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Impact of Income and Income Inequality on Infant Health Outcomes in the United States

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KEY WORDS

income inequality, infants, median family income, infant mortality rate, low birth weight

ABBREVIATIONS

SES—socioeconomic status
PTB—preterm birth
LBW—low birth weight
VLBW—very low birth weight
IMR—infant mortality rate
FPL—federal poverty level

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WHAT'S KNOWN ON THIS SUBJECT: The relationship between income inequality and health outcomes has been explored extensively for adults. However, relatively little is known about the impact of income inequality on infant health outcomes in the United States in the past decade.

WHAT THIS STUDY ADDS: This study demonstrates that both income and income inequality affect infant health in the United States. Also, the study documents that the health of the poorest infants in our country is affected more by absolute income than by relative income.

abstract

OBJECTIVES: The goal was to investigate the relationships of income and income inequality with neonatal and infant health outcomes in the United States.

METHODS: The 2000–2004 state data were extracted from the Kids Count Data Center. Health indicators included proportion of preterm births (PTBs), proportion of infants with low birth weight (LBW), proportion of infants with very low birth weight (VLBW), and infant mortality rate (IMR). Income was evaluated on the basis of median family income and proportion of federal poverty levels; income inequality was measured by using the Gini coefficient. Pearson correlations evaluated associations between the proportion of children living in poverty and the health indicators. Linear regression evaluated predictive relationships between median household income, proportion of children living in poverty, and income inequality for the 4 health indicators.

RESULTS: Median family income was negatively correlated with all birth outcomes (PTB, $r = -0.481$; LBW, $r = -0.295$; VLBW, $r = -0.133$; IMR, $r = -0.432$), and the Gini coefficient was positively correlated (PTB, $r = 0.339$; LBW, $r = 0.398$; VLBW, $r = 0.460$; IMR, $r = 0.114$). The Gini coefficient explained a significant proportion of the variance in rate for each outcome in linear regression models with median family income. Among children living in poverty, the role of income decreased as the degree of poverty decreased, whereas the role of income inequality increased.

CONCLUSIONS: Both income and income inequality affect infant health outcomes in the United States. The health of the poorest infants was affected more by absolute wealth than relative wealth. *Pediatrics* 2010; 126:1165–1173

The World Health Organization[1] reported recently that, throughout the world, poor children have worse health outcomes than do nonpoor children, an assertion that is supported by a wide range of health indicators. Infant mortality rates (IMRs) have been shown to be inversely related to socioeconomic status (SES).[2–5] Decreasing maternal educational level and decreasing family income are each associated with increasing IMRs.[4,5] Poor children also are more likely than nonpoor children to have low birth weight (LBW) (<2500 g), to be diagnosed as having asthma, to have any type of chronic health condition, and to have activity limitations because of a chronic health condition.[6] In addition, infants of lower SES have greater risk of persistent respiratory symptoms than do infants of higher SES.[7] Finally, both individual-level and population-level associations between lower SES and increased risk of obesity among youths have been identified.[8]

Interestingly, poverty alone does not entirely explain these findings. When considered at the population level, the absolute level of poverty does not seem to explain fully the worse health outcomes of poor individuals.[9–13] Once individuals and families are able to meet their basic needs, their relative income (ie, how their income compares with that of the people living around them) seems to play an increasing role in determining the health outcomes of the community in which they live.[9,10] Wilkinson[14,15] suggested that once a society progresses beyond the point of absolute deprivation and people are able to meet their basic needs, then it is the distribution of income within the society that affects health outcomes. He referred to this transition point as the epidemiological transition.

The idea that the distribution of income within a society may affect health outcomes for the population has become known as the income inequality hypothesis. According to this hypothesis, health outcomes for a community worsen as the gap between rich and poor individuals in the community increases.

The income inequality hypothesis has been explored extensively in the literature,[9–12,16] with the vast majority of the research focusing on adult health outcomes. The results of such studies are mixed, with some supporting the hypothesis that greater income disparity within communities, states, or nations leads to worse health outcomes[9,10,12,14,17–21] and others refuting such an association.[22–26] Only a small proportion of the published studies examined the impact of income inequality on infant and child health. The pediatric health indicators for which the relationship with income inequality has been investigated are neonatal mortality rates, IMRs, child mortality rates, preterm birth (PTB) rates, LBW birth rates, child overweight status, mental health problems, bullying, teen violence, teen pregnancy rates, and high school dropout rates.[27,28] Published studies have examined various populations, including those of developing nations, countries belonging to the Organization for Economic Cooperation and Development, counties and states within the United States, and subsets of other nations' populations. As in the adult literature, the findings are mixed, but the majority of studies supported an association between each of the indicators and income inequality.[27–40]

