# The Intergenerational Health Effects of the U.S. Bombing Campaign in Cambodia*

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**Abstract**

**Abstract:** I investigate the long-term persistence of negative health effects of the United States' Cambodian bombing campaign. In combination with detailed information from official U.S. military records on the timing, location, and intensity of bombing, I use two rounds of Demographic and Health Surveys (DHS) to estimate intergenerational health effects on children born between 1995 and 2005 to mothers who were *in utero* during the 1970-1974 bombing campaign. I identify effects of the bombing by exploiting within-location cohort variation in exposure. Children born to mothers who were *in utero* during periods of intense local bombing have substantially lower weight-for-age Z-scores (WAZ). Height-for-age Z-scores (HAZ) are also reduced among children older than 24 months. If the mother experienced the average exposure of 187 tons of bombs within a 10 km radius of her birthplace while she was *in utero* this causes a decrease of 0.4 SD in her child's HAZ. Stunting perpetuation seems to be one of the mechanisms of transmission, as *in utero* exposure of the mother also implies a 0.25 SD reduction in her adult height-for-age. These results imply that the legacy of the U.S. military campaign may explain a non-trivial portion the low health capital among current-day third-generation post-bombing Cambodians.

**Keywords:** Human capital, health capital, intergenerational transmission, violent conflict, war, health, fetal origins.

**JEL codes:** I150, O150

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# 1 Introduction

The increasing body of literature on the Fetal Origins Hypothesis and early life conditions has established that shocks experienced in these stages of life have long-term effects (Almond et al., 2017). These shocks can be particularly extreme in the case of violent conflict or war because it destroys physical and human capital, generates political instability, and damages institutions – all of which may lead to deleterious long-term effects on individual outcomes and economic growth, (Akresh et al., 2012; Miguel and Roland, 2011; Akbulut-Yuksel, 2014; Dell and Querubin, 2016; Islam et al., 2016).

During the course of military involvement in Vietnam, the United States carried out one of the largest aerial bombing campaigns in history on Cambodia between 1965 and 1973. In this paper, I investigate the intergenerational effects of the campaign on the health of children born more than 20 years after the bombing to mothers who were themselves *in utero* or in early life during the bombing campaign. Using the Cambodia Demographic and Health Surveys (DHS) and a database containing detailed records of the U.S. bombing campaign in Cambodia, I exploit within-location cohort variation in bombing timing and intensity to identify the effect of mothers' *in utero* and early life exposure on anthropometric measures of health and well-being of *their* children. Children born to mothers who were *in utero* or in their early life during the bombing are substantially less healthy than peers born to similar mothers in the same area who did not experience the bombing *in utero* or in early life.

An extensive literature investigates the negative effects of violent conflict on human capital. One of the mechanisms comes from the supply side, where affected communities experience a reduction in the amount and quality of resources during conflict (Duque, 2016). Other studies investigate the effects of the direct exposure to violence in early life on health, education and labor outcomes. Akbulut-Yuksel (2014) shows evidence of human capital deterioration in Germany following World War II, in which health outcomes of the cohorts exposed to the war were worsened by malnutrition and destruction of health facilities while the destruction of schools and teacher absence deteriorated educational attainment.

The evidence of the long-term effects of early life exposure to violence is unquestionable. However, there are only few studies that have investigated the legacy of these effects on subsequent generations conceived decades after the conflict ended. Akresh et al. (2017) and Wang Sonne and Nillesen (2015) study long-term effects of mother's exposure on their children's anthropometric outcomes, finding a negative and significant effect of mothers *in utero* exposure to the war on their children's height for age score (HAZ).

This paper contributes to the literature by providing evidence of the legacy of early life war exposure on future generations born after conflict. I overcome previous limitations of inaccurate measures of exposure, and find that women exposed to the bombing in their early life exhibit a reduction in their adult stature, and this exposure has adverse effects on their children's growth (measured by HAZ). These findings have important policy implications by adding the exposure to the bombing to the list of causes of the poor nutrition outcomes of Cambodian women and children. Also provides evidence in contrast with with previous literature that has found no impact of the Vietnam war in the long-run economic development of Vietnam (Miguel and Roland, 2011).

The paper is organized as follows: the next section will provide background information on the U.S. bombing of Cambodia, followed by a literature review. Section 4 provides the description of the data, section 5 describes the empirical strategy followed by the results, and the final section concludes.

## 2 The U.S. Bombing Campaign in Cambodia

Cambodia was a French colony until its independence in 1953. Then the country was governed by Norodom Sihanouk until March 1970 when he was deposed in a military coup by a pro-American general, Lon Nol, who became the president of the Khmer Republic. From 1965 to 1969 the United States' bombing campaign targeted the North Vietnamese forces and their use of Cambodian territory, which was declared neutral in the Vietnam war. After the coup in 1970, U.S. military forces were allowed to operate in Cambodia - but the motive by then was not only to disable the Viet Cong but to fight Nol's internal opposition in the civil war.

The U.S. bombing of Cambodia started on October 4th, 1965; the first four years of this campaign involved only targeted strikes of sporadic frequency. On March 18th, 1969,[1] the U.S. Air Force began a more intensified campaign, lasting until August 15th, 1973. According to data from the U.S. Air Force, more than 400.000 tons of ordnance were dropped across over 140 sorties on more than 40.000 sites. Figure 1 shows the spatial variation in the intensity of the campaign in Cambodia from 1965 to 1973 and Table 2 presents the distribution of sorties and tonnage of ordnance across the years of the operations. To put these numbers into perspective, during all of World War II the allies dropped over two million tons of bombs. The Nixon administration kept this campaign secret from the U.S. Congress, who believed U.S. planes would remain within 30 kilometers of the Vietnam border. It was in 1973 when the U.S. Congress realized the destruction of the masked campaign and legislated the end of the bombing.[2]

There is no consensus as to the number of civilian causalities inflicted by the campaign;

[1] The launch of Operation Menu, which started the carpet bombing of Cambodia with a raid of 60 B-52's, consisted of six missions "Breakfast, Lunch, Snack, Dinner, Supper, and Dessert." The Menu was then followed by Operation Freedom Deal between May 1970 and August 1973.

[2] See Kiernan and Owen (2006).

estimates vary between 150,000 and 500,000 people, and do not take into account the indirect effects of the bombing (displacement, disease and starvation).[3] The U.S. bombing and the civil conflict drastically affected the health of the Cambodian population: the life expectancy in Cambodia changed from 42 years old in 1965 to 32 years old in 1973.[4] After the end of the bombing, from 1975 to 1979, the Khmer Rouge, a nationalist communist group lead by Pol Pot took power. This period is known as the Cambodian Genocide. During this period the country was operating under a system of agrarian socialism and the estimated deaths are between 1.5 and three million people. Due to this human and physical capital destruction, the country's level of development fell behind for decades.

Almost two decades of peace have since dramatically changed the country. Cambodia's annual GDP growth rate averaged 7.6% from 1994 to 2015, and the poverty rate more than halved from 53% in 2004 to 20% in 2011. However, nutrition remains an important issue in Cambodia: in spite of economic growth and poverty reduction, the country has not been able to improve nutritional outcomes of its population – especially those of Cambodian women and children. The percentage of children stunted was 49.8% in 2000 and 42.7% in 2005, ranking Cambodia 63 out of 198 countries in terms of under-5 mortality rate.[5] The percentage of children underweight was 38.5% and 28.1% for the same years.[6]. Policy-makers attributed these outcomes to sanitation, health care and food intake, areas in which Cambodia is working on improving. The findings of this paper contribute to explain the health outcomes of this particular population, besides these common causes.

