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Early life shocks and mental health

The long-term effect of war in Vietnam

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Abstract: This paper provides causal evidence on early-life exposure to war on mental health status in adulthood. Using an instrumental variable strategy, the evidence indicates that early-life exposure to bombing during the American war in Vietnam has long-term effects. A one percent increase in bombing intensity during 1965–75 increases the likelihood of severe mental distress in adulthood by 16 percentage points (or approximately 50 percent of the mean) and this result is robust to a variety of sensitivity checks. The negative effects of war are similar for both men and women. These findings add to the evidence on the enduring consequences of conflict and identify a critical area for policy intervention.

Keywords: early-life, mental health, conflict, Vietnam
JEL classification: I1, I15, H56, I31, N35, O12

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1 Introduction

Wars and armed conflicts pose a serious threat to the development process. In particular, it is estimated that 250 million children live in conflict affected regions and make up nearly half of the 65 million people currently displaced by war (UNICEF, 2016; UNHCR, 2016). Living in fragile, conflict-affected areas can have debilitating effects on children. Food shortages, disruptions in access to sanitation and health care, make children exposed to conflicts twice as likely to be undernourished as children in low and middle income countries (World Bank, 2011). While infrastructure, resources, food supply chains, and other macro-economics indicators can recover in the long-run, growing up during a conflict may cast a long shadow on an individual's lifelong earnings, health and well-being. Understanding the channels through which conflicts can perpetuate poor health and poverty is essential for formulating effective public health policies.

In this paper I focus on the lasting consequences of early-life exposure to war on mental health in adulthood. During early childhood, the developing brain is particularly sensitive to sustained exposure to elevated cortisol levels (toxic stress). This can permanently alter the brain structure, leading to a reduced ability to regulate stress and fear responses, and thereby increasing the risk of developing mental and behavioral disorders in adulthood (Shonkoff et al., 2012; Danese and McEwen, 2012).

I estimate the impact of early-life exposure to the war in Vietnam on mental health during adulthood using a unique data set. The American bombing campaign in Vietnam was one of the largest in the history of warfare that caused millions of casualties and displaced millions more (Hirschman et al., 1995). Using data collected on mental health in Vietnam and an instrumental variable strategy to correct for potential endogenous exposure to conflict, I find that those who were born and grew up during the war experience significantly worse mental health in later adulthood. More specifically, a one percent increase in bombing intensity increases the likelihood of severe mental distress in adulthood by 16 percentage points (or approximately 50 percent of the mean) and this result is robust to a number of alternative specifications.

This paper contributes to several strands of literature, with the first relating to the determinants of mental health. Depressive disorders, one of the most common forms of mental illness, are estimated to affect more than 300 million people worldwide (WHO, 2017). As of 2010, depressive disorders were the second leading cause of years lived under disability and accounted for 3% of disability-adjusted life years worldwide (Ferrari et al., 2013). The economic costs of mental illness have been found to be high, particularly in terms of labor market participation, work productivity, and wages (Kessler et al., 2008; Bubonya et al., 2017; Frijters et al., 2014). Given substantial economic benefits of improving mental health - to the individual, and to the society in general - improving mental health has been included in the post-2015 Sustainable Development Agenda.[1] While studies have examined the effects of contemporaneous exposure to a variety of shocks, the evidence on how early-life circumstances may contribute to mental well-being is fairly limited.[2] Notable exceptions include Adhvaryu et al. (2016), who find that children born in coffee growing areas in Ghana during good coffee price years have lower likelihood of severe mental distress in adulthood. Similarly, prenatal exposure to temperature shocks, and loss of a maternal relative have been found to adversely affect adult mental health status (Adhvaryu et al., 2015 and Persson and Rossin-Slater, 2018, respectively).

It also contributes to the literature that examines long-lasting effects of exposure to conflict, particularly in early childhood. The importance of early-life circumstances for human capital accumulation and adult outcomes are now well-established. The literature finds living conditions up to the age of 5, including *in-utero*, to be a key determinant of a wide range of later life outcomes, such as educational attainment, health, wages and criminal activity (Almond and Currie, 2011; Currie and Vogl, 2013). While several studies find short-term impacts of conflict on health and education (Bundervoet et al., 2009; Shemyakina, 2009; Minoiu and Shemyakina, 2014; Mansour and Rees, 2012), it is possible that individuals may recover in the long-run. A small number of studies have recently made headway in identifying lasting consequences of conflict on human capital. Akresh et al. (2012) and Akbulut-Yuksel (2014) find that relative to children in less-affected areas, children in areas more affected by conflict have lower adult height-for-age z-scores. Akbulut-Yuksel (2017) and Kesternich et al. (2014) show that early-life exposure to conflict during WWII adversely affects health in adulthood in a number of other dimensions such as probability of having a stroke, hypertension, cardiovascular disorder and diabetes. Similarly, research by Justino et al. (2014) and León (2012) finds negative long-term effects on educational attainment. Furthermore, there

[1] For example, Kessler et al. (2008) estimate total societal cost of mental illness in the United States to be $193.2 billion per year during the period 2001-2003.

[2] For example, studies have examined the effects of contemporaneous changes in socio-economic conditions such as exposure to financial crisis (Friedman and Thomas, 2009); labor market conditions (Marcus, 2013); access to social protection (Baird et al., 2013); and changes in migration policies (Venkataramani et al., 2017). With relation to conflict, studies find that participation in (or exposure to) conflict during adulthood may have adverse affects on mental health (Do and Iyer, 2012; Brattia et al., 2016; Moya, 2018).

maybe intergenerational spillovers as well, particularly via poor health of mothers (Akresh et al., 2017). This paper adds to the literature by examining the link between exposure to conflict as an infant and a young child and subsequent mental health during adulthood in the context of the American war in Vietnam.

Finally, this paper also contributes to the literature on the impacts of the war in Vietnam and identifies a critical area for policy intervention. Using the same identification strategy, the analysis of Miguel and Roland (2011) finds that by the end of the 20th century, the war had no enduring effects on poverty rates, per capita consumption levels, literacy, and population density at the province and district level. However, adverse effects can persist at the individual level as has been the case in post-WWII Germany (Brakman et al., 2004; Akbulut-Yuksel, 2014 and 2017). Individual level effects could differ from aggregate effects depending on the proportion and segments of the population affected by war (rich vs. poor). Further, Miguel and Roland (2011) argue that the recovery was driven by post-war state investment, particularly in physical infrastructure such as electricity. However, during this same time there was a noted decline in the quality of health services (Segall et al., 1995; Palmer et al., 2016). So, while it is possible to remediate early-life disadvantage by timely intervention, the lack of adequate health inputs might have played a role in perpetuating the adverse health effects associated with the war.[3] The results of this paper are in line with those of Palmer et al. (2016) who find current disability rates to be higher in regions that experienced greater destruction during the American war in Vietnam. From a policy perspective, while there are certain policies in place to assist war veterans, children who grew up during the war without participating are often overlooked. I find that the long shadow of war extends to this group as well. Additionally, as welfare of children is closely associated with the psychological well-being of parents and caregivers, providing remedial services to the affected population (median age is approximately 50 years in 2017) may have much broader impacts by limiting inter-generational transmission of poor mental health.[4]

[3] For examples see Nham Tuyet and Johansson, 2001; Pham et al., 2013; and Do, 2009.

[4] For example, Baranov et al. (2017) find that providing psychotherapy to perinatally depressed mothers in rural Pakistan increased time and monetary intensive parental investments in children, particularly for girls.

The rest of the paper is organized as follows. In Section 2, I provide a brief description of the American war in Vietnam. I discuss the data in Section 3 followed by the identification strategy in Section 4. In Section 5, I describe the results and examine heterogeneous treatment effects. In Section 6 I discuss the mechanisms and additional analysis and finally, Section 7 concludes.

