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Preterm Birth in the Context of Increasing Income Inequality

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Abstract

Objective—Preterm birth is a leading cause of infant morbidity and mortality. Little is known about the contextual effect of US income inequality on preterm birth, an issue of increasing concern given that the current economic divide is the largest since 1928.

Methods—We examined changes in inequality over time in relation to preterm birth among singleton deliveries from an electronic medical record-based cohort ($n = 223,512$) conducted in 11 US states and the District of Columbia from 2002 to 2008. Increasing income inequality was defined as a positive change in state-level Gini coefficient from the year prior to birth. Multi-level models estimated the independent effect of increasing inequality on preterm birth (>22 and <37 weeks) controlling for maternal demographics, health behaviors, insurance status, chronic medical conditions, and state-level poverty and unemployment during the year of birth.

Results—The preterm birth rate was 12.3 % where inequality increased and 10.9 % where it did not. After adjustment, increasing inequality remained significantly associated with preterm birth (adjusted odds ratio 1.07, 95 % confidence interval 1.04, 1.11). We observed no significant interaction by insurance status or race, suggesting that increasing inequality had a broad effect across the population.

Conclusions—The contextual effect of increasing income inequality on preterm birth risk merits further study.

Keywords

Preterm birth; Income inequality; Gini coefficient

Significance

Previous research has demonstrated the impact of an individual's socioeconomic conditions, including income, on risk of preterm birth. Less is known about the importance of income in

context—that is unequal distribution of income across a population, and changes over time. Our study demonstrated that pregnant women who lived in a state where income inequality had increased over the year prior to their delivery were at increased risk of preterm birth. The elevated risk was not explained by differences in individual-level risk factors or by differences in poverty and unemployment rates in the states in which they delivered.

Introduction

An individual's socioeconomic status is a well-established determinant of morbidity and mortality such that wealthier individuals have better health outcomes than poorer individuals [1]. This relationship has also been demonstrated for preterm birth, a leading cause of infant mortality and morbidity in the US where preterm birth rates are consistently higher among socioeconomically disadvantaged women [2, 3]. However, less is known about the influence of an individual's socioeconomic status relative to other members of the community [4, 5]. This concept refers to income inequality, or the unequal distribution of income within a population. It is an issue of increasing concern in the US where the divide between the highest and lowest earning segments of the population is now the largest it has been since 1928 [6]. In 2012, the highest earning 1 % of families received just over 22 % of all pretax income while the bottom 90 % of families earned less than half (49.6 %) [6]. Moreover, a recent report found that the high level of income inequality in the US strengthens the association between personal economic resources and health to a greater degree than in countries where income is more evenly distributed [7].

Income inequality has been associated with depression, infant mortality, and reduced life expectancy [8–13]. These effects are thought to be driven by macro-level policy factors whereby underinvestment in community resources and social infrastructure limits individuals' access to educational and employment opportunities, material goods and health care [14]. This is known as the neo-materialist theory, and the adverse effects of such systemic lack of investment in public services are disproportionately shouldered by the poorer segment of the population who become less able to prevent and treat disease [15]. There may also be factors arising from the psychosocial environment in inequitable communities that degrade population health [15]. Reduced social cohesion and trust can lead to higher crime and poor housing and neighborhood conditions [16]; the cumulative biological effect of these chronic stressors may result in earlier health deterioration among poorer individuals relative to those of greater means [17].

Previous studies of income inequality in relation to preterm birth have had limited data on individual level factors [18–20] and results have been equivocal. Higher income inequality at the US county-level appeared to increase risk [18] while in US neighborhoods [19] and Japanese prefectures [20] no increase was observed. Further, all of these analyses utilized a cross-sectional measure of inequality, so it remains unknown whether changes in income inequality over time increase the risk of preterm delivery. The life course perspective suggests that socioeconomic contexts over time—including prior to pregnancy—may have important influences on birth outcomes [21, 22]. Therefore the purpose of this analysis was to examine the risk of preterm birth in the context of increasing income inequality over the year prior to birth using a large geographically- and racially-diverse sample of births in the

US. We hypothesized that women who were pregnant when inequality was increasing were more likely to give birth preterm.

