Multi-Generational Transmission of Maternal Stress in Pregnancy: Evidence from the 1980 Kwangju Uprising in South Korea (Proposal)

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Background and Significance

It is now widely accepted that in-utero exposure to adverse environment has strong and persistent effects on health and socioeconomic outcomes at older ages (Barker 1992, 1994, Currie and Hyson 1999; Chay and Greenstone 2003; Behrman and Rosenzweig 2004; Black, Devereux, and Salvanes 2007; Currie and Moretti 2007). In recent years, a growing number of studies offer semi-experimental evidence on the consequences of exogenously generated shocks to fetal health, including the 1918 Pandemic Influenza (Almond 2006; Almond and Mazumder 2005), the Dutch Famine (Neugebauer, Hoek, and Susser 1999; Roseboom, Meulen, Ravelli et al. 2001; Bleker et al. 2005), the Chinese Famine (St. Clair et al. 2005; Luo, Mu, and Zhang 2006; Meng and Qian 2009; Chen and Zhou 2007; Almond et al. 2010), the air pollution in the United States (Chay and Greenstone 2003), and the Chernobyl disaster (Almond, Edlund, and Palme 2009).

There is growing evidence that a more subtle form of negative health shock, namely, maternal psychological stress during pregnancy, negatively affects a wide variety of offspring outcomes (Weinstock 2001). Influences of a wide range of stressors have been investigated based on semi-experimental episodes, which include the German army's invasion of the Netherlands in 1940(Os and Selten 1998), the Six-Day War in 1967 (Meijer 2007), the Korean War in 1950 (Lee 2012), the September 11, 2001 terrorist attacks and its aftermath (Lauderdale 2006; Eccleston 2011), and hurricanes (Currie and Rossin-Slater 2012). A possible mechanism by which maternal stress affects the health of the next generation is hormonal change (Weinstock 2001; Aizer et al. 2009).

Animal studies suggest that negative influences of maternal stress during pregnancy persist across multiple generations (Drake and Walker 2004; Sheriff et al. 2010), but there is little direct evidence confirming that it is present among human populations. Meanwhile, human studies have found that parental and offspring birth weights are positively related (Emanuel et al. 1992; Klebanoff et al. 1997; Currie and Moretti 2007). If these findings are combined with the results that maternal stress in pregnancy reduces offspring birth weights, we might expect to find a multi-generational effects of maternal stress.

This study draws evidence on the intergenerational influences of maternal stress from the Kwangju uprising, arguably the bloodiest incidence that has occurred in South Korea since the end of the Korean War in 1953. The tragic event took place on May 18 in the southwestern city of Kwangju (with a population of 730,000 at the time) in the course of political crisis that followed the assassination of President Park in October 1979. Student demonstrations demanding democratic reform turned to mass protests by citizens who were angered by the brutal acts of violence conducted by paratroopers (special unit trained for guerrilla warfare), and soon escalated to a bloody warfare between armed civilian militias (called the Citizen Army) and martial law troops.

It is estimated that about five hundred civilians killed and over three thousand wounded as a consequence of the violence that engulfed the city (Shin and Hwang 2003, p. xvii). Even for the citizens who avoided any direct damage, the incidence must be extremely stressful event. It is still not systematically documented how the traumatic experiences during the Kwangju uprising affected the lives of the vast majority of the citizens who were not visibly influenced by the violence during the event. So far, no attempts have been made to understand the impact of the tragic event on offspring outcomes.

Data and Methods

The data used in this study are micro files of the 2000 and 2002 Vital Statistics for birth in Korea. These data include the digitalized birth registration records for all children born in the given years, providing information on characteristics of the parents and the newly-born babies. The variables offered by the data include: the child's sex, place of birth, date of birth, length of gestation (in week), birth weight; and age, education and occupation of the parents. The micro files of the data are available from 1991 (although birth weight began to be reported from 1993), but the exact birth dates of the parents are reported only in the 2000 and 2002 micro data. The data for the other years only provide ages of the parents at the time of registration. For the year except 2000 and 2002, therefore, it is difficult to identify the accurate year of birth, let alone the month of birth. Because of this feature of the data, the birth records of children born in 2000 or 2002 are utilized in this study.

