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The Dynamics of the AIDS Epidemic in Brazil: A Space-Time Analysis in the Period 1987-1995

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The dynamics of the spread of the AIDS epidemic in Brazil have been studied by an analysis of cases reported between 1987 and 1995. The analysis evaluates characteristics of the epidemic as it changed over time, geographic region and special sub-populations affected. Data collected by the National Coordination of sexually–transmitted diseases (STD's) and AIDS of the Health Ministry were reviewed and incidence rates calculated. Three periods of time were identified (1987-89, 1990-92, and 1993-95) and the distribution of cases by age group, sex, risk factor sub-population, and major geographic region recorded. Several observations can be made from this information: 1) The disease began among homosexual / bisexual males in large metropolitan areas of the southeast of Brazil. 2) It spread to other risk groups such as intravenous drug users (IDU) and recipients of blood products. 3) The diseases increased rapidly between 1987-89 and 1990-92, but then showed a plateau, particularly in the homosexual / bisexual group. 4) Increase in cases persisted in the IDU group. 5) The incidence among heterosexuals and in smaller municipalities has continued to increase indicative of a shift in the dynamics of the epidemic. The shift in the characteristics of the epidemic away from special groups and towards the socially vulnerable, poorly educated, heterosexual, smaller municipalities require new preventive strategies adaptable to regional patterns of each social structure, economy and culture.

Key Words: AIDS, epidemiological patterns, epidemic.

With more than 120,000 cumulative AIDS cases in 18 years of systematic report [1], the HIV / AIDS epidemic is presently a phenomenon of the greatest magnitude in Brazil. The first case in Brazil was registred in the city of São Paulo in 1980. This initial case was followed by others, confined almost entirely to the major cities, São Paulo and Rio de Janeiro, and the patients were most commonly in special sub-populations, including male homosexuals, bisexuals, hemophiliacs and others who received blood or blood components. Due to the fact that hemophiliacs regularly received blood components from a donor pool, this population segment was quickly and profoundly struck starting at the beginning of the epidemic, and having HIV infection rates among the highest ever recorded [2]. The issue of poor blood quality control, shown previously relation to other blood-transmitted pathogens, such as viral hepatitis, has developed, with the onset of HIV/AIDS, a very dark complexion [3]. Public discontent plus the action of various regional supervisory groups led to important changes in the pattern of HIV transmissions due to administration of blood and blood products. This was seen primarily after 1986 with the availability of tests for detection of anti-HIV antibody. Ever since, a substantial decrease in AIDS cases belonging to this category has been observed, although there are relevant exceptions still.

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With the first registred case of infection in an intravenous drug user in 1982, also in the city of São Paulo, this category became an important route of disease transmission associated with transfer of blood components, responsible at present for about 20% of the accumulated cases in the country [4].

In regard to sexual transmission of the virus, it is observed that after extensive initial spread of the disease among homosexual males, there was a certain plateau in latter years of the epidemic. This plateau was especially noted among those men belonging to the middle class, a segment that was severely affected in the beginning of the epidemic. The plateau in this group was associated with a relevant social mobilization and behavioral changes by use of safer sexual practices [5]. The same cannot be said for other population groups, such as infection and disease secondary to heterosexual transmission. Associated with heterosexual transmission, the frequency of cases among women increased substantially during the 80's, and has continued to be a major problem in the present decade.

The HIV/AIDS epidemic in Brazil has acquired during these two decades of the epidemic a clearly nationwide dimension, with high incidence rates in almost all states of the country, but associated with marked regional heterogeneicity. More precisely, the present epidemic can be considered as a sum of regional subepidemics influenced by migration cycles and population dislocation.

The same heterogeneicity of population segments and regions affected more or less profoundly by the HIV/AIDS epidemic, in a country characterized by important structural differences regarding its standard of wealth distribution and access to health services, and important impairments in policies of health care [6], makes thorough surveillance of epidemic indispensable.

Although limited by the considerable time lag between HIV infection and the indentification and recording of AIDS cases, research based on the cases recorded by the National Coordination of STDs and AIDS of the Ministry of Health are an essential component of a broad evaluation of the dynamics of epidemics. This data, together with a group of sectional prevalence studies developed in specific segments such as intravenous drug users [7], sex professionals [8], and patients in health care centers [9] provides an overview of the epidemic. In addition, a few studies of seroincidence [10], including surveillance studies or survey of broad population groups, with certain general characteristics, such as the military, women undergoing prenatal care, blood donors, among others [11] have allowed completion of the characteristics of the epidemic.

The present work analyses the spatial patterns of spread of AIDS in Brazil, using the available data in the National Notification System, and targets for analysis space-time tendencies according to municipality, sex, age group and risk-factor category to which the recorded cases belonged in the 1987-1995 period.

