Relative Deprivation and Child Health

Aparna Lhila
Central Michigan University, Economics Department, Sloan Hall 321, Mt Pleasant, MI 48859, United States

Kosali I. Simon
Cornell University, NY and Indiana University, Bloomington, IN, United States

Abstract

Relative deprivation is posited to share a negative relationship with health, and psychosocial stress and engaging in stress-related risky behaviors may be the link between the two. While there is a large literature on the association between one's absolute deprivation, i.e., income and child health, little is known about the association between relative deprivation and child health. This paper asks: controlling for several aspects of one's socioeconomic status, is a mother's socioeconomic deprivation relative to other mothers in her reference group negatively related to the health of her infant? We also test whether prenatal smoking, a stress-related behavior, is the likely link between the two. Using 2001 Natality Detail Files, we find that pregnant women of lower socioeconomic status relative to other expectant mothers in their MSA give birth to very slightly lighter babies and are more likely to smoke. A back-of-the envelope calculation shows the magnitude of the association we observe between relative deprivation and birthweight is close to what medical studies would predict if the probability of prenatal tobacco use were to increase by the amount we estimate.

Lhila, Aparna and Kosali I. Simon. 2010. "Relative Deprivation and Child Health in the USA", Social Science and Medicine, 71(4): 777-85.
DOI: 10.1016/j.socscimed.2010.03.058

Introduction

It is well accepted that income and socioeconomic status (SES) protect health (Newacheck 1994; Currie and Hyson 1999; Smith 1999; Case, Lubotsky, and Paxson 2002; Currie and Stabile 2003; Currie et al 2008). Though more controversial, the relationship between income inequality in the community (often defined as the state of residence) and health has also been examined (see Subramanian and Kawachi 2004 and Wilkinson and Pickett 2006 for reviews of the literature). The relationship that has received relatively little attention is that between relative deprivation (RD) and health. RD is defined as one's SES relative to other members of society and is the focus of this paper.

The RD effect on health is a different concept from the effect of income or income inequality on health. Income is an absolute measure of economic well-being and is associated with better health in many studies (see for e.g. Newacheck 1994; Case, Lubotsky, and Paxson 2002; Currie and Stabile 2003) as richer parents are better able to prevent, detect and treat ill health. RD, on the other hand, captures one's economic well-being *relative* to other members of the community. Its effect on health is not due to parents' absolute well-being; rather it is due to parents' sense of well-being relative to those to whom they compare themselves. The difference between income inequality and RD is that while everyone in the community is subject to the same level of income inequality, the extent of RD and its effect on health varies across individuals within the community (Wagstaff and Doorslaer 2000; Subramanian and Kawachi 2004, Eibner and Evans, 2005). The two concepts are related because the mean RD, particularly the Deaton measure, is in fact the same as the Gini coefficient, or the level of income inequality in the community (Eibner and Evans 2005). We focus on RD because few studies have empirically estimated this relationship, despite there being sound theoretical reasons for a RD – health relationship to exist. Reagan et al. (2007) is the only paper to examine this in the case of child health. This paper goes beyond that analysis in four ways: first, we examine prenatal smoking as the mechanism by which RD may affect infant health, which Reagan et al. (2007) is unable to do because of lack of data. Second, we utilize a larger sample of pregnant women which allows us to precisely estimate the RD – infant health relationship. Third, we consider an alternate definition of reference group, i.e. pregnant women, because expectant mothers may come into more frequent contact with and compare themselves to other pregnant women. Finally, in addition to IUGR, we consider other measures of infant health – preterm birth, birthweight, and APGAR scores.

RD has been linked to adverse health outcomes in several settings (Deaton 2001; Eibner and Evans 2005; Reagan et a. 2007), and psychosocial stress is posited to be the link between the two (Sapolsky 1993; Marmot 1994; Deaton 2001; Yngwe et al. 2003; Eibner and Evans 2005; Reagan et al. 2007). Some studies have tested this hypothesis empirically by examining the relationship between RD and stress-related risky behaviors (e.g. Eibner and Evans 2005), while others have estimated the association between RD and health itself (e.g. Yngwe et al 2003; Reagan et al 2007). There is another mechanism through which RD may have a positive impact on health which has not been considered in prior research. Conditional on one’s own characteristics, being more relatively deprived means living in a community with more individuals who are better off. This may lead to positive spillovers such as through higher funding of social services. Through this avenue, RD may have an independent positive impact on health, potentially counteracting some of the negative avenues currently discussed in the literature.

An important indicator of infant health is birthweight, as being born below the critical cutoff of 2500 g is associated with higher likelihood of being stunted and underweight in childhood (Osmani and Sen 2003). Many studies have found that low birthweight is also associated with lower educational attainment and earnings into adulthood (Behrman, Rosenzweig and Taubman 1994; Currie and Hyson 1999; Behrman and Rosenzweig 2004). The importance of birthweight as an indicator of child health is under dispute with some studies finding much smaller affects on health than earlier found (e.g, Almond et al 2005), but other papers with causal methods finding that birthweight does have substantial impacts on short and long term health (Black et al 2007).

In order to understand the association between RD and infant health via the stress mechanism, we also examine, as outcomes, the likelihood of preterm birth and intrauterine growth restriction (IUGR). Mothers' psychosocial stress is likely to affect birthweight through its effect on both preterm birth IUGR. Stress is an independent risk factor for preterm birth (Kramer et al 2000; Parker and Smith 2003), and feeling stressed or anxious may make it harder for mothers to quit smoking, a risk factor for both preterm birth and IUGR (Kramer et al 2000). We consider the five-minute APGAR score, a significant predictor of childhood health and cognition, as an additional outcome because birthweight may not be a meaningful predictor of long-term health (Almond et al 2005) and because prenatal smoking and maternal anxiety are risk factors for lower APGAR scores (Haddow et al 1988; Berle et al 2005; Okah et al 2005).

Studying prenatal tobacco use is relevant because it is one of the most important risk factors for LBW (Shiono and Behrman 1995; Wang et al. 2002) and decreasing prenatal smoking through cigarette tax hikes is likely to increase birthweight by approximately 400 grams on average (Evans and Ringel 1999). Between 1989 and 2000, prenatal smoking has dropped from 19.5% to 12.2%, partly due to public education and public health campaigns (Ventura et al. 2003). Yet the cost of prenatal smoking remains high: infants born to smoking mothers incur $724 more in neonatal costs on average (Adams et al. 2002). This figure does not include costs due to complications during pregnancy and delivery, e.g. bleeding during pregnancy, perinatal loss, and the costs later in life, e.g. LBW, sudden infant death syndrome, asthma, and other behavioral and cognitive developmental problems (Albrecht et al. 2004; US EPA 1992). Because of these reasons, reducing prenatal smoking rate to 10% has been listed as one of the goals of Healthy People 2010 (US DHHS 2000). Prenatal smoking is a behavior for which data are available for almost all mothers and with sub-state geographical detail. The source of our data, the Natality Detail Files, has been used to study prenatal smoking in several prior papers, e.g., Joyce and Grossman (1990), Evans and Ringel (1999), and Lien and Evans (2005). The cost of smoking cessation, including psychological cost, and the benefits to child health gives rise to demand functions for prenatal health inputs which will vary across women, perhaps systematically related to her relative economic status in the community. Reagan et al (2007) note that prenatal smoking may be an important pathway through which economic disadvantage translates into IUGR but do not investigate this link empirically.

