Published in final edited form as:

Ann Epidemiol. 2014 June ; 24(6): 432–440. doi:10.1016/j.annepidem.2014.02.014.

Economic contraction and maternal health behaviors during pregnancy in a national sample of U.S. women

Claire Margerison-Zilko, PhD¹

¹Department of Epidemiology and Biostatistics, Michigan State University

Abstract

Purpose—The purpose of this study was to examine associations between maternal exposure to unexpected economic contraction and health behaviors during pregnancy, using methods to account for impacts of economic contraction on selection into pregnancy.

Methods—Data on health behaviors among 7,074 pregnancies in the National Longitudinal Survey of Youth 1979 were linked to monthly unemployment rates in maternal state of residence. The study examined associations between exposure to unexpected economic contraction (higher than expected state-level unemployment) during each trimester of pregnancy and maternal smoking, alcohol use, and gestational weight gain using generalized linear models.

Results—Economic contraction was not associated with maternal smoking or gestational weight gain. Associations between economic contraction and maternal alcohol use differed by maternal race/ethnicity and education. Among Black/non-Hispanic women, exposure to economic contraction during the first and second trimester of pregnancy were associated with a 42% (95% CI: 1.08, 1.85) and 33% (95% CI: 1.01, 1.74) increased risk of alcohol use, respectively.

Conclusions—Findings suggest that exposure to extreme economic contraction during pregnancy may be associated with increased use of alcohol with differences by maternal race/ethnicity and educational attainment. Economic contraction was not associated with other maternal pregnancy behaviors.

Keywords

economic conditions; pregnancy; smoking; alcohol consumption; weight gain

INTRODUCTION

Although a growing literature suggests that economic downturns are associated with increased incidence of adverse perinatal health outcomes, including fetal death [1, 2], low and very low birth weight (LBW) [3–6], small for gestational age (SGA) [7], and neonatal

© 2014 Elsevier Inc. All rights reserved

Corresponding Author: Claire E. Margerison-Zilko.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

mortality [8, 9], little work has examined the relations between economic contraction and maternal health behaviors during pregnancy. Because smoking, alcohol use, diet, and physical activity are important determinants of both short- and long-term maternal and child health [10–13], it is critical to understand whether and how these behaviors are influenced by economic downturns. Moreover, these behaviors represent a potential mechanism through which economic conditions could influence fetal and infant health.

The economy may influence health behavior in several ways. Work hours may either decrease or increase during recessions, impacting leisure time for health-seeking behaviors [14]. Economic contraction may also alter spending on tobacco, alcohol, food, physical activity, or preventative care due to real or anticipated loss of income or changes in access to goods and services [15]. Contracting economies are also associated with increased psychosocial stress, which is associated with higher levels of smoking and decreased smoking cessation, alcohol use, and higher fat diets [16].

Importantly, influences of the macro-economy on maternal pregnancy behaviors may differ by race/ethnicity or socioeconomic status (SES). Individuals of minority race/ethnicity and those with low education bear a disproportionate burden of job loss during recessions [17], suggesting that any impacts of economic downturn on maternal pregnancy behaviors may be stronger among these groups. Because women of non-Hispanic black race/ethnicity and low SES are also at increased risk of adverse perinatal health outcomes compared to white women and those of higher SES, it is important to understand how the macro-economy may influence pregnancy behaviors among these potentially vulnerable populations.

Prior work has demonstrated that recessions are associated with reduced smoking, alcohol consumption, excess body weight, and physical inactivity in the general (non-pregnant) population [14, 18, 19], but little research has examined whether or how economic contraction influences health behavior during pregnancy. In their seminal study of U.S. births between 1975–1999, Dehejia and Lleras-Muney [20] found that increases in the unemployment rate in the year of conception were associated with improvements in maternal health behavior (e.g., smoking and drinking) during pregnancy, with behaviors improving primarily among black mothers and worsening among white mothers. These findings were attributed to impacts of economic change on both selection into pregnancy (i.e., who becomes pregnant during economic downturns) and health behavior during pregnancy.

The current study builds on this existing work by examining associations between maternal exposure to economic contraction (at several levels of severity) and maternal smoking, alcohol use, and gestational weight gain. In contrast to previous work, we focus on examining the relations between economic contraction during pregnancy and behavior change, using several methods to control for impacts on selection into pregnancy. Moreover, we examine whether these associations differ by maternal race/ethnicity, educational attainment, poverty, or employment status. In light of the recent deep recession in the US, it is critical that we develop a comprehensive understanding of whether and how economic contraction affects perinatal health.

METHODS

Data

Data came from the National Longitudinal Survey of Youth (NLSY79), a prospective cohort study enrolling youth ages 14–22 in 1979. The NLSY79 data is well-suited to these research questions because it includes data on maternal smoking, alcohol use, and gestational weight gain, as well as household income and maternal employment status over a period of 20 years and across all 50 states.

The study included 8,282 singleton births to 4,233 women in 50 states, Washington DC, and Puerto Rico from 1982–2002. Births missing variables needed to calculate economic events during pregnancy—i.e. date of birth ($n=1$), maternal state of residence during pregnancy ($n=222$), and length of gestation ($n=985$)—were excluded, for a study sample of 7,074 births to 3,975 women. Mothers of included births ($n=7,074$) were more likely to be <35, unmarried, poor, and nulliparous, compared to mothers of excluded births ($n=1,208$) (Appendix A), reflecting loss-to-follow-up among the NLSY79 cohort as mothers aged. Births to Hispanic mothers and those out of the labor force were also slightly more likely to be excluded.

Variables

Economic contraction during pregnancy—Following previous work [7, 8, 21], this study defined unexpected economic contractions as months in which the state unemployment rate was higher than its statistically expected value, using flexible autoregressive, integrative, and moving average (ARIMA) modeling. These models produce residual values representing the difference between the observed and expected unemployment rates. We then created binary variables, defining months with observed values significantly above the 99% confidence interval (CI) of expected values as unexpected economic contractions. If one of these months fell during a trimester of pregnancy, that trimester was categorized as exposed to an economic contraction. (Details available in Appendix B.) We also examined several less extreme measures of economic contraction: 1) the trimester-specific averages of the positive residuals from the ARIMA models (a continuous variable representing all deviations of the observed unemployment rate from its expected value) and 2) residuals above the 90th and 95th percentile (binary variables measuring less extreme economic contractions). We focus our analyses on the extreme unexpected economic contractions above the 99% CI (referred to as economic contractions for brevity), hypothesizing that these most severe economic contractions would elicit the largest population-level response.

Maternal pregnancy behaviors—Smoking and alcohol use were dichotomized as yes/no, with yes indicating any use. These data did not enable us to assess binge drinking during pregnancy, which is linked to adverse birth outcomes. Gestational weight gain (GWG)—although influenced by non-behavioral factors—may be considered an indicator of diet and physical activity behaviors [11] and is considered a “behavior” in this study. GWG was categorized according to the pre-pregnancy body mass index (BMI) specific ranges of gain recommended by the Institute of Medicine (IOM) [11]: gains below the range were

labeled “inadequate”, gains above the range were labeled “excessive”, and gains within the recommended range (“adequate”) were the reference group.