The impact of income inequality on infant and child health is a particularly pressing question in the United States, because the gap between rich and poor individuals in this country has increased significantly in the past 40 years. Income inequality, as determined with the Gini coefficient, a widely accepted statistical measure of income disparity, has increased ~16% for US households since 1967.[9,10,41,42] An increase in the Gini coefficient indicates increasing income disparity within a population. A significant portion of the increase in the Gini coefficient for US households occurred recently; between 1997 and 2007, the Gini coefficient increased 3.3%.[43] However, most published studies that examined infant and child health and income inequality within the United States did not include data from the current decade. This study was designed to examine the associations of both income and income inequality with neonatal and infant health by focusing on 4 key indicators: PTB rate, proportion of infants with LBW, proportion of infants with very low birth weight (VLBW), and IMR during the years 2000 to 2004.

METHODS

Data Sources and Measures

Data on health indicators, family income, and children living in poverty were obtained from the Annie E. Casey Foundation Kids Count Data Center Web site, a comprehensive, publicly available database of child health and well-being that compiles original data from a variety of sources. Data were extracted from the data set by the authors for all 50 US states for the years 2000 to 2004. Neonatal and infant health indicators included PTB rate (proportion of live-born infants born at <37 weeks of gestation), proportion of infants with LBW (<2500 g), proportion of infants with VLBW (<1500 g), and IMR (deaths among children <1 year of age per 1000 live births). Income first was evaluated by using median family income (in thousands of dollars). Then, to delineate the impact of increasing amounts of poverty on health, children living in poverty were stratified into 4 groups on the basis of family income (ie, <50% of federal poverty level [FPL], 50% to <100% of FPL, 100% to <150% of FPL, and 150% to <200% of FPL). These categories parallel the fact that many programs and services (eg, Medicaid and State Children's Health Insurance Program) are allocated on the basis of gradations of poverty, which potentially leaves infants living in lesser degrees of poverty with differing access to health care.

Income inequality was measured by using the Gini coefficient, a statistical measure of income distribution based on the Lorenz curve, with values ranging from 0 to 1. A lower value indicates more-equal distribution of wealth in a population, whereas a higher value indicates greater disparity.[16] The US Census Bureau calculates the Gini coefficient for each state annually. Gini coefficients for each state for the years 2000–2004 were obtained directly from the US Census Bureau Current Population Survey.

Data Analyses

Mean state data across the 5 years (2000–2004) were used for representational graphics prepared from the study data (Figs 1 and 2). However, all statistical analyses included data for each state for each year, with each analysis adjusted for year whenever statistically significant yearly variation existed.

Pearson correlations evaluated the associations between the proportion of children living in poverty (<50% of FPL, 50 to <100% of FPL, 100 to <150% of FPL, or 150 to <200% of FPL) and the 4 health indicators (PTB rate, LBW rate, VLBW rate, and IMR). Linear regression analyses were performed to identify associations between the 4 neonatal and infant health indicators (PTB rate, LBW rate, VLBW rate, and IMR), median income, poverty (<50% of FPL, 50 to <100% of FPL, 100 to <150% of FPL, or 150 to <200% of FPL), and income in-