Material and Methods

For the analysis developed in this work, the data source was the recorded cases in National Coordination on STDs and AIDS of the Ministry of Health. All notified cases that were 15 years of age and over were considered if their year of diagnosis was in the period from 1987-1995. For calculation of the incidence rates, the denominators were estimated by geometric interpolation from census data of 1980 and 1991, and of census populations from 1991 to 1996 for the years of 1992 to 1995.

For the follow-up of temporal evolution of incidence rates, average rates were estimated for period of 3 year including the years 1987-89, 1990-92 and 1993-95. The percent changes in disease rates were calculated by comparing the relative increase or decrease in incidence rates from one period to another, expressed in percentile. Yearly variation rates and geometric increase was adjusted to a three-year period.

The analysis was performed with attention to categories of sex, age group (15-29 yrs., 30-39 yrs. 40 and over), and type of risk-factor exposure. The following categories were considered: "homo-bisexuals"-constituted by the categories "homosexual"

and "bisexuals"; "heterosexuals"- constituted by the category "heterosexuals"; intravenous drug users (IDU) - constituted by the category "IDU", and the multiple category "IDU and heterosexual"; "IDU and homo/bisexual"-constituted by the multiple categories "IDU and homosexual" and "IDU and bisexual"; "blood"- constituted by the categories of "hemophiliacs" and "transfusion"; "data missing"- constituted by the category "data missing"; "others"- constituted by all other categories.

Regarding geographic features of the analysis, two distinctions were made. The first targeted study of spread of the epidemic over time according to the traditional division by large regions of the country. The second approach was made using the categorization of population size of each home municipality (0-50,000 inhabitants; 50,001-200,000 inhabitants; 200,001-500,000 inhabitants; 500,001-1,000,000 inhabitants; more than 1,000,000 inhabitants), which allowed us to evaluate the spread of the epidemic from the great urban centers to the small towns.

Results

AIDS incidence rates according to age group, sex and time period, calculated based on 100,000 inhabitants, are presented in Table 1. The preponderant category is, clearly, the 30-39 yrs in both sexes and any time period. The other two age groups are similar in relation to the magnitude of incidence rates, although the 15-29 yrs. group has slightly higher rates in all considered periods.

From the first to the second period (1981-89 to 1990-92) among individuals who were 15 years of age and over, the incidence increased approximately 150%, or, expressed in another way, 35% per year. From 1990-92 to 1993-95, the rate of increase was slower, i.e. 12.5% per year (Figure 1). It was noticed that the decrease in slope was much greater among male AIDS cases. While among men the annual increase changed from 33% to 9%, among women it changed from 52% to 26%. The disease rates in both sexes, decreased with the temporal evolution of the epidemic. However, the ratio between males and females went from 8.3 in 1981-89 to 5.6 and 3.7 in the following periods, indicating a higher relative frequency among females.

Regarding age groups, the youngest (15 to 29 yrs) showed the greatest relative increase from the first to the second time period; 37% per year. Nevertheless, in the 90's, this age group is the one presenting the least increase; 9% per year, in comparison to the 30-39 yrs and 40 and over, which had annual rates of 15% and 14%, respectively.

The analysis of the data shown in Table 2 indicates the preponderance of the "homo/bisexual" category among men 15 years old and over, followed by the "heterosexual" and "IDU" categories, which have similar rates of disease in the 1993-95 period. Among those 15-29 years old, though, the IDU category is the most important one.

Among women, the behavior is different, the IDU category being the least important. In all age's groups, the relative incidence rate of heterosexual transmission is much greater than the rate relative to IDU transmission, in a ratio of 3.2:1. Among younger women, the ratio decreased to 2.6 while in the older ones it increased to 7.6.

It is worth indicating that in the 15-29 yrs age group, we saw the smallest incidence ratio between male and female genders (2.9:1). In particular, the frequency of females in the heterosexual category was greater than males in this age group.

Figure 2 shows a comparison between percentages of AIDS incidence rates among individuals 15 years old and over by category from the second time period (1990-92) to the last (1993-95). In both sexes, the heterosexual category is the one with greatest slope, with increases up to 200% or 44% yearly. In second place is the IDU category, with an approximate increase of 25% from one period to another, corresponding to 8% yearly. On the other hand, the homo/bisexual category demonstrates, if not a decrease, at least stability, from which we can conclude that the tendency of the epidemic is to show an absolute preponderance of heterosexual cases. As expected, transmission by blood products diminished more in males than in females.

Table 1. Incidence rates (per 100,000 inhabitants) of AIDS according to age, sex and time period. Brazil 1987-1995.

