Low-Income Neighborhoods and the Risk of Severe Pediatric Injury: A Small-Area Analysis in Northern Manhattan

Maureen S. Durkin, PhD, DrPH, Leslie L. Davidson, MD, MSc, Louise Kuhn, MA, MPH, Patricia O'Connor, PhD, and Barbara Barlow, MD, MS

A B S T R A C T

Objectives. The purpose of this study was to investigate the relationship between socioeconomic disadvantage and the incidence of severe childhood injury.

Methods. Small-area analysis was used to examine socioeconomic risk factors for pediatric injury resulting in hospitalization or death in Northern Manhattan, New York, NY, during a 9-year period (1983 through 1991).

Results. The average annual incidence of all causes of severe pediatric injury was 72.5 per 10 000 children; the case-fatality rate was 2.6%. Census tract proportions of low-income households, single-parent families, non–high school graduates, and unemployment were significant predictors of risk for both unintentional and intentional injury. Among the socioeconomic factors considered, low income was the single most important predictor of all injuries; other socioeconomic variables were not independent contributors once income was included in the model. Compared with children living in areas with few low-income households, children in areas with predominantly low-income households were more than twice as likely to receive injuries from all causes and four and one half times as likely to receive assault injuries. The effect of neighborhood income disparities on injury risk persisted after race was controlled.

Conclusions. These results illuminate the impact of socioeconomic disparities on child health and point to the need for injury prevention efforts targeting low-income neighborhoods. (*Am J Public Health.* 1994;84:587–592)

Introduction

Childhood injuries are now recognized as a leading public health problem in the United States and other developed countries.[1–4] Studies of the incidence and risk factors of severe injuries, including nonfatal injuries, are needed to provide direction in planning and implementation of appropriate prevention programs.[5,6] Low socioeconomic status is one risk factor that is relatively well documented for injury fatality, particularly for house fires and homicide,[1,7–11] but it has rarely been investigated for the far more frequent outcome of severe nonfatal injury.[12] In general, the epidemiology of nonfatal injuries differs from and cannot be extrapolated from that of fatal injuries.[13] Another limitation of current knowledge is the absence of information on specific components of low socioeconomic status that affect a child's risk of injury.

We used methods of small-area analysis[14–17] to investigate associations at an ecological (census tract) level between multiple indicators of socioeconomic status and the incidence of severe pediatric injury in an inner-city environment in New York City. One aim of the study was to describe the variability between census tracts in socioeconomic indicators and in mean annual incidence rates during the 9-year study period. Another was to investigate the extent to which geographic variations in injury incidence are explained by variations in socioeconomic indicators. The results are presented for overall severe pediatric injury incidence rates and for broad subcategories of causes.

Methods

The study population consisted of residents of two Northern Manhattan health center districts, Central Harlem and Washington Heights, with a combined population in 1990 of 94 762 children younger than 17 years (Table 1).[18] According to major socioeconomic indicators, Northern Manhattan is disadvantaged relative to the rest of New York City, and the Central Harlem health district is disadvantaged relative to Washington Heights. For example, according to the 1990 census, 34% of the households in Northern Manhattan (40% in Central Harlem and 31% in Washington Heights) lived below the poverty level, compared with 19% in New York City as a whole.[18]

Data Sources

The Northern Manhattan Injury Surveillance System collected data on all injuries to residents of Northern Manhattan younger than age 17 that resulted in hospitalization or death during the years 1983 through 1991.[19] Data were abstracted from medical charts of the two

At the time of the study, Maureen S. Durkin, Leslie L. Davidson, and Louise Kuhn were with the Gertrude H. Sergievsky Center and the Division of Epidemiology, Columbia University, New York, NY. Patricia O'Connor is with the Department of Psychology, Russell Sage College, Troy, NY. Barbara Barlow is with the Department of Pediatric Surgery, Harlem Hospital Center, New York, NY.

Requests for reprints should be sent to Maureen S. Durkin, PhD, DrPH, Sergievsky Center, Faculty of Medicine, Columbia University, 630 W 168th St, New York, NY 10032.

This paper was accepted November 12, 1993.

Editor's Note. See related editorial by Pless (p 537) in this issue.

