OBJECTIVE: To examine the relation between county-level income inequality and rates of child maltreatment.

METHODS: Data on substantiated reports of child abuse and neglect from 2005 to 2009 were obtained from the National Child Abuse and Neglect Data System. County-level data on income inequality and children in poverty were obtained from the American Community Survey. Data for additional control variables were obtained from the American Community Survey and the Health Resources and Services Administration Area Resource File. The Gini coefficient was used as the measure of income inequality. Generalized additive models were estimated to explore linear and nonlinear relations among income inequality, poverty, and child maltreatment. In all models, state was included as a fixed effect to control for state-level differences in victim rates.

RESULTS: Considerable variation in income inequality and child maltreatment rates was found across the 3142 US counties. Income inequality, as well as child poverty rate, was positively and significantly correlated with child maltreatment rates at the county level. Controlling for child poverty, demographic and economic control variables, and state-level variation in maltreatment rates, there was a significant linear effect of inequality on child maltreatment rates \( (P < .0001) \). This effect was stronger for counties with moderate to high levels of child poverty.

CONCLUSIONS: Higher income inequality across US counties was significantly associated with higher county-level rates of child maltreatment. The findings contribute to the growing literature linking greater income inequality to a range of poor health and well-being outcomes in infants and children. *Pediatrics* 2014;133:454–461
A social gradient in child and adult health by socioeconomic status (SES) exists across a range of health conditions and mortality causes.1,2 Poverty may impact health and development owing to poor housing and sanitation, lack of access to healthy food, healthcare, and other social services, exposure to toxic environments and hazardous working conditions, behavioral risk factors, and exposure to psychosocial stressors.2,3

A growing literature suggests an effect of income inequality, in addition to poverty, on health and well-being. Income inequality refers to the degree to which income in a given geographic area is distributed equally or unequally. A positive correlation between state-level (in the United States) or national-level income inequality and aggregate rates of morbidity and mortality, and social problems like crime, is commonly documented, even when controlling for individual SES.4–6 Income inequality is also associated with several adverse child health and well-being outcomes. Earlier research using the United Nations Children’s Fund index of child well-being from 21 Organization for Economic Co-operation and Development countries indicated that income inequality was significantly related to infant mortality, low birth weight, injuries, low educational achievement, teenage births, obesity, and poor peer relations.7 In a recent study of US state data from 2000 to 2004, income inequality was positively correlated with rates of preterm births, low birth weight, very low birth weight, and infant mortality, after controlling for median household income.8

Child abuse and neglect is a significant public health problem in the United States. The Fourth National Incidence Study estimated that in 2005 to 2006, nearly 3 million children younger than age 18 years were physically abused, sexually abused, or emotionally abused in 1 year, representing 4% of children.9 SES is 1 of the strongest and most consistent predictors of child maltreatment.10,11 In the Fourth National Incidence Study, children in low SES households were 3 times more likely to be abused and ~7 times as likely to be neglected as children in higher SES households.9

Several studies have reported associations between economic factors and maltreatment rates at the neighborhood and community levels.12–15 Recently, a retrospective study of children admitted to 38 hospitals between 2000 and 2009 showed that rates of admissions for physical abuse and high-risk traumatic brain injury were significantly related to increases in local mortgage foreclosure and delinquency rates in the associated metropolitan areas.16 Although there is considerable evidence that income inequality has a negative impact on health and well-being for both adults and children, and that poverty is associated with rates of child maltreatment, no study has examined the association of income inequality with child maltreatment. The goal of this study was to examine this association using county-level data on income inequality and corresponding child maltreatment rates in the United States over a 5-year period.

METHODS

Data Sources and Measures

Data on income inequality and children living in poverty were obtained from the US Census Bureau’s American Community Survey (ACS).17 County-level data were extracted for all 3142 US counties and statistically equivalent entities from the 5-year estimates from 2005 to 2009. Only 5-year estimates are available from ACS for all counties. The Gini coefficient was used as a measure of income inequality. A value of 0 indicates perfect equality of income for all members of a population, while a value of 1 indicates perfect inequality, with all income in the population concentrated in a single individual.18 The percent of children living at or below the federal poverty line was used as a measure of child poverty.

