The Disappearing Income Gradient in New York City Birth Outcomes: Thirteen Years of Convergence From 1988 to 2001

Andrew D. Racine, MD, PhD*, and Theodore J. Joyce, PhD‡

ABSTRACT. *Objective.* Income has long been identified as a potent determinant of infant mortality, yet little is known about the stability of its influence over time in defined populations. The objective of this study was to characterize trends in the income gradient in infant mortality in New York City from 1988 to 2001.

Methods. An ecological analysis was conducted of infant, neonatal, and postneonatal mortality rates in 30 health districts from 14 years (1988-2001) of birth cohorts of the 5 boroughs of New York City divided by quartile of income based on the 1990 census (*N* = 1 692 721 births). Infant mortality (deaths occurring at <365 days of age), neonatal mortality (deaths occurring at <28 days of age), and postneonatal mortality (deaths occurring from 28 to 364 days of age) expressed as rates per 1000 live births were measured.

Results. From 1988 to 2001, infant mortality in the highest income quartile in New York City fell 50.5% from 10.5 to 5.2, whereas in the lowest income quartile, it fell 62.6% from 17.4 to 6.5 per 1000 live births. The equivalent declines in neonatal mortality were 46.6% from 7.3 to 3.9 in the highest income quartile and 61.4% from 11.4 to 4.4 per 1000 live births in the lowest income quartile. For postneonatal mortality, rates fell 58.1% from 3.1 to 1.3 in the highest income quartile and 65% from 6 to 2.1 per 1000 live births in the lowest income quartile. Adjusted for covariates, relative to the highest income quartile, infant, neonatal, and postneonatal morality rates in the lowest income quartile declined 0.36 (95% confidence interval [CI]: −0.52 to −0.19), 0.20 (95% CI: −0.34 to −0.07), and 0.15 (95% CI: −0.23 to −0.07) per 1000 live births more per year.

Conclusions. From 1988 to 2001, New York City witnessed a significant convergence in the income gradients of infant, neonatal, and postneonatal mortality rates. Understanding the origins of this trend should constitute an important public policy priority. *Pediatrics* 2004; 114:e51–e57. URL: http://www.pediatrics.org/cgi/content/full/114/1/e51; *infant mortality, income, small-area analysis.*

The inverse relationship between income and infant mortality has been demonstrated in cross-sectional ecological analyses for more than a century.[1–5] Contemporary investigations confirm the persistence of this income gradient within the United States,[6,7] within other industrialized nations,[8,9] and between different countries.[10–12] With few exceptions, areas with lower aggregate income experience rates of infant mortality that are elevated compared with areas with higher aggregate income. What is not known is the degree to which this association remains stable in specific geographic locations over time as other factors change. The policy implications of a temporally mutable income gradient in infant mortality would not be insignificant. The findings might be used to guide future decisions with respect to the allocation of health care resources, the incentives for labor force participation, the establishment of educational priorities, or societal efforts to influence fertility behavior.

In New York City, remarkable progress has been made recently in decreasing the aggregate rate of infant mortality such that, between 1988 and 2001, New York City caught up with and then surpassed improvements in this metric recorded by the nation as a whole.[13,14] During this same period, the population of New York City experienced sizable expansions in Medicaid income eligibility thresholds,[15] the inauguration of Child Health Plus to provide health insurance coverage for near-poor families,[16] the growth of managed care as the dominant financing mechanism for health care services,[17] the initiation of welfare reform,[18] and the largest continuous economic expansion since the Second World War. In light of these developments, we sought to investigate whether the overall improvement in rates of infant mortality in New York City from 1988 to 2001 was accompanied by changes in the income gradient associated with this important measure of population health.

METHODS

The New York City Department of Health and Mental Hygiene annually reports a variety of vital statistics aggregated to 30 health districts in the 5 boroughs.[13] For the purposes of this investigation, we abstracted, by health district, the following variables from these reports for the years 1988–2001: infant, neonatal, and postneonatal mortality rates; percentage of infants whose delivery was financed by Medicaid; percentage of births to teenage mothers, percentage of births to foreign-born mothers; percentage of women who received late or no prenatal care; number of live births; and percentage of low birth weight infants. We appended to these variables the percentage of births to black women abstracted from birth certificate tapes furnished by the New York City Department of Health and Mental Hygiene. We elected not to include a separate measure of ethnicity beyond inclusion of the variable for foreign-born women.

Infant mortality rates were defined as deaths of children under

1 year of age per 1000 live births occurring in the same calendar year as the deaths. Neonatal mortality rates were defined as deaths at <28 days per 1000 live births, and postneonatal mortality rates were defined as deaths from 28 to 364 days per 1000 live births occurring in the same calendar year as the deaths. In calculating the rates, births and deaths refer to events occurring to infants of health district residents.