TABLE 1—Socioeconomic and Demographic Characteristics of Northern Manhattan

Total population	381 995
Children younger than 17 y	94 762
Race/ethnicity, %	
Hispanic	47.0
Non-Hispanic Black	40.2
Non-Hispanic White	10.7
Other	2.1
Age distribution, %	
0–4 y	8.1
5–9 y	7.3
10–14 y	6.8
15–16 y	2.6
>16 y	75.2
Socioeconomic indicators, %[a]	
Low income	33.1
Single parents	36.9
Non–high school graduates	45.0
Crowding	2.7
Mothers not employed	57.4
Unemployed men	15.6

Note. Northern Manhattan comprises two health center districts, Central Harlem and Washington Heights.
Source. Data are from the 1990 US census.[18]
[a]See text for definitions.

TABLE 2—Mean Annual Injury Incidence and Mortality (per 10 000 Population) in Northern Manhattan, 1983 through 1991

	Incidence	Mortality	Case–Fatality
All injuries	72.5	1.8	2.6
Unintentional injuries	57.8	0.8	1.4
Assault injuries	7.1	0.6	10.1
Self-inflicted injuries	2.0	0.1	3.2
Injuries of undetermined cause	4.7	0.3	7.1
All motor vehicle injuries	12.6	0.3	2.4
Pedestrian injuries	7.8	0.2	2.1
Occupant injuries	1.1	0.01	1.1
Fall injuries	16.4	0.2	1.0
Gunshot injuries	3.1	0.3	11.1
Burn injuries	9.5	0.3	3.1
By age group (all injuries)			
0–4 y	81.5	2.5	3.1
5–9 y	59.0	0.9	1.6
10–14 y	64.2	1.2	1.9
15–16 y	88.0	3.2	3.9
By sex			
Male	92.8	2.4	2.6
Female	50.5	1.2	2.4
By race/ethnicity			
Hispanic	44.3	0.7	1.7
Non-Hispanic Black	96.0	2.8	3.0
Non-Hispanic White	27.9	1.1	4.1

Note. Northern Manhattan comprises two health center districts, Central Harlem and Washington Heights.

study hospitals (Harlem Hospital Center and Columbia-Presbyterian Medical Center, the two major hospitals serving the area) and New York City death certificates. Data on residents of other areas hospitalized in these two hospitals were excluded. Injury cases include all those with *International Classification of Diseases* (9th revision) E-codes 800 to 999, which incorporate all trauma, poisonings, and burns resulting from unintentional, intentional, and undetermined external causes. Detailed data are included in the surveillance system for all deaths (n = 162, including 33 deaths following admission to one of the two study hospitals) and for the 4592 survivors who were hospitalized in the two study hospitals during the 9-year period. Less than 2% of the hospitalizations involved readmission of the same child for injury. According to a computerized hospital discharge database maintained by the New York State Department of Health, 76% of all Northern Manhattan children with nonfatal injuries were hospitalized in one of the two study hospitals (72% of those in Central Harlem and 85% of those in Washington Heights). The incidence rates given in Table 2 of this paper were first calculated on the basis of the detailed data on patients treated in the study hospitals, then inflated by 24% to represent the proportion of residents treated in other hospitals.[19] To validate this approach, we compared patients from the study area treated in other hospitals with those treated in the study hospitals and found no major differences in age, sex, ethnicity, or frequency of diagnoses. It was not possible to compare external cause (E-code) distributions because this information was not included in computerized New York State hospital discharge data prior to 1990. The deaths (assumed to be complete) were then added. The denominators (population younger than 17 years) of the incidence rates were weighted averages obtained from US census data for 1980 and 1990.[18,21]

Socioeconomic Variables

The following socioeconomic indicators for each census tract in the study area were derived from the 1990 census: (1) low income (proportion of households with annual incomes of less than $10 000); (2) poverty (proportion of households below the poverty level); (3) single parents (proportion of family households with only one parent present); (4) non–high school graduates (proportion of the population older than 17 years who did not graduate from high school); (5) crowding (proportion of occupied housing units with two or more persons per room); (6) mothers not employed (proportion of women with children younger than 6 years old who are not employed); and (7) unemployed men (proportion of men who are unemployed). The poverty variable is derived from the variables low income and household size; we found its relation to injury risk to be similar to, if somewhat weaker than, that of low income. For brevity's sake, the results for poverty are not reported here. The frequency in the study population of each socioeconomic variable examined, as well as age and ethnic variables, is given in Table 1. After reviewing socioeconomic indicators for Northern Manhattan from the 1980 and 1990 censuses and finding no major changes over the decade, we used only the indicators from the 1990 census in this paper.

