Neighborhood Poverty and the Resurgence of Tuberculosis in New York City, 1984–1992

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Objectives. The resurgence of tuberculosis (TB) in New York City has been attributed to AIDS and immigration; however, the role of poverty in the epidemic is unclear. We assessed the relation between neighborhood poverty and TB at the height of the epidemic and longitudinally from 1984 through 1992.

Methods. Census block groups were used as proxies for neighborhoods. For each neighborhood, we calculated TB and AIDS incidence in 1984 and 1992 with data from the Bureaus of Tuberculosis Control and AIDS Surveillance and obtained poverty rates from the census.

Results. For 1992, 3343 TB cases were mapped to 5482 neighborhoods, yielding a mean incidence of 46.5 per 100 000. Neighborhood poverty was associated with TB (relative risk = 1.33; 95% confidence interval = 1.30, 1.36 per 10% increase in poverty). This association persisted after adjustment for AIDS, proportion foreign-born, and race/ethnicity. Neighborhoods with declining income from 1980 to 1990 had larger increases in TB incidence than did neighborhoods with increasing income.

Conclusions. Leading up to and at the height of the TB epidemic in New York City, neighborhood poverty was strongly associated with TB incidence. Public health interventions should target impoverished areas. (*Am J Public Health.* 2001;91:1487–1493)

Tuberculosis (TB) rates in New York City surged throughout the 1980s and early 1990s as various factors coalesced to promote the transmission and reactivation of TB. Contributors to the epidemic included AIDS,[1] immigration,[2] injection drug use,[3,4] multidrug resistance,[5] homelessness,[6,7] nosocomial transmission,[8,9] and a breakdown in public health measures.[10]

As TB incidence in New York City rose from 1307 cases in 1978 to 3811 cases in 1992, the poverty rate, an older risk factor for TB, also increased. From 1979 to 1993, the poverty rate rose from 11.7% to 15.1% nationally, and the poverty rate in New York City went from 19.3% to 27.3%.[11]

Public health officials have long recognized the predilection of TB for poor neighborhoods,[12,13] and TB rates continue to correlate with poverty in other settings.[14–18] However, in an area with high rates of AIDS and immigration, the contribution of poverty to TB risk may be overshadowed.

We investigated whether poverty remained a major risk factor for TB at the peak of the New York City TB epidemic. Given the large and differential changes in poverty rates in neighborhoods in New York City in the 1980s, we also examined the longitudinal association of changes in poverty with changes in TB incidence.

METHODS

We performed 2 analyses of New York City neighborhoods: (1) cross-sectional, at the peak of the epidemic in 1992, and (2) longitudinal, comparing the change in neighborhood poverty from 1980 to 1990 with the change in neighborhood TB incidence from 1984 to 1992.

Data Sources

For both analyses, neighborhoods were used as the unit of analysis and were defined by the census block group. The block group, a subdivision of a census tract, has a median population of approximately 1000 and covers approximately 4 city blocks. The cross-sectional analysis included all block groups in New York City listed in the 1990 census[19] (n=5785), except block groups likely to have cases of TB for which place of domicile was ambiguous (i.e., hospitals, prisons, or homeless shelters [n=90]) and block groups for which census estimates were unstable (i.e., populations of <100 [n=213]). The longitudinal analysis included all block groups listed in the 1980 census[20] (n=5997), except those with boundary changes between 1980 and 1990 (n=133) and those with a hospital, prison, homeless shelter, or population of fewer than 100 persons in either year (n=458).

The 1980 and 1990 censuses listed population demographics for each block group based on 100% sampling; socioeconomic data, including poverty, median household income, and place of birth, were based on a random sample of approximately 1 in 6 housing units. Sample data were weighted by the census with an iterative ratio estimation procedure to obtain estimates for the complete count.[21]

Incident cases of TB consisted of all notifications to the Bureau of Tuberculosis Control of newly diagnosed, culture-positive, or Centers for Disease Control–defined[22] TB in New York City for the calendar years 1984, the first year for which reliable data were available, and 1992. Each case of TB was matched geographically by street address to a block group with digital maps (Wessex Co, Winnetka, Ill) and MapInfo 3.1 (Mapinfo Corp, Troy, NY). Of the 3811 cases in 1992, 3503 (91.9%) were successfully matched to census block groups; of these, 160 were matched to neighborhoods with a hospital, prison, homeless shelter, or population of fewer than 100 persons, leaving 3343 cases (87.7%) in the analysis. Persons with TB who were homeless were excluded de facto by lack of street address or assignment to an excluded block group via a homeless shelter or hospital address. Of the 1630 cases of TB in 1984, similar proportions were excluded, leaving 1379 cases (84.6%) in the analysis.

