The HIV/AIDS Epidemic in Sub-Saharan Africa
in a Historical Perspective
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The HIV epidemics in sub-Saharan Africa: Why So Severe? Why So Heterogenous? An epidemiological perspective

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Introduction

UNAIDS and WHO estimated that there were globally 34 to 46 million people living with HIV by the end of the year 2003.[1] Of these more than 50% (25 to 28.2 million) were living in sub-Saharan Africa which houses about 10% of the world's population. It is estimated that 7.5 to 8.5% of adults in sub-Saharan Africa are infected with HIV[2]. Africa south of the Sahara is the region in the world worst affected by HIV/AIDS.

UNAIDS and WHO define an HIV epidemic as generalised when the prevalence of HIV infection in pregnant women, used as a proxy for the prevalence in the general adult population, exceeds 1%. Using this definition 33 of the 44 countries in sub-Saharan Africa had a generalised epidemic at the end of 2001.[3] In four countries (Madagascar, Mauritius, Somalia and Senegal) the HIV prevalence in pregnant women was 1% or less. For seven countries, including the Comoros, Djibouti, Gabon, Guinea, Liberia, Mauritania and Niger, no reliable data were available. In the countries with generalised epidemics the HIV prevalence in the adult population ranged between 1.6% in the Gambia and 38.8% in Botswana. In general the populations of Eastern and Southern Africa are more severely affected than the populations of West and Central Africa. In seven countries of Africa, including Botswana, Lesotho, Namibia, South Africa, Swaziland, Zambia and Zimbabwe, at least one in five adults is infected with HIV and all of these countries are in Southern Africa.

There is evidence that differences in prevalence of HIV between different regions in sub-Saharan Africa can not always be explained by differences in time since introduction of the virus into the population. In fact, in most instances, differences in prevalence are the result of differences in rate of spread of HIV in the population. This is illustrated in Table 1 and figure 1 which show trends in HIV prevalence in several African cities. There are striking contrasts in the evolution of the HIV prevalence between Kinshasa (Democratic Republic of Congo) and Yaoundé (Cameroon) on the one hand and Gauteng Province (South Africa) and Gaborone (Botswana) on the other hand. Only the epidemics in Southern Africa can be called explosive.

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[1]UNAIDS/WHO, *AIDS Epidemic Update: December 2003*. UNAIDS/03.39E (Geneva, UNAIDS/WHO, 2003).
[2]UNAIDS/WHO Working Group on Global HIV/AIDS/STI Surveillance, *Guidelines for second generation HIV surveillance*. WHO/CDS/CSR/EDC/2000.5 - UNAIDS/00.03E (Geneva, World Health Organization and Joint United Nations Programme on HIV/AIDS, 2002).
[3]UNAIDS, *Report on the Global HIV/AIDS Epidemic 2002*. UNAIDS/02.26E (Geneva, UNAIDS, 2002).

This paper gives an overview of the evolution of the HIV epidemic in sub-Saharan Africa and reasons will be explored for the heterogeneity of the epidemic in different African regions HIV epidemics. In addition an explanation will be proposed for the severity of the HIV epidemics in sub-Saharan Africa compared to other regions in the world and their severity. This will be done from an epidemiological perspective which means that the focus of the attention will be on behaviours and on biological factors that may explain the course of the HIV epidemics in sub-Saharan Africa.

2. The early years of the HIV epidemics

The acquired immune deficiency syndrome (AIDS) was first described in 1981 in homosexual men in North America, following reports to the Centers for Disease Control on Kaposi's sarcoma and *Pneumocystis carinii* pneumonia.[1] Cases dating from 1978 and 1979 were retrospectively diagnosed, later on.[2] The first case of AIDS in a Haitian immigrant in the United States was diagnosed in 1980 and up till 1983 AIDS was only described in homosexual men, intravenous drug users (IVDU), haemophiliacs and Haitian immigrants in the United States.[3] The first report on AIDS in patients from Central Africa was published in 1983. The patients, three of whom had been living in Belgium for less than three years, were admitted to hospital in Brussels.[4] This report was followed by investigations in Central Africa[5] and by 1986 it was clear that the human immunodeficiency virus (HIV) had spread in the populations of numerous countries in sub-Saharan Africa and posed a major public health problem there.[6]

In retrospect the first cases of AIDS seem to have appeared in Uganda and Tanzania shortly after the liberation war in Uganda in 1978-1979.[7] The start of the AIDS epidemic in the Democratic Republic of Congo is situated around the same time,[8] although HIV infection may have been present in the population many years before that time. Antibodies against HIV were detected in a serum sample collected from a Kinshasa resident in 1959.[9]

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[1] Centers for Disease Control, "Pneumocystis pneumonia - Los Angeles," *Morbidity and Mortality Weekly Report,* 30 (1981), 250-252; M.S. Gottlieb, R. Schroff, H.M. Schanker, J.D.Weisman, P.T. Fan, R.A. Wolf, A. Saxon, "*Pneumocystic carinii* pneumonia and mucosal candidiasis in previously healthy homosexual men. Evidence of a new acquired cellular immunodeficiency". *New England Journal of Medicine,* 305 (1981), 1425-1431.

[2] R.M. Selik, H.W. Haverkos, J.W. Curran, "Acquired immune deficiency syndrome (AIDS) trends in the United States, 1978 – 1982," *American Journal of Medicine,* 76 (1984), 493-500.

[3] *Ibid*.

[4] N. Clumeck, F. Mascart-Lemone, J. De Maubeuge, D. Brenez, L. Marcelis, "Acquired immune deficiency syndrome in black Africans," *The Lancet,* i (1983), 642.

[5] P. Piot, T.C. Quinn, H. Taelman et al., "Acquired immunodeficiency syndrome in a heterosexual population in Zaire," *The Lancet,* ii (1984), 65-69.

[6] T.C. Quinn, J.M. Mann, J.W. Curran, P. Piot, "AIDS in Africa: An epidemiologic paradigm," *Science,* 234 (1986), 955-963.

[7] D. Serwadda, N.K. Sewankambo, A. Lwegaba et al., "Slim disease: a new disease in Uganda and its association with HTLV-III infection," *The Lancet,* ii (1985), 849-852; E. Hooper, "Frozen in space: a rural epicentre in Africa," in *The River* (London, Allen Lane/ The Penguin Press, 1999), 31-51.

[8] N. Clumeck, F. Mascart-Lemone, J. De Maubeuge, D. Brenez, L. Marcelis, "Acquired immune deficiency syndrome in black Africans," *The Lancet,* i (1983), 642; P. Piot, T.C. Quinn, H. Taelman et al., "Acquired immunodeficiency syndrome in a heterosexual population in Zaire," *The Lancet,* ii (1984), 65-69.