Materials and Methods

Study Design and Population

The data in these analyses are from the Consortium on Safe Labor (CSL), a national retrospective cohort study from 2002 to 2008. The CSL included 19 hospitals located in 12 jurisdictions: California, Delaware, District of Columbia (DC), Florida, Illinois, Indiana, Maryland, Massachusetts, New York, Ohio, Texas, and Utah. For ease of presentation, we describe indicators for the District of Columbia as state-level variables. Clinical centers were required to have electronic medical records and were selected to achieve geographic representation of 9 American College of Obstetricians and Gynecologists US districts [23]. Data on maternal demographic characteristics; medical, reproductive, and prenatal history; labor and delivery; and post-partum and newborn information were extracted from electronic medical records for births at 23 weeks or later. Electronic discharge summaries for mothers and infants were linked to the medical records. A total of 228,562 births were captured over the course of the study, a majority (87 %) of which occurred between the years 2002–2005 [23]. This analysis was restricted to singleton births ($n = 223,512$ births to 204,180 women). CSL data were anonymized, and the Institutional Review Boards at all participating sites approved the study.

Income Inequality

The Gini coefficient—a measure of statistical dispersion commonly used to describe the distribution of resources in a population—was used to quantify state-level income inequality [24]. Values of the coefficient range from 0 (completely equal distribution such that 50 % of the population owns 50 % of the income) to 1 (completely unequal distribution whereby one person owns 100 % of the income) [25].

Personally identifying data, including maternal address, were not collected in the CSL and therefore state of residence was based on the location of the delivery hospital. The US Census Bureau's American Community Survey provides annual estimates of the pre-tax Gini coefficient by state [26] and births were grouped by state and year and linked to corresponding Gini coefficient values based on the Census Federal Information Processing Standards (FIPS) codes. For each state and year of birth in the CSL, the percent change in the Gini coefficient from the year prior to the birth was calculated and examined both as a continuous measure and then dichotomized into categories of increasing inequality (a positive change in Gini coefficient) or decreasing/steady inequality (a negative or zero change in Gini coefficient). The intention of this dichotomization was to broadly define the context of increasing inequality and to provide a more meaningful interpretation of preterm birth risk than a one-unit change in Gini coefficient, which is less intuitive.

In order to examine whether the extent of the increase in inequality affected the magnitude of association between increasing inequality and preterm birth, we examined the percent change in the Gini coefficient from the previous year as a continuous variable and then

created a three-level variable to indicate decrease or no change in inequality, small change in inequality—defined as less than or equal to the mean plus one standard deviation of the percent change (1.5 %)—and large change in inequality, defined as greater than 1.5 %, based on the similar categorization of absolute Gini coefficients by Fujiwara et al. [20] We hypothesized that a greater increase in inequality would correspond to a greater risk for preterm birth.

Individual and State-Level Covariates

A number of sociodemographic covariates were included in adjusted analyses to control for individual-level influences on the risk of preterm birth. Maternal race categories were White, Black, Hispanic, Asian/Pacific Islander, and multi-ethnic or other. Maternal age modeled continuously. Parity (nulliparous, 1, 2, 3, 4, 5), marital status (married, single, and divorced or widowed, unknown), insurance status (private, public, and self-pay or other), smoking and drinking alcohol during pregnancy (both yes/no or unknown), pre-pregnancy body mass index (underweight, normal, over-weight, obese, unknown) pre-pregnancy medical conditions (chronic hypertension, anemia, asthma, diabetes, heart diseases, kidney disease, thyroid disease, sexually transmitted infection, and history of depression, all yes/no or unknown), and year of birth were also included in adjusted models. Missing covariates were coded as such in order to ensure all observations remained in multivariable models.

In order to control for potentially important state-level socioeconomic differences between states, we included percentage of individuals living below the federal poverty level and percent unemployment at the year of birth. These variables are available for all states annually in the US Census Bureau's American Community [27].