Maternal pre-pregnancy characteristics—Race/ethnicity was classified by NLSY79 as Black/non-Hispanic, Hispanic, and non-Black/non-Hispanic. In the original NLSY79 sample, those classified as non-Black/non-Hispanic self-identified as being of European descent (68%), Asian/Pacific Islander (1%), American Indian (8%), “American” (9%), or other (14%). Maternal educational attainment, poverty status, marital status, employment status, and body mass index (BMI) were taken from the survey closest to, but prior to, each woman's estimated date of conception. Educational attainment was categorized as less than high school (<12), high school (12), and greater than high school (>12). Employment status was categorized as employed, unemployed, keeping house, and out of the labor force.

Statistical analysis

Associations between economic contraction in the first, second, and third trimester of pregnancy and risk of each outcome (i.e., smoking, alcohol use, inadequate vs. adequate weight gain, and excessive vs. adequate weight gain) were estimated using generalized linear models (GLMs) with a binomial distribution to obtain risk ratios. Model 1 was adjusted for state and year fixed effects, which control for any state- or year-specific factors that may be correlated with both economic contraction and pregnancy behaviors. To identify potential confounders, we assessed whether pre-pregnancy characteristics thought to be associated with health behaviors during pregnancy were also associated with exposure to economic contraction (Appendix C), after adjusting for year of birth to account for the fact that economic contraction was more common earlier in the study period when the cohort was younger (Appendix Table B2). Model 2 was then adjusted for the characteristics found to be associated with exposure: maternal race/ethnicity and educational attainment. NLSY79 used stratified- and over-sampling methods, but recommends against using sampling weights in regression analyses (Bureau of Labor Statistics 2008)¹; we therefore included indicator variables for sampling strata in multivariable models and sampling weights in descriptive analyses only.

Analyses were conducted only among births not missing the outcome of interest, and analyses of GWG were restricted to term births (n=5,916) only, as the IOM guidelines are for full-term pregnancies. Heterogeneity of associations between economic contraction and maternal behavior outcomes by race/ethnicity and SES was assessed using two-way interaction terms between each measure of economic contraction and indicator variables for race/ethnicity, education, poverty, and employment status (in four separate models). Wald tests were used to assess whether interactions achieved statistical significance ($p<0.05$).

Selection bias—Several additional tests were conducted to reduce potential impacts of differential selection into pregnancy during economic contractions. First, we examined

¹Per NLSY79 User's Guide, “*Regression Analysis*: A common question is whether one should use the provided weights to perform weighted least squares when doing regression analysis. Such a course of action may not lead to correct estimates. If particular groups follow significantly different regression specifications, the preferred method of analysis is to estimate a separate regression for each group or to use dummy (or indicator) variables to specify group membership.”

models adjusted for economic contraction in the three months prior to conception to account for the possibility that prior economic contraction may alter the distribution of women becoming pregnant and therefore impact maternal pregnancy behaviors. Second, propensity scores for the probability of being exposed to economic contraction in the first month of pregnancy were calculated based on maternal age, race, education, marital status, poverty, parity, employment, and health prior to conception and included as covariates in the models. Finally, a within-mother analysis was conducted, comparing outcomes across multiple pregnancies in the dataset with different exposure patterns. (To account for the fact that this analysis was restricted to women with >1 pregnancy in the dataset whose outcome differed across pregnancies, we also ran the original models in this same restricted subsample.)

Tests of robustness—An ideal analysis would have clustered standard errors by mother; however, because the sample size was small relative to the number of parameters, clustered models did not converge. Therefore, an additional test was conducted using clustered standard errors by mother with a continuous variable for year instead of state and year fixed effects. Models were also estimated using a complete case analysis that included only births with complete data on all variables to assess the impact of missing data on covariates. All analyses were conducted using SAS Version 9.2 (Cary, NC).

RESULTS

Table 1 displays characteristics of the pregnancies in the study sample. One-quarter of mothers reported smoking during pregnancy and 34% reported using alcohol. Approximately 29% of women gained inadequate weight during pregnancy, and almost 39% gained excessive weight. Of the 7,074 pregnancies, 5.1% were exposed to economic contraction in the first trimester, 5.6% in the second trimester, and 4.8% in the third trimester.

Unexpected economic contraction was not significantly associated with risk of maternal smoking (Table 2) or GWG (Table 2) in any trimester but was associated with a 15 percent increase in risk of alcohol use (95% CI: 1.01, 1.31) in Model 1 (Table 2). This association no longer reached statistical significance after adjustment for maternal characteristics (Table 2).

There were significant interactions between economic contraction and both race/ethnicity ($p=0.01$) and maternal education ($p=0.03$) for alcohol use. Black/non-Hispanic women had an increased risk of alcohol use if exposed to an economic contraction during the first (risk ratio (RR): 1.42; 99% CI: 1.08, 1.85) or second (RR: 1.33; 99% CI: 1.01, 1.74) trimester (Table 3), whereas non-Black/non-Hispanic women had moderately increased risk if exposed in the third trimester. Women with 12 years education had increased risk of alcohol use if exposed to an economic contraction in the second trimester (RR: 1.20; 99% CI: 1.01, 1.42) and women with >12 years education had increased risk if exposed in the third trimester (RR: 1.30, 95% CI: 1.04, 1.62) (Table 4). There were no significant interactions by maternal employment or poverty status. Less extreme continuous and binary measures of unexpected economic contraction were not significantly related to any pregnancy outcomes in any trimester of pregnancy (Appendix D). There was a significant interaction between

maternal race/ethnicity and exposure to economic contraction using the 95th percentile cut-off for the alcohol outcome ($p=0.01$), with a pattern of higher risk of alcohol use among black women exposed in early pregnancy, although these individual associations were not statistically significant (Appendix E).

Additional tests for selection and robustness were conducted only on the race/ethnicity and education interaction models for alcohol use. Estimates from models adjusting for economic contraction in the three months prior to conception and propensity score models were substantively similar to those from the original models in Table 3 and 4, as were estimates from complete case models and those using clustered standard errors (Appendix Tables F1 and F2). Estimates from the within-mother analysis were in the same direction as the results in Table 3 and 4, but confidence intervals were wider due to smaller sample sizes. Wald tests for heterogeneity were no longer statistically significant for the maternal education interactions in propensity scores or within-mother analyses (Appendix Table F2).