RD is a social comparison theory which argues that individuals compare themselves to those who are better-off than themselves, and pay little attention to those who are worse-off than themselves (Runciman 1966). These negative comparisons produce stress and anxiety which may affect individual health directly through high blood pressure, heart disease and suicide, or indirectly through participating in risky behavior such as smoking, consuming alcohol and poor eating habits (Marmot 1994; Wilkinson 1997; Eibner and Evans 2005). There are two sources of biological evidence: the first comes from the relationship documented between social rank and health among baboons (Sapolsky 1993), where higher ranked baboons used physical violence to exert their influence. Being subject to continual aggression triggered a biological stress response among the low-ranked baboons which increased their susceptibility to disease. The second evidence comes from the Whitehall studies where low-ranked British civil servants were found to be more likely to die due to coronary disease and cancers compared to higher ranked civil servants. This difference in the probability of mortality between the lowest and highest ranked civil servants has been attributed to RD (Marmot 1986).

Another avenue through which living with richer neighbors can affect infant health is through the positive externalities generated by relatively well-off neighbors' activities, such as larger transfers through the tax system. Luttmer (2005), in an empirical study of U.S. households, found that although one's neighbors' earnings reduces own happiness, satisfaction with the city or town increases as neighbors' income increases, holding one's own income constant. The author interprets this as meaning that individuals are aware of the advantages of living in an area with relatively wealthier neighbors. In the developing country context, Ravallion and Lokshin (2001) theorized that individuals may benefit from having better-off neighbors who can help in times of need and the relatively worse-off can take advantage of living in such a community which may provide local public goods.

One source of ambiguity in the RD literature is how one draws the appropriate reference group for empirical tests. There is little consensus on whom individuals are most likely to compare themselves with – coworkers, own birth cohort, residents of own state or MSA, or others who share characteristics like age, sex, race, and education have been considered in the literature. The idea is that individuals compare themselves with those they come in contact with or consider themselves similar to. The general practice in the literature is to use geographical units of varying size, although exceptions exist. For instance, Deaton (2001) analyzed within-state RD, Deaton (1999) defined the reference group as national birth cohort, and Reagan et al. (2007) argued that mothers compare themselves to other MSA residents. The two narrowest definitions of a reference group are offered by Yngwe et al. (2003) and Eibner and Evans (2005): Yngwe et al. (2003) defined reference groups on the basis of occupation, age, geographic region of residence, and two time periods; Eibner and Evans (2005) defined an individuals' reference group as those in his/her state of residence, and are same in years of age, education and race. Since our goal is to assess mothers' relative SES at the time of pregnancy, we define our reference group as all women in the MSA who gave birth in a particular year. While this definition may be as ad hoc as the others used in this literature, we argue that expectant mothers tend to interact with and compare themselves more to other pregnant women in their MSA than other reference groups that have been used in the literature. Additionally, we consider several other definitions of reference group – some that are broader, e.g., pregnant women in the state, and some that are narrower, e.g., MSA by education and MSA by race/ethnicity. Further, we consider the possibility that women compare themselves to all women in the MSA of residence, irrespective of whether they had a baby in the past year; we do so by defining two alternate reference groups – all women residing in the MSA and all women of reproductive age (15-49 years) in the MSA.

The RD – health literature has almost exclusively focused on adult health outcomes and found a negative association between the two: Deaton (2001) focused on mortality; Yngwe et al. (2003) examined self-rated health; and Eibner and Evans (2005) studied the probability of mortality especially due to tobacco-related cancers and coronary heart disease, body mass index, and risky health behaviors. To our knowledge, Reagan et al. (2007) is the only other study of RD and prenatal health; they found that RD (measured as the Deaton and Yitzhaki measures) is associated with increased likelihood of IUGR. They hypothesized that prenatal tobacco use by mothers, a behavior on which they do not have data, may be the pathway explaining the association between socioeconomic disadvantage and IUGR, lending further importance to the question examined in our paper.

Theoretical Framework

RD has long been a concept in the social science literature (Duesenberry 1949; Runciman 1966; Yitzhaki 1979; Frank 1985; Marmot 1986; Wilkinson 1999; Deaton 2001; Eibner and Evans 2005; Reagan et al 2007). It was introduced to the economics literature by Yitzhaki (1979) and later modified by Deaton (2001).

Wilkinson (1999) notes that individuals respond to unhappiness and stress in many ways such as eating comfort foods, smoking and consuming alcohol. It is plausible that controlling for own income, being of lower SES relative to other mothers causes stress, and that stress may be greater the lower the woman's relative position. Since stress, anxiety, and emotional distress have been identified as reasons women may continue to smoke during pregnancy (see Floyd et al. 1993), we expect that relatively lower SES and the associated stress may make it more difficult for women to quit smoking in the prenatal period (Ludman et al. 2000).

Grossman (1972) conceptualized a model of health investment whereby mothers are agents who invest in the health stock of their unborn children, subject to constraints. Thus the stress that she experiences while pregnant and her prenatal investment decisions, including smoking, may be considered negative inputs into the infant health production function. Figure 1 is a diagrammatic overview of the hypothesized relationship between RD and birthweight, and explains how stress relates RD to birthweight via preterm birth, tobacco use, and IUGR. Another dimension of infant health, APGAR scores, is also likely to be affected by RD because prenatal smoking and maternal anxiety are risk factors for lower APGAR scores (Haddow et al 1988; Berle et al 2005; Okah et al 2005). It is also possible that RD, holding SES constant, positively affects infant health because more deprived mothers reap the benefits of local public good investments made by her relatively wealthier neighbors. This positive aspect of RD has been not been studied in the literature, but such an effect is plausible and some of the negative effects of RD on infant health may be counteracted by this positive externality.

The hypotheses that emerge from this framework are that RD will lead to a higher probability of preterm birth, IUGR and prenatal tobacco use and will lower both birthweight and APGAR scores. However, if the positive externality effect dominates then the RD effects will move in the opposite directions.

Method and Data

Our approach is to estimate the relationship between RD and various measures of infant health and prenatal smoking, holding constant mothers' income and income inequality. We also include as controls characteristics of the community that may be correlated with both RD and infant health. In this section we discuss the empirical strategy after presenting a brief overview of the measures of RD employed.

Strictly speaking, RD can be defined as one's relative ranking in terms of any desirable trait or characteristic, e.g. beauty, intelligence, possessions, etc. (Yitzhaki 1979; Eibner and Evans 2005), and income is one such yardstick. The literature has almost exclusively used current income to capture one's relative disadvantage. Reagan et al. (2007) distinguished between contemporaneous and permanent income and demonstrated that the magnitude of the results were sensitive to the choice of RD measure. They also found that mothers' education, race/ethnicity, marital status and two childhood characteristics (fathers' education and a measure of family structure) collectively predict a greater fraction of the variation in permanent disadvantage than contemporaneous disadvantage. Our approach is to create a socioeconomic index by utilizing information on mothers' socioeconomic and demographic characteristics, including variables that Reagan et al (2007) show are more predictive of permanent income, to capture an individual's well-being.