Age group (year)	Sex	Time period		
		1987-1989	1990-1992	1993-1995
15-29	M	6.6	16.0	19.2
	F	1.0	3.7	6.6
	T	3.8	9.8	12.8
30-39	M	14.4	34.7	48.8
	F	1.5	5.4	11.7
	T	7.8	19.7	29.8
≥40 years	M	6.2	13.0	17.7
	F	0.6	2.0	4.2
	T	3.3	7.3	10.7
≥15 years	M	8.1	19.0	25.0
	F	1.0	3.4	6.8
	T	4.5	11.0	15.7

Table 2. Incidence rates (per 100,000 inhabitants) of AIDS by exposure category, age, and sex. Brazil 1993-1995

Age group (year)	Sex	Exposure category				
		Homo/bisex	Heterosex	IDU*	IDU and homo/bi	Blood rec.**
15-29	M	14.5	8.5	19.2	3.0	0.8
	F	-	10.9	4.2	-	0.3
	T	7.2	9.7	11.6	1.5	0.6
30-39	M	49.3	26.7	30.4	6.3	1.5
	F	-	19.0	5.9	-	0.9
	T	24.0	22.7	17.8	3.1	1.2
≥40	M	19.6	12.1	4.2	1.1	1.0
	F	-	6.8	0.9	-	0.8
	T	9.4	9.3	2.5	0.5	0.9
≥15	M	23.8	13.7	13.7	2.6	1.0
	F	-	11.2	3.4	-	0.6
	T	11.6	12.4	9.8	1.5	0.8

* IDU = injecting drug user.
** rec. = recipient.

Figure 1. Rate of relative increase (%) for age-groups and sex for years 1987-1989 to 1990-1992 and years 1990-1992 to 1993-1995