Child maltreatment data were obtained from the US Children’s Bureau’s National Child Abuse and Neglect Data System (NCANDS).19 NCANDS data are collected from state child welfare systems on an annual basis. For each year from 2005 to 2009, counts of child maltreatment victims were derived from the investigated Child Protective Service reports disposed in that year. Victims were defined as children for whom a maltreatment allegation was substantiated, indicated, or designated as “alternative response — victim.” Alternative response is a dual-track system in some states to handle lower risk cases that are reported to child protective services. Alternative response — victim is a category used in only 3 states, and represented 0.5% of cases receiving a child protective response in 2011.20 The US Census counts of county-level child population provided in the NCANDS data sets were used to construct annual rates of victims per 1000 children in the population. The annual mean victim rates over the 5-year period were averaged and merged with the 5-year Gini estimates and child poverty rates from the ACS data set. Owing to the skewed nature of the victim rate distribution, a natural log transformation was applied before conducting statistical analyses. For counties with no victims, a small constant was added to 0 so that the value could be log transformed. Data from Puerto Rico and the District of Columbia were excluded from analyses. In 7 states (Alaska, Louisiana, Nebraska, Rhode Island, South Dakota, Vermont, and Virginia), numerous counties reported...
their child welfare data to adjacent counties, giving the impression that they had no victims of maltreatment. To adjust for this reporting artifact, counties were combined into regions that mirrored these administrative practices in those states. As a result, data from 259 counties were absorbed into regions. An additional 6 counties across 4 states were dropped from the analysis owing to missing NCANDS data. The final analytic sample consisted of 2877 counties, recoded regions, and statistically equivalent entities. Statistically equivalent entities (state subdivisions) exist for Alaska, Louisiana, Maryland, Missouri, Nevada, and Virginia.

Additional county level data were obtained from the ACS data source and from the 2011–2012 Health Resources and Services Administration Area Resource File, covering the 2005 to 2009 5-year period.21 Potential confounders for income inequality and child poverty were chosen that had significant bivariate correlations with the natural log of victim rate. Our analyses controlled for the following potential confounders: percent of the total population who are African American; percent of the total population who are Latino; percent of adults age 25+ years who have 4 or more years of college; percent of households with Supplemental Security Income or public assistance income; and the ratio of infant deaths to 1000 live births.

Statistical Analysis

The statistical analysis was performed by using SAS 9.3 software (SAS Institute, Cary, NC). Examination of the relations among the Gini coefficient (Gini), child poverty rate (Poverty), and the natural log of victim rate (LnVictim) was conducted by using the generalized additive model (GAM) procedure in SAS. GAMs are a powerful and flexible nonparametric regression modeling technique that allows parametric variables and non-parametric smoothers to be included in the same statistical model. Using this technique can uncover non-linearities in the relationships among variables while controlling for other variables.22,23 In the present analysis, smoothers using a local regression method known as Loess were used, and their smoothing parameters were selected automatically by using the generalized cross validation method.24 The results of the GAM were used to inform the parametric specification for a general linear model predicting LnVictim from Gini and Poverty to test for the presence of an interaction between Gini and Poverty. State was included as a fixed effect in all analyses to control for state-level differences in victim rates.

RESULTS

Table 1 provides descriptive statistics for the study variables and the bivariate correlations among them. The correlations are all positive and highly significant. Wide variability in victim rate exists among states. Average state rates range from 0.2% to 3.1%, and the state in which a county is located accounts for 56% of the variance. Victim rate is provided in the table, but LnVictim was used for all analyses.

A GAM was constructed to examine the relation between Gini and LnVictim, controlling for State, Poverty, and the control variables described above. As reported in Table 2, the linear parameters for Gini and Poverty were both significantly different from 0, as were those for each of the control variables. Significant nonlinear components were also found for both variables. In Table 2, the linear regression parameter for Gini has been multiplied by 100 so that it appears on a similar scale to the other variables.

The estimated partial relationship between Gini and LnVictim is shown in Fig 1. The linear component can be seen in the overall upward slope of the line; the nonlinear component results from a more strongly positive association between inequality and victim rate before the mean value of Gini (0.431) than after that value.

To test for the presence of an interaction between Gini and Poverty, a fully significant at \( P < .0001 \).

TABLE 1 Descriptive Statistics and Bivariate Correlations for US County Victim Rate, Gini Coefficient, and Child Poverty

<table>
<thead>
<tr>
<th>Variable</th>
<th>Victim Rate, %</th>
<th>Natural Log of Victim Rate</th>
<th>Gini Coefficient</th>
<th>Child Poverty, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victim rate, %</td>
<td>Mean (SD): 1.21 (0.90)</td>
<td>Mean (SD): −0.11 (0.88)</td>
<td>Mean (SD): 0.431 (0.036)</td>
<td>Mean (SD): 21.0 (9.5)</td>
</tr>
<tr>
<td></td>
<td>Max: 11.0</td>
<td>Max: 2.40</td>
<td>Max: 0.621</td>
<td>Max: 68.0</td>
</tr>
<tr>
<td></td>
<td>Median: 1.05</td>
<td>Median: 0.05</td>
<td>Median: 0.429</td>
<td>Median: 19.9</td>
</tr>
<tr>
<td></td>
<td>Min: 0.01</td>
<td>Min: −4.50</td>
<td>Min: 0.272</td>
<td>Min: 0.0</td>
</tr>
</tbody>
</table>