2 Background

The French colonial rule over Vietnam ended with the Indochina War (1946-1954).[5] Following the July 1954 Geneva Accords, the country was divided into two along the 17th Parallel - a communist state in the north lead by Ho Chi Minh and the Viet Minh, and US-backed pro-Western state in the south. During the latter half of the fifties, South Vietnam was subject to frequent, large-scale protests and riots largely driven by disillusionment with the government of Ngo Dinh Diem. The National Liberation Front (NFL, also known as the Viet Cong) established in 1960 started an insurgency in South Vietnam. The NFL, backed by North Vietnam and the North Vietnamese Army (NVA), soon held sway over large parts of the country. Initially, the US involvement was limited - primarily providing advisory support to South Vietnam and its army, the Army of the Republic of Vietnam (ARVN). However, an attack on US ships in the Gulf of Tonkin in 1964 sparked an escalation of US involvement. American Congress passed the Southeast Asia Resolution which allowed President Lyndon Johnson to conduct military operations in the region. In 1965 the US deployed around 200,000 troops in Vietnam and launched an intense bombing campaign in retaliation against North Vietnam.

The aerial bombing of Vietnam was one of the most intense in history. Estimates suggest that the total tonnage of bombs and other ordnance used during the war was about three times greater than that used during World War II. The aerial bombing was largely not discriminatory as it targeted communities rather than specific individuals (Kocher et al., 2011). The most heavily bombed area was around the 17th Parallel, the border between North and South Vietnam. But the bombing was not restricted to North Vietnam. Aerial bombing of South Vietnam also occurred in an effort to suppress support for the NFL, particularly to disrupt support to the NFL arriving along the Ho Chi Minh Trail through

[5] This section provides a brief overview of the war, for more detailed descriptions see Turley (1986) and Harrison (1989).

Laos. However, such coercive military strategies failed, leading to more South Vietnamese participation in NFL's military and political activities (Dell et al., 2017; Kocher et al., 2011). By the time the war ended in April 1975, it is estimated that between 1 to 4 million Vietnamese lives were lost during 1965-1975 (Hirschman et al., 1995; Obermeyer et al., 2008).

3 Data

This study combines data from two sources - the first on war intensity in Vietnam and the other on mental health. I proxy war intensity by bombing activities of the United States Air Force and Navy during 1965-1975 in Vietnam. Bombing intensity is defined as total quantity of U.S. bomb, missiles and rockets dropped per square km. The data are available at the level of the district for the period as a whole, and are provided by Miguel and Roland (2011).[6]

The data on depressive symptoms and other household and individual characteristics come from the 2016 wave of the Vietnam Access to Resources Household Survey (VARHS hereafter; see CIEM 2015). The VARHS is a long-running panel survey of almost 2500 rural households conducted every second year since 2006 in 12 provinces of Vietnam. I combine these data with a sample of approximately 1,000 households that were surveyed along with the VARHS households (using the same survey instrument).[7] Both the samples are independently representative at the level of the province.

Mental health is measured using the 10-item Center for the Epidemiological Studies of Depression short form (CES-D). The CES-D is one of the main scales used to measure depressive symptoms internationally and a number of studies show that it strongly predicts clinical diagnoses of depression and anxiety disorders (Weissman et al., 1977).[8] A higher CES-D score reflects poorer mental health. I use CES-D scale to construct two dependent variables. First,

[6]The data come from the 1965-70 Combat Activities-Air, the 1970-1975 South East Asia, and Combat Naval Gunfire databases. They include the number of general purpose bombs, cluster bombs, missiles, rockets, chemicals, cannon artillery, incendiary, projectiles, ammunition, mines and flares, measured in units.

[7]These households were added to evaluate an aid program that was ultimately not implemented.

[8]The CES-D was developed by Radloff (1977). The responses to the CES-D are on a four-scale metric that ranges from never (0 days in a week) to all the time (5-7 days of in a week). These are coded from 0 to 3 for the negative questions and the positive questions are reverse coded such that a higher score reflects a higher likelihood of having depression. A detailed description of the CES-D questions is provided in Table A1 in the appendix.

I use the log of the composite score of the 10-item questions (ranging from 0 to 30). Second, a score of 10 and above (out of a maximum of 30) is used as an indicator for the presence of significant depressive symptoms (Andresen et al., 1994).

Table 1: Summary Statistics

	Mean
Panel A: Individual-level	
CESD-10 index	7.55
	(4.14)
Severe stress	0.31
	(0.46)
Female	0.35
	(0.48)
Non-Kinh	0.30
	(0.46)
Observations	1421
Panel B: District-level	
Total U.S. bombs, missiles, rockets per km2	25.06
	(48.93)
Av. precipitation (cm)	153.67
	(29.74)
Av. temperature (Celsius)	23.66
	(1.74)
Population density, 1960-61	94.91
	(79.42)
Former South Vietnam	0.51
	(0.50)
Latitude	18.30
	(4.74)
Observations	112

Notes: Population density is measured at the level of the province.
Source: Author's calculations based on the survey data.

The CES-D was administered to the the primary respondent of the household - the household head or his/her spouse in most cases. Since the focus of this paper is on the effects of exposure to war in early-life, I restrict the sample to those respondents who were aged 5 or below during the war, i.e. those born during 1960-1975. As the VARHS does not provide information on place of birth, I assume district of current residence to be the same as that of birth, and am able to match 112 districts in the VARHS provinces to the district-level bombing intensity data from Miguel and Roland (2011).

In Section 6.1 I also make use of the Vietnam Living Standard Survey 1997-98 (VLSS 97-98) to test mechanisms that could explain the results. The VLSS 97-98 was a nationally representative survey that sampled almost 6000 households across the country. For each member of the surveyed household, the survey contains information on gender, year of birth, age, anthropometric outcomes such as height and weight, and whether parents of the respondent were alive at the time of the survey. At the household level, information is available on the ethnicity of the household head and the province of residence. I am able to match all 59 provinces in the VLSS 97-98 data to those in the data of Miguel and Roland (2011).

Summary statistics are presented in Table 1. The analysis sample from VARHS consists of 1421 individuals. Figure A1 in the Appendix presents the distribution of the CES-D scores for the sample. The Cronbach's α is 0.766, which indicates a reasonably high level of internal consistency. The average score on the CES-D is 7.55 for the sample and 31 percent of the sample exhibits symptoms of severe distress. Overall, 35 percent of the sample is female and 30 percent are an ethnic minority (non-Kinh).[9] During the American bombing campaign in Vietnam, on average 25 bombs, missiles and rockets were dropped per square kilometer in the survey districts during 1965-75. The average pre-war population density was 94.91. The average precipitation during the war years was 153 centimeters and the average temperature was 23.6 Celsius. The districts are equally distributed across former North and South Vietnam.

4 Estimation strategy

In order to estimate the effect of bombing intensity on the prevalence of depressive symptoms, the following linear regression framework could be used:

$$Y_{icj} = \alpha + \beta B_j + \gamma X_{icj} + \theta Z_j + \lambda_c + \epsilon_{icj} \tag{1}$$

[9]There are 54 officially recognized ethnic groups in Vietnam. The Kinh, the ethnic majority, constitute around 85 per cent of the population. The ethnic minorities largely reside in the Central Highlands and the Northern Uplands. As there regions are extensively covered under the VARHS, the ethnic minorities are over represented in the sample.

where, Y_{icj} is the outcome measure for individual i, of birth cohort c and residing in district j. The intensity of bombing in district j during the period 1965-1975 is represented by the variable B_j. The vector X_{icj} are individual-level characteristics such as gender and ethnicity. The vector Z_j represents district-level characteristics such as the pre-war population, average rainfall and temperature during the war years, and an indicator variable that take a value of 1 if the district was located in former South Vietnam. Other geographical district variables include latitude, proportion of land at different altitudes, and proportion of land in 18 different soil categories.[10] These variables help to control for district-level socio-economic conditions. I also include birth cohort fixed effects, λ_c, defined by the year in which the respondent is born. These account for any unobserved factors that might affect the mental health of all individuals in a particular birth cohort. Finally, ϵ_{icj} corresponds to a random error term. In all the tables reported in this paper I allow for arbitrary correlation at the level of the district by clustering the standard errors at the district level.