Income data (for 1989) were obtained from the 1990 census by census tract, and, following an algorithm provided by the New York City Department of Health and Mental Hygiene, median family income figures for the census tracts were mapped to health districts. We chose median family income as the measure of central tendency for this metric because of the widely recognized skewness of the distribution of income in populations. Aggregate median family incomes were then calculated for each health district and appended to the variables listed above. A second set of income data were obtained in a similar manner from the 2000 census. The health district rankings changed marginally between the 2 decennial census reports, but the results were robust to repeating the analysis using health district rankings based on the 2000 census (results available on request).

The 30 health districts were ranked by 1989 median family income and separated into quartiles, with quartile I containing the group of health districts with the highest median family income and quartile IV containing the group of health districts with the lowest median family income. Unadjusted and adjusted weighted ordinary least squares regressions were estimated with infant mortality rates, neonatal mortality rates, postneonatal mortality rates, and low birth weight rates as outcomes according to the model $IMR = \alpha + \beta_1 HD + \beta_2 TREND + \beta_3 QUARTILE * TREND + \beta_4 X$, where dichotomous indicators for each health district control for time invariant unobservable differences across health districts and a linear time trend variable captures the secular trend in the outcome over the entire period. We also include quartile*trend interaction terms for quartiles II to IV. Coefficients for these quartile*trend interaction terms capture the effect of how much more the outcomes of interest changed over time in the 3 lowest income quartiles relative to the highest income quartile in the city. Adjusted regressions included a vector of year and health district–specific indicators for percentage of infants whose delivery was financed by Medicaid, percentage of births to teenage mothers, percentage of births to foreign-born mothers, percentage of births to black women in each district, percentage of women who received late or no prenatal care, and percentage of low birth weight infants. These variables control for potential health district compositional changes over time that might influence the rate of infant mortality.

RESULTS

Table 1 summarizes the changes that occurred from 1989 to 1999 in median family income and from 1988 to 2001 in rates of low birth weight, infant mortality, neonatal mortality, and postneonatal mortality. It can be seen that the median family income of the highest income quartile increased 40.5% from $48 368 per year to $67 944 per year, whereas the income of the lowest income quartile increased 48.2% from $16 870 to $25 006. This observed relative nar-

rowing of the income gap between the lowest income and highest income quartiles contrasts with the prevalent belief that the rich were getting much richer relative to the poor during the 1990s. The use of median family income in this study rather than mean income may account for this discrepancy. US families whose incomes increased the most from 1990 to 2000 were those in the top 5% of the population (mean income for the highest income 5% of the population increased from $148 124 to $280 312 for a rise of 89% compared with an increase of only 42% in the mean income of families in the lowest income fifth of the income distribution).[19] Were we to have recorded mean incomes, this effect would have predominated.

Each measured health outcome in this table demonstrates an income gradient from the lowest income quartile to the highest income quartile. The table also indicates that the proportionate decline in these adverse health outcomes for the lowest income quartile exceeded the decline experienced by the highest income quartile without exception. Trends for these health outcomes over the course of the entire 14-year period are represented in Figs 1–4. In each of these figures, the absolute convergence between income quartiles is apparent over the course of the 14 years of observations.

In Table 2, we depict similar trends in the following covariates by quartile of income: percentage of foreign-born mothers, percentage of teenage mothers, percentage of deliveries financed by Medicaid, percentage of deliveries to black women, and percentage of deliveries that had late or no prenatal care. The influx of foreign-born mothers during the 1990s seemed more heavily concentrated in the quartiles of middle income rather than the highest income or the lowest income sections of the city, although in percentage terms, the greatest increase was seen in quartile IV. Rates of teenage deliveries remain relatively stable with slight declines toward the end of the period in all income quartiles. In the early part of the decade, federal legislation that expanded the income thresholds for Medicaid resulted in increased percentages of deliveries financed through this mechanism in all quartiles. The greatest absolute percentage increases in this variable occurred in the 2 middle income quartiles, as might be expected from a policy that increased the income eligibility threshold for this program to 185% of the federal poverty level. The percentage of deliveries to black women

TABLE 1. Changes in Median Family Income and Rates of Low Birth Weight, Infant Mortality, Neonatal Mortality, and Postneonatal Mortality by Quartile of Income in New York City, 1988–2001

