# The aerial bombing of Cambodia and the recovery of communities*

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**Abstract**

We study how local areas in Cambodia are still shaped by past exposure to US bombing decades ago, leading to divergent patterns in health and economic development. Using a wide range of geo-coded data and a spatial regression discontinuity adapted to many boundaries, we find that the long-term impacts of past bombings vary significantly by location dependent on whether they persist as unexploded ordnance (UXO). In areas of hard ground, bombs are more likely to detonate leaving destruction but no lingering risk, while in soft ground, bombs fail more frequently leaving UXO. We confirm this pattern using data on causalities from explosive remnants of war, and we then show this difference gives rise to a diverging pattern in health and economic development. In bombed, hard ground locations that are free from the dangers of UXO, investments in economic activities and healthcare infrastructure have even improved outcomes post-conflict. However, in areas where UXO remains a threat, development has been hindered, and negative consequences are persistent. Overall, our results offer an important lesson that while conflicts can be harmful, the impacts on future generations can be mitigated through investments in the post-conflict era, if remnants of war no longer remain.

**Keywords**: Cambodia, bombing, conflict, unexploded ordnance, health, economic development
**JEL-Codes**: I10, I15, I18

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## 1 Introduction

Millions of people in developing countries live on land exposed to explosive ordnance that continues to shape their communities decades after the conflicts have ended. Particularly, during the Indochina War, the United States dropped over 7.5 million tons of munitions on the Indochinese peninsula – more than twice the tonnage of World War II – leaving vast areas either destroyed or littered with unexploded ordnance (UXO). Conflicts clearly affect individual health and development (Akbulut-Yuksel 2017, Akresh et al. 2012, Islam et al. 2016), but in the long-run, past destruction from exploded bombs or the unexploded remnants of war may influence a divergence in the local recovery of communities and shape the well-being of future generations. While some evidence suggests that conflicts impose enduring harm on local development (Abadie & Gardeazabal 2003, Yamada & Yamada 2021), others highlight opportunities for revitalization (Davis & Weinstein 2002, Miguel & Roland 2011, Strauss & Thomas 2008). This tension raises a critical question: how does the legacy of either past destruction or unexploded ordnance influence long-term recovery and health outcomes?

To address this, we examine the case of Cambodia, a nation profoundly impacted by US bombing campaigns during the late 1960s and early 1970s. We draw on individual-level health data among women over thirty years post-bombing from the Cambodian Demographic and Health Survey (DHS), spatial information on US airstrike missions from the Yale University Cambodian Genocide Program, multiple historical data sources that we digitize on pre-bombing demographics and transportation networks, and contemporary data on causalities from explosive remnants of war, economic outcomes, and healthcare infrastructure. Based on the bombing data, we identify areas profoundly impacted by the bombing and establish bombing boundaries dividing regions subjected to bombings from those that were not.[1]

We start by focusing on how health outcomes diverge across communities in the long-term based on whether the bombing left destruction or remants of war that may render the land dangerous many decades later. Continued exposure to unexploded ordnance heightens risk and may depress activity compared to destruction from exploded bombs which may be more readily built over. We first distinguish between bombed locations with high versus low UXO risks, drawing on Lin (2022) who demonstrates with extensive ethnographic fieldwork that bombs were less likely to detonate on soft, fertile soil. To assess this, we match pre-bombing soil fertility data with contemporary data on UXO-related incidents. In Section 4, using a simple difference-in-differences framework, we show that bombed areas with soft soil exhibit significantly higher UXO incidents today, with an effect size equivalent to 18% of the mean UXO rate. We then show that health, income, agriculture, and infrastructure are also worse in these same areas today.

In Cambodia, bombed areas with soft soil remain disproportionately affected by past exposure, whereas harder ground locations may be more likely safe for re-development. This could lead to a divergence in the long-term effects from the bombing with significant

[1] We leverage a method from epidemiology that draws grids across Cambodia preserving the spatial clustering of strikes. We discuss this in more detail in Section 3.

implications for spatial inequality, well-being, and the value of UXO clearance. Motivated by these observations, we next turn to provide evidence on this divergence through identifying the effect of bombing on the health outcomes of women today separately across low and high UXO risk areas. Health, in particular, has long been considered an important dimension of well-being (Deaton 2003, Helliwell et al. 2020) and better health is linked with better labor market outcomes (Stephens Jr & Toohey 2022). We view health as an important outcome to capture potential long-run differences in well-being. In later parts of the paper, we turn to assess economic activity and health infrastructure as drivers of divergence.

Identifying the long-term effects of the bombing is challenging due to potential selection bias in bombing site locations, while instrument designs may lack suitable randomness. To overcome this challenge, we employ a spatial regression discontinuity design (RDD), similar to Bühler (2023), Dell (2010), and Dell et al. (2018), with the geographic coordinates of households as running variables. We compare individuals on either side of constructed bombing boundaries and show that our design passes a range of validity checks around the core RDD assumptions, ensuring that observed discontinuities in outcomes are attributable to bombing exposure rather than other factors (Section 5).[2] Importantly, in our design, we show that soil softness is independent of residing in a bombed location, which we will then use to split our analysis by low and high UXO risk locations.

In Section 6.1, we provide evidence on the long-term health effects for women living in previously bombed areas. Overall, health outcomes are improved in areas with low UXO risks (hard soil) relative to control hard soil areas. Specifically, women in bombed, hard soil locations have 5% higher height-for-age Z-scores, are less likely to be underweight (2.5 percentage points), and are less likely to suffer from anemia (3 percentage points). In contrast, areas with high UXO risks (soft soil) show null or slightly harmful effects relative to control soft soil areas, which are likely conservative estimates due to reasons discussed in Section 5. Further, these findings are robust to an extensive set of sensitivity checks giving confidence to the credibility of the evidence.

Next, we turn to economic development and health infrastructure to explain these results. It is possible that the re-vitalization of locations having experienced destruction could offer better economic activity and health access but this is only likely to occur in areas where activity is safe, i.e., the low UXO locations. Of course, at present if the estimated returns to clearing UXO are considered high, then locations may be made safe for development. However, our approach is designed so that comparisons are made among bombing locations independent of factors at the time of bombing likely to make them targeted and potentially better for re-development. Consistent with this, in our design bombing locations are independent of observable factors contemporaneous to the bombing, such as distance to major railways or roads, soil fertility, agricultural activity, population density, and other measures. Thus, our evidence points toward the value of

[2] It is crucial that outcomes are transformed smoothly as we move in geographic space except for discontinuities at the boundaries due to the long-run effects of local area exposure to bombing. We discuss this in more detail in Section 5.

UXO clearance being under-estimated through missed opportunity for improvements in health and development.

In Section 7, using our empirical design, we show that long-run improved economic activity and healthcare infrastructure in bombed locations appear only in hard soil, low UXO areas. This findings highlight that re-vitalization can emerge where bombs caused destruction but do not leave lingering risk. Particularly, we observe several positive effects on economic development in hard soil areas, including higher population and market densities, increased household income and family wealth, and greater educational attainment among women. Turning to health accessibility, distances to health facilities today are significantly shorter within hard ground locations for those on the bombing side, even in the region where health facilities were highly concentrated. Given the fact that the national healthcare system in Cambodia was totally destroyed due to US bombing and the Khmer Rouge Genocide, our findings indicate that areas previously affected by bombing exhibit better healthcare infrastructure development in the post-conflict period. Finally, bombed locations in pre-bombing soft soil areas compared to unbombed, soft soil areas experience consistently harmful effects on these outcomes. In these areas, we find negative effects on economic development, characterized by lower night-time light intensity, reduced crop yields and revenue based on household data, and a higher likelihood of families experiencing food shortage.

Our findings provide an answer to the puzzle of whether post-conflict areas experience revitalization and development or endure long-term harm and under-development. We demonstrate significant variation in long-term outcomes depending on whether bombs still shape activities in the area today. The lack of sufficient evidence on long-term well-being, such as health, obscures the true benefits of investments in UXO removal, particularly in resource-constrained settings where immediate returns may seem less tangible. Our evidence highlights the substantial long-term costs of UXO and the importance of effective clearance efforts. Additionally, it suggests that revitalizing previously destroyed areas offers substantial potential for improving well-being and development, underscoring the importance of post-conflict targeted interventions. In the case of Cambodia, bombed hard soil areas can re-build, while soft soil locations remain UXO-prone, resulting in a divergence of outcomes decades after the bombs were dropped.

**Related literature.** Altogether, our results contribute to the literature on how explosive ordnance shapes activity in the long term. For residents in locations with active UXO, its presence intrudes on every aspect of daily life (Lin 2024). Several recent studies demonstrate the costs of UXO across multiple war torn countries. Guo (2020) examines the impacts of UXO in Laos by instrumenting locations where airstrikes were more intense with distance to important bombing centers, showing that more intensive bombings harm long-term educational outcomes. Similarly, Riano & Valencia Caicedo (2024) leverage geographic instruments to provide evidence of economic harm mediated through the persistent presence of UXO in Laos. In Vietnam, Nguyen et al. (2024) then shows that increased UXO contamination negatively impacts the density of foreign direct investment, large firms, and economic activity. We advance this literature demonstrating how development and well-being can improve in the long-run where revitalization is possible, in contrast to regions hindered by the persistent presence of UXO.

We further connect to a literature on the value of landmine removal. Estimates of landmine clearance efforts in Cambodia have conflicted on whether the net benefits are positive. This is partly through the high cost of removal and difference in the estimated benefits (Cameron et al. 2010, Harris 2000). Further afield, Chiovelli et al. (2018) demonstrates that landmine clearance enhances transportation network linkages and economic activity in Mozambique, offering an important lesson that the value of clearance can be easy to miss. We focus on aerial bombings which are wide-spread, hard to pin down to particular contamination fields where bombs failed to explode, and potentially are even more costly to clear. Thus, a divergence in community economic activity and individual's well-being becomes very important to understand the possible value of a costly search and clearance of the remnants of war from aerial bombings.

Our study also adds to existing literature on the long-term impacts of war and human conflicts on health. Most studies in this field have focused on generations who are directly exposed to conflicts either *in utero* or in their early childhood. Numerous papers have found negative health impacts for those directly exposed to conflicts,[3] and a wide range of work also finds similar effects on the next generation.[4] These studies are grounded in the "Fetal Origins Hypothesis", which posits a connection between prenatal environment and the development of future diseases (Barker 1990). Additionally, conflicts also affect the next generation because parents' health inputs, family background, and environmental factors are determinants of an individual's health (Strauss & Thomas 2008). However, only a limited number of studies have delved into how conflicts affect differences in health and well-being in the long-run.[5] We show health can diverge dependent on the ability to re-vitalize.

Finally, we speak to a literature assessing how historical differences affect long-run development. In general, the imprint of better organizational systems or institutions leads to better outcomes many years after the original systems have gone (Dell & Olken 2020, Dell et al. 2018), while deeply extractive and repressive systems without the building of organizations or institutions lead to lower development years after the repression ends (Dell 2010). War and conflicts may have indirect repercussions on human life through the destruction of infrastructure such as hospitals, schools, and food systems (Levy 2002, Frost et al. 2017) and through economic wealth and public health (Ghobarah et al. 2003). However, post-war investments in public healthcare, infrastructure, and human capital accumulation have the potential to gradually mitigate and cancel out negative shocks

[3] A variety of work finds that exposure to conflicts and external shocks leads to lower birth weights (Camacho 2008, Mansour & Rees 2012, Maric et al. 2010), lower height-for-age scores among children (Sonne & Nillesen n.d., Duque 2017, Islam et al. 2017), lower adult height (Akresh et al. 2012, Akbulut-Yuksel 2014), overweight likelihood (Akresh et al. 2023), or reduced life expectancy (Akresh et al. 2012)

[4] The evidence of negative health impacts on the second generation is found in Britain (Emanuel et al. 1992), Denmark (Eriksson et al. 2005), and Cambodia (Moyano 2017, Islam et al. 2017).

[5] Palmer et al. (2019) find more disability at present in locations exposed to intense bombing in Vietnam and Yamashita & Trinh (2022) find chemical exposure of locations to Agent Orange in southern Vietnam is still associated with greater disability 30-years later.

(Strauss & Thomas 2008). Adverse effects may be fully alleviated after multiple generations as a region strives to restore its pre-war conditions (Devakumar et al. 2014). By examining populations living in areas affected by past bombing in Cambodia, we address how conflicts shape local recovery in the long run, showing the impact varies significantly dependent on how the past shapes activities today.

In the following section, we provide a historical overview of the US bombing campaign in Cambodia. Next, in Section 3, we discuss the data and our construction of bombing areas and bombing boundaries followed in Section 4 by analysis on the likelihood of local UXO causalities and preliminary evidence on health outcomes. In Section 5, we present our empirical strategy and assumptions behind this framework and the results on health in Section 6. Finally, in Section 7, we examine different mechanisms that potentially shed light on our results and conclude in Section 8.

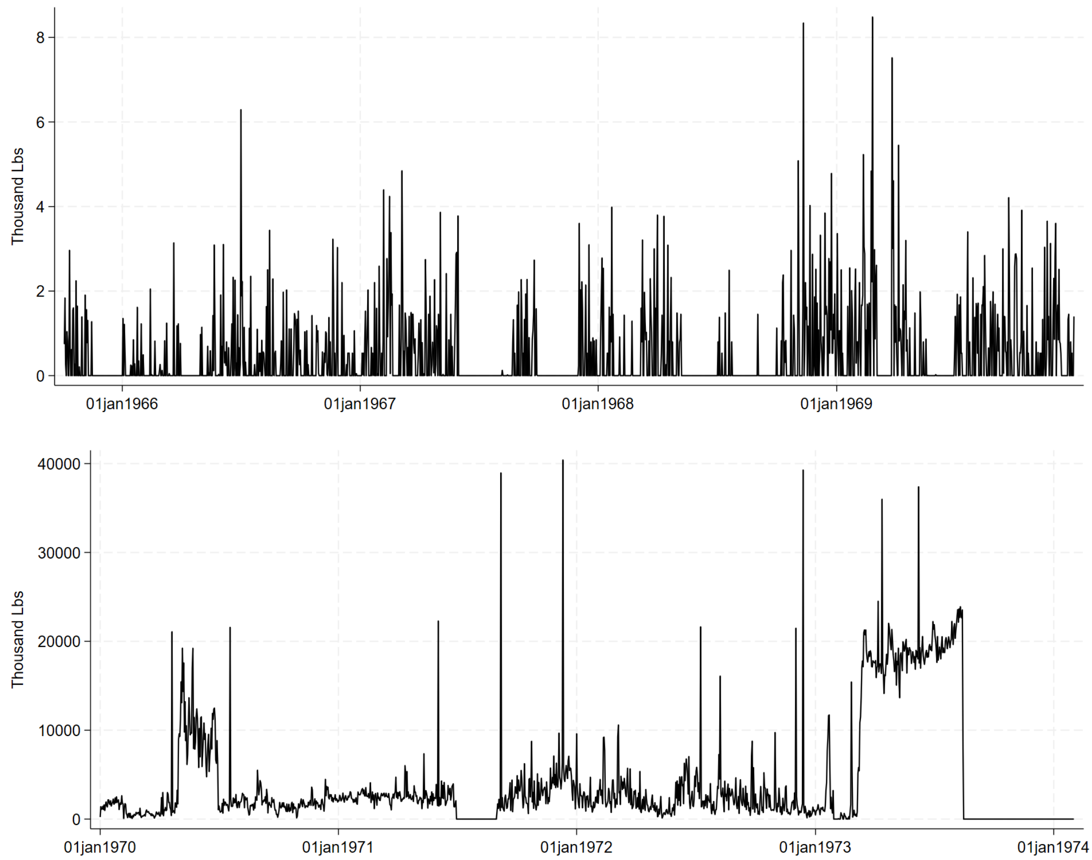
## 2 Historical background

Over the last century, Cambodia experienced a sequence of events, including colonisation, civil wars and genocide (Rany et al. 2012, Chandler 2018). After a 90-year period of French protectorate and colonization from 1863-1953, independence was established in the country at the Geneva Conference on November 9th, 1953. Following a coup d'état on 18 March 1970, Prince Sihanouk, who was leading the country at the time, was deposed by the Lon Nol Government. This event triggered a civil war within the country lasting until 1975. In April 1975, the Khmer Rouge, led by Pol Pot, took control of the country, marking the end of the civil war and the beginning of a period often referred to as genocide. During this time, approximately 1.7 million people were tragically lost due to executions, punishment, exhaustion, illness, and deprivation. The Khmer Rouge regime persisted until 1979 when a new government was established with the support of Vietnamese forces. However, political instability still remained in the country until the establishment of the UN protectorate over Cambodia in 1991 at the Paris Peace Conference (Rany et al. 2012, Chandler 2018).

During 1965-1975, the country suffered from the spill-over of the Vietnam-American War through extensive bombing campaigns. Cambodia is historically recognized as one of the most heavily bombed country (Owen & Kiernan 2006). Beginning in 1965, under the Johnson administration, Cambodia was subjected to bombing aimed at disrupting supply lines and destroying Communist bases. The initial intense wave of bombings at this time, known as the Menu campaign, targeted Cambodia's border areas and concluded in May 1970 following the coup. After the coup in 1970, the bombing campaign of the U.S. military forces was not only to eradicate Vietnam Communist forces but also to support Lon Nol's regime in the internal civil war. Funding for the war was halted in 1973 when the U.S. Congress became aware of Nixon's deception regarding the military campaign (Owen & Kiernan 2006).

Data from Yale University (Cambodian Genocide Program) reveal that 2,757,107 tons of munitions were dropped on 115,273 bombing sites in Cambodia. This amount of

Figure 1: US ordnance dropped on Cambodia

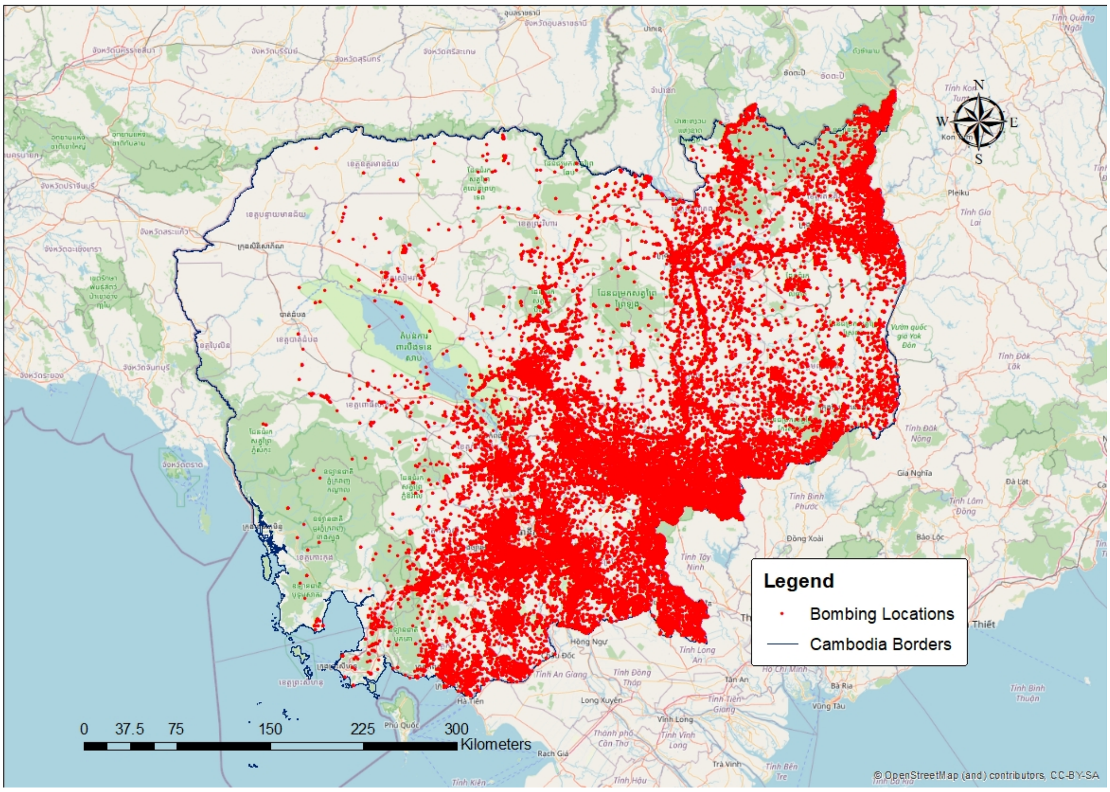



*Notes:* Calculations by the authors' from the Yale University Cambodia Genocide Project data on the universe of US airstrikes in Cambodia with detailed information on payload sizes for each strike.

bombing far exceeded the amount dropped by the Allies during World War II - around 2 million tons in total (Owen & Kiernan 2006). As we can see in Figure 1, starting from January 1st, 1970, bombing escalated in Cambodia, increasing dramatically from less than one ton per day to hundreds or even tens of thousands of tons per day. Additionally, Figure 2 demonstrates that while many of the bombing sites were located in Eastern Cambodia close to Vietnam's borders, the bombing campaign spread over significant portions of the interior. The previously estimated number of casualties caused by this campaign was between 50,000 and 150,000 people, yet it is alleged that aerial bombings caused the death of 600,000 Cambodians (Ear 1995), not to mention other consequences such as starvation and displacement. The bombing and conflict also had significant impacts on health in Cambodian with the reduction in life expectancy and poor nutritional outcomes (Moyano 2017).

The bombing can also pose threats to people's livelihoods today through the presence of unexploded ordnance. Unexploded ordnance (UXO) denotes military ammunition or explosive devices that have not functioned as they should, often known as Explosive Remnants of War (ERW). Ariel bombs that failed to explode are categorized as UXOs (Martin et al. 2019). In Cambodia, decades of armed conflicts, including the U.S. aerial bombing, the Vietnamese invasion in 1979, and civil wars in the 1970s and 1980s, have deeply

Figure 2: Bombing sites targeted in Cambodia




*Notes:* Red dots give the location of bombing sites between October 1965 and May 1975. Data provided by Yale University (Cambodian Genocide Program). Map overlaid on OpenStreetMap base map and drawn on ArcGIS.

contaminated the country with landmines and UXO (Martin et al. 2019).[6] Cambodia is recognized as one of the most heavily UXO-affected countries with thousands of individuals being incapacitated and losing their lives (Moyes et al. 2002, Martin et al. 2019). Typical injuries from UXO accidents consist of extensive limb amputations, cuts from fragments, eardrums, and blindness caused by fragments or the blast (Moyes et al. 2002). Since 1979, Cambodia has witnessed over 64,700 casualties due to UXO, leading to more than 19,700 fatalities (Martin et al. 2019). Cambodia bears the world's highest per capita amputee rate, with 25,000 UXO-related amputees. UXO also causes hindrances to infrastructure, makes land unusable, and leads to interruptions in both water supplies and irrigation systems (Hamlin et al. 2018, Martin et al. 2019).

UXO from aerial bombs is commonly discovered in soft ground, which is less likely to trigger detonation. In other words, areas with high soil fertility that were bombed during conflicts are more likely to contain UXO (Moyes et al. 2002, Lin 2022). Ethnographic field work indicates that due to the presence of UXO, farmers today change their agriculture practices, for example through using hand held tools in an effort to not dig too deep. The

[6] It is critical to distinguish between landmines and UXO in Cambodia. Extensive minefields were laid by the Khmer Rouge, the Royal Cambodian Armed Forces (RCAF), the Vietnamese military and also the Thai army. The majority of these minefields are found in the western regions of Cambodia, notably in "K-5 mine belt" along the border with Thailand. Meanwhile, eastern and northeastern parts of Cambodia are contaminated with unexploded ordnance (UXO) primarily from U.S. air and artillery attacks during the Vietnam War and conflicts along the Vietnam border (Roberts 2011, Martin et al. 2019).

effect is to render fertile land unproductive due to the high risks associated with farming (Lin 2022).

Areas with a higher risk of UXO today are likely to experience difficulty in re-building and lower growth, while areas with a low risk may be able to leverage re-building into growth. This pattern then can explain variation in well-being today. We first show that pre-bombing soil fertility is independent of bombing locations in our empirical strategy and then show that the intersection of bombed, soft soil locations is a strong predictor for local areas to experience casualties from explosive remnants of war today. Given that UXO failure is more likely in softer ground, we will examine the heterogeneous impacts on areas that pre-bombing are classified with fertile (soft) soil – likely frequent UXO occurrences – versus areas classified with pre-bombing infertile (hard) soil – likely less frequent UXO occurrences. We anticipate that the impacts of residing in areas exposed to bombing in the past on health and economic activity today will vary depending on the current risk of encountering UXO.

Cambodia today is a democracy, but one ruled by a dominate party characterized by corruption (Bühler & Madestam 2023, Calavan et al. 2004, Un 2015). This context represents challenges for continued development and factors holding back recovery for local populations can exacerbate these challenges. The World Bank highlights growth in human capital as a important factor necessary to move modern Cambodia towards sustainable and equitable growth (World Bank 2017). As we will show, the history of the US bombing campaigns still plays an important role for communities, demonstrating re-vitalization of locations is feasible but challenges can remain in what is an already difficult environment.

## 3 Data

In this section, we outline the data utilized in our study. To comprehensively examine the long-term impacts of local area exposure to bombing and their underlying mechanisms, we integrate diverse data sources, including individual-level health data from the Demographic and Health Survey (DHS), spatial data on US airstrike missions, and other historical and contemporary data on demographic, economic and healthcare characteristics.

### 3.1 Bombing and the identification of bombing areas

The bombing data used in this study was compiled by the Yale University Cambodian Genocide Program and provides information on 115,273 bombing sites targeted in Cambodia between October 1965 and May 1975. This dataset includes details such as the date of the bombing, precise locations, the number and type of aircraft involved in the sorties, bombing loads, and ordnance types.

We use the dataset to pinpoint regions heavily affected by bombing in the past, referred to as bombing areas. These designated areas must accurately capture the clustered patterns of bombing incidents, as areas beyond these boundaries are minimally impacted.

To map out areas impacted by the bombing we use a clustering analysis, which is utilized widely across various scientific disciplines, including geography, public health, and ecology (Aldstadt 2009, Grubesic et al. 2014).

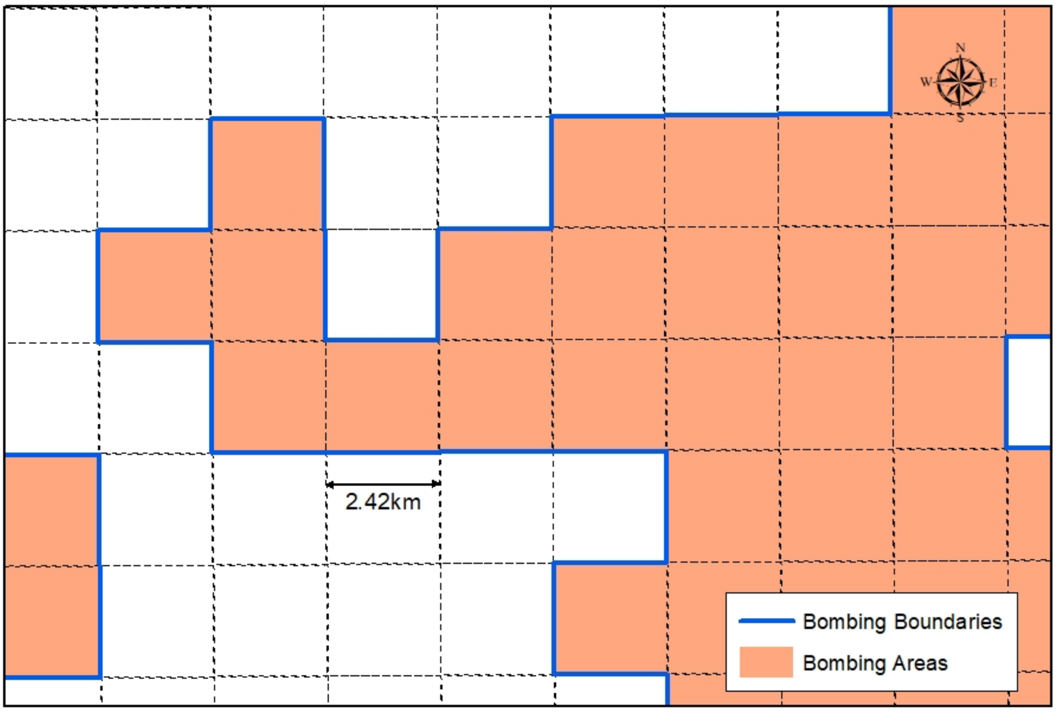
Spatial cluster detection integrates location attributes and events to detect meaningful patterns in geographical activities. In the fields of epidemiology and health-related sciences, clustering techniques help understand how location specific features impact health outcomes (Rushton & Elliott 2003, Elliott & Wartenberg 2004, Beale et al. 2008, Auchincloss et al. 2012). A common approach for identifying point clustering in the data space is by utilizing grid cell densities (Ankerst et al. 1999), sometimes mentioned as quadrat analysis in the literature. This method creates a geographic histogram partitioning the data space into distinct, non-overlapping regions or cells. Cells with a significant number of objects signify cluster centers. Using this approach has several benefits (Boots & Getls 1988). First, most of the points in the data space are used for the analysis. Second, it enables the identification of high-density regions in the data with square quadrats (or grid cells) easily combined and merged into larger regions (Boots & Getls 1988). However, the effectiveness of this method relies on the user-defined size of the cells because small cells can lead to a noisy density estimate, while large cells may excessively smooth the density estimate (Ankerst et al. 1999, Cheng et al. 2018).