The gist of this concept is to line up all individuals in a community on the basis of a desirable metric, e.g. income, and assign a ranking so that the RD of person *i* is defined as the sum of the distances between *i*'s income and every income above *i*, normalized by the total population, n, in the community. Dividing by n makes cross-community comparisons insensitive to differences in population size. The Yitzhaki (1979) specification of RD is:

$$YRD_i = \frac{1}{n}\sum_j (y_j - y_i) \qquad \text{for all } y_j > y_i \qquad (1)$$

Intuitively, the RD of person *i* increases as both the absolute incomes and the number (or fraction) of people above her increase. Within a community, an individual with a higher RD value may be considered to be more deprived than an individual with a lower value for RD. Further, two individuals in different communities with different income distributions who have the same value for Yitzhaki's measure, are not necessarily equally deprived because RD depends both on the number of comparisons and the absolute income differentials that lie above person *i* in the community.

Another property of the Yitzhaki measure is that doubling the incomes of everyone in a community will double every individual's RD. Deaton (2001) suggested normalizing the Yitzhaki measure by the average income in the community, μ, so that RD is invariant to the size of the community income. The Deaton (2001) measure may thus be represented as follows:

$$DRD_i = \frac{1}{\mu n}\sum_j (y_j - y_i) \qquad \text{for all } y_j > y_i \qquad (2)$$

In contrast to the Yitzhaki measure, the Deaton measure assumes that when making comparisons, individuals consider the *proportion* of total community income earned by people who are higher on the income distribution instead of the *sum* of the absolute incomes. Further, assuming a continuous income distribution, the Deaton measure of the highest-ranked individual will be zero, while that of the lowest-ranked individual will be one. We use both the Yitzhaki and Deaton measures of RD along with a measure of rank[1] to test for the robustness of the RD and infant health association.

Method

We estimate the following equation:

$$H_{ic} = \gamma_0 + \gamma_1 R_{ic} + \gamma_2 C_c + \gamma_3 S_{ic} + \varepsilon_s + \upsilon_{ic} \qquad (3)$$

H represents our dependent variables, the birthweight of infant *i* in MSA *c*, other measures of infant health – probability of preterm birth, IUGR, and APGAR score, and an indicator for prenatal tobacco use by mother *i* in MSA *c*; *R* represents individual *i*'s RD; γ_1, measures the association between RD and health; *C* is a vector of MSA characteristics such as median income, income inequality, and racial composition; *S* represents mother and child characteristics such as household income, mothers' age, race, education, marital status, child sex, and birth order; ε are unobserved state characteristics that are common to all pregnant women within the state; finally, υ represents the idiosyncratic error term. In addition to controlling for MSA characteristics that are likely to be correlated with both relative status and her infant's health, e.g. median MSA income, we include state fixed-effects. Doing so allows us to control for unobserved state characteristics, e.g. welfare expenditure and public good provision, which may be correlated with both RD and infant health. It also means that the effect of RD is estimated

[1] The relative rank of expectant-mother *i* is the fraction of pregnant women in the community that are better-off than her.

by comparing similar women across MSAs within the same state rather that across states that are far off from each other.

The source of variation is the RD of mothers within the same state. Mothers with the same income, living in different MSAs in the same state, will have different relative rankings because the distribution of incomes will be different in the two MSAs. We caution against a causal interpretation of our results for several reasons. First, individuals' decision to locate in an MSAs could depend upon their expected relative position in that MSA. It is conceivable that individuals select into MSAs where they are likely to be higher in the income distribution to avoid the negative comparisons associated with living on a lower rung of the SES ladder. This will cause a bias towards finding less of a negative effect of RD because those for whom the effect would be more negative will not display it. Second, if we do not control adequately for the distribution of income or MSA characteristics that are correlated with both infant health and one's relative position, then the coefficient on relative position is likely to suffer from omitted variable bias. We control for MSA median income, income inequality, socioeconomic characteristics, and state fixed-effects to mitigate the potential omitted variable bias, but we cannot be certain that all factors have been accounted for. Since we use cross-sectional data, adding MSA fixed effects would leave no variation in RD as income and RD are perfectly collinear within an MSA. Since we cannot rule out the potential for selection and omitted variable biases, our results should be interpreted only as associations.

In summary, we estimate reduced form birthweight and APGAR score production functions and an equation that estimates the RD – prenatal smoking relation. Since both preterm birth and IUGR can lead to lower birthweight we estimate the relationship between RD and both preterm birth and IUGR. Evidence of a tobacco effect would lend support to psychosocial stress being the mechanism by which RD affects in-utero health. We define reference groups based on the idea that pregnant women are most likely to interact with other pregnant women residing in her MSA, the smallest geographic identifier available. However, in order to test the sensitivity of the results to alternate definitions of reference group we consider RD with respect to several reference groups, namely: pregnant women in the state, state x educational attainment, state x race/ethnicity, MSA x educational attainment, and MSA x race/ethnicity. Further, to allow for the possibility that expectant mothers compare themselves to all women and not just pregnant women, we construct two additional reference groups – all women in the mothers' MSA, and all reproductive-age women (15-49 years) in the MSA.

We estimate our models using Ordinary Least Squares procedure when the dependent variable is birthweight and five-minute APGAR score. We estimate the model as a Probit when the outcome is prenatal tobacco use, IUGR, or preterm birth, and report marginal effects evaluated at the mean of the independent variables for our key regressors which are continuous.

The primary source of individual-level data is the 2001 Natality Detail File, the latest year for which we can supplement information from the Decennial census. The Natality data provide information on the universe of live births in the U.S. These files are a compilation of birth certificates and describe birth outcomes, parental demographics, prenatal care utilization and congenital abnormalities. Approximately 300 MSAs with a population of over 100,000 each are identified. There are approximately 4,000,000 live births in the U.S. every year, which yields an extraordinarily large sample for our analysis. For computing feasibility, we restrict our analysis to a 15% random sample, which yields a sample of 201,243 singleton births. The large sample size allows us to conduct meaningful sub-state analysis and provides precise estimates of the RD effect on child health.

Birthweight, smoking during pregnancy, and length of gestation (weeks) are reported on the birth certificate. We use the standard cutoff, gestation less than 37 weeks, to identify preterm births and birthweight less than the tenth percentile of birthweight for gestational age, is used to identify IUGR infants (Lu and Halfon 2003). Finally, although APGAR scores are assigned both at the first and fifth minute after birth, the 2001 Natality file only provides the five-minute APGAR score.

To create our index of socioeconomic status, we use the 2000 5% Integrated Public Use Microdata Series (IPUMS). We impute household income to the Natality data based on information contained in common. Within the IPUMS, we use the sample of women, 15-49 years old, who had a one year old child at the time of the survey. Ideally we would use the subset of women who were pregnant to obtain an IPUMS sample comparable to the Natality sample; however, pregnancy status was not reported in the IPUMS. Thus the closest we come to obtaining identical samples is to limit the IPUMS sample to recently pregnant women.

For each woman in the IPUMS sample, household income is calculated as the sum of income from all reported sources, including wage, business, investment, retirement, welfare, social security, and other sources, for all members of the household. We regress household income on socioeconomic and demographic variables -- mothers' age, race/ethnicity, educational attainment, marital status, state or country of birth if not

U.S. born, urban/rural residence, state of residence, and fathers' age and race/ethnicity. The OLS coefficients obtained from estimating the household income equation in IPUMS are used to predict household income for mothers in the Natality data set. Using this rich set of socioeconomic characteristics that have been shown to predict permanent disadvantage (Reagan et al. 2007), we estimate a household-income prediction equation on a sample of 634,755 women; the estimation produced an adjusted R-square of 0.266. The imputed household income is arguably a less noisy measure of permanent income because is does not pick up the transitory shocks that is part of current income.