Sample consists of 2877 US counties and statistically equivalent entities. All correlation coefficients are statistically significant at \( P < .0001 \).
parametric approximation of the GAM was constructed. Linear and quadratic terms for Gini and Poverty and the interaction of Poverty with both Gini terms were included in addition to the control variables and State classification variable. The Gini*Poverty interaction was significant \((P = .013)\). The Gini*Gini*Poverty interaction was not \((P = .396)\). Figure 2 illustrates that the inequality effect was stronger at moderate and higher levels of Poverty, but was less positive at lower levels.

**DISCUSSION**
This study found that higher rates of income inequality across US counties are significantly associated with higher county-level rates of child maltreatment. Our findings contribute to the growing literature linking greater income inequality to a range of poor health and well-being outcomes in infants and children.\(^7,8\)

Child maltreatment is a significant and common adversity in the lives of children in the United States and worldwide. Child maltreatment is a toxic stressor\(^25\) in the lives of children that may result in childhood mortality and morbidities and have lifelong effects on leading causes of death in adults.\(^26\) This is in addition to long-term effects on mental health, substance use, risky sexual behavior, and criminal behavior.\(^27\) Child maltreatment is also associated with increased rates of unemployment, poverty, and Medicaid use in adulthood.\(^28\) suggesting that economic

**TABLE 2** Results of the Generalized Additive Model Regression

<table>
<thead>
<tr>
<th>Variable*</th>
<th>Linear Component</th>
<th>Nonlinear Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter (95% confidence interval)</td>
<td>(P)</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Gini coefficient ((\times 100))</td>
<td>0.022 (0.014 to 0.029)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Child poverty, %</td>
<td>0.010 (0.006 to 0.013)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
| 4+ years college, % | -0.015 (-0.018 to -0.012) | <.0001 | \n| African American, % | -0.009 (-0.012 to -0.007) | <.0001 | \n| Latino, %       | -0.006 (-0.008 to -0.003) | <.0001 | \n| Infant mortality (per 1000) | 0.013 (0.007 to 0.020) | <.0001 | \n| Public assistance, % | 0.021 (0.002 to 0.040) | .0263 | \n
* State was also included in the model as a 50 level classification variable.
disadvantages associated with child maltreatment may persist across generations.

Our study adds significant new findings to the literature on the association of socioeconomic factors with the risk for child maltreatment. Some studies have shown that socioeconomic characteristics, such as family-level poverty, increase the risk for maltreatment. Other studies show that socioeconomic factors measured at a more aggregate ecological level are also associated with maltreatment. To our knowledge, our study is the first to specifically examine income inequality as an important risk factor associated with child maltreatment.

Our study has several strengths. It includes a national census of maltreatment victims rather than using local or regional data or estimates based on samples. The use of county-level data provided a large sample and thus more precise estimates, in comparison with state data. With state as a fixed effect in our models, we controlled for state variations in child welfare policies and systems that could impact child maltreatment reporting and substantiation rates. Maltreatment data were also averaged across a 5-year period to provide more stable estimates similar to other studies that have examined the effect of income inequality on child and adult health outcomes. Finally, we used GAMs to capture nonlinearities in the relationship between inequality and maltreatment. Our results showed significant nonlinear and linear components in the relation of inequality to child maltreatment. The slope was steeper below the mean Gini value than for values above the mean. Previous studies of income inequality have generally used correlational or linear regression analyses, and thus have not reported nonlinear relationships. A study using 1990 data from all US counties, however, showed that mortality rates for all causes, heart disease, and cancer increased substantially when counties with the least inequality (≤25th percentile) were compared with counties with higher levels of inequality, but the increase was much less when comparing counties in the middle range of inequality (e.g., 50th–75th percentile) with the counties with the highest levels of inequality (>75th percentile). This suggests a nonlinear inequality effect similar to what we report, but these authors did not discuss or provide a formal test for such an effect. Future research should explore and replicate nonlinear effects more fully, and for child health outcomes specifically.

