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Income Inequality and Infant Mortality in New York City

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ABSTRACT *A series of studies have demonstrated that people who live in regions where there are disparities in income have poorer average health status than people who live in more economically homogeneous regions. To test whether such disparities might explain health variations within urban areas, we examined the possible association between income inequality and infant mortality for zip code regions within New York City using data from the 1990 census and the New York City Department of Health. Both infant mortality and income inequality (percentage of income received by the poorest 50% of households) varied widely across these regions (range in infant mortality: 0.6–29.6/1,000 live births; range in income inequality: 12.7–27.3). An increase of one standard deviation in income inequality was associated with an increase of 0.80 deaths/1,000 live births (*$P < .001$*), controlling for other socioeconomic factors. This finding has important implications for public health practice and social epidemiological research in large urban areas, which face significant disparities both in health and in social and economic conditions.*

KEYWORDS *Income inequality, SES, New York City, Infant mortality.*

> Infant mortality is not a health problem. Infant mortality is a social problem with health consequences.
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> Marsden G. Wagner, *Journal of Public Health Policy*, 1988

There has been a growing awareness in recent years of the widening gap between rich and poor in the United States, and concern about its health and social consequences. Recent studies by the US Bureau of the Census indicate that the level of income inequality has grown by at least 20% from a post–World War II low in 1968.[1] In 2001, the top fifth of all families in the United States received approximately 50% of the nation's total income, while the bottom fifth received less than 4%.[2] As a result, income inequality in the United States now surpasses that of all other advanced industrial countries.[3,4] Wealth is even more dramatically skewed

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than income: In 1995, 39% of total household wealth was controlled by the top 1% of wealth holders, while the bottom 80% controlled just 16% of the nation's wealth.[5,6] This is the highest concentration of wealth amassed in the United States since the Great Depression.

There is some evidence that inequalities in health have paralleled this widening gap in income and wealth.[7–10] An individual's socioeconomic level within a society, often measured by income, has long been recognized as an important determinant of health. However, it has only been in the past few years that differences in the level of income disparity between countries, states, and metropolitan areas have also been linked to health outcomes. A number of research groups have demonstrated statistically significant relationships between unequal income distribution and mortality.[11–26] Furthermore, this relationship appears to be independent of fertility, maternal literacy, and education in developing countries and, strikingly, independent of average incomes, absolute levels of poverty, smoking, racial differences, and the provision of medical services in developed countries. However, the most recent research findings have been somewhat inconsistent,[27–30] and there has been considerable debate about how to interpret these inconsistencies given the variation in study designs.[31–33] While some argue that the association between income inequality and health outcomes reflects insufficient adjustment for confounding by absolute income, others argue that public health can be advanced by uncovering a more precise pathway between income inequality—defined at various societal levels—and specific health outcomes. Thus, the association between income inequality and poor health remains a provocative hypothesis.

The possibility that income inequality per se influences health in the United States has important policy implications. It indicates that strategies aimed at increasing income are unlikely to have as full an impact as possible on health disparities unless they are appropriately targeted to reduce inequality. However, a study that compared the impact of income inequality on mortality in U.S. and Canadian cities is also worth noting.[34] While income inequality was significantly associated with mortality in the United States, it was not associated with mortality in Canada, a country with both lower income inequality and health and social policies that ensure certain services and living conditions across socioeconomic groups. Thus, programs and services to more broadly improve socioeconomic disparities in the United States may be needed in addition to more targeted programs to reduce income inequalities.

One unanswered question relevant to policymakers is at what level of social organization income inequality most efficiently predicts health outcomes. To date, studies have focused on inequalities measured at the national, state, and metropolitan-area levels, but only a few studies have reported the effect of income inequality at lower levels of geographic aggregation.[35–37] The ability to define the efficiency of income inequality at narrow as well as broad social levels should help policymakers develop the most effective strategies to reduce disparities in health by socioeconomic group. It should also help improve our understanding of the pathways between inequality and health. Thus, in this article we examine the health impact of income inequality in a large urban center, New York City, at relatively low levels of aggregation—zip code areas. Our outcome for this analysis is infant mortality.

METHODS

The income inequality measure used in this analysis is the percentage of income received by the least well-off 50% of households, based on the 1990 U.S. Census.

This represents the proportion of the total aggregate income earned by the poorest 50% of the population in the sampling unit (e.g., zip code) to the total aggregate income in each unit, and ranges from 0% (perfect inequality) to 50% (perfect equality). We followed the method used by Kaplan et al.[19] in calculating income inequality from census data.

Other socioeconomic characteristics were also obtained at zip code level from the 1990 census, including population size, per capita income, percentage high school educated, percentage unemployed, and percentage black versus nonblack.