Neighborhood Measures

Neighborhood poverty rate was defined as the proportion of persons in the neighborhood living below the federal poverty level.

The federal poverty line is based on household income adjusted for number of household members and was $12 674 for a family of 4 in 1990.[21] The definition of poverty changed in 1981,[23] making a direct comparison of 1980 and 1990 poverty rates difficult; therefore, median household income was used in place of neighborhood poverty in the longitudinal analysis. Median household income from the 1980 census was adjusted to 1990 census values (1989 dollars) with the consumer price index.[24]

Because neighborhoods were quite segregated, the category of predominant race/ethnicity was defined as the race/ethnicity most numerous in a block group. A crowding index was calculated as the mean number of persons divided by the mean number of bedrooms in the block group. Our estimates of the major demographic and socioeconomic indices matched published summary figures for New York City.[25,26]

AIDS incidence was not available at the block group level for reasons of confidentiality. Incident AIDS cases for 1984 and 1992 were obtained at the zip code level from the Bureau of AIDS Surveillance; zip code–level AIDS incidence was calculated by dividing the number of new cases by the population of the zip code[27,28] and was assigned to overlying block groups.

Statistical Analysis

For the cross-sectional analysis, we plotted the weighted mean TB incidence by deciles of neighborhood poverty. Poisson regression was used to estimate the relation of TB incidence to neighborhood characteristics.[29] The logarithm of the number of cases of TB in each neighborhood was modeled as a function of neighborhood variables, with the logarithm of the total population of the neighborhood included as an offset. An overdispersion parameter was included in regressions to correct standard errors. To estimate the relative contributions of independent variables, we calculated the reduction in model deviance from the null model (intercept only) to models containing the intercept and each individual variable. To estimate the strength of associations, we obtained bivariate relative risks (RRs) from Poisson regression models. Because all independent variables were approximately linearly related to TB incidence, they were included in the models as continuous variables.

In the multivariate analysis, we investigated the effects of poverty separately in areas with high and low AIDS incidence, because the effect of poverty appeared to vary by AIDS incidence and because information on AIDS incidence was available only at the zip code level, potentially limiting adjustment.

For the longitudinal analysis, we plotted weighted mean TB incidence in 1984 and in 1992 by quintiles of change in median household income and tested the trend in relative increase in TB incidence with the Kruskal-Wallis test. A Poisson regression model was used to estimate the relative increase in TB between 1984 and 1992 after adjustment for covariates. The logarithm of the number of cases of TB in each neighborhood in 1984 (time=0) and 1992 (time=1) was modeled as a function of time, categories of change in median household income, and the interaction of time with change in median household income. Baseline median household income (at time 0) and covariates (at time 0 and time 1) were included for purposes of adjustment. The generalized estimating equations approach was used to account for the correlation between repeat measures on block groups over time.[30] Coefficients for time and the interaction between time and change in median household income were used to estimate the relative risk of TB

TABLE 1—Characteristics of the New York City Neighborhoods (Block Groups) Included in the Analysis, Based on 1980 and 1990 US Census Data[a]

	Neighborhoods in 1980 (n = 5406)		Neighborhoods in 1990 (n = 5482)		Difference From 1980 to 1990
	Mean	SD	Mean	SD	
Population size (persons)	2069	2445	2160	2349	91
Male, %	46.2	4.1	46.8	5.3	0.6
Median age,[b] y	36.6	11.5	36.4	6.4	−0.2
Race/ethnicity					
White, %	54.6	37.3	43.4	36.8	−11.2
African American, %	23.9	32.3	25.5	32.2	1.6
Hispanic, %	18.6	27.1	23.8	24.0	5.2
Asian, %	2.9	7.4	6.8	11.1	3.9
Mean rate of poverty[c]					
Poverty, %	20.1	16.3	19.3	16.4	. . .[d]
Abject poverty, %	. . .		10.0	10.2	
Median household income, 1989 US dollars	23 732	10 951	30 799	15 506	7067
% With interest or dividend income	. . .		32.4	19.7	
% Who own home	. . .		32.4	29.5	
Crowding (persons per bedroom)	1.44	0.28	1.44	0.38	0.0
Foreign-born, %	23.8	14.5	28.6	17.2	4.8
Recent immigrants, %	. . .		4.5	4.7	
Median AIDS incidence (1984 and 1992 cases, per 100 000)	19.9	27.8	131.0	111.0	111.1
Tuberculosis incidence (1984 and 1992 cases, per 100 000)	20.3	54.8	46.5	87.7	26.2