[9] A.J. Nahmias, M. Schanfield, A. Motulsky et al., "Evidence for human infection with HTLV III/LAV-like virus in Central Africa," *The Lancet,* ii (1986), 1279-1280.

Table 1 Trends in HIV seroprevalence among pregnant women in selected capital cities in sub-Saharan Africa[1]

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Central Africa														
Kinshasa[2]	5.9	5.9	5.7	7.1	6.5	4.8	6.6	10.8					2.7 - 6.2	
Yaoundé					0.2	1.3	1.6	1.7	1.3		2.7			5.5
West Africa														
Abidjan		3.0	2.6 - 7.0		5.5	4.0 - 9.6	10.0	9.0 - 13.5			8.2 - 12.0			
Cotonou		0.0				0.4	0.4	0.0		0.6				
Maiduguri[3]			0.0	2.3	0.1	0.2								
East Africa														
Kampala		13.5			24.5	25.0	27.8	29.5	24.9		16.8	15.3	14.9	13.4
Nairobi	2.0	2.8		5.7		5.8 - 17.5	7.6 - 15.8	8.5 - 15.0		8.4 - 21.2		10.5 - 20.0		
Dar es Salaam					8.9	9.0		11.0	10.6	13.8	12.2			
Southern Africa														
Lusaka[4]	8.0		11.6			24.5		22.6	26.8	24.7		26.1		25.9
Gaborone						6.0		14.9	19.2	27.8	28.7		34.0	39.1
Gauteng (RSA)						0.7	1.1	2.5	4.1	7.3	12.0	18.7	17.1	22.5

There have been heated discussions about the origins of HIV but unfortunately not all these discussions were based on sound scientific evidence. Nowadays there is a consensus among virologists that HIV in humans is a zoonosis, i.e. that simian immunodeficiency viruses have been transmitted from non-human primates to humans. Five lines of evidence are used to substantiate cross-species transmission: similarities in viral genome organization, phylogenenetic relatedness, occurrence of SIV in the host population, geographical coincidence, and plausible routes of transmission.[5] HIV-2 and SIV in sooty mangabeys in West Africa were the first viruses for which these criteria were satisfied. Finding the origins of HIV-1 proved more difficult but current evidence suggests that it originated from SIV in chimpanzees in West Central Africa.[6] Exposure of humans to blood and tissues of infected primates during hunting and butchering is thought to be the most plausible route for these cross-species transmissions. Phylogenetic analysis of different HIV-1 strains dates the presence of the common ancestor of the different strains in the human population as far back as 1931.[7] What may have happened in the time between the first introductions of SIV/HIV in the human population and the appearance of increasing numbers of patients with AIDS in the early 1980's remains uncertain. Work with mathematical models however offers a plausible

[1] The data in the tables are for HIV-1.
[2] Until 1990 the date for Mama Yemo Hospital, the largest maternity clinic in town. The prevalence figure of 1992 is also from Mama Yemo Hospital.
[3] Nigeria.
[4] Data from 1992 on are for one for the four sentinel sites in Lusaka (Zambia) where intermediate HIV prevalence rates are found.
[5] B.H. Hahn, G.M. Shaw, K.M. De Cock, P.M. Sharp, "AIDS as a zoonosis: scientific and public health implications," *Science*, (2000), 287, 607-614.
[6] *Ibid.*
[7] B. Korber, M. Muldoon, J. Theiler et al., "Timing the ancestor of the HIV-1 pandemic strains," *Science*, (2000), 288, 1789-96.

explanation why HIV infection may have remained unnoticed for many decades.[1] Because of the nature of the zoonotic transmission, the first HIV infections would have occurred in isolated populations with limited sexual networks outside the village. These first HIV infections affected only limited numbers of people and as such could not spark off an epidemic. However increased population growth rates and migration would have created the conditions for a more extensive spread of HIV.

3. The spread of HIV in sub-Saharan Africa

Reconstructing the spread of HIV infection in sub-Saharan Africa is fraught with many difficulties. When trying to get a picture of the early years of the HIV epidemic we are faced with the problem that no reliable diagnostic test existed until 1985 when the first antibody test for the detection of HIV infection was approved by the United States Food and Drug Administration. Up till the mid 1980s we have to rely on clinical reports and (few) stored serum samples.

Table 2 Historical development of th HIV epidemic in sub-Saharan Africa

	Sub-Saharan Africa	World
1930s (?)	Simian immunodeficiency viruses are transmitted from non-human primates to humans.	
1959	A serum sample is collected from a Kinshasa resident with HIV infection, and stored to be tested more than 20 years later.	
1980	Increasing numbers of patients with a new syndrome, "Slim Disease", are reported by doctors in Uganda and Tanzania. Later Slim Disease was found to be AIDS.	
1981		The first cases of AIDS are described in gay men in the United States.
1983	Patients from sub-Saharan who are admitted to hospital in Brussels are diagnosed with AIDS. They do not have any of the known risk factors for AIDS and provide the first evidence that AIDS is transmitted through heterosexual intercourse.	The human immunodeficiency virus is identified as the cause of AIDS.
1984	According to estimates by WHO 1 to 5% of adults in 11 African countries are infected with HIV. These countries are Uganda, Rwanda, Burundi, Tanzania, Zambia, Zimbabwe, Ivory Coast, Burkina Faso, Togo, Cameroon and Congo Brazzaville.	
1985		The first antibody test to detect HIV infection is approved by the FDA of the United States of America.At least one case of HIV/AIDS has been reported from every region in the world.
1989	According to estimates by WHO more than 10% of adults in Zambia and Zimbabwe are HIV infected. Zambia and Zimbabwe are the countries with the highest HIV rates in the world.[2]	
1991-1993	HIV prevalence in young pregnant women in Uganda begins to decrease, the first major decrease in HIV prevalence in a developing country.	
1994	The HIV epidemic has shifted to Southern Africa, including South Africa.	An HIV outbreak in Eastern Europe is recorded in intravenous drug users.
2001	The majority of countries in sub-Saharan Africa have a generalised HIV epidemic.	
2003		Globally an estimated 34 to 46 million people are living with HIV/AIDS.

[1] R.M. Anderson, R.M. May, M.C. Boily, G.P. Garnett, J.T. Rowleyn (1991), "The spread of HIV-1 in Africa: sexual contact patterns and the predicted demographic impact of AIDS", *Nature*, vol. 352, 581-589.
[2] UNAIDS (2000), *Report on the global HIV/AIDS epidemic*. UNAIDS/00.13E. Geneva, UNAIDS.

