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Population migration and the spread of types 1 and 2 human immunodeficiency viruses

(AIDS/demography/human immunodeficiency virus epidemiology)

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ABSTRACT Over 14 million people are estimated to be infected with the human immunodeficiency viruses (HIV), with nearly three-fourths of the infected persons residing in developing countries. One factor responsible for dissemination of both HIV-1 and HIV-2 worldwide was the intense migration of individuals, from rural to urban centers with subsequent return migration and internationally due to civil wars, tourism, business purposes, and the drug trade. In sub-Saharan Africa, between 1960 and 1980, urban centers with more than 500,000 inhabitants increased from 3 to 28, and more than 75 military coups occurred in 30 countries. The result was a massive migration of rural inhabitants to urban centers concomitant with the spread of HIV-1 to large population centers. With the associated demographic, economic, and social changes, an epidemic of sexually transmitted diseases and HIV-1 was ignited. Migratory patterns were also responsible for the spread of endemic HIV-2 to neighboring West African countries and eventually to Europe, the Americas, and India. Although Southeast Asia was the last region in which HIV-1 was introduced, it has the greatest potential for rapid spread due to population density and inherent risk behaviors. Thus, the migration of poor, rural, and young sexually active individuals to urban centers coupled with large international movements of HIV-infected individuals played a prominent role in the dissemination of HIV globally. The economic recession has aggravated the transmission of HIV by directly increasing the population at risk through increased urban migration, disruption of rural families and cultural values, poverty, and prostitution and indirectly through a decrease in health care provision. Consequently, social and economic reform as well as sexual behavior education need to be intensified if HIV transmission is to be controlled.

It has been more than a decade since the recognition of the first cases of the acquired immunodeficiency syndrome (AIDS), and during this time AIDS has rapidly become a global pandemic with more than 750,000 cases officially reported from 173 countries (1). Because of underreporting in many areas, the World Health Organization estimates that over 2.5 million cumulative AIDS cases and 1 million deaths have occurred to date (Fig. 1). However, the impact of the AIDS epidemic is even greater when one considers the magnitude of spread of the human immunodeficiency viruses (HIV). From selected seroprevalence studies and mathematical models, it is now estimated that 14 million people are infected with HIV (Fig. 1). Of these individuals, \approx 8 million

are men, 5 million are women, and 1 million are infants and children. Two-thirds of all estimated AIDS cases to date have occurred in sub-Saharan Africa, but more recently, HIV infection has increased rapidly in Southeast Asia, with over 1.5 million cumulative HIV infections estimated to have occurred within the last 5 years. It is within these developing countries that HIV will clearly have its greatest impact on morbidity and mortality, as well as having profound economic and social consequences.

In some urban centers of sub-Saharan Africa, Western Europe, and the Americas, AIDS has already become the leading cause of death for both men and women aged 15-49 years (2-4). It has been estimated that the HIV pandemic may have already resulted in the death of nearly 750,000 children worldwide and that, by the year 2000, 10 million children under 15 may be orphaned because of the premature death of HIV-1-infected mothers and fathers from AIDS (5). Overall infant and child mortality rates will increase as much as 30% more than previously projected as a direct consequence of perinatal HIV infection. Consequently, pediatric AIDS is now threatening much of the progress that has been made in child survival in developing countries during the past 20 years.

While the origin of HIV infection remains an enigma, several factors have been hypothesized to be responsible for the eventual spread of HIV. Historically, from retrospective serologic studies it is evident that HIV existed in humans as early as the late 1950s, although it did not become epidemic until nearly 20-30 years later (6). One hypothesis is that the migration of individuals from areas of low endemicity to new uninfected areas was eventually responsible for dissemination of HIV throughout the world. This was by no means a rapid event but probably occurred over a 40-year period. Unfortunately, because of the lack of vaccine or effective antivirals, it is inevitable that further dissemination will still occur from established indigenous transmission resulting in an escalation of the epidemic over the next decade. The World Health Organization now estimates that as many as 40 million people will be HIV-infected by the year 2000 (7).

This paper will review the conceptual issues regarding the migration of populations with its associated social changes in certain regions as a major force responsible for the eventual dissemination of HIV infections worldwide. Because data are limited on the frequency and size of population movements, and in particular in reference to HIV infection, no definitive

Abbreviations: HIV, human immunodeficiency virus(es); STD, sexually transmitted disease.

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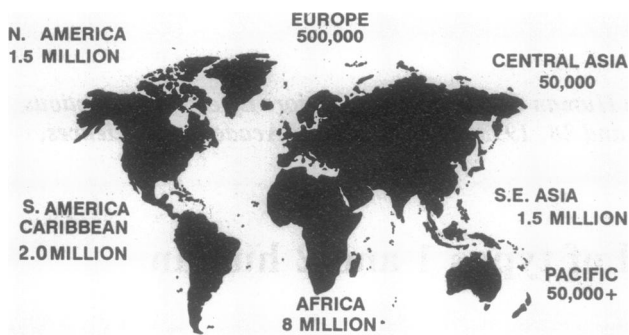


FIG. 1. Estimated global distribution of HIV-1 infections by region. Data were taken from the World Health Organization (1).

conclusions can be made regarding the origins of HIV; rather, these concepts are presented to provide a better framework to understand the behavioral and demographic changes responsible for the AIDS epidemic.