Note. Ellipses indicate that data are not available.
[a]Totals differ slightly from published census and registry data for the city of New York because of the exclusion of 287 block groups in 1980 and 303 block groups in 1990. Results are weighted by the population of the neighborhood.
[b]Mean age for each block group was estimated as the average of the midpoints of available age brackets weighted by the population in each age bracket.
[c]Rate of poverty was defined as the percentage of the population of the block group living below the federal poverty line; rate of abject poverty was defined as the percentage of the block group living below half of the federal poverty line.
[d]The definition of the federal poverty line changed between the 1980 and 1990 censuses; therefore, the rates are not directly comparable.

for 1992 compared with 1984 by categories of change in median household income. SPSS 6.5 (SPSS Inc, Chicago, Ill) and SAS 7.0 (SAS Institute, Inc, Cary, NC) were used for analyses.

RESULTS

Cross-Sectional Analysis

The incidence of TB in 1992 in the 5482 New York City neighborhoods included in the analysis was 46.5 per 100 000 persons, and the mean rate of neighborhood poverty across these neighborhoods was 19.3% (Table 1). Neighborhood poverty rate varied greatly: 785 neighborhoods had poverty rates of higher than 40%, whereas 1107 neighborhoods had rates of 5% or less.

Cases of TB are described in Table 2. Concurrent HIV infection was higher among United States–born persons with TB than among foreign-born persons with TB (40.0% vs 24.4%, $P<.001$), and the percentage known to be HIV negative was lower (15.1% vs 22.1%, respectively). Citywide, TB incidence was higher among persons born in the United States (47.9 per 100 000) than among foreign-born persons (40.6 per 100 000, $P<.001$).

Association of Neighborhood Poverty With TB

The geographic association of neighborhood poverty and TB cases in New York City in 1992 is shown in Figure 1. Neighborhood poverty explained more of the variability in TB incidence across New York City than did other available neighborhood measures, including proportion foreign-born and race/ethnicity (Table 3).

TB incidence rose linearly with increasing neighborhood poverty (Figure 2). Overall, a 10% increase in the proportion of a neighborhood living at or below the poverty line was associated with a 33% increase in the incidence of TB (Table 3). TB incidence was significantly associated with AIDS incidence, proportion African American, proportion Hispanic, and neighborhood crowding and negatively associated with proportion White, median household income, measures of neighborhood assets (proportion with interest or dividend income and home ownership), and proportion foreign-born.

TABLE 2—Characteristics of Cases of Culture-Positive or CDC-Defined, Newly Diagnosed Tuberculosis (TB) Reported to the New York City Bureau of Tuberculosis Control in 1984 and 1992 That Were Included in the Analysis

	Cases of TB in 1984		Cases of TB in 1992	
	N	%	N	%
Total	1379	100.0	3343	100.0
Sex, male	931	67.5	2250	67.3
Mean age, y	38.0		40.6	
Race/ethnicity				
White	260	18.9	382	11.4
African American	746	54.1	1798	53.8
Hispanic	262	19.0	910	27.2
Asian	109	7.9	252	7.5
Place of birth				
Outside United States	...	...	833	24.9
United States	...	...	2461	73.6
Unknown	...	...	49	1.5
Serostatus				
HIV+	...	...	1187	35.5
HIV–	...	...	555	16.6
Unknown	...	...	1601	47.9

Note. CDC = Centers for Disease Control. Ellipses indicate that data are not available.

