IV. Geographic Distribution of Newborn HIV Seroprevalence in Relation to Four Sociodemographic Variables

Dale L. Morse, MD, MS
Lawrence Lessner, PhD, MPH
Michael G. Medvesky, MPH
Donna M. Glebatis, MS
Lloyd F. Novick, MD, MPH

Introduction

Since the AIDS epidemic was first recognized, there has been geographic clustering of AIDS cases within the United States and New York State. Most of this clustering is related to pools of HIV-infected individuals and to risk behavior activities which occur most frequently in metropolitan areas and states with large populations at risk. Witness the high rates of AIDS cases among homosexual and bisexual men in New York City and San Francisco and among intravenous drug users in urban areas of New York, New Jersey, and Florida.[1,2] In an earlier study in New York City, zip code areas with rates of drug-related hospital discharges in the top quartile had a newborn HIV seroprevalence of 2.2 percent versus 0.8 percent in all other zip code areas.[3]

Identification of geographic clusters of cases can be useful in focusing preventive efforts and allocation of health care resources. HIV/AIDS cases are also likely to be closely clustered in association with other sociodemographic variables. Knowledge of such relationships could be useful for targeting and design of prevention services which would differ between high-risk areas and areas where HIV/AIDS has not yet surfaced.

This report summarizes data on the geographic distribution of HIV seroprevalence among New York State newborns and its association with four sociodemographic variables: birthweight, maternal education, race/ethnicity, and drug abuse leading to hospitalization. Although such associations do not indicate causation, they provide insights for further investigation.

Methods

Three sources of data were used: the New York State Newborn HIV Seroprevalence Study, the Birth Certificate Registry, and the New York State hospital discharge file. The data variables analyzed included newborn HIV seroprevalence;[3] hospital discharges with opioid, cocaine, and infant drug withdrawal diagnoses; birthweight; maternal education; and race/ethnicity. All results were converted to rates or percents by zip code, using 1988 postal zip codes.[4]

Newborn HIV seroprevalence and race/ethnicity data included all newborns born after December 31, 1987 and tested for HIV between January 1, 1988 and August 31, 1989. Rates for these variables were calculated as percentages of the total number of newborns tested.

Opioid, cocaine, and infant drug withdrawal diagnoses were obtained from the Statewide Planning and Research Cooperative System for 1988[5] by using the International Classification of Diseases—Ninth Revision codes (304.0, 304.7 and 305.5 for opioid; 304.2 and 305.6 for cocaine; 779.5 and 760.72 for infant drug withdrawal). A combined all-drug variable was established by combining all such adult discharges. Rates per 100,000 population were determined by using zip codes of residence for all persons discharged and zip code population data from the 1985 National Planning Data Corporation estimates.[6] For the infant drug withdrawal rate the denominator was the number of newborn discharges per zip code.

Data on low birthweight (defined as less than 2,500 grams) and low maternal education (defined as fewer than 12 years) were obtained from the registry of 1987 birth certificates.

Geographic comparisons at zip code level were made separately for New York City and for New York State exclusive of New York City. Zip code areas were excluded from the statistical analysis if they had fewer than 100 births, absent variables, or extreme values which were outliers. All variables were mapped by quar-

