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Spread of AIDS in Rural America, 1982–1990

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Summary: Using a national county database, we examine the hypothesis of increasing spread of acquired immune deficiency syndrome (AIDS) in rural America. Data for county-level AIDS caseloads for the period 1982–1990 were obtained by contacting state health officials of individual states. Yearly and cumulative AIDS cases by county or health district were converted to rates with use of the 1986 population figures. The data were grouped into 3-year periods, 1982–1984, 1985–1987, and 1988–1990, and analyzed. The top 25 counties that had the highest rates of increase were identified, and their average population sizes were derived. Pearson's correlation coefficients between the rates of increase and county populations were also computed. The results corroborate data from previous studies based on selected regions and clearly point to an increasing spread in rural counties on a national basis. During 1982–1984, highly populated counties had the highest rates of increase in number of cases of AIDS, with the populations of the top 25 counties averaging 1.1 million. Between 1988 and 1990, the top 25 counties that had the highest rates of increase are mostly rural counties with an average population of 73,000. Not only are we presently faced with a much larger base of population infected with AIDS than before, the epidemic has also entered a dangerous phase of spreading to rural America where health care facilities are far less adequate than in urban areas. Together with the recent sobering trends of spreading to the heterosexual population, low-income classes, and ethnic minority groups, the AIDS epidemic will have even more immense and far-reaching impacts on our society in the next decade. **Key Words:** AIDS epidemic—Rural spread—Geographical patterns—United States.

A decade has elapsed since the first case of acquired immune deficiency syndrome (AIDS) was recognized in 1981. As of June 30, 1993, 315,390 AIDS cases have been reported to the Centers for Disease Control (CDC) for the United States, among which 194,334 persons have died (~62% fatality rate) (1). As the second decade begins, several disturbing trends of the AIDS pandemic, in addition to its magnitude, have been noted. Several studies have documented a steady increase in human immunodeficiency virus (HIV)/AIDS prevalence among the general heterosexual population, low-income classes, and ethnic minority groups in the second decade, as opposed to the first decade, which is characterized by a high increase among certain risk groups such as homosexual men and drug addicts (2–4). Using the HIV data extracted from military applicants during the period 1985–1987, Gardner and his group studied the seven most populous states and four metropolitan areas and demonstrated that the nonepidemic regions had higher rates of increase in HIV seroprevalence in the later period (5). Their study provides evidence for HIV spread in rural America. A few other studies based on various localities also reported the rise

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of HIV/AIDS prevalence in rural areas or smaller cities (6–8). Moreover, in a study of HIV-related diseases in rural eastern North Carolina, Rumley and others reported that rural patients are more likely to be female, heterosexual, nonwhite, and younger (9). The socioeconomic impacts of this geographical difference, along with the other sobering trends, are enormous, as medical and social facilities are generally less available in rural areas and in low-income, ethnic minority groups, making the treatment of the patients and the curbing of the pandemic a more difficult task.

In this article, we examine the spatial as well as temporal trends of the spread of AIDS from 1982 to 1990 for the entire nation and test specifically whether these trends support the hypothesis of rural spread on a national basis. Our analyses are based on a national database of yearly AIDS caseload by county collected from individual state health agencies for the period 1982–1990.

DATA AND METHODOLOGY

Since the CDC does not release AIDS caseload data at the county level because of confidentiality concerns, we directly contacted the state health agencies of all 50 states to acquire a national database by county. Our database contains AIDS caseload data by county by year for the period 1982–1990. Of the 50 states, 39 provided data at the county level; 7 (Georgia, Ken-

