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Wars and child health: Evidence from the Eritrean–Ethiopian conflict☆

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ABSTRACT

Conflict between and within countries can have lasting health and economic consequences, but identifying such effects can be empirically challenging. This paper uses household survey data from Eritrea to estimate the effect of exposure to the 1998–2000 Eritrea–Ethiopia war on children's health. The identification strategy exploits exogenous variation in the conflict's geographic extent and timing and the exposure of different birth cohorts to the fighting. The unique survey data include details on each household's migration history, which allows us to measure a child's geographic location during the war and without which war exposure would be incorrectly classified. War-exposed children have lower height-for-age Z-scores, with similar effects for children born before or during the war. Both boys and girls who are born during the war experience negative impacts due to conflict. Effects are robust to including region-specific time trends, alternative conflict exposure measures, and mother fixed effects.

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1. Introduction

Exposure to conflicts that take place within and between countries is common for individuals in many developing countries and can be a source of considerable stress on low-income households that lack adequate coping mechanisms. Indeed, armed conflict has affected three-fourths of all countries in sub-Saharan Africa since World War II (Gleditsch et al., 2002). In many instances, the conflicts are started or are exacerbated by territorial disputes.[1] Despite the casualties and destruction caused by such wars, there has been relatively little attention given to possible effects on the health outcomes of children who are exposed to conflict.[2] This is a potentially important omission, as conditions experienced early in life are known to have persistent and long-term effects on health, education, and socioeconomic outcomes (see seminal work by Stein et al., 1975 and more recent papers by Maccini and Yang, 2009 and Maluccio et al., 2009). While recent work has begun to fill this gap (Akbulut-Yuksel, 2009; Akresh et al., 2011; Akresh et al., 2012; Alderman et al., 2006), a number of data limitations have limited the ability to determine causal effects of conflict exposure on child health.

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[1] The United States Central Intelligence Agency World Factbook (2010) lists over 180 regions in the world that have existing disputes over international land or sea boundaries or have resource or resident disagreements; 41 of these disputes are in sub-Saharan Africa.

[2] Seminal work on conflict focuses on understanding the causes and spread of war and its role in reducing growth (Collier and Hoeffler, 1998; Do and Iyer, 2010; Guidolin and La Ferrara, 2007; Miguel et al., 2004). The magnitude of conflict's long-term negative economic consequences is debated in the literature (see Davis and Weinstein, 2002 for Japan; Brakman et al., 2004 for Germany; Bellows and Miguel, 2009 for Sierra Leone). There is also a growing literature examining the relationship between conflict and education outcomes (Akresh and de Walque, 2008; Ichino and Winter-Ebmer, 2004; Miguel and Roland, 2011; Shemyakina, 2011; Swee, 2009). Research focusing exclusively on soldiers finds large negative impacts on their earnings, and soldiers exposed to more violence face a harder time reintegrating into civilian society (Angrist, 1990; Blattman and Annan, 2010; Humphreys and Weinstein, 2007; Imbens and van der Klaauw, 1995).

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In this paper, we estimate the effect of exposure to war at birth or as a young child on subsequent health status. We study the 1998–-2000 Eritrea–Ethiopia war that was based on a territorial border dispute.[3] When Eritrea, formerly a province of Ethiopia, became independent in 1993 following a long guerrilla war, sections of the new border were never properly demarcated. Full-fledged fighting started in May 1998 over these areas, which have been described as desolate and inconsequential. Reporters have portrayed the Eritrea–Ethiopia war as having "echoes of World War One in its bloody stalemate and trench warfare" (GlobalSecurity.org., 2000). More than 300,000 troops were dug in and deadlocked on both sides of the border. Most of the conflict's casualties were soldiers, since most civilians left the war-torn areas, leaving the armies to fight over empty villages.