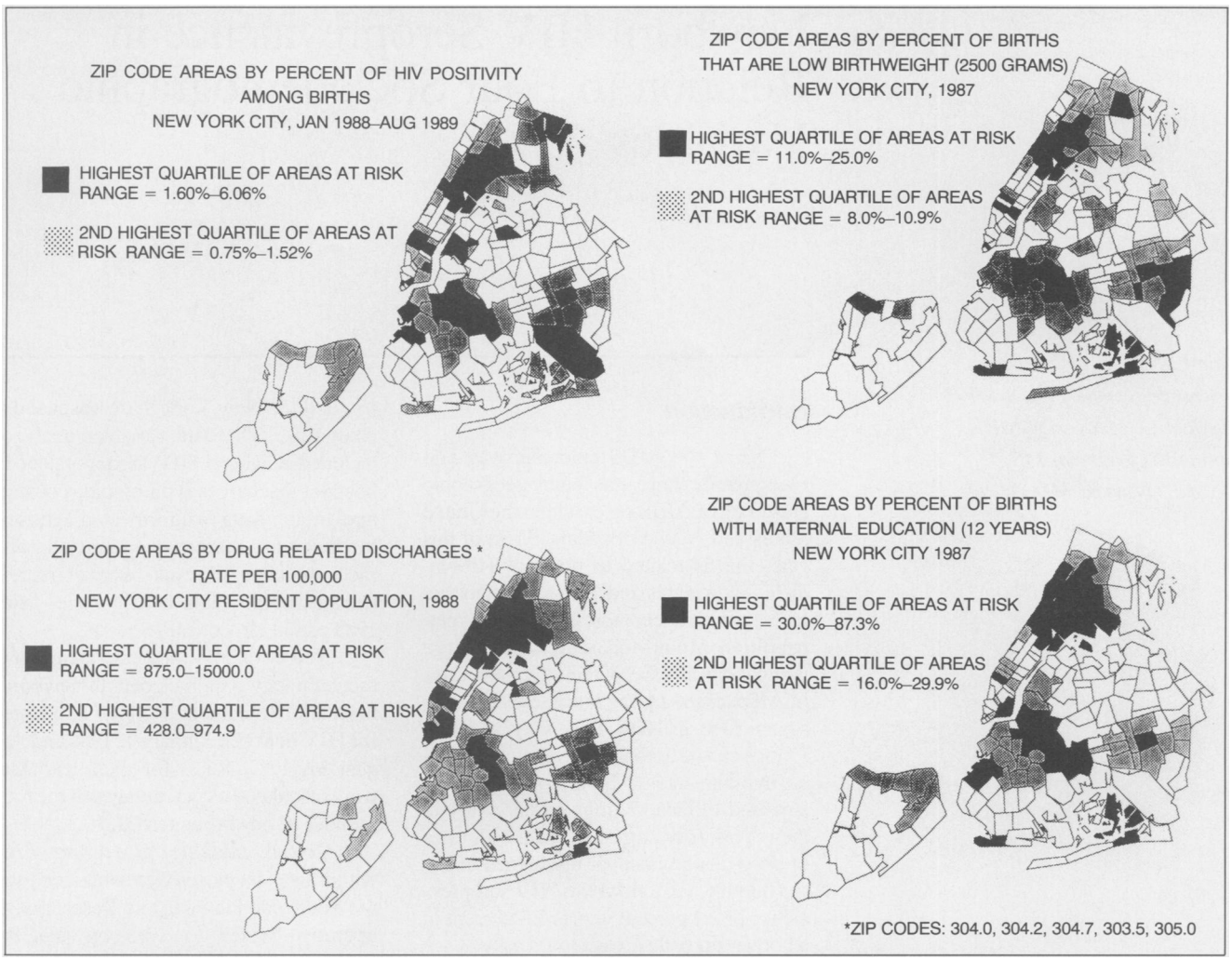

FIGURE 1—Geographic Comparison of Rates of Newborn HIV Seropositivity, Low Birthweight, Hospital Drug Discharges, and Low Maternal Education by Zip Code, New York City.

tiles for visual ecologic comparison. The geographic distribution of newborn HIV seroprevalence was compared to that of each sociodemographic variable by using Pearson correlation coefficients and multiple regression.

Results

Ecologic Mapping

Visual review of maps of newborn HIV seroprevalence rates by zip code area showed clustering in both New York City (Figure 1) and New York State exclusive of New York City. For New York City all maps of individual drug variables showed a similar pattern so only the most significant variable, all drugs, is presented here. Maps for New York State excluding New York City are not displayed, because release of such data from zip code areas with small numbers could compromise confidentiality.