Outcome

The outcome of interest was preterm birth defined as delivery occurring at <37 weeks of gestation by the best clinical estimate as recorded in the medical record. As the CSL included only records for deliveries that occurred at 23 weeks or later, we did not include preterm births occurring <23 weeks.

Analyses

Differences in individual-level factors and preterm birth by change in Gini coefficient were assessed in preliminary analyses in order to broadly characterize the context of increasing inequality. Multi-level logistic regression was used to estimate the contextual effect of increasing income inequality relative to decreasing or constant inequality on the risk of preterm birth and to account for repeated births to the same mother (contributed by about 9 % of women in the study population). In order to systematically assess potential pathways between income inequality and preterm birth, we created a series of nested models (Models A–E) to estimate adjusted odds ratios (aOR) and 95 % confidence intervals for preterm birth by sequentially adjusting for independent variables grouped by the following domains: maternal demographic characteristics, individual-level socioeconomic position, health behaviors, underlying medical characteristics and conditions, and finally state-level socioeconomic indicators. Model A included race, age, and parity. Model B included all variables in Model A and further adjusted for marital status and insurance type as proxy-

indicators of individual-level socioeconomic position. Model C included all variables in Model B and further included smoking and alcohol use during pregnancy. Model D contained all of the above covariates in addition to maternal medical history variables: pre-pregnancy body mass index, chronic hypertension, anemia, asthma, pregestational diabetes, heart diseases, kidney disease, thyroid disease, sexually transmitted infection, and history of depression. Fully-adjusted Model E included all covariates in Model D plus two indicators of state-level socioeconomic conditions: percent of the population below the poverty level and percent unemployment for the year of birth. Finally, in order to test whether the harmful effect of inequality was greater for more disadvantaged individuals, we tested for interactions by insurance status and maternal race in the fully-adjusted model. All analyses were conducted in SAS version 9.4 (SAS Institute Inc, Cary, NC) using the GLIMMIX procedure for mixed effects logistic regression models with both random and fixed effects (state- and individual-level covariates, respectively), where an unstructured covariance matrix was used to account for the correlations within states and repeated births to some mothers.

We conducted sensitivity analyses to test the robustness of our overall results. Changes in income distribution may be driven by changes in total income, or other economic conditions. While Model E controlled for potentially important state-level differences in absolute economic indicators between states at the time of birth, we further controlled for measures of relative changes in socioeconomic indicators within states. These included the percentage by which poverty, unemployment, and median household income (adjusted for inflation) increased or decreased from the year prior to birth. Second, among deliveries classified as preterm (>22 and <37 weeks) in these data, the mean gestational age at delivery was 33.7 weeks. We therefore repeated the above analyses comparing early preterm birth (>22 and <34 weeks) to deliveries that occurred after 34 weeks. Third, to evaluate the use of state-level income inequality as the relevant scale for our main outcome, we repeated the analyses using county-level income inequality which was available through the US Census Bureau for a limited number of our study years (2006–2008, $n = 47,486$ births). Third, we stratified the main analysis by preterm birth subtype (medically indicated or spontaneous) to examine whether the relationship between income inequality and preterm birth varied by clinical precursors. Finally, while our primary hypothesis regarded increasing income inequality as a proximal exposure (over 1 year prior to the year of birth), we also tested the impact of a longer term increase in inequality over 3 years prior to the year of birth.

Results

The mean Gini coefficient across all 12 CSL states from 2002 to 2008 was 0.46, ranging from 0.39 in Utah in 2002 to 0.54 in DC in 2005. Income inequality increased on average 0.5 % (SD 1.0, skewness 0.02) annually across all states and years included in the analysis, but fluctuated from a decrease of 1.6 % in Maryland from 2005 to 2006 and increased as much as 2.7 % in DC between 2004 and 2005. There were a total of 131,024 births that occurred in states and years where income inequality had increased from the previous year. The remaining 92,478 births occurred in a state and year where inequality remained the same or decreased from the prior year. Women who delivered in the context of increasing inequality were more likely to be non-white, teenaged, single mothers with public insurance

(Table 1). These women were also more likely to have poorer health with higher rates of chronic hypertension, heart and kidney disease, asthma, anemia, and diabetes. The rate of preterm birth among women in areas of increasing inequality was 12.3 % compared to 10.9 % among women in states where inequality decreased or remained constant.