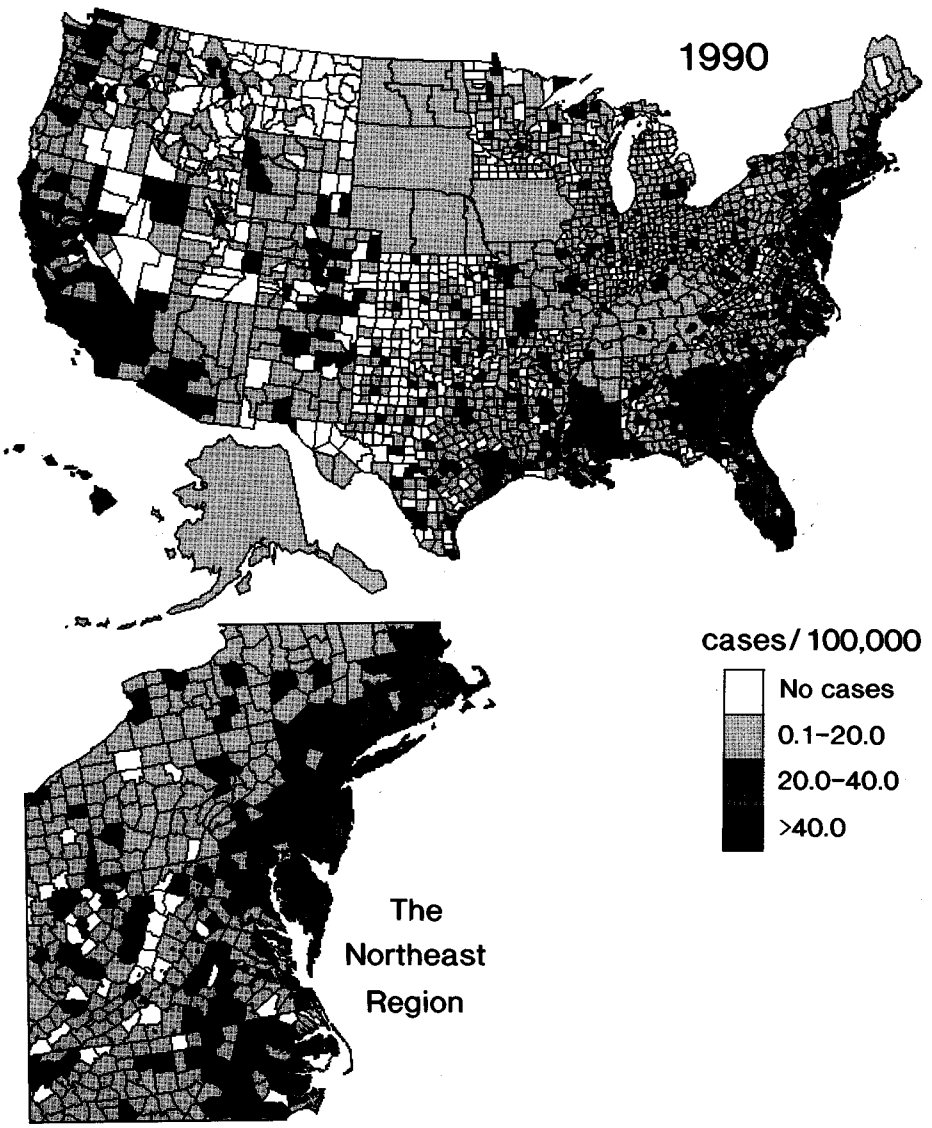

FIG. 1. Cumulative incidence rates of acquired immune deficiency syndrome in the United States by county as of the end of 1990 and an enlarged view of the northeast region.