Migration of Populations: Definitions

Migration is the movement of people in space, often involving a change in the usual place of residence (8). Internal migration is such a movement within national boundaries, whereas international migration involves movement of individuals across political boundaries. Because migration is a continuous, often repeated process rather than a single event, it is often difficult to measure. Migration is further defined in terms of movement in time. The principal distinction is between circulation—i.e., involving repetitive, nonpermanent moves such as daily commuting and other short-term mobility—and definitive migration (8). Periodic movements are mostly short term, whereas seasonal movements have a regular annual rhythm. Long-term circulation involves an absence of more than 1 year but with expectation of return. Definitive migration by contrast implies a permanent movement away from one residence with little indication of return visit. Some examples of internal migration include rural-rural, rural-urban, urban-rural, and urban-urban, each with its own characteristic features and consequences (Table 1).

Africa

Following independence in the 1960s, many African countries experienced dramatic demographic changes, which may underlie the movement of HIV infection from potentially remote areas to more populous areas. One of the most important types of migration during this period represented rural-urban movement, which was significant in the long-term spatial redistribution of populations. The number of cities with more than 500,000 inhabitants rapidly increased from 3 in 1960 to 28 by 1980 (10). Though the total urban population in sub-Saharan Africa increased substantially, the average growth rates did not. Between 1965 and 1985 the proportion of the total population living in urban areas in

Table 1. Factors contributing to population migration in sub-Saharan Africa

1. Political instability: 75 military coups in 30 countries
2. Environmental degradation from population pressure, bad land use, weather changes, etc
3. Natural disasters such as flooding and earthquakes
4. Pursuit of productive employment
5. Artificial boundaries established by colonists, which ignored cultural and ethnic boundaries
6. Decline in the effect of religion on population migration

Adapted from ref. 9.

southern Africa rose from 43% to more than 50%; in middle Africa, from 21% to 35%; and in western Africa, from 17% to 29% (Fig. 2) (8, 10). The least urbanized subregion, eastern Africa, has experienced increased urbanization, though the urban proportion has stayed less than 20%, rising from less than 10% in 1965. By year 2000, the projected proportion of people living in urban centers is expected to exceed one-third of the national populations in all regions except eastern Africa. As a consequence of urbanization, the crude population density increased in every country for which data are available, averaging greater than a 100% increase (8).

Unlike much of the industrialized world, where urbanization followed industrialization, urbanization and industrialization have largely taken place independently in sub-Saharan Africa. As a result, employment was frequently unavailable within these centers. Demographically, the migrants tended to be young adult males who have a higher level of educational attainment than those who do not migrate. Women were not encouraged to migrate but later were forced to migrate to the urban centers for economic reasons. Unfortunately, because of the large number of migrants to the urban centers, unemployment and social disruption became common, and many individuals reverted to commercial sex for a means of survival (9). During this period, health officials noted marked increases in sexually transmitted diseases (STDs), including HIV-1 infection, within the urban centers.

One of the first studies to suggest migration of HIV-1 from a rural setting to an urban center was based in Zaire. In 1985 Nzilambi *et al.* (11) tested sera for HIV-1 that had been previously collected in 1976 during an Ebola hemorrhagic fever outbreak in the remote Equateur province of Zaire. Five (0.8%) of 659 specimens were positive, and HIV-1 was isolated from one of these. Follow-up investigation 10 years later revealed that three of the five seropositive persons had died of illnesses suggestive of AIDS and that two remained healthy but seropositive. In 1986 the seroprevalence was unchanged at 0.8% among 389 randomly selected residents in the same area. However, the seroprevalence of HIV-1 was 11% in 283 prostitutes in nearby cities. Similarly, a 10-fold increase in prevalence was documented in pregnant women between 1970 and 1980 in Kinshasa. The authors concluded that HIV infection was endemic and demonstrated long-term stability in residents of rural Zaire but that urbanization with its attendant social changes may have promoted the spread of AIDS in Africa.