Tracking the spread of HIV infection in a population, however, is not only conditional on the availability of reliable diagnostic tests but also on a well functioning surveillance system that provides estimates of HIV infection in representative samples of the general population and special vulnerable sub-populations. Because of the stigma attached to HIV/AIDS there were considerable delays in most African countries in facing up to the problem and setting up systems to collect high quality data on the spread of the infection. With these caveats in mind the table below is an attempt to describe the historical development of the HIV epidemics in sub-Saharan Africa and in the world.

4. The predominant mode of transmission of HIV in Africa: sex or injections?

When AIDS was first described in African patients who were neither homosexual men nor intravenous drug users, epidemiologists realised that HIV could also be transmitted through heterosexual intercourse. Since the early years of the HIV epidemics in sub-Saharan Africa it has been estimated that over 90% of HIV infections in adults are acquired through heterosexual intercourse. Recently WHO has estimated that only 2.5% of all HIV infections in sub-Saharan Africa are due to inadequate sterilisation of skin piercing instruments.[1] This low estimate of the proportion of HIV infections in sub-Saharan Africa attributable to injections has been challenged.[2] Gisselquist and his colleagues argued that heterosexual transmission could not explain the high rates of HIV infection found in Africa and they estimated that 20 to 40% of HIV infections on the continent are in fact due to unsafe injections in health care settings. However their arguments and estimates could not withstand the test of closer scrutiny for a variety of reasons. Laboratory experiments have demonstrated that the transmission efficiency of HIV is low. The few population based studies that have included children aged 5 to 12-14 years have found very low numbers of HIV infection in this age group while HIV prevalence abruptly increases in those age groups where sexual activity is initiated. And last but not least there is no correlation between population rates of HIV infection and of hepatitis C, the latter being nearly exclusively transmitted through injections.[3] In conclusion, available evidence supports that the predominant mode of transmission of HIV in sub-Saharan Africa is heterosexual intercourse. This begs two important questions. If sexual intercourse between men and women is the predominant mode of HIV transmission in sub-Saharan Africa why are there large differences in HIV prevalence between different regions? And secondly: why are the HIV epidemics in sub-Saharan Africa so severe compared to other regions in the world?

5. Determinants of the heterosexual spread of HIV

The probability that a person becomes infected with HIV during a sexual contact is the product of the probability that a susceptible individual has intercourse with an infected individual and the probability that during this sexual encounter the virus is transmitted. Table

[1] A.M. Hauri, G.L. Armstrong GL, Hutin YJF, "The global burden of disease attributable to contaminated injections given in health care settings," *International Journal of STD and AIDS* (2004), 15, 7-16.

[2] D.P. Gisselquist, J.J. Potterat, "Let it be sexual: how health care transmission of AIDS in Africa was ignored," *International Journal of STD and AIDS* (2003), 14, 148-161; D. P. Gisselquist, R. Rothenberg, J. Potterat, E. Drucker, "HIV infections in sub-Saharan Africa not explained by sexual or vertical transmission," *International Journal of STD and AIDS* (2002), 13, 657-666.

[3] G.P. Schmid, A. Buvé, P. Mugyenyi et al., "Transmission of HIV-1 infection in sub-Saharan Africa and effect of elimination of unsafe injections," *The Lancet* (2004), 363, 482-488.

3 gives an overview of the main factors that influence these probabilities.[1] The rate of spread of HIV in a population is the result of a complex interplay between these factors and it is to be expected that in populations where HIV is spreading rapidly, risky sexual behaviour patterns and/or factors that enhance the transmission of HIV during sexual intercourse will be more prevalent than in populations were the rate of spread of HIV has been slower.

Table 3 Possible determinants of the spread of HIV infection

SEXUAL EXPOSURE TO HIV	→ TRANSMISSION OF HIV	→ INFECTION
Sexual behaviour	• **Sexual practices**	
• rate of partner change	• **Condom use**	
• sexual mixing patterns	• **Classical STIs**	
• extent of concurrent partnerships	• **Circumcision**	
	• **Hormonal contraception**	
	• **Viral strain**	
	• **Genetic factors**	
	• **Other factors ?**	

Sexual behaviour

A high rate of sexual partner change has been found to be associated with an increased risk of HIV infection, in numerous studies from different regions in sub-Saharan Africa.[2] In addition, several studies have identified sex with a commercial sex worker as a risk factor for HIV infection in men.[3]

The role of sexual mixing patterns in determining the rate of spread of HIV in populations has mainly been studied with mathematical models. Results from simulations with mathematical models suggest that patterns of sexual behaviour whereby men have sex with a

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[1] A. Buvé, M. Caraël, R. Hayes, N.J. Robinson, "Variations in HIV prevalence between urban areas in sub-Saharan Africa: Do we understand them?," *AIDS* (1995), 9, Supplement A, S103 – S109.

[2] M. Bulterys, A. Chao, Ph. Habimana, A. Dushimimana, P. Nawrocki, A. Saah, "Incident HIV-1 infection in a cohort of young women in Butare, Rwanda," *AIDS* (1994), 8, 585-1591; M.J. Wawer, D. Serwadda, S.D. Musgrave, J.K. Konde-Lule, M. Musagara, N.K. Sewankambo, "Dynamics of spread of HIV-1 in a rural district of Uganda" *British Medical Journal* (1991), 303, 1303-1306; S.S. Malamba, H.-U. Wagner, G. Maude et al., "Risk factors for HIV-1 infection in adults in a rural Ugandan community: a case-control study," *AIDS* (1994), 8, 253-257; D.J. Hunter, B.N. Maggwa, J.K. Mati, P.M. Tukei, S. Mbugua, "Sexual behavior, sexually transmitted diseases, male circumcision and risk of HIV infection among women in Nairobi, Kenya," *AIDS* (1994), 8, 93-99; G.A. Dallabetta, P.G. Miotti, J.D. Chiphangwi et al., "High socioeconomic status is a risk factor for human immunodeficiency virus type 1 (HIV-1) infection but not for sexually transmitted diseases in women in Malawi: implications for HIV-1 control", *Journal of Infectious Diseases* (1993), 167, 36-42; M. Quigley, K. Munguti, H. Grosskurth et al., "Sexual behaviour patterns and other risk factors for HIV infection in rural Tanzania: a case – control study," *AIDS* (1997), 11, 237-248.