Quartile	Median Family Income			Low Birth Weight Rate*			Infant Mortality Rate†			Neonatal Mortality Rate‡			Postneonatal Mortality Rate§		
	1989	1999	% Δ	1988	2001	% Δ	1988	2001	% Δ	1988	2001	% Δ	1988	2001	% Δ
I	$48 368	$67 944	40.5	8.1	8.0	−1.2	10.5	5.2	−50.5	7.3	3.9	−46.6	3.1	1.3	−58.1
II	$36 935	$43 596	18.0	8.6	8.3	−3.5	10.8	5.1	−52.8	7.9	3.6	−54.4	2.9	1.5	−48.3
III	$26 247	$32 800	25.0	10.1	8.6	−14.0	14.5	5.7	−60.7	10.2	3.8	−62.7	4.3	1.9	−55.8
IV	$16 870	$25 006	48.2	13.0	9.1	−30.0	17.4	6.5	−62.6	11.4	4.4	−61.4	6.0	2.1	−65.0

* Births <2500 g as a percentage of all live births.
† Deaths per 1000 live births occurring <365 days after birth.
‡ Deaths per 1000 live births occurring <28 days after birth.
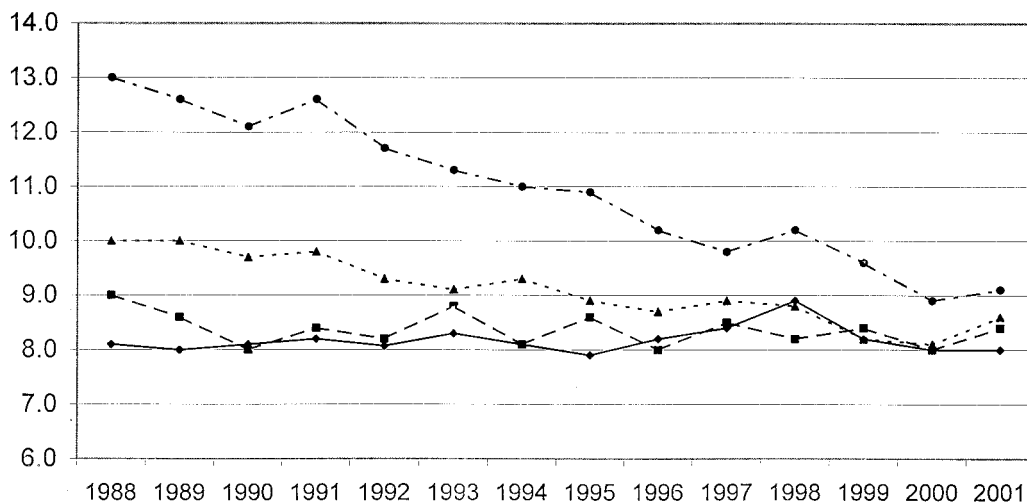§ Deaths per 1000 live births occurring from 28 to 364 days after birth.

Fig 1. Trends in New York City low birth weight rates by quartile of poverty, 1988–2001. Quartile I, —; quartile II,– – –; quartile III, · · · · · · · · · · · ; quartile IV, – · — · — · .
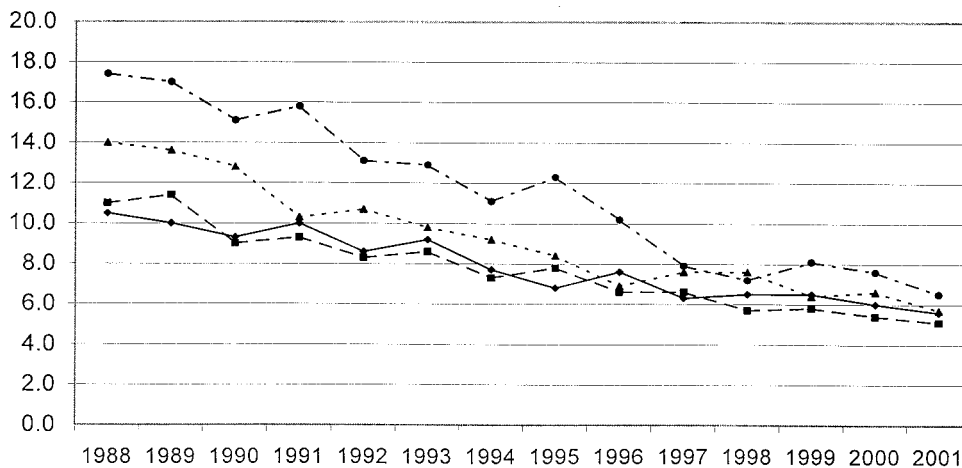

Fig 2. Trends in New York City infant mortality rates by quartile of poverty, 1988–2001. Quartile I, —; quartile II,– – –; quartile III, · · · · · · · · · · ; quartile IV, – · — · — · .

registered comparable declines across all income quartiles, reflecting secular changes in New York City as a whole rather than compositional change among quartiles. Finally, an appreciable convergence can be seen across income quartiles in the percentage of women who received late or no prenatal care. At its peak, in 1990, the relative rate ratio of quartile IV to quartile I for this characteristic was 2.2:1. By 2001, this relative rate ratio had converged to 1.45:1, a decline of 34%.