Under the specification in equation (1), the coefficient of interest is β, which indicates the effect of bombing density on the prevalence of depressive symptoms. However, the estimated β could be biased as the bombings were not random. Specifically, endogeneity concerns could arise due to omitted variables. Therefore, I use an instrumental variable approach to correct for the endogeneity problem. Following Miguel and Roland (2011) I use distance from the centroid of each district to the 17th parallel north latitude (around which bombing was the heaviest) as the instrument for the density of bombing in that district. The corresponding first stage regression is the following:

$$B_j = \alpha + \delta Dist_j + \gamma X_{icj} + \theta Z_j + \lambda_c + \epsilon_{icj} \tag{2}$$

where the distance from the centroid of district j to the 17th parallel north latitude is given by the variable $Dist_j$. The instrument is highly correlated with the intensity of bombing as most of the fighting occurred near the border. The instrument is exogenous as the 17th parallel north latitude was set as the border between the former northern and southern Vietnamese governments by the 1954 Geneva Accords which were a result of negotiations between the United States and the Soviet Union. The border was determined without regard to prevailing socio-economic conditions or consultations with the Vietnamese (Miguel and

[10]These variables have been obtained from the dataset of Miguel and Roland (2011).

Roland, 2011). Section 5.3 discusses the validity of the instrument in greater detail.

So far the identification of the war's impact on mental health comes from variation in conflict across districts. The results from equations 1-2 assume that apart from the war, there are no unobserved district-level factors that independently affect mental health. To allay this concern, as a robustness check I also report results from a difference-in-difference instrumental variable identification strategy that exploits *within* district variation in a child's exposure to war. For this purpose I take younger cohorts, those born between 1976-86, as a control group, and construct a continuous measure of the intensity of war exposure (*Intensity of exposure*) by interacting bombing intensity with the number of months a child was alive during the war.[11] While I set the duration of exposure for the control group to zero, it must be noted that the control group is not entirely unaffected by war, as Vietnam engaged in a border war with China and also invaded Cambodia in order to overthrow the Khmer Rouge during this period. The estimations take the following form:

$$Y_{icj} = \alpha + \beta Intensity\, of\, exposure_{icj} + \gamma X_{icj} + \eta_j + \lambda_c + \epsilon_{icj} \tag{3}$$

where the measure of a child's exposure to conflict (*Intensity of exposure*) is instrumented by the interaction of distance from the 17th parallel north latitude and the number of months the child was alive during the war. The variable η_j now captures all time-invariant unobservables common to those born in the same district j. As before, I continue to cluster the standard errors at the district level.

Before proceeding to estimating the causal effects of conflict on mental health, I check the validity of the instrument. The results of the corresponding first stage regression of equation (2) are shown in column 1 of Table A2 in the Appendix. The results clearly show that distance from the 17th parallel is strong, significant predictor of bombing intensity. Similarly, the Kleibergen-Paap F-statistic reported at the bottom indicates that the instrument is not weak.

[11] Specifically, I count the number of months the child was alive (or *in utero*) between February 1965 and April 1975. The measure - *Intensity of exposure* - is then calculated as the product of the log of the total bombs dropped per square km. in the the district during the conflict and the months of exposure ($B_j * Months\ alive_{ic}$).

5 Results

5.1 Main results

I begin investigating the effects of conflict in early-life on adult mental health by estimating equation 1. The results are presented in Table 2. The dependent variable in the first column is the log of the score on the CES-D index (a higher CES-D score reflects poorer mental health). In the second column the dependent variable is an indicator for severe mental stress that takes the value 1 if the score on the CES-D index is greater than or equal to 10. As shown in both the columns, exposure to conflict in early life has no significant effect on mental health during adulthood using OLS.

However, as discussed in Section 4, these results could be biased due to the non-random nature of the intensity of bombings during the American war in Vietnam. I correct for this using an instrumental variable approach where the intensity of bombing in a district during 1965-75 is instrumented by the distance from the centroid of the district to the 17th parallel north latitude. The results from these regressions are reported in columns 3 and 4 of Table 2. Column 3 shows that after the IV correction, the conflict has a significant, adverse effect on mental health. I find that a 1 percent increase in bombing during childhood increases adult CES-D score by approximately 22 percent.

Further, the result in column 4 indicates that exposure to conflict in early life also increases the probability of being severely distressed in adulthood. A 1 percent increase in bombing leads to a 16 percentage point increase in severe distress. Given a sample mean of 31 percent, this translates into a 52 percent increase. While this is large, the impact is comparable to other studies examining the role of early-life circumstances in determining mental health in adulthood. For example, Adhvaryu et al. (2016) find that a one standard deviation increase in cocoa prices reduced the likelihood of severe distress among adults in Ghana by 50 percent of the mean.[12]

[12] Similarly, results from the reduced form specification provided in columns 2-3 of Table A2 in the appendix, show that distance from the 17th parallel negatively affects mental health in adulthood.

Table 2: War and mental health: OLS and IV results

	OLS		IV			
	Log CES-D (1)	Severe Stress (2)	Log CES-D (3)	Severe Stress (4)	Log CES-D (5)	Severe Stress (6)
Log total bombing per km^2	-0.028	-0.010	0.220**	0.160***	0.235*	0.218**
	(0.022)	(0.013)	(0.094)	(0.061)	(0.125)	(0.100)
Female	0.139***	0.079***	0.113***	0.061**	0.108***	0.053*
	(0.039)	(0.026)	(0.041)	(0.029)	(0.041)	(0.032)
Non-Kinh	0.082	0.054	0.168**	0.113*	0.175**	0.135*
	(0.077)	(0.057)	(0.079)	(0.060)	(0.087)	(0.071)
Population density, 1960-61	-0.001	0.000	-0.001	0.000	-0.001	0.000
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Former South Vietnam	-1.009**	-0.129	-1.414***	-0.407	-1.584***	-0.709
	(0.405)	(0.254)	(0.430)	(0.344)	(0.551)	(0.516)
Latitude	-0.073	-0.001	-0.147**	-0.052	-0.190**	-0.100
	(0.047)	(0.032)	(0.062)	(0.047)	(0.076)	(0.063)
Av. precipitation (cm)	0.002	-0.001	-0.002	-0.003	-0.001	-0.002
	(0.002)	(0.001)	(0.003)	(0.002)	(0.003)	(0.003)
Av. temperature (Celsius)	0.138**	0.055	-0.208	-0.183*	-0.267	-0.262*
	(0.064)	(0.042)	(0.149)	(0.096)	(0.202)	(0.155)
Geographical controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort linear time trend	No	No	No	No	Yes	Yes
Mean of dep. var.	1.83	0.31	1.83	0.31	1.83	0.31
N	1421	1421	1421	1421	1421	1421

Notes: This table reports instrumental variable estimates described in the text. Geographical controls include proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.