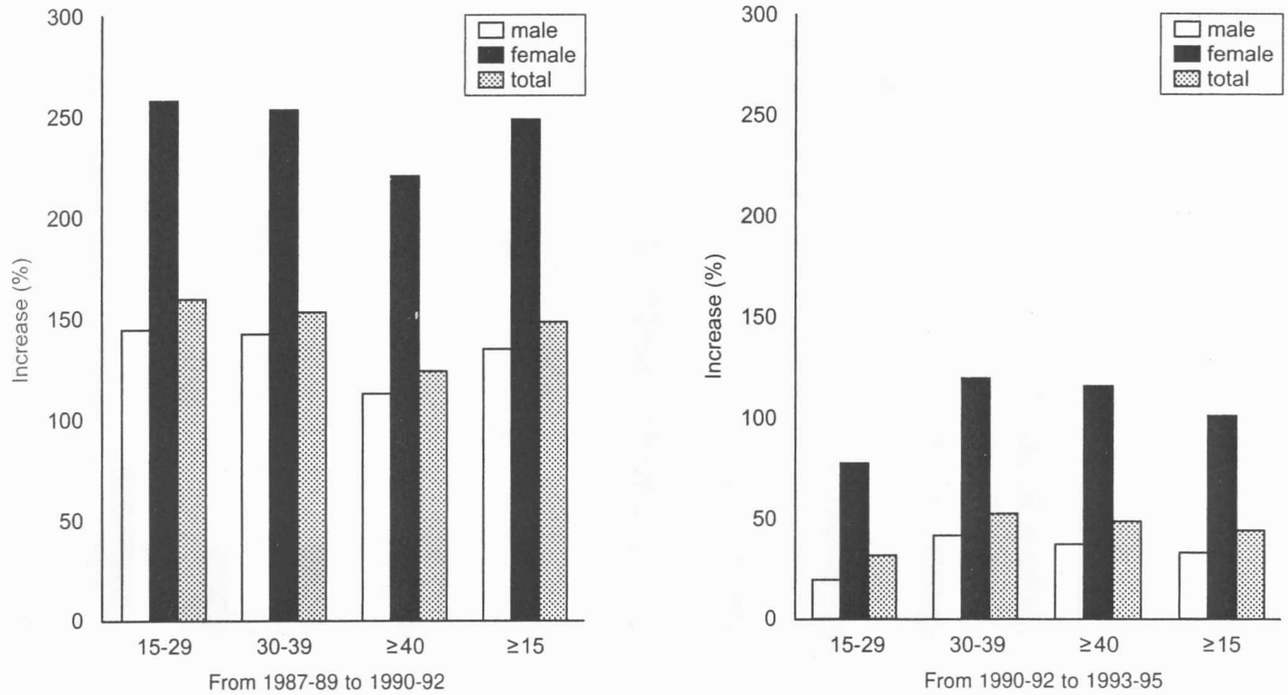

Figure 2. Relative rate of increase (%) by exposure category, age and sex

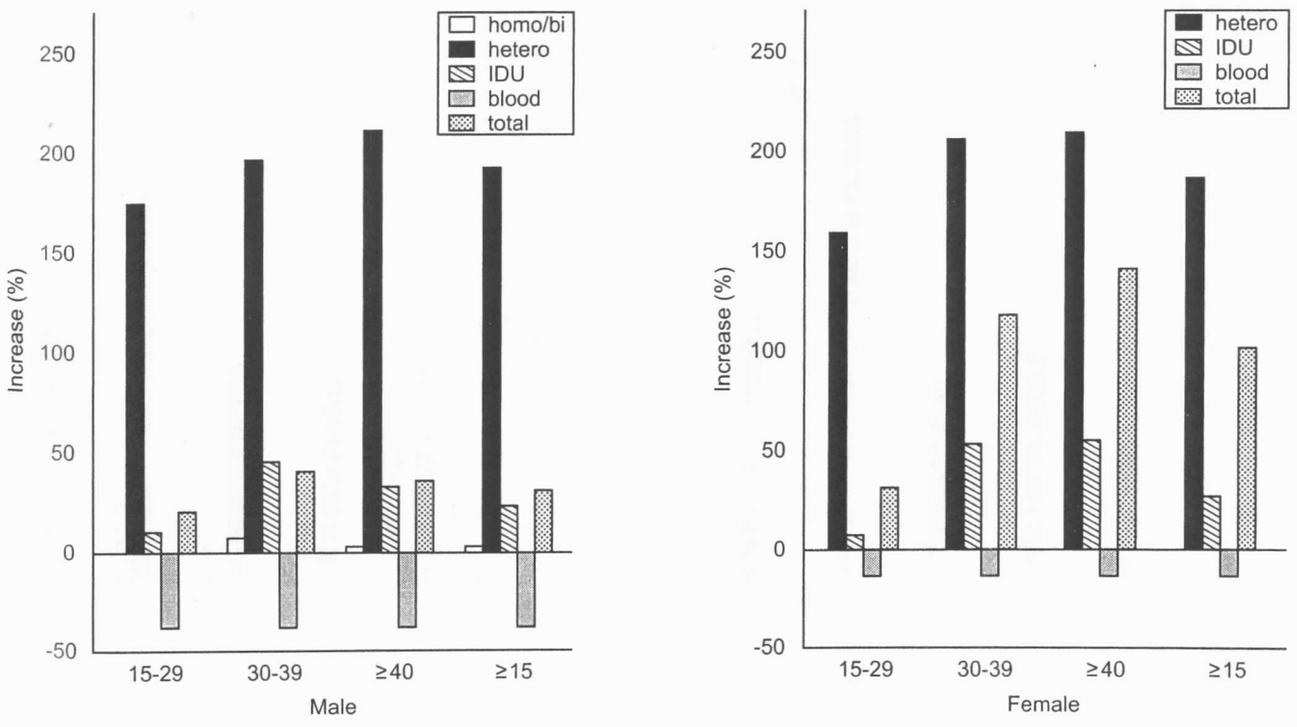

Figure 3. Rate of relative increase (%) by sex by large regions (Brazil)

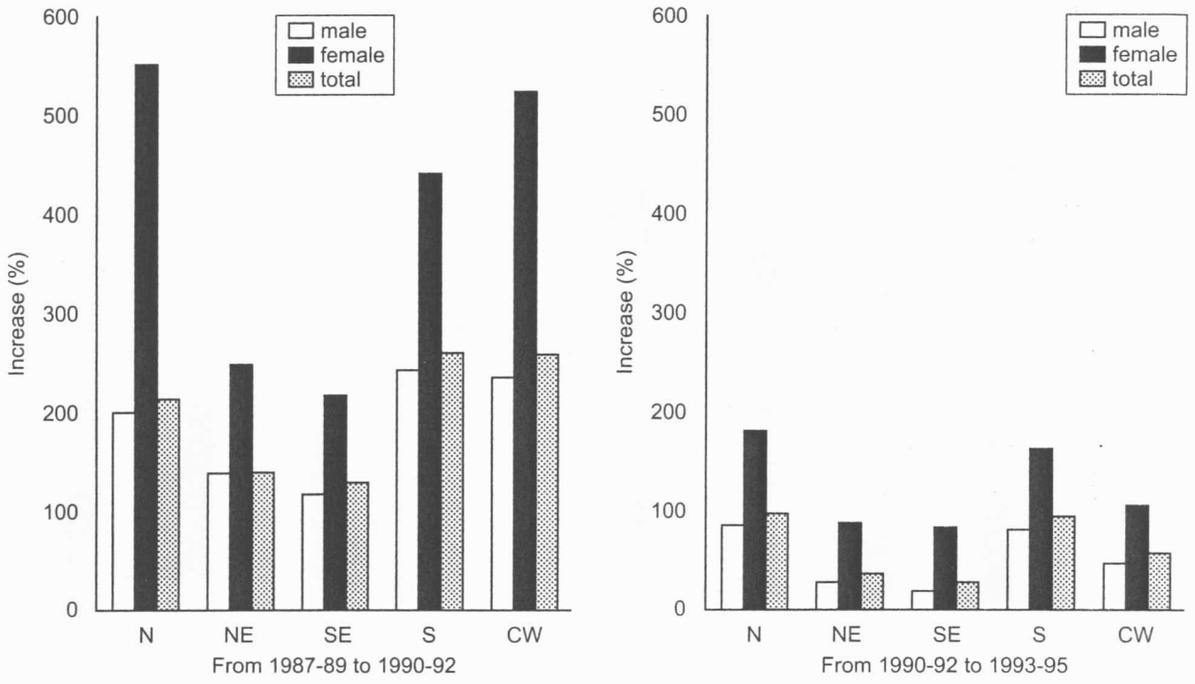

Figure 4. Rate of relative increase (%) by exposure category, sex and large regions (Brazil)