The magnitude of annual improvement in infant health outcomes for residents of the lowest 3 income quartiles relative to the highest income quartile is shown in Table 3. These unadjusted estimates reveal that relative to the highest income quartile, quartile I, the low birth weight rate in the lowest income quartile, quartile IV, improved 0.30 percentage points more per year. As a linear trend, this indicates that over the course of the 14 years recorded by this sample, low birth weight rates for those in the lowest income quartile fell >4.2 percentage points more than low birth weight rates in the highest income quartile. Similarly, infant morality rates in quartile

IV improved 0.46 per 1000 live births more per year than comparable rates in quartile I so that over the 14 years studied, infant mortality in the lowest income quartile improved >6.4 per 1000 live births more than infant mortality in the highest income quartile. Of that relative gain by the lowest income quartile, >60% of it occurred in neonatal mortality rates and the remainder occurred in postneonatal mortality rates.

Table 4 summarizes these results after controlling for a series of covariates, including individual health districts. It should be noted that inclusion of 1 of the covariates, percentage of infants delivered to foreign-born women, restricted the analysis to the years 1990 to 2001, when data were recorded for this variable. Although estimates of the magnitude of the observed effect are smaller in these regressions, even controlling for covariates that include race and foreign-born maternal status, the convergence of quartile IV relative to the highest income quartile is statistically significant for low birth weight, infant mortality, neonatal mortality, and postneonatal mortality. The coefficient for quartile IV indicates that over the
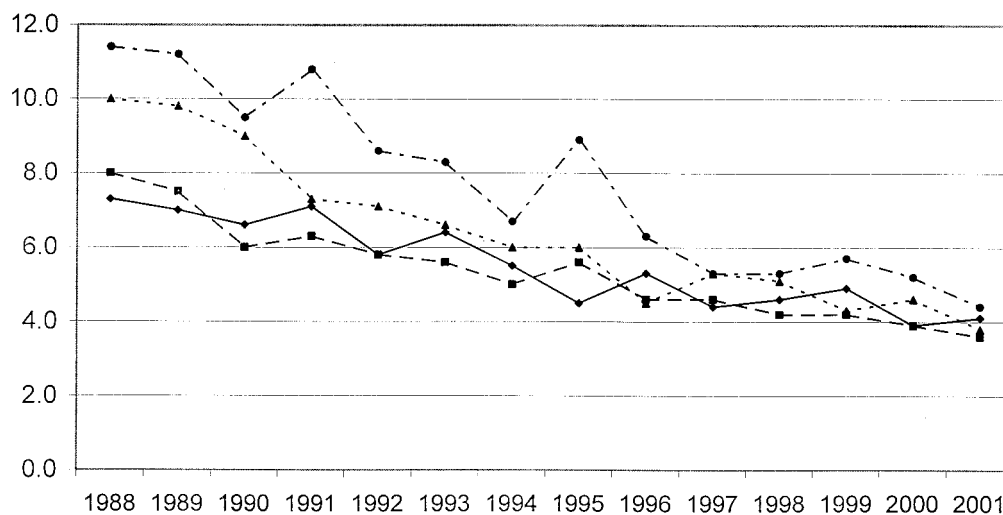
Fig 3. Trends in New York City neonatal mortality rates by quartile of poverty, 1988–2001. Quartile I, —; quartile II,– – –; quartile III, · · · · · · · · · · ; quartile IV, – · – · – · .
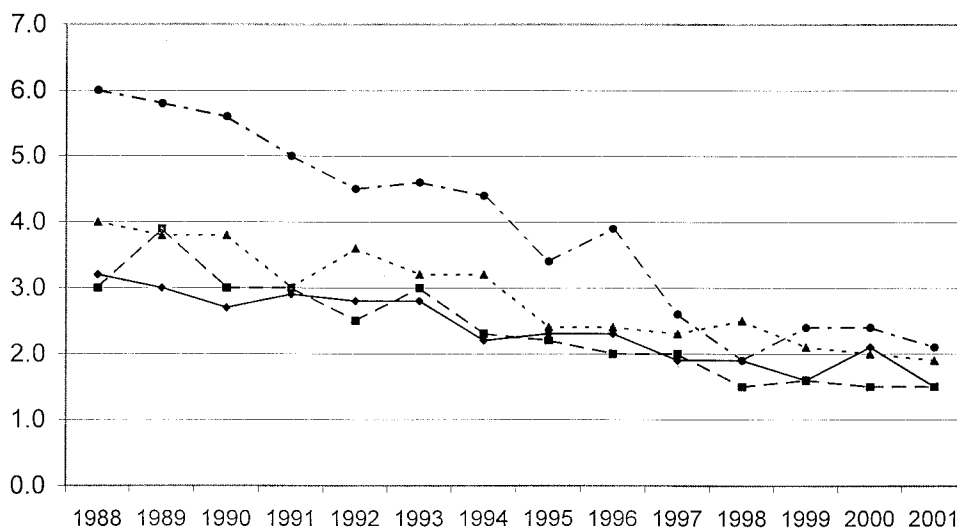