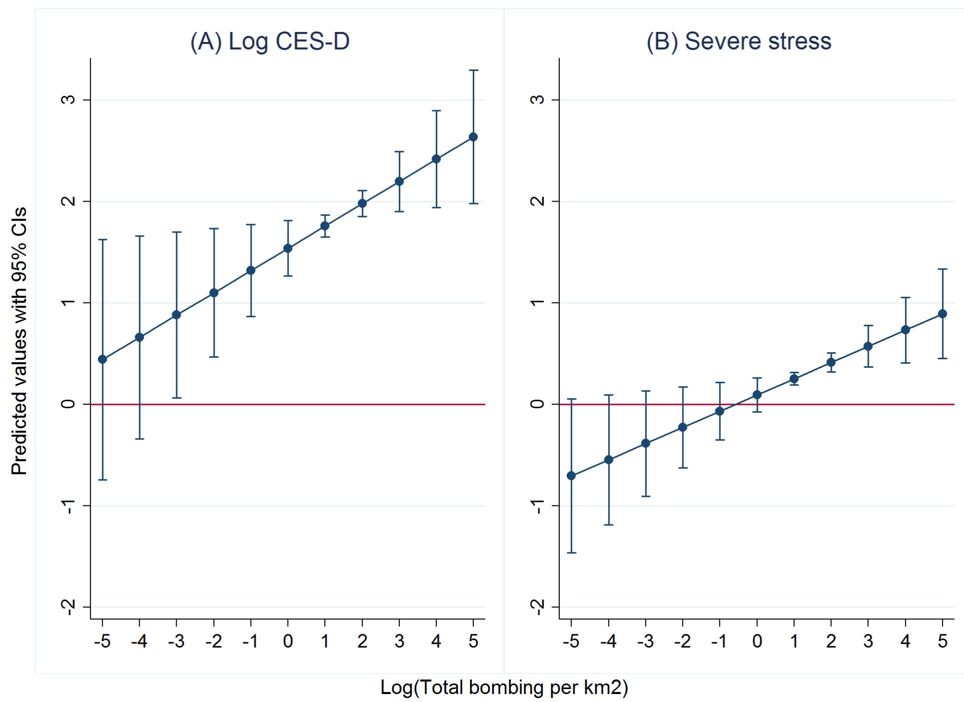
Source: Author's calculations based on the survey data.

Results in Table 2 point to the importance of several control variables as well. Females have a higher score on the CES-D and are also more likely to be severely stressed. This gender difference is in line with other studies such as Lei et al. (2014) for mid-aged and elderly in China. Mental health is worse for the ethnic minorities (the non-Kinh), but better if the respondent lives in the former South Vietnam and further north.

Figure 1 illustrates the relationship between instrumented conflict intensity and adult mental health. As expected, we find that adult mental health worsens with intensity of bombings across districts. The effect of bombings on the CES-D index becomes significant at approximately 0.05 bombs per square km and increase steadily from thereon. Similarly, the effect on severe distress becomes significant at 2.7 bombs per square km.

Overall, the results suggest that being *in utero* or growing up during conflict significantly increases the risk of depressive symptoms in adulthood and contribute to our understanding of long-term health effects of conflict. As discussed in Section 1, Akbulut-Yuksel (2017) and Kesternich et al. (2014) find early-life exposure to conflict leads to cardiovascular complications and diabetes in old age. My results could both be a manifestation of poor health status or help explain these related health effects.

Figure 1: Predicted values of mental health and different levels of bombing intensity



Source: Author's illustration based on the survey data.

5.2 Robustness checks

The results are robust to a number of sensitivity checks. First, I check if the results are driven by differential time trends in mental health across provinces. For example, differences in postwar province-specific policies or availability of resources could potentially be driving these results. To account for this I include interactions of province dummies with linear year-of-birth time trends. As results presented in columns 5 and 6 of Table 2 show, the estimates are similar in both magnitude and statistical significance.

Second, the main analysis exploits spatial variation across districts in exposure to the conflict to identify the effects on mental health. Alternatively, I use a difference-in-difference instrumental variable strategy outlined in Section 4 to estimate results exploiting within district variation in a child's exposure to the conflict. The main explanatory variable is a continuous measure of the intensity of war exposure, constructed by interacting bombing intensity with the number of months a child was alive during the war. The results using this alternative strategy are presented in Table 3 and clearly indicate that an increase in the intensity of exposure to the conflict leads to poorer mental health during adulthood. An increase of 1 percent in bombing leads to a 0.0003 percentage point increase in the probability of being severely distressed in adulthood for each month of exposure to the conflict. Not only is this effect statistically significant at the 5 percent level, it is meaningful as well. For a child experiencing the mean number of months of exposure (87.1) in a district that experienced the average bombing intensity (log value 3.22), this translates into a 8.4 percentage point increase in the likelihood of severe distress. Given a prevalence of 34 percent in control population, this implies an effect of 25 percent.

Third, in order to account for the possibility that correlation among the error terms of those living in the same district might bias the standard errors downwards, we have clustered the standard errors at the level of the district in all the regressions. To further allow for the possibility that error terms are also correlated among those born in a certain year, I cluster at both district and birth cohort levels using the method of Cameron et al. (2011). We find that the statistical significance of our results remains similar (results available with the author).

Table 3: War and mental health: using alternative conflict measures

	Log CES-D (1)	Severe Stress (2)
Intensity of exposure	0.00033	0.00031**
	(0.00023)	(0.00013)
Controls	Yes	Yes
Cohort Fixed Effects	Yes	Yes
District Fixed Effects	Yes	Yes
Control mean	1.84	0.34
N	1847	1847

Notes: This table reports instrumental variable estimates described in the text. The 1976-86 birth cohorts are used as the control group. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

Fourth, I check whether the results are driven by a particular component of the index by estimating the effect of bombing intensity on each individual component of the CES-D index separately. The results are shown in Table A3 in the Appendix, and I find that exposure to conflict significantly affects seven of the ten components.

Fifth, while it is standard to construct the CES-D score by simply adding up the score on each component, I check the robustness of the result to alternative measures as well. Specifically, I undertake a principal component factor analysis of the CES-D questions, and retain the first factor. Using the standardized value of this factor as the dependent variable, I once again find exposure to conflict to significantly affect mental health (results available with the author).

Sixth, while the analysis has been presented at the individual-level, the results also hold if I conduct it at the district-level. These results are presented in Table A4 in the Appendix. The standard errors are larger as the sample is now smaller. However, the effect on severe distress continues to be significant at 5 percent. Finally, I also find that the effects on severe distress are similar if I use a probit specification instead of linear regressions (Table A5 in the Appendix).

5.3 Interpretation concerns

It is important to point out some caveats. First, a key concern for a valid instrument is that it may be correlated with the unobserved factors driving the outcome, leading to a violation of the exclusion restriction. In the context of this study, given the geography of Vietnam, distance from the 17th parallel would be negatively correlated with distance of the district to the nearest of the two main cities - Hanoi and Ho Chi Minh City (HCMC). Areas closer to the big cities may have better economic opportunities, access to health services, etc. that could improve mental health. Concurrently, people further away might be more likely to migrate to these cities in search of better economic opportunities, confounding the effect of bombing on mental health. To address this issue, I include distance to the nearest megalopolis (Hanoi or HCMC, in km) in equations 1-2 and report the results in Table 4. I find that while distance to the 17th parallel and distance to the nearest megalopolis are negatively correlated, the correlation is not particularly high for the VARHS districts (pairwise correlation = -0.31, significant at 5 percent). Further, the first and second stage regressions are robust to the inclusion of distance to the nearest megalopolis. Column 1 shows that even after controlling for the distance to the nearest megalopolis, distance to the 17th parallel continues to be a strong significant predictor of bombing intensity (although precision is reduced). In the second-stage, the coefficient of bombing remains statistically significant, indicating a negative effect on mental health (columns 2 and 3).