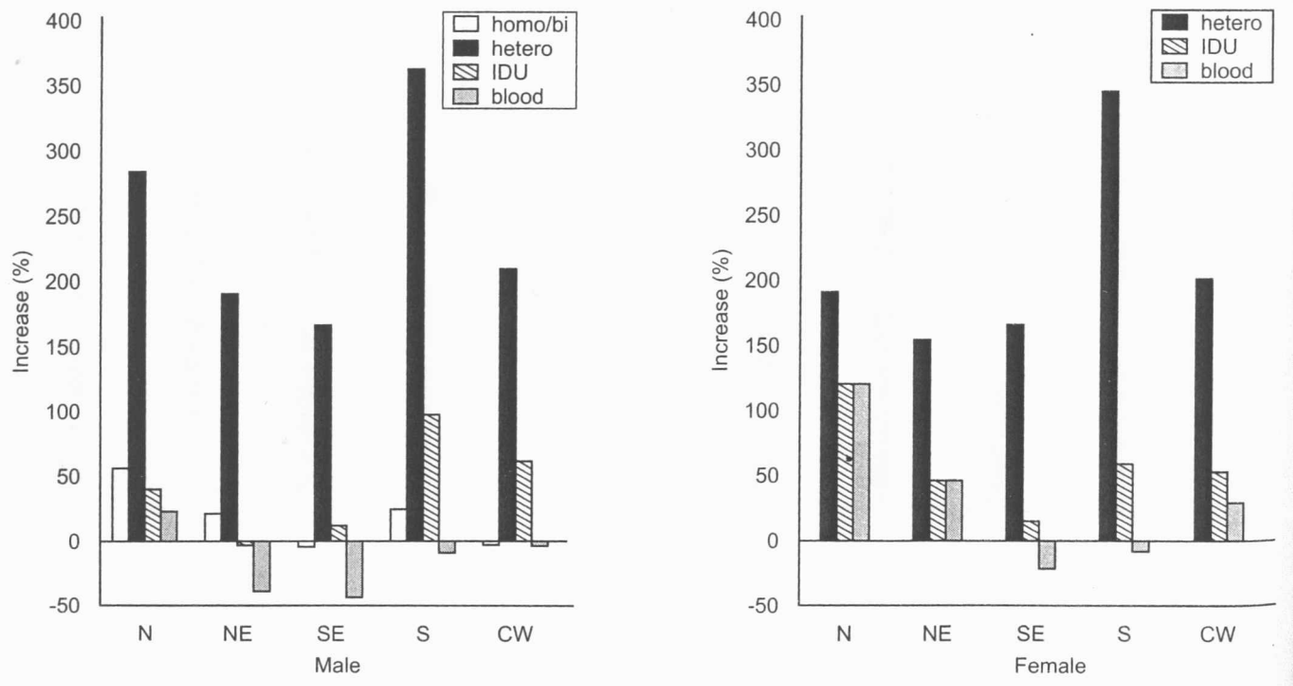

Figure 5. Rate of relative increase (%) by exposure category, sex and population size