TABLE 3—Change in Deviance Attributable to Neighborhood Characteristics and Unadjusted Relative Risk (RR) of Tuberculosis (TB) Incidence According to Neighborhood Characteristics: New York City, 1992

Neighborhood Characteristic	Change in Deviance[a]	RR of TB[b]
Male, %	–14.2	1.12 (1.03, 1.22)
Median age, 1-year increase	–359.5	0.95 (0.94, 0.96)
Race/ethnicity		
African American, %	–560.1	1.13 (1.11, 1.14)
Hispanic, %	–183.6	1.10 (1.08, 1.12)
Mean rate of poverty[c]		
Poverty	–933.8	1.33 (1.30, 1.36)
Abject poverty	–781.7	1.46 (1.42, 1.51)
Median household income ($10 000 increase in 1989 dollars)	–712.5	0.70 (0.67, 0.73)
With interest or dividend income	–777.0	0.77 (0.75, 0.79)
Who own home	–660.8	0.83 (0.81, 0.85)
Crowding (0.5 persons per bedroom increase)	–227.7	1.33 (1.27, 1.39)
Foreign-born, %	–44.5	0.94 (0.91, 0.96)
Recent immigrants, %	–0.2	1.01 (0.91, 1.12)
Median AIDS incidence (100 per 100 000 increase)	–834.0[d]	1.43 (1.39, 1.47)

[a]Change in deviance from Poisson regression model with covariate, compared with null model without covariate. Null model had a deviance of 7511.1. Significant ($P<.05$) reduction in deviance = 3.84.
[b]Unadjusted relative risks and 95% confidence intervals obtained from Poisson regression models. Relative risk denotes increase in TB for each 10% increase in neighborhood attribute, unless units otherwise specified.
[c]Rate of poverty was defined as the percentage of the population of the block group living below the federal poverty line; rate of abject poverty was defined as the percentage of the block group living below half of the federal poverty line.
[d]AIDS incidence data were available only at the zip code level for reasons of confidentiality; therefore, reduction in deviance from AIDS incidence cannot be directly compared with reductions from other variables.

Note. Neighborhoods (census block groups) included in analysis are shaded by decile of neighborhood poverty in 1990: white depicts lowest decile of poverty, ranging to dark gray, which depicts highest decile of poverty. Each dot represents 1 case of tuberculosis in 1992, mapped to its corresponding block group.

FIGURE 1—Geographic association of tuberculosis and neighborhood poverty in New York City in 1992.

The relation between poverty and TB observed in Figure 2 remained monotonic and positive after stratification by AIDS incidence and race/ethnicity. Differences in TB incidence between predominantly African American and predominantly White neighborhoods were greatest in poor neighborhoods and negligible in more affluent neighborhoods.

In stratified analysis, there was evidence of an interaction between proportion foreign-born and neighborhood poverty. TB incidence increased by 35% (95% confidence interval [CI]=31%, 38%) per 10% increase in poverty among the two thirds of the neighborhoods where the proportion of foreign-born persons was less than 33% and by 24% (95% CI=5%, 31%) in neighborhoods with a higher proportion of foreign-born persons. In the more affluent two thirds of the neighborhoods (<22% in poverty), the proportion of foreign-born persons was positively associated with TB incidence (RR=1.10; 95% CI=1.06, 1.15); however, in poorer neighborhoods, rates of immigration and TB were negatively associated (RR=0.86; 95% CI=0.83, 0.90).

Multivariate Analysis

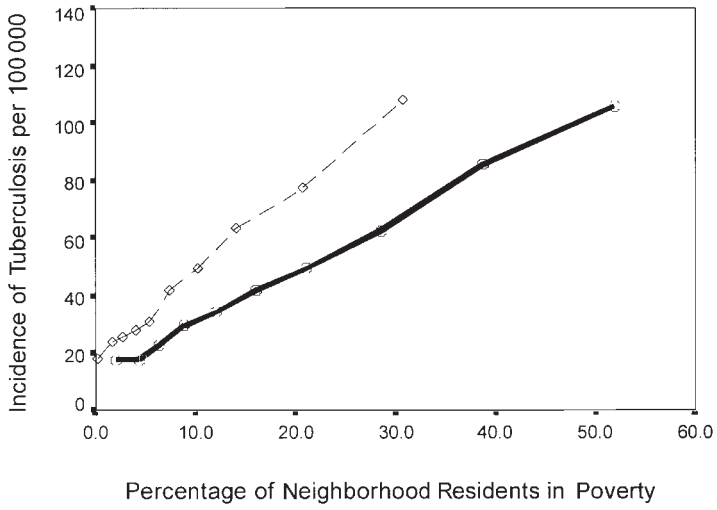
In neighborhoods with a high incidence of AIDS (>100 per 100 000), the poverty rate remained significantly associated with TB in multivariate models (RR=1.18; 95% CI=1.14, 1.23, for a 10% increase in neighborhood poverty rate; Table 4). AIDS incidence and proportion African American remained significantly associated with TB, but foreign-born was not (RR=1.01; 95% CI=0.97, 1.05). When recent immigration was substituted for foreign-born, its association approached statistical significance (RR=1.12; 95% CI=0.98, 1.19) but did not change the coefficients of other variables in the model. Two-way interactions of poverty with AIDS incidence, race/ethnicity, and foreign birth were not statistically significant.