DISCUSSION

This study examined associations between exposure to unexpected economic contraction during pregnancy and maternal smoking, alcohol consumption, and gestational weight gain in a national sample of U.S. women with births between 1982 and 2000. Exposure to economic contraction during pregnancy was not associated with maternal smoking or GWG in these data, and associations between economic contraction and maternal pregnancy behaviors did not differ by maternal employment or poverty status. Findings did suggest that economic contraction may be associated with increased risk of alcohol use, and that these associations may differ by maternal race/ethnicity and education. For example, economic contraction was associated with an increased risk of maternal alcohol use among only Black/non-Hispanic women, for whom economic contractions in the first and second trimester increased the risk of alcohol use by 42 and 33 percent, respectively.

Contrary to our findings, Dehejia & Lleras-Muney reported that increases in the unemployment rate in the year of conception were *negatively* associated with smoking and alcohol use during pregnancy among black mothers but positively associated with these behaviors among white mothers [20]. However, these prior findings reflect both impacts of economic change on maternal behaviors during pregnancy and differential selection into pregnancy. Indeed, changes in the economy around the time of conception have been shown to affect women's fertility behaviors [22,23] as well as the probability of carrying a pregnancy to term [2, 24]. The current study makes an important contribution by examining the association between economic contractions during pregnancy and maternal pregnancy behaviors, using several methods to account for differences in selection into pregnancy. In doing so, our study suggests that these previous finding may have been driven more by selection rather than changes in pregnancy behavior.

Our data suggested that extreme, unexpected economic contractions during pregnancy may be associated with increased risk of alcohol use among Black/non-Hispanic women. This finding was also present when using the 95th percentile economic contraction cut-off and remained statistically significant across a range of robustness tests. Previous work has also

found stronger associations between economic contractions and adverse infant health outcomes among black (compared to white) women [4, 8, 25]. Economic contraction in later pregnancy was also significantly associated with alcohol use among women with 12 or more years education and non-significantly associated with alcohol use among women with <12 years education (a smaller group, which could account for the lack of significance). However, these findings were more inconsistent across trimesters and were not in the expected direction, making interpretation challenging. We caution that both sets of interaction findings should be considered exploratory; the sample size in this study was small relative to the number of model parameters (making estimates potentially unstable), and we tested multiple models (increasing risk of a type I error). These findings did hold up to multiple robustness tests, suggesting the need for further research in larger samples; future studies could conduct fewer tests using more refined hypotheses.

The current findings may also suggest a threshold effect in the relation between economic contraction and maternal alcohol use; only the most extreme unexpected economic contractions were associated with alcohol use. The null associations between economic contraction and other maternal pregnancy behaviors indicate potential importance of a pathway other than behavior connecting economic downturn to fetal and infant health outcomes. For example, economic contraction may represent an important psychosocial stressor for both job losers and other members of the population, and research suggests links between psychosocial stress during pregnancy, the physiological stress response, and adverse birth outcomes [26].

Strengths of this study include the length (approximately 20 years) of the NLSY79, which ensured ample variation in state economies over the study period and that the data represent a diverse sample of U.S. women with a high retention rate (77.8% as of 2008) [27]. These data are unique in that they include measures of both maternal pregnancy behaviors and socioeconomic characteristics, which are not adequately assessed in vital record data. Limitations include exclusion of some births due to missing data and multiple testing. GWG could be assessed more accurately using measured weights from before pregnancy and delivery, although accuracy of self-report is unlikely to vary by exposure to economic contraction. Any measurement error in the unemployment rate is likely to be non-systematic with respect to the pregnancy behavior outcomes, suggesting bias towards the null. It should be noted that the prevalence of smoking and alcohol use in this sample is higher than current estimates [28]—likely due to increasing awareness of the dangers of these behaviors during pregnancy throughout the 1980s and 1990s—which may reduce generalizability of these findings to the present day.

In light of the recent Great Recession, during which approximately 40% of families experienced financial distress [29], median real family income fell by 6 percent, and the unemployment rate increased by 5 percent [30], it is critical that we gain a more in-depth understanding of how economic change affects health. Research focusing on the influences of economic decline on maternal and infant health is especially important given evidence that health during the perinatal period strongly predicts later life health and well-being [31–33].

Acknowledgments

This research was supported in part by two grants from the Eunice Kennedy Shriver National Institute of Child Health and Human Development awarded to the Berkeley Population Center at the University of California, Berkeley (R21 HD 056581) and to the Population Research Center at The University of Texas at Austin (grant 5 R24 HD042849). The author thanks Dr. Ralph Catalano for statistical support and Dr. Robert Hummer and Dr. Catalano for comments on the manuscript.

Appendix

Appendix A

Comparison of maternal characteristics between study sample (n=7,074) and excluded births (n=1,208).

	N (%)	
	Study sample (n=7,074)	Excluded (n= 1,208)
All		
Maternal smoking during pregnancy (missing =18)		
Yes	1871 (26.5)	85 (24.9)
Maternal alcohol use during pregnancy (missing =10)		
Yes	2198 (31.1)	95 (27.7)
Maternal gestational weight gain ^a (missing = 885)		
Inadequate	1889 (30.5)	69 (33.5)
Adequate	1868 (30.2)	57 (27.7)
Excessive	2432 (39.3)	80 (38.8)
Maternal age		
<20	286 (4.0) **	15 (1.2)
20–35	6215 (87.9) **	912 (75.5)
35	573 (8.1) **	281 (23.3)
Maternal race/ethnicity		
Black/non-Hispanic	1765 (25.0) **	334 (27.7)
Hispanic	1361 (19.2) **	287 (23.8)
Non-Black/non-Hispanic	3948 (55.8) **	587 (48.6)
Maternal educational attainment(missing = 491)		
< 12 years	1324 (20.1)	19 (14.7)
12 years	2838 (43.1)	67 (51.9)
> 12 years	2421 (36.8)	43 (33.3)
Maternal marital status (missing = 485)		
Married	3930 (59.6) *	87 (67.4)
Maternal poverty status (missing = 1098)		
Below federal poverty level	1397 (23.4) **	16 (13.7)
Parity		
Nulliparous	2548 (36.0) **	270 (22.4)
Maternal pre-pregnancy BMI (missing = 852)		
<18.5	497 (8.0)	22 (10.5)
18.5–24.9	4156 (66.8)	137 (65.6)

	N (%)	
	Study sample (n=7,074)	Excluded (n= 1,208)
25.0–29.9	992 (15.9)	33 (15.8)
>=30	577 (9.3)	17 (8.1)
Maternal employment status (missing = 771)		
Employed	3024 (48.0) **	329 (45.3)
Unemployed	344 (5.5) **	25 (3.4)
Keeping house	2279 (36.2) **	245 (33.8)
Out of the labor force	656 (10.4) **	127 (17.5)

* p-value for chi-square test <0.10

** p-value for chi-square test 0.05

Appendix B. Detailed methods for measurement of economic contractions during pregnancy

Economic conditions were characterized using monthly unemployment rates in the mother's state of residence. Previous research demonstrates that state unemployment rates are more salient predictors of depression and stressful life events compared to other state-level economic indicators and indicators at the metropolitan area level (Catalano and Dooley 1977). State unemployment rates are also more frequently reported by the media than local measures, making it more likely that the population is aware of these numbers. Moreover, unemployment data at smaller aggregations is unavailable prior to 1990, when the majority of births in this study occurred.

