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Does higher income inequality adversely influence infant mortality rates? Reconciling descriptive patterns and recent research findings

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ABSTRACT

As the struggle continues to explain the relatively high rates of infant mortality (IMR) exhibited in the United States, a renewed emphasis is being placed on the role of possible 'contextual' determinants. Cross-sectional and short time-series studies have found that higher income inequality is associated with higher IMR at the state level. Yet, descriptively, the longer-term trends in income inequality and in IMR seem to call such results into question. To assess whether, over the period 1990–2007, state-level income inequality is associated with state-level IMR; to examine whether the overall effect of income inequality on IMR over this period varies by state; to test whether the association between income inequality and IMR varies across this time period. IMR data - number of deaths per 1000 live births in a given state and year - were obtained from the U.S. Centers for Disease Control Wonder database. Income inequality was measured using the Gini coefficient, which varies from zero (complete equality) to 100 (complete inequality). Covariates included state-level poverty rate, median income, and proportion of high school graduates. Fixed and random effects regressions were conducted to test hypotheses. Fixed effects models suggested that, overall, during the period 1990–2007, income inequality was inversely associated with IMR ($\beta = -0.07$, SE (0.01)). Random effects models suggested that when the relationship was allowed to vary at the state-level, it remained inverse ($\beta = -0.05$, SE (0.01)). However, an interaction between income inequality and time suggested that, as time increased, the effect of income inequality had an increasingly positive association with total IMR ($\beta = 0.009$, SE (0.002)). The influence of state income inequality on IMR is dependent on time, which may proxy for time-dependent aspects of societal context.

1. Introduction

Amongst the world's longstanding, economically advanced nations, the United States has long been a population health outlier with indicators of health status far below those of its peer nations (Bezruchka, 2001, 2003). Indeed, even infant mortality, considered primarily a problem associated with the kinds of socioeconomic conditions found in economically developing societies, is markedly higher in the United States than in the other countries which make up the Organization for Economic Cooperation and Development (OECD). As of 2011, the United States had an infant mortality rate (IMR) – number of deaths occurring in the first year of life per 1000 live births – of 6.1(3). Amongst the OECD nations, only Turkey (IMR = 7.7) and Mexico (IMR = 13.6) had worse outcomes. Even the nations of Central and Eastern Europe have IMRs below 5.0. By contrast, of the perennial high-income nations, none even had IMRs above 4.0 with the exception of the United Kingdom and Luxembourg, whose 2011 IMR was 4.3. The lowest IMRs were found in Iceland (IMR = 0.9) and Sweden (IMR = 2.1) (OECD, 2011, 2013).

As alarming is the disparity in IMR between the United States and other nations, regional disparities within the United States paint a picture even graver. The latest available state-level data are for 2010 (when the national IMR was also 6.1). In this year, IMR varied from 3.57 in Alaska (a rate which resembled that of countries such as Austria, France, and the Netherlands) to 9.62 in Mississippi

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(a rate similar to that of Kuwait, The Russian Federation, and Ukraine). That equates to an absolute difference in IMR of 6.05 and a relative difference of almost threefold across the United States, a disparity on par with well-known U.S. racial disparities in IMR between non-Hispanic blacks (whose 2010 IMR was 11.46) and non-Hispanic whites (whose 2010 IMR was 5.18) (Prevention CfDCa, 2014). Indeed, a 2012 Congressional Research Service report cited state-level variation in infant mortality to be one of the most important dimensions of the problem to be addressed and that uncovering the causes of the high average IMR in the United States is intimately linked to uncovering the causes of these geographic disparities (Heisler, 2012).

In the mid 2000s, a series of papers began to examine the role of income inequality in explaining these state-level differences in IMR and other metrics of child health. These studies followed an influential body of literature that had established income inequality as a predictor of a variety of other state-level measures of population health including adult mortality, self-rated health, and firearm violent crime (Kennedy et al., 1996; Kawachi and Kennedy, 1997a; Kawachi et al., 1997; Kennedy et al., 1998). This prior research has theorized that as economic resources become increasingly concentrated at the top of the income distribution, a cascade of changes occur in societies, from the decline in social capital and cohesion to the concentration of political power in the hands of the wealthy and the resultant use of legislation to promote their interests (Kawachi et al., 1997; Subramanian and Kawachi, 2004; Kawachi et al., 2004; Wilkinson and Pickett, 2007; Kawachi and Kennedy, 1997b; Kawachi, 1999). In turn, these effects on the ambient social and economic aspects of the environment create both materially and psychologically stressful conditions, which lead to adverse physiological processes and damaging health behaviors (Phelan et al., 2004; Link and Phelan, 1995; McEwen and Gianaros, 2010; McEwen et al., 1999; Pham-Kanter, 2009). Because such conditions and their associated physiological and behavioral manifestations have been found through markers such as low birth weight to influence fetal and infant well-being, including infant mortality, it was reasonable to assess whether income inequality was also associated with IMR (Geronimus, 1992; Geronimus et al., 2006; Holzman et al., 2009; Messer and Kaufman, 2010).