A cluster sampling technique was used to document the difference in rural and urban HIV infection in other countries of Central and West Africa (Fig. 3) (12). The results of these studies have shown HIV prevalence rates below 1% in rural

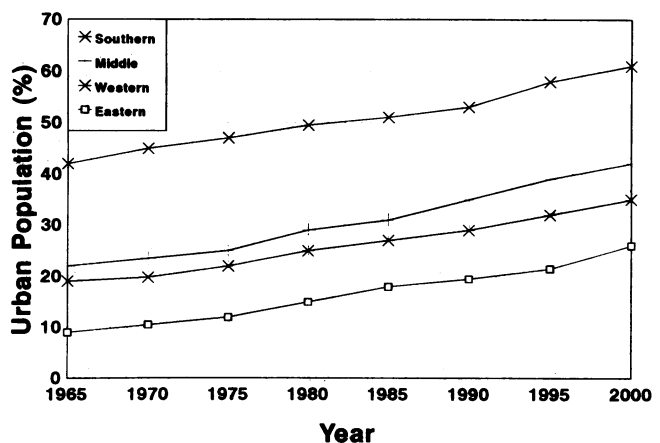


FIG. 2. Proportion of total population living in urban areas in sub-Saharan Africa from 1965 to 2000 (9, 10).

areas, with infection rates in the urban centers considerably higher. In Rwanda the HIV seroprevalence was 17.8% (14.3–21.2%) in an urban sample of 1870 and 1.3% (0.5–2.2%) in the rural sample of 742 individuals. More recent data, however, suggest that significant rates of infection are now occurring in rural areas due to return migration and other factors (14).

Other examples of population migration and spread of HIV are discussed below. Currently in Uganda there are an estimated 1 million HIV-infected individuals or 6% of the entire Uganda population. Three principal hypotheses have been proposed to explain the evolution of the AIDS epidemic and its distinct distribution throughout Uganda (15). In the “truck town” hypothesis, it has been proposed that the geographic distribution of HIV and AIDS reflects a diffusion process in which major roads act as principal corridors of virus spread between urban areas and other proximal settlements (16, 73). Truck drivers along these routes and commercial sex workers have been cited as potential vectors for the dissemination of HIV. In one study of 68 lorry drivers and their assistants, 24 (35.2%) were found to be HIV-infected (74). Epidemiologic evidence demonstrated a wide travel history involving seven different countries served by the port of Mombasa, including Kenya, Uganda, Zaire, Burundi, and Rwanda (17, 75). Second, the “migrant labor” hypothesis proposed that HIV diffused from areas of labor demand in urban areas to areas of labor supply in rural districts through a process of return migration (18, 19). A third hypothesis suggested that the dissemination of HIV-1 in Uganda correlated with ethnic patterns of recruitment into the Ugandan National Liberation Army after the overthrow of Idi Amin some 10 years earlier in 1979 (15, 20). In fact, probably all three hypotheses together help explain the spread of HIV within Uganda.

In addition to the movement of truck drivers and the military, female prostitutes, well recognized as a high-risk population for HIV infection, are also highly mobile. These women will frequently move from one locality to another due to economic pressures. For example, in South Africa, the migrant labor system created a market for prostitution in mining towns and established geographic networks of relationships within and between urban and rural communities (21). Industrialization, particularly the rapid growth of the mining industry with the migrant labor system it created, led to an epidemic of STDs among these populations (18). Gonococcal infections and syphilis have been documented in 10% and 17% of mine workers, respectively. Depending on the country of origin, HIV prevalence has varied from a low of 0.08% in residents of South Africa to as high as 17.8% in migrants from Malawi. Women who provide migrant mine

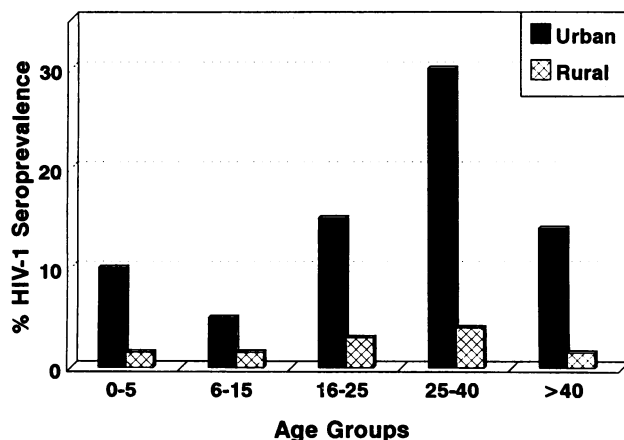


FIG. 3. HIV-1 seroprevalence by age in urban and rural samples in Rwanda and Zaire (12, 13).

workers with sexual services also come from socially and economically marginalized groups in rural and urban areas, many of whom also have a high rate of HIV infection and STDs, further potentiating the spread of both. These data illustrate one end of the spectrum of behavior where multiple partners and frequent partner change are common. This group may represent a “core” population involved in high-risk activity that acts as a major carrier of HIV (22).