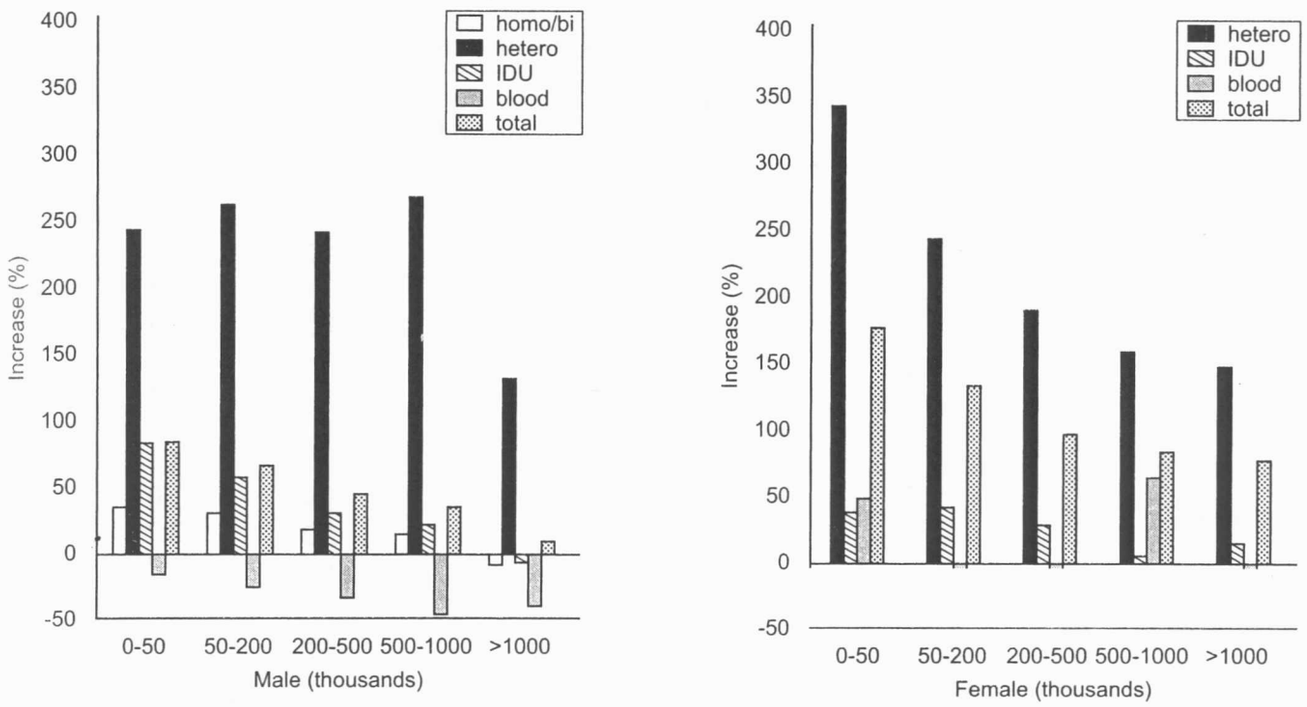

Table 3. Incidence rates (per 100,000 inhabitants) of AIDS in individuals ≥ 15 year of age, by sex, and time period according to the great regions. Brazil (1987-1995)

Region	Sex	Time period		
		1987-1989	1990-1992	1993-1995
Northern	M	1.4	4.1	7.8
	F	0.1	0.7	2.0
	T	0.8	2.5	5.0
Northeast	M	2.5	6.1	8.1
	F	0.3	0.9	1.8
	T	1.4	3.4	4.8
Southeast	M	14.8	32.4	39.7
	F	1.8	5.8	10.9
	T	8.1	18.7	24.9
Southern	M	3.2	10.9	20.0
	F	0.4	2.2	5.9
	T	1.8	6.5	12.8
Midwest	M	3.9	13.0	19.6
	F	0.4	2.8	5.8
	T	2.2	7.9	12.7

Table 4. Proportional distribution (%) of AIDS cases in individuals 15 years and over by exposure category according sex and urban region. Brazil 1993-1995.

Region	Sex	Exposure category						
		Homo /bisex	Heterosex	IDU	IDU and homo/bi	Blood	Unknown	Others
Northern	M	48.3	24.5	6.1	3.5	1.8	12.1	3.6
	F	-	61.1	3.9	-	3.9	18.3	12.8
	T	38.6	31.8	5.6	2.8	2.2	13.4	5.5
Northeast	M	5.3	18.5	5.7	3.1	1.4	13.3	2.6
	F	-	67.6	8.2	-	3.5	18.0	2.7
	T	44.8	27.9	6.1	2.5	1.8	14.2	2.6
Southeast	M	29.1	17.1	23.5	3.8	1.4	23.5	1.7
	F	-	51.7	16.8	-	2.9	26.2	2.3
	T	22.6	24.9	22.0	2.9	1.7	24.1	1.8
Southern	M	29.6	23.6	27.1	5.4	1.4	11.0	1.5
	F	-	62.6	19.9	-	2.2	13.7	1.7
	T	22.8	32.8	25.5	4.2	1.6	11.7	1.5
Midwest	M	25.9	16.8	19.4	5.8	1.4	28.4	2.3
	F	-	51.7	18.5	-	3.4	24.0	2.4
	T	20.0	24.7	19.1	4.5	1.9	27.4	2.3
Brazil	T	31.7	18.2	21.9	4.0	1.4	21.1	1.8
		-	54.5	16.5	-	2.9	23.7	2.4
		24.6	26.3	20.7	3.1	1.7	21.6	2.0

Table 5. Incidence rates (per 100,000 inhabitants) of AIDS in individuals ≥ 15 year of age, by sex, and time period according to population size in residence grounds. Brazil (1987-1995)

Population group	Sex	Study period		
(No. inhabitants)		1987-1989	1990-1992	993-1995
0-50,000	M	0.9	2.8	5.3
	F	0.1	0.6	1.8
	T	0.5	1.7	3.6
50,001-200,000	M	3.3	11.0	18.7
	F	0.5	2.4	5.6
	T	1.9	6.6	12.0
200,001-500,000	M	9.9	26.7	39.7
	F	1.5	5.6	11.2
	T	5.5	15.7	24.8
500,001-1,000,000	M	9.7	26.0	35.9
	F	1.2	4.9	9.0
	T	5.2	14.9	21.8
>1,000,000	M	25.1	50.4	55.8
	F	2.4	7.2	12.8
	T	12.9	27.3	32.8

Table 6. Proportional distribution (%) of AIDS cases in individuals 15 years and over by exposure category according to sex and population size of region. Brazil 1993-1995.