One caveat to using imputed income and imputed RD measures in our regression analysis is that the standard errors on these regression coefficients are likely to be underestimated (Allison 2001). Consequently, the likelihood of obtaining statistically significant results or the probability of rejecting the null hypothesis is likely to be higher. Thus, we interpret the statistical significance of our results with caution.

Finally, we obtain MSA data from the 2000 Census Summary Files. The 2000 Census Summary Files provide information on median MSA income, racial composition, educational attainment, and stability in the community (percentage of owner occupied homes that have been occupied for at least five years). We include the fraction of single male-headed households to control for family structure in the community. We also include MSA income inequality (Gini coefficient) as a control variable, which we construct from the IPUMS household income data.

Results

Table 1 contains the means and standard deviations of the variables of interest. It reveals that mean birthweight and APGAR scores are 3,331 grams and 8.9, respectively;

the probabilities of preterm birth, IUGR, and prenatal tobacco use are 0.11, 0.10 and 0.12, respectively. The mean imputed relative deprivation (IRD) depends on the definition of the reference group and the deprivation measure used; e.g. mean imputed Deaton measure in the reference group MSA and MSA x education are 28.0 and 22.2, respectively, and for the same reference groups the imputed Yitzhaki measure is 121.5 and 88.0, respectively. The fraction of MSA population that is black is around 13%, while 24.4% of the population that is 25+ years has a college degree or higher level of education.

We next turn to the results from our multivariate models investigating the association between infant health and each of the IRD measures – the Deaton measure (scaled by multiplying by 100), Yitzhaki measure (scaled by dividing by 100), and rank (scaled by multiplying by 100), presented in Tables 2, 3, and 4, respectively. Each table contains results from regressions that use alternate definitions of reference group.

Table 2 shows that irrespective of the reference-group definition, the imputed Deaton measure shares a negative and statistically significant relationship with birthweight and APGAR scores, and a positive and statistically significant association with probability of preterm birth, IUGR, and tobacco use. The statistical significance of the results is not surprising given the large sample size and that using IRD likely predisposes us to rejecting the null; however, this table also reveals that although the direction of association between IRD and infant health are consistent with the stress story, the magnitudes of the relationships are not substantively meaningful. A one standard deviation increase in this measure is associated with birthweight being lower by 13.6 to 26.7 grams (relative to a mean of 3,331 grams) and APGAR score being lower by

0.02 to 0.03 points (relative to a mean of 8.9), depending on the definition of the reference group. It is not surprising then that the relationship between the imputed Deaton measure and probability of IUGR and preterm birth are miniscule as well. However, consistent with the stress story, one standard deviation increase in the Deaton measure is associated with 1.2 to 3.2 percentage point higher probability of prenatal smoking. This effect is not minuscule, given that the mean rate of tobacco use among pregnant women in our sample is 12 percentage points

Table 3 reveals that the imputed Yitzhaki measure shares a similar relationship with birthweight. The magnitudes of the relationships are somewhat different, but here too the associations are not substantively meaningful. Results show that a one standard deviation increase in the imputed Yitzhaki measure is associated with 10.8 to 31.8 grams lower birthweight, 0.2 to 0.6 percentage point higher probability of preterm birth, 0.5 to 1.4 percentage point higher probability of IUGR, and 2.4 to 4.6 percentage point higher probability of prenatal tobacco use. Intuitively, this means that holding constant mother *i*'s imputed income, a one standard deviation (106.3 units) decrease in her imputed Yitzhaki measure, which is tantamount to transferring $106,300 a year from a women richer than her to one poorer than her in her MSA, is associated with an 22.4 gram and 0.01 point increase in her infant's birthweight and APGAR score, respectively, and a 3.4 percentage point lower probability of smoking.

When imputed rank is used, the results reported in Table 4, are somewhat different. Like the previous results the magnitude of the birthweight results are small; however, while the previous results were consistent with the stress story regardless of the reference group, the relationship between imputed rank and infant health presents some exceptions. We find that when the reference group consists of *pregnant* women, imputed rank, like the other measures, is negatively correlated with birthweight and APGAR scores, and positively associated with the probability of preterm birth, IUGR, and prenatal tobacco use. However, when the reference group is defined as *all* women in the MSA or *all* reproductive-age women in the MSA, the directions of associations are switched around. Decreasing the percentage of the population higher on the income scale by one standard deviation (28 points), or moving someone from the 50th to the 78th percentile of the income distribution, is associated with an 11.7 grams improvement in her infant's birthweight when the reference group is pregnant women in the MSA, but a 17.5 gram reduction in her infant's birthweight when the reference group is all women in the MSA. Similarly, a one standard deviation decrease in the imputed rank measure is associated with a 3.6 percentage point lower probability of smoking when the reference group is pregnant women, and a 1.3 percentage point higher probability of tobacco use when the reference group is all women in the MSA.

There may be some concern that the IRD coefficient is capturing a nonlinear effect of imputed income, and including income in a flexible way could control for it. Since our income and IRD measures are based on a limited set of SES characteristics that is used for income imputation and as controls in the model, we are unable to enter IRD and imputed income in multiple forms without losing statistical precision. However, not including imputed income and IRD in flexible ways may not be too problematic because the coefficient on the IRD measure tells us how movements in relative rank of imputed income as a result of being in different MSAs are associated with health outcomes. A priori we expect that the RD coefficient does not capture nonlinear effects of income;

however, in an alternate specification we estimate the models in Tables 2, 3, and 4 with imputed income-squared on the right hand side. The results (available upon request) are similar to the ones presented above both in terms of magnitude and direction of association, although some of the results become statistically insignificant when imputed income-squared is included.

Discussion

Our results show that one's relative standing in the community, controlling for individual and community characteristics, is associated with a very slightly lower birthweight of one's child, small increase in the probability of both preterm birth and IUGR, and an increase in the probability of tobacco use during pregnancy. With very few exceptions, the results are consistent across three different measures of RD and eight alternate definitions of reference group. Another way to judge the consistency of our results is to compare the magnitude of the results we estimate to a back-of-the-envelope estimate of the change in birthweight implied by our result for smoking. If the birthweight change we estimate is close to, but somewhat larger than the magnitude that would be implied by the change in tobacco use alone, then this would suggest that psychosocial stress, manifested as increased smoking, is an important mechanism by which RD may act upon infant health. Table 5 shows the change in birthweight implied by prior findings versus what we actually estimate. Note, our estimate of the implied birthweight change is a simple back-of-the-envelope estimate and we do not attempt to calculate a confidence interval for it. Evans and Ringel (1999) estimated that smoking during pregnancy decreased mean birthweight by approximately 400 grams This means that as the probability of prenatal smoking increases by .096 percentage points due to a rise in imputed Deaton RD (Table 2), it is associated with the mean birthweight being lower by 0.384 grams. Our estimated imputed Deaton RD effect on birthweight is -0.860. Similarly, the estimated imputed Yitzhaki and rank effects on tobacco use implies that RD is associated with a decreased mean birthweight via the smoking effect by 0.128 and 0.500 grams, respectively. Comparatively, the imputed Yitzhaki RD relationship with birthweight is estimated to be -0.212 grams and the rank relationship with birthweight is estimated to be -0.406 grams. Two of our three estimated IRD associations with birthweight are larger than those implied by combining our tobacco findings with Evans and Ringel (1999) findings. This is very consistent with the notion that there may be mechanisms other than smoking through which RD affects birthweight.