Fig 4. Trends in New York City postneonatal mortality rates by quartile of poverty, 1988–2001. Quartile I, —; quartile II,– – –; quartile III, · · · · · · · · · · ; quartile IV, – · – · – · .

TABLE 2. Changes in Covariates by Quartile of Income in New York City, 1988–2001

Quartile	% of Foreign-Born Mothers			% of Teenage Mothers			% of Deliveries Financed by Medicaid			% of Black Live Births			% With Late or No Prenatal Care		
	1990	2001	% Δ	1988	2001	% Δ	1988	2001	% Δ	1988	2001	% Δ	1988	2001	% Δ
I	43.5	49.6	14.0	6.8	5.4	−20.6	22.1	35.8	62.0	32.0	25.6	−20.0	9.0	5.7	−36.7
II	46.6	61.6	32.2	9.0	8.2	−8.9	28.2	56.3	100.0	24.2	20.2	−16.5	12.1	7.7	−36.4
III	49.8	57.0	14.5	12.1	9.9	−18.2	45.4	65.0	43.2	35.2	30.9	−12.2	13.7	7.6	−44.5
IV	31.1	42.8	37.6	17.1	14.1	−17.5	58.5	72.9	24.6	40.5	33.5	−17.3	16.4	8.3	−49.4

course of the 12 years of these data, infant mortality among the lowest income quartile in New York City, controlling for the covariates and health district fixed effects, fell 4.3 per 1000 live births more than did infant mortality in the highest income quartile.

The infant mortality rate of a population can be thought of as an average of birth weight–specific death rates weighted by the percentage of the population born in different birth weight categories. The infant mortality rate therefore can improve either if the percentage of low birth weight infants in the population falls or if the mortality rates within birth weight categories declines without any shift in the population's birth weight distribution. Having demonstrated convergence across income quartiles in both rates of low birth weight and infant mortality, we sought, in the final specification depicted in Table 5, to determine how much convergence remained when rates of low birth weight were held constant. For these results, percentage of low birth weight was

TABLE 3. Unadjusted Annual Trend Comparisons With Quartile I by Quartile of Income in New York City, 1988–2001

Quartile	Low Birth Weight*		Infant Mortality†		Neonatal Mortality‡		Postneonatal Mortality§	
	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
II	−0.04	−0.08 to 0.01	−0.06	−0.17 to 0.05	−0.02	−0.11 to 0.07	−0.04	−0.10 to 0.01
III	−0.15	−0.19 to −0.11	−0.24	−0.35 to −0.13	−0.20	−0.29 to −0.11	−0.04	−0.10 to 0.02
IV	−0.30	−0.34 to −0.25	−0.46	−0.58 to −0.35	−0.28	−0.37 to −0.19	−0.19	−0.24 to −0.13

CI indicates confidence interval.
* Births <2500 g as a percentage of all live births.
† Deaths per 1000 live births occurring <365 days after birth.
‡ Deaths per 1000 live births occurring <28 days after birth.
§ Deaths per 1000 live births occurring from 28 to 364 days after birth.

TABLE 4. Adjusted Annual Trend Comparisons With Quartile I by Quartile of Income in New York City, 1990–2001*

Quartile	Low Birth Weight†		Infant Mortality‡		Neonatal Mortality§		Post Neonatal Mortality‖	
	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
II	0.00	−0.05 to 0.06	−0.03	−0.17 to 0.11	0.03	−0.10 to 0.09	−0.06	−0.13 to 0.01
III	−0.11	−0.17 to −0.06	−0.11	−0.25 to 0.03	−0.10	−0.22 to 0.01	0.00	−0.07 to 0.07
IV	−0.21	−0.28 to −0.15	−0.36	−0.52 to −0.19	−0.20	−0.34 to −0.07	−0.15	−0.23 to −0.07

* Covariates include health district fixed effects, trend, percentage of infants delivered covered by Medicaid, percentage of live births to teenage mothers, percentage delivered to foreign-born women (available only from 1990), percentage delivered to black women, and percentage with late or no prenatal care.
† Births <2500 g as a percentage of all live births.
‡ Deaths per 1000 live births occurring <365 days after birth.
§ Deaths per 1000 live births occurring <28 days after birth.
‖ Deaths per 1000 live births occurring from 28 to 364 days after birth.

added as an independent variable to the multivariate model. The coefficients in Table 5 reveal a statistically significant convergence between quartile IV and quartile I in infant mortality and postneonatal mortality but not in neonatal mortality holding birth weight constant.