Amongst the first studies to focus on income inequality came a study using data pooled between 1985 and 1991 which found that state-level income inequality was associated with neonatal mortality rates but not post-neonatal mortality rates (Mayer and Sarin, 2005). A subsequent cross-sectional correlative examination of state-level indicators of child well-being (including material deprivation, education, behavioral risk, and subjective sense of well-being) also found that these measures of child well-being were significantly worse in states with higher levels of income inequality (Pickett and Wilkinson, 2007). Finally, in an ecological study of data pooled from 2000 to 2004, Olson and colleagues demonstrated positive associations between income inequality and preterm birth, low birth weight, very low birth weight, and IMR: after controlling for median income, states with higher levels of unfavorable outcomes were those with higher levels of inequality (Olson et al., 2010).

While these studies suggest higher income inequality is associated with higher IMR and other metrics of child health, their results lie in rather stark contrast to the longer-term secular trends, which suggest that, over the past two decades, mean state-level income inequality has been rising and mean state-level IMR has been declining (Fig. 1). This juxtaposition suggests the relationship between income inequality and IMR over the long term may be more nuanced and that time may be an important factor to consider.

The objective of this study is thus to examine the association between income inequality and IMR over the period 1990–2007, during which most prior studies of income inequality and health are subsumed. We conduct three primary tests: First, we examine whether, over this broader pool of years, the findings of these prior studies are replicated. Because of the opposing secular trends, we anticipate that the findings will not be replicated. Second, we examine whether the overall effect of income inequality on IMR over this period varies by state. Because the level of income inequality is quite different by state, and states vary greatly in other aspects of their economic, social, and political characteristics, we expect the effect of income inequality will vary by state. Finally, we assess whether the association between income inequality and IMR varies across this time period. As aforementioned characteristics also vary over time, we also expect variation in the effect of income inequality on IMR over time.

2. Methods

2.1. Data sources

State-level IMR data were obtained from the Centers for Disease Control and Prevention Wonder database (http://wonder.cdc.gov/) which contains a census of all births and deaths in the United States, and links birth and death records so that it is possible to ascertain deaths which occurred during the first year of life. Our analyses use data from 1990 to 2007, the period during which we have reliable data on income inequality and during which the US underwent significant social policy reforms (Evans and Sewell, 2013; Fourcade-Gourinchas and Babb, 2002; Harvey, 2007). We stop prior to the economic crisis so as not to conflate more 'routine' changes in societal circumstances with those of a sudden crash, which deserves separate future analysis. Data on income inequality were from the Income Statistics Branch of the U.S. Census Bureau. All other data (for co-variates) were obtained from U.S. Census Bureau through custom internet-assisted data queries.

2.1.1. Measures

From Wonder, we obtained state-level estimates of IMR: the number of deaths per 1000 live births in a given state in a given year. Income inequality was measured using the Gini coefficient, which varies from zero (complete equality) to 1 (complete inequality). In this study, for easier interpretation of the beta coefficients in our models, the Gini was transformed to a scale from zero to 100 (by multiplying by 100), and median income was standardized (mean = 0, standard deviation = 1). Covariates included those which are also major population-level predictors of IMR and are also associated with income inequality: percentage of the state population living below the poverty line, median income of the state, and the percentage of high school graduates in the state. For the District of Columbia (DC), we were unable to locate high school graduation data for 1992. In order to retain this year of DC in our analysis, a regression line of best fit (second order polynomial, $R^2 = 0.84$) using all other years of high school graduation data for DC was used to impute a value for 1992.

2.2. Analytic strategy

Descriptive statistics were obtained in order to characterize the underlying variation across states in each of the measures. Modeling drew on panel regression strategies to account for the longitudinal nature of our data and hypotheses. We tested our first hypothesis of the overall relationship between income inequality and IMR during the period 1990–2007 using (a) a univariable fixed effects model to assess the crude association between income inequality and IMR across all states and all years of our data and (b)