Use of the monthly, rather than annual, unemployment rate enabled me to accurately assess economic conditions during pregnancy, prior to pregnancy, and by trimester of pregnancy. Time series of monthly unemployment rates for all 50 states, Washington DC, and Puerto Rico from 1979–2009 were obtained from the Bureau of Labor Statistics (<http://www.bls.gov/lau/>). Months of pregnancy were estimated for women in the NLSY79 based on date of birth and length of gestation, and unemployment rates were then linked to pregnancy by state and month.

In this study, unexpected economic contractions are defined as months in which the state unemployment rate was higher than its statistically expected value. Calculating the statistically expected value of the unemployment rate requires taking into account time-dependent correlation between values. This “autocorrelation” includes secular trends, cycles, and the tendency to remain depressed or elevated following high or low values and implies that “position” in time predicts observed values better than the mean of the series. We used flexible methods for assessing and accounting for autocorrelation in a time series developed by Box and Jenkins and known as ARIMA modeling; these methods model autocorrelation (i.e., autoregressive, integrative, and moving average [ARIMA] parameters) based on the observed data (instead of using pre-specified parameters such as year indicator variables) (Box, Jenkins, and Reinsel 1994; McCleary and Hay 1980). For each state, we estimated an

ARIMA model to identify autocorrelation and decompose unemployment rates into expected and residual (difference between observed and expected) values. Details of the ARIMA equations and examples of observed and expected values are shown below in Appendix Table A1 and Figure A1, respectively.

Positive residual values from these models represent the amount by which the unemployment rate in a particular month was higher than its statistically expected value and can be considered a measure of an unexpected perturbation to the state economy. In order to capture more extreme economic contractions, we created a binary variable in which months with residual values significantly above the 99% confidence interval (CI) of expected values were classified as unexpected economic contractions. If one of these months fell during a trimester of pregnancy, that trimester was categorized as exposed to an extreme economic contraction.

Appendix Figure A2 (below) demonstrates the total number of months (among all U.S. states combined) classified as unexpectedly contractive using the method described above from 1980 until 2009. The recession of the early 1980s was, for example, characterized by years with many months of unexpected economic contractions at the outset, followed by fewer numbers of contractions once the recession was underway and high unemployment became “expected”.

We also examined the average positive residual values across pregnancy trimesters, a continuous variable ranging from 0 to 1 that estimates the magnitude of unexpected economic contraction during that three-month period. For pregnancies with durations of less than 9 months, we averaged the rates for only the months the pregnancy actually covered. Finally, we also examined residuals above the 90th and 95th percentile (binary variables measuring less extreme economic contractions).

Appendix Table B1

Best-fitting ARIMA models for each U.S. state, Washington D.C., and Puerto Rico

State	ARIMA equation
Alabama	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$
Alaska	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B)}$
Arizona	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2) (1 - \theta_3 B^{12}) a_t$
Arkansas	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
California	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2 - \theta_3 B^3) (1 - \theta_4 B^{12}) a_t$

State	ARIMA equation
Colorado	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2 - \theta_3 B^3) (1 - \theta_4 B^{12}) a_t$
Connecticut	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$
Delaware	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Washington, DC	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B)}$
Florida	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2) (1 - \theta_3 B^{12}) a_t$
Georgia	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Hawaii	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Idaho	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Illinois	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi B^2)}$
Indiana	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi B)}$
Iowa	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Kansas	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Kentucky	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Louisiana	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Maine	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Maryland	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Massachusetts	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2 - \phi_3 B^3)}$
Michigan	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$

State	ARIMA equation
Minnesota	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Mississippi	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Missouri	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Montana	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B) (1 - \theta_2 B^{12}) a_t$
Nebraska	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Nevada	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B^2 - \phi_2 B^3)}$
New Hampshire	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$
New Jersey	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2) (1 - \theta_3 B^{12}) a_t$
New Mexico	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
New York	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
North Carolina	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$
North Dakota	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Ohio	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Oklahoma	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Oregon	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$
Pennsylvania	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2) (1 - \theta_3 B^{12}) a_t$
Rhode Island	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2 - \phi_3 B^3 - \phi_4 B^4)}$
South Carolina	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B) (1 - \theta_2 B^{12}) a_t$

State	ARIMA equation
South Dakota	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Tennessee	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta_1 B^1)(1 - \theta_2 B^{12}) a_t}{(1 - \phi_1 B)}$
Texas	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B)(1 - \phi_2 B^3)}$
Utah	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B - \phi_2 B^2)}$
Vermont	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi B)}$
Virginia	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Washington	$\nabla \nabla_{12} Z_t = (1 - \theta_1 B - \theta_2 B^2)(1 - \theta_3 B^{12}) a_t$
West Virginia	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Wisconsin	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Wyoming	$\nabla \nabla_{12} Z_t = (1 - \theta B^{12}) a_t$
Puerto Rico	$\nabla \nabla_{12} Z_t = \frac{(1 - \theta B^{12}) a_t}{(1 - \phi_1 B)(1 - \phi_2 B^{12})}$

Appendix Figure B1.

Observed and expected (from ARIMA models) values of unemployment rate for one state (California), 1980–2009.

Appendix Figure B2.

Total number of months (among all U.S. states combined) classified as unexpectedly contractive by year from 1980–2009.

Appendix**Appendix C**

Associations between observed maternal pre-pregnancy characteristics and exposure to extreme unexpected economic contractions during pregnancy (all models adjusted for year of birth).

	OR (95% CI)		
	Exposure to economic contraction		
	1 st trimester	2 nd trimester	3 rd trimester
Maternal age	1.00 (0.95, 1.04)	1.03 (0.99, 1.08)	1.00 (0.95, 1.05)
Maternal race/ethnicity			
Black/non-Hispanic	1.01 (0.79, 1.28)	1.02 (0.81, 1.30)	0.78 (0.60, 1.03)
Hispanic	0.72 (0.53, 0.98)	0.78 (0.59, 1.04)	0.87 (0.65, 1.17)
Non-Black/non-Hispanic	reference	reference	reference
Maternal educational attainment			
< 12 years	1.40 (1.07, 1.83)	0.95 (0.73, 1.24)	0.95 (0.71, 1.27)
12 years	reference	reference	reference
> 12 years	1.34 (1.04, 1.74)	1.06 (0.83, 1.35)	0.99 (0.75, 1.30)
Maternal marital status			
Married	0.88 (0.71, 1.10)	1.11 (0.9, 1.38)	1.07 (0.85, 1.35)
Unmarried	reference	reference	reference
Maternal poverty status			