Infant deaths per 1,000 live births were calculated for each zip code using linked birth certificate and infant death data obtained from the New York City Department of Health for the years 1988–1989 and 1992–1993, periods just before and after the 1990 census. The zip code used is the residence of the mother. To exclude zip codes that were largely commercial with relatively small residential areas, we omitted the 26 zip codes with populations of fewer than 5,000 persons based on census data and seven zip codes with fewer than 100 live births during the study period. The final sample included 156 zip codes with 485,624 live births and 4,859 infant deaths. These figures represent 97% of all live births and 96% of infant deaths in New York City during this period.

Descriptive statistics such as the mean, median, and standard deviation of infant mortality, income inequality indices, and other predictors were derived using Stata software.[38] The correlations between infant mortality and both income inequality and per capita income were estimated using Spearman correlations. Because previous reports demonstrated that income and income inequality may operate differently for different income strata,[35,39] we categorized both income inequality and per capita income variables into tertiles. The mean, median, and standard deviation of infant mortality were calculated for each tertile. Infant mortality comparisons among tertiles of the income inequality and per capita income were made using Kruskal-Wallis tests. When statistically significant differences among tertiles were found, pairwise comparisons were carried out using the Wilcoxon rank sum procedure.

Multivariate analyses were conducted to examine the association between infant mortality and income inequality while controlling for other predictors. Probit regression analysis was conducted to estimate the marginal effect on the probability of infant death associated with an increase of one standard deviation in each predictor variable. The probit analysis was conducted using the *bprobit* function of Stata statistical software.[38] This function produces maximum-likelihood probit estimates on grouped data. We transformed predictor variables to approximately linearize their relationship with infant death in our probit models. As the results using the transformed and the untransformed predictor variables were essentially the same, we present the results using the untransformed variables for ease of interpretation. Analyses were also conducted separately for the three subgroups defined by tertiles of per capita income.

RESULTS

Infant mortality during the study period varied dramatically across zip code areas in New York City, ranging from 0.64 to 29.62 deaths per 1,000 live births, a 46-fold difference; the mean and median are 9.1 and 8.3, respectively (Table 1).

Higher income inequality and lower per capita income are both significantly correlated with higher infant mortality measured at the zip code level (Spearman

TABLE 1. Infant mortality and sociodemographic characteristics of 156 zip code areas in New York City

	Mean (s.d.)	Median	Range
Infant mortality/1,000 live births	9.1 (4.7)	8.3	0.6–29.6
Income inequality (percent)	19.9 (3.3)	19.8	12.7–27.3
Per capita income ($)	16,671 (10,729)	14,410	5,035–66,046
Percent black	27.0 (29.0)	16.0	0.3–96.0
Percent with high school education	69.0 (13.0)	70.0	38.0–95.0
Percent unemployed	9.2 (4.2)	8.1	3.6–22.6

Note: Infant mortality is based on infant births and deaths for the years 1988–1989 and 1991–1992. Sociodemographic data are based on the 1990 census. Income inequality is measured as the percentage of income received by least well-off 50% of households in each zip code area.

correlation for infant mortality and income inequality is –.42, and for infant mortality and per capita income is –.55). Median infant mortality increases significantly with income inequality, from 6.5, to 7.4, to 11.4 for most equal, moderately equal, and most unequal zip code groupings, and decreases significantly from 11.9, to 7.3, to 5.3 in low, middle, and high per capita income zip codes, respectively (Table 2).

Table 3 shows the change in the number of infant deaths per 1,000 live births that is associated with an increase of one standard deviation in income inequality. Column 1 shows the effect of income inequality on infant mortality for all 156 New York City zip codes included in this analysis. Holding other predictors constant, an increase in income inequality of one standard deviation is associated with an increase of 0.80 deaths per 1,000 live births ($P < .001$).

Columns 2–4 illustrate the effect of income inequality on infant mortality for zip codes in each tertile of per capita income. In unadjusted models, the association between risk of infant death and income inequality is statistically significant for both the lowest and highest income tertiles, but in adjusted models, this association is statistically significant only among those with the lowest per capita income: an

TABLE 2. Infant mortality by zip code–level income inequality and per capita income tertiles in New York City

	Mean (s.d.)	Median	Range
Income inequality*			
Equal (N = 44)	7.1 (3.7)	6.5	0.6–13.8
Moderately equal (N = 54)	7.8 (3.2)	7.4	1.6–15.9
Unequal (N = 58)	11.8 (5.3)	11.4	3.4–29.6
Per capital income†			
Low (N = 55)	12.4 (4.8)	11.9	3.6–29.6
Middle (N = 58)	8.1 (3.6)	7.3	1.7–19.8
High (N = 43)	6.1 (3.2)	5.3	0.6–13.0

*Infant mortality, equal vs. moderately equal income, $P = .2698$; equal vs. unequal income, $P = .0001$; moderately equal vs. unequal income, $P = .0001$; three income inequality group comparison, $P = .0001$.

