and that unique identifiers should be allocated to each site. Ensuring consistency of sites and in the time between surveys (e.g. recording data preferably either by calendar or by financial year (UNAIDS, 2002)) would help track and interpret HIV prevalence from specific geographical areas over time. (Zaba and Slaymaker, 2002) Details of dates and periods used when extracting the data should be specified on the surveillance reporting forms.

It is suggested that estimates of HIV prevalence are reported separately by sentinel site and that sites are grouped according to geographical location. In countries where findings may have socio-political implications for inhabitants of high prevalence areas, extreme care should be taken in reporting clinic-specific HIV prevalence estimates. (UNAIDS, 2000)

Finally, national surveillance systems should assess the importance of their private health sector in delivering ANC services. Where the private sector is well established, surveillance systems could work to include some private clinics, so as to ensure a better representation of different socio-economic classes in the sentinel system.

- ***Quality control***

To ensure compliance with surveillance protocols, it is recommended to combine quality control systems for HIV surveillance with regular supervisory visits of health facilities and to strengthen these supervisory mechanisms. Supervision can also have a positive effect on HIV surveillance by reducing the frequency and duration of shortages (e.g. laboratory and medical supplies) and by ensuring continuity in reporting of surveillance data of good quality.

Furthermore, assessing the quality of testing procedures and protocols, how systems deal with ethical issues related to collection of sentinel data could help improve the quality of surveillance data.

- ***Minimising and documenting changes over time***

Ensuring that indicators, sampling methodologies and HIV testing strategies are consistent over time is important in tracking trends in HIV prevalence within and between countries and over time. When changes are necessary in order to improve the quality of surveillance data, they should be clearly documented and described in national surveillance reports.

- ***Meeting sample size requirements***

Large sample sizes are needed to provide reliable statistical evidence based on sentinel surveillance data. Increasing the total ANC sample size until sufficient numbers of pregnant women aged 15 to

24 years have been obtained is critical to analyse prevalence according to this age group. It is recommended to track trends among the 15-24 year age-group, as opposed to the 15-19 group, because of the strong bias associated to the latter age category. Larger sample sizes would also allow analysis of prevalence data according to parity status (e.g. nulliparous and multiparous pregnant women).

- ***Collecting and reporting key demographic data***

In order to assess how the sentinel population relates to the population covered by the clinic, it is also recommended to collect some key socio-demographic information in a consistent way from all clinic attenders. Suggested data are: age in years, level of education, marital status, permanent address and place of origin and/or length of residence. Information related to pregnancy status might include: parity, birth interval, pregnancy stage at first attendance (e.g. month), history of contraceptive use and past ANC attendance.

The need for surveillance data must not compromise confidentiality of information provided by clinic attenders. To reduce the likelihood of bias associated with the use of sentinel data, it is advised to collect such data using standardised questionnaires and to restrict the number of questions to a minimum. Increasing the workload of health personnel may compromise the quality of both clinical work and surveillance data.

Other key information at clinic level that would help to interpret ANC estimates and trends in HIV prevalence are clinic location details, unique clinic identifier and annual number of first visits of pregnant women.

- ***Collecting HIV prevalence data on men***

Data on age-specific HIV seroprevalence in men obtained from population-based surveys could be used to obtain age-specific male-to-female ratios that can then be applied to sentinel surveillance data.

In the absence of such surveys, analyses of trends of HIV prevalence among STD clinic attenders may help to track infection rates in high-risk men, provided that changes in treatment seeking

behaviour do not occur. However, this group will be subject to substantial selection bias if there are behavioural changes (much more so than ANC) and, therefore, collecting and reporting basic socio-demographic data on clinic users (e.g. age in years, level of education, marital status, permanent address and place of origin and/or length of residence) and data on previous clinic attendance is important to identify changes in seeking behaviour and interpret observed trends of infection.

- ***Diversifying surveillance data sources***

Where possible and acceptable, seroprevalence surveys of HIV could be integrated into on-going health surveys for other communicable diseases or DHS. (WHO, 2001) It is recommended that such serosurveys provide nationally representative data and that they oversample young adults. Analysing socio-demographic and behavioural data from such samples could help explain and interpret HIV prevalence estimates.

Complementary information from other sources, such as FP or BD, could provide information on HIV prevalence by age and sex. The importance of obtaining such estimates from attenders of FP services lies in the fact that, in general, the proportion of regular users of effective contraceptive methods seen in ANC surveillance is low. Because contraceptive users are sexually active and, unless they are using barrier methods, not protected against HIV infection, it is also important to track trends in HIV infection in this population. (Zaba and Slaymaker, 2002)

Additional opportunities for surveillance may arise in particular contexts and depend on circumstances that bring large numbers of young people into contact with health services when they are not actually seeking treatment for health problems (e.g. health checks on army conscripts or pre-marital health consultations). Although estimates of HIV prevalence obtained from such populations may be biased if the risk of acquiring HIV infection is related to the probability of being screened (e.g. high risk groups excluded from the army or more likely to be screened before getting married), trends in HIV infection can be tracked if the same group is surveyed every year. (Zaba and Slaymaker, 2002)

- ***Strengthening behavioural surveillance systems***

Given that trends in HIV prevalence measured in pregnant women do not reflect trends in prevalence in the general population accurately, tracking behavioural changes will help to validate and explain ANC surveillance data. It is recommended that data are collected to monitor behaviours that are likely to increase or reduce the risk of HIV infection (UNAIDS, 1998) (e.g. age at first sexual intercourse and age at marriage, lifetime number of partners, partnerships with sex workers or other high-risk groups, age difference with regular partner, condom use at last commercial sex, consistent condom use with high-risk sexual partners). These data could be collected during behavioural surveys and DHS.

5.2 Research priorities

- ***Developing methods for correcting biases***

It is recommended that studies should be conducted to assess the acceptability of integrating HIV seroprevalence surveys into planned health surveys for other communicable diseases or DHS. In the short term, estimated male-to-female age specific prevalence ratios derived from such serosurveys could be applied to future estimates of female prevalence obtained from sentinel surveillance in ANC (or from other sources) to obtain estimates of male prevalence. If DHS is shown to be feasible and acceptable, data from such surveys could complement or even replace ANC clinics as the main source of surveillance data.

Where population-based serological surveys are too expensive to be used for routine monitoring of the HIV epidemic, they can be used to develop methods for correcting biases introduced when using sentinel surveillance data. They also help to establish the degree of representativeness of surveillance data by comparing socio-demographic characteristics of ANC users with those of the population living in the corresponding clinic catchment area. Where population cohorts are being followed, studies comparing population HIV prevalence estimates with ANC, FP or BD based estimates from the same areas should be encouraged. Collecting and analysing information on demographic factors such as migration, fertility and mortality during such studies are also extremely

useful in order to assess the importance of such factors in those areas and to interpret observed trends in prevalence of HIV infection in both the general population and ANC services.

Estimating HIV prevalence in users of FP services and assessing how such estimates relate to the general population and to ANC data are especially important in areas where contraceptive use is common.

- ***Developing STAHRS for African clades***

Research to develop STAHRS for non-B subtypes of HIV should be encouraged so as to be able to estimate incidence of HIV infection from surveillance data. Although the need to adjust for selection and coverage biases introduced by using a given data source will not disappear, (Remis *et al.*, 2002; Zaba and Slaymaker, 2002) looking at the relationship between incidence (as measured by STAHRS) and prevalence estimates from different sentinel sites will help in interpreting surveillance information from such sources of data.

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