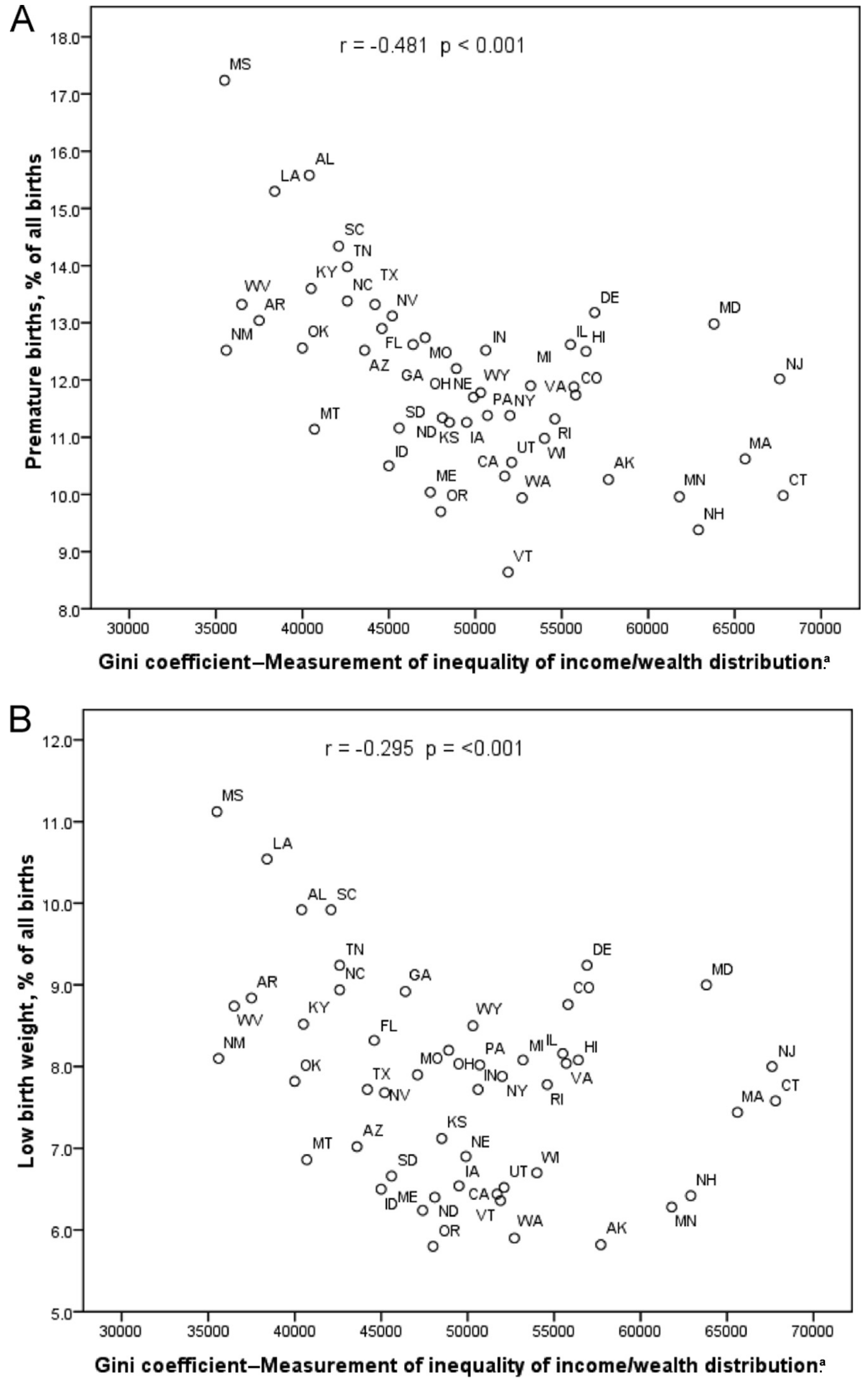

FIGURE 1

Correlations between median family income and PTB rates (A), LBW rates (B), VLBW rates (C), and IMRs (D) for US states. [a]Graphed values are averaged across all 5 years (2000–2004).

equality. Initial linear regression models included year (when statistically significant), median family income, and Gini coefficient as the potential predictors of the 4 health indicators (Table 1). Secondary stepwise linear regression analyses assessed the effect of each level of poverty (<50% of FPL, 50 to <100% of FPL, 100 to <150% of FPL, or 150 to <200% of FPL) separately, by including year as appropriate, poverty category individually, and