Summary and conclusion

There is a vast body of literature devoted to studying the effect of income and income inequality on health. In contrast, there has been little research on how RD affects health. In this paper, we consider one mechanism by which RD may affect the health stock of children at birth, while controlling for mother and community characteristics. We shed light on psychosocial stress as that mechanism, by examining the mothers' decision to smoke while pregnant. We consider birthweight, IUGR, preterm birth, and five-minute APGAR score as outcomes.

The 2001 Natality Detail Files, our primary dataset, has excellent details on birth outcomes and maternal socioeconomic characteristics, but it does not contain income. We use mothers' socioeconomic characteristics to impute household income which likely reflects mothers' lifetime permanent income. This imputed income is used to create the

Deaton, Yitzhaki, and rank measures of RD with respect to eight different definitions of reference groups.

Our empirical specifications test the hypothesis that one's relative position will affect in-utero health and stress-related behavior such as prenatal tobacco use, following the evidence from prior studies. We use birthweight and other child health outcomes as catch-all measures of health that may be affected by stress and stress-related behaviors. Although many women quit smoking upon learning of their pregnancy, about 12% of pregnant women continue to smoke and it is plausible that stress has an impact on a woman's ability to quit. Our results show that birthweight and tobacco use are associated with IRD in a statistically significant manner. More importantly, the magnitude of the relationship with birthweight is precisely estimated and is minuscule. The smoking effect is more substantial; a back of the envelop calculation suggests the results are internally consistent across the three different measures of RD and the two dependent variables. That is, the reduction in birthweight estimated is consistent with tobacco use being the primary mechanism by which stress manifests itself, but that other avenues also exist—this matches the notion that not all women who experience psychosocial stress related to RD smoke, or fail to quit smoking, upon learning of their pregnancy.

There are several limitations of our analysis. First, we use a reference group that is smaller and arguably more relevant than some used in the past. We use pregnant women in the MSA, rather than all individuals in a state. However, it may be that the relative reference group to whom people compare themselves is based on race or some other individual characteristic, or that it is more local (one's neighbors or coworkers), and we are not able to test this. Second, we impute income using socioeconomic variables which are thought to measure permanent income. We argue that our measure is a less noisy measure of economic wellbeing than current income, but we cannot test this claim. Further, using IRD may predispose us towards finding statistically significant results and future work should verify that these results hold when RD measures based on reported income are used instead. Third, our results are associations and further investigation is needed to shed light on the causal relationship between RD and infant health. The fourth limitation of this study is that we are unable to test whether RD experienced at younger ages has a cumulative effect on mothers' smoking decision while pregnant. This might be important to consider since individuals are likely to take-up smoking at a younger age. Finally, our sample is restricted to live births in the U.S. If mothers with very high values of RD experience fetal deaths, then our RD results may understate the true effect of RD on prenatal smoking and birth outcomes.

The findings in our paper are consistent with several past findings, and provide additional knowledge to the field. Reagan et al. (2007) found that relative position had a detrimental effect on IUGR, and hypothesized that the causal pathway may be through smoking. Our results lend support to their hypothesis and show that while smoking explains a large portion of the IRD effect on birthweight, it is not the only avenue through which IRD affects health. Future work should explore whether RD impacts other measures of child and maternal health and causal mechanisms, for the reference group as currently defined and for alternate reference groupings.

Table 1: Descriptive Statistics, 2001 Natality Detail Files
Means and Standard Deviations

Label	Mean	(s.d.)
Mean Birthweight (grams)	3331.31	(571.84)
Mean APGAR Score	8.90	(0.70)
Probability of Preterm Birth (gestation < 37 weeks)	0.11	(0.31)
Probability of Intrauterine Growth Retardation (IUGR)	0.10	(0.30)
Probability of Prenatal Tobacco Use	0.12	(0.33)
Mean Deaton RD (x100), Pregnant women, MSA	27.95	(24.41)
Mean Deaton RD (x100), Pregnant women, MSAxEducation	22.17	(21.41)
Mean Deaton RD (x100), Pregnant women, MSAxRace/Ethnicity	25.75	(22.59)
Mean Deaton RD (x100), Pregnant women, State	27.31	(24.20)
Mean Deaton RD (x100), Pregnant women, StatexEducation	21.45	(21.23)
Mean Deaton RD (x100), Pregnant women, StatexRace/Ethnicity	25.20	(22.35)
Mean Deaton RD (x100), All women, MSA	35.42	(25.84)
Mean Deaton RD (x100), Reproductive-age (15-49) women , MSA	36.46	(26.10)
Mean Yitzhaki RD (/100), Pregnant women, MSA	121.46	(106.34)
Mean Yitzhaki RD (/100), Pregnant women, MSAxEducation	88.00	(85.68)
Mean Yitzhaki RD (/100), Pregnant women, MSAxRace/Ethnicity	105.88	(91.65)
Mean Yitzhaki RD (/100), Pregnant women, State	113.11	(99.65)
Mean Yitzhaki RD (/100), Pregnant women, StatexEducation	82.09	(82.21)
Mean Yitzhaki RD (/100), Pregnant women, StatexRace/Ethnicity	98.97	(86.20)
Mean Yitzhaki RD (/100), All women, MSA	206.42	(149.92)
Mean Yitzhaki RD (/100), Reproductive-age (15-49) women , MSA	223.55	(159.12)
Mean Rank (x100), Pregnant women, MSA	49.92	(28.69)
Mean Rank (x100), Pregnant women, MSAxEducation	49.27	(28.41)
Mean Rank (x100), Pregnant women, MSAxRace/Ethnicity	49.54	(28.53)
Mean Rank (x100), Pregnant women, State	47.02	(28.45)
Mean Rank (x100), Pregnant women, StatexEducation	46.59	(28.37)
Mean Rank (x100), Pregnant women, StatexRace/Ethnicity	46.57	(27.93)
Mean Rank (x100), All women, MSA	68.89	(28.99)
Mean Rank (x100), Reproductive-age (15-49) women , MSA	73.31	(29.36)

Mean Household income, imputed ($1000)	44.03	(22.10)
Percent Mothers, Age < 19 years	7.29	(26.00)
Percent Mothers, Age 19-24 years	31.42	(46.42)
Percent Mothers, Age 25-34 years	49.55	(50.00)
Percent Mothers, Age >= 35 years	11.74	(32.19)
Percent Mothers, Education < HS	20.32	(40.24)
Percent Mothers, Education = HS Graduate	31.48	(46.44)
Percent Mothers, Education = Some College	22.91	(42.02)
Percent Mothers, Education = College Graduate, plus	25.29	(43.47)
Percent Mothers, Race = Non-hispanic White	63.89	(48.03)
Percent Mothers, Race = Non-hispanic Black	16.82	(37.40)
Percent Mothers, Race = Non-Hispanic Other race	3.23	(17.68)
Percent Mothers, Hispanic	16.06	(36.72)
Percent Married Mothers	65.76	(47.45)
Percent Children, Female	48.95	(49.99)
Percent Children, Birth order 1	40.67	(49.12)
Percent Children, Birth order 2	32.67	(46.90)
Percent Children, Birth order 3	16.60	(37.21)
Percent Children, Birth order 4	6.25	(24.21)
Percent Children, Birth order 5	2.16	(14.55)
Percent Children, Birth order 6	0.91	(9.47)
Percent Children, Birth order 7	0.36	(5.98)
Percent Children, Birth order>= 8	0.37	(6.11)
Percent in MSA, Black [1]	13.55	(11.10)
Percent Households in MSA w/ Single Male Head [1]	5.73	(0.77)
Percent 25+ in MSA w/ College Degree, plus [1]	24.42	(5.69)
Percent Homes Owner Occupied 5+ yrs in MSA [1]	48.29	(6.83)
Median MSA Family Income ($1000) [1]	48.24	(6.80)
Percent in State, Black [1]	13.84	(8.80)
Percent Households in State w/ Single Male Head [1]	5.79	(0.61)
Percent 25+ in State w/ College Degree, plus [1]	22.74	(3.00)
Percent Homes Owner Occupied 5+ yrs in State [1]	49.94	(5.59)
Median State Family Income ($1000) [1]	46.41	(4.36)
Observations	201,243	