[3] M. Caraël, Ph. Van De Perre, Ph. Lepage et al. "Immunodeficiency virus transmission among heterosexual couples in Central Africa", *AIDS* (1988), 2, 201-205; J. Bwayo, F. Plummer, M. Omari et al., "Human immunodeficiency virus infection in long-distance truck drivers in east Africa," *Archives of Internal Medicine* (1994), 154, 1391-1396; J.N. Simonsen, D.W. Cameron, M.N. Gakinya et al., "Human immunodeficiency virus infection among men with sexually transmitted diseases. Experience from a center in Africa". *The New England Journal of Medicine* (1988), 319, 274-278; M.O. Diallo, A.N. Ackah, M.-F. Lafontaine et al., "HIV-1 and HIV-2 infections in men attending sexually transmitted disease clinics in Abidjan, Côte d'Ivoire," *AIDS* (1992), 6, 581-585.

small group of highly sexually active women, such as commercial sex workers, and some contacts with low activity women, lead to explosive epidemics.[1] Also, extensive mixing between different age classes, i.e. when young women have sex with men who are much older than themselves, would enhance the rate of spread of HIV in the population. More recently it has been suggested that for the same rate of partner change concurrent partnerships are more efficient for the propagation of the virus than serial sexual relationships and that a pattern of concurrent partnerships in the population enhances the probability of an explosive epidemic.[2] This is explained by the fact that the virus does not "waste any time" between partners.

Factors that influence the transmissibility of HIV during sexual intercourse

Studies on HIV discordant couples in Europe and the US have found sexual intercourse during menses to be associated with an increased risk of HIV infection in male partners of female index cases, but not in female partners of male index cases.[3] In Europe and the US anal intercourse has been found to be strongly associated with HIV infection in women, even if couples infrequently engaged in it.[4] Little is known about the practice of anal intercourse in sub-Saharan Africa, but there is a taboo on it and it is believed to be uncommon. Intercourse with a dry and tight vagina, so called "dry sex", has been described as a fairly common sexual practice in many parts of the Democratic Republic of Congo, Zambia, Zimbabwe, Kenya and Uganda, as well as in Senegal, Mali, Benin and Ivory Coast.[5] About one third of women interviewed in Lusaka (Zambia) occasionally engaged in this practice, by using intravaginal substances or mopping up vaginal secretions with a cloth.[6] It is biologically plausible that this practice is associated with an increased risk of infection, because of bruising of the genital mucosa. In Zambia such association has been suggested in univariate analysis of risk factors for HIV infection in women,[7] but among Kinshasa sex workers there was no evidence of an increased risk.[8] Thus the role of this sexual practice in the spread of HIV in sub-Saharan Africa is far from clear. In conclusion, some sexual practices like anal intercourse are

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[1] R.M. Anderson, R.M. May, M.C. Boily, G.P. Garnett, J.T. Rowley, "The spread of HIV-1 in Africa: sexual contact patterns and the predicted demographic impact of AIDS," *Nature* (1991), 1352, 581-589.

[2] C.H. Watts, R.M. May, "The influence of concurrent partnerships on the dynamics of HIV/AIDS," *Mathematical Biosciences* (1992), 108, 89-104; C.P. Hudson, " Concurrent partnerships could cause AIDS epidemics," *International Journal of STD and AIDS* (1993), 4, 249-253; M. Morris, M. Kretzschmar, "Concurrent partnerships and transmission dynamics in networks," *Social Networks* (1995), 17, 299-318; M. Morris, M. Kretzschmar, "Concurrent partnerships and the spread of HIV," *AIDS* (1997), 11, 641-648.

[3] European Study Group on Heterosexual Transmission of HIV, "Comparison of female to male and male to female transmission of HIV in 563 stable couples" , *British Medical Journal* (1992), 304, 809-813; M. Seidlin, M. Vogler, E. Lee, Y.S. Lee, N. Dubin, "Heterosexual transmission of HIV in a cohort of couples in New York City," *AIDS* (1993), 7, 1247-1254.

[4] European Study Group on Heterosexual Transmission of HIV, "Comparison of female to male and male to female transmission of HIV in 563 stable couples"; Seidlin et al., "Heterosexual transmission of HIV in a cohort of couples in New York City"; N.S. Padian, S.C. Shiboski, N.P. Jewell, "The effect of number of exposures on the risk of heterosexual HIV transmission," *Journal of Infectious Diseases* (1990), 161, 883-887.

[5] R.C. Brown, J.E. Brown, O.B. Ayowa, "The use and physical effects of intravaginal substances in Zairean women," *Sexually Transmitted Diseases* (1993), 20, 96-99; M.J. Nyirenda, "A study of the behavioural aspects of dry sex practice in Lusaka urban," VIIIth International Conference on AIDS. Amsterdam, July 1992. Abstract POD 5448; A. Runganga, M. Pitts, J. McMaster, "The use of herbal and other agents to enhance sexual experience," *Social Science and Medicine* (1992), 35, 1037-1042; E. Vincke (1991), "Liquides sexuels féminins et rapports sociaux en Afrique centrale," *Anthropologie et sociétés*, vol. 15, 167-188.

[6] Nyirenda, "Study" (see previous note).

[7] S.K. Hira, U. Mangrola, C. Mwale, C. Chintu, G. Tembo, W.E. Brady, P.L. Perine, "Apparent vertical transmission of human immunodeficiency virus type 1 by breast-feeding in Zambia," *Journal of Pediatrics* (1990), 117, 421-424.

[8] N. Nzilambi, M. Laga, A.T. Manoka et al., "HIV and other sexually transmitted diseases among female prostitutes in Kinshasa," *AIDS* (1991), 5, 715-721.

associated with a marked increase in the risk of HIV infection but are thought to be uncommon in sub-Saharan Africa. For other practices including "dry sex", the risks are less well documented. In order to be a major determinant of the spread of HIV in a population, sexual practices need not only to enhance the transmission of HIV, but also to be common.

Condom use is considered one of the most cost-effective interventions to reduce the spread of HIV. A meta-analysis on data from studies on HIV discordant couples found that condom use may reduce the risk of HIV transmission by as much as 69%.[1] Results from a simulation exercise drawing on data from a cohort study in southwest Uganda, suggest that a substantial proportion of HIV infections, up to 39%, could have been averted in the 1990's if men had used condoms consistently with their one-off sexual contacts.[2] Throughout the 1980's and 1990's condoms were used by less than 1% of married couples in the majority of African countries.[3] Following HIV prevention campaigns condom use has increased in many countries, but this increase most likely came too late to be a major determinant of the differences in HIV prevalence between different regions in sub-Saharan Africa.