The Effect on Demographics

The population pyramid in most African countries is symmetrical with a broad base and quite distinct from that observed in developed countries (23, 24). Interestingly, in urban areas one finds a prominent one-sided bulge caused by the migration of young males (age 18–35) into the cities for employment (Fig. 4). The prevalence of HIV infection in urban populations is highest in the 25- to 35-year-old bracket among males and in the 15- to 25-year-old bracket for females (13). This difference is due to the fact that on the average sexual partnerships are formed between older men and younger women. The distortion of the urban population profile caused by male migration results in an overall 1:1 female-to-male prevalence ratio of infection. However, as the epidemic spreads into the larger rural population, the absolute size of the most severely affected younger female population is larger than the size of the older male population, which eventually results in a higher number of infections in women. This excess in female morbidity from HIV infection has important implications for the social and economic role of women in society (13, 23–26). It also adds fuel to an emerging epidemic of pediatric AIDS.

HIV-2 and West Africa

By 1986, HIV-2 infection was recognized among high-risk groups in West Africa. While related to HIV-1 in terms of morphology, cell tropism, and overall genetic organization, HIV-1 and HIV-2 differed significantly in terms of nucleotide sequences, with only 42% homology (27, 28). These genomic studies further demonstrated that HIV-2 had 70% or more homology with the simian immunodeficiency virus, suggesting that HIV-2 may be evolutionarily more closely related to Simian immunodeficiency virus, a nonhuman primate retrovirus, than to its other relative, HIV-1. A common ancestor with similar properties and pathogenic potential may have existed a long time ago, and the emergence of the AIDS epidemic was more likely a result of simultaneous modifications of epidemiologic parameters in West and Central Africa, such as rapid urbanization, leading to the infection of larger populations with HIV-1 and HIV-2 (14, 26, 29).

International migration across national boundaries also played a role in the movement of populations and HIV-2 infection from one country to another. Of the 35 million sub-Saharan African migrants, ≈5.4 million are officially recognized refugees (29, 30). International migrants include those seeking employment, family members accompanying or joining those who have migrated before them, and people seeking refuge from drought, famine, political upheavals, or military conflicts. The highest concentration of migrants is found in western Africa, an area that migrants have considered as an economic unit where trading goods and services flowed freely, as did people (29). Over the past two decades, Côte d'Ivoire has become a major center for migrants from Burkina Faso, Mali, Guinea, Ghana, Niger, and elsewhere. Foreigners who were 22% of the total population in the 1975 census are now nearly 30%, giving Côte d'Ivoire by far the highest concentration of foreigners in sub-Saharan Africa (29). The second highest concentration is in Gambia, where migrants, who are about 11% of the total population, include

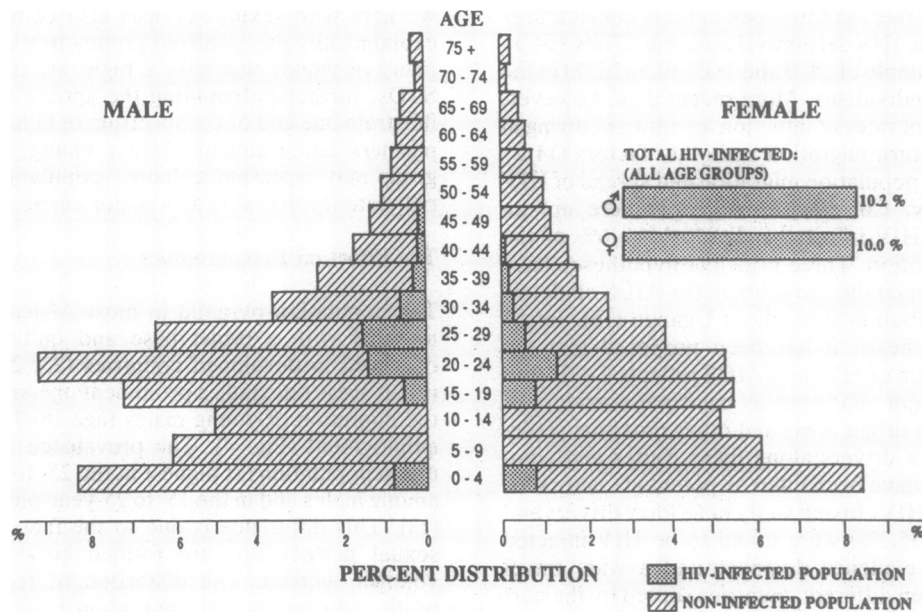


FIG. 4. Generic urban population pyramid: HIV-infected and noninfected population (23). The prominent bulge on the male side starting at age 20 is related to increased male migration from rural to urban centers, with resultant increase in overall HIV seroprevalence. Note that HIV-1 seroprevalence is higher in the younger females and in older males, a phenomenon common to epidemiology of STDs, reflecting the cultural phenomenon of older men having sex with younger women.

individuals from Senegal, Guinea, Guinea-Bissau, and Mali. Interestingly, migration to Nigeria has also increased substantially during the 1980s as a combined result of Nigeria's oil boom and the protocol on freedom of movement signed in 1980. The majority of migrants were from Ghana, Togo, Benin, Niger, and Chad.

