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In utero exposure to the Korean War and its long-term effects on socioeconomic and health outcomes☆

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ABSTRACT

Prenatal exposure to the disruptions caused by the Korean War (1950–1953) negatively affected the individual socioeconomic and health outcomes at older ages. The educational attainment, labor market performance, and other socioeconomic outcomes of the subjects of the 1951 birth cohort, who were *in utero* during the worst time of the war, were significantly lower in 1990 and in 2000. The results of difference-in-difference estimations suggest that the magnitude of the negative cohort effect is significantly larger for individuals who were more seriously traumatized by the war. Whereas the 1950 male birth cohort exhibited significantly higher disability and mortality rates at older age, the health outcomes of females are unaffected by the war. Different aspects of human capital (*e.g.*, health and cognitive skills) were impaired by *in utero* exposure to the war, depending on the stage of pregnancy when the negative shocks were experienced.

1. Introduction

Research across various disciplines suggest that *in utero* exposure to negative health shocks has strong and persistent effects on health and socioeconomic outcomes at older ages. This argument is widely known as the fetal origins hypothesis, which was developed and popularized by David J. Barker and his colleagues in the 1990s (Barker, 1992, 1994). Since then, a voluminous body of literature has been accumulated, providing a variety of evidence in favor of this thesis (Currie and Hyson, 1999; Chay and Greenstone, 2003; Behrman and Rosenzweig, 2004; Black et al., 2007; Currie and Moretti, 2007). In particular, an increasing number of studies offer semi-experimental evidence on the long-run consequences of exogenously generated shocks to fetal health. Such traumatic events include the 1918 Pandemic Influenza (Almond, 2006; Almond and Mazumder, 2005), the Dutch Famine (Neuzgebauer et al., 1999; Roseboom et al., 2001; Bleker et al., 2005), the Chinese Famine (St. Clair et al., 2005; Luo et al., 2006; Meng and Qian, 2009; Chen and Zhou, 2007; Almond et al., 2010), and the Chernobyl disaster (Almond et al., 2009).

The Korean War (1950–1953) offers a unique opportunity to examine the long-term effects of war-related disruptions such as arduous refugee experiences, suffering under the North Korean occupation, hunger, and direct exposure to combat. Although the war lasted for more than three years, the major war damage sustained by civilians was concentrated in the first nine months following the sudden invasion of North Korea (late June 1950 to late March 1951). At that time, the frontline rapidly and unexpectedly moved back and forth across South Korea (Halberstam, 2007; Chung, 2010; Yang, 2010). Furthermore, the severity of wartime experience considerably differs depending on the place of residence. For example, Central Region residents were hit particularly hard because they lived closer to North Korea and their area was invaded twice by enemy forces. These specific circumstances help identify the effects of the war on maternal and fetal health through a comparison of the adult outcomes across birth cohorts and places of birth.

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Drawing from these features of the Korean War, this article explores how *in utero* exposure to war-related disruptions affects adult health and economic outcomes in South Korea. For this purpose, we examine how various measures of socioeconomic performance and health at older ages differ depending on the timing and the place of birth. Specifically, we investigate whether the individuals born in 1950 and 1951 (those who spent time *in utero* during the first nine months of the war) show discontinuous cohort effects, and whether the cohort effects are more distinct for those born in areas hit harder by the war. Several micro datasets, including micro samples of the 1990, 2000, and 2005 censuses, and Vital Statistics for death from 1991 to 2009, are used to construct variables on adult outcomes.

This study is one of the few attempts to understand the long-term socioeconomic consequences of disruptions directly caused by combat activities. Previous studies of this kind largely focused on the effects of famine, disease, and pollution. The present paper draws from South Korea evidence that were not investigated in the study of the long-term consequences of *in utero* circumstances: the relationship between early-life conditions and later socioeconomic outcomes can differ across periods and countries, which depends on the extent of economic development, institutional features, and cultural characteristics. Thus, evidence from the Korean War in the current study can widen the scope of the literature.

The evidence in this paper strongly suggests that prenatal exposure to the disruptions caused by the Korean War negatively affected individual socioeconomic and health outcomes at older ages. Measures of the educational attainment and labor market performance of individuals born in 1951, who were *in utero* during the worst time of the war, were significantly lower in 1990 and 2000. The results of difference-in-difference estimations suggest that the magnitude of the negative 1951 cohort effect is significantly larger for individuals whose places of birth were more seriously devastated by the war. As for health outcomes, the 1950 male birth cohort is more likely to have functional limitations and to die at older age than predicted by long-term trends in health variables. If potential selections in pregnancy, birth, and survival are considered, the actual negative effects of the war may be even greater than what this study suggests.