	OR (95% CI) Exposure to economic contraction		
	1 st trimester	2 nd trimester	3 rd trimester
Below federal poverty level	0.91 (0.69, 1.19)	0.79 (0.61, 1.04)	0.98 (0.74, 1.30)
Above federal poverty level	reference	reference	reference
Parity			
Nulliparous	0.96 (0.78, 1.20)	0.92 (0.75, 1.14)	1.10 (0.87, 1.38)
Multiparous	reference	reference	reference
Maternal pre-pregnancy BMI			
<18.5	0.83 (0.54, 1.26)	1.03 (0.71, 1.51)	0.88 (0.57, 1.36)
18.5–24.9	reference	reference	reference
25.0–29.9	1.02 (0.75, 1.40)	1.05 (0.77, 1.43)	0.99 (0.70, 1.39)
≥30	1.19 (0.80, 1.77)	0.96 (0.63, 1.45)	1.00 (0.63, 1.57)
Maternal employment status			
Employed	reference	reference	reference
Unemployed	0.90 (0.57, 1.43)	1.08 (0.69, 1.69)	0.82 (0.49, 1.38)
Keeping house	0.95 (0.75, 1.21)	1.18 (0.94, 1.49)	0.99 (0.77, 1.28)
Out of the labor force	0.91 (0.62, 1.33)	1.19 (0.84, 1.70)	1.16 (0.80, 1.69)

Appendix

Appendix Table D

Associations between alternative measures^a of unexpected economic contraction by trimester of pregnancy and maternal pregnancy behaviors (risk ratios [RR] and 95% confidence intervals [CI])^b.

	Smoking (n=7,056 ^c)			Alcohol use (n=7,064 ^c)		
	Continuous	>90th	>95th	Continuous	>90th	>95th
Economic contraction						
1 st trimester	1.27 (0.93, 1.75)	1.03 (0.95, 1.12)	1.03 (0.94, 1.14)	0.99 (0.69, 1.41)	1.04 (0.95, 1.13)	1.04 (0.94, 1.15)
2 nd trimester	1.07 (0.79, 1.44)	1.03 (0.95, 1.12)	1.00 (0.91, 1.09)	0.91 (0.63, 1.31)	1.01 (0.93, 1.09)	1.03 (0.93, 1.14)
3 rd trimester	1.26 (0.91, 1.76)	1.05 (0.97, 1.15)	1.02 (0.92, 1.13)	1.04 (0.72, 1.50)	1.08 (0.99, 1.17)	1.01 (0.91, 1.13)
Race/ethnicity						
Black/non-Hispanic	0.94 (0.86, 1.02)	0.92 (0.84, 1.02)	0.93 (0.85, 1.01)	0.72 (0.66, 0.80)	0.72 (0.65, 0.80)	0.72 (0.65, 0.80)
Hispanic	0.64 (0.57, 0.72)	0.59 (0.51, 0.67)	0.62 (0.55, 0.70)	0.62 (0.55, 0.70)	0.62 (0.55, 0.70)	0.62 (0.55, 0.70)
Non-Black/non-Hispanic						
Educational attainment						
Less than high school	1.39 (1.28, 1.50)	1.49 (1.37, 1.62)	1.42 (1.31, 1.53)	0.92 (0.83, 1.02)	0.92 (0.83, 1.02)	0.92 (0.83, 1.01)
High school						
Greater than high school	0.61 (0.56, 0.67)	0.55 (0.50, 0.61)	0.59 (0.54, 0.65)	1.10 (1.02, 1.19)	1.10 (1.01, 1.18)	1.10 (1.02, 1.19)

	Inadequate gestational weight gain (n=5,175 ^a)			Excessive gestational weight gain (n=5,175 ^a)		
	Continuous	>90th	>95th	Continuous	>90th	>95th
Economic contraction						
1 st trimester	1.12 (0.80, 1.58)	1.00 (0.91, 1.09)	0.98 (0.87, 1.10)	1.01 (0.75, 1.36)	0.95 (0.89, 1.03)	0.94 (0.86, 1.04)
2 nd trimester	1.02 (0.69, 1.51)	0.97 (0.88, 1.06)	1.03 (0.92, 1.14)	0.91 (0.66, 1.27)	0.95 (0.89, 1.02)	0.96 (0.88, 1.05)
3 rd trimester	1.18 (0.80, 1.76)	1.00 (0.91, 1.09)	1.03 (0.92, 1.15)	1.06 (0.76, 1.47)	0.98 (0.91, 1.05)	0.96 (0.87, 1.06)
Race/ethnicity						
Black/non-Hispanic	1.30 (1.18, 1.43)	1.30 (1.18, 1.43)	1.30 (1.18, 1.43)	1.15 (1.06, 1.24)	1.15 (1.07, 1.24)	1.14 (1.06, 1.23)
Hispanic	1.27 (1.12, 1.43)	1.26 (1.12, 1.42)	1.27 (1.12, 1.43)	1.13 (1.03, 1.23)	1.12 (1.02, 1.23)	1.12 (1.02, 1.23)
Non-Black/non-Hispanic						
Educational attainment						
Less than high school	1.03 (0.93, 1.13)	1.03 (0.93, 1.13)	1.03 (0.94, 1.13)	0.97 (0.90, 1.05)	0.97 (0.90, 1.05)	0.97 (0.89, 1.05)
High school						
Greater than high school	0.95 (0.87, 1.04)	0.95 (0.86, 1.04)	0.95 (0.87, 1.04)	0.92 (0.86, 0.98)	0.92 (0.86, 0.98)	0.92 (0.86, 0.98)

^a All measures based on residuals from ARIMA models: average continuous positive residuals by trimester, occurrence of a positive residual above the 90th percentile, and occurrence of a positive residual above the 95th percentile

^b Models include state and year of birth fixed effects, sample characteristics (including race/ethnicity) and educational attainment.

^c Sample sizes reflects that 18 observations were missing data on maternal smoking, 10 observations were missing data on maternal alcohol use, that analyses of gestational weight gain were restricted to full-term pregnancies (n=5,916), and that 741 of those observations were missing data on weight gain

Appendix

Appendix E

Associations between exposure to unexpected economic contraction during pregnancy using 95th percentile cutoff and maternal alcohol consumption by race/ethnicity (risk ratios [RR] and 95% confidence intervals [CI])^a.

	Alcohol use (n=7,064 ^b)
Black/non-Hispanic	
1 st trimester exposure	1.21 (0.98, 1.49)
2 nd trimester exposure	1.05 (0.83, 1.31)
3 rd trimester exposure	0.77 (0.58, 1.03)
Hispanic	
1 st trimester exposure	1.03 (0.77, 1.39)
2 nd trimester exposure	0.82 (0.59, 1.14)
3 rd trimester exposure	0.65 (0.44, 0.98)
Non-Black/non-Hispanic	
1 st trimester exposure	1.00 (0.88, 1.13)
2 nd trimester exposure	1.06 (0.94, 1.19)
3 rd trimester exposure	1.12 (0.99, 1.26)
Maternal educational attainment	
< 12 years	0.92 (0.83, 1.01)

	Alcohol use (n=7,064 ^b)
12 years	reference
> 12 years	1.09 (1.01, 1.18)

^a Models include state and year of birth fixed effects, sample characteristics and educational attainment.