Serologic surveys for HIV-2 have demonstrated high rates of infection among several countries of West Africa. Moderate to high rates of infection have been found in urban areas of Senegal, Guinea-Bissau, Guinea, Burkina Faso, Ivory Coast, Gambia, and Cape Verde (31-36). Interestingly, significant rates of HIV-2 infection have been reported in Angola and Mozambique, two countries located in southern Africa (33). These countries were formerly Portuguese colonies and maintain ongoing relationships with countries in West Africa such as Guinea-Bissau and Cape Verde, which were also Portuguese colonies. In contrast, HIV-2 has rarely been reported from other countries of Central Africa. In Guinea-Bissau and Gambia, HIV-2 is prevalent and HIV-1 is rare. In Ivory Coast and Burkina Faso, HIV-2 and HIV-1 are both present in an appreciable proportion of the population.

Differences in these patterns of infection are likely to be consequences of different types of interrelations and contacts within West Africa, where HIV-2 predominates, and between West Africa and Central Africa, where HIV-1 predominates. In general, it seems likely that the migration of sexually active, high-risk populations played a major role in the observed spread of these sexually transmitted viruses in these countries. One example is seasonal migration of young men and women in Senegal and Gambia. In one study by Pison *et al.* (37), of 3230 persons residing in rural Senegal, 0.8% were HIV-2 and 0.1% were HIV-1 seropositive. Seropositivity was directly associated with seasonal migration, history of blood transfusion, injections, and STDs.

In a study by Kanki *et al.* (38), of 278 female prostitutes from Ziguinchor, Senegal, HIV-2 seroprevalence was associated with women of Guinea-Bissau nationality and increased years of sexual activity. The acquisition of either HIV infection may have occurred in Senegal or in their country of origin. In addition, Ghanaian and Gambian prostitutes report that they migrate and work in a number of other

West African countries (39, 40), such as Burkina Faso, Ivory Coast and Mali, all countries with significant HIV-2 prevalence.

Within the last few years, investigators have noted the introduction of both HIV-1 and HIV-2 infection among certain high-risk populations in Nigeria. Although relatively spared during the early 1980s, several surveys have documented increasing rates since 1990 throughout Nigeria (41, 42). This is of critical importance since the population in Nigeria, estimated at 110 million people, represents 25% of the total population of sub-Saharan Africa. In one recent study by Dada *et al.* (42), 12.3% and 2.1% of 885 females prostitutes were infected with HIV-1 and HIV-2, respectively, a rise from a combined prevalence of only 1.7% 2 years previously. Women in the youngest age group, age 12-19, had the highest prevalence (20%). Furthermore, HIV-2 infection was significantly associated with low socioeconomic class and non-Nigerian nationality. The finding that both HIV-1 and HIV-2 are present in this population suggests that both infections are spreading within Nigeria but at differential rates. Foreign female prostitutes may represent one group responsible for the introduction of HIV-2 into Lagos. In addition, prostitutes residing in the port area of Lagos, which serves as a major convergence of overland and sea routes within and outside Nigeria, had the highest prevalence of HIV-1 infection. The federal highway region that is traversed by the overland interstate highway also had high rates. Because Lagos is the largest cosmopolitan city in Africa, there is constant migratory movement of people into and out of Lagos and a major trade center, thereby providing opportunity for further HIV dissemination.

Spread of HIV-2 Outside of West Africa

Because HIV-2 infection has been relatively confined to West Africa, its appearance in other areas generally reflects epidemiologic links to West Africa. The greatest number of cases have been reported in Portugal, France, and Germany (31-34). The cultural and economic ties between Portugal and its former colonies may have enhanced the spread of HIV-2 to Europe and possibly to Brazil, a former Portuguese colony

(43). Although most countries can link the presence of HIV-2 within their country to ties with West Africa, France and Portugal now report HIV-2 infection among the indigenous population (32, 34). In Portugal, 60% of HIV-2 cases are no longer directly linked to West African contacts. In France, 13% of cases are not directly linked to West Africa.

In the United States, the first reported case of AIDS caused by HIV-2 was reported in December 1987 in a West African residing in the United States (44). The number of HIV-2 infections documented in the United States has since risen to 32 (45). In all cases for which a history has been available, the infected individuals have previously lived in West Africa or have been sexual partners from that region. Geographically, 28 of the 32 persons with HIV-2 are from the northeastern United States. Thus far, there have been no cases of HIV-2 among i.v. drug users or homosexual men. Nevertheless, because of its presence, the Food and Drug Administration recommended in June 1992 that all blood donations should be screened for both HIV infections (46).

Reports from India now suggest the appearance of HIV-2 infection predominantly in the Maharashtra state, particularly Bombay and Pune (47, 48). Several studies have suggested that HIV-2 may represent between 3% and 7% of all HIV infections in Bombay. In other studies in Maharashtra State, HIV-2 infection, while noted, has not increased appreciably during the past 3 years. Genetic sequence analysis of these strains of HIV-2 has not been completed, and their linkage to West Africa, while suggestive, needs further evaluation.