We hypothesize that the maternal stress negatively affected the fetal health of the children, and that the impact of the adverse early-life shock even transmitted to the health of the next generation. More specifically, we suspect that maternal stress in pregnancy from the Kwangju uprising adversely affected birth outcomes of the mother's grandchildren after twenty years or more.

The Kwangju uprising took place between May 18 to 27 in 1980, and it was largely Kwangju citizens who were directly exposed to traumatic experiences. Thus, individuals whose mother resided in Kwangju in May 1980 and who were born between June 1980 and February 1981 should be exposed to the violence in utero. Unfortunately, neither the grandmother's place of residence in May 1980 nor the mother's place of birth is reported in the Vital Statistics. Only the place of birth for the child is given in the data. Thus, we use the place of birth for children as a proxy for the place of residence of the grandmother (or the place of birth of the mother) 20 years earlier.

To study inter-generational transmission of the maternal stress caused by the violence during the Kwangju uprising, the following difference-in-difference model is employed in regression analyses:

$$(1)\quad y_i = \alpha + \beta_1 I_i + \beta_2 (I_i \times S_i) + \beta_3 S_i + \gamma_1 YOB_i + \gamma_2 YOB_i^2 + \gamma_3 YOB^3 + \delta X_i + \varepsilon_i$$

where *I* denotes the dummy variable that identifies a mother as *in utero* between June 1980 and February 1981, *S* is the dummy variable that indicates whether the child was born in the city of Kwangju, YOB stands for the mother's year of birth, and *X* represents other characteristics of the child and parents that potentially influence birth outcomes, including year of birth, sex, multiple births, and parents' education and occupation.

Preliminary Results

OLS regressions for birth weight and length of gestation are conducted based on a difference-in-difference model displayed in Equation (1). If a pregnant woman's exposure to the Kwangju uprising negatively affected the birth outcomes of their grandchildren, then the coefficient of the interaction between the dummy variable for having a mother born in Kwangju (B_Kwangju) and the dummy variable for having a mother who were born from June 1980 to February 1981 (B_Jun80-Feb81) should be negative.

In the baseline model (Column 1), polynomial terms of the year of birth of the mother (YOB, YOB^2, and YOB^3) are included to consider long-term changes in birth weight across birth cohorts. In addition, variables on key determinants of birth weight are included, such as year of birth (Year 2002, omitted category is Year 2000), sex of the child (Male), multiple birth (Twins; Triplets), and birth parity (second; third or higher). In the second model (Column 2), variables on mother's educational attainment and occupation are added. Schooling is classified into four categories: (1) middle school or less, (2) high school, (3) college or higher, and (4) education unknown; and occupation is divided into eight: (1) Professional (2) clerical job, (3) service and sales, (4) farming, (5) skilled, (6) unskilled, (7) not working, and (8) occupation unknown. In the final model (Column 3), variables on the father's socioeconomic status are included along with the mother's.

The regression results for birth weight are reported in Table 1. The results suggest that the mother's prenatal exposure to the Kwangju uprising had a negative effect on offspring birth weight. The coefficient for the interaction term (B_Kwangju*B_Jun80-Feb81) is negative and marginally significant (p-value = 0.0524). Its magnitude shows that mother's in-utero exposure to the Kwangju

Uprising reduced the offspring birth weight by about 56 grams, controlling for mother's year of birth and some key characteristics of birth. Adding parental socioeconomic characteristics does not change the result much. The coefficient for the interaction term remains little changed in magnitude (about 57 grams), and becomes slightly more significant.