[3]See: http://rabble.ca/toolkit/on-this-day/us-secret-bombing-cambodia. Last accessed: May 13th, 2017
[4]World Development indicators.
[5]2013 results, taken from the State of the World's Children 2015 Country Statistical Tables from UNICEF.
[6]DHS calculations. Percentage of children stunted: Percentage of children under 5 that are below -2 SD of height for age according to the WHO standard. Percentage of children underweight: below -2 SD of weight for age according to the WHO standard

# 3 Related Literature

It is well established that violent conflict affects health, education and labor market outcomes. There are three strands of the literature relevant to my study. Studies based on the "Fetal Origins Hypothesis" of later-life disparities in the context of violent conflict show how *in utero* exposure to high levels of stress or lack of resources reduce birth weight or cause still births (Barker, 1990). Camacho (2008) uses random land-mine explosions as exogenous stress shocks in Colombia, finding that pregnant mothers exposed during the first trimester to a land-mine explosion in their municipality delivered babies who weighed 8.7 grams less at birth than their siblings.

Mansour and Rees (2012) use data from Palestine Demographic and Health Survey (PDHS) on children born to mothers from the West Bank to find that intrauterine exposure to armed conflict is associated with a small increase in the incidence of low birth weight. Brown (2014) using data from Mexican Family Life Survey and official reports of intentional homicides at the month and municipality level controlling for selective migration and fertility finds that an increase in local homicide rates in early gestation leads to a large and significant decrease in birth weight. Other studies have shown the relevance of low birth weight in adult outcomes. Black et al. (2007) found that birth weight has a significant effect on long-run outcomes such as height, IQ at age 18, earnings, and education.

Another literature investigates how violent exposure during early life changes later health outcomes. Akresh et al. (2012) uses data from an Eritrea's household survey to estimate the effect of exposure to the 1998–2000 Eritrea-Ethiopia war on children's health to find that war-exposed children have lower height-for-age Z-scores, and these effects are similar for children born before or during the war. Akbulut-Yuksel (2014) combines a data set on city-level destruction in Germany caused by Allied Air Forces bombing during World War II with individual survey data from the German Socio-Economic Panel (GSOEP). He uses city-by-cohort variation in the intensity of the war destruction as source of identification. His results suggest detrimental long lasting effects on Germans who were at school age during World War II. These children had 0.4 fewer years of schooling, and the children in the most affected cities attained 1.2 fewer years of schooling. In terms of health outcomes, affected children were half an inch shorter. Finally, their future labor market earnings are reduced an average of 6% due to exposure to wartime destruction.

There are two studies that have investigated the impact of the civil war and the Cambodian genocide on education, earnings, fertility and sex ratios. Islam et al. (2016) provides evidence of the long-term effects of exposure to Cambodia's civil war and genocide during primary school age (cohorts born between 1950 and 1965 that were at school age during the Lon Nol and Khmer Rouge regimes) on educational attainment, earnings, and fertility. They exploit cohort variation in exposure to the regimes and find that exposure decreases educational attainment in men and women, lowers earnings of men and increases female completed fertility. They also explore geographic variation in the intensity of the Khmer Rouge regime[7] and find no effects on schooling, earnings or fertility of the individuals exposed during primary school age. In Islam et al. (2017), the authors investigate the intergenerational effect of the Cambodian genocide. Using geographic variation on the intensity of the genocide, they show that in districts with high mortality rates during the Khmer Rouge regime children born to parents who were in the prime age for marriage (14-29, cohort of 1950 to 1965) have lower educational and health outcomes, and that the channel leading to these results is the imbalanced sex ratio of their parents' generation.

Closest to this paper, Wang Sonne and Nillesen (2015) examine the long-term effects of mothers' exposure to the 1989 Liberian civil war on their children's anthropometric outcomes. They collect data from 332 children under five years of age in 267 Liberian households and 95 villages. This data has anthropometric measurements for all children under five years old

[7] The intensity is measured by estimating mortality rates based on the information on mass graves from the Cambodia Genocide Project.

and information about migration and whether the mother and (or) father were born in the village. The authors use spatial and temporal variation in parents' exposure to district-level violence to identify a causal impact of civil war violence on health outcomes of the following generation. Their results show that HAZ-scores of children whose mothers lived in high-violence areas are significantly lower (-1.58 vs. -1.29, p=0.07) than those in the low-violence areas. In a recent working paper Akresh et al. (2017) analyze the long-term impacts of the 1967-1970 Nigerian Civil War and provide evidence of intergeneration impacts, finding the war exposure of the mothers has adverse effects on child growth, survival and education.

In this study, I overcome earlier limitations imposed by self-reported violence measures, and time invariant conflict intensity by using official, comprehensive and detailed government data on the timing and intensity of the bombing campaign. I also add to the literature by studying the U.S. bombing campaign and a generation that is not explored in the previous research on Cambodia: those women born during the intense bombing period (1970 to 1974) and the children of this generation.

# 4 Data

## 4.1 *Mother's birthplace and children's health: Cambodia DHS 2000 and 2005*

The Cambodia Demographic and Health Surveys (DHS) are nationally representative cross-sectional household surveys of women of reproductive age (15 to 49 years old). The DHS collects data on both household socioeconomic characteristics and maternal and child health. Analysis is based on fields collected in the mother and children's questionnaires, which contains information on mothers' place of birth and anthropometric indicators for (up to six) children under five years of age.

Beginning in 2000, the Cambodian DHS provides geo-referenced household cluster locations collected at the time of survey administration. To maintain respondents' confidentiality, the coordinate points are randomly displaced by either up to two kilometers (for clusters in urban areas) or five kilometers (for rural clusters), with one percent of rural clusters displaced up to ten kilometers.

The DHS data provide information on the exact date of birth of the mother, which is used to construct measures of prenatal and postnatal exposure to the bombing campaign. The outcomes of the children are the anthropometric measures of the nutritional status of their children. I use the measures of height, weight and age of the children to calculate standard Z-scores based on the World Health Organization (WHO) Multicenter Growth Reference (World Health Organization, 2009).

Migration is a concern when evaluating the effects of exposure to violence. The DHS data do not provide detailed information on migration or childhood location for the mothers. However, the survey allows me to identify non-movers based on a question that asks how long the respondent has lived in their place of residence. I restrict all analysis to the population born between 1970 and 1974 that responds to this question as "always." 55% of mothers in the sample answer in this manner and are classified as non-movers. Table 1 presents summary statistics from this sample of mothers and their children. The majority of mothers are married, and only 0.1% has more than secondary education. The average age of these mothers is 30, and the mean age at first birth was 21.

The children of these mothers have an average age of 30 months (2.5 years). For health outcomes, I present standardized anthropometric measures based on the sample, along with Z-scores from the WHO methodology (WHO, 2009) for comparison. The WHO Z-scores provide information of the level of malnutrition that Cambodian children have compared to international standards. A child is considered stunted if the WHO height-for-age Z-score (HAZ) is less than -2, and underweight if the WHO weight-for-age Z-score (WAZ) is less than -2. The average Cambodian child is just at the threshold of being classified as stunted and/or underweight[8] according to WHO standards. Table 3 also presents Z-scores calculated using Cambodia population as a reference, which are the outcomes used in the regression analysis.