DISCUSSION

We have demonstrated a dramatic decrease in the income gradient of several measures of birth outcomes across quartiles of income in New York City during the period 1988 to 2001. Relative to the highest income quartile of health districts, rates of low birth weight and infant, neonatal, and postneonatal mortality declined by increasingly larger magnitudes across successively poorer quartiles. In 1988, the infant mortality rate in the highest income quartile in New York City was 10.5 per 1000 live births and that in the lowest income quartile was 17.4, for a relative rate ratio of 1.66: 1. By 2001, the respective rates were 5.2 and 6.5 per 1000 live births and the rate ratio had fallen to 1.25:1. Should this rate of convergence continue, parity of infant mortality rates across income quartiles will be achieved in New York City by the latter part of this decade.

Small-area income differentials in rates of infant mortality are known to be robust across historical periods. Since first identified in the modern era by Villermais in Paris in the beginning of the 19th century,[1] many other studies have confirmed their existence in the United States and elsewhere.[20] Much less is known about the persistence of these differentials over time. Narrowing of income differences in childhood mortality have been documented by some in the past,[7] whereas others have found an opposite trend,[21] but the degree of attenuation in the income gradient for rates of infant mortality documented here is without historical precedent to our knowledge. To what can these developments be attributed?

At the outset, one must caution against interpreting these results as necessarily signifying a decline in the income gradient in infant mortality at the individual level. To reason from observations of aggregate data collected across geographic areas to individual relationships is a perilous exercise,[22] specifically in the presence of unobserved confounding

TABLE 5. Birth Weight Adjusted Annual Trend Comparisons With Quartile I by Quartile of Income in New York City, 1990–2001*

Quartile	Infant Mortality†		Neonatal Mortality‡		Post Neonatal Mortality§	
	Rate	95% CI	Rate	95% CI	Rate	95% CI
II	−0.03	−0.17 to 0.10	0.03	−0.09 to 0.14	−0.06	−0.13 to 0.01
III	−0.04	−0.18 to 0.10	−0.04	−0.16 to 0.07	0.01	−0.07 to 0.08
IV	−0.22	−0.39 to −0.05	−0.09	−0.22 to 0.05	−0.14	−0.22 to −0.05

* Covariates include health district fixed effects, trend, percentage of infants delivered covered by Medicaid, percentage of live births to teenage mothers, percentage delivered to foreign-born women (available only from 1990), percentage delivered to black women, percentage with late or no prenatal care, and percentage with low birth weight.
† Deaths per 1000 live births occurring <365 days after birth.
‡ Deaths per 1000 live births occurring <28 days after birth.
§ Deaths per 1000 live births occurring from 28 to 364 days after birth.

variables within each geographic area of study (in this case, each quartile). Unobserved confounders lead to biased estimates of the relationship between an exposure and an outcome measured at the aggregate level.[23] We have taken pains to guard against this possibility in the current context. By including on the right hand side of the regression indicators for each health district, we control for time invariant unobserved characteristics among health districts. In this way, if the health districts contained in the lowest income quartile had, for example, higher quality prenatal care providers than the districts in the highest income quartile, then we might have erroneously attributed the effect of this quality differential to the income gradient that we measured. Fixed-effects indicators of the type used in our analysis will control for this unobserved variation.

A more salient methodologic feature than the incorporation of fixed-effects estimators in the current study is its longitudinal design. Because our measure of interest is not simply the infant mortality differential across income quartiles but the change over time in this differential, any unobserved confounding features of the quartiles that are time invariant cannot account for how the differences among quartiles changed from 1988 to 2001. To use the previous example, quality differences in prenatal care across quartiles that are unchanging will not cause a convergence in rates of infant mortality over time. Unless the quality of prenatal care providers in the lower income quartiles increased disproportionately relative to the quality of prenatal care providers in the higher income quartiles, we would not anticipate that quality differentials among quartiles would bias our findings of the effect of income on infant mortality. If, alternatively, residents of lower income quartiles were increasingly likely over time to travel for their prenatal care to providers in higher income quartiles, then this would result in an apparent narrowing of income gradients in infant mortality, but we do not have data to test this hypothesis.