Table 4: War and mental health: controlling for distance to nearest megalopolis

	First stage	IV	
	Log total bombing per km^2	Log CES-D	Severe Stress
	(1)	(2)	(3)
abs(Latitude - 17 N)	-0.473**		
	(0.202)		
Dist to nearest megalopolis (km)	-0.013***	0.004	0.003
	(0.004)	(0.003)	(0.002)
Log total bombing per km^2		0.342*	0.230**
		(0.182)	(0.117)
Controls	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes
Kleibergen-Paap F-stat	5.49		
AR Weak Instrument Robust Test: Chi2 (p-val)		10.4 (0.00)	12.76 (0.00)
AR Weak Instrument Robust Test: 90% CI		[0.150, 1.447]	[0.107, 0.956]
N	1421	1421	1421

Notes: This table reports instrumental variable estimates described in the text. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Dist to nearest megalopolis is the distance to the nearest of the two biggest cities - Hanoi/Ho Chi Minh City (HCMC). Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

The F-statistic for the first stage is 5.49, potentially raising concerns of a weak instrument.[13] For this reason, in columns 2 and 3, I also report Anderson-Rubin (AR) test statistics for the 2SLS model with clustered standard errors that provide valid inference on the coefficient of the endogenous variable even when the instrument is weak (Finlay and Magnusson, 2009). According to the AR tests, the null of no effect of bombing intensity on the CES-D index and severe stress can both be rejected at the one percent level ($p - value \leq 0.01$). I also find that the 90 percent confidence intervals based on the AR tests do not include zero. The lower bounds from the 90 percent confidence intervals suggest an estimated effect of 15 percent on the CES-D index and 11 percentage points on the likelihood of severe stress (approximately 35 percent), indicating that the effect of exposure to bombing is economically and statistically significant.[14]

[13]However, it should be noted that in the case of clustered standard errors the relationship between the F-statistic and weakness of the instrumental variable is not clear (Angrist and Pischke, 2009).

[14]Table A6 in the Appendix reports the corresponding reduced form estimates controlling for distance to the nearest megalopolis. Results show a negative and statistically significant relationship between distance to the 17th parallel and mental health, and the coefficients are very similar to the reduced form estimations reported in Table A2 of the Appendix (which do not control for distance to the nearest megalopolis). Further,

A second concern relates to migration. Over the last couple of decades internal migration has gained pace in Vietnam. The 1999 Census identified 4.5 million internal migrants (i.e., those who changed location during 1994-99), and this number increased to 6.6 million in the 2009 Census (i.e., those who changed location during 2004-09).[15] The data show that migration is characterized by movements from low income to high income provinces (Phan and Coxhead, 2010), and that a majority of the migrants are young, and moving alone to look for better economic opportunities in larger cities (Marx and Fleischer, 2010).

Migration could affect the interpretation of the results by invalidating the instrument and/or by changing the size and composition of the sample. If healthier individuals or households are more likely to migrate, then we could observe a sample with poorer mental health. Furthermore, if migration is related to distance to the nearest megalopolis, it may also lead to a violation of the exclusion restriction. For example, healthier individuals further away from Hanoi/Ho Chi Minh City (HCMC) may be pushed to migrate in search of better economic opportunities, generating a positive association between distance to the 17th parallel (which is negatively associated with distance to the nearest megalopolis) and mental health of those observed in the sample. Unfortunately, I do not have information on the district of birth and have to proxy this by the current district of residence.[16]

I have attempted to ascertain the extent of the bias stemming from migration in a couple of ways. First, as discussed above, controlling for distance to Hanoi/HCMC does not affect the results. Second, following Maccini and Yang (2009), I check the extent of selection into the sample by testing if birth cohort sizes vary with the bombing intensity. In Table A7 in the appendix, I report the results of this check using two different data sets. In column 1 I use the VARHS data to construct a district-year panel, where the outcome of the interest is the district-level birth cohort size in each year (1960-75). In column 2 I check if the results hold at the national level by using the VLSS 97-98 to construct a similar province-year panel. I do not find bombing intensity to systematically effect cohort size at either the district level or the province level. This is in line with the result of Miguel and Roland (2011), who using data from the 1999 Census do not find the bombing to have had any statistically significant

I find no significant relationship between distance to the nearest megalopolis and mental health.

[15]The Census defines a migrant as someone who has changed residence during the five years preceding the survey (and not place of birth). These numbers could be an underestimate as they do not capture those who moved over five years ago, and seasonal migrants who might have returned home during the five years (Marx and Fleischer, 2010).

[16]However, note that as conflict exposure is measured at the district level, the results in this paper are only affected by the extent of inter-district migration.

effect on district-level population density. Third, from the VARHS data we know if the household head or spouse were born in the same commune. As robustness check I limit the analysis sample to only those households where either the household head or spouse were born in the commune of current residence and re-estimate the main results of Table 2 (this is the case for 77% of the sample). Results presented in Table A8 in the Appendix show that the effects are similar. Overall, while these checks alleviate some of the concerns about sample selection, the results could be biased if migration affected certain characteristics of the birth cohorts without affecting the cohort size.

A third potential confounding factor is related to selective mortality. To the extent that stronger, healthier children are more likely to survive, my estimates are an underestimate of the true effects.[17] Birth cohort size is not only a good proxy for migration but maybe considered a proxy for selective mortality as well, as it also encompasses the effects of mortality during and after the conflict (Akbulut-Yuksel, 2017; Minoiu and Shemyakina, 2014). As discussed above, I do not find that bombing intensity does not systematically effect cohort size at either the district level or the province level, suggesting that selective mortality during the conflict may not be biasing the results.

Fourth, I have used the Miguel and Roland (2011) measure of bombing activities as a measure of exposure to the war. While this measure does not include dioxin contaminated herbicides such as Agent Orange used during the conflict, herbicide usage is likely be highly correlated with bombing intensity in Central and South Vietnam (Miguel and Roland 2011; Do 2009).[18] It is estimated that over 72 million liters of herbicides were sprayed, mostly during "Operation Ranch Hand" (1962-1971), containing at least 366 kg of dioxin (Stellman et al., 2003). Dioxin (TCDD) is a highly stable compound and there continue to exist pockets of TCDD contamination even almost 50 years after the conclusion of spraying in Vietnam. In the context of this study, it is possible that direct past exposure or current indirect exposure (via contaminated soil and food) to TCDD could have effects on adult mental health through channels that are different from those of early-life exposure to bombings.[19] As a robustness check I exclude districts that contain current TCDD hotspots and re-estimate the main

[17]Conflict may also lead to endogenous fertility choices further affecting the features of the observed sample.

[18]The US military used Agent Orange and other herbicides to clear forests and destroy crops used by the opposition. The herbicides mixtures contained 2,4,5-trichlorophenoxyacetic acid which was found to be contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD or dioxin).

[19]For example, exposure to TCDD has been associated with increase in the prevalence of cancer, and congenital birth defects in children in Vietnam (Do 2009; Nham Tuyet and Johansson 2001; Pham et al. 2013).

results.[20] These are presented in Table A9 in the Appendix, and show that the effects are similar.

Lastly, one may also be concerned regarding the interpretation of the results when the outcomes are self-reported. Respondents may both understate mental health issues (if they are reticent about them) and overstate them (if the questions evoke loss and sacrifice during the war). If this measurement error in the dependent variables is random, then it will only reduce the precision of the estimates, without biasing the results. For biased reporting of depressive symptoms to be driving the results of this study, individuals would have to systematically report poorer mental health in districts with greater exposure to the war. This seems unlikely, as respondents were not primed about the war before the depressive symptoms module or at any point during the survey. Further, even if reporting bias varied systematically with district-level exposure, as long as reporting bias is similar for individuals born during and after the war in the same district, then the difference-in-difference instrumental variable estimation strategy outlined in equation 3 would account for it. As estimated results in Table 3 show, I still find early-life exposure to conflict to negatively affect long-run mental health. Therefore, I do not believe that differential misreporting is likely to be the main mechanism behind the results.

5.4 Heterogeneity

Having shown that early-life exposure to conflict causes higher prevalence of depressive symptoms during adulthood among affected cohorts, it is instructive to analyze whether these effects differ by gender or ethnicity.