Population group (No. inhabitants)	Sex	Exposure category						
		Homo /bisex	Heterosex	IDU	IDU and homo/bi	Blood	Unknown	Others
0-50,000	M	25.4	24.0	21.4	4.2	2.0	20.6	2.3
	F	-	60.1	14.8	-	3.4	18.6	3.1
	T	19.1	33.0	19.8	3.2	2.4	20.1	2.5
50,001-200,000	M	24.2	22.2	30.1	4.6	1.2	16.0	1.7
	F	-	58.9	19.5	-	2.6	16.3	2.6
	T	18.4	31.0	27.5	3.5	1.5	16.1	1.9
200,001-500,000	M	24.8	20.1	30.1	4.8	1.1	17.4	1.7
	F	-	56.3	19.5	-	2.2	19.0	3.0
	T	19.0	28.6	27.6	3.7	1.4	17.7	2.0
500,001-1,000,000	M	31.2	19.1	21.7	3.6	1.2	21.6	1.6
	F	-	54.0	15.9	-	4.3	22.8	2.9
	T	24.4	26.7	20.4	2.8	1.9	21.9	1.9
>1,000,000	M	38.4	14.8	15.6	3.5	1.5	24.4	1.8
	F	-	50.5	13.7	-	3.0	30.3	1.9
	T	30.3	22.3	15.3	2.8	1.8	25.6	1.8

In all age groups the temporal evolution patterns by exposure categories was similar. The heterosexual transmission category showed, without exception, the greatest increase. It is interesting to note that, although the IDU category had a more important role among young people, it was in this age group that the smallest relative increase was seen.

The incidence rates over time when examined by use of data from large regions of the country is shown in Table 3 and Figure 3. For both sexes, the greatest incidence was in the Southeast region, but this region, nevertheless had, the smallest rate of increase and greatest tendency to stabilize. The sharp slopes of the South and North regions are noted between the second and the last time periods. In the last period (1993-95), the South region occupied second place regarding the magnitude of incidence, with higher infection rates than the Central-West region, which occupied this position until the second time period. The South region is, therefore, the one deserving particular attention, due to its increase percentage of infection, higher than the national average, and its particular role in the epidemic, with about 13% of the cases in the 1993-95 period.

The distribution of AIDS cases by category in the large regions of Brazil demonstrated distinct regional patterns (Table 4). The North and Northeast regions are characterized by a preponderance of sexual transmission in both sexes, with low proportions of IDU cases. In contrast, in the South and Southeast the IDU category played an important role, with similar percentiles in homo/bisexual cases, heterosexuals and IDU. It is worth mentioning that the proportion of cases in the category "data missing" are different in each region, reaching up to one fourth of the cases in the Southeast and Central-West regions. This fact should be taken into account when comparing regional distributions of patients (Figure 4).

As shown previously, the heterosexual category was the one with the greatest increase, and this occurred in all regions (Table 4). The most marked increase is shown by the South region, which, from the second to the third time period, increased 350%, that is, around 65% per year. In this region, the IDU increase is also outstanding, in that it occurred at a much quicker pace than in the rest of the country. Particular attention should be given to the increase in blood transmission cases that still occur in the North (both sexes), Northeast and Central-West (female gender) regions.

The data shown in Table 5 allow the observation of the spreading of the disease by the size of the municipality population. The epidemic began in the great urban centers, but these same centers remained at the lowest rate of increase and greatest tendency to stabilize. Medium sized cities, 200 to 500 thousand inhabitants, showed a relevant temporal evolution. From the second to the third time period, they had a 16.5 yearly increase in cases and now present the second greatest incidence rate of disease, above the one found in larger cities, with five hundred thousand to one million inhabitants. The epidemic in small municipalities, with less than 200,000 inhabitants has also expanded with a high percent increase in rates. It is interesting to note that the speed of expansion of the disease varied inversely with population size; the smaller the city the greater the incidence-time slope. Concerning case distribution by category, we can see that big cities have a differentiated pattern (Table 6). In these, the homo/bisexual category was predominant. This category became less important as the population size diminished. IDU transmission, though, occurred in towns with 50 to 200 thousand inhabitants as well as medium sized ones, with 200 to 500 thousands inhabitants. In these cities, the IDU cases represented 28% of the patients. It should be noted that the greatest percentiles of "data missing" cases were found in big municipalities, particularly in those with more than one million inhabitants.

The percentages from 1990-92 to 1993-95 of AIDS incidence rates per exposure category according to population size group are shown in Figure 5. Beyond the uncontrolled increase on the heterosexual category, the following are also important; 1) the increase of the IDU category in small cities in conjunction with the decrease (or stability) tendency in greater centers; 2) the positive increase in rates of blood transmission of infections in the female gender occurring, in cities with less than 50,000 inhabitants as well as in those with populations ranging from 500 thousand to one million inhabitants; and 3) the relatively small percentiles of increase in the homo/bisexual category, with decreased frequency in large urban centers, showing this category as the one with greatest control over the epidemic.