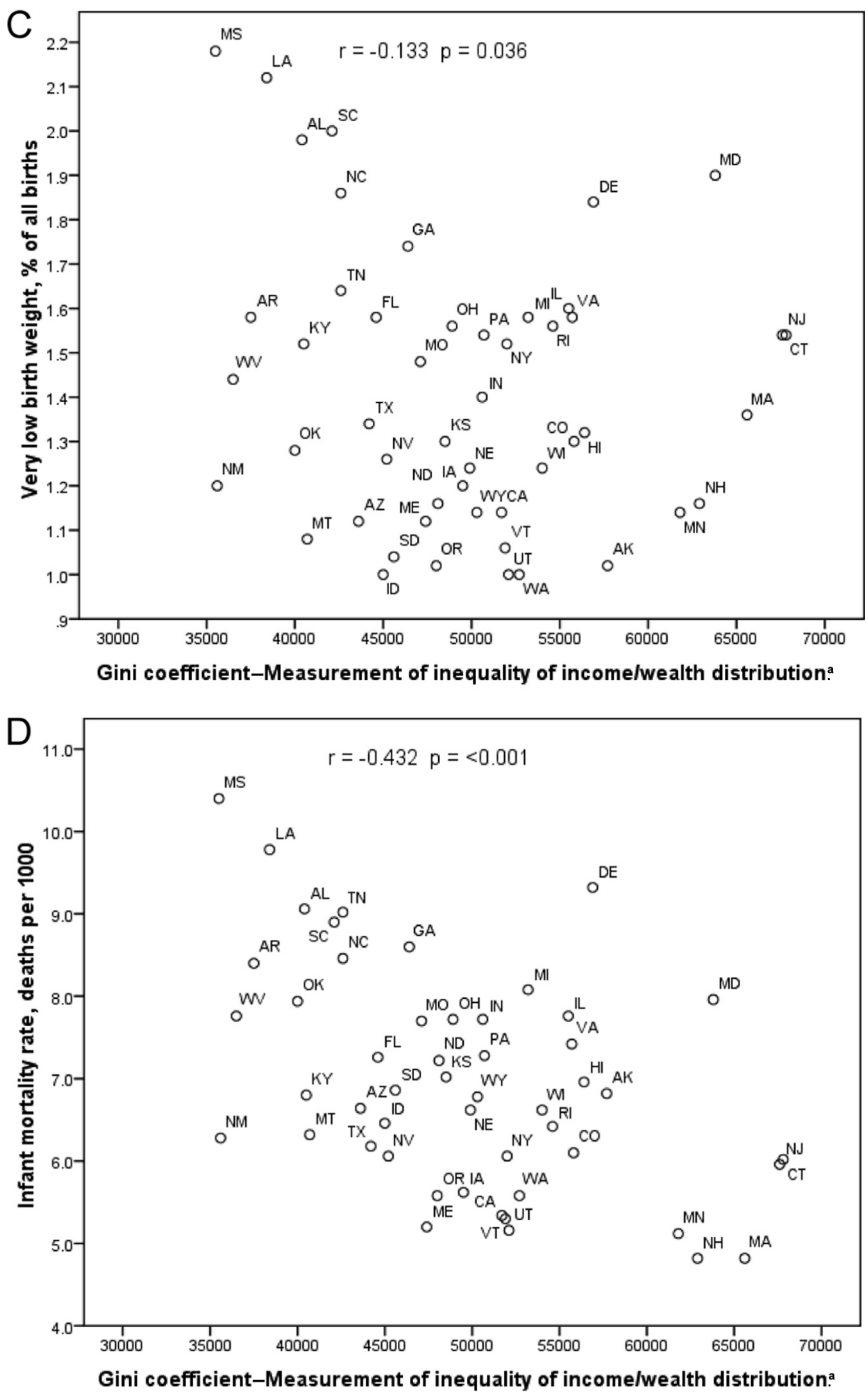

FIGURE 1
Continued.

then Gini coefficient as the potential predictors of the 4 health indicators, to determine whether there were trends in the amounts and proportions of the variance explained by poverty and Gini coefficient across increasing poverty levels.

RESULTS

The median family income for the 50 US states during the 5-year period of our study was \$48 900 (25th percentile: \$43 435; 75th percentile: \$54 500). The lowest median income was in West Virginia (\$31 400) and the highest was in New Jersey (\$76 200). The mean Gini coefficient was 0.447 (SD: 0.025), with the lowest value being that for Alaska in 2001 (Gini coefficient: 0.389) and the highest being that for New York in 2001 (Gini coefficient: 0.515). The PTB rates ranged from 8.2% (Vermont in 2000) to 17.9% (Mississippi in 2004), with a mean of 12% (SD: 1.7%). The proportion of infants born with LBW was smallest in Oregon in 2001 (5.5%) and largest in Mississippi in 2004 (11.6%), with an overall mean of 7.8% (SD: 1.3%). The VLBW rate ranged from 0.8% in Alaska in 2000 to 2.3% in Louisiana in 2001, with a mean of 1.4% (SD: 0.3%). Finally, the mean IMR was 7.0 deaths per 1000 live births (SD: 1.4 deaths per 1000 live births). The lowest rate was 3.8 deaths per 1000 live births in New Hampshire in 2001, whereas Mississippi in 2000 and Delaware in 2001 tied for highest rate, at 10.7 deaths per 1000 live births.

Median family income was negatively correlated with PTB rate, LBW rate, VLBW rate, and IMR (Fig 1). Linear regression analyses evaluated the associations between these outcomes and year (when significant), median family income (in thousands), and Gini coefficient (Table 1). Median family income was found to explain a statistically significant proportion of the variance in rate for each of the outcomes, as represented by the associated R^2 change values, with decreasing income levels being associated with worse health outcomes for neonates and infants with respect to all 4 outcome variables. The health indicator with the largest proportion of variance explained by median family income was PTB rate, with the smallest proportion for VLBW rate.

Income inequality, as measured with the Gini coefficient, was positively correlated with PTB rate, LBW rate, VLBW rate, and IMR (Fig 2). Income inequality also was positively associated with all 4 health indicators when included in linear regression models with median family income (Table 1). Income inequality explained a statistically significant proportion of the variance in rate for each outcome. The infant health indicator with the largest proportion of variance explained by income inequality was VLBW rate, with the smallest proportion for IMR.