In neighborhoods with a lower incidence of AIDS (<100 per 100 000), the association of poverty and TB differed by proportion foreign-born ($P<.05$). In neighborhoods with a low proportion of foreign-born persons, poverty was associated with TB incidence (RR=1.27; 95% CI=1.17, 1.37), whereas in neighborhoods with a high proportion of foreign-born persons, poverty was not associated with TB incidence (Table 4). Foreign birth was associated with TB incidence, particularly in more affluent neighborhoods. Interactions of poverty with AIDS incidence and with race/ethnicity were not statistically significant.

Longitudinal Analysis

From 1984 to 1992, TB incidence increased from 20.3 to 46.5 per 100 000 (Table 1). Median household income rose from $23 732 to $30 799, but income inequity also increased (SD rose from $10 951 to $15 506). The inverse association of median household income and TB was stronger in 1984 (RR=0.52 per $10 000 increase; 95% CI=0.48, 0.57) than in 1992 (RR=0.70; 95% CI=0.67, 0.73).

The surge in TB incidence from 1984 to 1992 was inversely related to quintile of change in median household income from



Note. Solid line depicts percentage of neighborhood residents in poverty (household income less than the federal poverty line in 1990); dashed line depicts percentage of neighborhood residents in abject poverty (household income less than half of the federal poverty line in 1990).

FIGURE 2—Tuberculosis incidence in New York City in 1992 plotted by decile of neighborhood rates of poverty and abject poverty.

TABLE 4—Multivariate Analysis of Tuberculosis (TB) Incidence and Neighborhood Attributes, by Incidence of AIDS: New York City, 1992

Neighborhood Attribute	RR of TB[a] (95% CI)
Model 1: Neighborhoods With AIDS Incidence > 100 per 100 000 (n = 2526)	
Poverty	1.18 (1.14, 1.23)
Foreign-born	1.01 (0.97, 1.05)
AIDS incidence	1.20 (1.15, 1.26)
African American	1.10 (1.08, 1.13)
Hispanic	1.03 (1.00, 1.06)
Model 2: Neighborhoods With AIDS Incidence < 100 per 100 000 (n = 2944)	
Poverty in neighborhoods with	
13.9% foreign-born (15th percentile)	1.27 (1.17, 1.37)
52.0% foreign-born (85th percentile)	0.97 (0.88, 1.07)
Foreign-born in neighborhoods with	
12.0% in poverty (15th percentile)	1.26 (1.19, 1.34)
21.9% in poverty (85th percentile)	1.10 (1.06, 1.15)
AIDS incidence	1.16 (0.82, 1.65)
African American	1.09 (1.06, 1.13)
Hispanic	1.10 (1.06, 1.13)

Note. RR = relative risk; CI = confidence interval.
[a]Adjusted relative risk from Poisson models is per 10% absolute increase in neighborhood attribute (except for AIDS incidence, which is per 100/100 000 increase). The effects of poverty and foreign birth are shown at 15th and 85th percentiles in model 2 because of a significant multiplicative interaction between these variables.