HIV-1 in the Americas

The United States has the highest number of reported AIDS cases worldwide, with over 339,000 cases and nearly 200,000 fatalities as of October, 1993 (49). During the 1980s HIV infection emerged as one of the leading causes of death in the U.S. In 1992, HIV infection was the leading cause of death among men aged 25–44 years and the fourth leading cause of death among women in this age group, accounting for 19% and 6% of deaths, respectively (2). In 1992, heterosexual contact accounted for the largest proportionate increase in AIDS cases compared to 1991 (17.1% in reported cases) (Fig. 5). The proportionate increase in cases attributed to heterosexual contact was greater for men (26.3%) than for women (11.5%); however, women accounted for most persons infected through heterosexual contact (15.9%) (49). The second largest proportional increase was in perinatal transmission

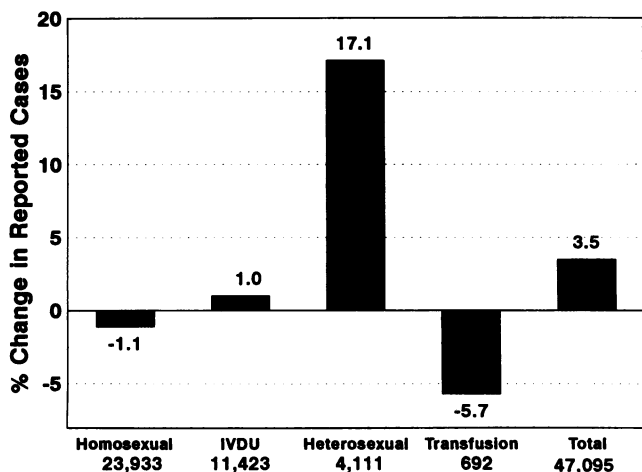


FIG. 5. Proportional change in AIDS cases reported to the Centers for Disease Control for 1992 compared to cases reported in 1991, by HIV exposure category (49). IVDU, i.v. drug users.

(13.4%). In 1992 the number of AIDS cases among women infected through heterosexual contact exceeded those infected through i.v. drug use for the first time.

While anecdotal cases of sexual clusters have been documented, rapid travel within the United States soon blurred any strong epidemiologic associations with travel. However, there are situations in the United States that are similar to the issues of migration described for Africa, which fueled the spread of HIV in the rural areas of the United States. One area that can be used as an analogy to the migrant workers in Africa is Belle Glade, Florida (50, 51). Between 1985 and 1988 alone, the prevalence of AIDS in Belle Glade quadrupled from 188 to 806 cases per 100,000 persons. Most of the spread of HIV was related to sexual intercourse, i.v. drug use, and low socioeconomic status. Socioeconomic conditions seen among the migrant population of Belle Glade date back for the past 50 years and are responsible for epidemics of STDs. Crowded living conditions, poverty, varying access to health care, and other resulting factors promote HIV transmission in Belle Glade much as they did syphilis 50 years before (50).

In a study in rural South Carolina (52), 25 (13%) of 198 migrant workers were HIV antibody positive and 32 (16%) had a reactive serologic test for syphilis. Of 166 workers who reported the frequency of condom use, 77 (46%) indicated they never use condoms. Similar to Belle Glade, rural South Carolina migrant workers also demonstrate behaviors that place them at risk for HIV infection and other STDs. In one study in North Carolina in 1987, 2.6% of 426 migrant workers were HIV seropositive (53). Persons positive for syphilis had higher rates of HIV infection (5.6%) than those who did not (2.2%). Estimates of the prevalence of HIV infection in other migrant and seasonal farm workers are limited. The transience of this population makes it difficult for health care workers to assess the health status of these persons, who frequently do not have access to health care.

In the Americas outside of the United States, HIV-1 infection has been predominantly documented among homosexual/bisexual men who initially had sexual relations with individuals from the United States. Subsequently indigenous transmission has evolved, and there is increasing evidence for heterosexual transmission within many Latin American countries (54). One aspect of HIV transmission throughout the region has been the documented high rate of infection among female prostitutes who provide their services in different countries. In one study of 80 international prostitutes who traveled to 27 countries, 38 (49%) were HIV seropositive, which was considerably higher than that of the general population (1%), homosexual men (10%), or local prostitutes (2%) in Dominica, their country of origin (55). In view of the low prevalence of HIV in nontraveling Dominican prostitutes, these women were probably infected outside of the country. Nevertheless, many of them returned to their home, resulting in further spread within their home country.