Notes:

1. MSA and State characteristics obtained from 2000 Census Summary Tape Files

2. Natality data restricted to 15% random sample of original data. Analysis restricted to singleton births in MSAs with population>100k

Table 2: Association Between Relative Deprivation (Deaton measure x 100) on Infant Health, 2001 Natality Detail Files

	Birthweight (grams)	Prob. Of Preterm Birth	Prob. Of IUGR	APGAR Score	Prob. Of Prenatal Tobacco Use
Pregnant women, MSA	-0.860***	0.00023**	0.00026***	-0.001***	0.00096***
	[0.191]	[0.00010]	[0.00010]	[0.000]	[0.00009]
Pregnant women, MSAxEducation	-0.940***	0.00025***	0.00024***	-0.001***	0.00070***
	[0.159]	[0.00008]	[0.00008]	[0.000]	[0.00007]
Pregnant women, MSAxRace/Ethnicity	-0.906***	0.00022**	0.00020**	-0.001***	0.00077***
	[0.172]	[0.00009]	[0.00008]	[0.000]	[0.00008]
All women, MSA	-0.995***	0.00026*	0.00037***	-0.001***	0.00113***
	[0.243]	[0.00013]	[0.00013]	[0.000]	[0.00012]
All reproductive-age women, MSA	-1.022***	0.00026*	0.00041***	-0.001***	0.00124***
	[0.248]	[0.00014]	[0.00013]	[0.000]	[0.00012]
Pregnant women, StatexRace/Ethnicity	-0.745***	0.00026***	0.00014	-0.001***	0.00081***
	[0.174]	[0.00009]	[0.00009]	[0.000]	[0.00008]
Pregnant women, StatexEducation	-0.850***	0.00024***	0.00019**	-0.001***	0.00057***
	[0.156]	[0.00008]	[0.00008]	[0.000]	[0.00007]
Pregnant women, State	-0.563***	0.00020**	0.00015	-0.001***	0.00077***
	[0.189]	[0.00010]	[0.00009]	[0.000]	[0.00009]
N	201,243	201,243	201,243	182,444	201,243

Notes:

1. *(**)(***) represents statistical significance at .1(.05)(.01) levels, respectively

2. Each pair of OLS coefficient and its associated standard error in the Birthweight and APGAR score equations, and probit marginal effect and its associated standard error in the P(Preterm Birth), P(SGA), and P(Tobacco Use) equations is obtained from a separate regression.

3. Regressions control for mother/child characteristics: imputed household income, mothers' age, race/ethnicity, educational attainment, marital status at the time of childbirth, and child's sex and birth order.

4. Regressions control for MSA characteristics: % Black, % single male headed households, % 25+ with college degree or more, % homes owner occupied for 5+ years, median family income, and MSA Gini coefficient; and state fixed-effects

5. Restricted to 15% random sample of the 2001 Natality Detail Files limited to singleton births to MSA residents.

Table 3: Association Between Relative Deprivation (Yitzhaki measure / 100) on Infant Health, 2001 Natality Detail Files

	Birthweight (grams)	Prob. Of Preterm Birth	Prob. Of IUGR	APGAR Score	Prob. Of Prenatal Tobacco Use
Pregnant women, MSA	-0.212***	0.00004*	0.00008***	-0.0001***	0.00032***
	[0.041]	[0.00002]	[0.00002]	[0.00006]	[0.00002]
Pregnant women, MSAxEducation	-0.345***	0.00006**	0.00015***	-0.0001	0.00032***
	[0.043]	[0.00002]	[0.00002]	[0.00001]	[0.00002]
Pregnant women, MSAxRace/Ethnicity	-0.251***	0.00003	0.00011***	-0.0001	0.00032***
	[0.038]	[0.00002]	[0.00002]	[0.00005]	[0.00002]
All women, MSA	-0.185***	0.00004*	0.00009***	-0.0001**	0.00031***
	[0.041]	[0.00002]	[0.00002]	[0.00006]	[0.00002]
All reproductive-age women, MSA	-0.188***	0.00004*	0.00009***	-0.0001**	0.00032***
	[0.039]	[0.00002]	[0.00002]	[0.00005]	[0.00002]
Pregnant women, StatexRace/Ethnicity	-0.257***	0.00006**	0.00010***	-0.0001	0.00034***
	[0.042]	[0.00002]	[0.00002]	[0.00006]	[0.00002]
Pregnant women, StatexEducation	-0.387***	0.00007***	0.00014***	-0.0002***	0.00030***
	[0.045]	[0.00002]	[0.00002]	[0.00006]	[0.00002]
Pregnant women, State	-0.108**	0.00002	0.00005**	-0.0001**	0.00024***
	[0.044]	[0.00002]	[0.00002]	[0.00006]	[0.00002]
N	201,243	201,243	201,243	182,444	201,243

Notes:

1. *(**)(***) represents statistical significance at .1(.05)(.01) levels, respectively

marginal effect and its associated standard error in the P(Preterm Birth), P(SGA), and P(Tobacco Use) equations is obtained from a s

3. Regressions control for mother/child characteristics: household income, mothers' age, race/ethnicity, educational attainment, marital status at the time of childbirth, and child's sex and birth order.

4. Regressions control for MSA characteristics: % Black, % single male headed households, % 25+ with college degree or more, % homes owner occupied for 5+ years, median family income, and MSA Gini coefficient; and state fixed-effects

5. Restricted to 15% random sample of the 2001 Natality Detail Files limited to singleton births to MSA residents.

Table 4: Association Between Relative Deprivation (Rank x 100) on Infant Health, 2001 Natality Detail Files

	Birthweight (grams)	Prob. Of Preterm Birth	Prob. Of IUGR	APGAR Score	Prob. Of Prenatal Tobacco Use
Pregnant women, MSA	-0.406*	0.00014	0.00032***	0.0001	0.00125***
	[0.229]	[0.00013]	[0.00012]	[0.000]	[0.00010]
Pregnant women, MSAxEducation	-0.268*	0.00003	0.00023***	-0.00003	0.00052***
	[0.154]	[0.00008]	[0.00008]	[0.000]	[0.00007]
Pregnant women, MSAxRace/Ethnicity	-0.442***	0.0001	0.00011	-0.0004	0.00055***
	[0.169]	[0.00009]	[0.00008]	[0.000]	[0.00008]
All women, MSA	0.603***	-0.00004	-0.00013	0.001**	-0.00044***
	[0.201]	[0.00011]	[0.00010]	[0.000]	[0.00009]
All reproductive-age women, MSA	0.605***	-0.00002	-0.00016**	0.001***	-0.00047***
	[0.157]	[0.00008]	[0.00008]	[0.000]	[0.00007]
Pregnant women, StatexRace/Ethnicity	-0.686***	0.00021**	0.00012	-0.0002	0.00069***
	[0.193]	[0.00010]	[0.00010]	[0.000]	[0.00010]
Pregnant women, StatexEducation	-0.828***	0.00018*	0.00030***	-0.0006***	0.00043***
	[0.173]	[0.00009]	[0.00009]	[0.000]	[0.00007]
Pregnant women, State	-0.446*	0.00013	0.00030**	0.00001	0.00106***
	[0.260]	[0.00014]	[0.00013]	[0.000]	[0.00012]
N	201,243	201,243	201,243	182,444	201,243

Notes:

1. *(**)(***) represents statistical significance at .1(.05)(.01) levels, respectively

2. Each pair of OLS coefficient and its associated standard error in the Birthweight and APGAR score equations, and probit marginal effect and its associated standard error in the P(Preterm Birth), P(SGA), and P(Tobacco Use) equations is obtained from a s

3. Regressions control for mother/child characteristics: household income, mothers' age, race/ethnicity, educational attainment, marital status at the time of childbirth, and child's sex and birth order.