Within our specific context, it is crucial for the designated bombing areas to accurately capture the spatial patterns and distribution of the bombing incidents. These areas must depict the geographical regions affected by the bombing, ensuring a precise representation of the impact zones. Based on this grid-based clustering technique, we divide the country map into geographic grid cells. We use an approach commonly employed by ecologists to identify the size of the grid cells. As outlined by Boots & Getls (1988), a suitable quadrat or grid size can be estimated as double the area per point, in particular: $I = \sqrt{2 \times A/n}$, where $I$ denotes the calculated length of the side of a grid cell, $A$ denotes the area of the focused region, and $n$ denotes the number of features – airstrikes in our case – in the study area.

Our cell size equals 5.856 $km^2$ (2.42 km on each side) given Cambodia's overall area being 337,561 $km^2$ and the number of airstrikes being 115,273.[7] In total, the country is divided into 31799 grid cells. After identifying the bombing loads in each cell, only cells that have bombing loads greater than 0 are selected, and defined as bombing areas. Figure 3 demonstrates the way we construct bombing areas, zooming in on an actual portion of our data, and later bombing boundaries from the grid-cells. Figure 4 illustrates the spatial distribution of identified bombing areas in Cambodia, demonstrating that they preserve the spatial distribution of strike locations. These specified areas depict the clustered spatial occurrences of bombing, and we consider areas outside these boundaries as the areas not exposed to bombing. It is evident that the bombing areas are not evenly dispersed throughout the country, but rather predominantly concentrated in the eastern and southern regions of Cambodia along the borders with Vietnam.

[7] This is similar to the cell size selected by Kohama et al. (2020) who examines how the economic characteristics of conflict zones influence the choice of military strategies.

Figure 3: Bombing boundaries and bombing areas




*Notes:* We exploit the spatial discontinuity around the bombing boundaries which separate areas exposed to past bombing from those that weren't. Map was drawn on ArcGIS.

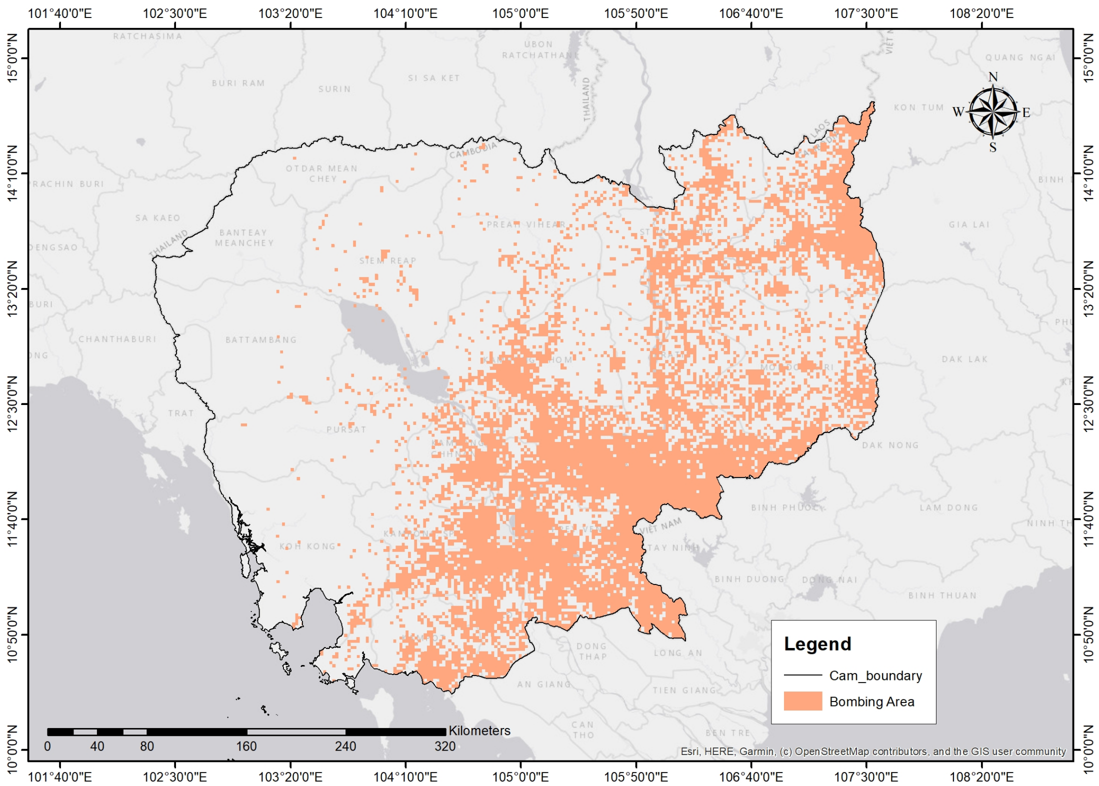
### 3.2 Cambodia Demographic and Health Survey

Our empirical analysis builds upon four waves of the Cambodia Demographic and Health Survey (DHS 2000, 2005, 2010, and 2014).[8] We rely on the DHS individual womens' data, as it offers extensive health information that is not available for the male sample. DHS surveys provide the geo-location of a cluster which is a group of 25-30 households participating in the surveys. A household cluster in DHS can be considered an enumeration area, or a village in rural or urban areas. To keep respondents' confidentiality, GPS locations of clusters are displaced geospatially. Specifically, urban points are randomly displaced by a maximum distance of 2 kilometers, while rural points are randomly displaced by up to 10 kilometers. The randomness of this displacement ensures classical measurement error with unbiased estimates.

We use three outcomes as measures of health status. Our first outcome is Height-for-age measured in Z-scores (HAZ). HAZ is calculated by DHS using the WHO Growth Reference, reporting the difference between an individual's actual height and the median

[8]Demographic and Health Surveys (DHS) Program has conducted six surveys in Cambodia, including CDHS 1998, 2000, 2005, 2010, 2014, and 2021-2022. Data on the exact locations of clusters or GPS data is not available in Cambodia DHS 1998. Meanwhile, DHS 2021-2022 does not provide information on anemia level – one of the outcomes analysed in this study.

Figure 4: Areas of bombing in Cambodia(1965-1975)



*Notes:* The map depicts areas that suffer from bombing during 1965-1975 period. Map overlaid on World Light Gray Base map (Canvas Map) on ArcGIS.

height of a reference population of the same age and sex.[9] A below-median HAZ is an indication of stunting or malnutrition (Leroy & Frongillo 2019). Our second outcome is being underweight, which is constructed based on women's Body Mass Index (BMI) and has been used in Kountchou et al. (2019) and Conti et al. (2024) as an indicator of health status. Women are considered underweight when their BMI is under 18.5 kg/m$^2$ (Weir & Jan 2019). Our last outcome of interest is anemia, an indicator of inadequate nutrition and overall poor health, often associated with iron deficiency (WHO 2008), that has been used as a health outcome in prior research (Aguilar & Vicarelli 2011, Rosales-Rueda 2018). The classification of anemia status is determined by measuring hemoglobin levels, which are obtained through blood tests conducted by the DHS Program. Based on the available DHS data, individuals are categorized into two groups: those experiencing moderate or severe anemia, and those with mild or no anemia.

We also use data on households' elevation/altitude provided by Cambodia DHS in our balance checks as we expect households' elevation/altitude would not change due to bombing. This data is collected from the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model for the specified coordinate locations of DHS clusters.

In addition, we exploit data on women's education, specifically, secondary education

[9]Height-for-age Z-score is calculated based on WHO Growth Reference tools, factoring in sex, age and height data, with computations performed via WHO Anthro-based software. See https://dhsprogram.com/data/Guide-to-DHS-Statistics/Nutritional_Status.htm for more details.

completion, and household possessions of durable goods to assess demographic and economic developments at household locations in the post-bombing period. In particular, following a generalized least-squares weighting procedure proposed by Anderson (2008), we construct a variable called "family wealth" based on households' accessibility to electricity and ownership of durable goods.[10]

### 3.3 Pre-bombing data

We exploit several datasets from before the bombing or thereabouts for controls, heterogeneity dimensions, and balance testing.

**Soil types in 1962.** We use the data on the distribution of soil types in Cambodia provided by Crocker (1962) to identify pre-bombing soil fertility.[11] Based on the discussion on soil type characteristics in White et al. (1997) and similar to the classification in Kohama et al. (2020), we create a dummy variable, Soil fertility in 1962, which equals 1 if a DHS cluster is located in areas that are considered fertile (soft soil) and equals 0 otherwise.[12] A detailed discussion on soil classification is provided in Appendix B.

**1970 Indochina Atlas.** We digitize three maps from the Indochina Atlas for location specific measures of transportation links, agriculture, and population.[13] The Indochina Transportation map depicts the major roads and railways of the country in 1970 (Appendix, Figure G.2). We geo-reference the map and measure the distance from DHS households to 1970 roads and railways. The Indochina Agriculture map outlines regions where agricultural activities took place (Appendix, Figure G.3). We then match this information with household locations to determine whether there were any agricultural activities at DHS households during the pre-bombing period. Finally, the Indochina Population map displays population density (persons per square kilometers) in Indochina (Appendix, Figure G.4), enabling us to identify the population density at DHS clusters in 1970. We argue these are "pre-bombing" characteristics, because although bombing started in the mid 1960s, the bombs escalated over a thousand times since 1970 (Owen & Kiernan 2006), meaning that most of the strikes occurred after 1970 (see Figure 1).

**Global Agro-Ecological Zones (GAEZ).** To assess the climate and potential crop productivity at DHS clusters, we use the agro-ecological zones (AEZ) classification developed by The Food and Agriculture Organization of the United Nations (FAO) and the International

[10]Durable goods include radio television, telephone, refrigerator, wardrobe, sewing machine, means of transport like bicycle, animal-drawn cart, motorcycle/scooter, car/truck, boat with or without a motor.

[11]The data were provided to Open Development Cambodia in ESRI Shapefile format by Save Cambodia's Wildlife's 2013 Atlas Working Group. For more details, see https://opendevelopmentcambodia.net.

[12]Specifically, among sixteen different soil types given in Crocker (1962), the following six types of soils are classified as fertile: Latosols, Alluvial soils, Brown alluvial soils, Lacustrine alluvial soils, Regurs, and Brown hydromorphics (Kohama et al. 2020).

[13]These maps were released in October 1970 by the Directorate of Intelligence, Office of Basic and Geographic Intelligence, U.S. Central Intelligence Agency and are available at https://maps.lib.utexas.edu.

Institute for Applied Systems Analysis (IIASA). This AEZ classification offers a comprehensive assessment of bio-physical resources essential for agricultural production.[14] Based on the Dominant AEZ classification dataset which is part of the GAEZ v4 Theme 1 Land and Water Resources, we match household clusters in the DHS with their corresponding AEZ zone (Appendix, Figure G.1). Subsequently, we create a binary variable indicating whether a household is located in a grid cell characterized as tropics and lowland.

### 3.4 Post-bombing economic and healthcare development data

We utilize the following datasets to evaluate post-bombing economic growth and healthcare infrastructure development.

**Cambodia Socio-Economic Survey 2009 and 2014.** To capture households' economic development at present, we use the Cambodia Socio-Economic Survey (CSES) 2009 and 2014 which are nationally representative surveys covering 12,000 households across 720 villages in 2009 and 12,096 households across 1,008 villages in 2014. The surveys contain information about households' economic activities, agricultural and non-agricultural incomes, vulnerability to food shortages, and field productivity. Although CSES 2009 & 2014 does not provide geo-locations of households, we are able to geo-locate households using village coordinates provided by Cambodia 2008 Population Census. We selected the 2009 and 2014 waves because they are on a roughly equal sampling scheme and size and come after the 2008 census.

**Night-time light intensity.** We use night-time light emissions data collected by U.S. Air Force Defense Meteorological Satellite Program (DMSP) as a proxy for economic development. Satellite night light data is considered a valuable proxy for economic activities where traditional data are lacking or unreliable (Henderson et al. 2012). A growing number of economics studies, particularly in development economics, have utilized DMSP data to explore various topics (Gibson et al. 2020). In this paper, we use the average visible, cloud-free light detections multiplied by the percent frequency of light detection.[15] Data are detailed at 30 arc-second grid cells ( 1km at the Equator), enabling us to identify night-time light intensity at a certain DHS household village in its survey year. The value of this proxy ranges between 0 and 63 and is used as an outcome for the economic activity of a household village (a DHS household cluster).

[14]The AEZ map incorporates thermal and moisture regimes, soil/terrain qualities, the presence of irrigated soils, and the identification of areas with significant bio-physical limitations such as extreme cold, arid deserts, steep terrains, and poor soil conditions. Geographical regions classified within the same AEZ category share similar climatic attributes, including rainfall and temperature patterns, which consequently contribute to comparable agricultural potentials. Several studies use GAEZ data to control for geographic characteristics or local agricultural suitability (e.g., Whatley & Gillezeau 2011, Cagé & Rueda 2016). Data can be accessed via https://gaez.fao.org.

[15]We draw this from the Version 4 DMSP Operational Linescan System Nighttime Lights Time Series which provides annual data from 1992 to 2013. This data is available at https://ncei.noaa.gov.

**Market Density.** We investigate market density using the Commune Database produced by Cambodia National Committee for Subnational Democratic Development.[16] The data was constructed based on the number of markets per 5 $km^2$ and is reported as a density ranging from 0 to 1. We standardise this variable and use it as another indicator for economic development.

**UN-Adjusted Population Density.** To analyze population density at DHS clusters, we use UN-Adjusted Population Density.[17] The data demonstrates the number of people per square kilometer, adjusted to match the corresponding official United Nations population estimates in each country.[18] In particular, we use population data for 2000, 2005, 2010, and 2014 to identify the population density of each DHS location in each survey year.

**Health facilities in Cambodia (2010).** We use distance to health facilities as proxies for health infrastructure development and healthcare accessibility. Distances to hospitals, district-level health centres, and health facilities, in general, are calculated using data on health facilities in Cambodia (2010).[19] This dataset provides comprehensive information on healthcare facilities in Cambodia, including national hospitals, referral hospitals, health centers, and health posts. Based on the classification of health facilities in Cambodia's Health Strategic Plan 2016–2020 (Ministry of Health (MOH) 2016), we divide health facilities into different groups: (1) hospitals, including national and referral hospitals (2) district-level health centres including health centres and health posts and (3) all health facilities including all hospitals and health facilities in Cambodia. Then, we calculate the distances from a household to the nearest hospital, the nearest district-level health center, and the nearest health facility.

**Mine/ERW casualties (2005-2013).** In addition to the above datasets, we use data on Mine/ERW casualties (2005-2013) to test whether UXO is more prevalent in regions with pre-bombing softer soil. This data provides detailed locations of landmine and remnants of war (ERW) incidents. The data also reports the number of victims and casualties resulting from these incidents in Cambodia between 2005 and 2013.[20] In our analysis, we only

[16] This data was provided to Open Development Cambodia directly by Save Cambodia's Wildlife's 2013 Atlas Working Group. See https://opendevelopmentcambodia.net for more details.

[17] The data is collected by the WorldPop research program, based in the School of Geography and Environmental Sciences at the University of Southampton. This program provides different types of gridded population count datasets, which are available at a resolution of 30 arc-seconds (approximately 1km at the equator). The data can be accessed via https://hub.worldpop.org.

[18] The units are the number of people per square kilometer, calculated using each country's total population, and adjusted to align with the official United Nations population estimates - Revision of World Population Prospects 2019 (United Nations, Department of Economic and Social Affairs Population Division 2019).

[19] Cambodia's Ministry of Health (MoH) originally compiled the data, which was subsequently contributed to the Humanitarian Data Exchange (HDX) by the Office for the Coordination of Humanitarian Affairs (OCHA). Open Development Cambodia's team gathered data from Google Maps and utilized references from Cambodia's Ministry of Health. See https://opendevelopmentcambodia.net for more details.

[20] The data was compiled by The Cambodia Mine/ERW Victim Information System (CMVIS) of the Cambodian Mine Action and Victim Assistance Authority (CMAA) and shared via the Office for the Co-ordination of Humanitarian Affairs (OCHA) on the Humanitarian Data Exchange (HDX) platform. See https://opendevelopmentcambodia.net for more details.

use information on incidents occurring due to ERW rather than landmines. We count the number of incidents within 3km of household locations and construct a binary outcome equal to 1 if there are any incidents in this 3-km radius.[21]

**Descriptive statistics.** We provide descriptive statistics for each of these outcomes and the health outcomes in Appendix Section G and Table G.1. We now turn to identify how bombing and soil interact to vary the current risk of unexploded ordnance and the health outcomes of those living today in these areas. Subsequently, we turn to an identification strategy based on spatial discontinuities to better understand the long-term impact of the bombings across locations by their risk of UXO today.

## 4 Bombing and soft soil: UXO risk and health

Now, we begin with some motivating analyses based on a simple difference-in-differences (DD) design. We first test whether UXO incidents are more prevalent in bombed locations which pre-bombing had softer soil, using data on ERW casualties from 2005 to 2013 across Cambodia. In Section 2, we provided a detailed discussion on UXO problems in Cambodia and highlighted reasons why UXO may be more prevalent in areas where soil was softer and more fertile at the time of bombing. Bombs are more likely to fail on softer soil leaving UXO today (Moyes et al. 2002, Lin 2022). This suggests there should be differences in the risk of UXO within bombed locations dependent on whether they are softer or harder soil areas. This could then translate into a divergence of long-term outcomes with some areas more difficult to re-vitalize than others.

To assess UXO risk today, we count the number of UXO incidents within 3km of household locations and construct a binary outcome equal to 1 if there are any UXO incidents in this 3-km radius. We leverage the bombing area definitions and the pre-bombing soil measure of soft and hard ground discussed in Section 3 and estimate the following specification:

$$\begin{aligned} UXO_{icbd} = \alpha_0 + \alpha_1 Bombing_b + \alpha_2 SoftSoil_c + \alpha_3 Bombing_b \times SoftSoil_c \\ + f(Geo_c) + Strike_c + \lambda \mathbf{X}_c + \delta_d + \epsilon_{icbd} \end{aligned} \quad (1)$$

where $UXO_{icbd}$ is a binary indicator of a UXO incident within a 3-km radius for an individual woman $i$ living in a DHS cluster $c$, bombing grid $b$, and district $d$. We control for each individual's household location coordinates in $f(Geo_c)$,[22] 1km distance-to-nearest-strike fixed effects in $Strike_c$, pre-bombing characteristics defined at the DHS household cluster level in $\mathbf{X}_c$,[23] and district fixed effects in $\delta_d$. Importantly, $Bombing_b$ indicates

[21] We note that UXO/ERW incidents can include those from separate causes than the US aerial bombing campaign (Roberts 2011, Martin et al. 2019)

[22] Instead of controlling for the latitude and longitude of household locations, we control for x- and y-coordinates of households in a projected coordinate system, as recommended by (Lehner 2021). Particularly, we choose EPSG:9212 as a projected system for our geometry computations.

[23] Pre-bombing characteristics include geographic characteristics (elevation, tropics/lowland), demographic characteristics (population density in 1970) and other economic characteristics (agricultural activities and distance to main roads/railways in 1970).

whether a woman lives in a grid defined as a bombing area or not, and $SoftSoil_c$ indicates whether a woman lives in a location characterized by soft or hard soil in 1962. Our parameter of interest is $\alpha_3$ which captures the effect of living in a bombed area that has softer soil. This forms our first-stage analysis, testing empirically the claim that UXO risk is higher where bombs fell on softer soil and motivates our later analyses.

Our specification defines a difference-in-differences in space rather than time. The identification assumption is that bombed locations would not be differentially likely to experience UXO except for the impact of soft soil on detonation rates.[24] Any selective targeting of soft soil locations will be captured by the level differences in UXO risk across soil type locations. Also, any differences in pre-bombing population or other factors are captured by the bombing level effect across bombing grids, while we also control for a set of pre-bombing and at time of bombing location characteristics specific to each DHS household cluster in $X_c$.

Table 1: The likelihood of having UXO incidents (data from 2005-2013)

| | Having UXO incidents within 3-km area | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Bombing | -0.010 | -0.011 | -0.008 | -0.013* |
| | (0.007) | (0.007) | (0.007) | (0.008) |
| Soft Soil (1962) | 0.035*** | 0.034*** | 0.039*** | 0.028*** |
| | (0.008) | (0.008) | (0.008) | (0.008) |
| Bombing × Soft Soil (1962) | 0.043*** | 0.043*** | 0.037*** | 0.038*** |
| | (0.010) | (0.010) | (0.010) | (0.010) |
| Dist. to VN | No | Yes | Yes | No |
| Dist. to Capital | No | Yes | Yes | No |
| Dist. to Thai | No | No | Yes | No |
| District FE × (x,y) | No | No | No | Yes |
| Mean | 0.234 | 0.234 | 0.234 | 0.234 |
| Observations | 30948 | 30948 | 30948 | 30948 |

Note: The unit of analysis is DHS households. We count the number of UXO incidents within 3km of household locations and construct the binary outcome equal to 1 if there are any UXO incidents in this 3-km buffer. In all models, we control for households' spatial locations (x- and y- coordinates), 1km-distance-to-nearest-strike fixed effects, district fixed effects and other pre-bombing characteristics. The second regression also controls for distance to Vietnam borders and the distance to the capital. The third regression additionally includes the distance to Thai borders. The last regression further controls for district fixed effects corrected for spatial dependence. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

We report the results for this DD design in Table 1, column (1). We find that households in bombed locations with softer soil are 4.3 percentage points more likely for UXO incidents to occur in their vicinity than households in bombed locations on harder ground. This represents 18% of the mean UXO rate. In column (2) - (4), we supplement our simple DD specification with some additional controls. Locations closer to Vietnam may have been more likely to be bombed and may represent a higher density of softer soil loca-

[24] Lin (2024) provides detailed descriptions that support this assumption and field work that is highly consistent with this pattern.

tions,[25] thus we add a control for distance to the Vietnam border and we also control for distance to the capital - the largest urban city. Moreover, because locations in the west of the country are more likely to have UXO from mining in later periods rather than aerial bombs (Roberts 2011, Martin et al. 2019), we also add a control for distance to the Thai border. Finally, we add interactions between household location coordinates and district fixed effects in our most stringent specification, allowing the unobservables captured by controlling for geographic space to vary across districts. Across all specifications, we continue to find that bombed, soft soil locations are more likely to have causalities from UXO.

Our evidence provides a clear picture that bomb failures on soft soil make life and activity more risky today. This could then translate into prolonged differences in health outcomes. In Table 2, we use our same DD specification and look at a series of health outcomes among women. We see that those living in areas with bombed, soft soil have significantly lower height for their age by about 7% of a standard deviation and they are about 2% more likely to be anemic. We then extend our DD analysis to a wide range of outcomes in the Appendix Tables G.4, G.5, and G.6. There we find sweeping consequences with negative effects on economic development, household income and agricultural production, and health infrastructure development

These patterns could be due to diverging differences across bombed locations in their ability to re-vitalize and (or) through those left in high risk UXO areas facing difficulties to make land productive. Indeed, stories from farmers on the ground suggest that in these high risk UXO areas people shape their activities around this risk, leading to less efficient farming methods and lower productivity (Lin et al. 2021, Lin 2024), while in bombed, hard ground locations with less UXO, past destruction can be more readily built over.

Table 2: Bombing and soil conditions: Effects on health

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Bombing | 0.066*** | 0.066*** | -0.006 | -0.006 | -0.022*** | -0.022*** |
| | (0.021) | (0.021) | (0.009) | (0.009) | (0.007) | (0.007) |
| Soft Soil (1962) | 0.021 | 0.022 | 0.006 | 0.006 | -0.023*** | -0.023*** |
| | (0.020) | (0.020) | (0.009) | (0.009) | (0.007) | (0.007) |
| Bombing × Soft Soil (1962) | -0.070*** | -0.070*** | -0.013 | -0.012 | 0.020** | 0.022** |
| | (0.026) | (0.026) | (0.012) | (0.012) | (0.009) | (0.009) |
| Dist. to VN | No | Yes | No | Yes | No | Yes |
| Dist. to Capital | No | Yes | No | Yes | No | Yes |
| Dist. to Thai | No | Yes | No | Yes | No | Yes |
| Mean | -1.789 | -1.789 | 0.170 | 0.170 | 0.0901 | 0.0901 |
| Observations | 30948 | 30948 | 30948 | 30948 | 30948 | 30948 |

Note: The unit of analysis is DHS households. All regressions control for households' spatial coordinates, 1km-distance-to-nearest-strike fixed effects, district fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics. Regressions (2) (4) (6) also controls for distance to Thai borders and district fixed effects corrected for spatial dependence. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

A diverging pattern in the long-term outcomes of local areas exposed to past bombing

[25] See Figure 2.

in Cambodia has important implications for the value of UXO clearance and patterns of health inequalities stemming from past conflict. Hard ground locations in Cambodia can recover, re-build, and grow leading to a positive effect, while soft ground locations lag behind and are directly harmed by the presence of UXO today. To investigate this more clearly, we need to separately identify the effect of bombing on health and economic activity today. To do this, we next turn to a novel spatial regression discontinuity.

## 5 Empirical strategy and specification checks

### 5.1 Empirical framework

We now proceed to estimate the effects of local exposure to bombing on health, employing a spatial regression discontinuity (RD) design. The spatial RD design exploits discontinuous transformations at bombing boundaries, comparing individuals living in areas heavily bombed 40 years ago to those living in adjacent locations that did not suffer from bombing with the idea that bombing boundaries act as cut-offs. For the design to follow, we will focus on estimating it separately across soft and hard soil locations to evaluate the diverging consequences of bombing in Cambodia.

Similar to designs in Bühler (2023) and Dell & Olken (2020), our regressions take the form:

$$\begin{aligned} Y_{icbpt} &= \alpha + \beta Bombing_b + f(Geo_c) + Strike_c + \gamma \mathbf{D}_c + \lambda \mathbf{X}_c \\ &\quad + \theta_g + \delta_p + \tau_t + \epsilon_{icbpt} \end{aligned} \tag{2}$$

where $Y_{ict}$ is the outcome variable of interest for a woman $i$ in cluster $c$, bombing grid $b$, province $p$ in survey year $t$, and $Bombing_b$ is an indicator equal to 1 if an individual is currently living in areas that were bombed in the past and equal to zero otherwise. $Strike_c$ controls for 1-km distance-to-nearest-strike fixed effects so that we remove potential indirect spillover effects from distance to strike locations. $\mathbf{D}_c$ controls for distance to the capital of Cambodia – the largest urban city – and distance to the Vietnam border, and $\mathbf{X}_c$ is a vector of covariates, including other pre-bombing characteristics.[26] In Section 5.2, we will show that the characteristics in $D_c$ and $X_c$ are balanced across bombing boundaries. $\theta_g$ represents 50x50 km grid-cell fixed effects, playing a role as spatial fixed effects to ensure comparisons of individuals within a grid-cell.[27] $\delta_p$ is a vector of province-fixed effects, further controlling for spatial dependence. Finally, $\tau_t$ is survey-year fixed effects. Standard errors are clustered at the DHS survey cluster level.