## 4.2 *Cambodian bombing campaign data*

The Theater History of Operations Reports Database of the Air Force Research Institute (THOR from here on) provides airpower records from three Vietnam-era Joint Chief of Staff databases, The data represents 4.3+ million airpower records from three Vietnam-era Joint Chiefs of Staff databases: Combat Air Activities File (CACTA) 1965-1970, Southeast Asia Database (SEADAB) 1970-1975, and Strategic Air Command Activities Database (SAC-COACT) 1965-1975. These databases contain records from the United States Air Force, Navy, Marine Corps, and allies during this time period. I follow the procedure described by High et al. (2013) to create a comprehensive data set for the bombing of Cambodia. I combine CACTA and SEADAB to provide the records of the sorties from 1970 to 1975. These two data sets have different issues regarding the measurement of tonnage of ordnance dropped. For CACTA, load quantity is calculated by adding delivered quantity (dropped on targets), jettisoned quantity (dropped for other reasons) and returned quantity (returned to base on aircraft). The load quantity variable is then multiplied by the weight of the weapon type and the number of air crafts sent in each sortie, which provides the load weight variable that I use for the exposure measure. SEADAB data was simpler, with a load weight variable

[8]This calculation is for children under 5 years old.

representing the total weight of ordnance in all the aircrafts per record.[9] [10][11]

The bombing database is comprised of sortie-level records containing the exact location of the target (latitude and longitude), the date and time of the sortie, ordnance type and bombing load weight,[12] the number and type of aircraft in the sortie and the nature of the intended target. Individual sortie payloads ranged in size from a few to several thousand tons. The dataset details the aircraft types deployed, including B-52s, and the different types of munitions dropped, including 500-lb. "carpet bombs", cluster bombs, incendiary bombs, and 1000-lb. bombs.

### 4.3 *Constructing the bombing intensity measure by mother*

My study is the first study that exploits the accuracy of the GPS location of the bombing and the household in a within location-cohort identification strategy for the bombing of Cambodia. With the location and the date of birth of non-migrating mothers I create a measure of the intensity of the bombing that affected the mother at different periods relative to her birth. I add the weight of the bombing load dropped within a ten-kilometer radius around the location of the mother's place of residence.[13] For example: The *In utero* bomb

[9] The only issue is that this variable was multiplied by ten in the official records, therefore I divided it by ten to obtain the load weight variable needed for my estimations.

[10] For this project I initially contacted the Cambodian Genocide Program, Yale University (CGP) that provided me with their bombing database. However I have to thank Ben Kiernan director of the program for his useful comments on the article and pointing out the data issues related with the CGP. I then used THOR data that essentially corresponds to the CGP but the issues mentioned by High et al. (2013) are easier to identify and correct with a high degree of accuracy as described in the text. Also many magazines and previous studies have used or refer the CGP data with out correcting the data issues, providing highly inaccurate information regarding the magnitude of the bombing. For more information about the data issues related with CGP see(Kiernan and Owen, 2010, 2015)

[11] High et al. (2013) have a very comprehensive data base analysis of all the problems they encounter with the data and the tests performed to achieve the most accurate numbers from the electronic records of the air war over South East Asia during the Vietnam War

[12] THOR website states that there are some gaps in the record, namely Nov 1967 is missing, due to water damaged data files. There are also isolated gaps occurring throughout the record totaling approximately three weeks in the whole Vietnam war. Accounting for this issue does not change the results, tables are available upon request

[13] As mentioned, there is some displacement in the location of households, however this shouldn't be a concern for my results because the rural households that might be displaced ten kilometers are likely located in

intensity measure of exposure for a mother that was born September 1st, 1970, equals the log of the total tons of ordnance dropped from January 1st, 1970 to September 1st, 1970 in a 10 kilometer radius of her household location.

I construct different measures of the exposure to the bombing for each period from conception to early life: *in utero* (the prenatal period of 9 months), 0-1 years, 1-2 years, 2-3 years and 3-4 years. This measure provides the source of variation for my analysis because I have within-location cohort differences in exposure to the bombing.

Table 2 contains the summary statistics of the intensity of the bombing experienced by the mothers in a given time spam relative to birth date. While *in utero*, the average mother was exposed to 187 tons of ordinance dropped in a 10 kilometers radius of her place of residence. One of the most common bomb used in this campaign was the 500-lb bomb which actually weights 531 pounds, this means that the average mother was exposed to 704 500-lb bombs *in utero*. The average bomb exposure for mothers in other stages of their early life is around the same magnitude.

Figure 3 illustrates the within-location cohort variation in *in utero* exposure to bombing in two specific household survey cluster locations in the DHS. The horizontal bars represent the nine months while mothers were *in utero*.[14] The curve represents the exposure to the bombing measure in tons of ordinance in a ten-kilometer radius for the indicated month. The shape of the curve over the nine months represented by the horizontal bar shows the variation in exposure that mothers from the same location experienced due to the timing of their birth. Previous literature of conflict exposure and health impacts (Akresh et al., 2016) shows how impacts using GPS location information are two to three times larger than when the exposure is measured at the imprecise regional level.

very underpopulated areas, that were not affected by the bombing.

[14]Because of data limitations I assume that the gestation period for all mothers is nine months.

# 5 Empirical strategy and results

## 5.1 Model specification

I use within-location cohort variation in the mother's level of exposure to the bombing as described in the previous section to estimate the impact of the bombing on the anthropometric outcomes of their children. The empirical specification that incorporates the within-location cohort variation is:

$$Outcome_{ijt} = \beta_1 \; Exposure \; in \; utero_{ijt} + \beta_2 \; Exposure \; 0 \; to \; 1 \; year_{ijt} +$$
$$\beta_3 \; Exposure \; 1 \; to \; 2 \; year_{ijt} + \beta_4 \; Exposure \; 2 \; to \; 3year_{ijt} + \beta_4 \; Exposure \; 3 \; to \; 4year_{ijt} +$$
$$\gamma \; birth \; order_{ijt} + \lambda \; survey \; year_{ijt} + \alpha_j + \delta_t + \epsilon_{ijt} \quad (1)$$

Where $Outcome_{ijt}$ refers to the outcome of the children, in particular the health measures weight-for-age (WAZ)and height for age (HAZ,) of child $i$ in the location $j$ whose mother was born in year $t$. In this equation the treatment variable incorporates geographic and time variation in the mother's exposure to the bombing. $Exposure \; inutero_{ijt}$ refers to the *in utero* mother's exposure, $Exposure \; 0 \; to \; 1year_{ijt}$ represents exposure during the first year of life of the mother, the other three measures refer to the next life periods of the mother's exposure. Dummies for birth order and survey year are also added. $\alpha_j$ represents the location fixed effects and $\delta_t$ the mother's birth year fixed effects. No other household or mother characteristics are added because the addition of certain variables as controls can bias the results (Angrist and Pischke, 2008), and play the role of "bad controls." For example, age at first birth or number of children can be affected by war exposure, and these variables in the regression could induce selection bias.

## 5.2 Results

The results of the estimation of equation (1) suggest that the bombing deteriorated the health capital of the mothers to the extent that if they experience exposure *in utero* or in their first three years of age (both crucial developmental stages,) the health capital of their children is also affected. I use two measures of exposure to the bombing for each *in utero* and early-life stages. A measure incorporates the intensity of the bombing based on the tonnage dropped ten kilometers around mothers place of residence and where I use a quartic root transformation. [15] The other measure is a dummy variable taking the value of 1 for the respective period, if the mother experienced any exposure or zero if no exposure. This variable provides a measure of the effect of mean exposure.