[20] In assessments conducted during 2002-05, 33 sites were deemed to have residual TCDD levels that posed a risk to public health (US-Vietnam Dialogue Group On Agent Orange/Dioxin, 2012).

Table 5: Heterogeneity results

	Log CES-D (1)	Severe Stress (2)	Log CES-D (3)	Severe Stress (4)
Panel A: Gender				
	Males		*Females*	
Log total bombing per km^2	0.248**	0.199**	0.185**	0.137**
	(0.125)	(0.085)	(0.077)	(0.065)
Controls	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes
Mean of dep. var.	1.79	0.28	1.90	0.34
N	930	930	491	491
Panel B: Ethnicity				
	Kinh		*non-Kinh*	
Log total bombing per km^2	0.222*	0.185**	-0.891	-0.904
	(0.120)	(0.081)	(1.538)	(1.707)
Controls	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes
Mean of dep. var.	1.80	0.27	1.90	0.39
N	998	998	423	423

Notes: This table reports instrumental variable estimates described in the text. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.

Source: Author's calculations based on the survey data.

Substantial literature finds gender bias in parental investments during early childhood. Such bias might result in heterogeneous impacts of the conflict on boys and girls (see Buvinic et al. 2013 for a review). In Panel A of Table 5 we examine if this is the case by estimating the long-term effects of war on mental health separately for men and women. Column 1 shows that, on average, a 1 percent increase in the amount of bombing in Vietnam leads to a 25 percent increase in depressive symptoms among males. Turning to column 2 we find that it also increases the likelihood of severe mental distress in adulthood by 20 percentage points among males. This is more than two-thirds of the mean prevalence of severe mental distress among males (prevalence is 28 percent). Columns 3 and 4 show the corresponding analysis for females. While we find similar effects on females, the magnitudes are slightly smaller - a 1 percent increase in the amount of bombing increases depressive symptoms by 19 percent and the likelihood of severe mental distress by 13.7 percentage points (over an average of 34 percent) for females. Overall, our separate estimations of the impact of early-life exposure to war on boys and girls find that both suffer similar negative consequences.

In Panel B of Table 5 I present the effects by ethnicity. The ethnic majority in Vietnam are the Kinh while the ethnic minority consist of 53 other ethnic groups. The results show that exposure to conflict during early childhood negatively affects mental health status during adulthood only for the Kinh. On average, a 1 percent increase in the amount of bombing in Vietnam leads to a 22.2 percent increase in the CES-D score and an approximately 19 percentage point increase in the likelihood of severe mental distress for the Kinh. There are no corresponding effects for the non-Kinh. However, I can not reject the null hypothesis that the effects are similar across the two groups (p-value = 0.47 for log CES-D score, and 0.52 for severe distress).

6 Discussion

6.1 Mechanisms

I find that exposure to greater conflict in early childhood leads to higher depressive symptoms during adulthood in Vietnam. Understanding the channels through which this occurs is essential to framing policies that protect children from adverse effects of war. In the discussion that follows, I argue that the primary channel for this effect are adverse circumstances faced during the formative years. While I do not have detailed household data to disentangle various competing mechanisms, I provide suggestive evidence of the likely pathways by which conflict affects mental health.

Conflict could have lowered household income and/or resulted in psychological stress, both directly or indirectly via injury or death of a family member. According to the "fetal origins hypothesis" of Barker (2001) poor conditions during the prenatal period can "program" a fetus to have metabolic characteristics associated with future disease, such as coronary heart disease and diabetes at older ages. Furthermore, as discussed in Section 1, a number of recent studies, using a variety of methods and data sets, document a negative effect of conflict on long-term indicators of well-being such as birth weight and height (Bundervoet et al., 2009; Minoiu and Shemyakina, 2014; Mansour and Rees, 2012). Indeed, malnutrition, especially during the fetal stage, has been linked to lower adult mental health in a number of studies (Almond and Mazumder, 2011; Neugebauer et al., 1999; Adhvaryu et al., 2016; see Lumey et al. 2011 for a review).

Growing up during a conflict also exposes children to toxic stress - a continuous activation of a stress response system over a prolonged period, with severe consequences for development of healthy brain architecture. Over-stimulation of stress response system can lead to elevated levels of the cortisol stress hormones in the brain, resulting in hypertrophy in the amygdala, and deterioration of neural network in the hippocampus and prefrontal cortex (Shonkoff et al., 2012; Danese and McEwen, 2012; Heim and Nemeroff, 2001). This in turn can adversely affect memory, learning ability, and tolerance for stress, thereby increasing the risk of mental health problems in the future. Furthermore, by impairing cognitive development at an early age, toxic stress can lead to lower levels of education, income and physical health, and addiction - all of which may, too, adversely affect mental health. In addition to a number of epidemiological studies examining this channel, a few recent studies in economics highlight this mechanism too. Using administrative data from Sweden, Persson and Rossin-Slater (2018) find that *in-utero* exposure to maternal stress from the death of a close relative leads to an increase in the take-up of medication related to depression in adulthood.

I use the VLSS 97-98 to comment on the relative importance of these two sub-channels. The VLSS 97-98 gathered anthropometric measures - heights and weights - of all individuals in the household. In addition to gender and ethnicity, the survey also recorded if the parents of each individual were alive at the time of the survey. However, in the VLSS data one can only identify the province where the surveyed household resides. Therefore we compute province level averages of the total bombings and all other district-level controls used in Table 2, and conduct the same instrumental variable analysis (equations 1-2) at the province level.

Table 6: Mechanisms: impact of war on anthropometric outcomes and parental survival

	Height-for-age	Weight-for-age	Parents alive in 1998	
	(z-score)	(z-score)	Father alive	Mother alive
	(1)	(2)	(3)	(4)
Log total bombing per km^2	-0.026***	-0.021	-0.013	-0.012
	(0.007)	(0.019)	(0.013)	(0.014)
Controls	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes
N	5910	5911	6209	6209

Notes: This table reports instrumental variable estimates using the VLSS 97/98 data. Height for age and weight for age are standardized z-scores. Controls include gender, ethnicity, a dummy for Former South Vietnam, and provincial level averages of pre-war population, rainfall and temperatures during the war, latitude, and proportion of land in different altitude and soil categories. Standard errors clustered at the province level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

Columns 1 and 2 of Table 6 show the effects on adult height-for-age and weight-for-age z-scores, respectively. Adult height-for-age has been established as a strong proxy for *in utero* and early childhood socio-economic conditions (see Strauss and Thomas, 2007 for a review). Alternatively, weight-for-age has been found to reflect current socio-economic circumstances. The results show that exposure to conflict in early childhood significantly reduced adult height-for-age by 0.026 standard deviations. As one standard deviation of height-for-age in the estimation sample is equivalent to 0.914, and the average respondent is 30 years old, this implies that the conflict resulted in a deficit of approximately 0.71 centimeters in adult height. This effect comparable to impact of early-life exposure to 1967-70 Nigerian civil war reported in Akresh et al. (2012), who find girls aged 3 and below during the war to be 0.75 centimeters shorter in adulthood, relative to girls in unaffected areas. While the corresponding effect on weight-for-age is also negative, it is not statistically significant. This is in line with Miguel and Roland (2011) who find that the affected regions had recovered by the end of the 20th century, possibly due to the inflow of aid and investment.

Results in columns 3 and 4 of Table 6 show that the likelihood that an individual had a parent alive in 1997-98 did not differ systematically with exposure to the conflict. Taken together, the results presented in Table 6 suggest that the negative long-term effects on mental health are more likely to be driven by early-life conditions such as malnutrition, stress, etc. than the loss of a parent during the war.