*Leveraging boundaries.* Why should the boundaries in our design be useful to assess discontinuities? First, in settings with historical borders, the borders are almost necessarily an approximation, implying measurement error in the drawn border locations. As long as this error is random, it should attenuate results. Second, in our setting, let us suppose

[26] Pre-bombing characteristics include geographic characteristics (elevation, tropics/lowland, soil fertility in 1962), demographic characteristics (population density in 1970) and other economic characteristics (agricultural activities and distance to main roads/railways in 1970).

[27] We divide the country into 79 grid cells of 50x50km. See Figure G.6.

a true set of bombing boundaries exists. This latent set of borders is unobservable, so we aim to approximate them. Importantly, our method, described in Section 3 and shown in Figure 3, intuitively draws borders that are random relative to other features, as confirmed by our balancing tests. However, it also captures the spatial dispersion of strikes, plausibly approximating the latent borders. Thus, we expect our borders are measured with some degree of random error that will attenuate our results. Later, we will provide evidence consistent with this intuition through placebo testing in the robustness checks.

Next, the function $f(Geo_c)$ contains our running variables. We use a multidimensional RD polynomial controlling for smooth functions of geographic locations of cluster $c$, with demeaned x- and y-coordinates of household locations as running variables.[28] This subsumes the distance to the bombing boundaries but accounts for the two-dimensional nature of geographic space. Since we aim to compare individuals living at similar geographic positions on opposite sides of the boundaries, this multidimensional polynomial precisely captures the gradual variation of unobservable factors in two geographical dimensions. As long as potential outcomes transform smoothly over geographic space, then we accurately identify the discontinuity at the boundaries due to the prolonged consequences of the bombings with our treatment $Bombing_c$. Following Gelman & Imbens (2019), a local linear RD polynomial is selected for the baseline specification $f(Geo_c) = x + y$. We examine specifications with higher orders of RD polynomials in robustness checks.[29] In all regressions, a triangular kernel is employed, where the weight assigned to each observation diminishes as the distance from the bombing boundaries increases.

Literature on spatial RD analysis has emphasized the crucial role of incorporating segment-fixed effects (Dell 2010, Dell et al. 2018, Dell & Olken 2020, Lehner 2021). Boundary-segment fixed effects ensure that the analysis compares observations in close geographic vicinity. In our context, bombing boundaries are numerous and spread throughout the country. In order to control for geographic treatment effect heterogeneity and to ensure that we compare individuals located very close to each other, we include 50x50 km grid-fixed effects in our main specification. We further include province-fixed effects to ensure that we make comparisons between individuals in the same province.[30] A concern, however, is that any within-grid or within-province sorting would bias our effects. We address this through refinements of 50x50km grid-fixed effects and province-fixed effects in our robustness checks. Particularly, we replace 50x50km grid-fixed effects with smaller sizes of grids, and province-fixed effects with district-fixed effects, ensuring a comparison between individuals situated within a highly confined area. We will show later that our results from this approach remain strongly robust.

In terms of bandwidth selection, the estimation sample is restricted to individuals falling within the bandwidth of 1km and 1.5km around bombing boundaries. Samples with other bandwidth restrictions are analysed in robustness checks.

[28] We choose a projected coordinate system (EPSG:9212) for our geometry computations, which ensures correct distance calculations (Lehner 2021).

[29] Quadratic polynomial will take the form as $f(Geo_c) = x + y + x^2 + y^2 + xy$. Cubic polynomial will take the form as $f(Geo_c) = x + y + x^2 + y^2 + x^3 + y^3 + xy + x^2y + xy^2$.

[30] There are 25 provinces in Cambodia. The smallest province is Kep, covering an area of 336 square kilometers, while Mondulkiri is the largest with an area equal to 14,288 square kilometers.

In appendix C, we use a more parsimonious RD design with a uni-dimensional RD polynomial. Specifically, we use distance to bombing boundaries as a running variable. The local linear unidimensional polynomial has a function as $f(Geo_c) = \eta dist_c + \theta Bombing_c \times dist_c$ with the forcing variable $dist_c$ denoting the Euclidean distance between a household location and the closest point on bombing boundaries. Higher-order polynomials will take the following form: $f(Geo_c) = \sum_{k=1}^{a} \eta_k dist_c^k + \theta_k Bombing_c \times dist_c^k$. The interaction term of the treatment variable with the distance to the bombing areas is of great importance because it allows for different slopes of the functions on two sides of bombing boundaries. For unidimensional RD specifications, optimal bandwidths are selected following Calonico et al. (2014).

Although the uni-dimensional RD polynomial plays a similar role in capturing the smooth changes at the bombing boundaries, we do not choose uni-dimensional models as our main specification because they lack a clear economic interpretation in the case of geographic space with two-dimensional changes. Compared to the same-order multidimensional polynomial, the uni-dimensional one possesses fewer degrees of freedom to smoothly capture the variation near the boundary (Dell 2010). However, because a more flexible approach may not guarantee a more reliable estimate (Dell 2010), the uni-dimensional specifications offer valuable crosschecks for our multidimensional RD analysis.

### 5.2 Validity of RD Assumptions

The spatial RD design requires two identifying assumptions: a smooth variance of covariates at bombing boundaries and no sorting around cutoffs.

**Assumption 1: Smooth variance of covariates at bombing boundaries.** A key assumption of the RD design is the smooth variance of all relevant factors and covariates besides the treatment. In particular, if $c_1$ and $c_0$ denote potential outcomes under treatment and control, and *x,y* denote x- and y-coordinates of household locations, then $E[c_1|x, y]$ and $E[c_0|x, y]$ must be continuous at the discontinuity, as described in Dell (2010). This assumption allows for individuals on the non-bombing side to serve as a valid counterfactual for individuals on the bombing side. In order to assess the plausibility of this assumption, we use equation 2 to examine a wide range of geographic, demographic and economic characteristics on two sides of bombing boundaries in the pre-bombing period or thereabouts. All of these characteristics are measured at the DHS survey cluster level and used as outcome variables in equation 2. Results are reported in Table 3. We find no evidence that there were discontinuities of geographic, demographic or economic features at the bombing boundaries. Particularly, the estimates for elevation, tropic/lowland are both insignificant, indicating a smooth variation of geographic features (columns 1-2). In terms of soil fertility and agriculture activities, the coefficients are null estimates and noticeably small in magnitude (columns 3-4). In addition, we do not observe any statistically significant difference in 1970 population density between the two sides of bombing boundaries (column 5). For distance to 1970 main roads and railways (column 6), we see a weakly

Table 3: Balance check

| | Dependent variable is: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Elevation | (2) Tropics/lowland | (3) Soil Fertility | (4) Agri. Activities | (5) Pop. Density | (6) Dist. roads | (7) Dist. VN | (8) Dist. Capital |
| Bombing | 5.156 | 0.041 | -0.033 | 0.004 | -0.021 | 0.761* | 0.313 | -0.197 |
| | (3.410) | (0.038) | (0.038) | (0.036) | (0.023) | (0.440) | (0.376) | (0.842) |
| Mean | 34.58 | 0.585 | 0.335 | 0.621 | 0.458 | 6.472 | 88.89 | 93.91 |
| Observations | 12045 | 12045 | 12045 | 12045 | 12045 | 12045 | 12045 | 12045 |
| Clusters | 864 | 864 | 864 | 864 | 864 | 864 | 864 | 864 |

Note: The unit of analysis is survey respondents. The sample restricted to those living within 1.5km bandwidth from bombing boundaries. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects and province fixed effects are present in all regressions. "Tropics/lowland" is a dummy variable reflecting whether this location belongs to areas classified as "tropics, humid" based on agro-ecological zones classification. "Soil Fertility" is also a dummy variable demonstrating whether the soil was fertile(soft) in 1962 (before the bombing). The last three columns use data from the Indochina Atlas, published in October 1970. Agri. activities indicate whether there were any agricultural activities in these areas in 1970. Pop. density is a binary variable reflecting if the population density in 1970 was at least fifty inhabitants per square kilometre. Dist. to roads refers to distance (in km) to 1970 main roads/railways. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

significant (10% level) discontinuity (column 6), but one that is small in magnitude. Finally, distances to Vietnam borders and to the capital are balanced across the bombing boundaries, which is particularly important given that selected targets were more likely closer to Vietnam in efforts to hinder supply operations of the North Vietnamese Army (Owen & Kiernan 2006).

In section 4, we showed that the effects of living in bombing areas vary with pre-bombing soil conditions. To further support our use of 1962 soil fertility to split our coming analysis, we split the country by 1962 soil fertility and re-run these checks, finding that all pre-bombing characteristics vary smoothly at the bombing boundaries, except the tropics/lowland in soft soil areas (Table G.2). Thus, our evidence for the continuity assumption holds in both soft and hard soil areas. This additionally validates our use of 1962 soil fertility to divide the country into two distinctive regions: (1) soft soil areas with high occurrences of UXO and (2) hard soil areas with a lower likelihood of UXO.

**Assumption 2: No sorting around bombing boundaries.** Another important assumption for the validity of our design is that individuals cannot sort themselves around the cut-off boundaries. This assumption would be violated if individuals at the time of bombings were able to sort themselves around locations more likely to be bombed. Our method of drawing borders should be independent of features that may lead to sorting. Consistent with this and assumption 2, we find that population density from 1970 was balanced across bombing boundaries with no statistically significant differences (column 5 in Table 3).

**Assumption 3: Stable Unit-Treatment Value Assumption (SUTVA).** Spatial RD designs can be biased if a violation of SUTVA occurs at the boundaries (Keele & Titiunik 2015). SUTVA, introduced by Rubin (1986), requires that a unit's outcome is unaffected by the treatment status of other units. In our case, we would worry if the outcomes for a woman living just outside the bombing area would be influenced by outcomes in the bombing areas. We will focus our analysis on comparisons around boundaries in the subset of soft soil (high UXO) locations and again in the subset of hard soil (low UXO) locations. One possible manipulation is that people living in soft soil, bombed areas (high UXO risk) might relocate to control areas (non-bombed, soft soil). We expect this pattern would depress outcomes in our control locations as those from high UXO areas likely lack resources and skills, obscuring the true harmful effect of the bombing exposure. However, this spillover is unlikely to occur as we show in our mechanism (Table 6) that post-bombing population density is indifferent across the bombing borders for soft soil locations. Moreover, for hard soil locations, we even observe a statistically significant higher contemporary population density consistent with the re-vitalization mechanism we will explore. A second concern for spillovers is that bombs may have missed their targets and destroyed not only treated locations but also control locations. In this case, we expect effects to move in the same direction – hard soil locations can re-build, soft soil locations become UXO prone – bringing the outcomes of treated and control units closer together again obscuring the true effect. Thus, we expect SUTVA violations would likely bias the bombing effect in our design toward zero, meaning any observed effects are conservative estimates. Later, in a donut exercise (Section 6.2), excluding observations closest to our bombing boundaries, we show that our results remain consistent and even become more efficient.

# 6 Results

## 6.1 Baseline results

The results of the main RD design are reported in Table 4 (Panel A). We estimate the long-term impacts of local area exposure to bombing on different health outcomes of the current population from three to five decades after the bombing occurred. We report results for both a 1km and a 1.5km bandwidth selection. Across all specifications, and maybe surprisingly, we observe positive long-term health effects. Specifically, for women currently living in bombing areas, their Health-for-age Z-scores increase by 0.06 or 0.07 (about 3.5%) compared to those living outside bombing areas. Also, while there are no effects on the likelihood of being underweight, we see a lower likelihood of being anemic among those living in bombing areas. Women living inside bombing areas are 1.6 percentage points less likely to suffer from serious anemia, a decrease of more than 16% compared to the mean. Figure 5 illustrates the main results graphically. There is a clear jump in Health-for-age Z-scores and a significant drop in anemia for women residing within bombing areas.

These results become clearer when we split the effects between locations with high (soft soil) and low (hard soil) UXO exposure reported in Panels B and C of Table 4. In soft soil areas, we observe either null or harmful effects on health across all specifications (Panel A). Women living in pre-bombing soft soil areas are more likely to be underweight and anemic, at least with the 1km bandwidth. This evidence is consistent with ethnographic work by Lin (2022, 2024) that while people over time adapt to their new living conditions, such as adopting alternative agricultural practices to reduce risk exposure, their locations do not gain through re-development and they work with cautioun leading to reduced efficiency and lower productivity. Put simply, life becomes harder due to the ever present nature of the UXO risk.

Table 4: The long-term effects of local area exposure to bombing on health

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All population* | | | | | | |
| Bombing | 0.071** | 0.061** | -0.005 | -0.006 | -0.016** | -0.016** |
| | (0.030) | (0.027) | (0.010) | (0.009) | (0.008) | (0.007) |
| Mean | -1.815 | -1.809 | 0.187 | 0.185 | 0.0977 | 0.0954 |
| Observations | 9135 | 12045 | 9135 | 12045 | 9135 | 12045 |
| Clusters | 658 | 864 | 658 | 864 | 658 | 864 |
| *Panel B: Soft soil (1962)* | | | | | | |
| Bombing | -0.055 | -0.040 | 0.028* | 0.013 | 0.021** | 0.011 |
| | (0.051) | (0.045) | (0.016) | (0.014) | (0.010) | (0.010) |
| Mean | -1.785 | -1.793 | 0.182 | 0.177 | 0.0792 | 0.0799 |
| Observations | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 |
| *Panel C: Hard soil (1962)* | | | | | | |
| Bombing | 0.103*** | 0.090*** | -0.027** | -0.023* | -0.030*** | -0.028*** |
| | (0.036) | (0.033) | (0.013) | (0.012) | (0.011) | (0.010) |
| Mean | -1.831 | -1.817 | 0.190 | 0.189 | 0.107 | 0.103 |
| Observations | 6041 | 8014 | 6041 | 8014 | 6041 | 8014 |
| Clusters | 428 | 562 | 428 | 562 | 428 | 562 |

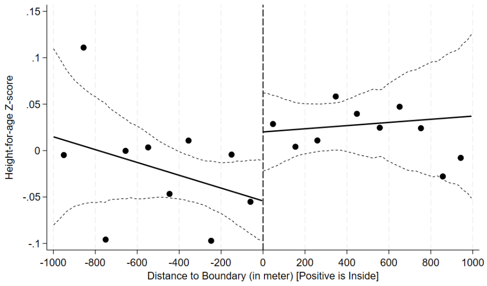
Note: The unit of analysis is survey respondents. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) include individuals living within 1km from bombing boundaries. Regressions (2) (4) (6) include individuals living within 1.5 km of bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Meanwhile, in hard-soil areas (Panel B), we see significant positive effects on health outcomes. Specifically, women residing on the bombing side have their Height-for-age Z-scores increased by at least 0.09 (about 5%). The probability for them to be underweight decreases by around 2.2 or 2.7 percentage points, representing a 13% reduction relative to the mean. Additionally, they are also less prone to anemia, with a reduction of 3 percentage points (or 2.8 percentage points in 1.5km bandwidth analysis), equivalent to a drop of approximately 30% compared to the mean likelihood of anemia.

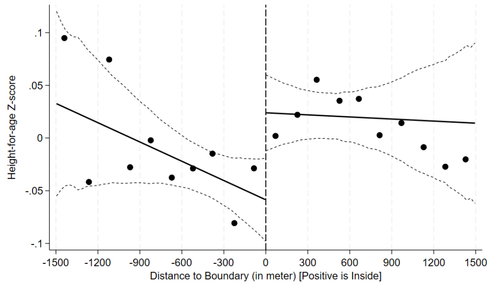
**Obfuscation from landmines and low density strike regions.** Landmines also contaminate Cambodia. These were mostly laid during the later Khmer Rouge (KR) and post-Khmer Rouge period. When the KR initially overtook the country, they deployed landmines in many regions as a fear tactic when subduing local areas. These are not a concern as they were less dense and normally isolated in their locations and have been

Figure 5: The impacts of local area exposure to bombing on health: RD plots

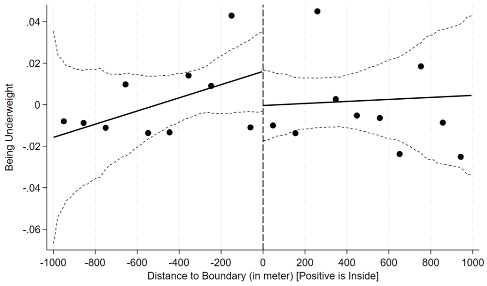
**Panel A: Within 1km bandwidth** **Panel B: Within 1.5km bandwidth**



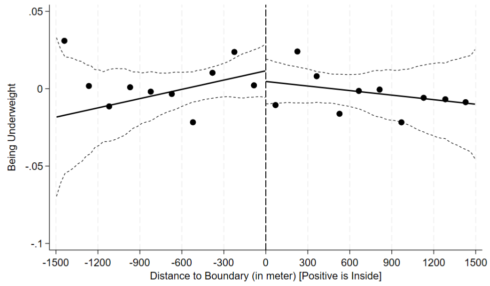

(a) Height-for-age Z-score



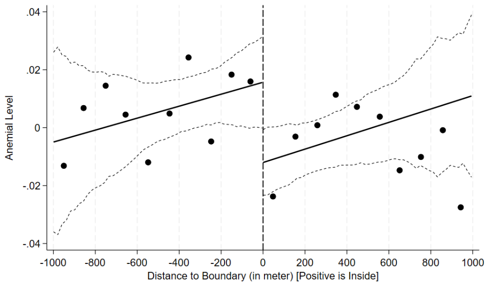

(b) Height-for-age Z-score



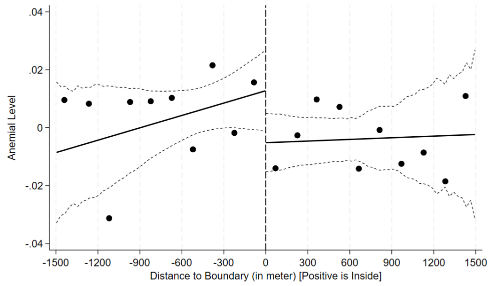

(c) Being underweight




(d) Being underweight




(e) Anemia Level




(f) Anemial level

*Note:* The points represent binned residuals derived from a main regression of the outcome variable on a linear polynomial in spatial coordinates and other control variables. Solid lines depict a local linear regression, separately estimated on each side of the threshold, while dashed lines represent 95% confidence intervals. "Negative" values of distance indicate locations outside the bombing areas.

largely removed for sometime now (Roberts 2011).[31] However, when the KR regime collapsed, its supporters fled to western areas along the border with Thailand. Opposition forces at the time sought to seal them in with landmines, leading to the "K-5 mine belt". Today, remaining mines are predominately in the far western regions.

Important for our analysis is that the likelihood of encountering landmines would not necessarily follow soil condition as with aerial dropped bombs. This could obfuscate our heterogeneity analysis split by soil fertility, because some hard soil areas are still

[31] Roberts (2011) discusses how the KR would inform villages that landmines surrounded the village, while actually they only laid mines in a small area. Then, they would force someone to run through the laid mines as an example to trigger fear and capitulation. The end result is that landmines from these operations were not as wide spread as suggested.

dangerous today due to leftover mines. Moreover, these regions along the Thai border have a much lower density of past airstrikes. Some of these areas will have no airstrikes for a given 50x50 km fixed effect, potentially leading to a less efficient estimated effect.

Table 5: Excluding provinces along the K-5 mine belt

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) <1km | (2) <1.5km | (3) <1km | (4) <1.5km | (5) <1km | (6) <1.5km |
| *Panel A: Soft soil (1962)* | | | | | | |
| Bombing | -0.058 | -0.040 | 0.036** | 0.019 | 0.022** | 0.011 |
| | (0.053) | (0.047) | (0.016) | (0.014) | (0.011) | (0.010) |
| Mean | -1.784 | -1.790 | 0.184 | 0.179 | 0.0796 | 0.0811 |
| Observations | 2865 | 3712 | 2865 | 3712 | 2865 | 3712 |
| Clusters | 216 | 280 | 216 | 280 | 216 | 280 |
| *Panel B: Hard soil (1962)* | | | | | | |
| Bombing | 0.095*** | 0.086*** | -0.030** | -0.028** | -0.034*** | -0.032*** |
| | (0.034) | (0.033) | (0.014) | (0.013) | (0.011) | (0.011) |
| Mean | -1.815 | -1.806 | 0.190 | 0.189 | 0.104 | 0.0992 |
| Observations | 5426 | 7235 | 5426 | 7235 | 5426 | 7235 |
| Clusters | 386 | 507 | 386 | 507 | 386 | 507 |

Note: All specifications follow our baseline analysis and the notes to Table 4. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

To better understand how these concerns may impact our estimates and inference, in Table 5, we drop regions along the Thailand border and re-estimate our specifications. The results remain entirely consistent with our previous analysis with some improvements in efficiency, particularly for soft soil areas where our sample size is smaller. Here we find a clear pattern of harm from the bombings in the soft soil, high UXO risk locations, while we continue to see a clear pattern of positive effects in the hard soil locations. Finally, we perform our analysis again, adding back the dropped regions but controlling for distance to the Thai border (see Table A.1), finding no changes to our results.

Finally, in appendix E and D, we extend the results and consider some additional heterogeneity by different generations and regions. The results and discussion are provided in the appendix. We generally find some differences across early and later generations, and the southest region drives the positive effects in hard soil areas. For re-building to lead to re-vitalization, as we suggest in the hard soil bombed areas, then this plausibly should occur where strikes were more intense. Consistent with this, the southest experienced the highest strike intensity and is indeed where the hard soil locations return the strongest positive effects.

**Summary.** Overall, the estimated effects we observe are consistent with a diverging pattern of health inequality across locations due to the likelihood that past strikes linger today as UXO. We also observe the same heterogeneity with the unidimensional RD design (see Table C.3) where we accommodate differing slopes on either side of the borders further corroborating the estimates here. The presence of UXO may create long-term harmful effects, which is consistent with existing literature on how bombings and UXO shape outcomes in the local population (Lin 2022, 2024, Riano & Valencia Caicedo 2024). However, in areas where UXO are less likely, adverse health effects can diminish over multiple generations as local areas are re-constituted and can grow (Devakumar et al. 2014). Post-conflict investments can gradually offset negative impacts and even lead to better outcomes (Strauss & Thomas 2008). The end result is that the remnants of past conflict can lead to diverging paths and spatial health inequalities. We will investigate this pattern further on economic activity and health infrastructure in Section 7. Next, we turn to examine the robustness of these results.

### 6.2 Robustness

We conduct multiple robustness checks to test the sensitivity of the results and address potential concerns associated with our spatial RD design. We show that our results are robust to alternative bandwidths, different orders of polynomials, a wide range of specifications, placebo tests and more refined spatial fixed effects than our baseline 50x50km grid-cell approach in the main regression. These results are presented in Appendix A.

**Grid-cell fixed effects.** Spatial RD designs often include border-segment fixed effects to guarantee a comparison of observations in very close geographic proximity. Within our context, because there are numerous bombing borders widespread across the country, we employ 50km grid-fixed effects along with province fixed effects to ensure that we compare individuals within a confined area. However, we are also concerned that 50x50km grids may be too broad to account for between-area heterogeneity. Therefore, instead of using 50x50km grids to control for spatial variation, we divide the country into smaller grid-cells, ranging from 10x10km, 20x20km up to 50x50km, and control for grid-cell fixed effects in our main regressions. Figures A.1, A.2 and A.3 present our results. When smaller-grid fixed effects are employed, the results remain similar: living in bombing areas is associated with better health outcomes and these effects are concentrated in hard soil areas with a lower probability of UXO.

**Choice of polynomial orders.** Figures A.4, A.5, and A.6 plot the main coefficients for different orders of RD polynomial in spatial coordinates with two different options of bandwidth. The results are consistent when higher orders of polynomials are used in the main regression with significantly positive effects on height and a considerable drop in anemia level for people living in bombing areas. We also continue to find that the positive impacts are especially substantial for those residing in pre-bombing hard soil locations, whereas there are null or even negative effects in soft soil areas.

**Bandwidth sensitivity.** We conduct sensitivity checks to different choices of bandwidth ranging from 0.5 to 2.5 km with 0.1km intervals. Figures A.7, A.8 and A.9 show that our results are robust to any choice of bandwidths. Especially, for all bandwidths, we observe the consistent heterogeneous effects in pre-bombing soft soil and hard soil locations.

**Alternative specifications.** In Tables A.3, A.4 and A.5 we investigate robustness to various specifications. The first two columns control for 50x50km grid fixed effects and district fixed effects instead of province fixed effects.[32] Columns (3) (4) show the results when our specifications include interacted grid fixed effects with x- and y- coordinates. The following two columns present outcomes without the inclusion of a triangular kernel weight.[33] Columns (7) (8) (9) (10) exclude the distance to the capital and the distance to Vietnam's borders in the main regressions. The last two columns run a *donut* exercise by removing all observations close to bombing boundaries (within 0.1km) and keeping the remaining data to fit the current spatial RD model. The objective of the *donut* exercise is to address the potential issue of systematic disparities between border populations and populations further away from bombing boundaries. In general, the enduring impacts on health outcomes remain consistent across different specifications. For HAZ, Table A.3 shows estimates of the bombing effect remain significant and stable across specifications, underscoring the reliability of our findings. Even in the more restrictive *donut* model the effects remain strong and significant. Similarly, we observe consistent results on the likelihood of being underweight A.4. Although there are no observable effects for the entire population, we see null or even negative effects for those living in soft soil areas. Conversely, women in hard soil areas are less likely to be underweight, indicating a positive impact on weight. Finally, Table A.5 also suggests a solid result on anemia. Our estimates are robust in terms of magnitude and significance level across different specification choices.

**Placebo tests.** We conduct placebo tests to confirm that the treatment effect does not come from other factors such as random variation or bias. Placebo boundaries are created by shifting bombing areas by 3km in all directions (north/ east/ west/ south). Then, we re-assign treatment and estimate the treatment effects in placebo situations both for the aggregate effects and again split by soil fertility. As illustrated in Table A.6, there are no significant placebo-boundary effects on Height-for-age Z-score, except in the case of a westward border shift, where the estimate goes in the opposite direction of our main result. For the likelihood of being underweight, we generally observe no positive effects (Table A.7). In soft soil areas, we can see some negative impacts when the border shifts eastward, yet in other cases, the estimates are indifferent from zero. Meanwhile, the effects in hard-soil areas are all insignificant, opposite our main findings which show the impacts on weight predominantly driven by individuals residing in hard soil areas. In terms of anemia level (Table A.8), coefficients are generally statistically insignificant for all directional shifts, especially in the hard soil areas. Throughout all of these many placebos the majority of estimates are null, and for those that are significant, we do not

[32] In our dataset, households are located in 176 districts

[33] A triangular kernel involves decreasing the weight assigned to each observation as the distance from the boundaries increases

find them concerning. They do not indicate any clear pattern. It is not surprising to have a significant effect with an ample number of placebos, and most importantly, all of these particular estimates are opposite to our actual estimates.

In summary, our analysis indicates that after more than three decades since the bombing incidents, individuals residing in local areas exposed to the past bombing demonstrate better health outcomes. These positive impacts on health are sensible because they are entirely driven by areas where soil was hard before the bombing. These areas are precisely those expected to have a lower probability of UXOs at the present time. Where UXOs are less prevalent, positive post-bombing developments are more likely to be useful and improvements in infrastructure achievable. Our results are consistent with this narrative and lead us to our following investigation of mechanisms.