A one-unit increase in percent change in the continuous Gini coefficient was not significantly associated with pre-term birth [aOR 1.01, 95 % CI (0.99, 1.03)]. However, after classifying the percent change as increasing or decreasing/constant, in the fully-adjusted model the odds of preterm delivery were elevated [aOR 1.07, 95 % CI (1.03,1.10)] among women who gave birth when state-level inequality was increasing compared to women who gave birth in states where inequality had decreased or remained constant from the previous year (Table 2). The association between increasing income inequality and increased risk of preterm delivery was consistent across Models A–E as sequential adjustment for individual-level socioeconomic indicators (Model B), negative health behaviors (Model C), pre-pregnancy medical conditions (Model D) and state-level socioeconomic indicators (Model E) resulted in negligible attenuation of the association above and beyond adjustment for maternal demographics (Model A) and ranged from 6 to 8 % increased risk across all models.

For 82,051 (62.6 %) of the 131,024 births in a state and year when inequality had increased, the increase was categorized as small (less than the mean plus one standard deviation in percent change). The remaining 48,973 (37.4 %) occurred in the context of a larger increase in inequality from the previous year. After adjustment, both of these groups were at similarly increased risk for preterm birth relative to births that occurred when inequality decreased or did not change indicating that the magnitude of inequality was less important than the increase itself [small increase aOR 1.08, 95 % CI (1.04, 1.13); large increase aOR 1.07, 95 % CI (1.02, 1.12)].

There was no difference in the magnitude of the effect of increasing inequality by insurance status or maternal race as indicated by non-significant interaction terms. Women who had private insurance were at an equally increased risk of giving birth preterm compared to women who were publically insured when inequality in the state had increased from the previous year. Likewise there was no difference in risk observed across racial/ethnic groups.

Sensitivity Analyses Results

On average, fluctuations in unemployment and household income levels were larger than changes in income inequality observed over states and years represented in the CSL: mean(SD) change in unemployment rate = −5.0 % (13.0), mean (SD) change in median household income = 4.3 % (2.6). Poverty rates changed to the same degree as income inequality, although in the opposite direction [mean (SD) −0.5 % (5.5)]. Controlling for both differences in economic conditions between states at the time of birth as well as within states over the year prior to birth strengthened the association between increasing income inequality and preterm birth to a greater degree than any of the previous models [aOR 1.11, 95 % CI (1.06,1.16)], although confidence intervals were overlapping. In the analysis examining early preterm birth (<34 weeks) the magnitude of the effect estimates across the

model building was slightly but not significantly higher than those for late preterm [<37 weeks] ranging from 1.12 (95 % CI (1.06,1.18)) in Model A to 1.09 [95 % CI (1.04, 1.15)] in fully-adjusted model E, suggesting that the association between increasing income inequality and preterm delivery was not specific to early or late preterm birth. For the limited sample of births with data on county-level inequality, there was no difference in preterm birth risk for women in counties of increasing inequality and those in decreasing or steady inequality [aOR 0.94, 95 % CI (0.89, 1.00)]. We found higher risk of both spontaneous and medically-indicated preterm births among women who were living in a context of increasing state-level inequality prior to giving birth compared to women who were not [spontaneous aOR 1.08, 95 % CI (1.05, 1.12), indicated aOR 1.08, 95 % CI (1.00, 1.16)]. Finally, when we examined increases in income inequality over 3 years prior to the year of birth, effects were of greater or approximately equal magnitude across the sequentially adjusted models [final fully-adjusted OR 1.07, 95 % CI (1.01, 1.13)].