Finally, using VARHS 2016 data we can also rule out alternative explanations such as contemporary access to health care and exposure to other shocks. First, differences in current mental well-being across districts could be due to unequal access to health care. For instance, the war could have affected everyone equally but lower availability of health care during the post-war years in the more bombed districts could result in higher incidence of depressive symptoms. I check if this is the case by using household distance to the nearest hospital as a proxy for access to health care. Results reported in column 1 of Table 7 indicate that unequal access to health care do not explain my results.[21]

Next, I check if differences in current mental well-being are due to systematic differences in exposure to contemporary shocks. The VARHS data has information on household exposure to three types of shocks in the two years preceding the survey: (i) natural shocks such as flooding, drought, typhoons, etc.; (ii) economic shocks such as changes in crop or food prices, unemployment, theft, etc.; and (iii) serious illness, injury or death of a household member. The outcomes in columns 2-4 of Table 7 are dummy variables that take the value 1 if the household was exposed to these categories of shocks. As the results indicate, I do not find adults exposed to more conflict in early life to be more susceptible to shocks. Finally, I also check if the results could be driven by differences in household size and do not find this to be the case (column 5 of Table 7).

[21] While there are no differences in the availability of health care, take-up could be low due to stigma associated with seeking help for mental-health related issues. However, Das et al. (2009) find that across a number of developing countries, individuals with poor mental health are more likely to utilize existing health services. Furthermore, we have no reason to suspect that this varies systematically across districts.

Table 7: Mechanisms: differences in socio-economic conditions

	Distance to hospital (km)	Shocks to household			Household size
		Natural disaster	Economic	Illness or death	
	(1)	(2)	(3)	(4)	(5)
Log total bombing per km^2	-1.321	0.036	0.008	-0.043	0.014
	(0.909)	(0.046)	(0.011)	(0.028)	(0.116)
Controls	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean of dep. var.	12.82	0.29	0.04	0.09	4.55
N	1391	1421	1421	1421	1421

Notes: This table reports instrumental variable estimates described in the text. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

6.2 Other health outcomes

In this section I check if early-life exposure to conflict also affected adult health in a number of other dimensions. Respondents were asked how often in the 30 days preceding the survey, they (i) had difficulty sleeping, (ii) did not feel like eating, (iii) had bodily aches and pains, and (iv) had difficulty remembering things. The responses are coded on a scale of 1 to 4 (none of the time, some of the time, most of the time, and all the time) such that a higher number indicates worse health outcomes. Effects on these measures are reported in columns 1-4 of Table 8. I find that while these is no effect on appetite, those with a greater exposure to conflict are more likely to experience bodily aches and pains, and have difficulty sleeping and remembering things. Taken together, these results provide some evidence of a more general adverse effect of early-life exposure to conflict on adult health.

Table 8: Effects on other health measures

	In last 30 days....			
	Difficulty sleeping (1)	Loss in appetite (2)	Bodily aches (3)	Memory loss (4)
Log total bombing per km^2	0.140**	0.046	0.152**	0.208***
	(0.062)	(0.054)	(0.061)	(0.075)
Controls	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes
Mean of dep. var.	1.79	1.65	1.77	1.63
N	1420	1421	1421	1421

Notes: This table reports instrumental variable estimates described in the text. All outcome variables are coded on a scale of 1 to 4 (none of the time, some of the time, most of the time, and all the time) such that a higher number indicates worse health outcomes. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

7 Conclusion

In this paper we examine how adverse shocks in early life can have enduring consequences. In the context of the American bombing campaign in Vietnam during 1965-75, we find that children aged 5 or below during the war report higher depressive symptoms in adulthood.

The paper adds to the evidence on the long-term risks to children exposed to conflict. Through no fault of their own, children living in fragile and conflict-affected states are denied a chance to learn and develop the necessary skills to become fully functional members of society. Results presented here highlight that ensuring a safe environment for children to grow in is paramount for their lifelong physical and mental well-being. Unfortunately with continuing conflict all over the world, not all children are exposed to such secure environments during their formative years.

The results imply that the costs of war on children are greater than has been previously estimated. While existing studies have found significant negative effects on physical health and education, there can be adverse effects on mental health as well. From a policy perspective, the paper identifies cohorts in need of better access to mental healthcare in Vietnam. Furthermore, psychological well-being of children is closely associated with that of their parents and caregivers (Goodman and Gotlib, 1999). As the group being examined in this study are currently parents, addressing their mental health issues may have broader impacts by limiting inter-generational transmission of poor mental health.

A more general policy implication could be to prioritize provision of healthcare in post-conflict societies, not only to adults but also to children (Addison et al., 2016). While there are policies in place to assist war veterans with mental health problems such as post-traumatic stress disorder (PTSD), children who grow up during the war without participating are often overlooked from a policy perspective. Mental healthcare for children can be integrated into such post-conflict health programs in order to address their psychosocial needs.

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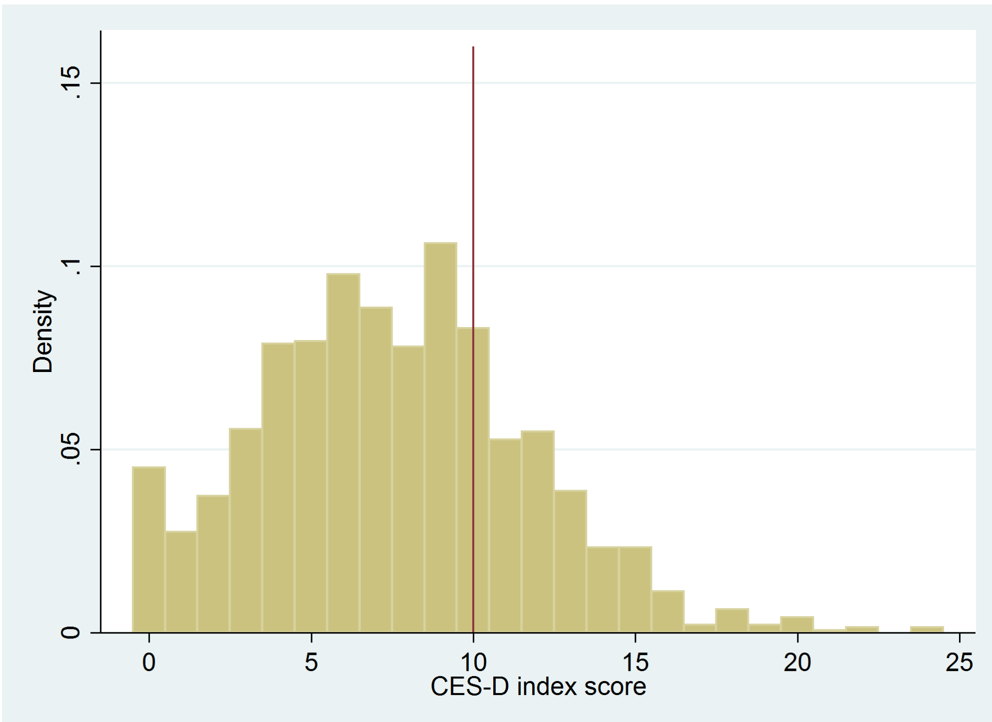
Appendices for:

Early life shocks and mental health: The long-term effect of war in Vietnam

Figure A1: Density of CES-D score



Notes: The red line at a CES-D score of 10 represents the threshold for severe stress.
Source: Author's illustration based on the survey data.

Table A1: CES-D questions

In the last 7 days	
1	how often did you sleep well?
2	how often were you happy?
3	how often did you have trouble concentrating in what you were doing?
4	how often did you feel hopeful about the future?
5	how often did you feel that everything you did was an effort?
6	how often did you feel lonely?
7	how often did you feel depressed?
8	how often did you feel that you could not "get going"?
9	how often were you bothered by things that don't usually bother you?
10	how often did you feel fearful?