It is now established that other sexually transmitted infections (STIs), including ulcerative STIs as well as gonorrhoea and chlamydial infection, facilitate the transmission of HIV infection during sexual intercourse and can play a key role in the dynamics of HIV epidemics.[4] So called classical STIs have been found to enhance the susceptibility of HIV uninfected individuals and the infectiousness of HIV infected individuals. Evidence for the facilitating role of classical STIs in the transmission of HIV was first provided by epidemiological studies on risk factors for HIV seroconversion[5] and later confirmed by a controlled intervention trial which found a 40% reduction in HIV incidence in the general population of Mwanza Region, Tanzania following improved case detection and management of STIs.[6] Studies in pregnant women and in female sex workers in sub-Saharan Africa have shown that the prevalence of STIs can be very high in certain African populations and that there can be large variations in prevalence and mix of STIs between different regions in Africa.[7] There are several possible explanations for the variation in STI prevalence rates, including: (a) differences in sexual behaviour, i.e. rate of partner change and sexual mixing patterns; (b) differences in access to and use of effective treatment; (c) variations in the prevalence of other factors that may increase the risk of STIs such as lack of male circumcision and genital hygiene.

Male circumcision may have a direct effect on the probability of HIV transmission, as well as an indirect effect. The inner surface of the foreskin is rich in Langerhans' cells that have

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[1] H. Grosskurt, F. Mosha, J. Todd et al., "Impact of improved treatment of sexually transmitted diseases on HIV infection in rural Tanzania: randomised controlled trial," *The Lancet* (1995), 346, 530-536.

[2] N.J. Robinson, D.W. Mulder, B. Auvert, R.J. Hayes, "Modelling the impact of elternative HIV intervention strategies in rural Uganda," *AIDS* (1995), 9, 1263-1270.

[3] U.S. Bureau of the Census, *Report WP/98. World Population Profile: 1998* (Washington DC: U.S. Government Printing Office, 1999).

[4] D.T. Fleming, J.N. Wasserheit, "From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection," *Sexually Transmitted Infections* (1999), 75, pp 3-17; N.J. Robinson, D.W. Mulder, B. Auvert, R.J. Hayes, " Proportion of HIV infections attributable to other sexually transmitted diseases in a rural Ugandan population: simulation model exercises," *International Journal of Epidemiology* (1997), 26, 180-189.

[5] D.W. Cameron, J.N. Simonson, L.J. D'Costa et al., "Female-to-male transmission of HIV-1: risk factors for seroconversion in men," *The Lancet* (1989), ii, 403-407; M. Laga, A. Manoka, M. Kivuvu et al., "Non-ulcerative sexually transmitted diseases as risk factors for HIV-1 transmission in women: results from a cohort study," *AIDS* (1993), 7, 95-102.

[6] H. Grosskurt, F. Mosha, J. Todd et al., "Impact of improved treatment of sexually transmitted diseases on HIV infection in rural Tanzania: randomised controlled trial," *The Lancet* (1995), 346, 530-536.

[7] J. Goeman, A. Meheus, P. Piot, "L'épidémiologie des maladies sexuellement transmissibles dans les pays en développement l' re du SIDA," *Annales de la Société belge de médecine tropicale* (1991), 71, 81-113.

HIV receptors and that are thus entry points for HIV infection, so that men lacking a foreskin would be less susceptible to HIV infection.[1] In addition, uncircumcised men would be more susceptible to infection because of small abrasions of the foreskin, greater proneness to balanitis and higher susceptibility to ulcerative STIs.[2] A meta-analysis of twenty-seven studies on the association between male circumcision and HIV infection in sub-Saharan Africa has provided convincing evidence for a reduced risk of HIV infection in men who are circumcised.[3]

It has been suggested that the use of hormonal contraception is a risk factor for the acquisition of HIV infection by women.[4] However, it remains unclear whether hormonal contraception is truly a risk factor for HIV infection or whether the association is confounded by behavioural factors. But even if the use of hormonal contraception were shown to increase women's susceptibility to HIV infection it is unlikely to be a major explanatory factor for the spread of HIV in sub-Saharan Africa because it is used by only a minority of women.

HIV is characterised by a high genetic variability .[5] There are two types HIV-1 and HIV-2 and three groups of HIV-1 (M,N and O). Both HIV types and all three HIV-1 groups are found in sub-Saharan Africa. All nine subtypes of HIV-1 as well as five out of the nine known circulating recombinant forms (CFRs) have been isolated from patients in Africa.[6] There is strong epidemiological evidence for a higher transmissibility of HIV-1 compared to HIV-2. Whether there are also differences in transmissibility between different HIV-1 subtypes and CRFs is not clear. So far there is no convincing evidence that there exist major differences in transmissibility and pathogenesis between HIV-1 strains that may determine differences in rate of spread of HIV between different populations.[7]

In 1996 the first report was published on a small group of sex workers in Nairobi who appeared to be resistant to HIV infection despite repeated exposure to the virus.[8] The exact mechanism of this resistance is still unclear. However, so far no genetic factor has been found

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[1] R. Szabo, R.V. Short, "How does male circumcision protect against HIV infection?," *British Medical Journal* (2000), 320, 592-1594.

[2] I. de Vicenzi, T. Mertens, "Male circumcision: a role in HIV prevention?," *AIDS* (1994), 8, 153-160; S. Moses, F.A. Plummer, J.E. Bradley, J.O. Ndinya-Achola, N.J.D. Nagelkerke, A.R. Ronald, "The association between lack of male circumcision and risk for HIV infection: a review of the epidemiological data," *Sexually Transmitted Diseases* (1994), 21, 201-210; L.S. Cook, L.A. Koutsky, K.K. Holmes, "Circumcision and sexually transmitted diseases," *American Journal of Public Health* (1994), 84, 97-201; L. Lavreys, J.P. Rakwar, M.L. Thompson et al., "Effect of circumcision on incidence of human immunodeficiency virus type 1 and other sexually transmitted diseases: a prospective cohort study of trucking company employees in Kenya," *Journal of Infectious Diseases* (1999), 180, 330-336.

[3] H.A. Weiss, M. Quigley, R.J. Hayes, "Male circumcision and risk of HIV infection in sub-Saharan Africa: a systematic review and meta-analysis," *AIDS* (2000), 14, 2361-2370.

[4] C.C. Wang, J.K. Kreiss, M. Reilly, "Risk of HIV infection in oral contraceptive pill users: a meta-analysis. Journal of acquired immune deficiency syndromes," *Journal of Acquired Immune Deficiency Syndromes* (1999), 21, 51-58.

[5] The human immunodeficiency viruses belong to the genus of the lentiviruses. "Lenti" meaning slow these viruses establish chronic infections. There are two human immunodeficiency viruses, HIV-1 and HIV-2. HIV-1 is subdivided in three groups (M, N and O). Group M is by far the most important as only a few individuals have been found to be infected with group N or group O. HIV-1 group M viruses are classified into nine subtypes on the basis of their genome. Among viruses belonging to a particular subtype, variations in the genome encoding for the envelope do not exceed 30%. Over the years more and more viruses have been identified that are recombinants, i.e. viruses with a genome that is a combination of two or more subtypes. Some of these recombinants have been quite successful and are by now widespread. These recombinants are called "circulating recombinant forms".