Statistical Analysis

For the small-area analyses, the unit of analysis is the census tract. Injury data from the two study hospitals for residents of 75 of Northern Manhattan's 84 tracts were used. Three tracts with fewer than 100 children and six on the boundaries of the area with high proportions of injury admissions to other hospitals were excluded from the small-area analyses to avoid instability of rates due to small denominators. Coefficients of variation[22–24] were computed for each variable by dividing the standard deviation by the mean and chi-square tests of homogeneity were done to assess whether variation between census tracts in both independent and dependent variables was larger than would be expected by chance.[24]

Consistency of the injury rates within each tract over the 9-year period was assessed with Cronbach's alpha coefficient.[25,26] Regression analyses were done only for the overall and cause-specific injury rates considered consistent or reliable (alpha coefficients greater than .40). A simple linear regression of each social indicator with a given type of injury rate and a multiple linear regression of combinations of social indicators with a given injury rate were performed.[27] Injury incidence (all causes and major subtypes) was the dependent variable and indicators of socioeconomic status were the independent variables. In the multiple regression analyses, independent variables with P values of less than .10 were entered. The R^2 is the percentage of variance in injury incidence explained by a given socioeconomic variable after any other variables in the model are controlled.

To further assess low-income neighborhood as a risk factor, we computed the ratio of the incidence rate in census tracts with moderate and large numbers of low-income households to that in a reference area composed of tracts with few low-income households. Confidence intervals around the rate ratios were computed by the Taylor series approximation.[28]

Results

Average annual incidence rates for all injuries and those due to the most frequent external causes, by age, sex, and ethnicity, are displayed in Table 2. Measures of variation between census tracts in injury rates as well as socioeconomic indicators show large and significant variations across the area (Table 3). The bivariate regression results for all injuries show large and significant positive associations with the variables low income and single parents; smaller but still significant positive associations with non–high school graduates, mothers not employed, and unemployed men; and no significant association with crowding (Table 4). The same directions of associations are seen for each category of injury cause, although the strengths and significance levels of the associations vary for different categories (Table 4).

TABLE 3—Range and Variability of Census Tract Mean Injury Incidence and Socioeconomic Indicators, and Year-to-Year Consistency[a] of the Rank Order of Tract-Level Injury Incidence Rates

	Range of Means across Census Tracts	SD	Coefficient of Variation	Cronbach's α
Socioeconomic indicators[b]				
Low income	8.1–77.3	12.47	0.35	
Single parents	4.8–59.1	12.42	0.34	
Non–high school graduates	2.4–75.6	14.35	0.25	
Crowding	0.0–8.4	1.75	0.71	
Mothers not employed	0.0–100.0	17.14	0.32	
Unemployed men	0.0–55.1	9.67	0.57	
Mean injury incidence[c]				
All injuries	3.9–160.2	36.6	0.60	.88
Unintentional injuries	3.9–127.0	28.1	0.57	.83
Assault injuries	0.0–32.8	6.6	1.03	.73
Self-inflicted injuries	0.0–6.6	1.9	1.27	.17
Injuries of undetermined cause	0.0–13.3	3.3	0.84	.30
Motor vehicle injuries	0.0–36.8	7.6	0.73	.46
Pedestrian injuries	0.0–32.9	6.0	0.86	.58
Occupant injuries	0.0–4.6	1.0	1.36	.14
Fall injuries	0.0–39.1	9.3	0.62	.66
Gunshot injuries	0.0–13.4	3.3	1.23	.46
Burn injuries	0.0–276.4	62.5	0.77	.52

[a]As indicated by Cronbach's alpha.
[b]See text for definitions.
[c]Mean annual injury incidence per 10 000 population in each of the 75 included census tracts, 1983 through 1991.

The apparent protective effect of crowding, which is significant for assaults and burns and nearly significant for gunshot injuries, is unexpected and is probably due to confounding by ethnicity. The percentage of Hispanic residents in a census tract is positively correlated with crowding (Pearson correlation coefficient = .76), and Hispanic children have lower injury rates than non-Hispanic Black children. When racial and ethnic composition of neighborhoods is controlled, crowding is no longer associated with assault, burn, or gunshot injury risk.