4. Regressions control for MSA characteristics: % Black, % single male headed households, % 25+ with college degree or more, % homes owner occupied for 5+ years, median family income, and MSA Gini coefficient; and state fixed-effects

5. Restricted to 15% random sample of the 2001 Natality Detail Files limited to singleton births to MSA residents.

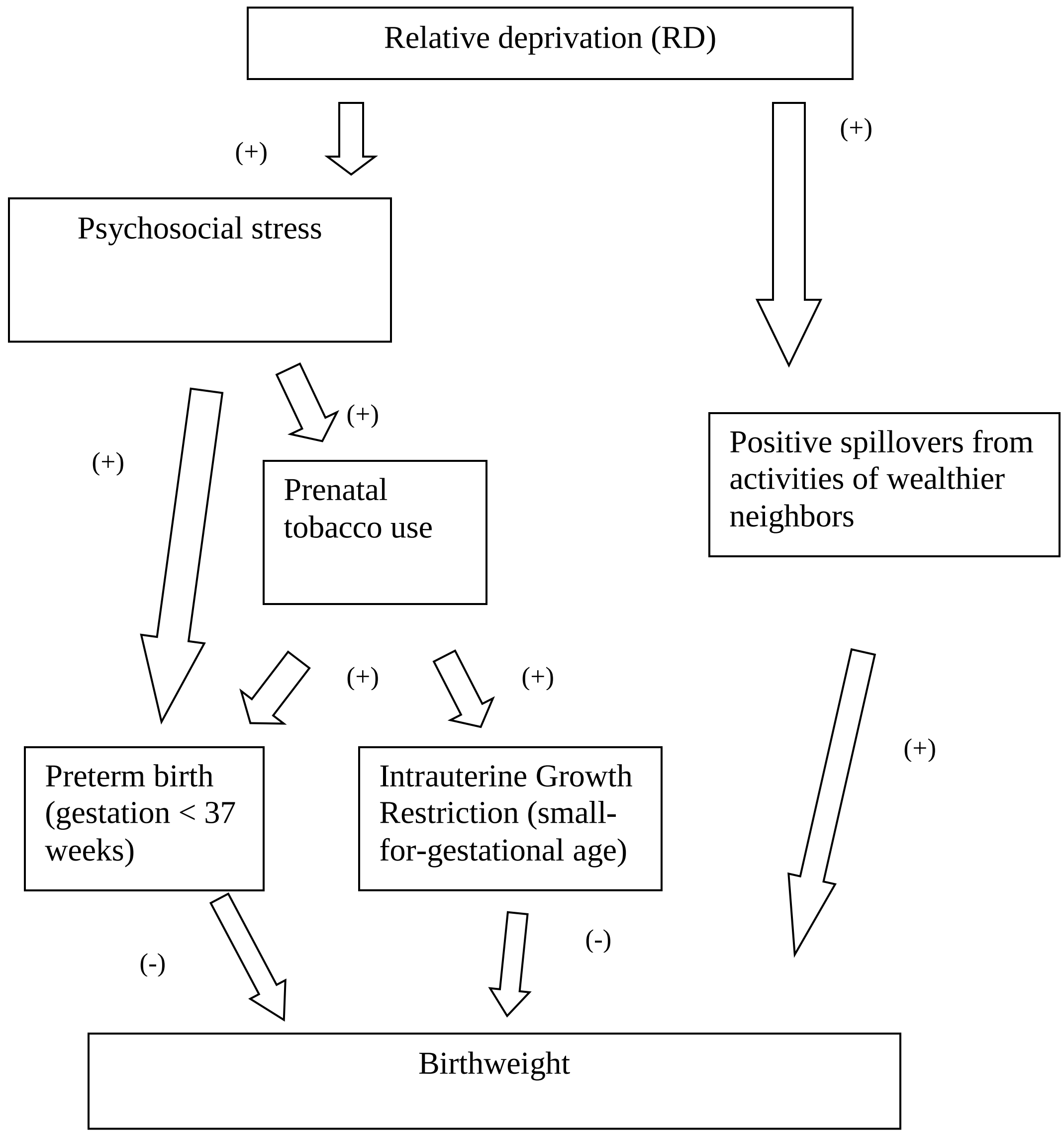
Table 5: Association Between Relative Deprivation (RD) and Birthweight, Estimated vs. Implied, 2001 Natality Detail Files

	Effect of RD on mean birthweight, estimated	Effect of RD on mean birthweight, implied
Deaton Relative Deprivation (x100)	-0.860*** [0.191]	-0.384
Yitzhaki Relative Deprivation (/100)	-0.212*** [0.041]	-0.128
Rank (x100)	-0.406* [0.229]	-0.500

Notes:

1. Estimated RD effect same as those reported for reference group: Pregnant Women in MSA, in Tables 2, 3, and 4
2. Implied effect calculation assumes that smoking reduces mean birthweight by 400 g (Evans and Ringel 1999); Implied effect = probit marginal effect (in Table 2) x 400 g
3. Implied effect is a back-of-the-envelope calculation thus we do not attempt to calculate confidence intervals for it.

Figure 1: Hypothesized Relationship Between Relative Deprivation and Birthweight



References:
Adams, E.K, V. Miller, C. Ernst, B. Nishimura, C. Melvin, and R. Merritt. 2002. "Neonatal Healthcare Costs Related to Smoking During Pregnancy" *Health Economics* 11: 193-206

Albrecht, S., J. Maloni, K. K. Thomas, R. Jones, J. Holleran, and J. Osborne. 2004. "Smoking Cessation Counseling for Pregnant Women who Smoke: Scientific Basis for Practice for AWHONN's SUCCESS Project." *Journal of Obstetric, Gynecologic, and Neonatal Nursing* 33(3): 298-305

Allison, P.D. 2001. *Missing Data*. Sage University Papers Series on Quantitative Applications in the Social Sciences, 07-136. Thousand Oaks, CA: Sage

Behrman, J. and M. Rosenzweig. 2004. "Returns to Birth Weight." *Review of Economics and Statistics* 86(2): 586-601.

Behrman, J, M. Rosenzweig, and P. Taubman. 1994. "Endowments and the Allocation of Schooling in the Family and in the Marriage Market: The Twins Experiment." *Journal of Political Economy* 102(6): 1131-1174.