The regression is estimated using the sample of children whose mothers were born between 1970 and 1974. These are the mothers born during the intense bombing as shown in Table 2; the 1974 cohort is included because although the bombing was over, they experienced intense *in utero* exposure during 1973. All models have birth order of the child, mother year of birth and location fixed effects. Each pair of columns in Table 4 is based on a different grouping for the location fixed effects of the households based on the geo-referenced data provided by DHS. For columns 1 and 2, location fixed effects are based on the commune level administrative division, because some of the DHS household locations can be in the same commune and this aggregation can incorporate, if any, similarities among the original DHS locations. Columns 3 and 4 use location fixed effects based on the original locations from the two rounds of the DHS; for purposes of inference this is the most conservative approach.[16]

I find negative effects of mother's exposure for the *in utero* and in the first three years of

[15] The quartic root transformation behaves similar to the logarithmic transformation for positive values and it is used in order to avoid dropping observations from mothers have that zero exposure to the bombing, while also reducing the influence of outliers in the data. See (Brown and Velásquez, 2017)

[16] All the tables omit the coefficient for 3-4 years, this results have the expected sign but are not precisely estimated.

her life on their children's weight-for-age (WAZ) and height for age (HAZ). Table 4 shows the results for these two outcomes in each of the location groupings described above. These results have the expected sign although are less precisely estimated. The height-for-age measure is noisy for children under 24 months due to the fact that it is taken with the child lying down. I then restrict the sample to children older than 24 months. Table 5 shows these results, where mother's exposure *in utero* and in first three years of age (0 to 3 year) have a negative and significant effect on the anthropometric measure of HAZ. These results suggest that if a mother had the average *in utero* exposure of 187 tons of bombs their child will be 0.41 standard deviations lower HAZ.[17] Height-for-age is a more structural measure of the health status and nutrition of children, whereas weight for age speaks of the current nutritional status of a child. Finding significant results on the HAZ outcome speaks about the chronic effects of the bombing on the health capital of the Cambodian children. These results, together with the negative effects found on the height Z-scores of the mother (next section), suggest that the U.S bombing campaign contributed to the perpetuation of stunting across generations in Cambodia.

Table 6 simplifies the exposure measure to use a dummy variable for when the mother experiences *any* bombing in the relevant period. The results support the findings in Table 5: children between two and five years of age whose mothers experience any bombing while *in utero* present lower WAZ and HAZ. If the mother experience any bombing during her first year of age the children WAZ reduces by 0.36 standard deviations. As before, if we restrict the sample to children older than 24 months to account for the noise in the measure of height, any exposure of the mother while *in utero* causes a reduction of 0.53 standard deviations of their children HAZ. This result is similar in magnitude to the one found for the average exposure of the mother.

[17] This is calculated as $\beta 1 * (In\ utero\ average\ exposure^{(1/4)} = -0.112 * (187^{(1/4)})$

### 5.2.1 Mechanisms

It has been well established that prenatal and early life events can have long-term consequences in health capital, earnings, and education. When these events are associated to war or any type of violent conflict, there are multiple channels or mechanisms through which these can affect the exposed generation and their descendants. This paper explores the transmission of these consequences into the children born to mothers that were directly exposed to the bombing. These women could have carried the consequences to their adult life in many of their health and human capital outcomes. In the case of Cambodia, disentangling the effects of the bombing on the adult outcomes of mothers is particularly challenging since there is not any information about their early lives. However, with the data available in the DHS and using the same within-location cohort variation strategy, I find that the exposure to the bombing has effects deteriorating the adult height-for-age Z-scores of the mothers. This result allows me to argue that one of the intergenerational effects of the bombing is perpetuation of stunting. Table 7 shows that *in utero* exposure reduces the adult height for age Z-scores by 0.24sd. The first two columns in this table use location fixed effects at the commune level, the next two use location fixed effects based on the original DHS household locations. Columns (1) and (3) show the effects using the intensity of the bombing as *quartic root(tonnage of ordinance dropped)* as a measure of the exposure, columns (2) and (4) presents results where the exposure is measured as a dummy variable for any bombing during each specific period in the mother's prenatal and early life.

There is extensive research in the medical and epidemiological literature that provides evidence on the possible mechanism driving these results. Humans with low birth weight or infants that present poor growth have small organs because of a reduced cell size and/or number. This can both be consistent with a non-genetic mechanism (epigenetics) resulting in physiological consequences, for example poor uterine and ovarian size. This adverse intrauterine environment then affects the mother's offspring and the physiological changes persist in the next generation (Hackman et al., 1983; Emanuel, 1997; Lee, 2014). In the particular case of Cambodia the exposure to bombing could have stressed the grand mothers (prenatal stress) or affected the mothers in their early life deteriorating their growth *in utero* or as infants to the point that they couldn't reach their potential genetic growth leading to adverse effects on the growth of the offspring.

### 5.2.2 Civil conflict confounding factors

The purpose of the bombing was to eliminate North Vietnamese and Communist Party of Kampuchea (CPK - Lon Nol's opposition) forces. If the presence of these groups in the villages negatively influenced the wellbeing of the population, it will induce a confounding negative bias in the results. Unfortunately, there is no specific data on the presence of these forces in the villages. However, there is enough evidence in historical accounts to claim that this wasn't the case. The U.S. bombing was done in a partially indiscriminate manner and the communist forces weren't harming the population in the villages at the time. The following quotes summarize evidence that supports the claim.

*In 1970 US Intelligence: "The report went on to quote a 'recent' Lon Nol regime intelligence assessment, to the effect that "the population has been largely taken in hand by the enemy and could become in a relatively short time a trump for him."* ***The communists had won this popular support not only because they are well-behaved and respectful of the needs and cares of the population****, but also because aerial bombardments against the villagers have caused civilian loss on a large scale Unsurprisingly, the peasant survivors of the bombing were turning to the CPK for support."*(emphasis added) (Kiernan, 1989)

In the book Sideshow: Kissinger, Nixon, and the Destruction of Cambodia, the author William Shawcross reports the story of a young Air Force captain who flew twenty-five B-52 missions over Cambodia in 1973, and was court-martialed for refusing to fly after learning that a Cambodian wedding party had been "boxed" by B-52s. *"It forced him, he said, to realize that the* ***Cambodians***

***were human beings and to recognize that non-military targets were being hit."***(emphasis added)(Shawcross, 1979)

The evidence suggests that the CPK presence was primarily focused on political indoctrination during the period of study. If anything, the atrocities were used as political propaganda making it easy for the KR to win people over.

## 5.3 Threats to identification and robustness

The effect of exposure can biased downward if there was considerable migration to avoid being affected by the bombing. These will be the case if the families that stayed are the most vulnerable ones (poor health, low skills or income), and this implies a selection bias in the results. There is no detailed data on migration in Cambodia in the DHS and even less information about migration the 70's. However, the statistics on migration from the 1998 and 2008 Cambodian Census allow me to largely rule out that endogenous migration as a threat to identification in this case. Table 8 includes the population born before 1974 from 1998 and 2008 Cambodian census and identifies the population that appeared to have moved during the war, between 1965 -1974. This population represents a very small percentage of the migrants in the census only 1.05% of the population migrated during that period. To put this number in perspective the percentage of people that migrated after the Khmer Rouge 1979 or 1980 is around 13%, suggesting that endogenous migration should not be a concern in this case. Table 9 constitutes another piece of evidence that endogenous migration is not a threat to identification. Among migration causes for the population of interest that migrated during the period of the bombing, only around 9% answered that *violence or insecurity* or *natural disaster or insecurity* were their reasons for migration, showing that migration preventing the exposure to the bombing is not the main reason for the migration of this population.