In the multiple regression analyses, low income (or poverty) was the strongest predictor of all injuries and of each causal category examined. Changes in the order in which the variables were entered did not affect this result. Once income is in the model, crowding continues to have a small negative effect for assault, burn, and gunshot injuries, and the effects of the remaining socioeconomic variables are insignificant.

The rate ratio estimates show a strong positive association between residence in a low-income neighborhood and risk of severe pediatric injury (overall and for each causal category) (Table 5). Compared with children in neighborhoods with few low-income households, children living in largely low-income neighborhoods have more than twice the risk of severe injury from all causes and four and one half times the risk of severe assault injury. For most injury categories considered, a dose–response association is present (Table 5).

Race, ethnicity, and socioeconomic status are highly confounded in Northern Manhattan census tracts, making it difficult to demonstrate an effect of poverty independent of racial composi-

TABLE 4—Simple Linear Regression Results: Socioeconomic Indicators[a] and Injury Incidence[b]

	β[c]	P	R^2
All injuries			
Low income	16.713	.000	.325
Single parents	14.879	.000	.255
Non–high school graduates	9.727	.001	.146
Crowding	−30.972	.205	.022
Mothers not employed	7.522	.002	.124
Unemployed men	13.457	.002	.127
Unintentional injuries			
Low income	12.942	.000	.330
Single parents	11.354	.000	.252
Non–high school graduates	7.673	.000	.153
Crowding	−20.290	.280	.016
Mothers not employed	5.849	.002	.127
Unemployed men	10.312	.002	.126
Assault injuries			
Low income	2.821	.000	.280
Single parents	2.281	.000	.182
Non–high school graduates	1.374	.010	.088
Crowding	−10.043	.022	.070
Mothers not employed	1.206	.007	.097
Unemployed men	2.383	.002	.121
Motor vehicle injuries			
Low income	3.304	.000	.297
Single parents	3.151	.000	.268
Non–high school graduates	1.746	.004	.110
Crowding	−5.028	.320	.013
Mothers not employed	1.069	.036	.059
Unemployed men	2.343	.009	.090
Pedestrian injuries			
Low income	2.858	.000	.355
Single parents	2.240	.000	.217
Non–high school graduates	1.356	.004	.106
Crowding	−5.715	.151	.028
Mothers not employed	0.702	.083	.040
Unemployed men	1.710	.016	.077
Fall injuries			
Low income	3.469	.000	.215
Single parents	2.603	.002	.120
Non–high school graduates	2.246	.002	.119
Crowding	−5.914	.343	.012
Mothers not employed	1.879	.002	.119
Unemployed men	3.380	.002	.123
Gunshot injuries			
Low income	1.049	.001	.153
Single parents	1.070	.000	.158
Non–high school graduates	0.419	.070	.044
Crowding	−4.280	.053	.050
Mothers not employed	0.510	.023	.068
Unemployed men	0.531	.188	.024
Burn injuries			
Low income	2.246	.000	.201
Single parents	2.009	.000	.159
Non–high school graduates	1.452	.004	.111
Crowding	1.583	.706	.002
Mothers not employed	1.151	.006	.100
Unemployed men	0.847	.262	.017

[a]See text for definitions.
[b]Mean annual incidence per 10 000 population in each census tract, 1983 through 1991.
[c]The beta coefficient for low income can be interpreted as the change in injury incidence per 100 000 population for every 1% change in the percentage of low-income households in a census tract. The beta for single parents is the change in injury incidence per 100 000 population for every 1% change in the percentage of family households with only one parent present. The beta coefficients for the remaining independent variables can be interpreted similarly.

tion. In only 3 of 31 predominantly African-American tracts were fewer than one third of the households considered low-income. In an attempt to control for race, we computed incidence rates for non-Hispanic Black children only and found low-income neighborhood to be a significant predictor of injury risk within this group ($R^2 = .14$, $P < .001$). The marginally lower effect in this race-specific regression analysis compared with that of the total population is likely to be due to smaller variation in the proportions of low-income families in African-American neighborhoods. In a relative risk analysis of incidence of all injury types for Black children, the relative risk for low-income neighborhood is 1.9 (95% confidence interval = 1.5, 2.7), not significantly different from the effect among all children. We also tried controlling for race in a multiple regression analysis; after we entered census tract proportion of non-White residents ($R^2 = .49$, $P < .0001$, for all injuries), low income did not explain significant additional variation in injury risk (incremental R^2 for low income = .02, $P = .09$, for all injuries). Perhaps neighborhood racial composition is more accurately measured by the census and provides a better and more comprehensive marker of socioeconomic disadvantage than household income and other intended socioeconomic indicators. Thus, the confounding of poverty with race may be only partly extricable in the census measures; once race is held constant, our ability to show an effect of income is limited.