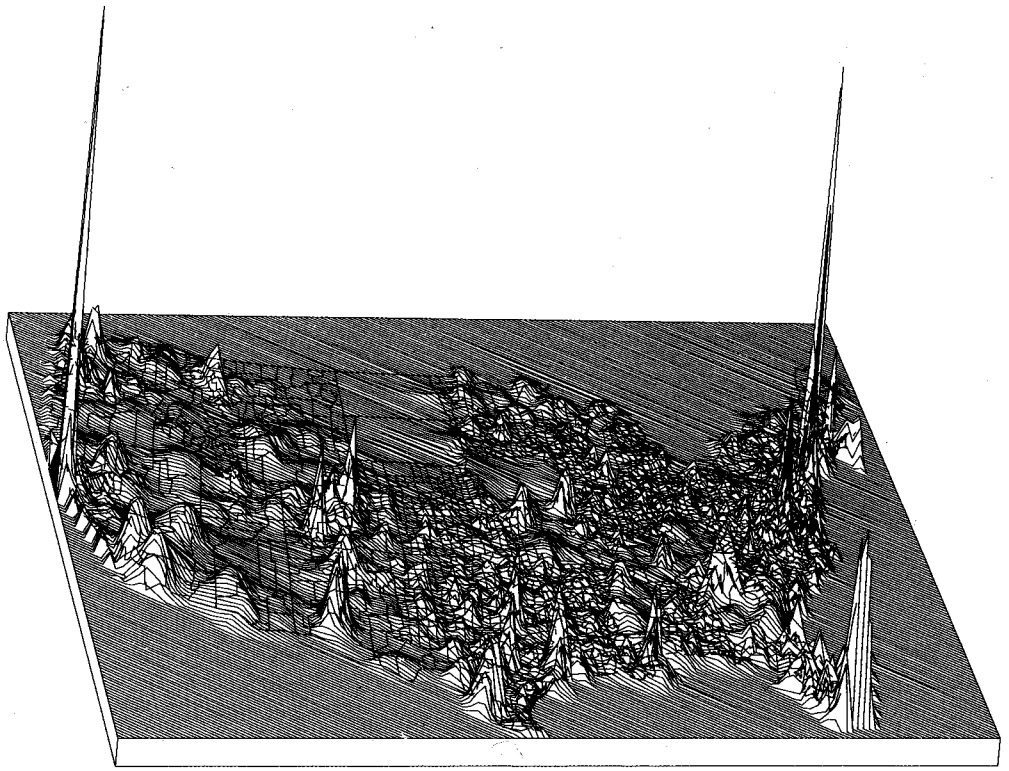

FIG. 2. A three-dimensional view of cumulative incidence rates of acquired immune deficiency syndrome in the United States as of the end of 1990.

tucky, Mississippi, Nebraska, New Mexico, North Dakota, and Tennessee) provided data by health districts or regions, which are direct aggregations of counties; and 2 are special cases (Alaska reports data by municipality and the District of Columbia is one unit). The remaining three, Iowa, South Dakota, and Vermont, were unwilling to release the data at the county or district level (Iowa, however, began to release county data after 1991); thus for these three we used the state-level data. Accordingly, we modified and aggregated respective county boundaries into health districts or states so that boundaries on our maps reflect the reporting units. The final total number of areal units for analysis is 2,299 for all years.

We standardized our AIDS caseload data based on the year of diagnosis. Population values from the 1986 Census for individual counties were used as a common denominator for converting number of AIDS cases into AIDS incidence rates (number of cases/1986 population × 100,000) for all 9 years. When the AIDS caseload data are reported by health districts that are direct aggregations of counties, the respective county boundaries and their population figures were combined to derive the appropriate AIDS incidence rates for analysis and mapping.

To determine the overall trends and dominant patterns of the AIDS epidemic, we aggregated the data into three consecutive 3-year periods: 1982–1984, 1985–1987, and 1988–1990. This aggregation helps to reduce the "noise" in the data due to year-to-year fluctuations, changes in AIDS definition, and reporting delays, and facilitates comparison and interpretation.

The three periods also correspond roughly to stages in the historical development of the AIDS epidemic in the United States (10–12). The first three years, 1982–1984, represent an initial stage when the general public had little awareness and the occurrence of AIDS was largely limited to large metropolitan areas spatially and to certain risk groups such as homosexual men socially, and its geographical spread mostly occurring between cities. The second period, 1985–1987, is characterized by a rapid increase in the number of AIDS cases along with greater public awareness. AIDS incidence increased significantly both vertically at the origins (i.e., in the metropolitan areas) and horizontally (i.e., spreading to neighboring counties). During 1988–1990, the rate of increase in number of AIDS cases in the United States has declined, but the spread is no longer limited to certain social groups, it is a pandemic affecting all groups of the population. By then almost every individual in the nation would have known someone in his or her social circles who is HIV-infected or has developed AIDS (13).