[6] F.E., McCutchan, "Understanding the genetic diversity of HIV-1". *AIDS* (2000), 14, Supplement 3, S31-S44.

[7] D.J. Hu, A. Buvé, J. Baggs, G. van der Groen, T.J., Dondero, "What role does HIV-1 subtype play in transmission and pathogenisis? An epidemiological perspective," *AIDS* (1999), 13, 873-881.

[8] K.R. Fowke, N.J.D. Nagelkerke, J. Kimani et al., "Resistance to HIV-1 infection among persistently seronegative prostitutes in Nairobi, Kenya," *The Lancet* (1996), 348, 1347-1351.

that confers resistance against HIV infection ánd that is prevalent enough in a population to have an impact on the rate of spread of HIV.

It has been suggested that nutritional deficiencies, in particular vitamin A, may enhance disease progression and transmission of HIV infection.[1] But two randomised trials on the effects of vitamin A supplementation on mother-to-child transmission of HIV-1 found no evidence for a protective effect of vitamin A supplementation.[2]

6. The multi-centre study on factors determining the differential spread of HIV in four cities in Africa

Using the framework presented in Table 3, a study was designed to explore possible reasons for the differences in rate of spread of HIV between different regions in sub-Saharan Africa. The study was conducted in four cities by a multidisciplinary team.[3] In two of the cities, Cotonou in Benin and Yaoundé in Cameroon, the prevalence of HIV infection was relatively low (below 5% at the time the study was designed), in the two other cities, Kisumu in Kenya and Ndola in Zambia, the HIV prevalence was over 20%. It was hypothesised that in the two cities with high HIV prevalence risky sexual behaviour would be more common than in the cities with relatively low HIV prevalence and/or that factors that enhance the per sex act transmission probability, such as other STIs, would be more prevalent.

The study was a population based study and in each of the four cities a representative sample of about 1000 men and 1000 women aged 15 to 49 years was taken. Selected men and women were visited in their homes and asked for their informed consent. Consenting men and women were interviewed about their socio-demographic characteristics and sexual behaviour, including details about their sexual partners of the past year. They were also asked to provide blood samples and urine samples for testing for HIV and other STIs. In addition men were interviewed and examined on their circumcision status and women were asked to provide a swab with vaginal secretions to be tested for trichomoniasis. Apart from the study in the general population there was also a survey among sex workers. First a census was conducted of women who were self acknowledged sex workers. From the list of bars, brothels, hotels etc a representative sample of female sex workers was then taken. Sex workers who gave their informed consent to participate in the study were interviewed and tested for HIV and other STIs.

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[1] W.W. Fawzi, D.J. Hunter, "Vitamins in HIV disease progression and vertical transmission," *Epidemiology* (1998), 9, 457-466.

[2] A. Coutsoudis, K. Pillay, E. Spooner, L. Kuhn, H. Coovadia, "The South African Vitamin A Study Group. Randomized trial testing the effect of vitamin A supplementation on pregnancy outcomes and early mother-to-child HIV-1 transmission in Durban, South Africa," *AIDS* (1999), 13, 1517-1524; W.W. Fawzi, G. Msamanga, D. Hunter et al., "Randomized trial of vitamin supllements in relation to vertical transmission of HIV-1 in Tanzania," *Journal of Acquired Immune Deficiency Syndromes* (2000), 23, 246-254.

[3] The members of The Study Group on Heterogeneity of HIV Epidemics in African Cities were: A. Buvé (coordinator), M. Laga, E. Van Dyck, W. Janssens, L. Heyndrickx (Institute of Tropical Medicine, Antwerp, Belgium); M. Caraël (UNAIDS); S. Anagonou (Programme National de Lutte contre le SIDA, Benin), M. Laourou (Institut National de Statistiques et d'Analyses Economiques, Bénin), L. Kanhonou (Centre de Recherche en Reproduction Humaine et en Démographie, Bénin); L. Zekeng (Programme de Lutte contre le SIDA, Cameroon), E. Akam, M. de Loenzien (Institut de Formation et de Recherche en Démographiques, Cameroon), S.-C. Abega (Université Catholique d'Afrique Centrale, Cameroon); M. Kahindo (formerly National AIDS/STD Control Programme, Kenya), J. Chege, N. Rutenberg (The Population Council, Nairobi), V Kimani (Department of Community Health, University of Nairobi); R. Musonda, T. Sukwa, F. Kaona (Tropical Diseases Research Centre, Zambia); B. Auvert, E. Lagarde (INSERM U88, Paris, France); N.J. Robinson (formerly INSERM U88, Paris, France); B. Ferry, N. Lydié (Centre français sur la Population et le Développement, Paris, France); R. Hayes, L. MorisonWilliams, H. Weiss, J. Glynn (London School of Hygiene and Tropical Medicine).

Table 3 shows the HIV prevalence in each of the four cities by age and sex.[1] The HIV prevalence was higher in women than in men, except in Cotonou: the ratio of the HIV prevalence in women to the HIV prevalence in men was 1.03 for Cotonou, 1.9 for Yaoundé, 1.5 for Kisumu and 1.38 for Ndola. The difference in HIV prevalence between men and women was especially striking in Kisumu and Ndola in the age group 15 to 19 years. In this age group in Kisumu the HIV prevalence in women was more than 6 times higher than in men (23% vs 3.5%) and in Ndola more than 4 times higher (15.4% vs 3.7%). Sexual behaviour as reported by young women alone could not explain the observed differences in HIV prevalence between young women and young men and it is believed that there are biological factors, such as genital herpes infection, that play an important role in increasing the vulnerability of young women to HIV infection.[2]

Table 4 Prevalence of HIV infection by age group, sex and city

	COTONOU	YAOUNDÉ	KISUMU	NDOLA
MEN	N = 928	N = 896	N = 622	N = 624
15 - 19	0	0	3.5%	3.7%
20 - 24	2.3%	1.4%	12.3%	13.2%
25 - 29	6.7%	3.1%	28.7%	27.3%
30 - 39	3.9%	9.9%	33.1%	39.6%
40 - 49	3.8%	5.7%	27.7%	25.8%
All	3.3%	4.1%	19.8%	23.2%
(95% CI)	(2.3 – 4.8)	(3.0 – 5.7)	(16.8 – 23.2)	(20.0 – 26.8)
WOMEN	N = 1015	N = 1017	N = 893	N = 910
15 - 19	2.4%	3.4%	23.0%	15.4%
20 - 24	3.8%	9.3%	38.3%	41.8%
25 - 29	4.8%	11.2%	37.1%	43.8%
30 – 39	3.5%	8.9%	30.1%	34.8%
40 – 49	2.6%	6.1%	18.5%	20.4%
All	3.4%	7.8%	30.1%	31.9%
(95% CI)	(2.4 – 4.8)	(6.2 – 9.6)	(27.2 – 33.3)	(28.9 – 35.0)
FEMALE SEX WORKERS	N = 275	N = 320	N = 296	N = 319
(95% CI)	57.5% (51.4 - 63.3)	34.4% (29.2 – 39.9)	74.7% (69.2 - 79.4)	68.7% (63.2 - 73.6)

[1] A. Buvé, M. Caraël, R.J. Hayes et al., "Multicentre study on factors determining differences in rate of spread of HIV in sub-Saharan Africa: methods and prevalence of HIV infection," *AIDS* (2001), 15, Supplement 4, S5-S14.