^b Sample size reflects that 10 observations were missing data on maternal alcohol use

Appendix F. Results of selection analyses and robustness checks

Appendix Table F1

Associations between extreme unexpected economic contractions by trimester and alcohol use from models including effect modification by maternal race/ethnicity^a.

	Alcohol use (n=7,064 ^b)		Alcohol use (n=7,064 ^b)		Alcohol use (n=7,064 ^b)		Alcohol use (n=7,064 ^b)	
	Adjustment for unexpected economic contraction in three months prior to pregnancy	Adjustment for propensity of being pregnant during first trimester economic contraction	Matched analysis comparing pregnancies to the same mother	Unmatched analysis in restricted sample of pregnancies to the same mother	Complete case analysis	Clustered standard errors by mother		
Black/non-Hispanic								
1 st trimester exposure	1.42 (1.08, 1.86)	1.34 (1.03, 1.73)	1.15 (0.55, 2.39)	1.11 (0.80, 1.53)	1.41 (1.07, 1.85)	1.40 (1.06, 1.86)		
2 nd trimester exposure	1.32 (1.01, 1.74)	1.27 (0.98, 1.65)	1.85 (0.45, 7.61)	1.30 (0.94, 1.79)	1.30 (0.98, 1.73)	1.32 (1.00, 1.74)		
3 rd trimester exposure	0.62 (0.37, 1.04)	0.68 (0.43, 1.08)	4.05 (1.13, 14.54)	0.84 (0.46, 1.52)	0.59 (0.34, 1.02)	0.63 (0.38, 1.04)		
Hispanic								
1 st trimester exposure	1.07 (0.67, 1.70)	1.05 (0.68, 1.63)	0.88 (0.23, 3.38)	1.26 (0.82, 1.95)	1.09 (0.69, 1.73)	1.08 (0.68, 1.71)		
2 nd trimester exposure	1.11 (0.73, 1.69)	1.08 (0.73, 1.61)	0.46 (0.12, 1.80)	1.07 (0.67, 1.71)	1.04 (0.66, 1.63)	1.12 (0.73, 1.71)		
3 rd trimester exposure	0.74 (0.43, 1.28)	0.80 (0.49, 1.31)	0.89 (0.23, 3.34)	0.74 (0.34, 1.59)	0.76 (0.44, 1.31)	0.74 (0.43, 1.28)		
Non-Black/non-Hispanic								
1 st trimester exposure	0.93 (0.77, 1.11)	0.92 (0.77, 1.10)	0.53 (0.29, 0.98)	0.74 (0.53, 1.03)	0.92 (0.77, 1.11)	0.90 (0.75, 1.07)		
2 nd trimester exposure	1.06 (0.91, 1.24)	1.05 (0.90, 1.23)	0.62 (0.34, 1.14)	0.87 (0.64, 1.17)	1.05 (0.89, 1.23)	1.03 (0.88, 1.21)		
3 rd trimester exposure	1.18 (1.01, 1.38)	1.18 (1.01, 1.38)	1.07 (0.58, 2.00)	0.98 (0.74, 1.30)	1.18 (1.01, 1.39)	1.15 (0.98, 1.35)		
p-value for Wald test	0.01	0.04	0.09	0.20	0.02	0.01		

^a Models include state and year of birth fixed effects, sample characteristics and educational attainment.

^b Sample size reflects that 10 observations were missing data on maternal alcohol use

Appendix Table F2

Associations between extreme unexpected economic contractions by trimester and alcohol use from models including effect modification by maternal education^a.

	Alcohol use (n=7,064 ^b)					
	Adjustment for unexpected economic contraction in three months prior to pregnancy	Adjustment for propensity of being pregnant during first trimester economic contraction	Matched analysis comparing pregnancies to the same mother	Unmatched analysis in restricted sample of pregnancies to the same mother	Complete case analysis	Clustered standard errors by mother
<12 years education						
1 st trimester exposure	1.09 (0.84, 1.41)	1.06 (0.82, 1.36)	0.75 (0.34, 1.67)	0.88 (0.60, 1.29)	1.08 (0.83, 1.41)	1.11 (0.84, 1.48)
2 nd trimester exposure	1.27 (0.96, 1.67)	1.20 (0.92, 1.57)	3.82 (1.08, 13.51)	1.03 (0.66, 1.61)	1.30 (0.98, 1.72)	1.24 (0.93, 1.64)
3 rd trimester exposure	0.88 (0.61, 1.26)	0.88 (0.62, 1.25)	0.84 (0.22, 3.26)	0.63 (0.32, 1.27)	0.87 (0.60, 1.26)	0.83 (0.56, 1.21)
12 years education						
1 st trimester exposure	0.87 (0.69, 1.11)	0.88 (0.70, 1.11)	0.53 (0.27, 1.03)	0.71 (0.48, 1.04)	0.85 (0.66, 1.10)	0.83 (0.65, 1.06)
2 nd trimester exposure	1.20 (1.02, 1.42)	1.20 (1.02, 1.41)	1.26 (0.66, 2.41)	1.09 (0.83, 1.45)	1.16 (0.97, 1.39)	1.21 (1.02, 1.45)
3 rd trimester exposure	0.96 (0.77, 1.19)	0.97 (0.78, 1.20)	1.01 (0.50, 2.04)	0.93 (0.65, 1.32)	0.95 (0.75, 1.20)	0.95 (0.76, 1.18)
>12 years education						
1 st trimester exposure	1.22 (0.98, 1.52)	1.18 (0.95, 1.47)	0.25 (0.07, 0.89)	1.32 (0.94, 1.85)	1.24 (0.99, 1.55)	1.15 (0.92, 1.44)
2 nd trimester exposure	0.89 (0.69, 1.15)	0.90 (0.71, 1.16)	0.49 (0.10, 2.34)	0.87 (0.59, 1.29)	0.89 (0.69, 1.15)	0.88 (0.67, 1.15)
3 rd trimester exposure	1.30 (1.04, 1.62)	1.27 (1.02, 1.60)	1.31 (0.54, 3.18)	1.03 (0.72, 1.48)	1.32 (1.06, 1.66)	1.25 (0.99, 1.57)
p-value for Wald test	0.03	0.08	0.20	0.21	0.02	0.05

^a Models include state and year of birth fixed effects and sample characteristics (including race/ethnicity).