Additional analyses were performed to assess 4 categories of poverty (<50% of FPL, 50 to <100% of FPL, 100 to <150% of FPL, or 150 to <200% of FPL). As shown in the correlation analysis in Table 2, the strongest correlations existed between all 4 health indicators (PTB rate, LBW rate, VLBW rate, and IMR) and the proportion of children living at <50% of the FPL, with the correlations gradually decreasing as the level of poverty decreased. Linear regression analyses evaluated the associations between these 4 outcomes and year (if significant), each of the 4 levels of poverty (separately), and Gini coefficient (Table 3). Poverty levels demonstrated that the poorest infants' health was affected more by poverty than by income inequality. This trend gradually reversed for infants living in lesser degrees of poverty.

DISCUSSION

New Findings

This study supports and extends previous research that demonstrated the role of both income and income inequality in determining infants' health outcomes. These data documented that significant proportions of the variance in PTB rates, LBW rates, VLBW rates, and IMRs could be attributed to the combined impact of income and income inequality. The study also yielded interesting findings regarding the impact of income and income inequality on children living with different degrees of poverty.

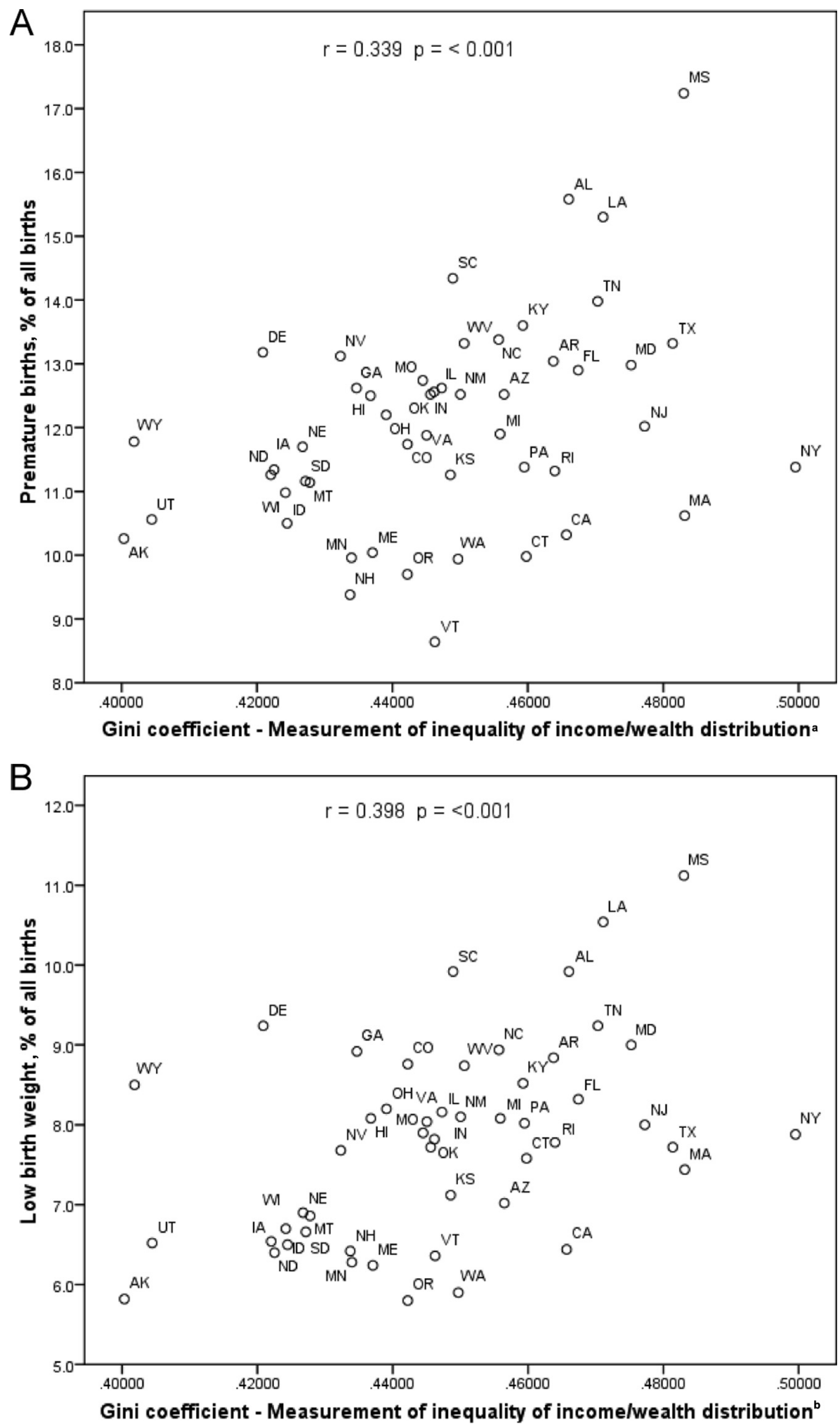

FIGURE 2

Correlations between Gini coefficient and PTB rates (A), LBW rates (B), VLBW rates (C), and IMRs (D) for US states. *Graphed values are averaged across all 5 years (2000–2004).