†Infant mortality, low vs. middle income, $P = .0001$; low vs. high income, $P = .0001$; middle vs. high income, $P = .0072$; three income group comparison, $P = .0001$.

TABLE 3. Change in infant deaths per 1,000 live births for each standard deviation increase in income inequality in zip code areas in New York City

	All NYC Zip codes	Zip codes with low income	Zip codes with middle income	Zip codes with high income
Unadjusted	2.03	1.43	0.17	1.16
	(s.e. = 0.14)	(s.e. = 0.29)	(s.e. = 0.34)	(s.e. = 0.31)
	($P < .001$)	($P < .001$)	($P = .62$)	($P < .001$)
Adjusted*	0.80	0.93	0.65	0.59
	(s.e. = 0.23)	(s.e. = 0.46)	(s.e. = 0.39)	(s.e. = 0.50)
	($P < .01$)	($P = .04$)	($P = .10$)	($P = .24$)
Number of zip codes	156	55	58	43
Number of infant deaths	4,859	3,165	1,230	464
Number of live births	485,624	259,910	148,956	76,758

*Adjusted models include the following covariates: per capita income, percent black, percent with a high school education, and percent unemployed.

increase in one standard deviation of income inequality results in an increase of 0.93 ($P = .04$) infant deaths per 1,000 live births for the lowest income tertile, holding other covariates constant.

DISCUSSION

Our results indicate that income inequality at the zip code level explains a small but statistically significant part of the variation in infant mortality within New York City, even after adjusting for other measures of socioeconomic status (SES). Consistent with other studies, this effect was evident mainly among those areas with the lowest SES (e.g., refs. 35 and 39). Thus, New York City Department of Health initiatives to lower infant mortality should consider the impact of income disparities on health and social conditions for the poor. In addition to targeting high-risk populations and geographic areas, this may include advocating for income support policies that have been successful at the state and national level, such as increasing the minimum wage and expanding the Earned Income Tax Credit program.[40–41]

In some ways, these findings appear to contradict earlier hypotheses that income inequality is unlikely to exert an effect on smaller levels of aggregation (such as zip code areas). According to Richard Wilkinson, at smaller levels of aggregation, the relevant social comparison hinges on how deprived the whole area is in relation to the standard of the wider society, which can be measured by median income.[33,42] However, zip code areas of New York City—and perhaps other large metropolitan areas in the United States—comprise relatively large and diverse populations (each zip code in New York City contains about 44,000 residents). Clearly, these zip code–level findings may not be generalizable to other parts of the country.

While this study did not test hypotheses that might explain how income inequality leads to increased infant mortality, it suggests that mechanisms of income inequality that can be measured at the zip code level, such as social capital and the psychosocial effects of relative deprivation, can and should be explored within New York City.[43] Furthermore, James House has argued that income inequality indices are related to health outcomes because they effectively measure the size of the population whose income level is insufficient to provide adequate standards of living.[44] In a post hoc analysis of our data, the effect of income inequality diminished once

the percentage in poverty was included in a multivariate analysis (data not shown), indicating this is probably a mechanism of income inequality in New York City that also should be examined further.

A significant limitation of this analysis is the lack of individual-level data on SES. Our inability to conduct multilevel analyses (due to lack of available data) may confound income inequality by individual income. However, previous research that incorporated both individual and community-level income variables suggests that with few exceptions (e.g., refs. 27 and 28), economic inequality does have an adverse effect on morbidity and mortality after appropriately controlling for individual or household income, at least in the United States.[35,39,45–47]

Another limitation is our approximation of neighborhoods using zip code areas. Kreiger et al. recently reported that zip code areas might be less efficient than other small-area measures, like census tract and block group, for social epidemiological research.[48,49] However, public health data in New York City are commonly available at zip code levels, and research based on these data has produced important and useful findings, despite the limitations. For example, recent studies in New York City found important patterns by SES measures at the zip code level for other health outcomes, such as asthma, HIV disease severity, and psychosis.[50–52] Thus, it appears that zip code areas, at least in New York City, represent a useful construct for social and economic research in public health.

Finally, while our analysis was not intended to focus on this, we note the dramatic variation in risk of infant death—a 46-fold difference across zip codes within New York City. During the study period (1988–1993), infant mortality rates in New York City decreased at an accelerated rate compared with previous years, and compared with the rest of the nation.[53,54] However, the factors that contributed to this citywide decline clearly did not eliminate the tragic disparities in infant mortality across different populations, racial groups, or small geographic regions. Public health interventions to address these patterns are urgently needed.

In conclusion, this work builds on an emerging empirical and theoretical foundation of knowledge about the dynamic between income inequality and health. The findings provide tangible support for integrating social welfare and public health initiatives in New York City and for including health impact assessments as economic and social policies are developed and evaluated.

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