[2] J.R. Glynn, M. Caraël, B. Auvert et al., "Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia," *AIDS* (2001), 15, Supplement 4, S51-S60.

Possible population risk factors for a rapid spread of HIV that were explored included:

a) exposure to an HIV infected partner through sexual behaviour, i.e.
   – age at first sexual intercourse;
   – marriage patterns (age at first marriage, pre-marital relations, number of spousal partners…);
   – rate of partner change (lifetime number of sex partners, number of non-spousal partners in the past year);
   – contacts with sex workers;
   – age difference between sex partners (spousal and non-spousal);
   – condom use.
b) factors that enhance the transmission of HIV during sexual intercourse:
   – prevalence of other sexually transmitted infections, including gonorrhoea, chlamydial infection, syphilis, genital herpes and (for women) trichomoniasis;
   – lack of male circumcision.

In addition a study was done on the distribution of different HIV-1 strains in the four populations.

Table 5 summarises the distribution of the main risk factors for HIV infection that were explored.[1]

Table 5 Summary of the distribution of risk factors for HIV infection across the four populations

	Consistently more common in the high HIV prevalence sites	**NOT consistently more common in the high HIV prevalence sites**
Parameters of sexual behaviour	• young age at first sexual intercourse (women) • young age at first marriage • large age difference between spouses	• high rate of partner change • sex with sex workers • concurrent partnerships • large age difference between non-spousal partners
Co-factors in HIV transmission	• HSV-2 infection • Trichomoniasis (women) • lack of male circumcion	• non-ulcerative STI's (gonorrhoea and/or chlamydial infection) • syphilis • dry sex • lack of condom use

High rates of partner change were not more common in the two high HIV prevalence cities than in the two "low" HIV prevalence cities. Also contacts with sex workers, concurrent partnerships and large age differences between partners, were not more common in Kisumu and Ndola than in Cotonou and Yaoundé. With the possible exception of contacts with sex workers these risk behaviours were more common in Yaoundé, one of the "low" HIV prevalence cities, than in the high HIV prevalence cities. Levels of condom use reported by men were similar in the four cities, but women in the "low" HIV prevalence cities reported less frequent condom use than women in the high HIV prevalence cities. The only parameters of sexual behaviour that distinguished Kisumu and Ndola from Cotonou and Yaoundé, were age at sexual debut of women and age at first marriage of men and women. Compared to the

[1] A. Buvé, M. Caraël, R.J. Hayes et al., "The multicentre study on factors determining the differential spread of HIV in four African towns: summary and conclusions," *AIDS* (2001), 15, Supplement 4, S127-S131.

"low" HIV prevalence cities women in the high HIV prevalence cities started sexual activity at a younger age, and men and women got married earlier.

These data on sexual behaviour suggest that the differences in epidemic spread of HIV between the East African cities and the West African cities can not be explained by differences in sexual behaviour patterns alone. However we do have evidence that there are important differences in the probability of transmission of HIV during sexual intercourse, between the high HIV prevalence cities and the low HIV prevalence cities. In the "low" HIV prevalence cities nearly all men were circumcised, whereas in the high HIV prevalence cities the majority of men were not circumcised. In addition ulcerative sexually transmitted infections, especially genital herpes, and trichomoniasis were more prevalent in Kisumu and Ndola than in Cotonou and Yaoundé. In Cotonou 13% of men had HSV-2 or syphilis, in Yaoundé 29%, in Kisumu 37% and in Ndola 40%. The corresponding figures for women were 31%, 52%, 69% and 58%.

As for circulating strains of HIV-1, subtype A was found to be the most prevalent subtype in the "low" HIV prevalence cities as well as in one of the high HIV prevalence cities, Kisumu. Subtype C, the predominant subtype in Ndola, has been found in the past in Cameroon as well. This suggests that differences in circulating subtypes of HIV-1 are not a major factor in determining the rate of spread of HIV in sub-Saharan Africa.

In conclusion in the four African populations that were studied differences in risky sexual behaviour were outweighed by differences in factors influencing HIV transmission probability, i.e. lack of male circumcision and ulcerative STIs, in particular HSV-2 infection and syphilis. This study has – once more – highlighted the importance of factors other than sexual behaviour in shaping HIV epidemics in sub-Saharan Africa.

7. Why are the epidemics in sub-Saharan Africa so severe compared to other continents?

By the end of the year 2003, 7.5 to 8.5% of adults in sub-Saharan Africa were estimated to be HIV infected.[1] Other regions in the world that are heavily affected are the Caribbean region with a prevalence among adults estimated at 1.9 to 3.1%; Eastern Europe and Central Asia with 0.5 - 0.9% of adults infected, mainly through intravenous drug use; and South and South East Asia where 0.4 to 0.8% of adults are infected. Estimates of numbers of people living with HIV in South and Southeast Asia range between 4.6 and 8.2 million. As such this region is the region in the world with the second highest number of people living with HIV. There is a lot of concern that the HIV epidemics in this region may become as severe as in sub-Saharan Africa.

As there are no truly comparative data on sexual behaviour and other risk factors for HIV infection from different continents, it is very difficult to predict what the course of the HIV epidemic will be in other populations than the African populations where the predominant mode of HIV transmission is heterosexual intercourse. Some cautious comparisons however can be made between sub-Saharan Africa and Southeast Asia.