This study adds to the existing literature in 2 important ways. First, it shows that, among 4 subsets of poverty, neonatal and infant outcomes improved as the amount of income increased; the poorest children had the worst outcomes. The results of this study document that the health of the

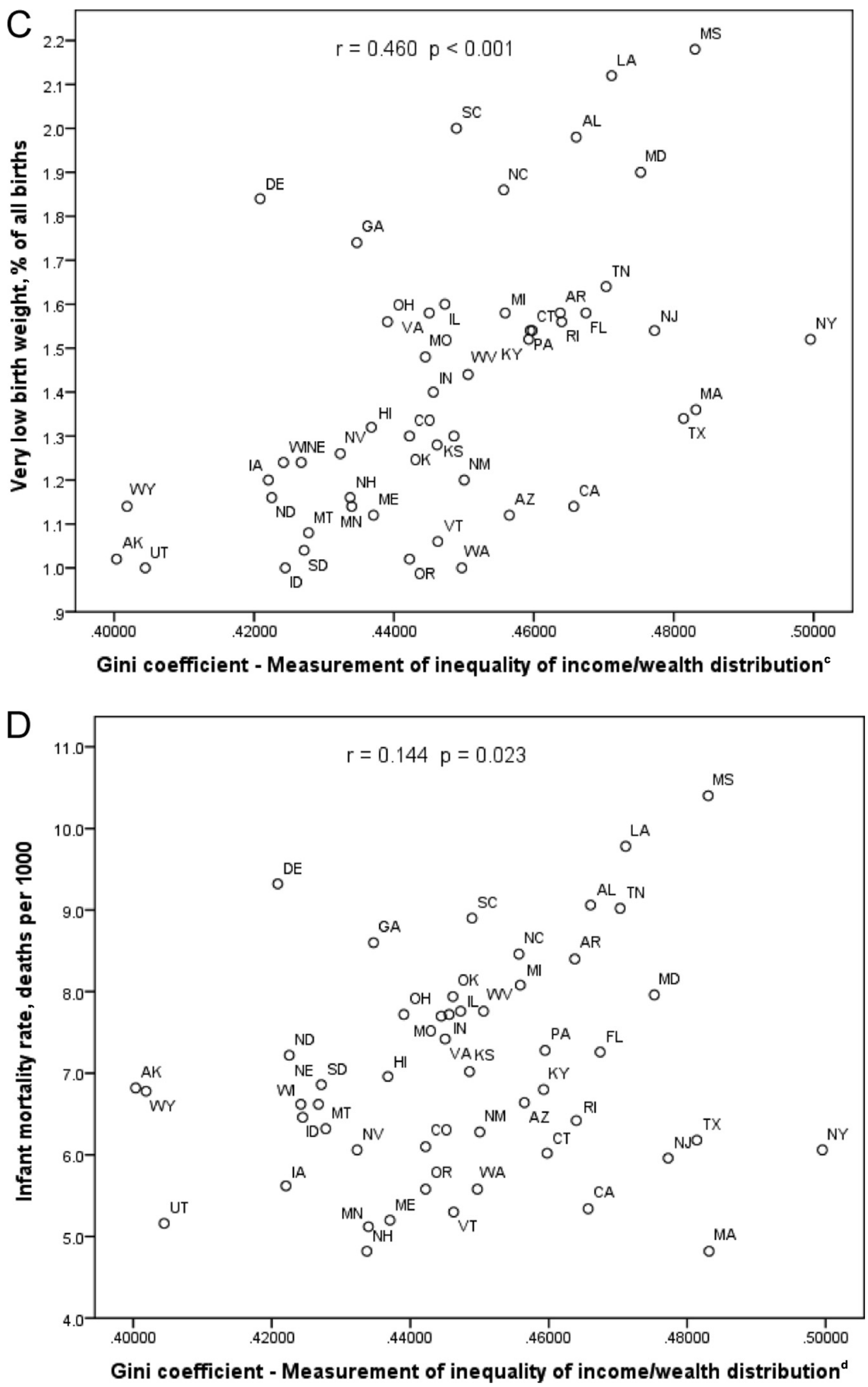

FIGURE 2
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poorest infants in our country is affected more by absolute income than by relative income. Therefore, on the basis of the explanation proposed by Wilkinson,[15] it can be argued that the United States has not fully made the epidemiological transition, a conclusion that is both surprising and troubling. It is surprising because the United States is one of the richest nations in the world,[9] and it is troubling because it suggests that the basic needs of the poorest children in this country are not being met. These results suggest that the public programs designed to serve the health needs of the poorest infants in this nation may not be meeting those needs.