^b Sample size reflects that 10 observations were missing data on maternal alcohol use

Abbreviations

(LBW)	Low birth weight
(SGA)	Small for gestational age
(SES)	Socioeconomic status
(GWG)	Gestational weight gain
(NLSY79)	National Longitudinal Survey of Youth
(ARIMA)	Autoregressive, integrative, and moving average
(CI)	Confidence interval
(BMI)	Body mass index
(IOM)	Institute of Medicine
(GLMs)	Generalized linear models
(RR)	Risk ratio

(SIDS) Sudden infant death syndrome

REFERENCES

1. Brenner MH. Fetal, infant, and maternal mortality during periods of economic instability. *International Journal of Health Services*. 1973; 3(2):145–59. [PubMed: 4716553]
2. Catalano R, Bruckner T, Anderson E, Gould JB. Fetal death sex ratios: a test of the economic stress hypothesis. *International Journal of Epidemiology*. 2005; 34(4):944–8. [PubMed: 15833788]
3. Catalano R, Hansen HT, Hartig T. The ecological effect of unemployment on the incidence of very low birthweight in Norway and Sweden. *Journal of Health and Social Behavior*. 1999; 40(4):422–8. [PubMed: 10643164]
4. Catalano R, Serxner S. The effect of ambient threats to employment on low birth weight. *Journal of Health and Social Behavior*. 1992; 33(4):363–77. [PubMed: 1464720]
5. Fisher ES, Leger JP, Daling JR. Prenatal care and pregnancy outcomes during the recession: the Washington state experience. *American Journal of Public Health*. 1985; 75(8):866–9. [PubMed: 3895992]
6. Schempf AH, Decker SL. Decline in the United States black preterm/low birth weight rate in the 1990s: can the economic boom explain it? *Ann Epidemiol*. 2010; 20(11):862–7. [PubMed: 20933194]
7. Margerison-Zilko CE, Catalano R, Hubbard A, Ahern J. Maternal exposure to unexpected economic contraction and birth weight for gestational age. *Epidemiology*. 2011; 22(6):855–8. [PubMed: 21900824]
8. Catalano R, Serxner S. Neonatal mortality and the economy revisited. *International Journal of Health Services*. 1992; 22(2):275–86. [PubMed: 1601546]
9. Lin SJ. The effects of economic instability on infant, neonatal, and postneonatal mortality rates: Evidence from Taiwan. *Social Science & Medicine*. 2006; 62(9):2137–50. [PubMed: 16289742]
10. Andersen AM, Andersen PK, Olsen J, Gronbaek M, Strandberg-Larsen K. Moderate alcohol intake during pregnancy and risk of fetal death. *Int J Epidemiol*. 2012
11. Institute of Medicine. Weight gain during pregnancy: reexamining the guidelines. The National Academies Press; Washington, D.C.: 2009.
12. Rogers JM. Tobacco and pregnancy. *Reprod Toxicol*. 2009; 28(2):152–60. [PubMed: 19450949]
13. Sood B, Delaney-Black V, Covington C, Nordstrom-Klee B, Ager J, Templin T, et al. Prenatal alcohol exposure and childhood behavior at age 6 to 7 years: I. dose-response effect. *Pediatrics*. 2001; 108(2):E34. [PubMed: 11483844]
14. Ruhm CJ. Healthy living in hard times. *Journal of Health Economics*. 2005; 24(2):341–63. [PubMed: 15721049]
15. Catalano R, Goldman-Mellor S, Saxton K, Margerison-Zilko C, Subbaraman M, Lewinn K, et al. The Health Effects of Economic Decline. *Annu Rev Public Health*. 2010
16. Umberson, D.; Liu, H.; Reczek, C. Stress and Health Behavior Over the Life Course. In: Turner, HA.; Schieman, S., editors. *Stress Processes across the Life Course*. Vol. 13. Elsevier; Oxford, UK: 2008. p. 19-44.
17. Farber, HS. The incidence and costs of job loss: 1982–1991 *Brookings Papers on Economic Activity*. 1993. p. 73-132.
18. Ruhm CJ. Are recessions good for your health? *Quarterly Journal of Economics*. 2000; 115(2): 617–50.
19. Ruhm CJ, Black WE. Does drinking really decrease in bad times? *Journal of Health Economics*. 2002; 21(4):659–678. [PubMed: 12146596]
20. Dehejia R, Lleras-Muney A. Booms, Busts, and Babies' Health*. *Quarterly Journal of Economics*. 2004; 119(3):1091–130.
21. Catalano R, Serxner S. Time series designs of potential interest to epidemiologists. *Am J Epidemiol*. 1987; 126(4):724–31. [PubMed: 3631061]

22. Butz WP, Ward MP. The emergence of countercyclical U.S. fertility. *American Economic Review*. 1979; 69:318–28.
23. Colen CG, Geronimus AT, Phipps MG. Getting a piece of the pie? The economic boom of the 1990s and declining teen birth rates in the United States. *Soc Sci Med*. 2006; 63(6):1531–45. [PubMed: 16753244]
24. Catalano R, Zilko CE, Saxton KB, Bruckner T. Selection in utero: a biological response to mass layoffs. *Am J Hum Biol*. 2010; 22(3):396–400. [PubMed: 19918916]
25. Bruckner T, Catalano RA. Economic antecedents of sudden infant death syndrome. *Annals of Epidemiology*. 2006; 16(6):415–22. [PubMed: 16185895]
26. Dunkel Schetter C. Psychological science on pregnancy: stress processes, biopsychosocial models, and emerging research issues. *Annu Rev Psychol*. 2011; 62:531–58. [PubMed: 21126184]
27. Bureau of Labor Statistics. National Longitudinal Studies Handbook. 2008. Retrieved January 26, 2010 (<http://www.nlsinfo.org/nlsy79/docs/79html/tableofcontents.html>)
28. Phares TM, Morrow B, Lansky A, Barfield WD, Prince CB, Marchi KS, et al. Surveillance for disparities in maternal health-related behaviors--selected states, Pregnancy Risk Assessment Monitoring System (PRAMS), 2000–2001. *MMWR Surveill Summ*. 2004; 53(4):1–13. [PubMed: 15229409]
29. Hurd, M.; Rohwedder, S. National Bureau of Economic Research Working Paper Series. Cambridge MA: 2010. Effects of the Financial Crisis and Great Recession on American Households.
30. Hoynes H, Miller D, Schaller J. Who Suffers During Recessions? *Journal of Economic Perspectives*. 2012; 26(3):27–48.
31. Barker DJP, Eriksson JG, Forsen T, Osmond C. Fetal origins of adult disease: strength of effects and biological basis. *International Journal of Epidemiology*. 2002; 31(6):1235–9. [PubMed: 12540728]
32. Behrman, R.; Butler, A., editors. Preterm birth: causes, consequences, and prevention. National Academies Press; Washington, DC: 2005.
33. Conley D, Bennett NG. Is biology destiny? Birth weight and life chances. *American Sociological Review*. 2000; 65(3):458–67.

Table 1

Characteristics of births in study sample: singleton births between 1982 and 2000 to women in National Longitudinal Survey of Youth 1979 (n=7,074).