Discussion

These results show that children living in low-income neighborhoods are at increased risk of severe injury from both unintentional and intentional causes. This general finding is consistent with previous studies of fatal childhood injuries[7,9–11] but has not to our knowledge been demonstrated for the much more frequent occurrence of injury hospitalization. One study, a case–control study carried out in Belfast and published in 1959,[12] showed significant individual-level associations between several indicators of poverty and pediatric morbidity due to motor vehicle collisions.

Another case–control study of nonfatal child bicycle and pedestrian injuries found a twofold excess risk for low vs high maternal education but no signifi-

cant association with residence in an economically disadvantaged neighborhood.[29] Two other studies of nonfatal child pedestrian injuries found that more cases occurred in low-income areas than in more advantaged and less densely populated areas, but these studies did not compute population-based incidence rates to control for differences between areas in population size.[30,31] The present study, based on incidence rates and confined to an inner-city area, shows significant ecological associations between socioeconomic disadvantage and incidence of all major categories of severe pediatric injury.

The two analytic approaches, linear regression and rate ratio estimation, produced similar results except that the regression results imply that low-income neighborhood may be a slightly more important risk factor for unintentional injuries (R^2 = .33) than for assault injuries (R^2 = .28), while the rate ratio results suggest that low-income neighborhood is a much more important risk factor for assault injuries (rate ratio = 4.5) than for unintentional injuries (rate ratio = 2.0). Perhaps this is because the association between low-income neighborhood and injury risk is not linear for all causes, as assumed by the regression approach. For unintentional causes the association fits a linear model, whereas for assault injuries there appears to be a threshold effect. Limitations in the use of linear regression to estimate measures of effect, due to model mispecification and violations of assumptions regarding the distributions of the variables, have been noted.[32]

Because small-area analysis reveals ecological rather than individual-level associations, it is advantageous for identifying risk factors that operate on an ecological level.[33–35] For example, if poor neighborhoods have fewer safe play areas, more children are likely to play in the streets, abandoned buildings, and other hazardous areas. Poor neighborhoods may present other hazards, such as broken playground equipment, broken glass, poor housing, drug activity, violence, and a high prevalence of firearms in the hands of children, adolescents, and young adults.[36] In addition, children in low-income neighborhoods may have limited opportunities to engage in organized extracurricular activities. Other factors may operate at an individual or family level, such as supervision, knowledge, and education regarding child safety; access to safe and affordable child care; teenaged pregnancy; use of violence in response to conflicts; mental health; and stress. For risk factors that work at an individual level, the possibility of ecological fallacy[35,37] must be considered when the small-area approach is used.

TABLE 5—Injury Rate Ratios (RRs) in Moderately Low-Income and Largely Low-Income Census Tracts Relative to Rates in Referent Tracts

	Moderately Low-Income Tracts		Largely Low-Income Tracts	
	RR	95% CI	RR	95% CI
All injuries	1.7	1.6, 1.8	2.2	2.0, 2.4
Unintentional injuries	1.6	1.5, 1.8	2.0	1.8, 2.3
Assault injuries	2.6	1.9, 3.7	4.5	3.2, 6.5
Self-inflicted injuries	2.3	1.3, 4.1	1.9	1.0, 3.7
Injuries of undetermined cause	1.6	1.2, 2.2	1.8	1.2, 2.6
Motor vehicle injuries	1.9	1.6, 2.4	2.5	2.0, 3.2
Pedestrian injuries	2.0	1.5, 2.7	3.1	2.3, 4.2
Fall injuries	1.5	1.3, 1.8	1.9	1.5, 2.2
Gunshot injuries	2.4	1.5, 3.9	3.4	2.0, 5.7
Burn injuries	1.4	1.1, 1.8	1.6	1.3, 2.1

Note. Referent census tracts were those in the lower 25th percentile in proportion of low-income households (n = 19). Moderately low-income tracts = census tracts in the middle two quartiles in proportion of low-income households (n = 37); largely low-income tracts = census tracts above the 75th percentile in proportion of low-income households (n = 19). CI = confidence interval.