Notes: Respondents were asked to indicate how often they had these feelings in the last week on a four-scale metric - "never (0 days in a week)", "sometimes (1-2 days of the week)", "often (3-4 days of the week)", and "all the time (5-7 days of in a week)". These responses are coded from 0 to 3 respectively. The response scale is reversed for the positive questions, so that they have the same sign as those negative questions.
Source: The VARHS survey.

Table A2: War and mental health: First stage and reduced form results

	Log total bombing per km^2 (1)	Log CES-D (2)	Severe Stress (3)
abs(Latitude - 17 N)	-0.755***	-0.166***	-0.121***
	(0.238)	(0.041)	(0.028)
Female	0.100**	0.135***	0.077***
	(0.049)	(0.038)	(0.026)
Non-Kinh	-0.409**	0.078	0.047
	(0.174)	(0.071)	(0.052)
Former South Vietnam	0.412	-1.323***	-0.341
	(1.712)	(0.326)	(0.207)
Population density, 1960-61	0.008**	0.001	0.002***
	(0.004)	(0.001)	(0.000)
Latitude	0.187	-0.106***	-0.023
	(0.234)	(0.038)	(0.026)
Av. precipitation (cm)	0.000	-0.002	-0.003***
	(0.012)	(0.002)	(0.001)
Av. temperature (Celsius)	0.488	-0.101	-0.105**
	(0.381)	(0.070)	(0.048)
Geographical controls	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes
Kleibergen-Paap F stat	10.08		
N	1421	1421	1421
R^2	0.80	0.12	0.12

Notes: Geographical controls include proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

Table A3: Robustness check: CES-D components

	Sleepless	Unhappy	Trouble concentrating	Future hopeless	Everything an effort
	(1)	(2)	(3)	(4)	(5)
Log total bombing per km^2	0.169**	0.154*	0.113**	0.237***	-0.091
	(0.081)	(0.085)	(0.050)	(0.086)	(0.073)
Mean of dep. var.	0.84	1.03	0.79	1.08	1.28
	Felt lonely	Depressed	Could not “get going”	Easily bothered	Fearful
	(6)	(7)	(8)	(9)	(10)
Log total bombing per km^2	0.041	0.162**	0.107*	0.234***	0.111
	(0.069)	(0.070)	(0.061)	(0.080)	(0.072)
Mean of dep. var.	0.47	0.60	0.55	0.62	0.29
Controls	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	1421	1421	1421	1421	1421

Notes: This table reports instrumental variable estimates described in the text. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.

Source: Author’s calculations based on the survey data.

Table A4: Robustness check: District-level

	OLS		IV	
	Log CES-D	Severe Stress	Log CES-D	Severe Stress
	(1)	(2)	(3)	(4)
Log(Total U.S. bombs, missiles, rockets per km2)	-0.025	-0.007	0.248	0.238**
	(0.027)	(0.018)	(0.154)	(0.115)
Former South Vietnam	-0.995*	-0.380	-1.096**	-0.470
	(0.517)	(0.289)	(0.459)	(0.369)
Population density, 1960-61	-0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Latitude	-0.099	-0.021	-0.148**	-0.064
	(0.060)	(0.034)	(0.065)	(0.054)
Av. precipitation (cm)	0.000	-0.001	-0.004	-0.005*
	(0.004)	(0.001)	(0.004)	(0.003)
Av. temperature (Celsius)	0.077	0.083	-0.255	-0.213
	(0.078)	(0.051)	(0.193)	(0.150)
Constant	2.025	-1.162	11.120**	6.962
	(2.531)	(1.623)	(5.552)	(4.416)
Geographical controls	Yes	Yes	Yes	Yes
N	112	112	112	112

Notes: This table reports linear regression estimates described in the text. Geographical controls include proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.

Source: Author's calculations based on the survey data.

Table A5: Robustness check: Severe stress (Probit)

	Probit (1)	Probit-IV (2)
Log total bombing per km^2	-0.033	0.407***
	(0.037)	(0.125)
Female	0.248***	0.173**
	(0.078)	(0.081)
Non-Kinh	0.170	0.293*
	(0.165)	(0.150)
Population density, 1960-61	0.002	0.001
	(0.001)	(0.002)
Former South Vietnam	-0.522	-1.163
	(0.753)	(0.913)
Latitude	-0.018	-0.149
	(0.097)	(0.121)
Av. precipitation (cm)	-0.002	-0.007
	(0.003)	(0.006)
Av. temperature (Celsius)	0.157	-0.480**
	(0.123)	(0.218)
Geographical Controls	Yes	Yes
Cohort Fixed Effects	Yes	Yes
N	1421	1421

Notes: This table reports probit regression estimates for severe stress. Geographical controls include proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

Table A6: Reduced form: controlling for distance to nearest megalopolis

	Log CES-D	Severe Stress
	(1)	(2)
abs(Latitude - 17 N)	-0.162***	-0.109***
	(0.043)	(0.027)
Dist to nearest megalopolis (km)	-0.000	-0.001
	(0.001)	(0.000)
Controls	Yes	Yes
Cohort Fixed Effects	Yes	Yes
N	1421	1421

Notes: This table reports reduced form estimates described in the text. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Dist to nearest megalopolis is the distance to the nearest of the two biggest cities - Hanoi/Ho Chi Minh City (HCMC). Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

Table A7: Robustness check: Variation in cohort size

	District cohort size (VARHS) (1)	Province cohort size (VLSS 97-98) (2)
Log total bombing per km^2	-0.369	-0.135
	(0.284)	(0.381)
Controls	Yes	Yes
Cohort Fixed Effects	Yes	Yes
N	1792	944

Notes: This table reports instrumental variable estimates described in the text. Controls in column 1 include pre-war population (province level), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Column 2 includes the same controls averaged at the province level. Standard errors are clustered at the district level in column 1 and at the province level in column 2. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.

Table A8: Robustness check: IV results excluding potential movers

	Log CES-D (1)	Severe Stress (2)
Log total bombing per km^2	0.131*	0.097**
	(0.067)	(0.043)
Female	0.152***	0.085***
	(0.047)	(0.033)
Non-Kinh	0.103	0.055
	(0.073)	(0.071)
Population density, 1960-61	-0.001	0.000
	(0.001)	(0.001)
Former South Vietnam	-1.708***	-0.560*
	(0.369)	(0.297)
Latitude	-0.164***	-0.055
	(0.055)	(0.044)
Av. precipitation (cm)	0.001	-0.001
	(0.003)	(0.002)
Av. temperature (Celsius)	-0.074	-0.088
	(0.128)	(0.084)
Geographical controls	Yes	Yes
Cohort Fixed Effects	Yes	Yes
Mean of dep. var.	1.79	0.28
N	1088	1088

Notes: This table reports instrumental variable estimates described in the text. Geographical controls include proportion of district land in different altitude and soil categories. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.

Source: Author's calculations based on the survey data.

Table A9: Robustness check: IV results excluding dioxin hotspots

	Log CES-D (1)	Severe Stress (2)
Log total bombing per km^2	0.180*	0.157**
	(0.106)	(0.079)
Controls	Yes	Yes
Cohort Fixed Effects	Yes	Yes
Mean of dep. var.	1.83	0.31
N	1351	1351

Notes: This table reports instrumental variable estimates described in the text. Controls include gender, ethnicity, pre-war population (province), district level average rainfall and temperatures during the war, a dummy for Former South Vietnam, latitude, and proportion of district land in different altitude and soil categories. Locations deemed to have significant levels of dioxin by the US-Vietnam Dialogue Group On Agent Orange/Dioxin (2012) were excluded. Standard errors clustered at the district level are reported in parentheses. * significant at 10%,** significant at 5%,*** significant at 1%.
Source: Author's calculations based on the survey data.