1980 to 1990, both in relative and in absolute terms (Figure 3, $P<.001$). Although TB increased across all categories of income change, neighborhoods with a decline in median household income from 1980 to 1990 had a larger increase in TB incidence (RR=2.86; 95% CI=2.45, 3.34) than did neighborhoods with a rise in median household income (RR=2.18; 95% CI=2.01, 2.36). After adjustment for AIDS incidence, proportion foreign-born, proportion African American, proportion Hispanic, and baseline median household income, neighborhoods with declining median household income had a larger increase in TB (RR=1.70; 95% CI=1.43, 2.02) than did neighborhoods with rising median household income (RR=1.33; 95% CI=1.20, 1.48, P for the difference=.028).

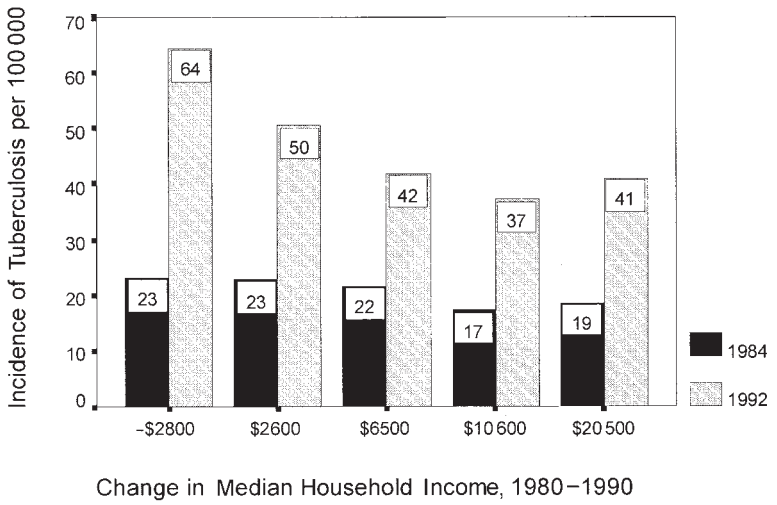
DISCUSSION

At the height of the recent TB epidemic in New York City, neighborhood poverty was strongly and independently associated with TB incidence. Indeed, neighborhood poverty explained a larger amount of the variability in TB incidence than did neighborhood measures of foreign birth and race/ethnicity. Neighborhoods with declining median household income from 1980 to 1990 experienced a larger rise in TB from 1984 to 1992 than did neighborhoods with increasing median household income. These findings suggest the importance of poverty in shaping the epidemic.

Although the surge in TB rates had various underlying causes, we have shown that historic trends in TB persist even in the setting of extremely high rates of AIDS incidence. Prior studies have shown a relation between pediatric TB and poverty in Chicago, Ill,[15] and between adult TB and indices of social deprivation in Liverpool, United Kingdom.[14,31] Excess cases of TB have been noted to occur in only the poorest areas in England and Wales,[32] and changes in unemployment were associated with a change in TB rates in London, England, from 1982 to 1991.[17]

Our study extends these results by examining the role of poverty in TB in the context of an AIDS epidemic and controls for AIDS incidence. One prior study in England and Wales that adjusted for AIDS mortality found that poverty explained more of the variance in TB rates than did AIDS mortality but showed an association between TB mortality and measures of poverty and AIDS only among the subgroup of younger men.[18] We found a similar effect of poverty on the variance of incident TB and a more consistent association of poverty and TB incidence.

Multiple factors may contribute to the relation between neighborhood poverty and TB rates. Residential crowding was associated with TB in this study and others.[15,33] However, residential crowding did not, in the current study, explain the effect of poverty on TB. Undernutrition also may mediate the relation between poverty and TB. Moderate protein undernutrition increases susceptibility to TB infection in animals,[34] and vegetarians seem to have a greater risk of reactivation of



Note. P for trend < .001 across quintiles of change in median household income (1989 dollars).

FIGURE 3—Incidence of tuberculosis in New York City in 1984 and 1992 plotted by change in neighborhood median household income from 1980 to 1990.