	N (weighted %)
Maternal smoking during pregnancy (missing = 18)	1871 (26.6)
Maternal alcohol use during pregnancy (missing = 10)	2198 (34.2)
Maternal gestational weight gain ^a (missing = 885)	
Inadequate	1889 (29.2)
Adequate	1868 (32.0)
Excessive	2432 (38.9)
No first trimester care (missing = 240)	1184 (15.3)
Maternal age	
<20	286 (2.8)
20–29	4781 (63.8)
30–39	1960 (32.6)
≥40	47 (0.8)
Maternal race/ethnicity	
Black/non-Hispanic	1765 (14.0)
Hispanic	1361 (6.7)
Non-Black/non-Hispanic	3948 (79.3)
Maternal educational attainment(missing = 491)	
< 12 years	1324 (13.6)
12 years	2838 (44.0)
> 12 years	2421 (42.4)
Mother married(missing = 485)	3930 (68.5)
Mother in poverty (missing = 1098)	1397 (14.9)
Nulliparous	2548 (38.7)
Maternal pre-pregnancy BMI (missing = 852)	
<18.5	497 (8.2)
18.5–24.9	4156 (68.0)
25.0–29.9	992 (14.8)
≥30	577 (9.1)
Maternal employment status (missing = 771)	
Employed	3024 (52.9)
Unemployed	344 (4.2)
Keeping house	2279 (33.6)
Out of the labor force	656 (9.3)

^aBased on recommendations by Institute of Medicine, specific to maternal pre-pregnancy BMI, among term births only (n=5,916)

Table 2

Associations between exposure to extreme unexpected economic contraction by trimester of pregnancy and maternal pregnancy behaviors (risk ratios [RR] and 95% confidence intervals [CI]).

	Smoking (n=7,056 ^a)		Alcohol use (n=7,064 ^a)	
	Model 1 ^b	Model 2 ^c	Model 1 ^b	Model 2 ^c
Economic contraction				
1 st trimester	1.14 (0.98, 1.32)	1.13 (0.99, 1.28)	1.04 (0.90, 1.20)	1.03 (0.89, 1.19)
2 nd trimester	0.97 (0.82, 1.14)	0.96 (0.83, 1.11)	1.15 (1.01, 1.31)	1.12 (0.98, 1.27)
3 rd trimester	1.08 (0.92, 1.26)	1.09 (0.95, 1.26)	1.02 (0.88, 1.19)	1.04 (0.89, 1.21)
Race/ethnicity				
Black/non-Hispanic		0.92 (0.84, 1.01)		0.72 (0.65, 0.80)
Hispanic		0.57 (0.50, 0.66)		0.62 (0.55, 0.70)
Non-Black/non-Hispanic		reference		reference
Educational attainment				
Less than high school		1.49 (1.37, 1.62)		0.92 (0.83, 1.02)
High school		reference		reference
Greater than high school		0.54 (0.49, 0.60)		1.10 (1.02, 1.19)

	Inadequate gestational weight gain (n=5,175 ^d)		Excessive gestational weight gain (n=5,175 ^d)	
	Model 1 ^b	Model 2 ^c	Model 1 ^b	Model 2 ^c
Economic contraction:				
1 st trimester	0.99 (0.85, 1.15)	1.01 (0.87, 1.18)	0.88 (0.77, 1.02)	0.90 (0.78, 1.04)
2 nd trimester	1.04 (0.90, 1.20)	1.03 (0.89, 1.19)	0.99 (0.87, 1.13)	0.99 (0.87, 1.13)
3 rd trimester	0.97 (0.82, 1.14)	0.98 (0.83, 1.15)	0.94 (0.82, 1.09)	0.95 (0.83, 1.10)
Race/ethnicity				
Black/non-Hispanic		1.30 (1.18, 1.43)		1.14 (1.06, 1.23)
Hispanic		1.26 (1.12, 1.43)		1.12 (1.02, 1.23)
Non-Black/non-Hispanic		reference		reference
Educational attainment				
Less than high school		1.02 (0.93, 1.13)		0.97 (0.90, 1.05)

Inadequate gestational weight gain (n=5,175 ^a)		Excessive gestational weight gain (n=5,175 ^a)	
	Model 1 ^b	Model 2 ^c	Model 2 ^c
High school		reference	reference
Greater than high school		0.95 (0.87, 1.04)	0.92 (0.87, 0.99)

^aSample sizes reflects that 18 observations were missing data on maternal smoking, 10 observations were missing data on maternal alcohol use, that analyses of gestational weight gain were restricted to full-term pregnancies (n=5,916), and that 741 of those observations were missing data on weight gain

^bModels include state and year of birth fixed effects

^cModels include state and year of birth fixed effects, sample characteristics (including race/ethnicity) and educational attainment.

Table 3

Associations between exposure to extreme unexpected economic contraction during pregnancy and maternal alcohol consumption by race/ethnicity (risk ratios [RR] and 95% confidence intervals [CI])^a.

Alcohol use (n=7,064)^b	
Black/non-Hispanic	
1 st trimester exposure	1.42 (1.08, 1.85)
2 nd trimester exposure	1.33 (1.01, 1.74)
3 rd trimester exposure	0.62 (0.37, 1.04)
Hispanic	
1 st trimester exposure	1.06 (0.67, 1.70)
2 nd trimester exposure	1.11 (0.73, 1.69)
3 rd trimester exposure	0.74 (0.43, 1.28)
Non-Black/non-Hispanic	
1 st trimester exposure	0.93 (0.77, 1.11)
2 nd trimester exposure	1.06 (0.91, 1.24)
3 rd trimester exposure	1.18 (1.01, 1.38)
Maternal educational attainment	
< 12 years	0.91 (0.83, 1.01)
12 years	reference
> 12 years	1.10 (1.01, 1.18)

^a Models include state and year of birth fixed effects, sample characteristics and educational attainment.

^b Sample size reflects that 10 observations were missing data on maternal alcohol use

Table 4

Associations between exposure to extreme unexpected economic contraction during pregnancy and maternal alcohol consumption by maternal educational attainment (risk ratios [RR] and 95% confidence intervals [CI])^a.

Alcohol use (n=7,064 ^b)	
<12 years education	
1 st trimester exposure	1.09 (0.84, 1.41)
2 nd trimester exposure	1.22 (0.98, 1.52)
3 rd trimester exposure	1.27 (0.96, 1.68)
12 years education	
1 st trimester exposure	0.87 (0.69, 1.10)
2 nd trimester exposure	1.20 (1.01, 1.42)
3 rd trimester exposure	0.96 (0.77, 1.19)
>12 years education	
1 st trimester exposure	0.89 (0.69, 1.15)
2 nd trimester exposure	0.88 (0.61, 1.26)
3 rd trimester exposure	1.30 (1.04, 1.62)
Maternal race/ethnicity	
Black/non-Hispanic	0.74 (0.68, 0.82)
Hispanic	0.65 (0.58, 0.73)
Non-Black/non-Hispanic	reference

^a Models include state and year of birth fixed effects and sample characteristics (including race/ethnicity).

^b Sample size reflects that 10 observations were missing data on maternal alcohol use