Discussion

In a large, US study of pregnant women with detailed medical record information we found that any increase in state-level income inequality from the year prior to birth was associated with an independent 7 % increased risk of preterm delivery less than 37 weeks even after controlling for individual-level demographic and socioeconomic factors, health behaviors, preconception medical history and differences in state-level poverty and unemployment rates. Importantly, living in a state when inequality expanded over the course of the year leading up to delivery increased preterm birth risk regardless of the degree of initial inequality and controlling for simultaneous changes in absolute income, poverty, and unemployment levels. Further, the magnitude of inequality increase was less important than the increase itself.

Previous investigations of the income inequality and preterm birth relationship were cross-sectional analyses of inequality at a single point in time (year of birth) and are not directly comparable to our study. Huynh et al. [18]. found that compared to pregnant women living in low inequality areas at the time of birth, women in areas of medium and high inequality were at increased risk for preterm birth compared to women in areas of low inequality (7 and 23 % increased risk, respectively). Fujiwara et al. [20] reported no association between income inequality and preterm birth in more egalitarian Japan, where the highest Gini coefficient they reported was lower than the lowest value in our data (0.385 vs. 0.394). In contrast to these studies, we examined income inequality longitudinally among a population of women whose individual socioeconomic status varied as did the economic contexts of the states in which they gave birth. While inequality levels fluctuated between years in all jurisdictions included in these analyses, overall the variation in change in inequality was relatively small (mean 0.5 %, range -1.6–2.7 %) which may explain our lack of significant finding associated with a continuous exposure measure and no difference in effect size between a categorically large or small increase in inequality.

Our findings that increasing inequality was equally detrimental among women with public and private insurance status indicates a broader impact on preterm risk which is not directly a response to the poorest economic conditions. These findings suggest that in addition to

intervention strategies intended to ameliorate conditions of poverty, those that aim to reduce the income disparity may promote population health as well. Elsewhere, such redistributive policies—welfare state and labor market policies, for example—have been associated with positive influences on population health as indicated by infant mortality, life expectancy at birth, and early child health and development [28, 29].

Still, across all states, rates of preterm birth were significantly higher among women with public insurance compared to private—the only marker of socioeconomic disadvantage available in the medical records data. This combined with our findings that both preconception health and preterm birth rates were worse among women in states when inequality increased implicates deprivations associated with the neo-materialist theory. Allocation of state-level resources and policies regarding availability of health services may influence a woman's health across the life-course, establishing health differentials that begin before pregnancy and are manifest in poorer birth outcomes. Unmeasured factors in our study such as economic segregation [30] or state supply of healthcare (provision of hospital beds and per capita hospital expenditures) [31] may be mechanisms linking state-level inequality to adverse population health outcomes. While we found no effect of changing county-level inequality in the sensitivity analysis, it may have been underpowered due to our sharply limited sample in terms of year of birth, numbers of births, and counties in which the births took place. Alternatively, it may be that state-level policies are more relevant to the outcome than county-level factors.

Our analysis is limited by the use of de-identified medical records which have no data on maternal home address. Therefore we were unable to directly define her geographic location; however, given our broad geographic level of analysis (state) it is unlikely that many women were misclassified given the assumption that they resided in the same state as their birthing hospital. Second, our classification of women by socioeconomic position was limited to insurance status which may not be as informative as individual income, particularly during pregnancy when public insurance eligibility is typically modified to provide greater coverage [32]. Additionally, we note that race in the medical records was not recorded with detailed ethnicity, and we are therefore unable to more specifically classify women into combined racial/ethnic categories (Black-Hispanics, for example). Furthermore, most of the hospitals represented in the CSL were located in urban areas and our results therefore may not generalize to experiences of women in more rural parts of the states where social contexts are different and the relative distribution of income may not be as readily apparent. Finally, data on additional potentially important factors which may be influenced by increasing income inequality (such as gestational week of initiation into prenatal care or access to abortion) were unavailable and should be explored in future research.