The proportions of variance in incidence rates explained by low income (0.15 to 0.36) appear modest relative to R^2s seen in small-area studies of other health outcomes.[14–17,22–24] The causes of injury are multifactorial and most cases may not be associated with economic disparities. Preventable injuries certainly occur to children across all social strata, although they appear to occur at a higher rate in poorer neighborhoods. An additional consideration is that a program to prevent childhood injuries was initiated in Central Harlem during the last 3 years covered by this study.[38] Methodological factors likely to have attenuated the observed effects are the presence of random measurement error in the variables of interest and the fact that coverage by the two study hospitals was lower in the more disadvantaged section of Northern Manhattan, Central Harlem (see Methods section), which also had the highest injury incidence. Although the rates were adjusted overall to take into account treatment in other hospitals, information was not available to make differential adjustments for incomplete case ascertainment by census tract.

Further research is needed to determine the extent to which the association between low-income neighborhood and pediatric injury risk is causal and to identify specific mechanisms and pathways. Prevention efforts, however, need not wait for further research. An immediate implication of the results presented here, along with findings on injury morbidity and mortality in other populations, is that programs, policies, and legislation for child injury prevention should target socioeconomically disadvantaged communities. Within low-income urban neighborhoods, efforts should focus on prevention of a wide range of intentional and unintentional causes of injury, including assaultive and suicidal behaviors, access to firearms, motor vehicle collisions (especially with pedestrians), falls, and burns. A model injury prevention program targeting many of these causes has been initiated in Central Harlem.[38] □

Acknowledgments

This research was supported by grants from the Centers for Disease Control (R49/CCR 202585 and R48/CCR 205055), the National Institute of Neurological Diseases and Stroke (R29 NS27971-03 and R29 NS27971-04), and the Robert Wood Johnson Foundation.

The authors would like to acknowledge Dr Margaret Heagarty for significant contributions to the design of the study and to data collection; Dr Jamal Naqvi for assistance with data collection for the Northern Manhattan Injury Surveillance System; Ms Louise Berenson of the New York City Department of Health for assistance with the death certificate data; and Drs Howard Andrews and Elmer Struening and an anonymous reviewer

for suggestions regarding the small-area analyses and content of the paper.