Endogenous fertility is also a concern, if mothers exposed to the bombing make fertility decisions that affect the results. In this case endogenous fertility could be happening both ways. Women opt to have more children to compensate for the lost population, by increasing quantity they sacrifice quality of care of their children and this affects their children health biasing the results downwards. The other direction is that women acted to defer fertility in which case the results will be biased upward. Table 10 provides results suggesting that the endogenous fertility concern can be ruled out. Column 1 shows that women exposed to bombing have fewer children (the result is only precisely estimated for the exposure at 1-2 years), if endogenous fertility is the case these women will defer fertility by having terminated pregnancies and/or using contraceptives for example. Columns 2 and 3 show that that is not the case; estimating an equation where the outcome variable is a dummy of 1 if the woman has terminated a pregnancy or a dummy of 1 if the woman has used or has the intention to use contraception, results in both case are not significant and in most cases close to almost zero in magnitude.[18].

One concern is that location and timing of the bombing are related to other unobserved trends, in which case those could be driving the results. To address this, I perform a placebo test focusing on birth cohorts from 1975 to 1979 and assign bombing intensity from the more intense period that came five years earlier. Table 11 shows that there is no relationship between the anthropometric measures of the children born to mothers before the bombing and the intensity of the bombing five years later, there are no significant results suggesting that unobserved trends in the same locations could be driving the main results.

Islam et al. (2016) investigate the impact of the civil conflict and the genocide on the 1950 to 1965 cohorts born before the bombing. Their results suggest that the human capital deterioration is via the destruction of educational infrastructure during that period, not via channels that affect health capital. I confirm their results by estimating the specification in equation (2) using the sample in these cohorts. Table 12 shows that there are not significant results for the health outcomes of the children of these women, supporting their evidence that the channel wasn't health for these cohorts. These results also add robustness to my findings in the following way: since the cohorts in my study experienced effects only due to exposure in the crucial physical developmental stages (*in*

[18]One could think that the results could be driven by very low fraction of women having terminated pregnancies or using contraception, but that is not the case. For terminated pregnancies 17% of the women in my sample have answered yes to the related question in DHS survey. For intention or use of contraception the fraction is 62%

*utero* and first three years of life), this suggests that health is the channel affecting the cohorts of my study – whereas the older cohorts that experienced bombing later in life are affected through the schooling channel.

# 6 Conclusions

This paper contributes to the literature that empirically investigates the long-run effects of prenatal and early life events caused by violent conflict. In particular it adds to the knowledge on the intergenerational effects of war. I quantify the effects on health capital among children (second generation) born to mothers (first generation) who were *in utero* and/or early life during the 1970-1974 U.S. bombing campaign in Cambodia using data from the Cambodian DHS matched with the records of the bombing campaign and a within-location cohort variation as a source of exogenous identification. This strategy overcomes the concerns related to the randomness of the location of the bombing, and challenges in accurately measuring exposure to conflict events. The models estimated indicate that if a mother was exposed to the average average bombing while she was *in utero* their children experience adverse health consequences of this exposure, a reduction of 0.4 sd in their HAZ.

It is difficult to disentangle the mechanisms of intergenerational transmission. Violent conflict, in this case a war in which the affected country experienced one of the most intense bombing campaigns in history -can impact the population born during the bombing through various channels. For example: a bomb in the location of residence can cause stress in the women carrying the baby and that can have posterior effects on children's health, but it can also destroy the roads restricting the resources available in the villages. Therefore, one can not attribute the long terms effects to one specific channel. The available data allowed me to look at the long-term effects of this exposure on the first generation by estimating the impact on mothers adult height. The results show that there is a negative effect of *in utero* exposure on height-for-age of the adult mothers, suggesting that channels that caused physiological changes that affected the health capital perpetuate the negative impacts of the bombing campaign into the generations born after the bombing.

The results remain strong after various robustness tests. I perform a placebo test that assigns the bombing intensity of the previous five years to the cohorts of mothers born between 1975 and 1979, showing no significant results and suggesting that no other unobserved trends could be driving the main results. Concerns of endogenous fertility and migration are also ruled out.

This is the first study that exploits accurate GPS information on exposure to the bombing in Cambodia instead of using aggregate regional levels. It is also one of the first studies that shows effects of war exposure on the next generation born decades after the end of the war, suggesting that the negative effects of a bombing campaign can be detected more than one generation after it occurred, and that health capital can be adversely affected by war exposure. This contrasts with previous literature that has found no impact on the long-run economic development of Vietnam (Miguel and Roland, 2011). Since health capital is directly correlated with labor productivity the legacy of the bombing is actually affecting the countries development. The bombing campaign studied may explain a non-trivial portion of the poor nutrition outcomes, stunting in particular, among current-day third-generation post-bombing Cambodians.