We found that the rate of county-level child poverty had a significant independent effect on maltreatment, consistent with other studies that have shown individual, family, or community-level poverty as a risk factor for child maltreatment. Child poverty

![Image of Figure 2](image-url)
also moderated the effects of inequality. The linear effect of inequality was positive at all levels of county-level child poverty, but was more positive for counties with moderate to high rates of child poverty. This serves to qualify the overall nonlinear effect of income inequality on child maltreatment, with the attenuation of the inequality effect much more evident in counties with low child poverty levels. In counties with high child poverty, increases in income inequality resulted in higher victim rates throughout the range of values of the Gini index.

The interaction of income inequality and poverty in our results is consistent with research showing that inequality has a larger impact on health outcomes in poorer versus wealthier counties. In 1 study of all US counties, income inequality interacted with county-level income for several causes of death for adults, with the inequality effect greater in poorer counties, although this pattern did not hold for infant mortality.33 Contrary to our findings, however, a state-level study reported stronger inequality effects on infant mortality, preterm births, and birth weights in states with lower versus higher child poverty rates, although a formal test of an interaction between inequality and poverty levels was not presented.8 Other studies conclude that income inequality exerts negative effects on health outcomes regardless of the level of income or poverty. In 1 study of National Health Interview Survey adult respondents, an overall dose-like response relationship between income inequality on mortality risk was found for white men at all income levels above poverty.34 Another study of US states found a significant relation between income inequality and rates of infant mortality that did not vary by county-level median income.35 Comparing such studies is difficult, because different measures of poverty at different levels of analysis (state versus county) were used, and outcomes varied across adults and children. Given the mixed evidence in the literature, a replication of the moderating effect of income we report here is warranted.

We chose county as the level of aggregation for examining the impact of inequality, rather than a larger (eg, state) or smaller (eg, zip codes or census tracts) unit of analysis. Although income inequality is by definition an ecological factor, studies may use a different geographic lens depending on the research question and outcome of interest. County is a meaningful unit of organization for health and human services that could affect the impact of income inequality on individuals and families. Multiple programs including Temporary Aid to Needy Families, Supplemental Nutrition Assistance Program, Medicaid, and child welfare are often administered at the county level.20,35,36 At the same time, we controlled for state variations in maltreatment rates, recognizing that states vary in their regulations, administrative reporting systems, or funding for services that impact counties in that state. Although many studies of income inequality and health outcomes in the United States have used states as the unit of analysis, others30,31,37,38 have reported county-level effects of inequality on health outcomes. Some reviews6,37 conclude that inequality effects are generally larger at larger units of analysis (eg, nations, states) and become smaller when smaller units such as neighborhoods are used,39 where income is a more powerful predictor. Further research on the impact of inequality measured at different levels of geographic aggregation is needed.

Our findings should be considered in light of certain limitations. First, our measure of maltreatment was drawn from administrative data collected by states and reflects substantiated cases of abuse or neglect. It is well accepted that reports to child protective services systems are undercounts of the true incidence of child maltreatment.5,40 We cannot be certain that the findings reported here would be the same for unreported cases of maltreatment. A recent study, however, has shown an effect of macroeconomic trends on hospital admissions for physical abuse,16 consistent with our findings. More research is needed to confirm our results by using alternative measures of maltreatment and by examining specific subtypes of maltreatment (eg, neglect, physical abuse, sexual abuse, and emotional maltreatment). Second, we did not have access to individual-level income data to use as a control variable. A review of mostly US research from 1997 through 2003,6 however, showed that studies that used the strongest multilevel designs to adjust for individual income still showed substantial evidence for worse health outcomes among adults in states with higher levels of inequality, although not all studies show this effect.41,42

CONCLUSIONS

More equal societies, states, and communities have fewer health and social problems than less equal ones.37 Our study extends the list of unfavorable child outcomes associated with income inequality to include child abuse and neglect. Our findings show that the effect of income inequality remained significant after adjustments were made for county-level variations in child poverty and for state variations in child maltreatment rates. The impact of income inequality was also greatest in counties with the highest child poverty rates. Future research should replicate this finding at other geographic units of analysis in the United States and in other countries.
Better understanding of early childhood adversities in relation to child and adult health outcomes has provoked a discussion of the role of the pediatric profession in promoting early childhood policies and services that would reduce exposures of children to toxic stressors or mitigate their impact.25,43 Such policy and practice discussions have included a separate report on the role of the pediatrician in child maltreatment prevention.44 Included in this report are recommendations for effective hospital-based programs (eg, abusive head trauma prevention programs), community-based programs (eg, home visitation and parent training programs), as well as guidance for the pediatrician for approaches to prevention within health supervision visits. Our findings, however, suggest that a comprehensive approach will ultimately require advocacy and action at the societal and community levels aimed at reducing income inequality.

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