The regression results for the length of gestation (Table 2) suggests that the mother's in-utero exposure to the Kwangju uprising had a significantly negative effect on the child's length of gestation, although its magnitude is rather small: The length of gestation of the Kwangju grandchildren were about 2.3 days shorter, holding constant mother's year of birth and some key characteristics of birth. Similar to the results for birth weight, adding parental SES does not change the magnitude and statistical significance of the coefficient for the interaction term.

The impact of exposure to maternal stress could differ by stage of pregnancy when the shock is received. To see if this is the case, children born to mothers exposed to the Kwangju uprising in utero are classified into three groups, depending on which trimester of pregnancy their mothers experienced the event. For example, the mothers born between December 1980 and February 1981 were in the first trimester when the Kwangju uprising took place. Similarly, those born from September 1980 to November 1980 and from June 1980 and August 1980 were exposed to the Kwangju incidence when they were in, respectively, the second and the third trimesters. The regression results (Table 3) suggest that mother's in-utero exposure to the stress during the second trimester exerted the strongest negative effect on the offspring birth weight. It diminished the birth weight by 102 grams, and the effect is statistically significant (p-value = 0.0348). Maternal exposure to stress during the first and final trimesters reduces grandchildren's birth weight, too, but the effects are statistically insignificant and smaller in magnitude (39 grams and 23 grams, respectively). The results remain little changed if parental SES is controlled for.

We also estimate the effect of mother's in-utero exposure to the Kwangju uprising in each trimester on offspring length of gestation (Table 4). Unlike the case of birth weight, mother's prenatal exposure to stress during the second and third trimesters has equally strong negative effects on children's length of gestation. They reduce the length of gestation by slightly more than half a week; and the effects are highly significant (p-values are, respectively, 0.0011 and 0.0026). Again, adding parental SES does not change the results.

Several robustness checks are performed (not reported in this proposal). First, to compare across mothers who are similar in terms of the year of birth, the children of women born from 1975 to 1984 are included in regressions, excluding the children of mothers who are much older or younger than the cohort who experienced the Kwangju uprising in utero. Second, only the babies born in the six metropolitan cities are included in the regression analyses to make comparisons across mothers living under similar conditions, e.g. medical facilities and ecological environment. Finally, only the birth records of those born in Kwangju or Jeonnam Province (that surrounds Kwangju) are considered in the regression analyses. The purpose of the final robustness check is to see if the negative effect of having a mother born between June 1980 and February 1981 captures the influences of exposure to the violence during the Kwangju uprising or the effects of the political oppression of the military regime during the period that were felt by a larger population in the region. It looks like the primary findings withstand these robustness checks.

Analyses in Progress

More results will be added regarding the impact of mother's in-utero exposure to the Kwangju uprising on the risks of low birth weight (birth weight below 2.5 kg) and of pre-term birth (length of gestation shorter than 37 weeks). We will also examine long-term influences of prenatal exposure to the violence on the first generation's own economic and health outcomes, utilizing recent micro panel data and the 2010 population census.

References

Omitted.

Table 1: Mother's In-Utero Exposure to the 1980 Kwangju Uprising and Offspring Birth Weight

		(1)		(2)		(3)	
	Mean	∂y/∂x	P-value	∂y/∂x	P-value	∂y/∂x	P-value
Intercept		4703.66	<.0001	4482.02	<.0001	4529.45	<.0001
Mother's place & timing of birth							
B_KWANGJU	0.03259	5.18	0.0252	3.54	0.1265	2.58	0.2655
B_KWANGJU*B_Jun80-Feb81	0.00021	-55.68	0.0524	-57.39	0.0454	-57.23	0.0460
B_Jun80-Feb81	0.00607	-15.25	0.0071	-16.22	0.0042	-15.93	0.0049
Mother YOB, YOB^2,YOB^3		Yes	Yes	Yes	0.0020	-87.84	0.0021
Characteristics of Birth		Yes	Yes	Yes	<.0001	1.66	<.0001
Mother's SES		No	Yes	Yes	<.0001	-0.01	<.0001
Father's SES		No	No	Yes			