As income and resources are increasingly concentrated among a smaller segment of the population, the adverse health consequences among the larger proportion of the population should be of concern. In our data, states fluctuated in annual Gini coefficient values, but inequality was higher in all states at the end of the study than in the beginning. Even after adjusting for year of birth as a proxy for any secular trend in preterm risk, we observed an increased risk in both spontaneous and medically indicated preterm delivery in relation to increasing inequality. The association was unaffected by differences in state-level income,

unemployment and poverty levels as well as a variety of individual-level clinical, social and demographic characteristics. If our results were confirmed, these findings suggest approximately 35,800 preterm births each year might be attributable to increasing income inequality, representing a significant economic burden given the immediate and long-term health consequences of prematurity [33]. Given the ubiquity of macro-level exposures such as income inequality [3], further research on their potentially broad population health impact utilizing samples drawn from varying sociopolitical contexts and more recent years may help inform efforts to promote socioeconomic equity and improve population health.

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Abbreviations

CSL	Consortium on Safe Labor
FIPS	Federal Information Processing Standards

References

1. Adler NE, & Ostrove JM (1999). Socioeconomic status and health: What we know and what we don't. *Annals of the New York Academy of Sciences*, 896, 3–15. [PubMed: 10681884]
2. Blumenshine P, Egerter S, Barclay CJ, Cubbin C, & Braveman PA (2010). Socioeconomic disparities in adverse birth outcomes: A systematic review. *American Journal of Preventive Medicine*, 39(3), 263–272. [PubMed: 20709259]
3. Daoud N, O'Campo P, Minh A, Urquia ML, Dzakpasu S, Heaman M, et al. (2015). Patterns of social inequalities across pregnancy and birth outcomes: A comparison of individual and neighborhood socioeconomic measures. *BMC Pregnancy Childbirth*, 14, 393. [PubMed: 25494970]
4. Lynch J, Smith GD, Harper S, Hillemeier M, Ross N, Kaplan GA, et al. (2004). Is income inequality a determinant of population health? Part 1. A systematic review. *Milbank Quarterly*, 82(1), 5–99. [PubMed: 15016244]
5. Wilkinson RG, & Pickett KE (2006). Income inequality and population health: A review and explanation of the evidence. *Social Science and Medicine*, 62(7), 1768–1784. [PubMed: 16226363]
6. Saez E (2013) Striking it richer: The evolution of top incomes in the United States. UC Berkeley, 2013 <http://elsa.berkeley.edu/users/saez/saez-UStopincomes-2012.pdf> Accessed 07 November 13.