The first and second quartiles for HIV seroprevalence in New York City had rates of 1.6 to 6.1 percent and 0.7 to 1.5 percent, respectively. The sociodemographic variables were also clustered but appeared to be more closely associated with HIV seroprevalence in New York City than in New York State exclusive of New York City.

Statistical Analysis: New York City

Of the 348 New York City zip code areas listed for 1988, 326 had valid entries listed, but 151 had no population and were excluded, leaving 175. All but five of these areas had a population of 3,798 or more. This restricted file contained 99.5 percent of all births, 99.8 percent of all HIV seropositives, and 99.7 percent of all drug discharges. Further exclusion of nine areas with fewer than 100 births and one area with an extreme drug discharge rate left 165 areas on which the analysis was done. These restrictions entailed minimal loss of data for the variables under consideration (Table IV-1). Over 98 percent of the information for each variable was included in the restricted data set for correlation and regression analyses.

Univariate correlation analysis showed HIV to be correlated in varying degrees with all sociodemographic variables studied in New York City (Table IV-2). Most variables were also highly correlated with one another. If one controlled for low birthweight and the various drug variables in calculating Pearson partial correlation coefficients, low maternal education, percent Black, and percent Hispanic were no longer significantly correlated with HIV. The drug variables were

TABLE IV-1—Number and Percent of Data Points Available for Correlation Analysis by Variable before and after Restrictions, New York City and New York State Exclusive of New York City

Variables	Total Number in Data File	Number Lost To Restrictions*	Number in Analyzed File	Proportional Decrease in Final Analysis
New York City				
Population	7,202,250	37,180	7,165,070	0.5%
Births	196,387	2,732	193,655	1.4%
HIV Positives	2,355	46	2,309	2.0%
All Drug Discharges	47,492	950	46,542	2.0%
Opioid Drug Discharges	28,755	647	28,108	2.3%
Cocaine Drug Discharges	25,701	460	25,241	1.8%
Infant Drug Discharges	4,117	81	4,036	2.0%
New York State Exclusive of New York City				
Population	10,548,363	1,896,471	8,651,892	18.0%
Births	236,648	38,521	198,127	16.3%
HIV Positives	396	54	342	13.6%
All Drug Discharges	12,980	2,179	10,801	16.8%
Opioid Drug Discharges	4,648	877	3,771	18.9%
Cocaine Drug Discharges	9,892	1,575	8,317	15.9%
Infant Drug Discharges	363	40	323	11.0%

*See Text

all highly correlated with one another. A model comprising low birthweight and all drug discharges was shown by multiple regression analysis to be the best predictor of HIV status (r^2 = .77). Addition of all remaining variables added little to the model. Low birthweight by itself contributed most to the model (r^2 = .69; data available on request).

Statistical Analysis: New York State Exclusive of New York City

Of the 1,918 zip codes listed for New York State exclusive of New York City in 1988, 1,884 had valid entries, but 354 had no population and were excluded. For the remaining 1,530 the median population was 2,441, and 25 percent had populations less than 1,000. This restricted file contained 98.9 percent of all births, 99.2 percent of all HIV seropositives, and 99.2 percent of all drug discharges. Because of small denominators, however, many areas had several extreme or missing values, leading to exclusion of 1,013 areas (1,006 with fewer than 100 births and seven as outliers). These exclusions left only 517 areas for the correlation and regression analyses and resulted in loss of data for a number of variables (Table IV-1). Overall 82 percent of the population, 88 percent of births, 86.4 percent of newborn HIV seropositives, and 83.2 percent of all drug discharges were included in the restricted data set.

Univariate correlation analysis on this restricted data set showed HIV to be less strongly correlated with all variables than in New York City. The variables with the highest correlation were percent Black, percent Hispanic, and the drug variables (Table IV-2). A model comprising percent Black, percent Hispanic, and cocaine drug discharges was shown by multiple regression analysis to be the best predictor of HIV status (r^2 = .39). Addition of all remaining variables added little to the model (r^2 = .43). The two race variables contributed most to the model (r^2 = .36), but all variables were closely associated, and a model without race/ethnicity was almost as good (r^2 = .42).