Figure 1: Survey Household locations and Bombing Target Locations

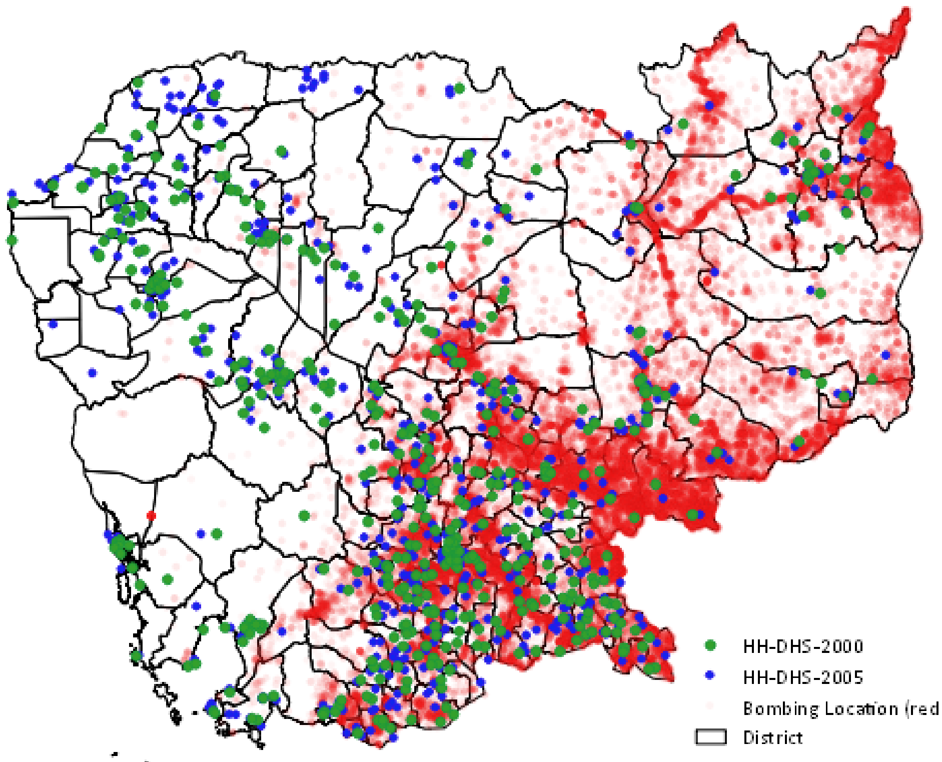


Figure 2: Source of identifying variation

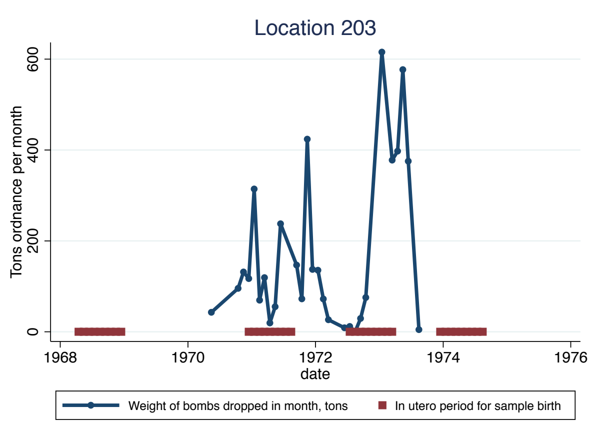

Figure 3: Source of identifying variation

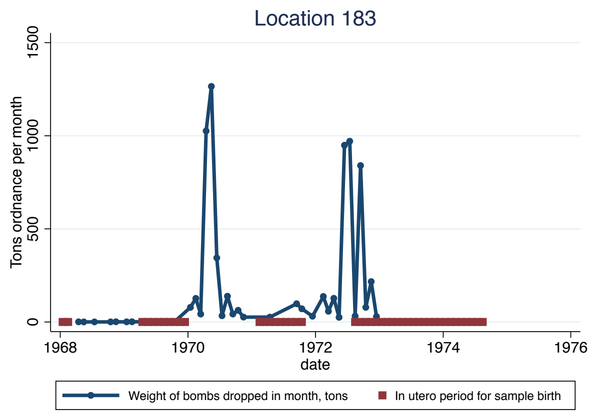


Table 1: Summary statistics, mothers and children

| Variable | Mean | Std. Dev. |
|---|---|---|
| Non mover | 0.55 | 0.498 |
| N | | 1260 |
| *Mothers* | | |
| Age | 29.567 | 2.98 |
| age of respondent at 1st birth | 21.033 | 3.268 |
| No education | 0.27 | 0.444 |
| Primary | 0.571 | 0.495 |
| Secondary | 0.157 | 0.364 |
| Higher | 0.001 | 0.038 |
| 2005 survey | 0.354 | 0.478 |
| N | | 693 |
| *Children* | | |
| child's age in months | 30.377 | 16.94 |
| Length/height-for-age Z-score (WHO) | -1.909 | 1.785 |
| Length/height-for-age Z-score* | -0.009 | 1.088 |
| Weight-for-age Z-score (WHO) | -1.637 | 1.169 |
| Weight-for-age Z-score* | -0.032 | 0.983 |
| N | | 923 |

**Note:** *Z-scores calculated with reference to Cambodian population. All the summary statistics are for non movers and mothers born between the heavy bombing from 1970 to 1974

Table 2: U.S. Bombing Campaign in Cambodia

| **Year** | **Sorties** | **Tons of ordnance** |
|---|---|---|
| 1969 | 14 | 48 |
| 1970 | 35,888 | 65,539 |
| 1971 | 41,741 | 59,605 |
| 1972 | 11,854 | 35,962 |
| 1973 | 57,456 | 251,628 |
| 1975 | 16 | 25 |
| **Total** | **146,969** | **412,808** |

Table 3: Bomb intensity summary statistics across mothers

| **Variable** | **Mean** | **Std. Dev.** | **Min.** | **Max.** |
|---|---|---|---|---|
| *in utero* | 187 | 891.3 | 0 | 15,904.4 |
| 0-1 year | 251.4 | 712.1 | 0 | 7,295 |
| 1-2 years | 198.6 | 699.5 | 0 | 7,342 |
| 2-3 years | 190.7 | 897.9 | 0 | 13,599.4 |
| 3-4 years | 136 | 911.4 | 0 | 15,783.1 |
| N | | 693 | | |

**Note:** For mothers born between 1970-1974, each number represents the tonnage the ordnance dropped in different stages from conception to 3 years old within a 10Km radius of the place of birth.

Table 4: Effects of mothers's bombing exposure intensity on their children anthropometrics

| | Commune Level | | Original Locations | |
|---|---|---|---|---|
| | HAZ | WAZ | HAZ | WAZ |
| | (1) | (2) | (3) | (4) |
| In utero | -0.060 | -0.068* | -0.040 | -0.070 |
| | (0.050) | (0.041) | (0.058) | (0.048) |
| 0 to 1 year | -0.096** | -0.111*** | -0.065 | -0.107** |
| | (0.044) | (0.040) | (0.050) | (0.046) |
| 1 to 2 years | -0.083* | 0.001 | -0.081* | -0.012 |
| | (0.042) | (0.034) | (0.045) | (0.037) |
| 2 to 3 years | -0.096* | -0.047 | -0.072 | -0.030 |
| | (0.051) | (0.040) | (0.061) | (0.046) |
| N | 923 | 923 | 923 | 923 |
| Mean of outcome | -0.06 | -0.06 | -0.06 | -0.06 |
| St. dev. of outcome | 1.06 | 0.97 | 1.06 | 0.96 |
| Unique locations | 388 | 388 | 443 | 443 |
| Mothers | 693 | 693 | 693 | 693 |

**Note:** All models include location, birth order and mother year of birth fixed effects, also controls for age at first birth and year of the survey. Estimated with OLS. Heteroskedasticity-consistent robust standard errors cluster by location in parentheses. Significance levels are indicated by $* < .1$, $** < .05$, $*** < .01$.

Table 5: Effects of mothers's bombing exposure intensity on their children anthropometrics - 24 months and older

| | 0-5 years old | | 24 months and older | |
|---|---|---|---|---|
| | HAZ | WAZ | HAZ | WAZ |
| | (1) | (2) | (3) | (4) |
| In utero | -0.040 | -0.070 | -0.112* | -0.106 |
| | (0.058) | (0.048) | (0.066) | (0.070) |
| 0 to 1 year | -0.065 | -0.107** | -0.124** | -0.142** |
| | (0.050) | (0.046) | (0.053) | (0.059) |
| 1 to 2 years | -0.081* | -0.012 | -0.124** | -0.000 |
| | (0.045) | (0.037) | (0.052) | (0.048) |
| 2 to 3 years | -0.072 | -0.030 | -0.147* | -0.115* |
| | (0.061) | (0.046) | (0.083) | (0.062) |
| N | 923 | 923 | 585 | 585 |
| Mean of outcome | -0.01 | -0.01 | -0.04 | -0.04 |
| St. dev. of outcome | 1.09 | 1.09 | 1.01 | 1.01 |
| Unique locations | 443 | 443 | 370 | 370 |
| Mothers | 693 | 693 | 531 | 531 |

**Note:** All models include location, birth order and mother year of birth fixed effects, also controls for age at first birth and year of the survey. Location fixed effects are based on original DHS locations. Estimated with OLS. Heteroskedasticity-consistent robust standard errors cluster by location in parentheses. Significance levels are indicated by $* < .1$, $** < .05$, $*** < .01$.