## 7 Mechanisms

To this point, we have interpreted our results on the long-term impact of bombing in local areas through the degree of UXO risk. Low UXO risk areas can re-develop and residents can conduct their activity less constrained by risk. High UXO areas can struggle more with higher risk levels constraining activity. In this section, we test whether the diverging pattern in health outcomes that we observe across bombed hard and soft soil locations can be explained by economic developments and healthcare accessibility.

### 7.1 Economic development in the post-bombing period

Table 6 shows the effects of local exposure to bombing on several indicators of economic development. These are contemporary population density, night time light emissions, market density, family wealth as an indicator for access to electricity and ownership of durable goods, and secondary education. Although the aggregate effects are not significant (Panel A), we observe contrasting effects in pre-bombing soft and hard soil areas: there are beneficial impacts on economic development in hard soil areas, whereas soft soil areas experience null or negative impacts.

In soft soil areas (Panel B), there are generally negative estimates for local exposure to bombing with night light emissions and family wealth significant. Compared to control soft-soil locations, bombed soft soil areas have roughly 35% less light emission compared to the mean (columns 3-4). Family wealth is also lower for those living in soft soil locations (columns 7-8). While the other results are inefficient, they generally point toward less economic activity in terms of population and market densities. These findings are consistent with the literature on how conflicts and UXO affect economic growth. Bombing and the ongoing threat from UXO may stifle economic growth, trapping populations in cycles of poverty (Yamada & Yamada 2021, Lin 2022, Riano & Valencia Caicedo 2024).

In contrast, hard soil areas experience beneficial impacts of local exposure to bombing on economic development (Panel C). First, modern population density is higher for

Table 6: Economic Development Indicators

| | Dependent variable is: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Population Density | | Light Intensity | | Market Density | | Family Wealth | | Secondary Edu. | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | | | |
| Bombing | -0.035 | -0.213 | -0.783 | -1.038 | -0.027 | -0.054 | 0.007 | 0.010 | 0.017 | 0.015 |
| | (0.426) | (0.387) | (0.775) | (0.709) | (0.077) | (0.070) | (0.016) | (0.015) | (0.019) | (0.017) |
| Mean | 1.599 | 1.697 | 4.187 | 4.628 | -0.00277 | 0.0247 | -0.000792 | 0.00155 | 0.314 | 0.318 |
| Observations | 9135 | 12045 | 200992 | 265012 | 9135 | 12045 | 9040 | 11918 | 9135 | 12045 |
| Clusters | 658 | 864 | 659 | 865 | 658 | 864 | 658 | 864 | 658 | 864 |
| *Panel B: Soft soil (1962)* | | | | | | | | | | |
| Bombing | -0.530 | -0.699 | -2.583* | -2.530** | -0.184 | -0.185 | -0.053** | -0.030 | -0.029 | -0.024 |
| | (0.886) | (0.771) | (1.403) | (1.244) | (0.133) | (0.117) | (0.027) | (0.026) | (0.036) | (0.031) |
| Mean | 3.353 | 3.407 | 7.491 | 7.501 | 0.294 | 0.308 | 0.0559 | 0.0524 | 0.393 | 0.378 |
| Observations | 3094 | 4030 | 68068 | 88660 | 3094 | 4030 | 3053 | 3981 | 3094 | 4030 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 |
| *Panel C: Hard soil (1962)* | | | | | | | | | | |
| Bombing | 0.453** | 0.278* | 0.684 | 0.205 | 0.130** | 0.087 | 0.045** | 0.036** | 0.048** | 0.040** |
| | (0.179) | (0.164) | (0.631) | (0.595) | (0.060) | (0.055) | (0.019) | (0.018) | (0.020) | (0.019) |
| Mean | 0.701 | 0.838 | 2.495 | 3.184 | -0.155 | -0.118 | -0.0297 | -0.0240 | 0.273 | 0.288 |
| Observations | 6041 | 8014 | 132924 | 176352 | 6041 | 8014 | 5987 | 7936 | 6041 | 8014 |
| Clusters | 428 | 562 | 429 | 564 | 428 | 562 | 428 | 562 | 428 | 562 |

Note: The unit of analysis is survey respondents (individuals). All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) (7) (9) include individuals living within 1km from bombing boundaries. Regressions (2) (4) (6) (8) (10) include individuals living within 1.5 km of bombing boundaries. Population Density indicates households' current population density (the number of people per square kilometer). Light Intensity is night-time light emissions at DHS household villages. Market Density is a standardized variable showing the density of market at DHS household clusters. Family Wealth is a dummy variable constructed based on households' accessibility to electricity and ownership of durable goods. Secondary Edu. is a binary variable indicating whether a respondent has graduated from secondary education. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

locations inside the bombing areas (columns 1-2).[34] Second, while night-time light intensity is positive but insignificant, current market density appears to be higher on the bombing side (columns 3-4). Third, households residing inside the bombing areas are wealthier, being more likely to access electricity and to own durable goods (columns 7-8). Finally, the likelihood of women residing within the bombing areas completing secondary education is significantly higher, with an increase of 4.8 or 4.0 percentage points, about 14% compared to the mean (columns 9-10). This evidence suggests that regions with a lower risk of UXO have experienced a more successful post-conflict recovery, with improved economic conditions and better human capital accumulation. These areas have been developed more effectively due to the reduced risks from UXO, allowing restoration and growth, and overall healthier local economies.

To further validate this mechanism, in Table 7, we exploit CSES data to investigate the impacts of local exposure to bombing on household income, household vulnerability and agricultural productivity. In soft soil locations (Panel B), bombed areas are more likely to face food shortages and have lower crop yield and crop revenue. Our findings are aligned with the narrative and empirical evidence in Lin (2022, 2024) that historical bombing of high-fertility land, where bombs were likely to fail, have persistent negative impacts on household production and welfare, as farmers change cultivation practices and cut

[34]It should be noted that in hard soil areas, pre-bombing population density was slightly lower for locations on the bombing side (Table G.2). Additionally, we also find that people who live in hard soil locations and on the bombing side are less likely to migrate post-bombing (See Table G.3). These results demonstrate that these locations have better conditions post-bombing for populations to thrive and grow.

Table 7: CSES Data: Economic Development

| | Dependent variable is: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Household | | | | Field Productivity | | | |
| | Income | | Food Shortage | | Quantity | | Crop Revenue | |
| | (1) <1km | (2) <1.5km | (3) <1km | (4) <1.5km | (5) <1km | (6) <1.5km | (7) <1km | (8) <1.5km |
| *Panel A: All observations* | | | | | | | | |
| Bombing | 0.009 | 0.012 | 0.011 | 0.004 | -0.268** | -0.206* | -0.287** | -0.211* |
| | (0.098) | (0.088) | (0.023) | (0.021) | (0.125) | (0.110) | (0.134) | (0.120) |
| Mean | 14.06 | 14.07 | 0.140 | 0.147 | 6.365 | 6.359 | 13.02 | 13.01 |
| Observations | 7256 | 9481 | 7256 | 9481 | 9129 | 12176 | 9119 | 12163 |
| Clusters | 411 | 522 | 411 | 522 | 383 | 491 | 383 | 491 |
| *Panel B: Soft soil (1962)* | | | | | | | | |
| Bombing | -0.318* | -0.267* | 0.099*** | 0.084*** | -0.458** | -0.294* | -0.522*** | -0.383*** |
| | (0.162) | (0.148) | (0.036) | (0.032) | (0.184) | (0.152) | (0.164) | (0.145) |
| Mean | 13.95 | 13.95 | 0.144 | 0.146 | 6.386 | 6.415 | 13.08 | 13.12 |
| Observations | 3198 | 4027 | 3198 | 4027 | 3655 | 4558 | 3648 | 4549 |
| Clusters | 165 | 202 | 165 | 202 | 153 | 191 | 153 | 191 |
| *Panel C: Hard soil (1962)* | | | | | | | | |
| Bombing | 0.370** | 0.298** | -0.043 | -0.057** | -0.131 | -0.070 | -0.110 | -0.031 |
| | (0.152) | (0.130) | (0.027) | (0.026) | (0.133) | (0.118) | (0.160) | (0.144) |
| Mean | 14.15 | 14.15 | 0.136 | 0.148 | 6.352 | 6.326 | 12.98 | 12.95 |
| Observations | 4058 | 5454 | 4058 | 5454 | 5474 | 7618 | 5471 | 7614 |
| Clusters | 250 | 328 | 250 | 328 | 231 | 303 | 231 | 303 |

Note: The unit of analysis for the first 4 columns is households. Regressions (1) (3) include households living within 1km from bombing boundaries. Regressions (2) (4) include households living within 1.5 km of bombing boundaries. *Income* demonstrates households' income from agricultural and non-agricultural activities. *Income* is transformed ln(Cambodian riel). For income equal to 0, it is transformed ln(Cambodian riel+10000) . *Food Shortage* is a dummy variable indicating whether households have ever suffered from food shortage in the past. The unit of analysis for the last 4 columns is fields (agricultural land). Regressions (5) (7) include fields located within 1km from bombing boundaries. Regressions (6) (8) include fields located within 1.5 km of bombing boundaries. *Quantity* represents the total quantity produced or harvested from the field. *Crop Revenue* indicates total revenue from the field: $Revenue = (QuantityHarvested - PostHarvestLoss) \times SalesPrice$. Both *Quantity* and *Crop Revenue* are also log transformed. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Standard errors reported in parenthesis are at the village level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

investments in agricultural capital, reducing profit margins and increasing poverty levels.

Meanwhile, for hard soil areas, we observe positive effects on income. Households living inside bombing areas have about 3% higher income than those living in hard soil control areas (columns 1-2). This, however, tracks with hard soil locations having less of a role in agriculture and more of a role for market activity. Additionally, these households are also less likly to suffer from food shortage if they are on the bombing side (columns 3-4). In hard soil areas with a lower UXO risk, households have a greater potential for recovery and growth post-conflict. In our case, households have not only recovered but have also achieved significant improvements in their economic conditions with higher household's income.

Overall, our evidence suggests that improved economic development in bombing-affected regions is a possible mechanism behind better health outcomes. These positive effects are strong in areas which soil was hard in the pre-bombing period and currently have a lower likelihood of UXO, while we see null or harmful effects in areas where UXO are more likely. In the next section, we explore healthcare accessibility in Cambodia as another likely mechanism for our results.

### 7.2 Healthcare accessibility

During the 1970s, the dual impacts of US bombings and the Khmer Rouge regime resulted in the physical devastation of society and completely dismantled the national healthcare system (Annear 1998). Cambodia began rebuilding its healthcare system from scratch, initially focusing on hospitals and staff training. A major reform came in 1995 with the Health Coverage Plan, expanding services to rural areas through health centers and district hospitals (Grundy et al. 2009).

At present, health facilities in Cambodia are constructed based on population coverage and geographical access, structured by operational districts (ODs) - the smallest administrative level in Cambodia's healthcare management system (WHO 2015). Each OD typically has one referral hospital serving 100,000–200,000 people and multiple health centers serving 10,000–20,000. In remote areas, smaller health posts serve 2,000–3,000 people, providing similar but limited services (WHO 2015). Figure G.5 visually presents the locations and distributions of health facilities in Cambodia in 2010. The map shows that health facilities are highly concentrated around the capital city and in the central flatlands of the country.[35]

With our empirical design, we look at distances to different health facilities as indicators of healthcare accessibility. Results are reported in Table 8.[36] While the overall effects are not statistically significant, disaggregating by pre-bombing soil type reveals clear patterns: hard soil areas show strong positive outcomes, while soft soil regions with high UXO presence experience significant negative effects.

In soft soil regions (Panel B), those on the bombing side see the distance to hospital increase by over 2 km - about 20% of the average (columns 1-2), and significantly longer distances to the nearest health facility (columns 5-6). Meanwhile, in hard soil areas, we find consistent evidence of shorter distances to health facilities for those living inside the bombing areas (Panel C). Both distances to district health center and any health facility decrease by over 0.7 km—around 20% of the mean. This suggests that in hard soil locations, post-war investments in healthcare infrastructure can gradually offset the negative impacts of bombing and even lead to better outcomes (Strauss & Thomas 2008). In contrast, soft soil locations with high UXO threats tend to receive lower investment in healthcare infrastructure. The persistent risk of UXO in these regions may deter investment and development efforts, and as a result, hinder them from recovering fully from past conflicts.

A similar analysis restricted to the region around the capital - the Southeast, where health facilities are concentrated, also yielded robust statistical evidence.[37] Individuals

[35] This is the Southeast region in our heterogeneity analysis. See Appendix D.

[36] We categorized health facilities into three groups: (1) hospitals, including national and referral hospitals, (2) district-level health centers, including health centers and health posts, and (3) any health facilities, including all hospitals and health facilities in Cambodia. Subsequently, we computed the distances from each household to the nearest hospital, the nearest district-level health centre, and the nearest health facility. See section 3.4.

[37] This Southeast region is also where bombing strikes were more intense. See Section 2

Table 8: Distance to health facilities

| | Dependent variable is Distance (km) to | | | | | |
|---|---|---|---|---|---|---|
| | Hospital | | District health center | | Any health facility | |
| | (1) <1km | (2) <1.5km | (3) <1km | (4) <1.5km | (5) <1km | (6) <1.5km |
| *Panel A: The whole country* | | | | | | |
| Bombing | 0.057 | 0.298 | -0.386** | -0.331* | -0.289 | -0.247 |
| | (0.648) | (0.602) | (0.194) | (0.185) | (0.188) | (0.180) |
| Mean | 13.72 | 13.42 | 3.261 | 3.234 | 3.220 | 3.195 |
| Observations | 9135 | 12045 | 9135 | 12045 | 9135 | 12045 |
| Clusters | 658 | 864 | 658 | 864 | 658 | 864 |
| *Panel B: Soft soil (1962)* | | | | | | |
| Bombing | 2.315*** | 2.106*** | 0.201 | 0.235 | 0.419** | 0.426** |
| | (0.653) | (0.643) | (0.219) | (0.206) | (0.204) | (0.192) |
| Mean | 9.967 | 10.20 | 2.653 | 2.692 | 2.577 | 2.621 |
| Observations | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 |
| *Panel C: Hard soil (1962)* | | | | | | |
| Bombing | -1.186 | -0.646 | -0.904*** | -0.733*** | -0.865*** | -0.699*** |
| | (0.726) | (0.685) | (0.247) | (0.240) | (0.246) | (0.240) |
| Mean | 15.64 | 15.05 | 3.572 | 3.507 | 3.548 | 3.484 |
| Observations | 6041 | 8014 | 6041 | 8014 | 6041 | 8014 |
| Clusters | 428 | 562 | 428 | 562 | 428 | 562 |

Note: Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

residing in bombed areas exhibit improved accessibility to healthcare services. Especially, these improvements are only observed in pre-bombing hard soil locations with a lower likelihood of UXO (Table D.2, Appendix D).

In summary, our evidence suggests that better health outcomes observed in bombed areas can be attributed to improved economic conditions and enhanced healthcare accessibility in these areas. Most importantly, these beneficial effects are completely driven by pre-bombing hard soil areas with a lower likelihood of UXO at the present time. Meanwhile, in soft soil areas where UXO becomes more prevalent, we observe null or even negative effects on economic development and healthcare accessibility.

## 8 Conclusion

Why might communities experience diverging long-run outcomes as a legacy of past exposure to aerial bombing? We demonstrate in Cambodia that variation in whether bombs detonated or left UXO then led to long-term differences in health and economic outcomes today. Bombed locations with soft soil are more likely to experience causalities from UXO today making development risky and life harder. Using a spatial regression discontinuity approach and DHS survey's of women, we then show that bombed areas have better health outcomes in pre-bombing soft soil locations with a lower UXO prevalence at the present. Meanwhile, in areas where remnants of war are more likely, we find null or negative impacts on health. We interpret our results on women's health as a measure of community variation in well-being and then turn to community development to explain our results.

Economic growth and healthcare accessibility in the post-conflict era follow the same patterns we observe on health. In areas with a lower UXO probability, past bombing exposure is linked with better economic conditions and better access to healthcare today. On the contrary, in areas with a higher UXO probability, local exposure to bombing yields detrimental effects on both economic development and healthcare access.

Our paper contributes to the diverse body of literature examining the long-term impacts of conflicts on health and economic development. We provide empirical support to the lingering negative effects of conflicts due to UXO threats, which is consistent with findings found in Guo (2020), Riano & Valencia Caicedo (2024), Lin (2022), Nguyen et al. (2024). However, we also show that in areas free of UXO, post-conflict efforts can lead to revitalization and sustainable growth, significantly improving health and economic conditions. This finding underscores the potential for recovery and development when areas are no longer hindered by hazardous remnants of war, reinforcing the narrative that UXO clearance fosters improved economic activity and revitalization (Chiovelli et al. 2018).

Our findings also carry significant implications for all countries that experience past conflicts, highlighting the power of post-war recovery efforts and post-conflict strategic investments. These initiatives play an important role in mitigating the adversities caused by war and conflicts and paving the way for healing and development. In Cambodia, regions free from the lingering hazards of conflicts have seen substantial investments in economic infrastructure and public healthcare, reducing the negative impacts of bombing and even led to improved health outcomes. However, in regions where UXO remained a threat, development was hindered, and the negative impacts continued to persist. This stresses the critical role of UXO clearance in facilitating long-term recovery because without such efforts, regions with remnants of war are more likely to be left behind and unable to develop. From a public health perspective, landmine and UXO clearance not only reduces morbidity and mortality but also brings substantial socioeconomic improvements to impacted communities (Frost et al. 2017). However, clearance efforts must prioritize critical areas, such as key transportation routes and trade corridors like in the case of Mozambique, to be cost-effective and yield the greatest benefits (Chiovelli et al. 2018). Future research, therefore, should focus on understanding the intricate relationship between post-conflict development and UXO, and investigate how UXO clearance can be integrated into broader development initiatives to maximize its impact. Understanding these dynamics can help policymakers design more effective and sustainable post-conflict recovery frameworks that address both urgent safety issues and long-term developmental needs.

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# Appendix

## A Robustness

Table A.1: Controlling for distance to Thai borders

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: Soft soil (1962)* | | | | | | |
| Bombing | -0.052 | -0.038 | 0.029* | 0.014 | 0.021** | 0.011 |
| | (0.051) | (0.045) | (0.016) | (0.014) | (0.010) | (0.010) |
| Mean | -1.785 | -1.793 | 0.182 | 0.177 | 0.0792 | 0.0799 |
| Observations | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 |
| *Panel B: Hard soil (1962)* | | | | | | |
| Bombing | 0.099*** | 0.086** | -0.027** | -0.023* | -0.028** | -0.026** |
| | (0.036) | (0.034) | (0.013) | (0.012) | (0.011) | (0.010) |
| Mean | -1.831 | -1.817 | 0.190 | 0.189 | 0.107 | 0.103 |
| Observations | 6041 | 8014 | 6041 | 8014 | 6041 | 8014 |
| Clusters | 428 | 562 | 428 | 562 | 428 | 562 |

Note: The unit of analysis is survey respondents. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) include individuals living within 1km from bombing boundaries. Regressions (2) (4) (6) include individuals living within 1.5 km of bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table A.2: Propensity Score Matching: Nearest Neighbor Matching and Kernel Matching

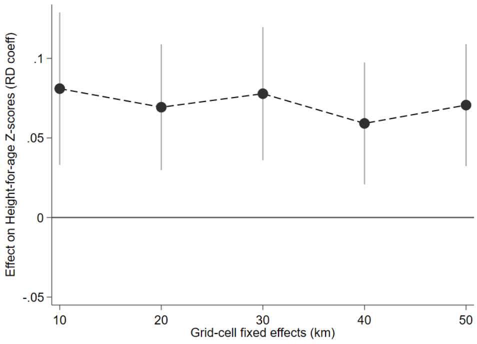
| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) NN | (2) Kernel | (3) NN | (4) Kernel | (5) NN | (6) Kernel |
| *Panel A: All population* | | | | | | |
| Bombing | 0.009 | 0.020 | 0.002 | -0.001 | -0.013 | -0.025** |
| | (0.032) | (0.021) | (0.017) | (0.010) | (0.016) | (0.010) |
| Mean | -1.790 | -1.789 | 0.177 | 0.170 | 0.0878 | 0.0901 |
| Observations | 23790 | 30948 | 23790 | 30948 | 23790 | 30948 |
| *Panel B: Soft soil (1962)* | | | | | | |
| Bombing | -0.037 | -0.032 | 0.001 | 0.001 | 0.007 | -0.013 |
| | (0.079) | (0.052) | (0.048) | (0.018) | (0.047) | (0.024) |
| Mean | -1.754 | -1.769 | 0.170 | 0.164 | 0.0720 | 0.0800 |
| Observations | 7960 | 11500 | 7960 | 11500 | 7960 | 11500 |
| *Panel C: Hard soil (1962)* | | | | | | |
| Bombing | 0.069* | 0.076** | -0.005 | -0.010 | -0.029** | -0.040*** |
| | (0.038) | (0.036) | (0.017) | (0.017) | (0.014) | (0.012) |
| Mean | -1.799 | -1.801 | 0.181 | 0.173 | 0.0946 | 0.0961 |
| Observations | 14681 | 19448 | 14681 | 19448 | 14681 | 19448 |

Note: Columns (1) (3) (5) show the average treatment effects on the treated using nearest-neighbor matching. Each treatment unit is paired with one control unit. Columns (2) (4) (6) show the treatment effects using kernel matching. In addition to matching on the propensity score, we ensure exact match on provinces and 50x50 grid cells, meaning we match individuals situated in the same province and the same grid area. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

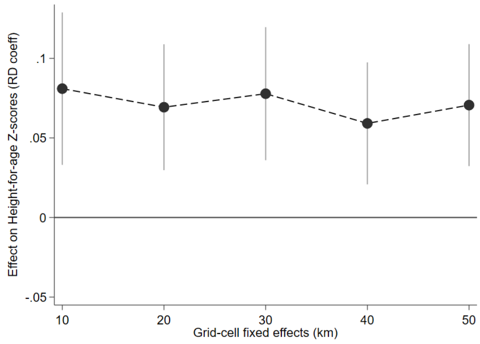
Figure A.1: Height-for-age Z-score: Sensitivity of Results to Different Grid Fixed Effects

**Panel A: Within 1km bandwidth**

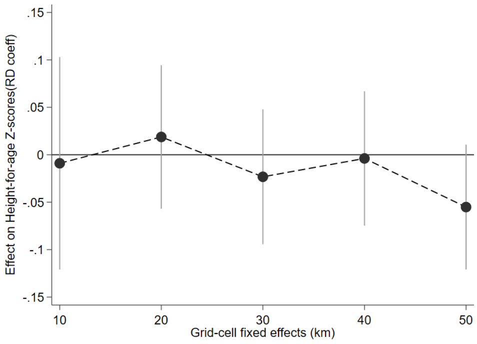
**Panel B: Within 1.5km bandwidth**



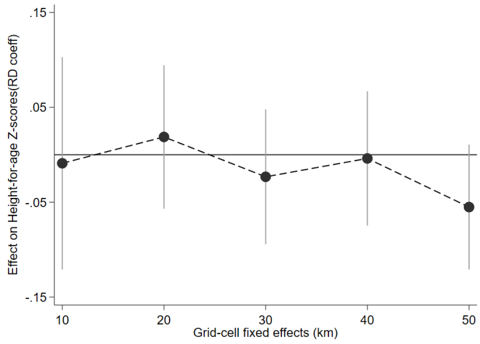

(a) All sample



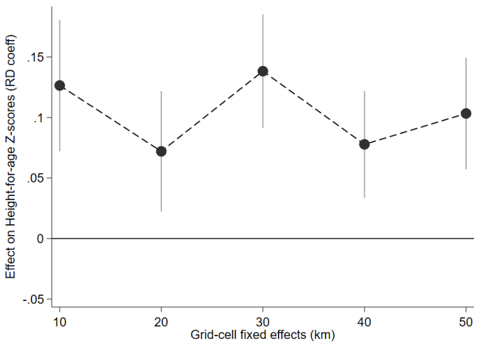

(b) All sample



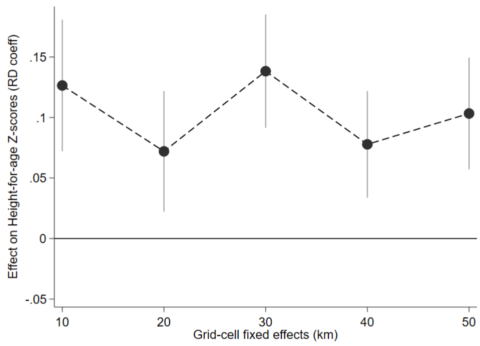

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

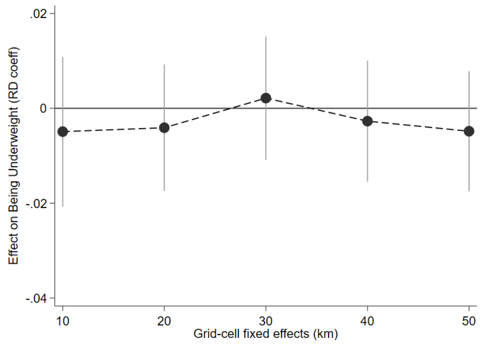



(f) Hard soil (1962)

*Note:* Dependent variable is Height-for-age Z-score (HAZ). Each dot represents the RD estimate using the specified order of RD polynomial in spatial coordinates. Range spikes represent 90% confidence intervals of the estimates.

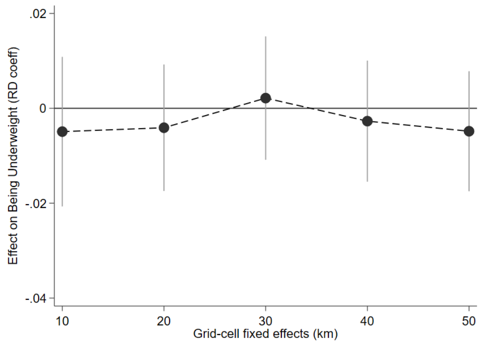
Figure A.2: Being Underweight: Sensitivity of Results to Different Grid Fixed Effects

**Panel A: Within 1km bandwidth**

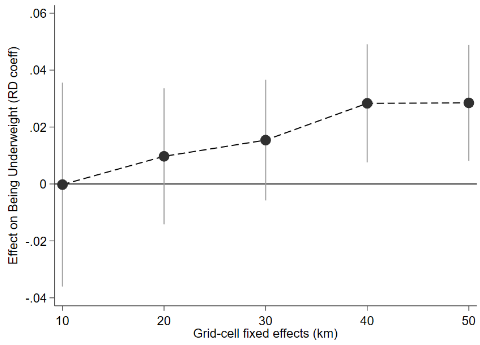



(a) All sample

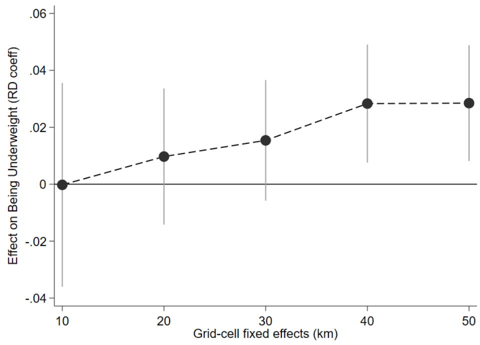
**Panel B: Within 1.5km bandwidth**



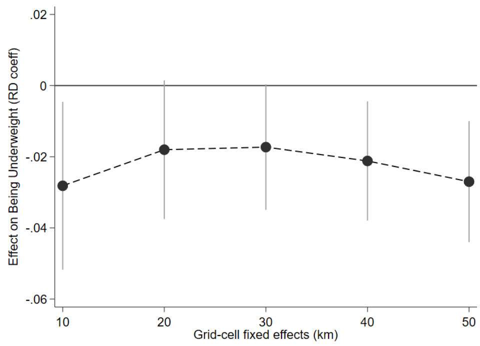

(b) All sample



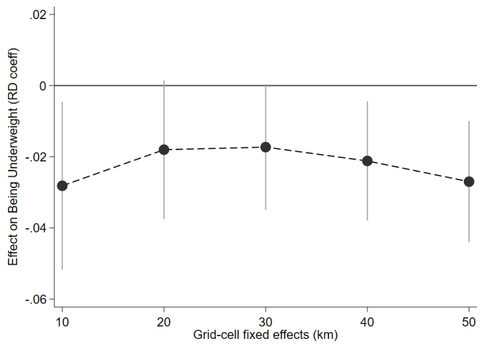

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

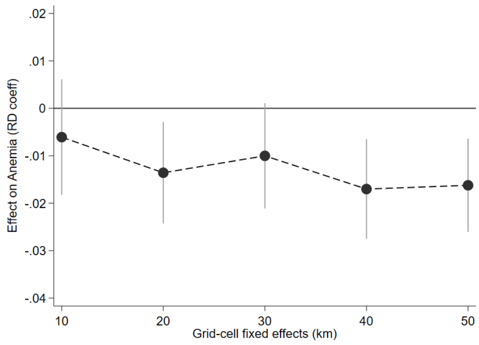



(f) Hard soil (1962)

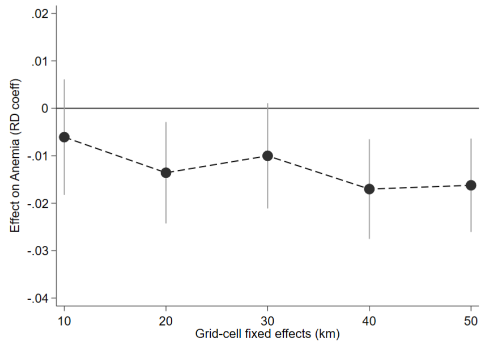
*Note:* Dependent variable is Being Underweight. Each dot represents the RD estimate using the specified order of RD polynomial in spatial coordinates. Range spikes represent 90% confidence intervals of the estimates.