The HIV epidemics in most parts of Africa started about ten years earlier than in Southeast Asia, but this is unlikely to fully explain the differences in HIV prevalence in the general population. For instance, in South Africa and in Thailand the HIV epidemics started around the same time, in the early 1990's. By 1997 the HIV prevalence in the general population was 12.9% in South Africa and 2.2% in Thailand.[2]

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[1] UNAIDS/WHO, *AIDS Epidemic Update: December 2003*. UNAIDS/03.39E (Geneva, UNAIDS/WHO, 2003).
[2] UNAIDS, *Report on the global HIV/AIDS epidemic - 2000.* UNAIDS/00.13E (Geneva, UNAIDS, 2000)

It seems that sex between men and female sex workers is prevalent in many parts of Africa as well as in Southeast Asia. In the multicentre study on factors determining the differential spread of HIV in four African cities, the proportion of men in the general population who declared at least one contact with a sex worker in the past year ranged between 3% in Kisumu and 12% in Yaoundé, but these figures are considered as grossly underestimated.[1] In a nation wide survey in Thailand 24.2% of men in urban areas and 9.5% in rural areas reported commercial sex in the previous year.[2] Sexual behaviour of Cambodian men appears to follow a similar pattern.[3] By way of comparison, in Western Europe the proportion of men who reported having paid for sex in the past year, ranged between 0.5% in Great Britain and 4.7% in Portugal. An outlier was Spain where 9.9% of men reported having paid for sex in the past year.[4] Moreover condoms have been in use by sex workers in Europe long before HIV infection was introduced in these populations.[5] What makes the difference then between sub-Saharan Africa and Southeast Asia?

First, large scale interventions to promote condom use with sex workers that were supported at the highest political level, were initiated earlier in the course of the HIV epidemic in Thailand and Cambodia than in most of sub-Saharan Africa. In Bangkok, Thailand, in 1996, 97% of brothel based sex workers and 78% of "indirect sex workers" reported consistent condom use with all their clients.[6] In Cambodia the interventions were started later but by 1999 78% of brothel based sex workers reported consistent condom use with all their clients.[7] This is in contrast to what sex workers reported in 1997 in the multicentre study: in Yaoundé and in Ndola 28% of sex workers reported condom use with their last client, in Kisumu 50% and in Cotonou 69%.[8]

A second important difference however between sub-Saharan Africa and Southeast Asia is the extent to which male clients of sex workers have intercourse with non-commercial female partners who in turn have sex with several other male partners. Surveys in several countries in Southeast Asia, including Singapore, Sri Lanka, Thailand and Cambodia, showed that in general unmarried women are not sexually active.[9] In contrast in sub-Saharan the percentage of unmarried women who reported at least one sexual partner in the past twelve months ranged between 2% in urban areas in Togo and 64% in rural areas in Guinea Bissau.[10] As such it seems unlikely that we will see in Southeast Asia the same high HIV prevalence rates among young women, which are seen in several countries in sub-Saharan Africa and which

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[1] L. Morison, H.A. Weiss, A. Buvé et al., "Commercial sex and the spread of HIV in four cities in sub-Saharan Africa," *AIDS* (2001), 15, Supplement 4, S61-S69.

[2] W. Sittitrai, P. Phanuphak, J. Barry, T. Brown, "A survey of Thai sexual behaviour and risk of HIV infection", *International Journal of STD and AIDS* (1994), 5, 377-382.

[3] C.A. Ryan , O.V. Vathiny, P.M. Gorbach et al., "Cambodia: explosive spread of HIV-1 and sexually transmitted diseases". *The Lancet* (1998), 351, 1175.

[4] H. Leridon, G. van Zessen, M. Hubert, "The Europeans and their sexual partners", in Michel Hubert, Nathalie Bajos and Theo Sandfort (eds), *Sexual behaviour and HIV/AIDS in Europe* (London, UCL Press, 1998), 190-193.

[5] N.J. Robinson, R. Hayes, D. Mulder, "Using condoms to prevent transmission of HIV". *British Medical Journal* (1993), 307, 1007.

[6] S. Mills, P. Benjarattanaporn, A. Bennet et al., "HIV risk behavioral surveillance in Bangkok, Thailand: sexual behavior trends among eight population groups". *AIDS* (1997), 11, Supplement 1, S43 – S51.

[7] National Center for HIV/AIDS Dermatology and STD and Family Health International, *Behavioral Surveillance Survey. Cambodia 1997, 1998, and 1999.*

[8] Sittitrai et al., "A survey of Thai sexual behaviour and risk of HIV infection".

[9] M. Caraël, "Sexual behaviour," in John Cleland and Benoît Ferry (eds), *Sexual behaviour and AIDS in the developing world* (London, Taylor & Francis on behalf of the World Health Organization, 1995); National Institute of Statistics and Directorate General of Health, Phnom Penh, Cambodia/ ORC Macro, *Cambodia Demographic and Health Survey 2000* (Calverton, Maryland, National Institute of Statistics and Directorate General of Health, Phnom Penh, Cambodia/ ORC Macro, 2001).

[10] Caraël, "Sexual behaviour".

are driving the HIV epidemics. This may however change very quickly if the sexual behaviour of young women in Southeast Asia changes under the influence of socio-economic developments and the adoption of modern lifestyles.

8. Conclusions

This paper explored reasons for the severity and the heterogeneity of the HIV epidemics in sub-Saharan Africa, from an epidemiological perspective. The spread of HIV in a population is the result of a complex interplay between sexual behaviour and biological factors that enhance the transmission of HIV - even in populations where there is only one predominant mode of transmission, as is the case in sub-Saharan Africa. Sexual behaviour patterns are shaped in a specific cultural and socio-economic context. Several cultural and socio-economic features of African societies conspire to enhance the vulnerability of African populations to HIV, including the subordinate position of women, impoverishment, rapid urbanisation and modernisation, and last but not least wars and conflicts. Associations between HIV infection and socio-economic status have been documented at the individual level since the mid 1980's. Unravelling associations at the population level proved more difficult. A World Bank study from 1995 found a relationship between the spread of HIV infection at the population level and four societal variables including per capita GNP, inequality of income distribution, ratio of urban males to females and male-female literacy gap.[1]

HIV epidemics in their turn lead to increased poverty; break down of social services and of the social fabric of society. They threaten further the respect for human rights if fear leads to inappropriate actions that ignore the rights of individuals, whether or not they are HIV infected. In this way societies that are facing a severe HIV epidemic may be trapped in a vicious circle. The only way out is to acknowledge the wider contextual factors of the spread of HIV and to take these into account in the design of control programmes. This reasoning has led to dissolution of the Global Programme of AIDS of the World Health Organisation in 1995, and the creation of UNAIDS, the Joint United Nations Programme on HIVA/IDS which brings together nine United Nations system organisations in order to provide promote a multisectoral approach to the HIV/AIDS pandemic.

The decline of social services, including health services and education, represents so many missed opportunities to stem the spread of HIV. The persistently high prevalence of STIs, such as syphilis, in certain populations, is the result of a failing health system. The breakdown of the education system represents a missed opportunity to provide young people with the knowledge and skills necessary to lead a healthy sexual life.

[1] World Bank, *Confronting AIDS. Public priorities in a global epidemic* (New York, Oxford University Press, 1997).