Table 6: Dummy for each period of exposure, 0 to 5 years and 24 months and older

| | 0-5 years old | | 24 months and older | |
|---|---|---|---|---|
| | HAZ | WAZ | HAZ | WAZ |
| | (1) | (2) | (3) | (4) |
| In utero | -0.258 | -0.364** | -0.535** | -0.660** |
| | (0.206) | (0.184) | (0.247) | (0.260) |
| 0 to 1 year | -0.190 | -0.472*** | -0.399* | -0.712*** |
| | (0.211) | (0.167) | (0.224) | (0.211) |
| 1 to 2 years | -0.174 | 0.157 | -0.374 | 0.183 |
| | (0.216) | (0.203) | (0.252) | (0.245) |
| 2 to 3 years | -0.035 | -0.151 | -0.021 | -0.309 |
| | (0.241) | (0.204) | (0.290) | (0.277) |
| N | 923 | 923 | 585 | 585 |
| Mean of outcome | -0.06 | -0.06 | -0.10 | -0.08 |
| St. dev. of outcome | 1.06 | 0.96 | 1.05 | 0.99 |
| Unique locations | 443 | 443 | 370 | 370 |
| Mothers | 693 | 693 | 531 | 531 |

**Note:** All models include location, birth order and mother year of birth fixed effects, also controls for age at first birth and year of the survey. Location fixed effects are based on a 5 km radius grouping of DHS locations for both rounds 2000 and 2005. Estimated with OLS. Heteroskedasticity-consistent robust standard errors cluster by mother and location in parentheses. Significance levels are indicated by $*$ < .1, ** < .05, *** < .01.

Table 7: The Mechanism: Effects of bombing exposure on Mother's HAZ

| | Commune Level | | Original Locations | |
|---|---|---|---|---|
| | HAZ | HAZ - Dummy | HAZ | HAZ - Dummy |
| | (1) | (2) | (3) | (4) |
| In utero | -0.064** | -0.184 | -0.065** | -0.264** |
| | (0.029) | (0.115) | (0.031) | (0.119) |
| 0 to 1 year | -0.023 | -0.151 | -0.021 | -0.206 |
| | (0.027) | (0.131) | (0.028) | (0.138) |
| 1 to 2 years | -0.069*** | -0.149 | -0.092*** | -0.226 |
| | (0.025) | (0.139) | (0.028) | (0.144) |
| 2 to 3 years | 0.020 | -0.111 | 0.016 | -0.088 |
| | (0.029) | (0.147) | (0.033) | (0.154) |
| N | 1162 | 1162 | 1162 | 1162 |
| Mean of outcome | 0.02 | 0.02 | 0.01 | 0.01 |
| St. dev. of outcome | 0.98 | 0.98 | 0.98 | 0.98 |
| Unique locations | 493 | 493 | 606 | 606 |

**Note:** All models include location, mother year of birth fixed effects, year of the survey when using commune as aggregation. Estimated with OLS. Heteroskedasticity-consistent robust standard errors cluster by location in parentheses. Significance levels are indicated by $* < .1$, $** < .05$, $*** < .01$.

Table 8: Migration during bombing period.

| Migration Status and time | Population | Percentage |
|---|---|---|
| No migration | 408,620 | 46.95 |
| Migrated during bombing | 9,098 | 1.05 |
| Migrated at a different time | 452,677 | 52.01 |
| Total | 870,395 | 100% |

**Note:** Population born before 1974. IPUMS - Cambodian Census 1998 and 2008.

Table 9: Reasons for migration

| Reason for migration | Migration at a different time | | Migration during bombing | |
|---|---|---|---|---|
| | **Number** | **Percentage** | **Number** | **Percentage** |
| Seeking work | 75,471 | 18.47 | 833 | 9.16 |
| Job relocation | 47,516 | 11.63 | 626 | 6.88 |
| Family move | 110,740 | 27.1 | 1,769 | 19.44 |
| Study | 1,643 | 0.4 | 20 | 0.22 |
| Marriage or union | 66,478 | 16.27 | 4,512 | 49.59 |
| Violence or insecurity | 5,620 | 1.38 | 192 | 2.11 |
| Natural disaster | 262 | 0.06 | 10 | 0.11 |
| Natural disaster or insecurity | 16,501 | 4.04 | 451 | 4.96 |
| Repatriation | 57,917 | 14.17 | 289 | 3.18 |
| Housing problems | 2,504 | 0.61 | 47 | 0.52 |
| Visiting | 7,978 | 1.95 | 60 | 0.66 |
| Other reason, not els | 8,376 | 2.05 | 125 | 1.37 |
| Not specified | 7,614 | 1.86 | 164 | 1.8 |
| Total | 408,620 | 100 | 9,098 | 100 |

**Note:** Population born before 1974. IPUMS - Cambodian Census 1998 and 2008.

Table 10: Endogenous Fertility

| | Number of children (1) | Terminated Pregnancy (2) | Contraceptives (3) |
|---|---|---|---|
| In utero | -0.046 | 0.000 | -0.009 |
| | (0.031) | (0.007) | (0.009) |
| 0 to 1 year | -0.020 | 0.003 | -0.002 |
| | (0.026) | (0.006) | (0.009) |
| 1 to 2 years | -0.050* | -0.008 | -0.010 |
| | (0.027) | (0.007) | (0.008) |
| 2 to 3 years | -0.039 | -0.003 | -0.011 |
| | (0.030) | (0.007) | (0.008) |
| N | 1162 | 1162 | 1162 |
| Mean of outcome | 2.66 | 0.17 | 0.62 |
| St. dev. of outcome | 1.80 | 0.38 | 0.49 |
| Unique locations | 606 | 606 | 606 |

**Note:** All models include location, mother year of birth fixed effects, year of the survey when using commune as aggregation. Estimated with OLS. Heteroskedasticity-consistent robust standard errors cluster by location in parentheses. Significance levels are indicated by $* < .1$, $** < .05$, $*** < .01$.

Table 11: Placebo test - Mother Birth Cohort 1975 to 1979 and exposure of 5 years earlier

| | 0-5 years old | | 24 months and older | |
|---|---|---|---|---|
| | HAZ | WAZ | HAZ | WAZ |
| | (1) | (2) | (3) | (4) |
| In utero | -0.030 | -0.008 | 0.014 | -0.011 |
| | (0.036) | (0.034) | (0.048) | (0.049) |
| 0 to 1 year | 0.012 | -0.010 | -0.020 | 0.023 |
| | (0.035) | (0.030) | (0.057) | (0.040) |
| 1 to 2 years | 0.020 | 0.017 | 0.045 | 0.070 |
| | (0.038) | (0.042) | (0.050) | (0.043) |
| 2 to 3 years | -0.000 | 0.070 | -0.051 | 0.068 |
| | (0.054) | (0.044) | (0.074) | (0.051) |
| 3 to 4 years | -0.061 | -0.118 | 0.065 | -0.028 |
| | (0.088) | (0.083) | (0.114) | (0.041) |
| N | 1923 | 1923 | 1550 | 1550 |
| Mean of outcome | -0.06 | -0.06 | -0.09 | -0.13 |
| St. dev. of outcome | 0.86 | 0.83 | 0.83 | 0.69 |
| Unique locations | 629 | 629 | 595 | 595 |
| Mothers | 1284 | 1284 | 1128 | 1128 |

**Note:** All models include location, birth order and mother year of birth fixed effects, also controls for age at first birth and year of the survey. Location fixed effects are based on original DHS locations. Estimated with OLS. Heteroskedasticity-consistent robust standard errors cluster by location in parentheses. Significance levels are indicated by $* < .1$, $** < .05$, $*** < .01$.