Figure A.3: Anemia: Sensitivity of Results to Different Grid Fixed Effects

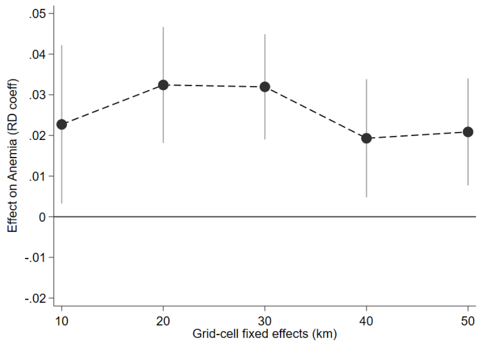
**Panel A: Within 1km bandwidth** **Panel B: Within 1.5km bandwidth**



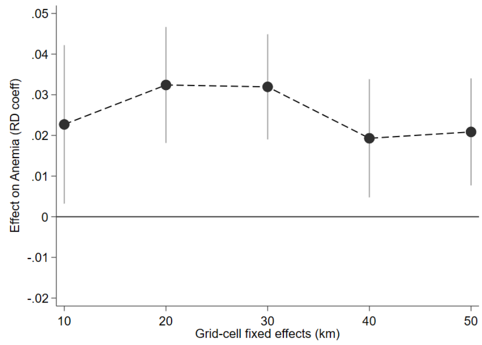

(a) All sample



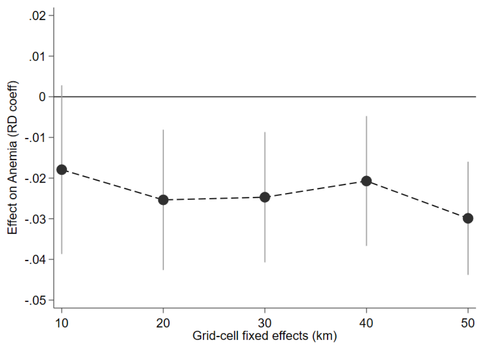

(b) All sample



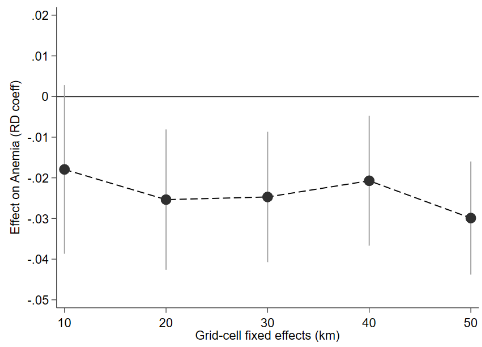

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

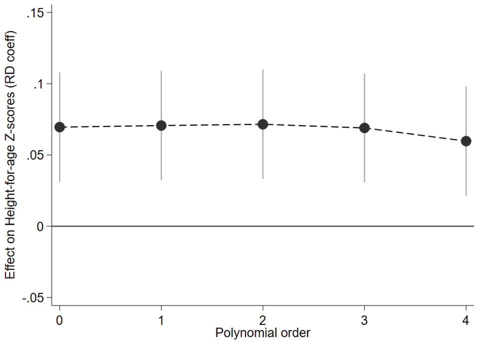



(f) Hard soil (1962)

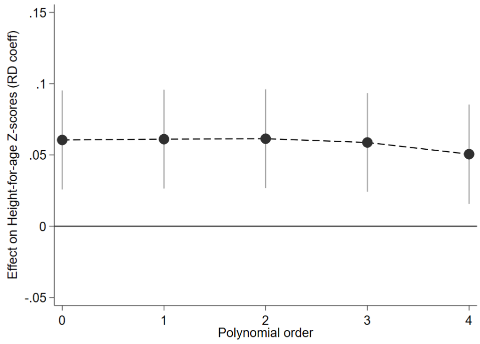
*Note:* Dependent variable is Anemia Level (ANE). Each dot represents the RD estimate using the specified order of RD polynomial in spatial coordinates. Range spikes represent 90% confidence intervals of the estimates.

Figure A.4: Height-for-age Z-score: Sensitivity of Results to Different Orders of Polynomial

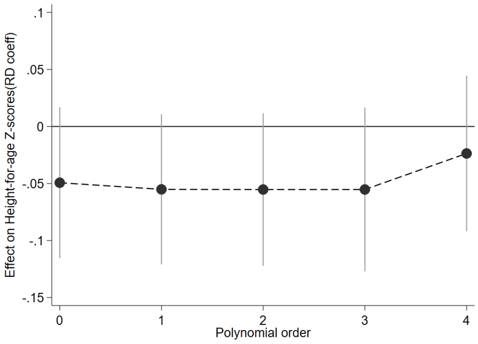
**Panel A: Within 1km bandwidth** **Panel B: Within 1.5km bandwidth**



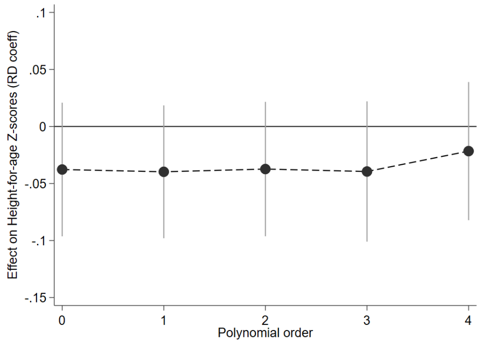

(a) All sample



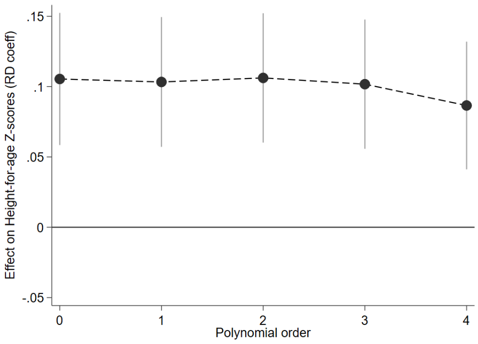

(b) All sample



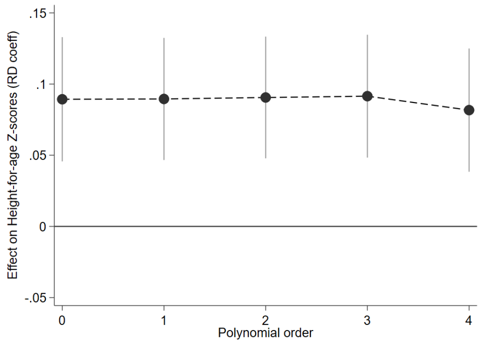

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

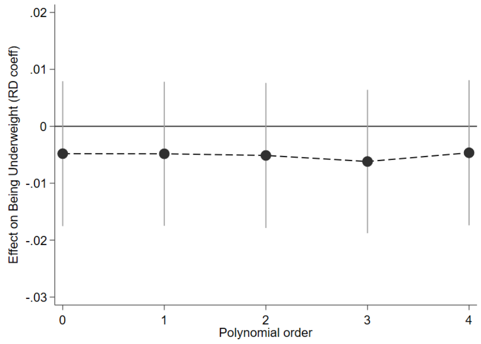



(f) Hard soil (1962)

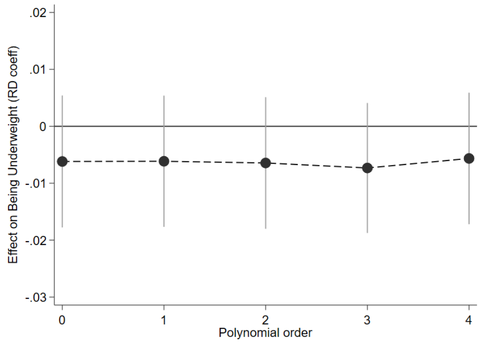
*Note:* Dependent variable is Height-for-age Z-score (HAZ). Each dot represents the RD estimate using the specified order of RD polynomial in spatial coordinates. Range spikes represent 90% confidence intervals of the estimates.

Figure A.5: Being Underweight: Sensitivity of Results to Different Orders of Polynomial

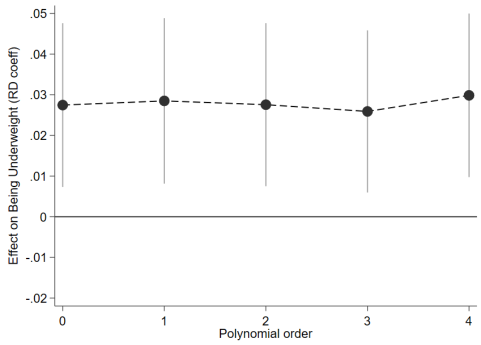
**Panel A: Within 1km bandwidth** | **Panel B: Within 1.5km bandwidth**



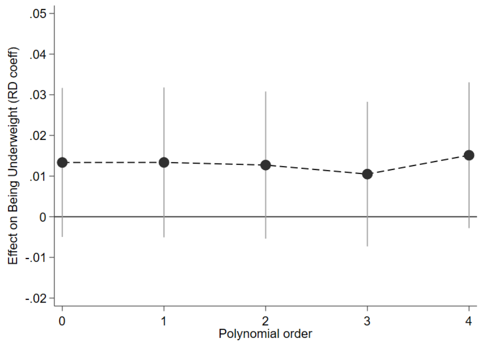

(a) All sample



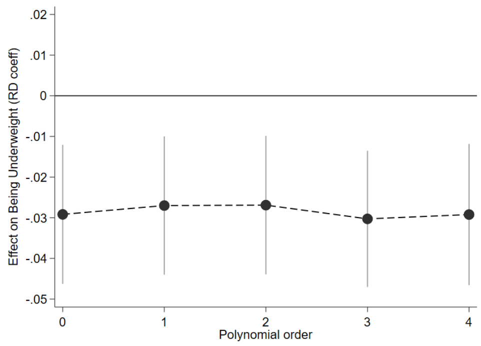

(b) All sample



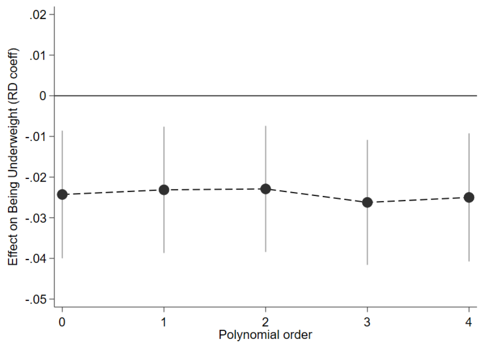

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

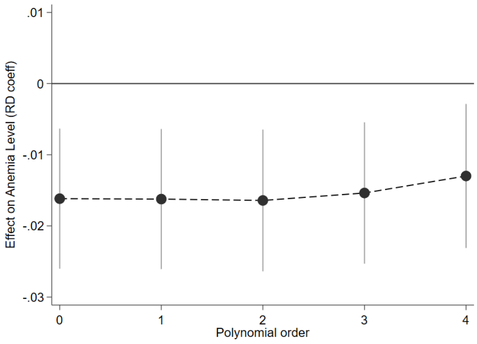



(f) Hard soil (1962)

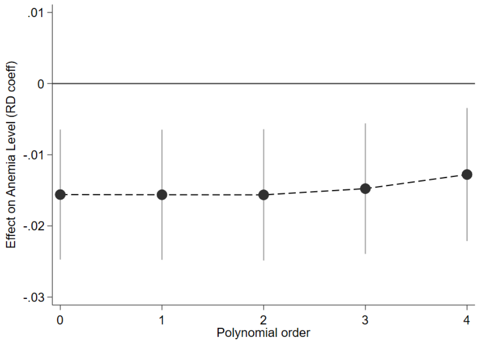
*Note:* Dependent variable is Being Underweight. Each dot represents the RD estimate using the specified order of RD polynomial in spatial coordinates. Range spikes represent 90% confidence intervals of the estimates.

Figure A.6: Anemia: Sensitivity of Results to Different Orders of Polynomial

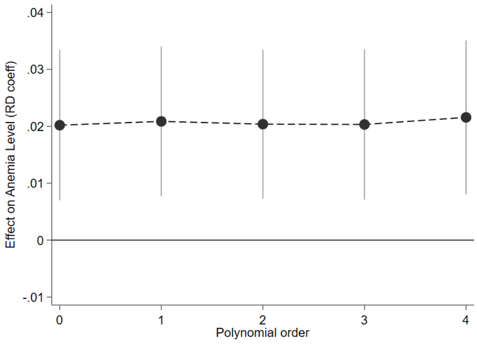
**Panel A: Within 1km bandwidth** **Panel B: Within 1.5km bandwidth**



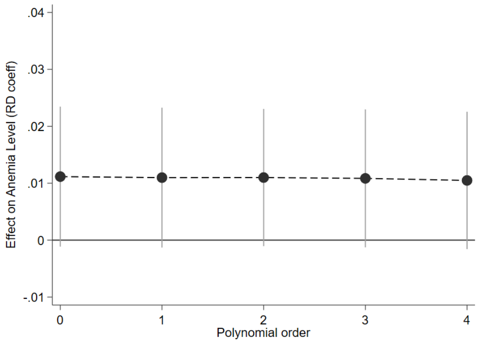

(a) All sample



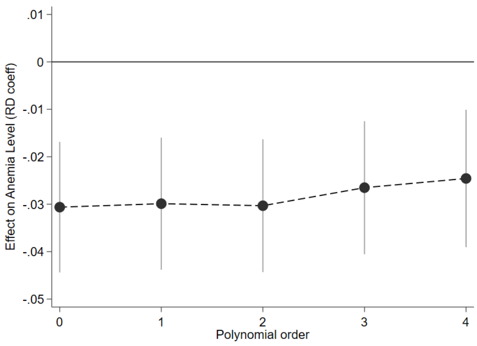

(b) All sample



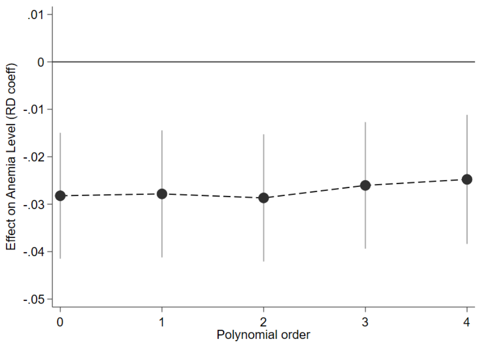

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

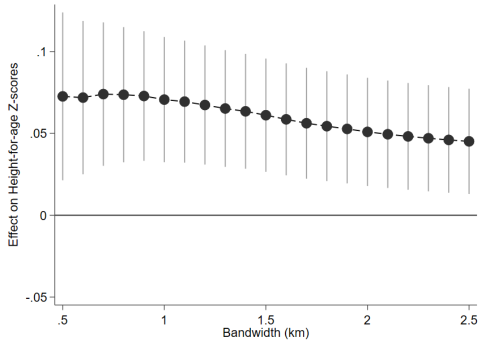



(f) Hard soil (1962)

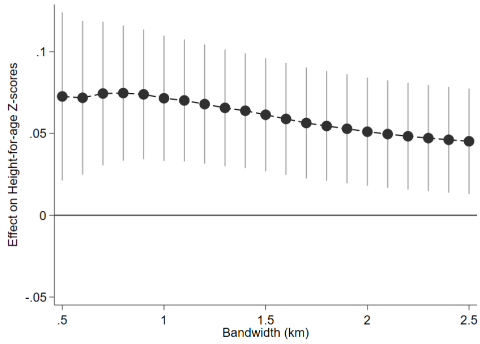
*Note:* Dependent variable is Anemia Level. Each dot represents the RD estimate using the specified order of RD polynomial in spatial coordinates. Range spikes represent 90% confidence intervals of the estimates.

Figure A.7: Height-for-age Z-score: Sensitivity of Results to Bandwidth Choice

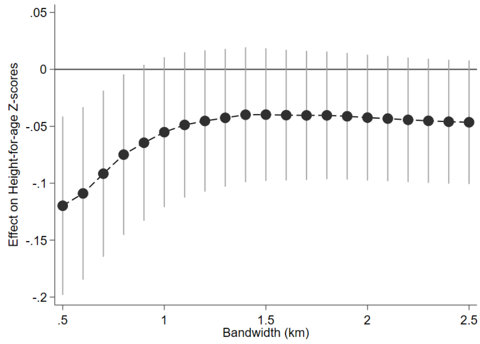
**Panel A: Linear polynomial** | **Panel B: Quadratic polynomial**



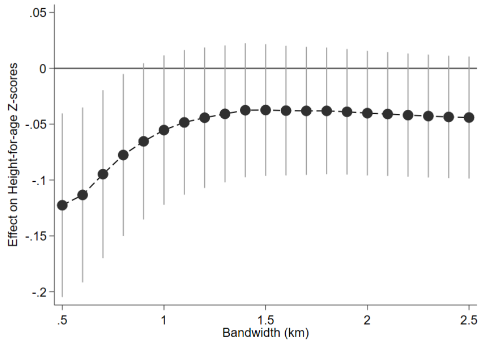

(a) All sample



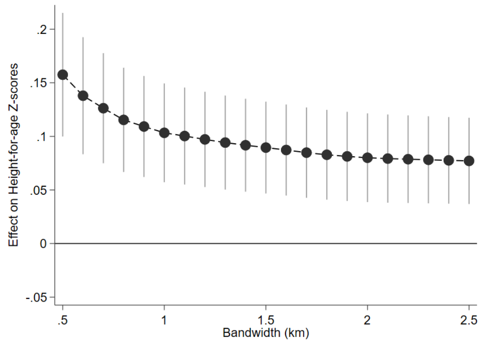

(b) All sample



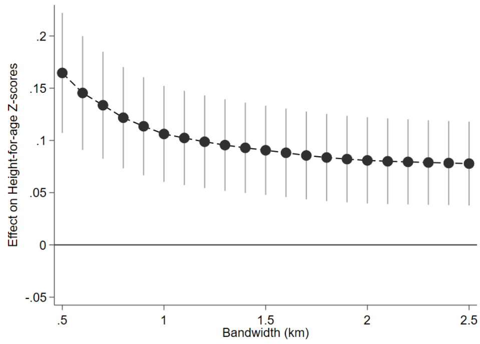

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

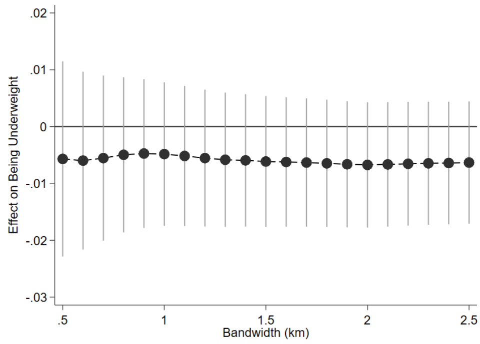



(f) Hard soil (1962)

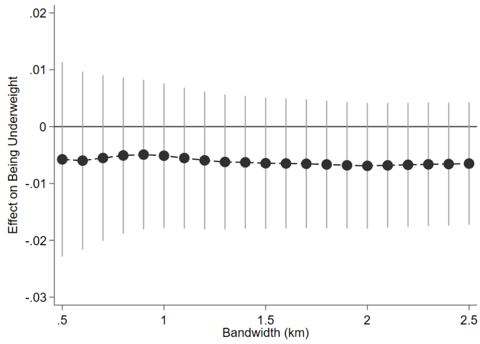
*Note:* Dependent variable is Height-for-age Z-score (HAZ). Each sub-graph reports coefficient estimates and confidence intervals for different bandwidth levels ranging from 0.5 to 2.5 kilometers (horizontal axis) with 0.1km intervals. Each dot indicates the RD estimate using the specified bandwidth. Range spikes represent 90% confidence intervals of the estimates. Panel A displays the coefficients in regresions controlling for a linear polynomial in spatial coordinates. Panel B reports the coefficients in regressions controlling for a quadratic polynomial in spatial coordinates.

Figure A.8: Being Underweight: Sensitivity of Results to Bandwidth Choice

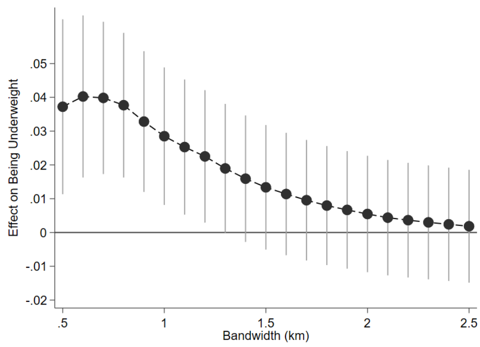
**Panel A: Linear polynomial** | **Panel B: Quadratic polynomial**



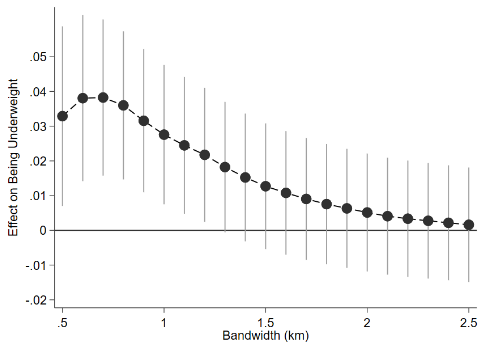

(a) All sample



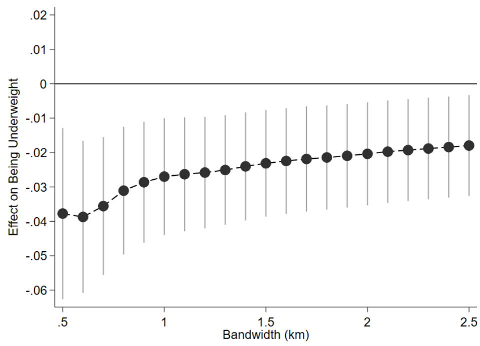

(b) All sample



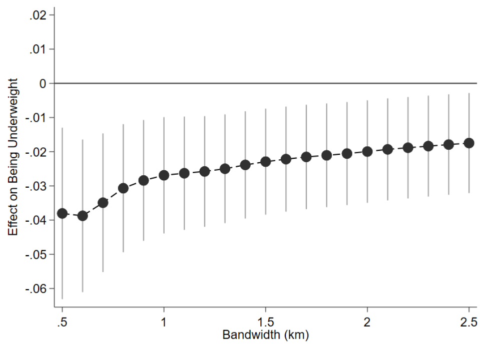

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)

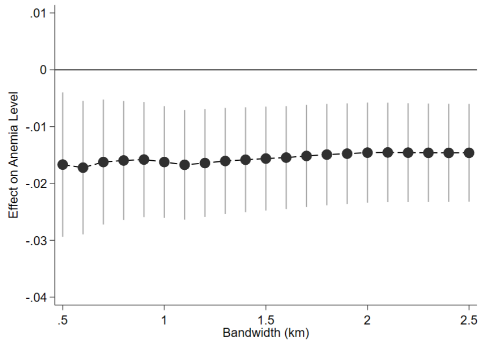



(f) Hard soil (1962)

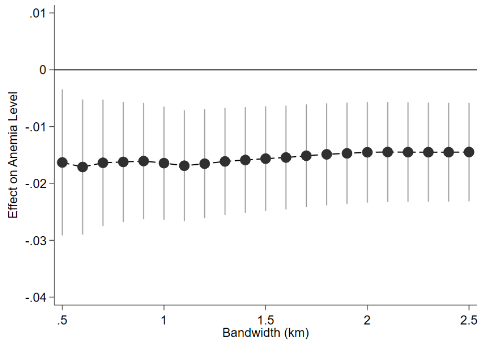
*Note:* Dependent variable is Being Underweight. Each sub-graph reports coefficient estimates and confidence intervals for different bandwidth levels ranging from 0.5 to 2.5 kilometers (horizontal axis) with 0.1km intervals. Each dot indicates the RD estimate using the specified bandwidth. Range spikes represent 90% confidence intervals of the estimates. Panel A displays the coefficients in regresions controlling for a linear polynomial in spatial coordinates. Panel B reports the coefficients in regressions controlling for a quadratic polynomial in spatial coordinates.

Figure A.9: Anemia level: Sensitivity of Results to Bandwidth Choice

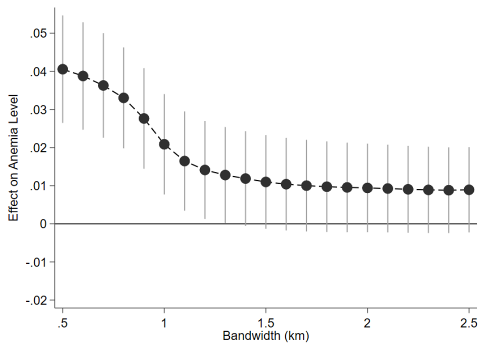
**Panel A: Linear polynomial** **Panel B: Quadratic polynomial**



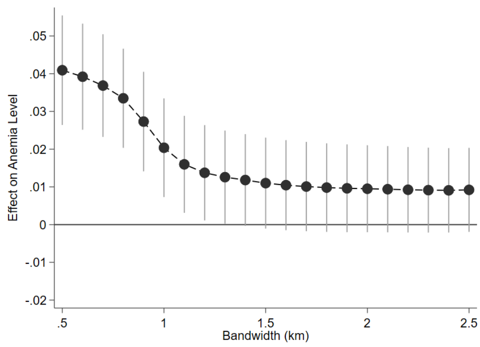

(a) All sample



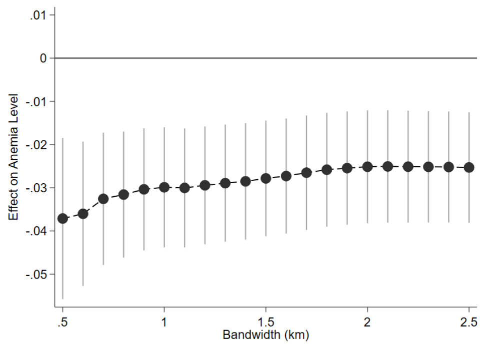

(b) All sample



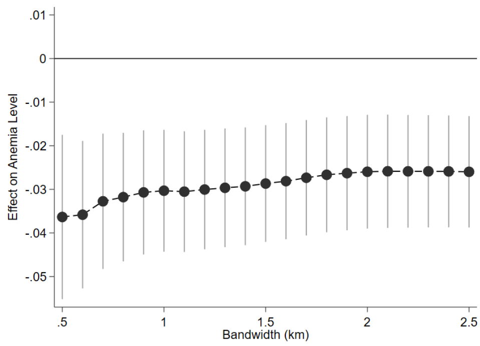

(c) Soft soil (1962)




(d) Soft soil (1962)




(e) Hard soil (1962)




(f) Hard soil (1962)

*Note:* Dependent variable is Anemia Level. Each sub-graph reports coefficient estimates and confidence intervals for different bandwidth levels ranging from 0.5 to 2.5 kilometers (horizontal axis) with 0.1km intervals. Each dot indicates the RD estimate using the specified bandwidth. Range spikes represent 90% confidence intervals of the estimates. Panel A displays the coefficients in regresions controlling for a linear polynomial in spatial coordinates. Panel B reports the coefficients in regressions controlling for a quadratic polynomial in spatial coordinates.