Table 2: Mother's In-Utero Exposure to the 1980 Kwangju Uprising and the Length of Gestation (in week)

		(1)		(2)		(3)	
	Mean	∂y/∂x	P-value	∂y/∂x	P-value	∂y/∂x	P-value
Intercept		72.542	<.0001	72.435	<.0001	72.745	<.0001
Mother's place & timing of birth							
B_KWANGJU	0.03259	-0.078	<.0001	-0.080	<.0001	-0.082	<.0001
B_KWANGJU*B_Jun80-Feb81	0.00021	-0.327	0.0008	-0.328	0.0007	-0.327	0.0008
B_Jun80-Feb81	0.00607	0.022	0.2437	0.022	0.2484	0.022	0.2528
Mother YOB, YOB^2,YOB^3		Yes	Yes	Yes	0.0020	-87.84	0.0021
Characteristics of Birth		Yes	Yes	Yes	<.0001	1.66	<.0001
Mother's SES		No	Yes	Yes	<.0001	-0.01	<.0001
Father's SES		No	No	Yes			

Table 3: Mother's In-Utero Exposure to the 1980 Kwangju Uprising and Offspring Birth Weight by Trimester

		(1)		(2)		(3)	
	Mean	∂y/∂x	P-value	∂y/∂x	P-value	∂y/∂x	P-value
Intercept		4676.21	<.0001	4450.92	<.0001	4496.94	<.0001
B_KWANGJU	0.032591	5.18	0.0252	3.54	0.1266	2.58	0.2657
B_KWANGJU*B_Dec80-Feb81	0.000067	-38.99	0.4425	-41.02	0.4190	-37.37	0.4615
B_KWANGJU*B_Sep80-Nov80	0.000075	-102.06	0.0348	102.97	0.0331	-103.97	0.0314
B_KWANGJU*B_Jun80-Aug80	0.000070	-22.96	0.6446	-25.20	0.6124	-27.14	0.5853
B_Dec80-Feb81	0.001949	-26.61	0.0061	-28.96	0.0028	-29.36	0.0025
B_Sep80-Nov80	0.002019	-5.81	0.5380	-6.36	0.5003	-5.98	0.5264
B_Jun80-Aug80	0.002105	-14.08	0.1275	-14.23	0.1236	-13.41	0.1465
Mother YOB, YOB^2,YOB^3		Yes		Yes		Yes	
Characteristics of Birth		Yes		Yes		Yes	
Mother's SES		No		Yes		Yes	
Father's SES		No		No		Yes	

Table 4: Mother's In-Utero Exposure to the Kwangju Uprising and Offspring Length of Gestation by Trimester

		(1)		(2)		(3)	
	Mean	∂y/∂x	P-value	∂y/∂x	P-value	∂y/∂x	P-value
Intercept		72.498	<.0001	72.387	<.0001	72.695	<.0001
B_KWANGJU	0.032591	-0.078	<.0001	-0.080	<.0001	-0.082	<.0001
B_KWANGJU*B_Dec80-Feb81	0.000067	0.087	0.6139	0.085	0.6191	0.091	0.5941
B_KWANGJU*B_Sep80-Nov80	0.000075	-0.537	0.0011	-0.539	0.0011	-0.539	0.0010
B_KWANGJU*B_Jun80-Aug80	0.000070	-0.506	0.0026	-0.507	0.0026	-0.509	0.0025
B_Dec80-Feb81	0.001949	-0.011	0.7316	-0.013	0.6945	-0.014	0.6667
B_Sep80-Nov80	0.002019	0.067	0.0369	0.067	0.0358	0.067	0.0356
B_Jun80-Aug80	0.002105	0.010	0.7402	0.010	0.7291	0.011	0.7172
Mother YOB, YOB^2,YOB^3		Yes		Yes		Yes	
Characteristics of Birth		Yes		Yes		Yes	
Mother's SES		No		Yes		Yes	