7. Semyonov M, Lewin-Epstein N, & Maskileysen D (2013). Where wealth matters more for health: The wealth–health gradient in 16 countries. *Social Science and Medicine*, 81, 10–17. [PubMed: 23422055]
8. Cifuentes M, Sembajwe G, Tak S, Gore R, Kriebel D, & Punnett L (2008). The association of major depressive episodes with income inequality and the human development index. *Social Science and Medicine*, 67(4), 529–539. [PubMed: 18524442]
9. Pabayo R, Kawachi I, & Gilman SE (2014). Income inequality among American States and the incidence of major depression. *Journal of Epidemiology and Community Health*, 68(2), 110–115. [PubMed: 24064745]
10. Olson ME, Diekema D, Elliott BA, & Renier CM (2010). Impact of income and income inequality on infant health outcomes in the United States. *Pediatrics*, 126(6), 1165–1173. [PubMed: 21078730]
11. Lynch JW, Kaplan GA, Pamuk ER, Cohen RD, Heck KE, Balfour JL, et al. (1998). Income inequality and mortality in metropolitan areas of the United States. *American Journal of Public Health*, 88(7), 1074–1080. [PubMed: 9663157]
12. Daly MWMVS (2001). Income inequality and homicide rates in Canada and the United States. *Canadian Journal of Criminology*, 43, 219–236.
13. Wilkinson RG (1992). Income distribution and life expectancy. *BMJ*, 304(6820), 165–168. [PubMed: 1637372]
14. Smith GD (1996). Income inequality and mortality: Why are they related? *BMJ*, 312(7037), 987–988. [PubMed: 8616378]
15. Lynch JW, Smith GD, Kaplan GA, & House JS (2000). Income inequality and mortality: Importance to health of individual income, psychosocial environment, or material conditions. *BMJ*, 320(7243), 1200–1204. [PubMed: 10784551]
16. Elgar FJ, & Aitken N (2011). Income inequality, trust and homicide in 33 countries. *European Journal of Public Health*, 21(2), 241–246. [PubMed: 20525751]
17. Crimmins EM, Kim JK, & Seeman TE (2009). Poverty and biological risk: The earlier “aging” of the poor. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 64(2), 286–292.
18. Huynh M, Parker JD, Harper S, Pamuk E, & Schoendorf KC (2005). Contextual effect of income inequality on birth outcomes. *International Journal of Epidemiology*, 34(4), 888–895. [PubMed: 15860635]
19. Nkansah-Amankra S, Dhawain A, Hussey JR, & Luchok KJ (2010). Maternal social support and neighborhood income inequality as predictors of low birth weight and preterm birth outcome disparities: Analysis of South Carolina Pregnancy Risk Assessment and Monitoring System survey, 2000–2003. *Maternal and Child Health Journal*, 14(5), 774–785. [PubMed: 19644741]
20. Fujiwara T, Ito J, & Kawachi I (2013). Income inequality, parental socioeconomic status, and birth outcomes in Japan. *American Journal of Epidemiology*, 177(10), 1042–1052. [PubMed: 23576676]
21. Lu MC, & Halfon N (2003). Racial and ethnic disparities in birth outcomes: A life-course perspective. *Maternal and Child Health Journal*, 7(1), 13–30. [PubMed: 12710797]
22. El-Sayed AM, Tracy M, & Galea S (2012). Life course variation in the relation between maternal marital status and preterm birth. *Annals of Epidemiology*, 22(3), 168–174. [PubMed: 22285870]
23. Zhang J, Troendle J, Reddy UM, Laughon SK, Branch DW, Burkman R, et al. (2010). Contemporary cesarean delivery practice in the United States. *American Journal of Obstetrics and Gynecology*, 203(4), 326 e1–326 e10. [PubMed: 20708166]
24. Kawachi I, & Kennedy BP (1997). The relationship of income inequality to mortality: Does the choice of indicator matter? *Social Science and Medicine*, 45(7), 1121–1127. [PubMed: 9257403]
25. Subramanian SV, & Kawachi I (2004). Income inequality and health: What have we learned so far? *Epidemiologic Reviews*, 26, 78–91. [PubMed: 15234949]
26. John J Hisnanick ALR. Household income inequality measures based on the ACS data: 2000–2005. US Census Bureau, 2006 Available from: http://www.census.gov/hhes/www/income/publications/ACS%20inequality%20report%202000-2005_v2.pdf.

27. US Census Bureau. American Community Survey, 2002–2008, detailed tables (database on the Internet). Available from: <http://factfinder.census.gov/home>.
28. Navarro V, Muntaner C, Borrell C, Benach J, Quiroga A, Rodriguez-Sanz M, et al. (2006). Politics and health outcomes. *Lancet*, 368(9540), 1033–1037. [PubMed: 16980120]
29. van den Heuvel M, Hopkins J, Biscaro A, Srikanthan C, Feller A, Bremberg S, et al. (2013). A comparative analysis of early child health and development services and outcomes in countries with different redistributive policies. *BMC Public Health*, 13, 1049. [PubMed: 24195544]
30. Mayer SE, & Sarin A (2005). Some mechanisms linking economic inequality and infant mortality. *Social Science and Medicine*, 60(3), 439–455. [PubMed: 15550294]
31. Lhila A (2009). Does government provision of healthcare explain the relationship between income inequality and low birthweight? *Social Science and Medicine*, 69(8), 1236–1245. [PubMed: 19699571]
32. US Department of Health and Human Services. (2014). Medicaid eligibility for pregnant women. <http://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Population/Pregnant-Women/Pregnant-Women.html>. Accessed 12 March 2014.
33. Soilly AL, Lejeune C, Quantin C, Bejean S, & Gouyon JB (2014). Economic analysis of the costs associated with prematurity from a literature review. *Public Health*, 128(1), 43–62. [PubMed: 24360723]