Black, S., P. Devereux, and K. Salvanes 2007 "Black, Sandra, P. Devereux and K. Salvanes. 2007. "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes." ", *Quarterly Journal of Economics* 122(1): 409-436

Byrne, D.G., A.E. Byrne, and M.I. Reinhart. 1995. "Personality, Stress and the Decision to Commence Cigarette Smoking in Adolescence." *Journal of Psychosomatic Research* 39(1): 53-62.

Case, A., D. Lubotsky and C. Paxson. 2002. "Economic Status and Health in Childhood: The Origins of the Gradient." *American Economic Review* 92(5): 1308-1334.

Currie, J. S. Decker and W. Lin. 2008. "Has Public Health Insurance For Older Children Reduced Disparities in Access to Care and Health Outcomes?" *Journal of Health Economics*. 27. pp.157-1581.

Currie, J. and R. Hyson. 1999. "Is the Impact of Health Shocks Cushioned by Socioeconomic Status? The Case of Low Birth Weight." *AEA Papers and Proceedings* 89: 245-250.

Currie, J. and M. Stabile. 2003. "Socioeconomic Status and Child Health: Why is the Relationship Stronger for Older Children?" *American Economic Review* 93(5): 1813-1823.

Deaton, A. 1999. "Inequalities in Income and Inequality in Health." National Bureau of Economic Research Working Paper # 7141

Deaton, A. 2001. "Relative Deprivation, Inequality and Mortality." National Bureau of Economics Research Working Paper # 8099.

Eibner, C. and W. Evans. 2005. “Relative Deprivation, Poor Health HabitsDeprivation, Poor Health Habits, and Mortality.”.”*Journal of Human Resources XL, 3 p.591-620* 40(3): 591-620

Evans, W. and J. Ringel. 1999. “Can Higher Cigarette Taxes Improve Birth Outcomes?” *Journal of Public Economics* 72: 135-154

Kramer MS, Seguin L, Lydon J, Goulet L. Socioeconomic disparities in pregnancy outcome: Why do the poor fare so poorly? *Paediatric Perinatal Epidemiology* 2000;14:194–210

Floyd, R.L., B. Rimer, G. Giovino, P Mullen, and S. Sullivan. 1993. “A Review of Smoking in Pregnancy: Effects on Pregnancy Outcomes and Cessation Efforts.” *Annual Review of Public Health* 14: 379-411

Grossman, M. 1972. “On the Concept of Health Capital and the Demand for Health.” *Journal of Political Economy* 80: 223-255

Joyce, T. and M. Grossman. 1990. “Pregnancy Wantedness and Early Initiation of Prenatal Care.” *Demography* 27(1): 1-17.

Kassel, J.D., L.R. Stroud, and C.A. Paronis. 2003. “Smoking, Stress, and Negative Affect: Correlation, Causation, and Context Across Stages of Smoking.” *Psychological Bulletin* 129(2): 270-304.

Lien, D. and W. Evans. 2005. “Estimating the Impact of Large Cigarette Tax Hikes: The Case of Maternal Smoking and Infant Birth Weight.” *Journal of Human Resources* 40(2): 373-392

Lu, M. and Halfon, N. Racial and Ethnic Disparities in Birth Outcomes: A Life-Course Perspective. *Maternal and Child Health Journal.* 2003; 7(1): 13-30.

Ludman, E., J. Nelson, L. Grothaus, C. McBride, S. Curry, H. Lando, and P. Pirie. 2000. “Stress, Depressive Symptoms, and Smoking Cessation Among Pregnant Women.” *Health Psychology* 19(1): 21-27

Maritz, G.S., C. Morley, and R. Harding. 2005. “Early Developmental Origins of Impaired Lung Structure and Function.” *Early Human Development* 81: 763-771

Marmot, M. G. 1986. “Social Inequalities in Mortality: The Social Environment.” In *Class and Health*. ed. Richard Wilkinson. London and New York: Tavistock Publications.

Marmot, M.G. 1994 “Social Differences in Health Within and Between Populations.” *Daedalus* 123: 197-216

McKee, S.A., P.K. Maciejewski, T. Falba, and C.M. Mazure. 2003. “Sex Differences in the Effects of Stressful Life Events on Changes in Smoking Status.” *Addiction* 98: 847-855.

Osmani, S. and A. Sen. 2003. “The hidden penalties of gender inequality: fetal origins of ill-health.” *Economics & Human Biology* 1(1): 105-121

Reagan, P., P. Salsberry, and R. Olsen. 2007. “Does the Measure of Economic Disadvantage Matter? Exploring the Effect of Individual and Relative Deprivation on Intrauterine Growth Restriction.” *Social Science and Medicine* 64: 2016-2029

Runciman, W. G. 1966. *Relative Deprivation and Social Justice*. London: Routledge and Kegan Paul.

Sapolsky, R.M. 1993. “Endocrinology Alfresco: Psychoendocrine Studies of Wild Baboons.” *Recent Progress in Hormone Research* 48:437-468.

Shiono, P.H. and R.E. Behrman 1995 “Low Birth Weight: Analysis and Recommendations.” *The Future of Children* 5(1): 4-18

Smith, J.P. 1999 “Healthy Bodies and Thick Wallets: The Dual Relationship Between Health and Economic Status.” *Journal of Economic Perspectives* 13(2): 145-166

Subramanian, S. and I. Kawachi. 2004. "Income Inequality and Health: What Have We Learned So Far?" *Epidemiologic Reviews* 26: 78-91.

U.S. Department of Health and Human Services. *Healthy People 2010*. 2nd ed. With Understanding and Improving Health and Objectives for Improving Health. 2 vols. Washington, DC: U.S. Government Printing Office, November 2000.

U.S. Department of Health and Human Services. *The Health Consequences of Smoking: A Report of the Surgeon General*. 2004

U.S. Environmental Protection Agency. 1992 “Respiratory Health Effects of Passive Smoking: Lung Cancers and Other Disorders.” Washington, DC: US Environmental Protection Agency, Office of Research and Development, Office of Air and Radiation # 600/6-90006F

Ventura, S., B. Hamilton, T.J. Mathews, and A. Chandra. 2003. “Trends and Variations in Smoking During Pregnancy and Low Birth Weight: Evidence From the Birth Certificate, 1990-2000.” *Pediatrics* 111: 1176-1180.

Wang, X., et al. 2002. “Maternal Cigarette Smoking, Metabolic Gene Polymorphism, and Infant Birth Weight.” *Journal of the American MedicalAssociation* 287(2): 195-202.

Wagstaff, A., & Doorslaer, E. V. (2000). Income inequality and health: What does the literature tell us? *Annual Review of Public Health* 21:543-567.

Wilkinson, R. 1999. “Income Inequality, Social Cohesion and Health: Clarifying the Theory – A Reply to Muntaner and Lynch.” *International Journal of Health Services* 29: 525-543.

Wilkinson, R. 1997. “Health Inequalities: Relative or Absolute Material Standards?” *British Medical Journal* 314(7080): 591-595.

Wilkinson, R. and K. Pickett. 2006. “Income Inequality and Health: A Review and Explanation of the Evidence.” *Social Science and Medicine* 62(7): 1768-84

Yitzhaki, S. 1979. “Relative Deprivation and the Gini Coefficient.” *The Quarterly Journal of Economics* 93(2): 321-324.

Yngwe, M., J. Fritzell, O. Lundberg, F. Diderichsen, and B. Burstrom. 2003. “Exploring Relative Deprivation: Is Social Comparison a Mechanism in the Relation Between Income and Health?” *Social Science and Medicine* 57: 1463-1473.