RESULTS AND DISCUSSION

The maps in Fig. 1 indicate the cumulative AIDS incidence rates by county as of the end of 1990, with an enlarged view of the Northeast region. The corresponding three-dimensional view is shown in Fig. 2. Whereas previous reports show that the growth of AIDS incidence in the United States began to decline in 1987 (14), it does not mean that we are facing a lesser problem. Instead, it should be cautioned that it is the rate of increase that is declining,

TABLE 1. *Rankings of the top 25 counties in the United States by cumulative rates and cumulative no. of cases of acquired immune deficiency syndrome (AIDS) for 1982–1990*

Name	Cumulative rate	Name	Cumulative no. of cases
San Francisco, CA	1,176.50	New York, NY	13,241
New York, NY	895.87	Los Angeles, CA	10,974
Washington, D.C.	425.81	San Francisco, CA	8,812
Monroe, FL	422.07	Kings, NY	6,513
Bronx, NY	412.03	Harris, TX	5,157
Hinsdale, CO	400.00	Bronx, NY	4,918
Essex, NJ	391.14	Dade, FL	4,114
Hudson, NJ	303.56	Cook, IL	3,867
Kings, NY	284.01	Queens, NY	3,611
Dade, FL	232.50	District 3, GA	3,576
Suffolk, MA	229.36	Essex, NJ	3,293
Orleans, LA	220.20	Dallas, TX	2,860
Broward, FL	217.61	Washington, D.C.	2,666
Denver, CO	209.31	Broward, FL	2,486
Baltimore, MD	199.12	San Diego, CA	2,380
Queens, NY	187.75	Philadelphia, PA	2,314
Harris, TX	184.29	Hudson, NJ	1,679
Alexandria, VA	182.75	Alameda, CA	1,635
Palm Beach, FL	181.18	King, WA	1,576
Arlington, VA	175.80	Suffolk, MA	1,517
Passaic, NJ	171.84	Baltimore, MD	1,499
District 3, GA	166.53	Orange, CA	1,393
Marin, CA	158.76	Palm Beach, FL	1,369
Dallas, TX	156.02	Orleans, LA	1,221
Sonoma, CA	150.17	Wayne, MI	1,090

not the annual number of new cases. Our data show that from 1982 to 1990, the number of new AIDS cases diagnosed annually was still increasing each year—37,693 new cases were reported in 1990, compared with 32,317 in 1989—but the rate of growth declined slightly since 1987. Nationally, on average, there are about 16 new cases diagnosed per areal unit in 1990, compared with 11 in 1987, 2 in 1984, and less than 1 in 1982.

In general, a positive relationship between caseload, population size, and incidence rate exists in our data set. The Pearson's correlation coefficients between population size, 1990 cumulative cases, and 1990 cumulative rates are statistically significant (0.70 and 0.37, respectively). In other words, metropolitan areas with large populations tend to have large number of AIDS cases, and in most circumstances they also tend to have high incidence rates. Table 1 ranks and compares the top 25 counties that had the highest cumulative incidence rates and those with the highest cumulative number of cases. In the case of cumulative incidence rates, San Francisco County ranks the highest, where on average for the last decade, ~1 in 85 people has been diagnosed with AIDS (or 1 in 750 people per year, if the cumulative incidence rate of 1176.50 is divided by 9 years). This is followed by New York County (1 in 112 for 9 years, or 1 in 1,005 each year), District of Columbia, Bronx County (New York), and Monroe County (west of Miami, Florida). On the other hand, if only the cumulative caseloads are considered, New York has 13,241 AIDS cases diagnosed since 1982, the highest of all counties. This is followed by Los Angeles, San Francisco, Kings County (New York), and Harris County (Houston, Texas). The two lists of the top 25 counties are quite similar, with 17 counties occurring on both lists.