Table 12: Effects on children of mothers born in the Pre-Bombing period 1950-1965

| | Commune Level | | Original Locations | |
|---|---|---|---|---|
| | HAZ | WAZ | HAZ | WAZ |
| | (1) | (2) | (3) | (4) |
| 4 to 5 years | 0.115 | 0.035 | 0.158 | 0.052 |
| | (0.206) | (0.183) | (0.220) | (0.189) |
| 5 to 6 years | -0.080 | -0.072 | -0.052 | -0.054 |
| | (0.098) | (0.086) | (0.110) | (0.099) |
| 6 to 7 years | -0.050 | -0.134 | -0.015 | -0.052 |
| | (0.104) | (0.088) | (0.124) | (0.099) |
| 8 to 9 years | -0.014 | -0.012 | -0.011 | -0.027 |
| | (0.049) | (0.043) | (0.060) | (0.049) |
| 9 to 10 years | -0.017 | -0.012 | 0.006 | -0.009 |
| | (0.047) | (0.040) | (0.049) | (0.040) |
| 10 to 11 years | -0.005 | -0.007 | -0.008 | -0.013 |
| | (0.046) | (0.042) | (0.050) | (0.045) |
| 11 to 12 years | -0.105** | -0.070 | -0.090* | -0.070 |
| | (0.051) | (0.044) | (0.054) | (0.046) |
| 12 to 13 years | 0.029 | 0.025 | 0.036 | 0.017 |
| | (0.045) | (0.043) | (0.048) | (0.046) |
| 13 to 14 years | -0.045 | -0.038 | -0.008 | -0.035 |
| | (0.050) | (0.042) | (0.057) | (0.052) |
| 14 to 15 years | 0.045 | -0.001 | 0.078 | 0.003 |
| | (0.058) | (0.058) | (0.066) | (0.062) |
| N | 910 | 910 | 910 | 910 |
| Mean of outcome | -0.13 | -0.19 | -0.13 | -0.19 |
| St. dev. of outcome | 1.15 | 1.06 | 1.17 | 1.08 |
| Unique locations | 355 | 355 | 408 | 408 |
| Mothers | 725 | 725 | 725 | 725 |

Standard errors in clustered by location parentheses. $* < .1$, $** < .05$, $*** < .01$.

# References


**Akbulut-Yuksel, Mevlude**, “Children of War The Long-Run Effects of Large-Scale Physical Destruction and Warfare on Children,” *Journal of Human resources*, 2014, *49* (3), 634–662.

**Akresh, Richard., German Daniel Caruso, and Harsha Thirumurthy**, “Detailed Geographic Information, Conflict Exposure, and Health Impacts,” 2016.

**Akresh, Richard, Leonardo Lucchetti, and Harsha Thirumurthy**, “Wars and child health: Evidence from the Eritrean–Ethiopian conflict,” *Journal of development economics*, 2012, *99* (2), 330–340.

**_ , Sonia Bhalotra, Marinella Leone, and Una Osili**, “First and Second Generation Impacts of the Biafran War,” *Working Paper*, 2017.

**Almond, Douglas, Janet Currie, and Valentina Duque**, “Childhood Circumstances and Adult Outcomes: Act II,” *NBER Working Paper*, 2017, (23017).

**Angrist, Joshua D and Jörn-Steffen Pischke**, *Mostly harmless econometrics: An empiricist’s companion*, Princeton University Press, 2008.

**Barker, David J**, “The fetal and infant origins of adult disease.,” *BMJ: British Medical Journal*, 1990, *301* (6761), 1111.

**Black, Sandra E, Paul J Devereux, and Kjell G Salvanes**, “From the cradle to the labor market? The effect of birth weight on adult outcomes,” *The Quarterly Journal of Economics*, 2007, *122* (1), 409–439.

**Brown, Ryan**, “The Mexican drug war and early-life health: The impact of violent crime on birth outcomes,” *Working Paper*, 2014.

**Brown, Ryan. and Andrea Velásquez**, “The effect of violent crime on the human capital accumulation of young adults,” *Journal of Development Economics*, 2017, *127*, 1–12.

**Camacho, Adriana**, "Stress and birth weight: evidence from terrorist attacks," *The American Economic Review*, 2008, *98* (2), 511–515.

**Dell, Melissa and Pablo Querubin**, "Nation Building Through Foreign Intervention: Evidence from Discontinuities in Military Strategies," *NBER Working Paper*, 2016, (22395).

**Duque, Valentina**, "Early-life conditions and child development: Evidence from a violent conflict," *SSM-Population Health*, 2016, *3*, 121–131.

**Emanuel, Irvin**, "Invited commentary: an assessment of maternal intergenerational factors in pregnancy outcome," *American journal of epidemiology*, 1997, *146* (10), 820–825.

**Hackman, Evette, Irvin Emanuel, Gerald Van Belle, and Janet Daling**, "Maternal birth weight and subsequent pregnancy outcome," *Jama*, 1983, *250* (15), 2016–2019.

**High, Holly, James R Curran, and Gareth Robinson**, "Electronic Records of the Air War Over Southeast Asia," *Journal of Vietnamese Studies*, 2013, *8* (4), 86–124.

**Islam, Asadul., Chandarany Ouch, Russell Smyth, and Liang Choon Wang**, "The long-term effects of civil conflicts on education, earnings, and fertility: Evidence from Cambodia," *Journal of Comparative Economics*, 2016, *44* (3), 800–820.

**Islam, Asadul, Chandarany Ouch, Russell Smyth, and Liang Choon Wang**, "The Intergenerational Effect of Cambodia's Genocide on Children's Education and Health," *Population and Development Review*, 2017.

**Kiernan, Ben**, "The American Bombardment of Kampuchea, 1969-1973," *Vietnam Generation*, 1989, *1* (1), 3.

**Kiernan, Ben. and Taylor. Owen**, "Bombs over Cambodia: new information reveals that Cambodia was bombed far more heavily than previously believed," *The Walrus, October*, 2006.

**Kiernan, Ben and Taylor Owen**, "Roots of US Troubles in Afghanistan: Civilian Bombing Casualties and the Cambodian Precedent," *The Asia-Pacific Journal, 26-4*, 2010, *10.*

— **and** — , "Making More Enemies than We Kill? Calculating US Bomb Tonnages Dropped on Laos and Cambodia, and Weighing Their Implications," *The Asia-Pacific Journal— Japan Focus Volume*, 2015, *13* (16).

**Lee, Chulhee**, "Intergenerational health consequences of in utero exposure to maternal stress: Evidence from the 1980 Kwangju uprising," *Social Science & Medicine*, 2014, *119*, 284–291.

**Mansour, Hani and Daniel I Rees**, "Armed conflict and birth weight: Evidence from the al-Aqsa Intifada," *Journal of Development Economics*, 2012, *99* (1), 190–199.

**Miguel, Edward and Gerard Roland**, "The long-run impact of bombing Vietnam," *Journal of development Economics*, 2011, *96* (1), 1–15.

**Shawcross, William**, *Sideshow: Kissinger, Nixon, and the destruction of Cambodia*, Simon & Schuster, 1979.

**Sonne, Soazic Elise Wang and Eleonora Nillesen**, "Long-term effects of violent conflict on second-generation health outcomes: evidence from Liberia," *Unpublished manuscript*, 2015.

**World Health Organization**, *WHO child growth standards: growth velocity based on weight, length and head circumference: methods and development*, World Health Organization, 2009.