Discussion

The variables used for the analysis were chosen because of their availability, completeness, and suitability as measures of sociodemographic status. Low birthweight has been associated with socioeconomic status.[7] Maternal education, available on the birth certificate, had been demonstrated as a good surrogate for maternal socioeconomic status in previous Departmental studies.[8] Drug discharges, while not a measure of the total drug problem, reflect its distribution by providing a measure of one of its severe outcomes (hospitalization).

Other variables were considered but rejected for one reason or another. For example, sexually transmitted disease rates were not always available by zip code, and Medicaid participation is a biased measure of socioeconomic status because of wide differences in enrollment by locality.

Zip code was chosen as the geographic level of analysis because prevention activities must be targeted to small geographic areas and because a dilutional effect is seen when larger units, such as counties, are used.

Most pediatric AIDS cases are associated with use of intravenous drugs by one or both parents.[1] Of the 590 pediatric cases reported in New York State through October 1989, 346 (59 percent) had mothers who used intravenous drugs, and 108 (18 percent) had mothers who were sexual partners of intravenous drug users.[9] The associations between newborn HIV seroprevalence and hospital intravenous drug discharges in the present study were therefore expected. The high correlation with cocaine discharges, however, is of particular concern. While these mothers may have also used intravenous drugs, the cocaine association could reflect an increased heterosexual transmission of HIV, given the marked increase in syphilis transmission associated with sex in exchange for crack cocaine.[10]

Low birthweight is associated with inadequate health care, poor nutritional status, low socioeconomic status, low level of maternal education, and alcohol and other substance abuse,[7,11–13] including use of cocaine and heroin.[14–16] Thus it was not surprising to find low birthweight closely correlated with newborn seropositivity in New York City. Although drug use, as measured by hospital discharges, added to the association, its contribution was less than that of low birthweight. Hospitalization for drug use measures only the more severe portion of a locality's drug problem. Low birthweight may be a better reflection of the problem for the total community. Theoretically low birthweight could be an outcome of, rather than a surrogate for, HIV seropositivity. However, several studies have shown that there are no significant differences in birthweight between

TABLE IV-2—Correlations between HIV Seropositivity, Low Birthweight, Drug Discharges, Low Maternal Education and Race/Ethnicity, New York City and New York State Exclusive of New York City

	Pearson Correlation Coefficients								
Variables	HIV	LBW	Drug	Opi	Coc	InDr	ME	Blk	His
New York City									
HIV	—	.81	.79	.75	.80	.77	.68	.61	.31
LBW	.81	—	.73	.65	.77	.75	.65	.79	.21
Drug	.79	.73	—	.98	.98	.86	.68	.45	.36
Opi	.75	.65	.98	—	.91	.82	.68	.34	.43
Coc	.80	.77	.98	.91	—	.87	.66	.54	.29
InDr	.77	.75	.86	.82	.87	—	.78	.54	.35
ME	.68	.65	.68	.68	.66	.78	—	.46	.70
Blk	.61	.79	.45	.34	.54	.54	.46	—	−.08
His	.31	.21	.36	.43	.29	.35	.70	−.08	—
NYS Exclusive of NYC									
HIV	—	.33	.49	.41	.50	.35	.33	.50	.43
LBW	.33	—	.44	.33	.46	.35	.52	.55	.23
Drug	.49	.44	—	.84	.98	.37	.44	.67	.47
Opi	.41	.33	.84	—	.72	.23	.31	.44	.46
Coc	.50	.46	.98	.72	—	.41	.50	.70	.45
InDr	.35	.35	.37	.23	.41	—	.30	.34	.21
ME	.33	.52	.44	.31	.50	.30	—	.53	.30
Blk	.50	.55	.67	.44	.70	.34	.53	—	.30
His	.43	.23	.47	.46	.45	.21	.30	.30	—

