Does Prenatal Exposure to Acute Malnutrition Increases the Risk of Fetal Loss? Evidence from the 1959-1961 Great Leap Forward Famine in China

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September 10, 2010

ABSTRACT

Using two large nationally representative sample survey data from China in 1988 and in 2001, I study the potential long-term impact of prenatal exposure to the 1959-1961 Great Leap Forward Famine in China on the risk of involuntary fetal loss by comparing the cohort difference between women born during the famine (1959-1961) and women born either before (1956-1958) or after (1962-1964). Preliminary results support the claim that prenatal exposure to famine may increase the risk of involuntary fetal loss of women when reaching childbearing age. The next step is to estimate "difference-in-difference" models to get more refined estimates of the potential long-term impact of prenatal exposure to famine on the risk of involuntary fetal loss.

INTRODUCTION

The importance of early-life condition, including that during the prenatal period, on adult health outcomes has been well documented. One of the most important factors is nutrition. Past research has shown that prenatal malnutrition can have permanent negative impact on a wide range of health outcomes (Barker et al., 2002; Chen and Zhou, 2007; Gluckman and Hanson, 2006; Rasmussen, 2001; Song et al., 2009; Stein and Lumey, 2000). Much less is known about the potentially long-term negative impact of prenatal exposure to acute malnutrition on health outcomes that are most important to understand the patterns and dynamics of the human reproduction, including fertility, fecundity (fecundability and sterility), involuntary fetal loss, and the vitality of the next generation.

In this research, I focus on involuntary fetal loss, including both miscarriage and stillbirth.[1] I use the 1959-1961 Great Leap Forward Famine in China as natural experiment to examine if prenatal exposure to acute malnutrition has long-term influence on the risk of involuntary fetal loss.

RESEARCH DESIGN

Identification Strategy

Using the 1959-1961 Great Leap Forward Famine as a natural experiment, the effect of prenatal exposure to acute malnutrition on the risk of involuntary fetal loss is identified through the following steps.

[1] Following (Wood, 1994, p. 240), I do not make distinction between miscarriage and stillbirth because of the increasingly blurred boundary between them; instead, I classify them both into "involuntary fetal loss" (as opposed to voluntary fetal loss and livebirth).

Cohort comparison. As the first step of analysis, the effect of prenatal exposure to acute malnutrition can be estimated by comparing the fetal loss risk between women born before (1956-1958), during (1959-1961), and after (1962-1964) the famine. Among these three birth cohorts, the post-famine cohort is completely unaffected by the famine and thus can be used as the "control" group; the famine cohort experienced the famine *in utero*[2] and thus is treated as the "treatment" group; the pre-famine cohort experienced the famine during infancy or early childhood but not *in utero* so it can be used as another control group. Comparing the risk of involuntary fetal loss between the post-famine cohort and the famine cohort yields an estimate of the effect of both prenatal and early-life exposure to acute malnutrition; comparing the risk of involuntary fetal loss between the pre-famine and the famine cohort yields an estimate of the effect of prenatal exposure to acute malnutrition (since they both were exposed to the famine during infancy).

Urban/rural difference in the cohort pattern of involuntary fetal loss. As past research documented, the rural population was influenced much more severely than the urban population by the famine (Kung and Lin, 2003; Peng, 1987). This urban-rural difference in famine severity provides an opportunity to get more fine-grained estimate of the effect of prenatal exposure to acute malnutrition. By comparing the urban/rural difference in the difference in involuntary fetal loss risk between the famine and the non-famine cohorts, it is possible to isolate a more refined "difference-in-difference" estimate of the effect of prenatal famine exposure, controlling for unobserved heterogeneity between birth cohorts.

Effect of regional variation in famine severity. The last set of models aim to further refine the analysis and to get estimates of the "dose-response" relationship between the the severity of the prenatal famine exposure and the risk of involuntary fetal loss. Following the procedure

[2]Since the famine lasted for three years, at least some of these women experienced the famine both *in utero* and during infancy.

used by Chen and Zhou (2007), I construct provincial level famine severity measure by differencing the peak mortality level during the famine years and the average mortality level in the pre-famine years. Since most of the famine-induced excess mortality occurred among rural population Kung and Lin (2003), this part of the analysis focuses only on rural population. By including this newly created provincial level famine severity measure, birth cohort (pre-famine, famine, and post-famine), and their interaction effects, it is possible to obtain more refined difference-in-difference estimates of the impact of the severity of prenatal exposure to the famine on involuntary fetal loss.

It may be possible to construct alternative measures of famine severity at even lower administrative level, such as prefecture- or city-level, based on census population counts for each birth cohort. Results based on these different famine severity measures can then be compared and checked against each other.

Data

This study utilizes the 1988 two-per-thousand fertility survey data and the 2001 family planning and reproductive health survey data, both conducted by the Chinese National Family Planning Commission. Both data has detailed retrospective pregnancy history information, including the outcome (live birth, induced abortion, miscarriage, stillbirth, or currently pregnant) and ending date of each pregnancy.

With 2.1 million respondents included in the sample, the 1988 two-per-thousand fertility survey is known to be the largest fertility survey in the world. This analysis focuses on the pregnancy history of 433,250 women born in 1956-1964. Such a large sample size can support highly sophisticated statistical analysis, such as the famine severity models using famine excess mortality information measured at province- or prefecture-level.

The main advantage of the 2001 survey data, as compared to the 1988 survey data,

despite its much smaller sample size,[3] is that the fact that it was collected 13 years after the 1988 survey data, which gives a much more complete coverage of the childbearing period than the 1988 data. One important use of the 2001 data is to check to see whether the estimated cohort difference in involuntary fetal loss is confounded by the age effect (the data are right censored because no pregnancy information is available after the time of survey interview).

Statistical Models

Two sets of analysis are conducted. As the first step, involuntary fetal loss is treated as a binary variable for each recorded pregnancy and is modeled as function of women's characteristics (birth cohort, ethnicity, place of residence, etc.) as well as pregnancy-specific information (woman's age at pregnancy, season, number of previous pregnancy and birth, etc.). To account for the fact that pregnancies of the same woman may be more alike than pregnancies of different women, I also include a woman-level random intercept to account for woman-level unobserved heterogeneity.

The second sets of analysis treats the dependent variable as a categorical variable with three values: (1) live birth, (2) voluntary fetal loss (induced abortion), and (3) involuntary fetal loss. By jointly model abortion and involuntary fetal loss (while treating live birth as the reference category) and allow the woman-level unobserved heterogeneity terms for each outcome to be freely correlated, it is possible to control for the potential selection biases caused by differential abortion.[4]

[3]The 2001 National Family Planning and Reproductive Health Survey collected information from 39,586 women living in all 31 provinces in China. This analysis focuses on pregnancy history information for 7,354 women born in 1956-1964.

[4]Women may be more likely to have an abortion if they somehow knew (for reasons unknown to the

All statistical models are estimated using open source statistical software *aML*.

PRELIMINARY RESULTS AND MORE ANALYSIS

Preliminary studies based on the 1988 and the 2001 survey data show that the famine cohort has a significantly higher risk of involuntary fetal loss than both the pre-famine and the post-famine cohorts, after controlling for place of residence, age at marriage, education, ethnicity, the number of previous pregnancy/birth, and the age of pregnancy ending.

The next step is to conduct the urban/rural difference model and the famine severity models as described above.

researchers) something wrong with a particular pregnancy. As a result, there may be a negative relationship between abortion and involuntary fetal loss, which, if not controlled for adequately, could bias the estimated cohort pattern in involuntary fetal loss.

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