HIV Infection in Southeast Asia

HIV was introduced relatively late into Asian countries. The first few cases of HIV infection were not documented until 1985, and it was not until 1988–1990 that the transmission of HIV escalated to epidemic proportions (56). A 1985 serosurvey of 600 individuals in Thailand including prostitutes, i.v. drug users, and STD patients revealed a very low HIV-1 seroprevalence (<0.5%) (57, 58). However, by 1988 HIV-1 began to spread rapidly among i.v. drug users to a prevalence of 40%. Seroconversion rates were as high as 3–5% per month (59). This wave of the HIV epidemic in i.v. drug users appears to be followed by one among female prostitutes. The National Sentinel Survey conducted 1 year after the spread of HIV among i.v. drug users showed that about 44% of lower-class prostitutes in Chiang Mai were infected with

HIV-1 (56). Nationally, the HIV seroprevalence among prostitutes increased steadily from 3.7% in 1989 to 15% in 1991 (Fig. 6). This was followed by successive waves of transmission into male clients of the prostitutes and from them into the wives and girlfriends of these men in the general population. Based on the current available data, it is estimated that there are 450,000 HIV-infected persons in Thailand, or 0.8% of the Thai population of 55 million (56). If this rate of HIV transmission continues, there will be 2–4 million cumulative HIV infections by the year 2000 (7).

Factors that contributed to HIV transmission included Thailand's commercial sex industry, international tourism, and i.v. drug use. The majority of commercial sex workers are 16- to 24-year-old females from poor, rural areas who enter the activity to remit money back to parents and siblings. Temporary affiliation with commercial sex trade has gained legitimacy in poor regions as a means of addressing the indebtedness of rural families (60). The circulatory nature of rural–urban migration as well as the substantial patronage of the sex industry by international tourists fueled HIV transmission throughout Thailand and neighboring countries. Similar factors are involved in the spread of HIV among i.v. drug users. Poverty in the rural regions leads to dependence on the opium trade, and opium consumption became an integral part of the East Asian culture. When opium was banned in 1958, heroin injection became widespread. It is not known epidemiologically how and from where HIV originally entered the country because of the large amount of international travel by both foreigners and Thai nationals to and from all regions of the world. In 1989 alone, Thailand recorded 25,573 tourist arrivals of residents of Africa, 340,011 from the Americas, and 1.1 million from Europe (61).

Genetic analysis of strains isolated from individuals in Thailand recently enabled investigators to epidemiologically link two distinct genotypes of HIV-1 (62, 63). Of 29 sexually infected patients, 25 (86%) had HIV-1 strains of genotype A and 4 (14%) had genotype B (62). Among 29 i.v. drug users, only 7 (24%) had genotype A and 22 (76%) had genotype B. This segregation is unlikely to have arisen by chance ($P < 0.001$). No patient was found to have dual infection. Nucleotide divergence averaged 3.4% among genotype A-infected patients and 3.5% among genotype B-infected patients, but it averaged 22% between the genotypes.

The low nucleotide divergence among people infected with the same HIV-1 genotype in Thailand is consistent with epidemiologic findings that widespread HIV transmission in Thailand has occurred only since 1988. This genetic homogeneity contrasts profoundly with the substantial diversity among HIV-1 strains from infected people in all other coun-

tries reported so far (62). The high nucleotide divergence between these two genotypes also suggests that the two variants resulted from separate, independent introductions into Thailand and that they did not evolve from a common progenitor virus already present in the country. Evolution from a common ancestor with an annual divergence of 0.5–1.0% in the C2-V₃ region of the *env* gene would have taken a minimum of 20 years (64). A continuous spectrum of intermediate strains would also be expected.

One possibility for the association of these two genotypes with behavior may be biologic—i.e., that genotype A is more efficiently sexually transmitted whereas B is more efficiently transmitted parenterally. Another possibility is that these associations are purely epidemiologically linked, demonstrating the introduction of a genotype into one high-risk group, which is distinct from another risk group in which a second genotype has been introduced. The presence of these two major distinct HIV genotypes in Thailand provides a unique opportunity to study the transmission efficiency of these strains (62, 63).

Similar increases in HIV infection have also been documented in India and Myanmar. In the northeast Indian states of Manipur, none of 2322 i.v. drug users seen from 1986 to 1989 were seropositive for HIV. However, the rate increased to 54% during the period October 1989 to June 1990 (65). In Bombay, HIV seropositivity rates among prostitutes increased from 2% in 1988–1989 to nearly 40% in 1991 (Fig. 6). In Vellore, the HIV seroprevalence among prostitutes increased from 0.5% in 1986 to 34.5% in 1990 (66). These marked increases of HIV in India are of concern since India is the most densely populated country in Asia with 858 million people. An estimated 1.0 million people have already been infected in India within the past 6 years, and if unchecked this number could increase dramatically, exceeding even the number of HIV infections in Africa. As is the case in Thailand, it is not entirely clear how HIV was introduced into India, although it is apparent that high rates among prostitutes were established rapidly in the port city of Bombay, and high rates of HIV infection among i.v. drug users were documented in Myanmar, part of the “golden triangle” for heroin exportation (65).