Table A.3: Heigh-for-age Z-score - Robustness checks: different specifications with x- and y- coordinates as running variables

| | Dependent variable is Heigh-for-age Z-score (HAZ) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grid-&District-FE | | Interacted Grid. FE | | No weight | | No Dist. Capital | | No Dist. Vietnam | | Donut 0.1km | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | | | | | |
| Bombing | 0.062** | 0.060** | 0.056* | 0.054** | 0.063** | 0.046* | 0.070** | 0.061** | 0.069** | 0.060** | 0.068** | 0.062** |
| | (0.029) | (0.027) | (0.030) | (0.027) | (0.027) | (0.026) | (0.030) | (0.027) | (0.030) | (0.027) | (0.034) | (0.030) |
| Mean | -1.815 | -1.809 | -1.815 | -1.809 | -1.815 | -1.809 | -1.815 | -1.809 | -1.815 | -1.809 | -1.815 | -1.808 |
| Observations | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 8070 | 10980 |
| Clusters | 659 | 865 | 659 | 865 | 659 | 865 | 659 | 865 | 659 | 865 | 582 | 788 |
| *Panel B: Soft soil (1962)* | | | | | | | | | | | | |
| Bombing | -0.058 | -0.038 | -0.052 | -0.020 | -0.025 | -0.045 | -0.054 | -0.039 | -0.053 | -0.039 | -0.053 | -0.045 |
| | (0.047) | (0.041) | (0.050) | (0.046) | (0.045) | (0.043) | (0.051) | (0.045) | (0.051) | (0.045) | (0.059) | (0.049) |
| Mean | -1.785 | -1.793 | -1.785 | -1.793 | -1.785 | -1.793 | -1.785 | -1.793 | -1.785 | -1.793 | -1.773 | -1.784 |
| Observations | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 2705 | 3641 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 205 | 276 |
| *Panel C: Hard soil (1962)* | | | | | | | | | | | | |
| Bombing | 0.118*** | 0.102*** | 0.101*** | 0.090*** | 0.082** | 0.077** | 0.104*** | 0.089*** | 0.103*** | 0.089*** | 0.119*** | 0.109*** |
| | (0.036) | (0.034) | (0.036) | (0.033) | (0.034) | (0.032) | (0.036) | (0.033) | (0.036) | (0.034) | (0.038) | (0.036) |
| Mean | -1.831 | -1.817 | -1.831 | -1.817 | -1.831 | -1.817 | -1.831 | -1.817 | -1.831 | -1.817 | -1.835 | -1.819 |
| Observations | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 5365 | 7339 |
| Clusters | 429 | 564 | 429 | 564 | 429 | 564 | 429 | 564 | 429 | 564 | 377 | 512 |

Note: The unit of analysis is survey respondents. Standard errors reported in parenthesis are at the DHS survey cluster level. Regressions (1) (2) control for grid-fixed effects and district-fixed effects (instead of province fixed effects). Regressions (3) (4) include interacted grid fixed effects with x- and y- coordinates. Regressions (5) (6) exclude the triangular kernel weight. Regressions (7) (8) (9) (10) exclude the distance to the capital and the distance to Vietnam's borders. Regressions (11) (12) conduct a donut exercise that excludes observations within 0.25 km the bombing boundaries. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table A.4: Being Underweight - Robustness checks: different specifications with x- and y- coordinates as running variables

| | Dependent variable is being underweight | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grid-&District-FE | | Interacted Grid. FE | | No weight | | No Dist. Capital | | No Dist. Vietnam | | Donut 0.1km | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | | | | | |
| Bombing | 0.002 | -0.002 | -0.007 | -0.006 | -0.005 | -0.007 | -0.004 | -0.006 | -0.004 | -0.006 | -0.002 | -0.004 |
| | (0.010) | (0.009) | (0.011) | (0.009) | (0.009) | (0.009) | (0.010) | (0.009) | (0.010) | (0.009) | (0.011) | (0.010) |
| Mean | 0.187 | 0.185 | 0.187 | 0.185 | 0.187 | 0.185 | 0.187 | 0.185 | 0.187 | 0.185 | 0.189 | 0.186 |
| Observations | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 8070 | 10980 |
| Clusters | 659 | 865 | 659 | 865 | 659 | 865 | 659 | 865 | 659 | 865 | 582 | 788 |
| *Panel B: Soft soil (1962)* | | | | | | | | | | | | |
| Bombing | 0.007 | 0.001 | 0.033** | 0.025* | 0.014 | -0.002 | 0.028* | 0.013 | 0.027* | 0.013 | 0.031* | 0.013 |
| | (0.017) | (0.015) | (0.016) | (0.014) | (0.015) | (0.013) | (0.016) | (0.014) | (0.016) | (0.014) | (0.017) | (0.015) |
| Mean | 0.182 | 0.177 | 0.182 | 0.177 | 0.182 | 0.177 | 0.182 | 0.177 | 0.182 | 0.177 | 0.180 | 0.175 |
| Observations | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 2705 | 3641 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 205 | 276 |
| *Panel C: Hard soil (1962)* | | | | | | | | | | | | |
| Bombing | -0.012 | -0.011 | -0.034** | -0.029** | -0.021* | -0.016 | -0.027** | -0.023* | -0.027** | -0.023* | -0.024 | -0.018 |
| | (0.016) | (0.013) | (0.015) | (0.014) | (0.012) | (0.012) | (0.013) | (0.012) | (0.013) | (0.012) | (0.015) | (0.014) |
| Mean | 0.190 | 0.189 | 0.190 | 0.189 | 0.190 | 0.189 | 0.190 | 0.189 | 0.190 | 0.189 | 0.193 | 0.191 |
| Observations | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 5365 | 7339 |
| Clusters | 429 | 564 | 429 | 564 | 429 | 564 | 429 | 564 | 429 | 564 | 377 | 512 |

Note: The unit of analysis is survey respondents. Standard errors reported in parenthesis are at the DHS survey cluster level. Regressions (1) (2) control for grid-fixed effects and district-fixed effects (instead of province fixed effects). Regressions (3) (4) include interacted grid fixed effects with x- and y- coordinates. Regressions (5) (6) exclude the triangular kernel weight. Regressions (7) (8) (9) (10) exclude the distance to the capital and the distance to Vietnam's borders. Regressions (11) (12) conduct a donut exercise that excludes observations within 0.25 km the bombing boundaries. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table A.5: Anemia - Robustness checks: different specifications with x- and y- coordinates as running variables

| | Dependent variable is Anemia Level | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grid-&District-FE | | Interacted Grid. FE | | No weight | | No Dist. Capital | | No Dist. Vietnam | | Donut 0.1km | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | | | | | |
| Bombing | -0.014 | -0.013* | -0.011 | -0.014* | -0.017** | -0.014** | -0.017** | -0.016** | -0.016** | -0.015** | -0.009 | -0.012 |
| | (0.009) | (0.008) | (0.008) | (0.007) | (0.007) | (0.007) | (0.008) | (0.007) | (0.008) | (0.007) | (0.009) | (0.008) |
| Mean | 0.0977 | 0.0954 | 0.0977 | 0.0954 | 0.0977 | 0.0954 | 0.0977 | 0.0954 | 0.0977 | 0.0954 | 0.0986 | 0.0958 |
| Observations | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 9136 | 12046 | 8070 | 10980 |
| Clusters | 659 | 865 | 659 | 865 | 659 | 865 | 659 | 865 | 659 | 865 | 582 | 788 |
| *Panel B: Soft soil (1962)* | | | | | | | | | | | | |
| Bombing | 0.020* | 0.012 | 0.032*** | 0.016 | 0.002 | 0.005 | 0.020** | 0.011 | 0.022** | 0.011 | 0.012 | 0.006 |
| | (0.011) | (0.010) | (0.011) | (0.010) | (0.010) | (0.009) | (0.010) | (0.010) | (0.010) | (0.010) | (0.011) | (0.010) |
| Mean | 0.0792 | 0.0799 | 0.0792 | 0.0799 | 0.0792 | 0.0799 | 0.0792 | 0.0799 | 0.0792 | 0.0799 | 0.0791 | 0.0799 |
| Observations | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 3094 | 4030 | 2705 | 3641 |
| Clusters | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 230 | 301 | 205 | 276 |
| *Panel C: Hard soil (1962)* | | | | | | | | | | | | |
| Bombing | -0.021* | -0.024** | -0.022* | -0.025** | -0.027** | -0.022** | -0.031*** | -0.028*** | -0.030*** | -0.028*** | -0.020 | -0.022* |
| | (0.013) | (0.011) | (0.012) | (0.011) | (0.011) | (0.011) | (0.011) | (0.010) | (0.011) | (0.010) | (0.013) | (0.012) |
| Mean | 0.107 | 0.103 | 0.107 | 0.103 | 0.107 | 0.103 | 0.107 | 0.103 | 0.107 | 0.103 | 0.108 | 0.104 |
| Observations | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 6042 | 8016 | 5365 | 7339 |
| Clusters | 429 | 564 | 429 | 564 | 429 | 564 | 429 | 564 | 429 | 564 | 377 | 512 |

Note: Note: The unit of analysis is survey respondents. Standard errors reported in parenthesis are at the DHS survey cluster level. Regressions (1) (2) control for grid-fixed effects and district-fixed effects (instead of province fixed effects). Regressions (3) (4) include interacted grid fixed effects with x- and y- coordinates. Regressions (5) (6) exclude the triangular kernel weight. Regressions (7) (8) (9) (10) exclude the distance to the capital and the distance to Vietnam's borders. Regressions (11) (12) conduct a donut exercise that excludes observations within 0.25 km the bombing boundaries. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table A.6: Height-for-age Z-score - Robustness checks: Shifting borders

| | Dependent variable is Height-for-age Z-score | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Shift east | | Shift west | | Shift north | | Shift south | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | |
| Bombing | 0.014 | 0.013 | -0.063** | -0.046* | 0.016 | 0.012 | -0.001 | -0.002 |
| | (0.026) | (0.023) | (0.030) | (0.027) | (0.024) | (0.022) | (0.029) | (0.026) |
| Mean | 0.623 | 0.769 | 0.560 | 0.711 | 0.633 | 0.757 | 0.614 | 0.781 |
| Observations | 9512 | 12662 | 8986 | 12426 | 10138 | 13216 | 9666 | 13407 |
| Clusters | 679 | 899 | 651 | 887 | 714 | 939 | 686 | 945 |
| *Panel B: Soft soil (1962)* | | | | | | | | |
| Bombing | 0.010 | 0.005 | -0.069 | -0.059 | -0.033 | -0.043 | 0.007 | 0.001 |
| | (0.040) | (0.035) | (0.047) | (0.045) | (0.039) | (0.035) | (0.052) | (0.043) |
| Mean | 0.668 | 0.847 | 0.623 | 0.751 | 0.646 | 0.779 | 0.583 | 0.743 |
| Observations | 3415 | 4786 | 3305 | 4537 | 3805 | 4881 | 3412 | 4703 |
| Clusters | 254 | 350 | 247 | 332 | 269 | 349 | 248 | 339 |
| *Panel C: Hard soil (1962)* | | | | | | | | |
| Bombing | 0.016 | 0.025 | -0.093** | -0.069** | 0.062* | 0.053* | -0.003 | -0.008 |
| | (0.035) | (0.032) | (0.039) | (0.034) | (0.033) | (0.030) | (0.035) | (0.033) |
| Mean | 0.601 | 0.730 | 0.528 | 0.691 | 0.627 | 0.746 | 0.629 | 0.800 |
| Observations | 6097 | 7876 | 5681 | 7889 | 6333 | 8334 | 6253 | 8703 |
| Clusters | 425 | 549 | 404 | 555 | 445 | 589 | 437 | 605 |

Note: The table shows the results of placebo tests which shift bombing borders by 3 kilometers to four different directions: east-west-north-south. The unit of analysis is survey respondents. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table A.7: Being Underweight - Robustness checks: Shifting borders

| | Dependent variable is Being Underweight | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Shift east | | Shift west | | Shift north | | Shift south | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | |
| Bombing | 0.008 | 0.002 | 0.014 | 0.014 | -0.002 | -0.002 | -0.007 | -0.007 |
| | (0.010) | (0.009) | (0.011) | (0.010) | (0.009) | (0.008) | (0.010) | (0.009) |
| Mean | 0.623 | 0.769 | 0.560 | 0.711 | 0.633 | 0.757 | 0.614 | 0.781 |
| Observations | 9512 | 12662 | 8986 | 12426 | 10138 | 13216 | 9666 | 13407 |
| Clusters | 679 | 899 | 651 | 887 | 714 | 939 | 686 | 945 |
| *Panel B: Soft soil (1962)* | | | | | | | | |
| Bombing | 0.051*** | 0.034*** | 0.029* | 0.021 | 0.031** | 0.017 | -0.005 | -0.002 |
| | (0.013) | (0.012) | (0.016) | (0.015) | (0.015) | (0.014) | (0.017) | (0.015) |
| Mean | 0.668 | 0.847 | 0.623 | 0.751 | 0.646 | 0.779 | 0.583 | 0.743 |
| Observations | 3415 | 4786 | 3305 | 4537 | 3805 | 4881 | 3412 | 4703 |
| Clusters | 254 | 350 | 247 | 332 | 269 | 349 | 248 | 339 |
| *Panel C: Hard soil (1962)* | | | | | | | | |
| Bombing | -0.017 | -0.021* | -0.001 | 0.009 | -0.012 | -0.011 | 0.001 | -0.005 |
| | (0.014) | (0.012) | (0.017) | (0.014) | (0.011) | (0.011) | (0.012) | (0.011) |
| Mean | 0.601 | 0.730 | 0.528 | 0.691 | 0.627 | 0.746 | 0.629 | 0.800 |
| Observations | 6097 | 7876 | 5681 | 7889 | 6333 | 8334 | 6253 | 8703 |
| Clusters | 425 | 549 | 404 | 555 | 445 | 589 | 437 | 605 |

Note: The table shows the results of placebo tests which shift bombing borders by 3 kilometers to four different directions: east-west-north-south. The unit of analysis is survey respondents. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

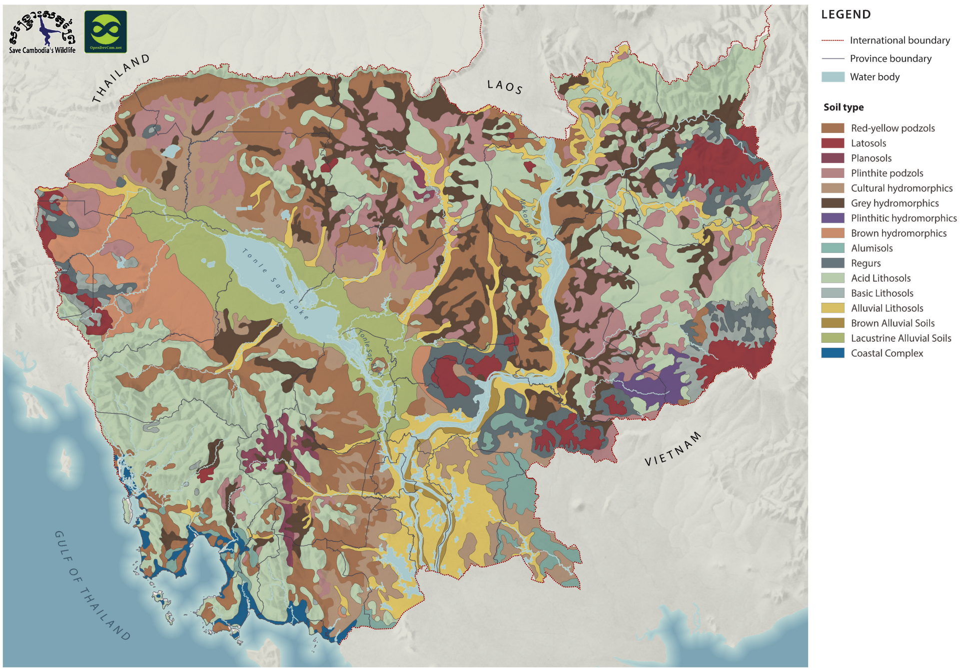
Table A.8: Anemia - Robustness checks: Shifting borders

| | Dependent variable is Anemia Level | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Shift east | | Shift west | | Shift north | | Shift south | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: All observations* | | | | | | | | |
| Bombing | 0.003 | 0.003 | 0.006 | 0.003 | 0.001 | 0.002 | 0.014* | 0.013* |
| | (0.008) | (0.007) | (0.008) | (0.007) | (0.006) | (0.006) | (0.008) | (0.007) |
| Mean | 0.623 | 0.769 | 0.560 | 0.711 | 0.633 | 0.757 | 0.614 | 0.781 |
| Observations | 9512 | 12662 | 8986 | 12426 | 10138 | 13216 | 9666 | 13407 |
| Clusters | 679 | 899 | 651 | 887 | 714 | 939 | 686 | 945 |
| *Panel B: Soft soil (1962)* | | | | | | | | |
| Bombing | 0.022** | 0.021** | 0.013 | 0.013 | 0.008 | 0.010 | 0.022* | 0.021** |
| | (0.010) | (0.009) | (0.011) | (0.010) | (0.009) | (0.008) | (0.012) | (0.011) |
| Mean | 0.668 | 0.847 | 0.623 | 0.751 | 0.646 | 0.779 | 0.583 | 0.743 |
| Observations | 3415 | 4786 | 3305 | 4537 | 3805 | 4881 | 3412 | 4703 |
| Clusters | 254 | 350 | 247 | 332 | 269 | 349 | 248 | 339 |
| *Panel C: Hard soil (1962)* | | | | | | | | |
| Bombing | -0.006 | -0.004 | 0.011 | 0.002 | -0.001 | -0.001 | 0.006 | 0.006 |
| | (0.012) | (0.010) | (0.012) | (0.011) | (0.008) | (0.008) | (0.010) | (0.009) |
| Mean | 0.601 | 0.730 | 0.528 | 0.691 | 0.627 | 0.746 | 0.629 | 0.800 |
| Observations | 6097 | 7876 | 5681 | 7889 | 6333 | 8334 | 6253 | 8703 |
| Clusters | 425 | 549 | 404 | 555 | 445 | 589 | 437 | 605 |

Note: The table shows the results of placebo tests which shift bombing borders by 3 kilometers to four different directions: east-west-north-south. The unit of analysis is survey respondents. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

## B Soil classification in Cambodia

Figure B.1: Soil types in Cambodia (Crocker, 1962)




*Notes:* The map displays the distribution of soil types in Cambodia, as documented by Crocker (1962). The data, in vector format, were provided to Open Development Cambodia by Save Cambodia's Wildlife's Atlas Working Group. See `https://opendevelopmentcambodia.net` for more details.

Crocker (1962) carried out an exploratory soil survey in Cambodia, followed by the publication of a general soil map at a 1:1,000,000 scale in 1963 (Kyuma & Kawaguchi 1966). The map classifies soil in Cambodia into 16 different soil types: red-yellow podzols, latosols, planosols, plinthite podzols, cultural hydromorphics, grey hydromorphics, plinthitic hydromorphics, brown hydromorphics, alumisols, regurs, acid lithosols, basic lithosols, alluvial lithosols, brown alluvial soils, lacustrine alluvial soils, and coastal complex (Figure B.1).

White et al. (1997) discuss the characteristics of each soil group in Cambodia and its potential for rice production. For example, Prey Khmer soils correspond to Red-Yellow Podzols and occasionally Planosols identified by Crocker (1962). These soils have low water holding capacity and limited potential for high rice yields. On the contrary, Kompong Siem Soils which are Regurs in Crocker (1962) are considered fertile and well-suited for rice cultivation, with top soil having good water holding capacity.

Based on the characteristics of each soil type described in White et al. (1997) and similar to the classification in Kohama et al. (2020), we define these six soil types in Crocker (1962) as fertile (soft) soils: Latosols, Alluvial soils, Brown alluvial soils, Lacustrine alluvial soils, Regurs, and Brown hydromorphics. These soils often have good water holding capaciy and are suitable for rice production. Most importantly, since areas with soft or fertile soil are more likely to contain UXO (Moyes et al. 2002, Lin 2022),[1] we use this classification of pre-bombing soil fertility in our analysis to disentangle the long term effects of local area exposure to bombing in areas with fertile (soft) soil - a high likelihood of UXO versus areas with infertile (hard) soil - lower UXO occurences.

[1] See Section 2.

## C Uni-dimensional RD design

### C.1 Specification with unidimensional RD polynomial

We use the uni-dimensional RD design to cross-verify our results. The regressions take the same form as our main specification. However, in this setting, RD polynomial $f(Geo_c)$ uses a mono-dimensional measure, in particular, distance to bombing boundaries as a running variable.

The local linear polynomial has a function as $f(Geo_c) = \eta dist_c + \theta Bombing_c \times dist_c$ with the forcing variable $dist_c$ denoting the Euclidean distance between a household location and the closest point on bombing boundaries. Higher-order polynomials will take the following form: $f(Geo_c) = \sum_{k=1}^{a} \eta_k dist_c^k + \theta_k Bombing_c \times dist_c^k$. The interaction term of the treatment variable with the distance to the bombing areas is of great importance because it allows for different slopes of the functions on two sides of bombing boundaries.

In terms of bandwidth selection, the estimation sample is restricted to individuals falling within a bandwidth around bombing boundaries chosen following Calonico et al. (2014).

### C.2 Results

Table C.1: Balance check

| | Dependent variable is: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Elevation | (2) Tropics/lowland | (3) Soil Fertility | (4) Agri. Activities | (5) Pop. Density | (6) Dist. roads | (7) Dist. VN | (8) Dist. Capital |
| Bombing | 12.135* | 0.009 | -0.088 | -0.014 | -0.013 | 0.613 | 0.398 | -2.091 |
| | (6.555) | (0.055) | (0.059) | (0.058) | (0.041) | (0.692) | (1.259) | (1.270) |
| Mean | 34.6 | 0.59 | 0.33 | 0.62 | 0.46 | 6.47 | 88.9 | 93.9 |
| Observations | 12045 | 12045 | 12045 | 12045 | 12045 | 12045 | 12045 | 12045 |
| Clusters | 864 | 864 | 864 | 864 | 864 | 864 | 864 | 864 |

Note: The unit of analysis is survey respondents. Strike fixed effects, 50x50km grid fixed effects and province fixed effects are present in all regressions. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table C.2: Balance check split by 1962 soil fertility

| | Dependent variable is: | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) Elevation | (2) Tropics/lowland | (3) Agri. Activities | (4) Pop. Density | (5) Dist. to roads | (6) Dist VN | (7) Dist. to capital |
| *Panel A: Soft soil (1962)* | | | | | | | |
| Bombing | 20.179 | 0.110 | -0.090 | 0.127** | 0.906 | 1.081 | -0.511 |
| | (14.525) | (0.079) | (0.084) | (0.056) | (0.979) | (1.628) | (1.728) |
| Mean | 40.3 | 0.56 | 0.68 | 0.49 | 6.31 | 77.6 | 83.1 |
| Observations | 4030 | 4030 | 4030 | 4030 | 4030 | 4030 | 4030 |
| Clusters | 301 | 301 | 301 | 301 | 301 | 301 | 301 |
| *Panel B: Hard soil (1962)* | | | | | | | |
| Bombing | 6.234 | -0.061 | 0.072 | -0.120** | 0.716 | -1.231 | -2.718 |
| | (3.989) | (0.075) | (0.068) | (0.059) | (0.924) | (1.724) | (1.727) |
| Mean | 31.7 | 0.60 | 0.59 | 0.44 | 6.56 | 94.6 | 99.3 |
| Observations | 8014 | 8014 | 8014 | 8014 | 8014 | 8014 | 8014 |
| Clusters | 562 | 562 | 562 | 562 | 562 | 562 | 562 |

Note: The unit of analysis is survey respondents. Strike fixed effects, 50x50km grid fixed effects, and province fixed effects are present in all regressions. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table C.3: Results with unidimensional RD design

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) Linear | (2) Quadratic | (3) Linear | (4) Quadratic | (5) Linear | (6) Quadratic |
| *Panel A: All population* | | | | | | |
| Bombing | 0.109*** | 0.058 | -0.008 | -0.008 | -0.023** | -0.031* |
| | (0.041) | (0.058) | (0.012) | (0.017) | (0.012) | (0.017) |
| Mean | -1.81 | -1.81 | 0.18 | 0.18 | 0.096 | 0.096 |
| Observations | 12715 | 12715 | 17446 | 17446 | 11918 | 11918 |
| Bandwidth (km) | 1.62 | 1.62 | 2.67 | 2.67 | 1.48 | 1.48 |
| Clusters | 907 | 907 | 1232 | 1232 | 857 | 857 |
| *Panel B: Soft soil (1962)* | | | | | | |
| Bombing | -0.016 | -0.073 | 0.023 | 0.051* | 0.009 | 0.013 |
| | (0.059) | (0.084) | (0.019) | (0.027) | (0.012) | (0.017) |
| Mean | -1.78 | -1.78 | 0.18 | 0.18 | 0.075 | 0.075 |
| Observations | 5570 | 5570 | 5892 | 5892 | 6574 | 6574 |
| Bandwidth (km) | 2.28 | 2.28 | 2.46 | 2.46 | 2.97 | 2.97 |
| Clusters | 403 | 403 | 424 | 424 | 470 | 470 |
| *Panel C: Hard soil (1962)* | | | | | | |
| Bombing | 0.169*** | 0.152** | -0.030* | -0.043* | -0.050*** | -0.072*** |
| | (0.053) | (0.076) | (0.015) | (0.022) | (0.017) | (0.025) |
| Mean | -1.82 | -1.82 | 0.19 | 0.19 | 0.10 | 0.10 |
| Observations | 7842 | 7842 | 11432 | 11432 | 7281 | 7281 |
| Bandwidth (km) | 1.47 | 1.47 | 2.77 | 2.77 | 1.32 | 1.32 |
| Clusters | 552 | 552 | 798 | 798 | 513 | 513 |

Note: The unit of analysis is survey respondents. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) control for a linear polynomial in distance to the bombing boundaries. Regressions (2) (4) (6) control for a quadratic polynomial in distance to the bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table C.1 and C.2 report the balance checks with our uni-dimensional design. There were no discontinuities of geographic, demographic and economic characteristics at the bombing boundaries. When we split by pre-bombing soil conditions, except the pre-bombing population density, all other features vary smoothly across the boundaries.

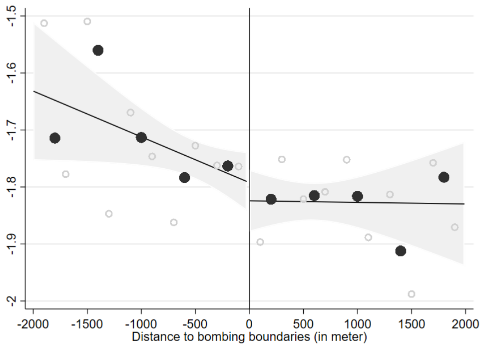
In terms of the main results, the unidimensional RD design yields similar results as our main design (Table C.3). In all analyses, individuals residing on the bombing side exhibit better health outcomes, specifically in height and reduced likelihood of anemia. About Height-for-age Z-scores, our estimates in unidimensional RD models are more significant and larger in magnitude: residents in bombing areas experience an average increase of 0.109 (approximately 6%) in Height-for-age Z-scores. In terms of the likelihood of being underweight, we do not see any effects as the estimates are indistinguishable from zero. Regarding anemia, those on the bombing side face a 2.3% (or 2.1%) lower risk of anemia.