Discussion

Ecological studies on the dynamics of the HIV/AIDS epidemic are still rare [6,12-15], being, nevertheless, essential to the diagnosis of epidemic tendencies. Also rare are the proposals (and subsequent evaluation) of preventive strategies adaptable to regional particularities and to the social, economic and cultural characteristics of different population segments. These observations are usually left to a secondary level in studies whose analysis foundations are constituted exclusively by data related to specific individuals [16].

From the present analysis, it is possible to realize that the HIV/AIDS epidemic in Brazil has undergone profound modifications in its scope. The epidemic was markedly regional and basically restricted to certain population segments in its early stage; it then increased nationwide during the years, reaching more and more varied population segments and bringing new challenges to public policies and actions of the society.

It is equally clear that the epidemic has been spreading more slowly in recent years, according to dynamics which result, probably, from the combination among saturation of segments with the greatest risk, spontaneous behavioral change in certain segments, and the impact of many initiatives developed in many settings and directed to diverse segments, from governmental and non-governmental organizations.

It should be observed, nevertheless, that this relative slowing down of the epidemic has not happened homogeneously, either from the most effected population segment point of view or different regions of the country. The speed of expansion of the epidemic decreased among men, in big cities and the Southeast region, while certain population segments such as IDU continue to be disprortionally affected by the epidemic. The increase with time, of cases secondary to transfusion of blood and blood derivatives among men in the North and specially among women in various parts of the country, including large municipalities, is worrisome, signaling that probably throughout the 80's (given the aforementioned time lag between infection and notification), there were still significant impairments in the quality control of these products.

As observed by the results of this study the epicenter for the epidemic in Brazil was and still is in the Southeast region, due to many factors: It is the most populated and interconnected region in the country through its communication [14]; the most urbanized region, with the greatest number of large and medium-sized municipalities (most precociously affected by the epidemic), and it is also the region where the epidemic has existed the longest. On the other hand, this region, where the saturation of segments under greatest risk seems more important and preventive action is most developed in intensity and range, tends to enter a phase of stability, with clearly decreasing incidence rates.

In more recent years, the growing role of the epidemic in the South region is outstanding. The participation of IDU is impressive, as detailed in a previous study [17], as well as the increase of cases secondary to heterosexual transmission. Considering not only expansion speed, but also its relative magnitude facing the national epidemic, this area deserves special attention by those crafting preventive policies.

Given the characteristics of Brazilian settlement, which is still reflected in population groups today, which have the main metropolitan regions located at the coastline or contiguous to it, it is possible to talk about an interiorization process of the epidemic, as the municipality network is gradually affected by spread of the ongoing epidemic. Through time, not only a greater number of municipalities are affected, but also this process increasingly includes small towns which are, as a rule, poorer and lacking in health and community resources.

If the AIDS epidemic has spread, with time, from the main centers towards medium and subsequently small-sized centers, in a process comparable to a hierarchically decreasing spread in terms of municipality network, this process is not homogeneous regarding different risk-factor categories. The epidemic, in its early stage, was basically metropolitan and affected mainly the homosexual and blood, specially hemophiliacs, categories. The IDU, most directly affected later in the epidemic, played a central role in the spread to medium and even small-sized centers, starting from an initial dissemination along the line connecting the Central-West region to the São Paulo countryside and, more recently, along the southern seashore.

Presently, heterosexual transmission is the "powerhouse" of the dynamics of the epidemic, with relevant expression in all regions, and contributing decisively to the increase in cases among women. In no other time of its spread has the epidemic affected the municipality network so greatly as now, in which the main methods of disease transmission are intertwined with the sexual habits of the general population. This creates difficulties in the definition of specific regions and segments under risk, and requires a great array of preventive interventions. After a period in which the spatial concentration was followed by a selectivity of spread regarding risk factor, in the beginning of the 80's, the AIDS epidemic began to increasingly affect new population segments. Following a broad, biphasic spreading pattern, described by Gupta, et al.[18] which combines a time of quick dissemination and saturation of high risk segments, followed by a period of slower spread, although broader (due to the greater population contingency affected in this subsequent moment), the Brazilian epidemic seems to now be going through a "second" stage. In this stage it is spread to a broad group of people, with so-called "low-risk" behavior patterns according to traditional indicators of individual vulnerability evaluation.

It is in this setting that the issue of social vulnerability emerges — people with lower formal educational levels, inserted in poorly paid occupations or excluded from the formal work market [12], with restricted access to health care and other policies of communitary and social action are becoming more and more exposed to HIV. This process combines material restrictions (lack of resources to acquire prophylactics or sterile syringes), social-medical factors, such as the preponderance of STD's (ensuring the sexual transmission of HIV), and factors regarding society affecting individual and group behavior, such as inequalities in gender, conflicts between self-protection initiatives, and necessities regarding food and housing [16].

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