Genetic sequencing similar to that described for Thailand has also been carried out on infected patients from Bombay and Goa. Several isolates appear to be related to a South African “clade C” strain and others to the Thai “clade E” strain (67). This is not surprising since there are strong cultural and educational ties between South Africa and India, and workers migrate between Thailand and India. As in previous reports the sequences within each clade were found to be quite homologous to each other, suggesting a recent and fast-spreading epidemic. From these preliminary data, it is likely that HIV infections will continue to increase throughout the next decade in Asia. The annual number of HIV infections by the year 2000 will far exceed that seen in sub-Saharan Africa. Projections are that in India 3 million people may be infected by 1996 and 20 million by the year 2000 (7).

Legal Restrictions

Whether real or imagined, the threat of increased risk of spreading HIV infection and AIDS through international population movements has resulted in restrictive reactions by some governments (68, 69). However, mandatory screening of international travelers is unlikely to reduce the rate of spread of HIV within countries. This would be true even for a country that has no HIV infection, assuming that the nationals traveling abroad would have to be readmitted even if they tested positive. The dilemma of how to protect simultaneously the public health and the rights of individuals

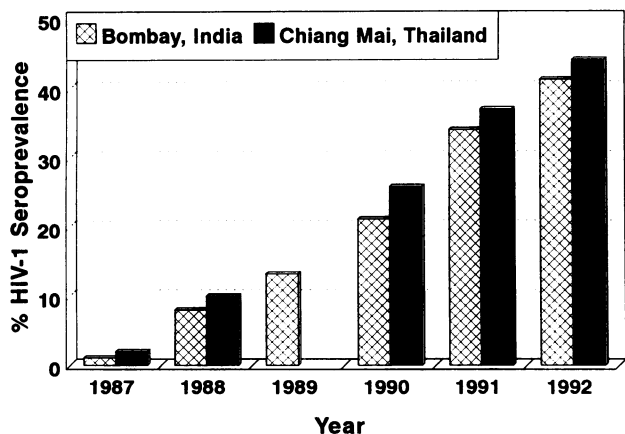


FIG. 6. Seroprevalence rates among commercial sex workers in Thailand and India from 1986 through 1992 (data from Center for International Research, United States Bureau of Census).

and social groups believed to threaten public health is not easily resolved. Policies that would restrict international movement or discriminate against travelers to prevent the spread of HIV do not address the real problems facing the control of HIV infection worldwide (69).

Conclusions

While intense educational efforts need to be focused on behavioral change as one key to preventing further spread, fundamental social change will be required if AIDS control efforts are to succeed. The migration of poor, rural, sexually active young people to urban centers in the Third World clearly played a role in the dissemination of HIV and other infectious diseases. Major causes of such population movement such as migrant work and/or political repression are social problems that extend well beyond the behavioral factors that result in interpersonal spread of HIV (Table 2). Increasing mobility has serious implications for the control of AIDS and this phenomenon cannot be fully addressed without profound social, cultural, and economic changes that lie at the root of the problem (70, 71). Unfortunately, the situation is compounded by the economic recession and debt crisis witnessed in many African countries. Violent protests and further civil disruption have occurred in Liberia (1979), Sudan and Tunisia (1985/86), Zambia (1987, 1990), Algeria (1988), Nigeria (1988/89), Ivory Coast (1990), and Zaire (1992). Twenty-four countries in sub-Saharan Africa with a total population of over 400 million were worse off in terms of average income per capita at the end of the 1980s than at the beginning of the decade (23, 25). In summary, the economic recession has further aggravated the transmission of HIV in Africa and Asia by directly increasing the population at risk through increased urban migration, disruption of rural families, poverty, women's subordinate status in society, and prostitution and indirectly through decrease in health care provision (72). The latter entails not only reduced facilities to care for patients with AIDS but also less effective diagnosis and treatment of STDs and decreased spending on health education programs.

The current AIDS epidemic in developing countries is inextricably linked to socioeconomic and political factors, both current and historical. To control the AIDS epidemic, countries will need to not only promote individual behavior change but also address the related problems of increasing landlessness, mounting unemployment, accelerated urbanization, prostitution, rapid decline in health services, and drug abuse in order to control its spread (Table 2). It is

Table 2. Factors associated with HIV dissemination

1. *Population migration.* Internal and international with >35 million people in Africa moving from one area to another
2. *Urbanization.* Migration of poor, sexually active young people from rural regions to cities in search of employment
3. *Social disruption.* Changes in social and cultural values secondary to migration from families or from political repression and civil disruption
4. *Poor medical services.* Less effective facilities for diagnosis and treatment of increasing medical problems associated with urbanization and a failing economy
5. *Declining economy.* Overall decrease in average income per capita, resulting in increased migration and prostitution
6. *Low social status of women.* Difficult to obtain educational opportunities, less training for skilled labor, and consequently fewer economic possibilities, resulting in increased prostitution
7. *STD epidemic.* Many of the factors above contributed to further spread of STDs, particularly genital ulcers, which facilitated HIV transmission

evident that the success of such AIDS control initiatives will be limited if they fail to confront such fundamental structural issues.

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