An obvious and alarming trend is that more and more counties were being infected over the 9-year period. In 1982, 168 (7%) counties or health districts reported AIDS cases, but in 1990, 1,788 (78%) of the counties in the nation reported AIDS cases. Compared with a decade ago, we are now faced with a disease that is much more enormous in quantity and has spread across much wider regions.

Figure 1 reveals that high rates occur on the East and West coasts and in the South, approximately forming a ring around the United States on three sides. High rates occur in the metropolitan areas, and the interior of the country generally has much lower rates. Although the geographical patterns shown by our maps generally conform to what has been shown before based on only metropolitan data

TABLE 2. *Top 25 counties in the United States with the highest rates of increase in incidence of acquired immune deficiency syndrome for the periods of 1982–1984, 1985–1987, 1988–1990*

1982–1984		1985–1987		1988–1990	
Name	Rate	Name	Rate	Name	Rate
King, WA (Seattle)	49.00	San Joaquin, CA (Oakland*)	44.00	Chesapeake City, VA	17.00
Westchester, NY (New York City*)	44.00	Solano, CA (San Francisco*)	40.00	Yuma, AZ (Phoenix*)	15.00
Passaic, NJ (New York City*)	25.50	District 9, MS (Gulfport)	36.00	Cabell, WV (Charleston*)	14.67
Marin, CA (San Francisco*)	20.00	Fort Bend, TX (Houston*)	34.00	Frederrickburg City, VA	14.00
Hartford, CT	18.00	Escambia, FL (Pensacola)	33.00	Porter, IN (Chicago*)	13.00
Orange, FL (Orlando)	18.00	El Paso, CO (Colorado Springs)	30.00	Jefferson, WV (Wheeling*)	13.00
St. Louis Region, MO	18.00	Summit, OH (Akron)	29.00	Lee, AL (Auburn)	12.00
Multnomach, OR (Portland)	18.00	Brazoria, TX (Houston*)	28.00	Kanawha, WV (Charleston)	12.00
Middlesex, NJ (Trenton*)	14.50	Worcester, MA	27.00	Avoyelles, LA (Alexandria*)	11.00
Washington, D.C.	14.40	Pasco, FL (Tampa*)	26.00	Hardee, FL (Tampa*)	11.00
Dallas, TX	14.00	Adams, CO (Denver)	26.00	Okeechobee, FL (Palm Beach*)	11.00
Onondaga, NY (Syracuse)	13.00	Kane, IL (Chicago*)	26.00	Kootenai, ID (Spokane, WA*)	11.00
Milwaukee, WI	13.00	Lucas, OH (Toledo)	26.00	McHenry, IL (Chicago*)	11.00
Orange, CA (Los Angeles*)	12.75	Denton, TX (Dallas*)	25.00	Ohio, WV (Wheeling*)	11.00
Los Angeles, CA	12.46	Tarrant, TX (Fort Worth)	24.78	Logan, IL (Springfield*)	10.00
Orleans, LA	12.00	Tulsa, OK	24.50	Martinsville City, VA (Roanoke*)	9.00
Mercer, NJ (Trenton)	12.00	Sussex, DE	24.00	Nassau, FL (Jacksonville*)	9.00
Baltimore, MD	11.00	Spokane, WA	24.00	Grant, IN (Fort Wayne*)	9.00
Morris, NJ (Newark)	11.00	Lubbock, TX	23.00	Hendricks, IN (Indianapolis*)	9.00
Franklin, OH (Columbus)	11.00	Richmond City, VA	23.00	Colleton, SC (Charleston*)	9.00
Charleston, SC	11.00	Midcumberland, TN (Nashville)	22.00	Grays Harbor, WA (Olympia*)	9.00
Davidson, TN (Nashville)	11.00	Allen, IN (Fort Wayne)	22.00	Lewis, WA (Tacoma)	9.00
San Francisco, CA	10.61	District 8, MS (Hattiesburg)	21.00	Hancock, WV (Wheeling*)	9.00
Denver, CO	10.20	Oklahoma, OK	20.80	Marathon, WI (Wausau)	9.00
Broward, FL (Miami*)	9.78	Cumberland, ME (Portland)	20.50	Dorchester, SC (Charleston*)	8.50