Second, by considering 4 key indicators of infant health, this study provides a comprehensive examination of the relationship between infant health and both income and income inequality. Income inequality explained little of the variation in infant outcomes in states with larger proportions of children in the lowest income categories, but income inequality explained more of the variation in states with larger proportions of children in higher income categories.

Study Strengths and Limitations

This study has several important strengths. Most existing studies pertaining to income inequality and pediatric health outcomes included only simple correlations. This study used regression analysis to define further the amount of variance in infant health outcomes attributable to both income and income inequality. The findings add support to the hypothesis that income inequality affects infants' health outcomes.

In addition, the study used recent data and thus provides a better reflection of the current social and political climate in the United States, compared with most previous studies. The data do not reflect the recent downturn in the economy and subsequent unemployment, which likely have further affected birth outcomes negatively. Despite that, the results offer a useful comparison with historical data, particularly because most existing studies used data from periods before the 1990s welfare reforms.

One important limitation of the study is that it was based on aggregate state-level data. Despite the lack of individual-level data, the results add important information to the research

TABLE 1 Regression Models for Neonatal and Infant Health Outcomes and Median Family Income, Gini Coefficient, and Year

	PTB Rate		LBW Rate		VLBW Rate		IMR	
	Coefficient	R^2 Change	Coefficient	R^2 Change	Coefficient	R^2 Change	Coefficient	R^2 Change
Year	0.298 ± 0.118[a]	0.031[b]	0.166 ± 0.096[b]	0.023[c]				
Median income	−0.103 ± 0.020[a]	0.269[a]	−0.047 ± 0.016[a]	0.106[a]	−0.004 ± 0.004[c]	0.018[c]	−0.072 ± 0.019[a]	0.186[a]
Gini coefficient	20.795 ± 6.604[a]	0.095[a]	18.910 ± 5.379[a]	0.142[a]	5.813 ± 1.410[a]	0.023[a]	7.232 ± 6.368[c]	0.016[c]

[a] $P < .001$.
[b] $P < .01$.
[c] $P < .05$.

TABLE 2 Pearson Correlations for Neonatal and Infant Health Outcomes and FPL Categories

	r			
	PTB Rate	LBW Rate	VLBW Rate	IMR
<50% of FPL	0.675[a]	0.608[a]	0.484[a]	0.477[a]
50% to <100% of FPL	0.575[a]	0.425[a]	0.281[a]	0.428[a]
100% to <150% of FPL	0.316[a]	0.126[b]	−0.061	0.221[a]
150% to <200% of FPL	0.252[a]	0.073	−0.106	0.215[a]

[a] $P < .001$.
[b] $P < .05$.

on income, income inequality, and infant health outcomes. Future studies based on both individual-level health and income data and population-level data should be useful for further delineation of these relationships.

The analysis also was limited to a relatively small number of infant health outcomes, and several of those (PTB, LBW, and VLBW rates) can be significantly affected by maternal factors. The results may be more a reflection of the impact of inequality on pregnant women's health than a description of the impact of income inequality on infants' health. Future studies are needed to explore the relationships between income inequality and a wider range of pediatric health indictors.

Other investigators included racial composition as a variable in similar analyses and documented that Gini coefficients were correlated with LBW rates before but not after correction for state racial composition.[44] Racial composition was not included in the current study for 2 reasons. First, racial composition is too highly correlated with income inequality to allow for their respective effects on health outcomes to be determined by using regression analysis.[45] Second, it can be argued that the association between income inequality and infants' health is relevant regardless of the racial composition of the population. Within the United States, there is regional variation in the racial composition of the population. Although race is worth noting in any study of the associations between income inequality and health, it is not a population-level variable that could or should be altered through public health or policy

TABLE 3 Regression Models for Neonatal and Infant Health Outcomes and Proportions Within Each FPL Category, Gini Coefficient, and Year