We also found consistent heterogeneous effects in two distinctive regions, with positive effects notably substantial for those living in pre-bombing hard soil areas with a lower UXO occurrence. Particularly, in these areas, those living on the bombing side experience an increase of 0.169 (or 0.152) in their Height-for-age Z-scores, equivalent to around 9% compared to the mean. They are also 3 percentage points less likely to be underweight and at least 5 percentage points less likely to suffer from severe anemia. Meanwhile, we do not observe any health impacts in soft soil areas with a high risk of UXO. The findings align consistently with our multi-dimensional RD results, with estimates not only larger in magnitude but also statistically significant.

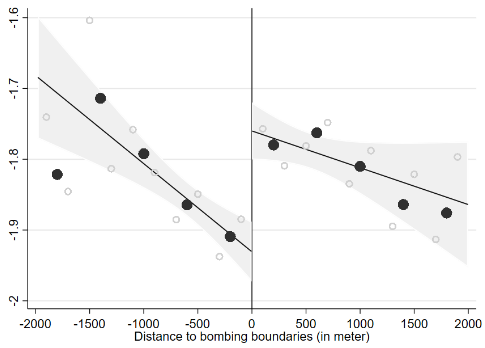
Figure C.1 visually illustrates the heterogeneous effects of bombing. Panel A shows the results in soft soil areas, while Panel B focuses on hard soil areas. In Panel A, all outcomes are continuous, meaning women's health is indifferent across the bombing boundaries. However, in Panel B, across all graphs, we can observe some clear discontinuities at the bombing boundaries. There is a significant jump in Height-for-age Z-scores for those located on the bombing side. In terms of being underweight, we can see a small drop, meaning that in hard soil areas, women are less likely to be underweight. Additionally, there is a noticeable decrease in anemia prevalence for those living in infertile areas and on the bombing side.

Figure C.1: Unidimensional RD design: Heterogeneous effects split by 1962 soil fertility

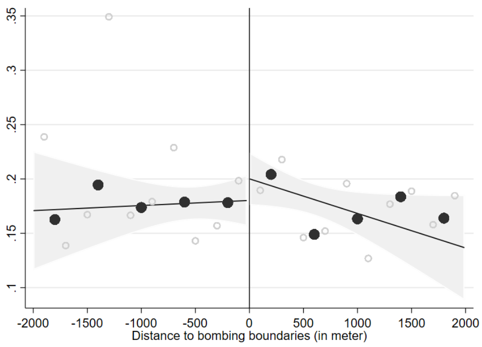
**Panel A: Soft soil (1962)** | **Panel B: Hard soil (1962)**



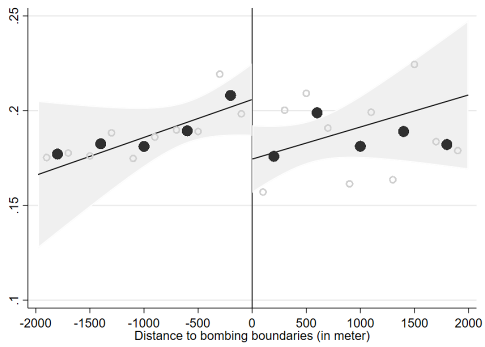

(a) Height-for-age Z-score



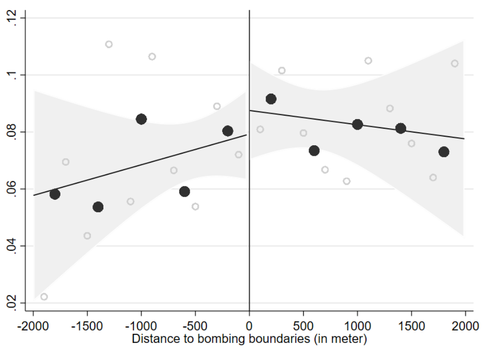

(b) Height-for-age Z-score



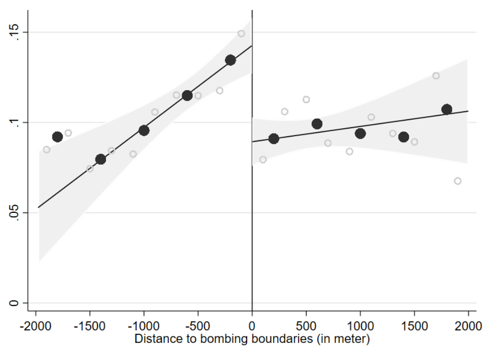

(c) Being Underweight




(d) Being Underweight




(e) Anemia Level



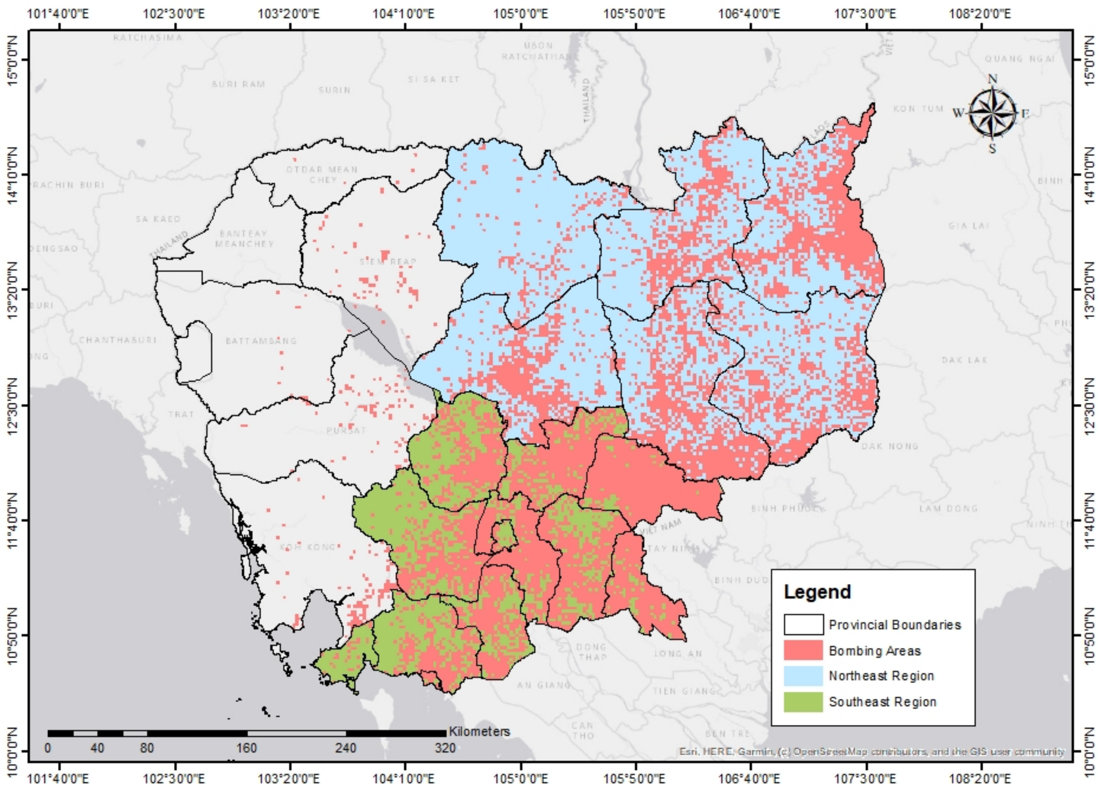

(f) Anemial level

*Note:* Solid dots present the average of outcomes for observations within 400-meter distane bins. Hollow dots present the average for observations within 200-meter distance bins. “Distance to bombing boundary” refers to the distance to the closest point in bombing boundaries. “Negative” values of distance indicate locations outside the bombing areas. The solid line trends give the predicted values from a regression of the outcome variable on a linear polynomial in distance to the bombing boundaries. Figures (a) (c) (e) illustrate results from the sample of population born by 1975 who experienced bombing, whereas figures (b) (d) (f) show results from a sample born after the bombing period.

## D Heterogeneity in Eastern Cambodia

Since bombing sites were concentrated in the east of the country along the borders with Vietnam,[2] we now focus on the east side of the country where bombing were intense. Particularly, we examine the heterogeneous effects into two regions: Northeast (NE) and Southeast (SE) regions. Figure D.1 illustrates the division into NE and SE regions. Both regions share borders with Vietnam and experienced harsh bombing in the past.

Figure D.1: Eastern and Western Cambodia




*Notes:* We divide the country into two regions: Eastern Cambodia and Western Cambodia. Map overlaid on OpenStreetMap and drawn on ArcGIS.

Table D.1 presents our results. We can see NE region is less populated compared to the SE as we have quite small sample sizes for our analysis (columns 1-3-5). As a results, we do not see statistically significant effects in this region, although the sign of all coefficients remain consistent with our main results. Meanwhile, in SE region, there are statistically significant positive effects in pre-bombing hard soil areas and somewhat negative effects in soft soil areas (columns 2-4-6). Specifically, in soft soil locations (Panel B), women on the bombing side are 2.8 percentage points more likely to be underweight (column 4), similar to the effect in whole country analysis. In hard soil locations (Panel C), those living in bombing areas have their Height-for-age Z-scores increased by 0.089, consistent with 0.090 in the nationwide analysis. They are also 3.8 percentage points less likely to be underweight and 3.9 percentage points less likely to suffer from severe anemia. These positive effects are much stronger in magnitude and more statistically significant than

[2] See Section 2

Table D.1: The heterogeneity effects in Northeast and Southeast Regions

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | NE | SE | NE | SE | NE | SE |
| *Panel A: All population* | | | | | | |
| Bombing | 0.058 | 0.052 | -0.012 | -0.011 | -0.013 | -0.016* |
| | (0.051) | (0.032) | (0.018) | (0.011) | (0.016) | (0.009) |
| Mean | -1.953 | -1.768 | 0.181 | 0.188 | 0.125 | 0.0865 |
| Observations | 2687 | 8312 | 2687 | 8312 | 2687 | 8312 |
| Clusters | 192 | 599 | 192 | 599 | 192 | 599 |
| *Panel B: Soft soil (1962)* | | | | | | |
| Bombing | -0.010 | -0.029 | 0.004 | 0.028* | 0.008 | 0.014 |
| | (0.069) | (0.052) | (0.026) | (0.017) | (0.016) | (0.012) |
| Mean | -1.891 | -1.759 | 0.167 | 0.181 | 0.0885 | 0.0767 |
| Observations | 1039 | 2830 | 1039 | 2830 | 1039 | 2830 |
| Clusters | 76 | 213 | 76 | 213 | 76 | 213 |
| *Panel C: Hard soil (1962)* | | | | | | |
| Bombing | 0.079 | 0.089** | -0.007 | -0.038** | -0.013 | -0.039*** |
| | (0.058) | (0.039) | (0.020) | (0.015) | (0.024) | (0.012) |
| Mean | -1.992 | -1.773 | 0.189 | 0.192 | 0.149 | 0.0916 |
| Observations | 1647 | 5482 | 1647 | 5482 | 1647 | 5482 |
| Clusters | 115 | 386 | 115 | 386 | 115 | 386 |

Note: The unit of analysis is survey respondents. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) show the effects in Northeast Region (NE). Regressions (2) (4) (6) show the effects in Southeast Region (SE). All regressions include women living within 1.5 km of bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

the effects in our main results.

In addition, we also see that the majority of health facilities are located in SE region (Figure G.5). We now examine the effects on distance to health facilities in this region only. Table D.2 displays the results. Even in the region where health facilities are concentrated, the distance to health facilities is significantly shorter for those on the bombing side. Most importantly, these positive effects are noticeable in pre-bombing hard soil areas. In hard soil locations, the distance to the nearest district health center drops by approximately 1km, roughly one-third of the average distance(columns 3-4). Similarly, there is a significant decrease of 1 km (or 0.843km) in the distance to any health facility (columns 5-6). Meanwhile, in soft soil areas with a high probability of UXO, we observe negative impacts on healthcare accessibility, with the distance to the nearest hospital increasing by more than 2.5km for those living inside bombing areas.

Table D.2: Southeast region: Distance to health facilities

| | Dependent variable is Distance (km) to | | | | | |
|---|---|---|---|---|---|---|
| | Hospital | | District health center | | Any health facility | |
| | (1) <1km | (2) <1.5km | (3) <1km | (4) <1.5km | (5) <1km | (6) <1.5km |
| *Panel A: Restricted region* | | | | | | |
| Bombing | 0.519 | 0.756* | -0.629*** | -0.461** | -0.495** | -0.344* |
| | (0.447) | (0.408) | (0.205) | (0.193) | (0.193) | (0.184) |
| Mean | 9.733 | 9.678 | 2.701 | 2.720 | 2.643 | 2.665 |
| Observations | 6355 | 8312 | 6355 | 8312 | 6355 | 8312 |
| Clusters | 463 | 599 | 463 | 599 | 463 | 599 |
| *Panel B: Soft soil (1962)* | | | | | | |
| Bombing | 2.541*** | 2.584*** | -0.078 | 0.022 | 0.201 | 0.274 |
| | (0.528) | (0.524) | (0.230) | (0.221) | (0.217) | (0.204) |
| Mean | 7.562 | 7.368 | 2.243 | 2.283 | 2.139 | 2.183 |
| Observations | 2248 | 2830 | 2248 | 2830 | 2248 | 2830 |
| Clusters | 168 | 213 | 168 | 213 | 168 | 213 |
| *Panel C: Hard soil (1962)* | | | | | | |
| Bombing | -0.904 | -0.674 | -1.061*** | -0.888*** | -1.008*** | -0.843*** |
| | (0.561) | (0.513) | (0.259) | (0.257) | (0.256) | (0.256) |
| Mean | 10.92 | 10.87 | 2.951 | 2.945 | 2.918 | 2.914 |
| Observations | 4107 | 5482 | 4107 | 5482 | 4107 | 5482 |
| Clusters | 295 | 386 | 295 | 386 | 295 | 386 |

Note: Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

## E Heterogeneous effects on different generations

We split these effects by those born during or after the bombing periods, anticipating that the impacts on health might vary based on whether an individual is from an older or younger cohort. Any positive mechanisms from later local area development to boost areas with greater degradation in the past may impact younger cohorts differently than older cohorts. For example, anemia may be most relevant among older cohorts and depend on their relative access to health care. Table E.1 presents the heterogeneous effects on two groups of the population: people born before and after 1975.

Table E.1: Heterogeneous effects on different generations

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1)<br><1km | (2)<br><1.5km | (3)<br><1km | (4)<br><1.5km | (5)<br><1km | (6)<br><1.5km |
| *Panel A: Individuals born by 1975* | | | | | | |
| Bombing | 0.034 | 0.031 | -0.014 | -0.014 | -0.027** | -0.024** |
| | (0.038) | (0.034) | (0.014) | (0.013) | (0.013) | (0.012) |
| Mean | -1.857 | -1.853 | 0.168 | 0.163 | 0.117 | 0.115 |
| Observations | 3603 | 4771 | 3603 | 4771 | 3603 | 4771 |
| Clusters | 654 | 859 | 654 | 859 | 654 | 859 |
| *Panel B: Individuals born after 1975* | | | | | | |
| Bombing | 0.102*** | 0.088*** | 0.001 | -0.001 | -0.007 | -0.008 |
| | (0.036) | (0.032) | (0.013) | (0.012) | (0.009) | (0.008) |
| Mean | -1.788 | -1.780 | 0.199 | 0.199 | 0.0855 | 0.0822 |
| Observations | 5532 | 7274 | 5532 | 7274 | 5532 | 7274 |
| Clusters | 646 | 849 | 646 | 849 | 646 | 849 |

Note: The unit of analysis is survey respondents. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) include individuals living within 1km from bombing boundaries. Regressions (2) (4) (6) include individuals living within 1.5 km of bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

We find statistically significant long-run positive effects of living in bombing areas on the height of populations born after 1975, while these effects are indifferent from zero for people who were born before 1975. In particular, women born after 1975 and currently residing in bombing areas witness an increase of 0.102 (or 0.088) in their Health-for-age Z-scores, equivalent to approximately 5%, compared to those living outside. The observed findings confirm that positive treatment effects on Height-for-age Z-scores are likely to be concentrated among subsequent generations who did not experience severe negative consequences of the bombing and have benefited from post-war investments. In terms of being underweight, we do not see any discontinuities at the bombing boundaries for both groups.

Anemia is a health issue that affects people of all ages, with a higher prevalence among older individuals (Timiras & Brownstein 1987, Anía et al. 1997, Gaskell et al. 2008). Age plays a significant role in determining both hemoglobin levels and anemia, with older adults generally having lower hemoglobin levels than their younger counterparts (Salive et al. 1992, Gaskell et al. 2008). Our summary statistics reveal that 11.7% of older generations typically suffer from anemia, whereas this rate decreases to only 8.5% in the younger group. When examining the impact of residing in past bombing locations on anemia levels, it becomes apparent that the effect on anemia would notably show up in older generations. Older people residing in areas heavily affected by the bombing exhibit a significantly lower risk of anemia, approximately 2.7 (or 2.4) percentage points lower than their counterparts on the other side. This effect is substantial and statistically significant. It represents over 20% shift relative to the mean of anemia in this age group population.

In section 6, we show that observed positive health impacts are driven by areas characterized by soft soil and a lower probability of encountering unexploded ordnance. Meanwhile, we see no effects in areas where soil was soft in 1962. We further deepen our understanding by investigating heterogeneous impacts on different generations in soft and hard soil regions.

Table E.2: Outcomes on different generations in soft soil areas

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) <1km | (2) <1.5km | (3) <1km | (4) <1.5km | (5) <1km | (6) <1.5km |
| *Panel A: Individuals born by 1975* | | | | | | |
| Bombing | -0.130* | -0.113* | 0.034 | 0.023 | 0.030* | 0.022 |
| | (0.070) | (0.061) | (0.024) | (0.020) | (0.017) | (0.016) |
| Mean | -1.818 | -1.812 | 0.161 | 0.152 | 0.0867 | 0.0881 |
| Observations | 1222 | 1600 | 1222 | 1600 | 1222 | 1600 |
| Clusters | 227 | 298 | 227 | 298 | 227 | 298 |
| *Panel B: Individuals born after 1975* | | | | | | |
| Bombing | -0.019 | 0.008 | 0.036* | 0.016 | 0.010 | -0.000 |
| | (0.056) | (0.051) | (0.020) | (0.018) | (0.016) | (0.014) |
| Mean | -1.764 | -1.780 | 0.196 | 0.193 | 0.0743 | 0.0745 |
| Observations | 1872 | 2430 | 1872 | 2430 | 1872 | 2430 |
| Clusters | 224 | 294 | 224 | 294 | 224 | 294 |

Note: The unit of analysis is survey respondents. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) include individuals living within 1km from bombing boundaries. Regressions (2) (4) (6) include individuals living within 1.5 km of bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table E.3: Outcomes on different generations in hard soil areas

| | Dependent variable is: | | | | | |
|---|---|---|---|---|---|---|
| | Height-for-age Z-score | | Being Underweight | | Anemia Level | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | <1km | <1.5km | <1km | <1.5km | <1km | <1.5km |
| *Panel A: Individuals born by 1975* | | | | | | |
| Bombing | 0.084* | 0.074* | -0.034* | -0.031* | -0.057*** | -0.051*** |
| | (0.046) | (0.043) | (0.018) | (0.017) | (0.017) | (0.016) |
| Mean | -1.877 | -1.874 | 0.172 | 0.169 | 0.132 | 0.129 |
| Observations | 2381 | 3171 | 2381 | 3171 | 2381 | 3171 |
| Clusters | 427 | 561 | 427 | 561 | 427 | 561 |
| *Panel B: Individuals born after 1975* | | | | | | |
| Bombing | 0.125*** | 0.104** | -0.022 | -0.018 | -0.010 | -0.011 |
| | (0.044) | (0.041) | (0.018) | (0.016) | (0.012) | (0.012) |
| Mean | -1.801 | -1.780 | 0.201 | 0.202 | 0.0912 | 0.0861 |
| Observations | 3660 | 4843 | 3660 | 4843 | 3660 | 4843 |
| Clusters | 422 | 554 | 422 | 554 | 422 | 554 |

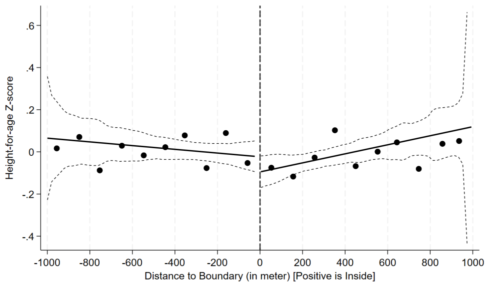
Note: The unit of analysis is survey respondents. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects, province fixed effects, distance to the capital, distance to Vietnam borders and other pre-bombing characteristics are present in all regressions. Regressions (1) (3) (5) include individuals living within 1km from bombing boundaries. Regressions (2) (4) (6) include individuals living within 1.5 km of bombing boundaries. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table E.2 and E.3 display the results. In soft soil regions where the chance of encountering UXO is high (Table E.2), we observe either null or slightly negative impacts across generations. On the contrary, in hard soil regions (Table E.3), the positive effects on two generations are different. In particular, we see slightly positive impacts on height for people who were born before 1975, but statistically significant positive impacts for individuals born after the bombing (columns 1-2). In terms of weight, the older generation is 3.4 (or 3.1) percentage points more likely to be underweight if they are on the bombing side, whereas there is no significant difference in the likelihood of being underweight among the younger generation (columns 3-4). With regard to anemia, older people residing on the bombing side are less likely to suffer from anemia, with a drop of around 5.7 (or 5.1) percentage points in anemia risk. This drop is equivalent to around 40% deviation from the mean value of anemia likelihood in this age group (columns 5-6).

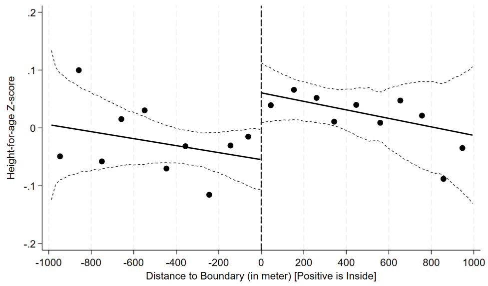
# F RD plots

Figure F.1: Heterogeneity impacts splitting by pre-bombing soil fertility: RD plots with 1km bandwidth

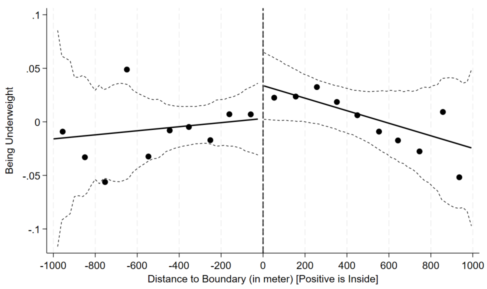
**Panel A: Soft soil (1962)** **Panel B: Hard soil (1962)**



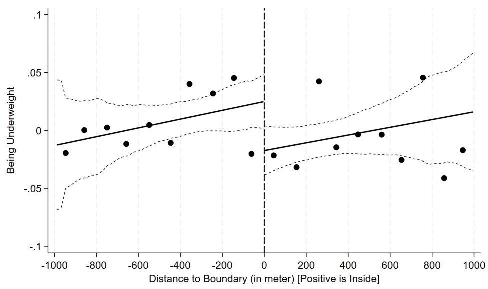

(a) Height-for-age Z-score



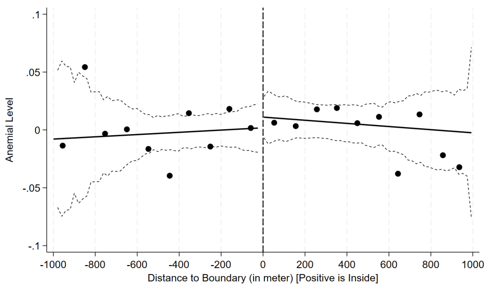

(b) Height-for-age Z-score



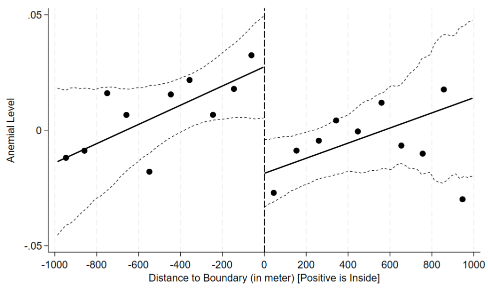

(c) Being underweight




(d) Being underweight




(e) Anemia Level

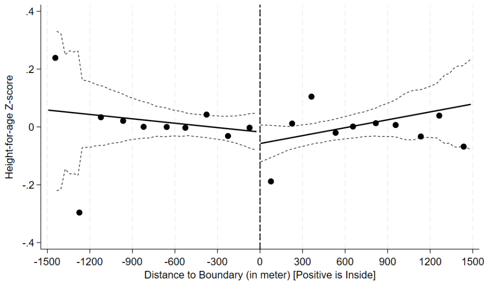



(f) Anemial level

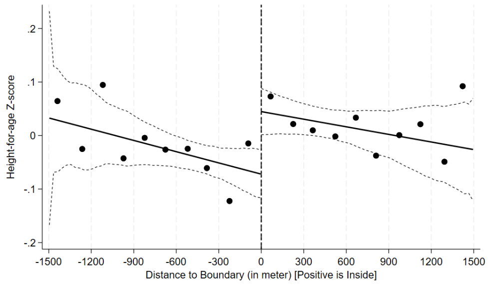
*Note:* The points represent binned residuals derived from a main regression of the outcome variable on a linear polynomial in spatial coordinates and other control variables. Solid lines depict a local linear regression, separately estimated on each side of the threshold, while dashed lines represent 95% confidence intervals. “Negative” values of distance indicate locations outside the bombing areas.

Figure F.2: Heterogeneity impacts splitting by pre-bombing soil fertility: RD plots with 1.5km bandwidth

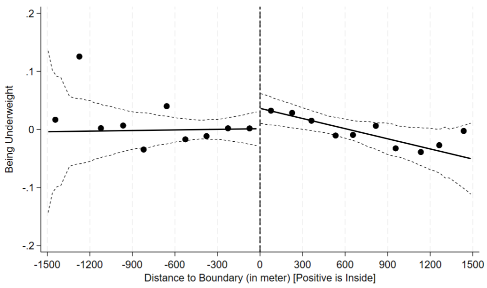
**Panel A: Soft soil (1962)** | **Panel B: Hard soil (1962)**



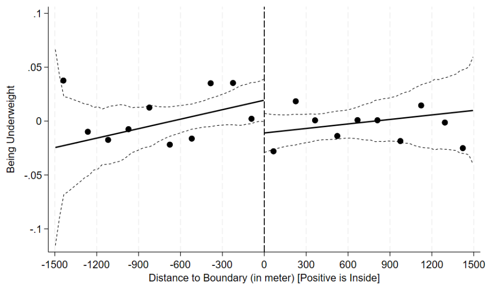

(a) Height-for-age Z-score



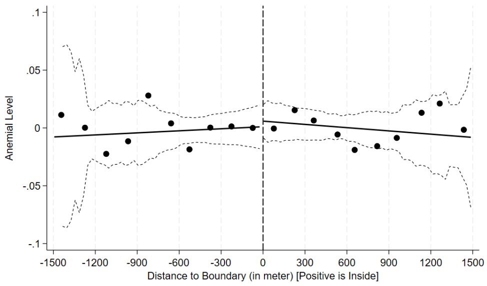

(b) Height-for-age Z-score



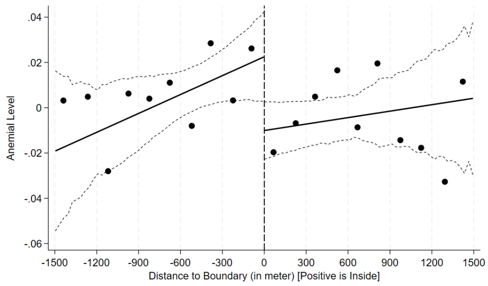

(c) Being underweight




(d) Being underweight




(e) Anemia Level




(f) Anemial level

*Note:* The points represent binned residuals derived from a main regression of the outcome variable on a linear polynomial in spatial coordinates and other control variables. Solid lines depict a local linear regression, separately estimated on each side of the threshold, while dashed lines represent 95% confidence intervals. "Negative" values of distance indicate locations outside the bombing areas.