Table 1

Demographic and medical characteristics of CSL births by change in state-level income inequality from the year prior to birth, 2002–2008, N = 223,512

	State-level income inequality	
	Decreased or stayed same (n = 92,483; 41.4 %)	Increased (n = 131,029; 58.6 %)
Race (%)		
White	58.5	46.8
Black	18.1	27.3
Hispanic	17.1	18.9
Asian/Pacific Islander	3.5	4.8
Multiracial/other/unknown	2.8	2.2
Marital status (%)		
Married	60.8	57.3
Single	33.2	38.8
Divorced/widowed	1.2	1.5
Unknown	4.3	2.5
Insurance type (%)		
Private	64.8	60.8
Public	34.0	37.5
Self-pay or other	1.2	1.7
Parity (%)		
Nulliparous	39.3	40.3
1	30.5	30.7
2	17.0	16.0
3	7.6	7.2
4	3.0	3.0
5	2.5	2.8
Smoking in pregnancy (%)	5.8	7.3
Alcohol use in pregnancy (%)	2.2	1.6
Pre-pregnancy BMI (%)		
Underweight	3.5	3.6
Normal	36.7	34.5
Overweight	15.1	14.9
Obese	12.2	12.7
Unknown	32.5	34.3
Medical history (%)		
Chronic hypertension	2.4	3.4
Sexually transmitted infection	2.2	4.4
Anemia	7.0	8.9
Asthma	6.8	7.0
Heart disease	0.5	0.9
Kidney disease	0.5	1.0

	State-level income inequality	
	Decreased or stayed same (n = 92,483; 41.4 %)	Increased (n = 131,029; 58.6 %)
Thyroid disease	2.0	1.8
Pre-gestational diabetes	1.6	2.6
Depression	4.8	3.7
Preterm birth (%)	10.9	12.3
Percentage of individuals below the federal poverty level (%)	11.7 (2.8)	12.9 (2.7)
Percent unemployed (%)	5.7(1.4)	6.7 (1.0)
	Mean (SD)	Mean (SD)
Median household income	53,073 (5495)	49,509 (5956)
Maternal age	27.6 (6.1)	27.6 (6.3)

Table 2

Adjusted odds ratios (aOR) and 95 % confidence intervals (95 % CI) for preterm birth by previous year change in state-level income inequality

MODEL A^a		MODEL B^b		MODEL C^c		MODEL D^d		MODEL E^e	
aOR	(95 % CI)	aOR	(95 % CI)	aOR	(95 % CI)	aOR	(95 % CI)	aOR	(95 % CI)
<i>Income inequality</i>									
Decreased or constant	Referent								
Increased	1.08 (1.05, 1.11)	1.07 (1.04, 1.11)	1.07 (1.03, 1.10)	1.06 (1.03, 1.09)	1.07 (1.03, 1.10)	1.07 (1.03, 1.10)			

^aModel A adjusted for year of birth and maternal demographics: age, race, parity

^bModel B adjusted for variables in Model A plus indicators of individual-level SES: marital status and insurance type

^cModel C adjusted for variables in Model B plus health behaviors: smoking and alcohol use during pregnancy

^dModel D adjusted for variables in Model C plus medical history (underlying conditions): pre-pregnancy body mass index, presence of a sexually transmitted infection, chronic hypertension, anemia, asthma, pre-gestational diabetes, heart disease, kidney disease, thyroid disease and history of depression

^eModel E adjusted for variables in Model D plus state-level socioeconomic characteristics: percent of individuals below the poverty level, percent unemployed at year of birth