	PTB Rate		LBW Rate		VLBW Rate		IMR	
	Coefficient	R^2 Change	Coefficient	R^2 Change	Coefficient	R^2 Change	Coefficient	R^2 Change
Model 1								
Year	0.079 ± 0.111	0.031[a]	0.049 ± 0.088	0.023[b]				
<50% of FPL	0.427 ± 0.070[c]	0.429[c]	0.259 ± 0.055[c]	0.350[c]	0.043 ± 0.015[c]	0.234[c]	0.290 ± 0.069[c]	0.228[c]
Gini coefficient	2.564 ± 7.010	0.001	7.598 ± 5.534[a]	0.018[a]	3.840 ± 1.502[c]	0.071[c]	−5.495 ± 7.021	0.007
Model 2								
Year	0173 ± 0.117[a]	0.031[a]	0.108 ± 0.094[b]	0.023[b]				
50% to <100% of FPL	0.311 ± 0.061[c]	0.322[c]	0.153 ± 0.049[c]	0.175[c]	0.020 ± 0.013[a]	0.079[c]	0.212 ± 0.059[c]	0.183[c]
Gini coefficient	13.684 ± 6.826[c]	0.039[c]	15.359 ± 5.490[c]	0.088[c]	5.305 ± 1.440[c]	0.162[c]	2.212 ± 6.646	0.001
Model 3								
Year	0.234 ± 0.130[c]	0.031[a]	0.131 ± 0.100[b]	0.023[b]				
100% to <150% of FPL	0.229 ± 0.073[c]	0.113[c]	0.073 ± 0.056[b]	0.020[b]	−0.007 ± 0.014	0.004	0.126 ± 0.068[c]	0.049[c]
Gini coefficient	22.652 ± 7.312[c]	0.113[c]	19.715 ± 5.637[c]	0.155[c]	5.858 ± 1.418[c]	0.211[c]	8.370 ± 6.870[b]	0.022[b]
Model 4								
Year	0.206 ± 0.130[a]	0.031[a]	0.123 ± 0.099[b]	0.023[b]				
150% to <200% of FPL	0.281 ± 0.093[c]	0.067[c]	0.099 ± 0.071[a]	0.006	−0.003 ± 0.018	0.011	0.178 ± 0.087[c]	0.046[c]
Gini coefficient	26.607 ± 7.484[c]	0.150[c]	21.112 ± 5.729[c]	0.171[c]	5.822 ± 1.446[c]	0.201[c]	10.868 ± 6.954[a]	0.035[a]

[a] $P < .01$.
[b] $P < .05$.
[c] $P < .001$.

interventions. On the basis of the results of this study, part of the solution to the very real problem of health disparities experienced by minority populations[46] is to decrease the degree of absolute and relative poverty they experience.

Future Research Questions

By focusing on infant health indicators, this study provides an initial look at the role of income and income inequality in children's health. Further research should examine other pediatric health indicators, including childhood mortality rates, teen mortality rates, teen pregnancy rates, and rates of specific diagnoses such as asthma, obesity, and respiratory infections. It also would be useful to examine the relative contributions of neonatal death and postneonatal death to IMRs, as well as the impact of income inequality on each of these outcomes, because Shi et al[19] suggested that income inequality affects neonatal mortality rates more than postneonatal mortality rates.

Although this study does suggest causal relationships between both income and income inequality and infant health outcomes in the United States, future studies will need to explore further the pathways that produce these relationships. For future research projects, the model suggested by Mayer and Sarin[32] may provide a framework to approach these issues. They described 4 potential mechanisms linking income inequality and IMRs, namely, nonlinearity in the relationship between parents' income and infant death, economic segregation, social resources (eg, state health care spending), and psychosocial mechanisms. An additional approach that may offer insight in future analyses is further investigation of psychosocial determinants, including maternal education level, because this has been shown to affect both family income level[47] and IMRs.[48]

CONCLUSIONS

The results of this study show that significant proportions of the variance in the PTB rate, LBW rate, VLBW rate, and IMR among US states in 2000–2004 can be attributed to the combined impact of income and income inequality. These findings support the hypothesis that both income and income inequality affect infants' health outcomes. Indeed, they strengthen this position, in that the regression results presented here suggest potential causal relationships of both median income and Gini coefficients with the outcomes of interest.

Many studies have shown that access to health care plays an important role in ensuring good pediatric health outcomes. However, the results of this study suggest that the public programs designed to meet the health needs of the poorest infants in this nation may not be adequately meeting those needs. This implies that ensuring health care access for all may not be sufficient; it also may be necessary to focus on interventions that address poverty and decrease income inequality to make significant improvements in infant health outcomes in this country. While our lawmakers consider how to build this into future health and social policies, as pediatric clinicians we must continue to be especially attentive to the health needs of our poorest patients.

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