The effects of prenatal exposure to the Korean War differ by gender and birth cohort. The health outcomes of females are unaffected by the war. However, the health of males who were *in utero* during the early stages of the war is significantly worse than predicted by the smooth cohort trends. This gender difference can be partly attributed to the stronger population selection among females born in 1951. It appears that the Korean War influenced the health of wives through adversely affecting the economic and health status of the husbands. The women married to the men born in 1950 were more likely to have a disability in 2005 than predicted by smooth cohort trends, which is explained in part by the higher disability rates of their husbands.

The aspects of human capital that were significantly impaired by wartime *in utero* influences differ between the 1950 and 1951 birth cohorts. The 1950 cohort exhibits worse health outcomes, while the major consequences of the war for the 1951 cohort are lower educational attainment and labor market performance. This difference by year of birth is attributed to the exposure of the two cohorts to negative health shocks at different stages of pregnancy. The subjects of the 1951 cohort were *in utero* during the first half of pregnancy, a critical period for human brain development. In contrast, the majority of the subjects of the 1950 cohort became exposed to war-caused shocks after prenatal brain development was completed.

2. Long-term consequences of *in utero* influences

Research across a range of disciplines establishes that early-life health and circumstances play an important role in determining health and economic conditions at older ages.[1] A series of studies by physicians and epidemiologists links many of the degenerative conditions of old age to exposure to infectious disease, malnutrition, and other types of biomedical and socioeconomic stress *in utero* and during the early years of life. Recent research by economists suggests that early-life circumstances have strong and persistent influences on human capital accumulation and labor market performance. These effects are also possibly mediated by the deterioration in health and cognitive ability.

A group of researchers paid particular attention to the long-term consequences of *in utero* influences. In the 1990s, David J. Barker and his colleagues developed and popularized the argument widely known as the fetal origins hypothesis. The hypothesis argues that disruptions to the prenatal environment are related to various chronic health outcomes at older ages, including coronary heart disease and diabetes (Barker, 1992, 1994). The hypothesis further emphasizes initial health endowment (formed *in utero*), rather than postnatal conditions, as a health determinant in early ages.

A wide variety of evidence pertaining to the fetal origins hypothesis has been presented over the last two decades. Experimental studies using animals provide evidence that maternal malnutrition has a causal effect on the subsequent health of the offspring. A voluminous body of literature evaluates the health and socioeconomic consequences of low birth weight (LBW), a proxy of exposure to malnutrition, infection, or toxic substances while *in utero*. Most of these studies reveal significant negative effects of LBW on human capital accumulation, socioeconomic status, and health outcomes (Currie and Hyson, 1999; Behrman and Rosenzweig, 2004; Black et al., 2007; Currie and Moretti, 2007).[2] A growing number of biomedical studies suggest that maternal stress during pregnancy may increase the likelihood of preterm birth, developmental delays, and behavioral abnormalities (Weinstock, 2001; Aizer et al., 2009).

A possible concern that confronts studies on size at birth and subsequent outcomes is that the positive correlation between measures of early life and adult health can be biased by omitted variables such as genetic factors or post-birth investments.[3] A new line of research addresses this potential problem by exploiting unique opportunities offered by natural experiments, in which individuals of a particular background or cohort are randomly exposed to a type of disruption *in utero*. If the probability of experiencing negative health shocks *in utero* is uncorrelated with unobservable determinants of health, then the estimated effects of the shock are not subject to omitted variable bias.

Influenza pandemics were used as a natural experiment to test the fetal origins hypothesis.[4] Historical famines were studied as

[1] See Almond and Currie (2010, 2011) for comprehensive surveys of the literature.

[2] For example, Black et al. (2007) analyzed Norwegian twins and found that LBW has long-run adverse effects on adult height, IQ, earnings, and education. Currie and Moretti (2007) stated that LBW among individuals born in California has modest but statistically significant negative effects on educational attainment and the probability of living in a wealthy neighborhood.

[3] Almond et al. (2005) compared the hospital costs, health at birth, and infant mortality rates between heavier and lighter infants of twins born in the United States to reduce potential bias arising from omitted variables such as genetic factors. They observed a minimal effect of LBW on infant mortality and other health measures from a sample of twins.

[4] Almond (2006) found that the cohorts *in utero* during the pandemic displayed reduced educational attainment, increased rates of physical disability, lower income, lower socioeconomic status, and higher transfer payments compared with other birth cohorts. Almond and Mazumder (2005) discovered that cohorts *in utero*