We include in this table the names of neighboring cities to help locate and identify the less-known counties. Counties not followed by a city name are metropolitan areas themselves bearing the same names as well-known cities. City names in parentheses without an asterisk indicates that either the city overlaps with or is situated in the county itself; city name with one asterisk indicates that the county is separated from that city by one or two counties.

(11,15), a number of interesting features stand out. For example, Chicago and a number of Midwestern cities have lower rates than what most people would anticipate. Counties in Texas along the Mexican border show unexpectedly high rates. Florida also stands out as a state that has a surprisingly large number of counties reporting AIDS cases as early as 1982 and has evolved into an important infected area in 1990, comparable with the states of New York and California.

In order to test the hypothesis that the spread of AIDS has become more important in rural America on a national basis, we compared the rates of increase in AIDS incidence for the three periods, 1982–1984, 1985–1987, and 1988–1990. Table 2 lists the top 25 counties that had the fastest increase in AIDS incidence rates in each of the three periods. The names of the closest city to the county are also included in the table for ease of interpretation. Simple Pearson's correlations between the rate of increase and the population by county for the three periods were computed, and the results are shown in Table 3. The correlation coefficients decrease from 0.33 to 0.18 in the first two periods, both statistically significant at the 0.001 level, to a low and nonsignificant value of 0.02 in the last period. This indicates that increase in the number of AIDS cases was dominant in big cities in early years, but no

TABLE 3. *Pearson's correlations between the rates of increase and county populations in the United States for the three periods*

Period	r	No. of units	Mean rate of increase	Mean population	Mean population of top 25 counties
1982–1984	0.33[a]	168	5.37	611,390	1,112,516
1985–1987	0.18[a]	509	6.84	341,535	372,700
1988–1990	0.02	1,352	2.15	166,298	72,620

[a] Significant at the 0.001 level.

correlation was found between population size and increase in number of AIDS cases in later years. However, the average population of the top 25 counties in each period (Table 3) shows clearly that large cities had the largest increase in number of AIDS cases in early years, with an average population of ~1.1 million; as time progressed, smaller or rural counties with an average population of about 73,000 had the highest rates of increase. Our results have confirmed that counties of smaller population have higher rates of increase in recent years, a sign that the disease is spreading through rural America at a fast pace.

As indicated in Table 2, during the period of 1982–1984, big cities (counties) such as Seattle (King County, Washington), the New York region, and the San Francisco region are included in the list of top 25 counties. During 1985–1987 and 1988–1990, smaller counties that are located close to big cities experienced the fastest growth in the number of AIDS cases, most of them are found in the Midwest, West Virginia, and rural Florida. Based on our high-resolution national database, spread of AIDS to rural counties is no longer a myth confined to isolated areas, but a national fact confirmed by our analysis.

CONCLUSIONS

Before any modeling, forecasting, and development of sound policy in the second decade, it is essential to understand what has happened and where in the United States with regard to the spatial dynamics of the AIDS pandemic during the last decade. On the basis of our national AIDS data by county for 1982–1990, we have confirmed that AIDS prevalence is rising rapidly in rural America. Such a dangerous trend is expected to continue in the next decade of the AIDS pandemic. Together with other sobering trends of steady increase among the heterosexual population, low-income classes, and ethnic minority groups, the AIDS pandemic has gained deeper and more troublesome roots in the populations where medical facilities are generally less available and in rural areas. The social, economic, ethical, and demographic impacts would be enormous, and any sound health policies and effective forecasting models designed for coping with the pandemic will need to consider these elements.

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