LBW = Low Birthweight
Drug = All Drug Discharges
Opi = Opioid Discharges
Coc = Cocaine Discharges
InDr = Infant Drug Discharges
ME = Maternal Education < 12 Years
Blk = Percent Black
His = Percent Hispanic

newborns of HIV-positive versus HIV-negative women when the analysis controls for drug use and socioeconomic status.[17–19]

Race/ethnicity was correlated with HIV seroprevalence in New York City, but this correlation appeared to be related primarily to low birthweight and drug use. This finding parallels AIDS case rates, where minorities have much higher case rates but primarily as a function of intravenous drug use.[20]

A different pattern of correlations was seen in New York State exclusive of New York City. The geographic distributions of all sociodemographic variables were still correlated with newborn HIV seroprevalence by zip code, but the correlation coefficients were far less strong. Also, on multiple regression analysis, race/ethnicity replaced low birthweight as the most significant, albeit minimal, predictor of HIV status, while drug use remained a contributor.

Minorities have previously been shown to be disproportionately affected by AIDS, with case rates three to 12 times those of Whites.[21] Blacks and Hispanics contribute 24 percent and 14 percent of the United States AIDS cases, respectively, while comprising only 12 percent and 7 percent of the population.[22] Among AIDS patients, 71 percent of all women are Black or Hispanic, as are 77 percent of all children.[1] These differences have been repeatedly associated with intravenous drug use and secondary heterosexual and perinatal transmission.[20–23]

The reason why race/ethnicity appears to be a better correlate for HIV than low birthweight or drug use in New York State exclusive of New York City is unclear. Some possible explanations are the smaller amount of data available for analysis by zip code, the lower prevalence of drug use resulting in hospitalization (drug discharges per 100,000 population were 17 percent of those in New York City), and the lower rate of newborn HIV seroprevalence (0.16 versus 1.25 percent). Furthermore, the ratios of AIDS case rates for Blacks and Hispanics compared to Whites have been much greater in New York State exclusive of New York City (7.6 and 5.2, respectively, versus 2.1 and 2.0). Similarly, the ratios of HIV newborn seroprevalence rates for Blacks and Hispanics are 15 and 10 times higher, respectively, than for Whites in New York State exclusive of New York City, compared to six and four times higher in New York City.

While the major emphasis for public health HIV/AIDS programs has been on universal education and precautions, efforts targeted at high-risk persons or geographic areas are also important. Our results confirm that prevention activities in New York City should be focused on geographic areas that have low HIV/AIDS rates but populations with low birthweights and high drug use—that is, populations at risk for future HIV/AIDS activity—as well as on geographic areas with already high HIV/AIDS rates. The extent to which sociodemographic factors are important predictors outside New York City remains to be seen.

Summary

The geographic distribution of newborn human immunodeficiency virus seroprevalence at zip code level was compared with the distribution of four sociodemographic variables. For New York City significant univariate correlations were found between HIV and low birthweight, drug use (as measured by hospital discharges), maternal education less than 12 years, and race/ethnicity. Less significant correlations were found for New York State exclusive of New York City. For New York City a model comprising low birthweight and all drug discharges was shown by multiple regression analysis to be most strongly associated with HIV status ($r^2 = .77$). Elsewhere a model comprising race/ethnicity (percent Black, percent Hispanic) and cocaine

drug discharges had the best, but less strong association (r^2 = .39). However, because of intercorrelations, race/ethnicity added little when the other variables were included first. Knowledge of the geographic association between HIV seroprevalence and sociodemographic status can be useful in designing and focusing prevention efforts in areas at highest risk for future HIV/AIDS activity. □

Acknowledgments

The authors are indebted to Joanne Sikorski, Michael Davisson, William Wallace, Hwa-Gan Chang, and Rachel Stricof of the New York State Department of Health for their assistance in preparation of the manuscript.