There is no evidence that other potential supply-side factors such as numbers of neonatal intensive care unit beds per capita or numbers of pediatric providers per capita underwent a disproportionate increase in lower income health districts relative to higher income health districts during the period of study. We also did not find evidence of migration effects. Mothers who were born outside the United States have been demonstrated to have birth outcomes superior to native-born mothers with respect to birth weight.[24] Teenage mothers and black mothers, conversely, have poorer outcomes than mothers who are older or from other ethnic backgrounds.[13,25] Although the total number of foreign-born mothers increased, the rates of teenage pregnancies were static, and the proportion of deliveries to black women declined in New York City during the 1990s, the relative proportion of these maternal characteristics across income quartiles did not change as we have shown. What is more, our findings are robust to the inclusion of these covariates in the multivariate analysis, indicating the existence of a convergence in

birth outcomes with respect to income that is independent of these factors.

Census data measurements of income contain associated reporting errors that may be both random and systematic. It is conceivable that the systematic reporting errors may be greater at the extremes of the income scale. One such scenario might lead to a form of misclassification bias in which residents of lower income quartiles actually enjoyed higher aggregate incomes than reported, leaving the true income gradient less pronounced than the observed one. For measurement error to account for our findings, however, we would have to postulate not only that poorer residents systematically underreport their income relative to others (or that those with higher incomes systematically overreport their incomes) but that this tendency increased over time because our data indicate a narrowing of the health outcomes with respect to income as the decade progressed. We find no a priori reason to suspect that this occurred. Inspection of trends for mortality rates in New York City from other causes such as cardiovascular disease, for example, indicate little variation in the income gradient over time, whereas the income gradient in mortality rates from homicide actually increased (data available on request).

If we look beyond possible methodologic concerns regarding the observed trends, how might we understand their significance? Two logical possibilities present themselves. Either the impact of living in a poor community relative to living in a richer community is less important over time in determining the probability of infant survival in New York City, or its importance has not diminished but the relative differences in income between high and low income quartiles has attenuated. Results in Table 1 suggest that, at least as measured by median family income, the lowest income quartile's aggregate income increased in relative terms more than that of the highest income quartile during the period that we studied. As a result, the income ratio of quartile I to quartile IV fell from 2.87 to 2.72. This fall of 5% is unlikely to account for the dramatic convergence witnessed in the clinical outcomes that we measured.

We are left, therefore, with the conclusion that health district income became less important as a factor in infant survival in New York City during the 1990s. Although income may yet remain a potent determinant at the individual level, the remarkable fact is that being born in a poor health district relative to a rich one in the nation's largest city leaves one at a much lower relative risk of dying in the first year of life than it did a mere 12 years ago.

Although the present study cannot identify an explanation for this pattern of relative infant mortality rate changes, the data that we have presented suggest some potentially fruitful avenues of additional inquiry. When controls are entered for birth weight, we find that only the convergence in postneonatal mortality rates achieved statistical significance. Without cause-specific death rates, the precise meaning of these findings remains uncertain, but it seems to suggest that within any given birth weight category, infants from poorer communities gained more

from the introduction of life-saving measures aimed at older infants than did the children of richer communities. Did expansions in Medicaid in the early 1990s, the inauguration of State Children's Health Insurance Program after 1997, or the Vaccines for Children Program in 1994 provide infants from poor neighborhoods access to effective interventions such the Back-to-Sleep campaign,[26] to new vaccines,[27] or to measures designed to protect infants from accidental fatal injuries previously unavailable to them?[28] Do these patterns represent a catch-up phenomenon wherein beneficial technologies diffused into poorer communities on the tails of improved access to health care? Answers to these questions must await future analyses of cause-specific mortality in this age group. Another reason that overall infant mortality rates for children from poor neighborhoods improved differentially relative to rates for children from richer neighborhoods was the fewer numbers of low birth weight infants who were born in poorer neighborhoods throughout the time frame studied. This finding is particularly interesting in light of the narrowed income differential in the percentage of women who delivered with late or no prenatal care.

The progress achieved in the decade of the 1990s in narrowing infant mortality differentials between rich and poor in New York City will likely prove to be multifactorial in origin. Other small-area analyses will be needed to determine whether this pattern is unique to New York City. Identifying the factors that produced this pattern, measuring their relative importance, and understanding which of them are amenable to public policy manipulation will inform decision makers and thereby help to sustain this salutary trend.