References

1. Baker SP, O'Neill B, Ginzburg MJ, Li GH. *The Injury Fact Book.* 2nd ed. New York, NY: Oxford University Press; 1992.
2. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives.* Washington, DC: US Dept of Health and Human Services; 1991. DHHS publication PHS 91-50212.
3. Fingerhut L, Kleinman J. Trends and current status in childhood mortality, United States, 1900–1985. *Vital Health Stat [3].* 1989; no. 26:1–44.
4. *World Health Statistics Annual.* Geneva, Switzerland: World Health Organization; 1990.
5. Haddon W. Advances in the epidemiology of injuries as a basis for public policy. *Public Health Rep.* 1980;95:411–421.
6. Robertson L. *Injury Epidemiology.* New York, NY: Oxford University Press; 1992.
7. Wise PH, Kotelchuck M, Wilson ML, Mills M. Racial and socioeconomic disparities in childhood mortality. *N Engl J Med.* 1985;313:360–366.
8. Baker SP, Whitfield RA, O'Neill B. Geographic variations in mortality from motor vehicle crashes. *N Engl J Med.* 1987;316:1384–1387.
9. Mierley MC, Baker SP. Fatal house fires in an urban population. *JAMA.* 1983;249: 1466–1468.
10. Nersesian WS, Petit MR, Sharper R, Lemieux D, Naor E. Childhood death and poverty: a study of all childhood deaths in Maine, 1976 to 1980. *Pediatrics.* 1985;75:41–50.
11. Winpisinger KM, Hopkins RS, Indian RW, Hostetler JR. Risk factors for childhood homicides in Ohio: a birth certificate–based case–control study. *Am J Public Health.* 1991;81:1052–1054.
12. Backett EM, Johnston AM. Social patterns of road accidents to children: some characteristics of vulnerable families. *BMJ.* 1959;1:409–412.
13. The National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge. *Am J Prev Med.* 1989;5(suppl 3):1–303.
14. Struening EL. Social area analysis as a method of evaluation. In: Struening EL, Guttentag M, eds. *Handbook of Evaluation Research.* Beverly Hills, Calif: Sage; 1975:203–215.
15. McPherson K, Wennberg H, Hovind OB, Clifford P. Small area variations in the use of common surgical procedures: an international comparison of New England, England and Norway. *N Engl J Med.* 1982;307:1310–1314.
16. Roos N. Hysterectomy: variations in rates across small areas and across physicians' practices. *Am J Public Health.* 1984;74: 327–335.
17. Andrews HF, Kerner JF, Zauber A, Mandelblatt J, Pittman J, Struening E. Using census and mortality data to target small areas for breast, colorectal, and cervical cancer screening. *Am J Public Health.* 1994;84:56–61.
18. *1990 Census of Population and Housing.* Washington, DC: US Dept of Commerce, Bureau of the Census; 1993. Publication 1990 CPH-3.
19. Davidson LL, Durkin MS, O'Connor P, Barlow B, Heagarty MC. The epidemiology of severe injuries to children in Northern Manhattan: methods and incidence rates. *Paediatr Perinat Epidemiol.* 1992;6:153–165.
20. *International Classification of Diseases.* 9th revision. Geneva, Switzerland: World Health Organization; 1980.
21. *1980 Census Tracts.* Washington, DC: US Dept of Commerce, Bureau of the Census; 1981. Publication PHC 80-2.
22. Diehr P, Cain K, Connell F, Volinn E. What is too much variation? The null hypothesis in small-area analysis. *Health Serv Res.* 1990;24:741–771.
23. Wennberg J, Gittelsohn A. Small area variations in health care delivery. *Science.* 1973;182:1102–1108.
24. Chassin MR, Brook RH, Park RE, et al. Variations in the use of medical and surgical services by the Medicare population. *N Engl J Med.* 1986;314:285–290.
25. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrica.* 1951;16:297–334.
26. Kerner JF, Andrews H, Zauber A, Struening E. Geographically-based cancer control: methods for targeting and evaluating the impact of interventions in defined populations. *J Clin Epidemiol.* 1988;41:543–553.
27. Cohen J, Cohen P. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences.* 2nd ed. Hillsdale, NJ: Lawrence Erlbaum; 1983.
28. Kleinbaum DG, Kupper LL, Morgenstern H. *Epidemiologic Research: Principles and Quantitative Methods.* Belmont, Calif: Lifetime Learning Publications; 1982.
29. Pless IB, Verreault R, Tenina S. A case–control study of pedestrian and bicycle injuries in childhood. *Am J Public Health.* 1989;79:995–998.
30. Rivera FP, Barber M. Demographic analysis of childhood pedestrian injuries. *Pediatrics.* 1985;76:375–381.
31. Braddock M, Lapidus G, Gregorio D, Kapp M, Banco L. Population, income, and ecological correlates of child pedestrian injury. *Pediatrics.* 1991;88:1242–1247.
32. Greenland S, Maclure M, Schlesselman JJ, Poole C, Morgenstern H. Standardized regression coefficients: a further critique and review of some alternatives. *Epidemiology.* 1991;2:387–392.
33. Morgenstern H. Uses of ecological analysis in epidemiologic research. *Am J Public Health.* 1982;72:1336–1344.
34. Greenland S. Divergent biases in ecologic and individual-level studies. *Stat Med.* 1992;11:1209–1223.
35. Von Korff M, Koepsell T, Curry S, Diehr P. Multi-level analysis in epidemiologic research on health behaviors and outcomes. *Am J Epidemiol.* 1992;135:1077–1082.
36. Grossman DC, Rivera FP. Injury control in childhood. *Pediatr Clin North Am.* 1992;39:471–485.
37. Robinson WS. Ecological correlations and the behavior of individuals. *Am Sociol Rev.* 1950;15:351–357.
38. Davidson LL, Durkin MS, Kuhn L, O'Connor P, Barlow B, Heagarty M. The impact of the Safe Kids/Healthy Neighborhoods Injury Prevention Program in Harlem, 1988 through 1991. *Am J Public Health.* 1994;84:580–586.