## G Additional Tables and Figures

Table G.1: Descriptive statistics

| | All observations | | | Within 1.5 km distance | | | Within 3 km distance | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Outside | Inside | All | Outside | Inside | All | Outside | Inside |
| ***Panel A: Health outcomes*** | | | | | | | | | |
| Height-for-age Z-score | -1.79 | -1.78 | -1.80 | -1.81 | -1.81 | -1.81 | -1.80 | -1.78 | -1.81 |
| | (0.87) | (0.87) | (0.88) | (0.88) | (0.88) | (0.88) | (0.87) | (0.87) | (0.88) |
| Being underweight | 0.17 | 0.16 | 0.18 | 0.18 | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 |
| | (0.38) | (0.37) | (0.38) | (0.39) | (0.39) | (0.39) | (0.39) | (0.38) | (0.39) |
| Anemia | 0.09 | 0.09 | 0.09 | 0.10 | 0.10 | 0.09 | 0.09 | 0.09 | 0.09 |
| | (0.29) | (0.29) | (0.28) | (0.29) | (0.30) | (0.29) | (0.29) | (0.29) | (0.29) |
| ***Panel B: Geographic characteristics*** | | | | | | | | | |
| Elevation/Altitude (meters) | 37.47 | 33.92 | 41.99 | 34.58 | 32.10 | 36.99 | 34.32 | 29.76 | 38.99 |
| | (68.51) | (51.69) | (85.03) | (71.02) | (59.33) | (80.67) | (71.09) | (52.04) | (86.12) |
| Tropics, lowland | 0.55 | 0.49 | 0.61 | 0.59 | 0.55 | 0.62 | 0.57 | 0.50 | 0.63 |
| | (0.50) | (0.50) | (0.49) | (0.49) | (0.50) | (0.49) | (0.50) | (0.50) | (0.48) |
| ***Panel C: Pre-bombing characteristics*** | | | | | | | | | |
| Soil fertility (1962) | 0.37 | 0.36 | 0.38 | 0.33 | 0.31 | 0.36 | 0.36 | 0.34 | 0.37 |
| | (0.48) | (0.48) | (0.49) | (0.47) | (0.46) | (0.48) | (0.48) | (0.47) | (0.48) |
| Agricultural activities (1970) | 0.56 | 0.54 | 0.58 | 0.62 | 0.63 | 0.61 | 0.62 | 0.64 | 0.60 |
| | (0.50) | (0.50) | (0.49) | (0.49) | (0.48) | (0.49) | (0.48) | (0.48) | (0.49) |
| Population density (1970) | 0.39 | 0.35 | 0.43 | 0.46 | 0.46 | 0.46 | 0.46 | 0.48 | 0.45 |
| | (0.49) | (0.48) | (0.50) | (0.50) | (0.50) | (0.50) | (0.50) | (0.50) | (0.50) |
| Distance (km) to roads/railways (1970) | 6.43 | 7.34 | 5.28 | 6.47 | 6.13 | 6.81 | 5.94 | 5.74 | 6.14 |
| | (8.56) | (9.96) | (6.15) | (7.04) | (6.97) | (7.09) | (6.90) | (7.08) | (6.70) |
| ***Panel D: Post-bombing characteristics*** | | | | | | | | | |
| Population density | 1.66 | 2.33 | 0.82 | 1.70 | 2.22 | 1.19 | 2.19 | 3.42 | 0.94 |
| | (5.41) | (6.77) | (2.59) | (4.95) | (5.90) | (3.73) | (6.78) | (8.84) | (3.13) |
| Market density | -0.00 | 0.13 | -0.16 | 0.02 | 0.15 | -0.10 | 0.11 | 0.35 | -0.14 |
| | (1.00) | (1.24) | (0.52) | (1.02) | (1.23) | (0.75) | (1.20) | (1.53) | (0.62) |
| Family Wealth | 0.33 | 0.33 | 0.33 | 0.32 | 0.32 | 0.31 | 0.33 | 0.34 | 0.32 |
| | (0.19) | (0.19) | (0.18) | (0.19) | (0.19) | (0.18) | (0.19) | (0.19) | (0.18) |
| Secondary education | 0.33 | 0.33 | 0.33 | 0.32 | 0.33 | 0.31 | 0.34 | 0.36 | 0.32 |
| | (0.47) | (0.47) | (0.47) | (0.47) | (0.47) | (0.46) | (0.47) | (0.48) | (0.47) |
| Distance (km) to | | | | | | | | | |
| Hospital (2010) | 12.37 | 13.16 | 11.36 | 13.42 | 13.69 | 13.17 | 12.47 | 12.48 | 12.45 |
| | (12.56) | (13.86) | (10.60) | (13.25) | (14.51) | (11.90) | (12.85) | (14.20) | (11.30) |
| District health center (2010) | 3.20 | 3.47 | 2.87 | 3.23 | 3.41 | 3.07 | 3.08 | 3.09 | 3.06 |
| | (3.10) | (3.69) | (2.05) | (2.86) | (3.38) | (2.22) | (2.74) | (3.17) | (2.20) |
| Health facility (2010) | 3.16 | 3.40 | 2.85 | 3.20 | 3.34 | 3.06 | 3.03 | 3.02 | 3.04 |
| | (3.07) | (3.66) | (2.05) | (2.87) | (3.40) | (2.23) | (2.75) | (3.20) | (2.20) |
| ***Panel E: Other characteristics*** | | | | | | | | | |
| Distance (km) to | | | | | | | | | |
| Vietnam borders | 139.14 | 193.47 | 70.02 | 88.89 | 98.75 | 79.35 | 95.10 | 116.38 | 73.28 |
| | (117.27) | (123.87) | (56.51) | (73.47) | (78.88) | (66.44) | (77.41) | (85.76) | (60.47) |
| Capital | 132.59 | 160.56 | 97.02 | 93.91 | 96.13 | 91.76 | 96.32 | 99.25 | 93.32 |
| | (98.99) | (102.62) | (81.29) | (78.74) | (78.17) | (79.24) | (80.00) | (81.09) | (78.76) |
| Nearest strike | 6.62 | 11.28 | 0.68 | 1.35 | 1.80 | 0.92 | 1.55 | 2.27 | 0.81 |
| | (13.94) | (17.25) | (0.49) | (0.79) | (0.77) | (0.54) | (1.13) | (1.09) | (0.52) |
| Thai borders | 169.41 | 129.31 | 220.43 | 202.81 | 194.17 | 211.18 | 199.72 | 182.20 | 217.69 |
| | (84.12) | (80.80) | (55.89) | (61.52) | (60.62) | (61.23) | (62.64) | (60.19) | (59.96) |
| Observations | 31135 | 17433 | 13702 | 12046 | 5926 | 6120 | 18399 | 9316 | 9083 |

Note: The table provides the mean/standard deviation of the corresponding variables. "All" means the whole sample, "Outside" means the sample includes observations located outside bombing areas, and "Inside" means the sample includes observations located inside bombing areas. "Within 1.5 km distance" means the sample is restricted to observations located within 1.5 km of bombing boundaries. "Within 3 km distance" the sample is restricted to observations within 3 km of bombing boundaries.

Table G.1 reports the summary statistics of variables used in this study. In general, health outcomes are comparable on average between the two groups residing inside and outside bombing areas, while there are noticeable variations in some demographic and economic characteristics.

For geographic and pre-bombing characteristics, the locations inside bombing areas have higher average elevation/altitude and are more likely to be classified as tropics and lowland. These locations also had higher soil fertility in 1962. Additionally, the mean distance to Vietnam's borders is significantly lower for those inside the bombing areas, aligning with the historical narrative. However, there were no significant differences with respect to population density and agricultural activities in 1970. In addition, for the whole sample, we observe significantly shorter distances to 1970 main roads or railways for those living inside bombing areas.

Finally, for post-bombing characteristics, education level (completion of secondary education) and family wealth are similar between the two groups, whereas areas within bombing zones exhibit considerably lower unconditional mean population density and market density compared to regions outside. Furthermore, individuals residing inside the bombing areas generally have shorter distances to hospitals and health facilities.

Table G.2: Balance check split by 1962 soil fertility

| | Dependent variable is: | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1)<br>Elevation | (2)<br>Tropics/lowland | (3)<br>Agri. Activities | (4)<br>Pop. Density | (5)<br>Dist. to roads | (6)<br>Dist VN | (7)<br>Dist. to capital |
| *Panel A: Soft soil (1962)* | | | | | | | |
| Bombing | 5.120 | 0.121** | -0.073 | 0.041 | 0.577 | 0.256 | -0.055 |
| | (7.290) | (0.059) | (0.051) | (0.031) | (0.612) | (0.555) | (1.217) |
| Mean | 40.34 | 0.559 | 0.681 | 0.488 | 6.306 | 77.58 | 83.14 |
| Observations | 4030 | 4030 | 4030 | 4030 | 4030 | 4030 | 4030 |
| Clusters | 301 | 301 | 301 | 301 | 301 | 301 | 301 |
| *Panel B: Hard soil (1962)* | | | | | | | |
| Bombing | 3.604 | -0.009 | 0.085* | -0.067* | 0.640 | 0.389 | -0.052 |
| | (2.311) | (0.049) | (0.044) | (0.035) | (0.601) | (0.532) | (1.096) |
| Mean | 31.69 | 0.598 | 0.591 | 0.442 | 6.556 | 94.58 | 99.32 |
| Observations | 8014 | 8014 | 8014 | 8014 | 8014 | 8014 | 8014 |
| Clusters | 562 | 562 | 562 | 562 | 562 | 562 | 562 |

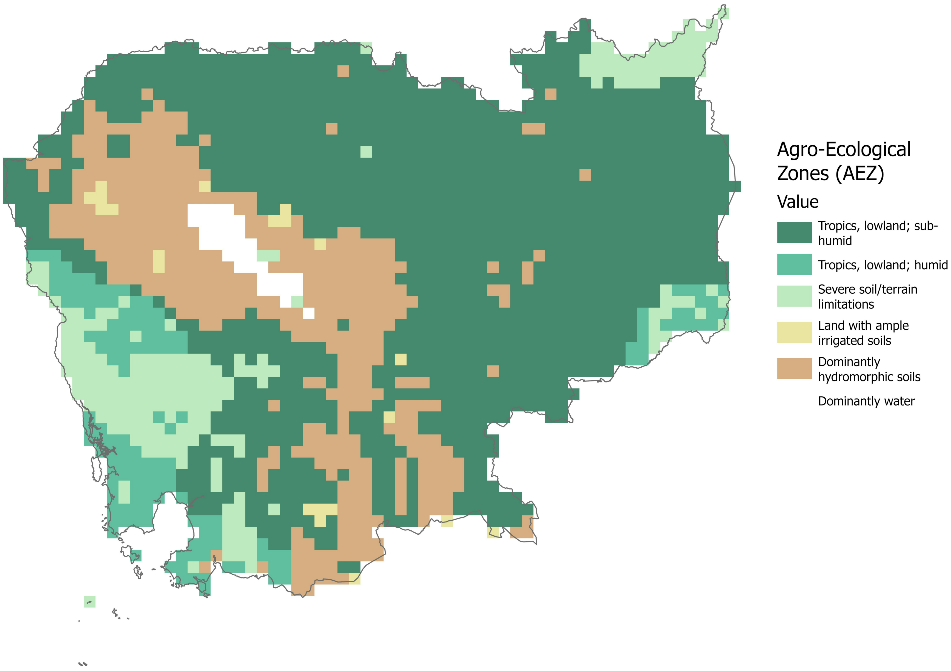
Note: The unit of analysis is survey respondents. The sample restricted to those living within 1.5km bandwidth from bombing boundaries. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. Strike fixed effects, 50x50km grid fixed effects and province fixed effects are present in all regressions. "Tropics/lowland" is a dummy variable reflecting whether this location belongs to areas classified as "tropics, humid" based on agro-ecological zones classification. The last three columns use data from the Indochina Atlas, published in October 1970. Agri. activities indicate whether there were any agricultural activities in these areas in 1970. Pop. density is a binary variable reflecting if the population density in 1970 was at least fifty inhabitants per square kilometre. Dist. to roads refers to distance to 1970 main roads/railways. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table G.3: Migration status

| | Dependent variable is: Never moving | | |
|---|---|---|---|
| | (1)<br>All observations | (2)<br>Fertile areas | (3)<br>Infertile areas |
| Bombing | 0.060** | 0.022 | 0.065* |
| | (0.026) | (0.039) | (0.036) |
| Mean | 0.637 | 0.626 | 0.643 |
| Observations | 4618 | 1533 | 3084 |
| Clusters | 417 | 143 | 273 |

Note: The unit of analysis is survey respondents. The sample restricted to those living within 1.5km bandwidth from bombing boundaries. All regressions use a local linear polynomial of spatial coordinates with a triangular kernel weight. "Never Moving" means individuals report having always live at their current locations. This information is only available in the DHS 2000 and 2004 surveys. Standard errors reported in parenthesis are at the DHS survey cluster level. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Figure G.1: Agro-ecological Zones classes

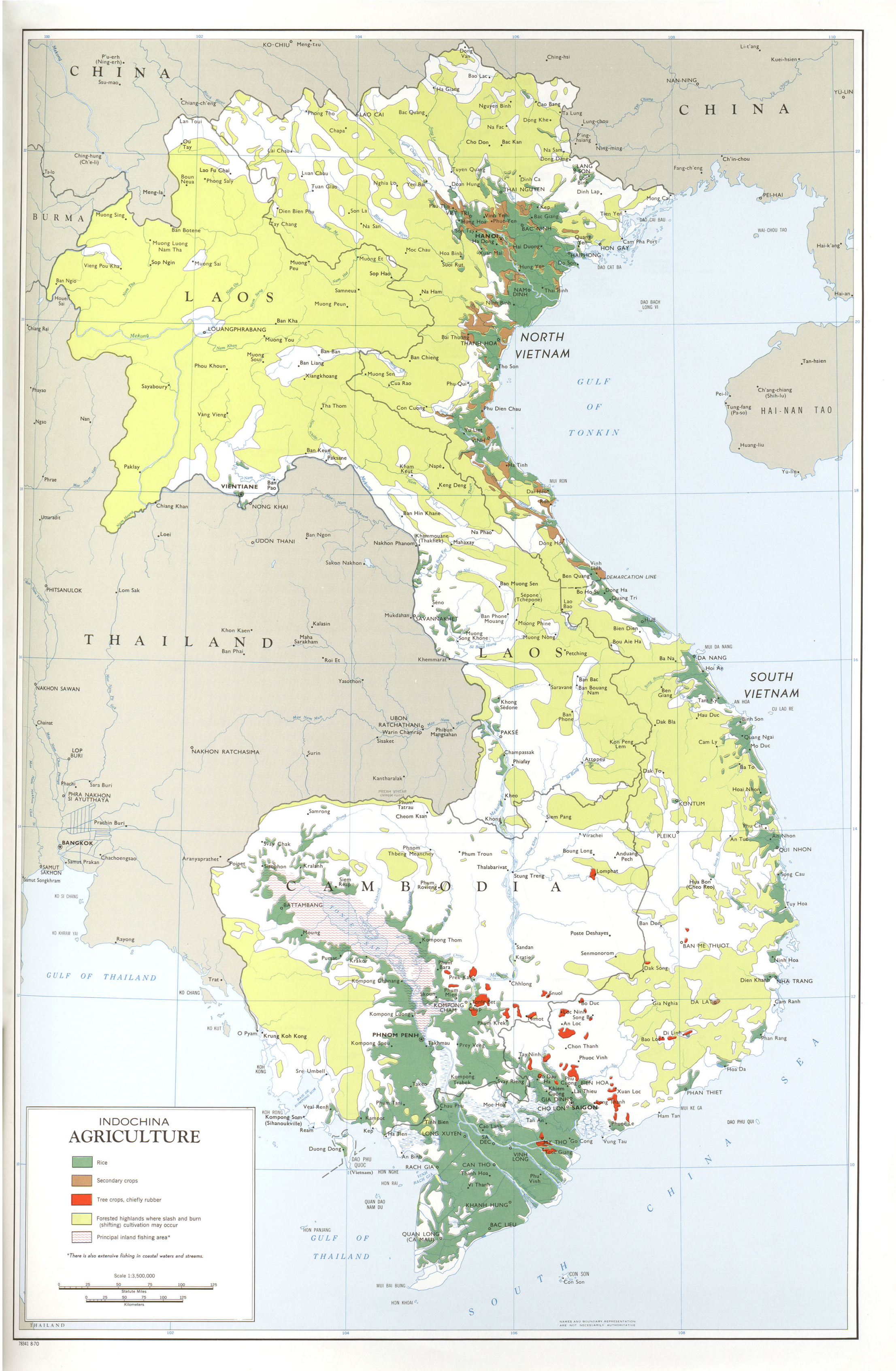



*Notes:* The map overlays Cambodia to the agro-ecological zones (AEZs) as classiffied by The Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA). Geographic areas belonging to the same AEZ category exhibit analogous climatic characteristics, encompassing rainfall and temperature patterns, and thus possess equivalent agricultural capabilities. Map is drawn on ArcGIS.

Figure G.2: Indochina Transportation in 1970


*Notes:* Indochina Transportation map, which was in "Indochina Atlas", published in October 1970 by the Directorate of Intelligence, Office of Basic and Geographic Intelligence, U.S. Central Intelligence Agency.

Figure G.3: Indochina Agriculture in 1970

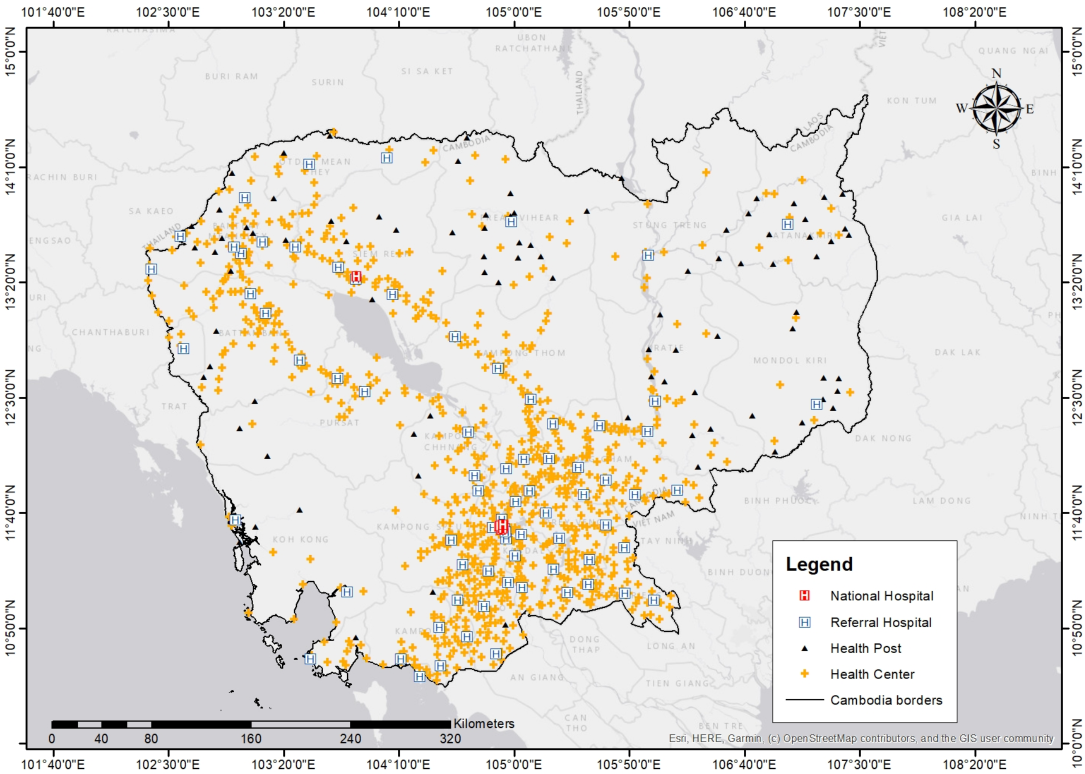



*Notes:* Indochina Agriculture map, which was in "Indochina Atlas", published in October 1970 by the Directorate of Intelligence, Office of Basic and Geographic Intelligence, U.S. Central Intelligence Agency.

Figure G.4: Indochina Population in 1970

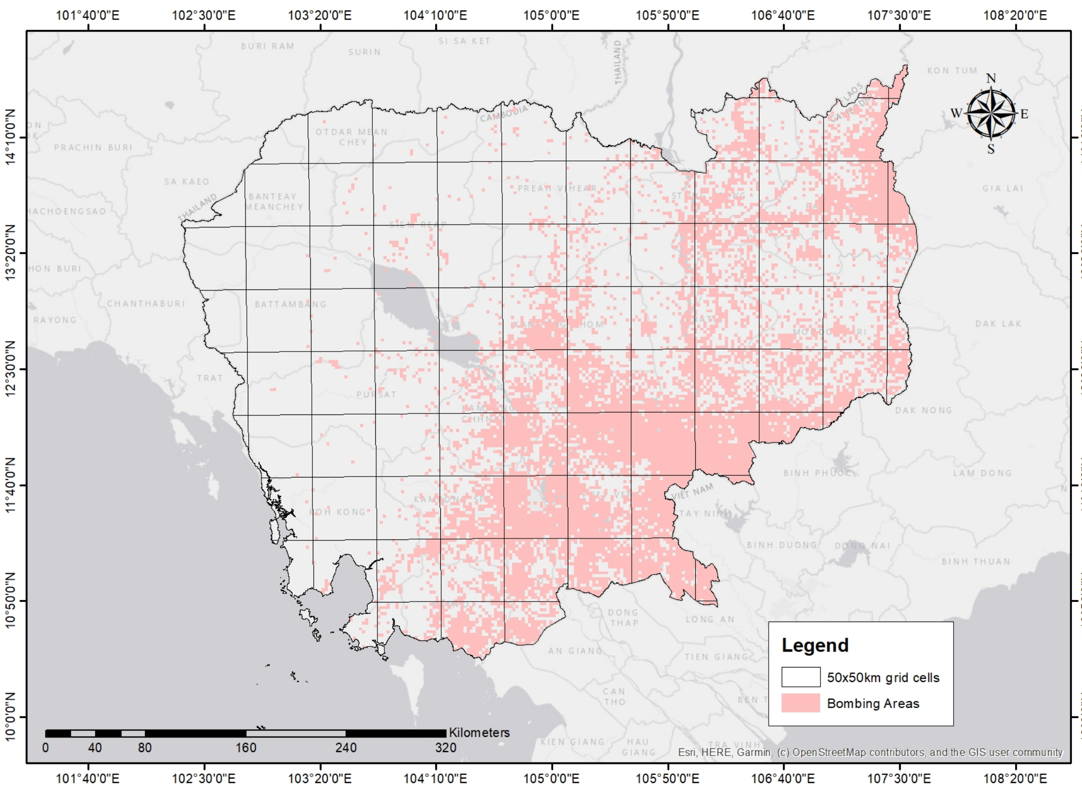

*Notes:* Indochina Population map, which was in "Indochina Atlas", published in October 1970 by the Directorate of Intelligence, Office of Basic and Geographic Intelligence, U.S. Central Intelligence Agency.

Figure G.5: Health facilities in Cambodia (2010)




*Notes:* The map depicts locations of health facilities, including national hospital, referral hospitals, health centers, and health posts in Cambodia. The Ministry of Health (MoH) of Cambosia originally compiled the data, which was then contributed by the Office for the Coordination of Humanitarian Affairs (OCHA) to the Humanitarian Data Exchange (HDX). Map overlaid on OpenStreetMap base map and drawn on ArcGIS.

Figure G.6: Generating 50x50km grid cells




*Notes:* The map illustrates how the country was divided into 50x50km grid-cells. Map overlaid on Open-StreetMap base map and drawn on ArcGIS.

Table G.4: DID: Effects on economic development indicators

| | Dependent variable is: | | | | |
|---|---|---|---|---|---|
| | (1) Population Density | (2) Light Intensity | (3) Market Density | (4) Family Wealth | (5) Secondary Edu. |
| Bombing | -0.545*** | -0.306*** | -0.030*** | 0.028*** | 0.054*** |
| | (0.065) | (0.031) | (0.008) | (0.008) | (0.010) |
| Soft Soil (1962) | 0.689*** | 1.438*** | 0.105*** | 0.065*** | 0.050*** |
| | (0.052) | (0.037) | (0.010) | (0.008) | (0.010) |
| Bombing × Soft Soil (1962) | -0.876*** | -2.040*** | -0.174*** | -0.044*** | -0.054*** |
| | (0.065) | (0.042) | (0.012) | (0.011) | (0.013) |
| Mean | 1.662 | 4.415 | -8.02e-10 | -2.45e-09 | 0.332 |
| Observations | 30948 | 680856 | 30948 | 30585 | 30948 |

Note: The unit of analysis is DHS households. All regressions control for households' spatial coordinates, 1km-distance-to-nearest-strike fixed effects, district fixed effects, distance to the capital, distance to Vietnam borders, distance to Thai borders and other pre-bombing characteristics. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table G.5: DID: Effects on economic development (CSES Data)

| | Dependent variable is: | | | |
|---|---|---|---|---|
| | Household | | Field Productivity | |
| | (1) Income | (2) Food Shortage | (3) Quantity | (4) Crop Revenue |
| Bombing | 0.237*** | -0.012 | -0.132*** | -0.119** |
| | (0.064) | (0.010) | (0.047) | (0.057) |
| Soft Soil (1962) | 0.345*** | -0.030*** | 0.225*** | 0.270*** |
| | (0.069) | (0.009) | (0.053) | (0.063) |
| Bombing × Soft Soil (1962) | -0.437*** | 0.042*** | -0.227*** | -0.257*** |
| | (0.081) | (0.012) | (0.065) | (0.079) |
| Mean | 14.08 | 0.141 | 6.344 | 12.93 |
| Observations | 22625 | 22625 | 28100 | 28079 |

Note: The unit of analysis for the first 2 columns is households. *Income* demonstrates households' income from agricultural and non-agricultural activities. *Income* is transformed ln(Cambodian riel). For income equal to 0, it is transformed ln(Cambodian riel+10000) . *Food Shortage* is a dummy variable indicating whether households have ever suffered from food shortage in the past. The unit of analysis for the last 2 columns is fields (agricultural land). *Quantity* represents the total quantity produced or harvested from the field. *Crop Revenue* indicates total revenue from the field: $Revenue = (QuantityHarvested - PostHarvestLoss) \times SalesPrice$. Both *Quantity* and *Crop Revenue* are also log transformed. All regressions control for households' spatial coordinates, 1km-distance-to-nearest-strike fixed effects, district fixed effects, distance to the capital, distance to Vietnam borders, distance to Thai borders and other pre-bombing characteristics. ***(**)(*) indicates significance at the 1%(5%)(10%) level.

Table G.6: DID: Effects on healthcare accessibility

| | Dependent variable is: Distance (in km) to | | |
|---|---|---|---|
| | (1)<br>Hospital | (2)<br>District health center | (3)<br>Any health facility |
| Bombing | -0.105 | -0.668*** | -0.605*** |
| | (0.113) | (0.051) | (0.051) |
| Soft Soil (1962) | -0.964*** | -0.639*** | -0.619*** |
| | (0.123) | (0.060) | (0.060) |
| Bombing × Soft Soil (1962) | 0.913*** | 0.747*** | 0.754*** |
| | (0.147) | (0.063) | (0.063) |
| Mean | 12.37 | 3.204 | 3.156 |
| Observations | 30948 | 30948 | 30948 |

Note: The unit of analysis is DHS households. All regressions control for households' spatial coordinates, 1km-distance-to-nearest-strike fixed effects, district fixed effects, distance to the capital, distance to Vietnam borders, distance to Thai borders and other pre-bombing characteristics. ***(**)(*) indicates significance at the 1%(5%)(10%) level.