REFERENCES

1. Krieger N. Theories for social epidemiology in the twenty-first century: an ecosocial perspective. *Int J Epidemiol.* 2001;30:668–677
2. Marx K. *Capital. A Critique of Political Economy.* New York, NY: International Publishers; 1973
3. Rowntree BS. *Poverty: A Study of Town Life.* New York, NY: Garland; 1980
4. Kitagawa EM, Hauser PM. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology.* Cambridge, MA: Harvard University Press; 1973
5. Antonovsky A. Social class, life expectancy and overall mortality. *Milbank Mem Fund Q.* 1967;45:31–73
6. Hadley J, Osei A. Does income affect mortality? An analysis of the effects of different types of income on age/sex/race-specific mortality rates in the United States. *Med Care.* 1982;20:901–914
7. Wise PH, Kotelchuck M, Wilson ML, et al. Racial and socioeconomic disparities in childhood mortality in Boston. *N Engl J Med.* 1985;313: 360–366
8. Turrell G, Mengersen K. Socioeconomic status and infant mortality in Australia: a national study of small urban areas, 1985–89. *Soc Sci Med.* 2000;50:1209–1225
9. Martens PJ, Derksen S. A matter of life and death for Manitoba's children: an overview of birth rates and mortality rates. *Can J Public Health* 2002;93(suppl 2):521–526
10. Pritchett L, Summers LH. Wealthier is healthier. *J Hum Res.* 1996;XXXI: 841–868
11. Marmot M. The influence of income on health: views of an epidemiologist. *Health Aff.* 2002;21:31–46
12. Schneider MC, Castillo-Salgado C, Loyola-Elizondo E, et al. Trends in infant mortality inequalities in the Americas 1955–1995. *J Epidemiol Community Health.* 2002;56:538–541
13. New York City Department of Health and Mental Hygiene Bureau of Vital Statistics. *Summary of Vital Statistics The City of New York.* New York, NY: New York City Department of Health and Mental Hygiene; 1988-2000
14. National Center for Health Statistics. *Health, United States, 2002 With Chartbook on Trends in the Health of Americans.* Hyattsville, MD: National Center for Health Statistics; 2002
15. Yudlkowsky BK, Tang SF. Children at risk: their health insurance status by state. *Pediatrics.* 1997;99(5). Available at: www.pediatrics.org/cgi/content/full/99/5/e2
16. Holl JL, Szilagyi P, Rodewald LE, et al. Evaluation of New York State's Child Health Plus: access, utilization, quality of care, and health status. *Pediatrics.* 2000;105(suppl E):711–718
17. Marquis MS, Long SH. Trends in managed care and managed competition 1993–1997. *Health Aff.* 1999;18:75–88
18. Smith LA, Wise PH, Chavkin W, Romero D, Zuckerman B. Implications of welfare reform for child health: emerging challenges for clinical practice and policy. *Pediatrics.* 2000;106:1117–1125
19. US Census Bureau. Historical income tables–families. Available at: www.census.gov/hhes/income/histinc/incfamdet.html
20. Macinko JA, Shi L, Starfield B. Wage inequality, the health system, and infant mortality in wealthy industrialized countries 1970–1996. *Soc Sci Med.* 2004;58:279–292
21. Singh GK, Yu SM. US childhood mortality, 1950 through 1993: trends and socioeconomic differentials. *Am J Public Health.* 1996;86:505–512
22. Rothman KJ, Greenland S. *Modern Epidemiology.* 2nd ed. Philadelphia, PA: Lippincott-Raven; 1998
23. Greenland S. Ecologic versus individual-level sources of bias in ecologic estimates of contextual health effects. *Int J Epidemiol.* 2001;30:1343–1350
24. Cervantes A. Adverse birth outcomes among native-born and immigrant women: replicating national evidence regarding Mexicans at the local level. *Matern Child Health J.* 1999;3:99–109
25. Infant mortality and low birth weight among black and white infants–United States, 1980–2000. *MMWR Morb Mortal Wkly Rep.* 2002; 51:589–592
26. Kattwinkel J, Brooks J, Myerberg D. Positioning and SIDS. AAP Task Force on Positioning and SIDS. *Pediatrics.* 1992;89:1120–1126
27. Haemophilus b conjugate vaccines for prevention of Haemophilus influenza type b disease among infants and children two months of age and older recommendations of the ACIP. *MMWR Recomm Rep.* 1991;40: 1–7
28. Effectiveness in disease and injury prevention child passenger restraint use and motor-vehicle-related fatalities among children–United States, 1982–1990. *MMWR Morb Mortal Wkly Rep.* 1991;40:600–602

The Disappearing Income Gradient in New York City Birth Outcomes: Thirteen Years of Convergence From 1988 to 2001

Andrew D. Racine and Theodore J. Joyce

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/114/1/e51
References	This article cites 20 articles, 5 of which you can access for free at: http://pediatrics.aappublications.org/content/114/1/e51#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): **Fetus/Newborn Infant** http://www.aappublications.org/cgi/collection/fetus:newborn_infant_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

The Disappearing Income Gradient in New York City Birth Outcomes: Thirteen Years of Convergence From 1988 to 2001

Andrew D. Racine and Theodore J. Joyce

The online version of this article, along with updated information and services, is located on the World Wide Web at:

http://pediatrics.aappublications.org/content/114/1/e51

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™