TB than do meat or fish eaters, with lactovegetarians having a particularly high risk.[35]

Molecular measures of new transmission (clustering by restriction fragment length polymorphism) correlate with markers of low socioeconomic status, such as homelessness, median household income less than $20 000, and minority race/ethnicity,[36–38] suggesting that poverty may act to increase transmission of TB. New transmission may be expected to cause more active TB in neighborhoods that are naive to TB than in neighborhoods with a high prevalence of latent TB infection. Consistent with this hypothesis, the effect of poverty was greatest in neighborhoods with a low proportion of foreign-born persons and attenuated in neighborhoods with a high proportion of foreign-born persons in our multivariate analysis. A similar interaction has been observed in England.[39]

Whereas national studies have shown a strong association between immigration and TB,[2,40] we found that the proportion of foreign-born persons predicted TB incidence only in neighborhoods with a low AIDS incidence. Our results likely differ from observations at the national level for 3 reasons. First, our definition of "low" AIDS incidence—less than 100 per 100 000—describes virtually all other regions of the United States. Second, 84% of the foreign-born persons in this study had immigrated more than 3 years before the 1990 census and thus would be expected to have a baseline risk of TB in 1992 close to that of the general population. Third, the lack of association of proportion foreign-born with TB in neighborhoods with high AIDS incidence may have resulted from a negative association between foreign-born persons and AIDS incidence in those neighborhoods (Spearman correlation coefficient=–0.426, $P<.001$), which may not have been fully accounted for by the measure used for AIDS adjustment.

Proportion African American remained significantly associated with neighborhood TB rate in the adjusted, cross-sectional model; however, the effect was marginal in neighborhoods with low poverty rates. The persistence of the association may be due in part to residual confounding by AIDS or poverty. High rates of undiagnosed HIV infection have been documented among African Americans in New York.[41] In addition, the poverty rate may not fully capture all differences in socioeconomic conditions across neighborhoods that also differ in racial/ethnic composition.[16]

Because our intent was to investigate the relation between neighborhood poverty and TB rates, we used an ecologic design, and our inferences refer to neighborhoods rather than to individuals. The lack of individual-level socioeconomic information on cases and noncases made it impossible to investigate individual-level associations. Like studies based on individual-level data, ecologic studies may be subject to confounding. We attempted to control for potential ecologic confounders by using stratification and multivariate adjustment. For reasons of confidentiality, our measure of AIDS incidence was less precise than other measures. However, the observed effect of poverty was not likely the result of residual confounding by AIDS, because the association of TB and median household income was considerably stronger in 1984—when AIDS incidence was much lower and less correlated with poverty—than in 1992.

Geographically proximal block groups may share characteristics relevant to TB more than distant block groups do. This residual correlation may violate the assumption of independence and lead to incorrect standard errors. Accounting for spatial correlation, however, raises a series of complex methodological problems. As a way to partly address this problem, we reanalyzed the data with mixed models with a random zip code intercept; all results were qualitatively similar to those presented here.

The undercount of the population by the Census Bureau in the 1990 census was estimated to be 1.8% for the general population, 4.6% for African Americans, and 5.0% for Hispanics.[42] This may have led to an overestimation of TB incidence in poorer neighborhoods in our analysis. When the analysis was repeated after up-weighting estimates of the minority populations by the above percentages, estimates did not change significantly.

Poverty can be linked to TB through a variety of identifiable risk factors over time and, as such, can be thought of as a "fundamental social cause" of diseases such as TB.[43] It may not be possible to correct one mechanistic link and expect the socioeconomic gradient to resolve. The introduction of widespread directly observed therapy and interventions in homeless shelters, prisons, and hospitals has reduced the total burden of TB cases in New York City since 1992.[44] However, it is unlikely that the association of TB and poverty will disappear, given the spread of AIDS into impoverished neighborhoods and reductions in government assistance. Ultimately, as TB control programs become victims of their own

success, priority should be given to impoverished neighborhoods. ■

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This article was accepted October 23, 2000.

Contributors

All authors were involved in the design, execution, and analysis of the study and the writing of the paper. R.G. Barr was primarily responsible for design, data gathering, analysis, and writing the paper. A.V. Diez-Roux assisted in the design, presentation, and particularly the multivariate analyses. C.A. Knirsch obtained data and was involved in the design and writing of the paper. A. Pablos-Méndez supervised the design and assisted in data gathering, analysis, and manuscript preparation.

Acknowledgments

Dr Barr was supported by National Research Service Award grant PE-11001 during work on this study.

The authors wish to thank Dr Thomas R. Frieden for help with access to data; the staff of the Electronic Data Service at Columbia University for assistance with census data; and Drs Steven Shea, Dick Menzies, Barron H. Lerner, and Daniel E. Singer for valuable comments on the manuscript.

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