References

1. Centers for Disease Control: HIV/AIDS Surveillance Report. Atlanta, GA: Centers for Disease Control, October 1989; 1–16.
2. New York State Department of Health: AIDS in New York State. Albany, NY: New York State Department of Health, March 1989.
3. Novick LF, Berns DS, Stricof RL, Stevens RW, Pass KA, Wethers JA: HIV seroprevalence in newborns in New York State. JAMA 1989; 261:1745–1750.
4. 1988–1989 five digit zip code boundary file. Lyme, NH: Geographic Data Technology, Inc., 1989.
5. New York State Department of Health: New York State Hospital Discharges. Statewide Planning and Research Cooperative System. Albany, NY: New York State Department of Health, 1988.
6. 1985 population estimates by zip code. Ithaca, NY: National Planning Data Corporation, 1985.
7. Committee to Study the Prevention of Low Birthweight, Division of Health Promotion and Disease Prevention, Institute of Medicine: Preventing Low Birthweight. Washington, DC: National Academy Press, 1985.
8. Therriault G: Development of socioeconomic measures in the analysis of vital statistics data. Presented at the Public Health Conference on Records and Statistics, Washington, DC, June 1978, sponsored by the National Center for Health Statistics.
9. New York State Department of Health: AIDS Surveillance Monthly Update. Albany, NY: New York State Department of Health, October, 1989; 1–34.
10. Centers for Disease Control: Congenital Syphilis—New York City, 1986–1988. MMWR 1989; 38:825–829.
11. Behrman RE: Preventing low birth weight: A pediatric perspective. J Pediatr 1985; 107:842–854.
12. Miller AC, Jekel JF: Incidence of low birth weight infants born to mothers with multiple risk factors. Yale J Biol Med 1987; 60:397–404.
13. McAnarney ER: Young maternal age and adverse neonatal outcome. Am J Dis Child 1987; 141:1053–1059.
14. Gregg GE, Davidson DG, Weindling AM: Inhaling heroin during pregnancy: Effects on the baby. Br Med J 1988; 296:754.
15. Chasnoff IJ, Lewis DE, Griffith DR, Wiley S: Cocaine and pregnancy: Clinical and toxicological implications for the neonate. Clin Chem 1989; 35:1276–1278.
16. Keith LG, MacGregor S, Friedell S, Rosner M, Chasnoff IJ, Sciarra JJ: Substance abuse in pregnant women: Recent experience at the Perinatal Center for Chemical Dependence of Northwestern Memorial Hospital. Obstet Gynecol 1989; 73:715–720.
17. The European Collaborative Study: Mother-to-child transmission of HIV infection. Lancet 1988; 2:1039–1043.
18. Selwyn PA, Schoenbaum EE, Davenny K, Robertson VJ, Feingold AR, Shulman JF: Prospective study of human immunodeficiency virus infection and pregnancy outcomes in the intravenous drug users. JAMA 1989; 261:1289–1294.
19. Johnstone FD, MacCallum L, Brettle R, Inglis JM, Peutherer JF: Does infection with HIV affect the outcome of pregnancy? Br Med J 1988; 296:467.
20. Selik RM, Castro KG, Pappaioanou M: Distribution of AIDS cases, by racial/ethnicity group and exposure category, United States, June 1, 1981–July 4, 1988. MMWR 1988;37 (Suppl. No. SS-3):1–3.
21. Curran JW, Jaffe HW, Hardy AM, Morgan WM, Selik RM, Dondero TJ: Epidemiology of HIV infection and AIDS in the United States. Science 1988; 239:610–616.
22. Hopkins DR: AIDS in the minority populations in the United States. Public Health Rep 1987; 102:677–681.
23. Bakeman R, Lumb JR: AIDS statistics and the risk for minorities. AIDS Res 1986; 2:249–252.