We make four main contributions to the literature examining the impacts of exposure to conflict on children's welfare. First, due to the unique survey data that includes information on each household's residence location during the war, this paper is able to accurately measure a child's geographic location during the war, without which we would incorrectly classify war exposure for 12% of children. As a result, the paper overcomes some of the limitations of previous attempts to estimate the effects of conflict on well-being. Second, we use multiple measures of exposure to the war in our empirical analysis. We rely on data from the 2002 Eritrea Demographic and Health Survey, a nationally representative household survey that includes detailed information on child health. Based on the exact timing and geographic extent of the war, our empirical analysis exploits the exogenous variation in children's birth cohorts that are exposed to the conflict. To verify that estimated health differences across regions and birth cohorts are due to the conflict, we incorporate direct measures of the number of displaced individuals in each region as a share of the region's pre-war population to proxy for the war's intensity in that area. Third, because of the fortuitous timing of the household survey data collection, we also examine how the effects of exposure to the conflict differ between children born before or during the war. Fourth, this paper contributes to the study of gender bias in early childhood development and how that bias might influence the effects of the conflict on boys and girls. Our separate estimation of the impact of war exposure for boys and girls finds that both suffer negative consequences of similar magnitude, contrasting with the existing literature.[4]

We find that war-exposed children in Eritrea have lower height-for-age Z-scores. Our main results indicate that children born during the war and living in a war region have 0.42 standard deviations lower height-for-age Z-scores, representing a decline of 22% compared to the average height-for-age Z-scores of children born during the war in a non-war region. By accurately measuring a child's geographic location at the time of the war, the estimated negative impacts of exposure to conflict are 13% larger than they would have been if we used the child's location at the time of the survey. Alternative measures of war exposure based on conflict intensity indicate negative impacts of a similar magnitude. Both boys and girls experience significant negative impacts that are similar in size. The results are robust to specifications that include region-specific time trends, household and mother characteristics, and mother fixed effects, and are not affected by issues of endogenous migration, fertility, and mortality. Based on the existing early childhood development literature, the negative health impacts of the Eritrean–Ethiopian conflict are also likely to have long-run welfare impacts on war-exposed children.

In addition to the literature on the effects of conflicts on socioeconomic outcomes, our results are related to research on gender bias during early childhood. Much of the literature finds evidence favoring boys over girls (see Rose, 1999 for evidence from India that gender bias in infant mortality drops significantly when districts experience higher rainfall or Dercon and Krishnan, 2000 for evidence from Ethiopia that poor households are unable to smooth their consumption, with women bearing the brunt of adverse shocks). However, in contrast to this literature, we find no differential gender impact of war on children's health, as both war-exposed boys and girls suffer negative consequences of similar magnitude.

There are several plausible mechanisms by which the Eritrea–Ethiopia war may influence children's health. These could include reduced crop production and assets, heightened exposure to disease and unclean water, disruptions in food aid, and physical displacement. We are able to rule out some of these possibilities, but the lack of longitudinal data limits our ability to definitely identify the mechanism of impact. Regardless of the pathway, it is easy to see how each of these mechanisms might cause growth disturbances that influence a child's future health. These effects on a child's growth trajectory may lead to lower adult height, less cognitive ability and education, lower productivity and wages, and worse marital outcomes (see Strauss and Thomas, 2008 for a review of the link between early childhood health and later life outcomes).

The remainder of the paper is organized as follows. Section 2 provides an overview of the history of the Eritrea–Ethiopia conflict and sketches the spatial and temporal event data for the most recent war. Section 3 describes the survey data used in the analysis and explains the key variables. Section 4 describes the empirical identification strategy and Section 5 presents the main results as well as robustness tests. Section 6 concludes.

2. Eritrean–Ethiopian war

2.1. History of conflict and independence of Eritrea

The war between Eritrea and Ethiopia lasted two years beginning in 1998 and stemmed from a border dispute. Even before this war, the two countries had a long history of conflict with each other. The post-World War II period saw the former Italian colony of Eritrea become a region of Ethiopia, but growing dissatisfaction with the Ethiopian occupation led to a prolonged period of armed struggle by the Eritrean People's Liberation Front (EPLF) against the Ethiopian Marxist government. The war against Ethiopia ended in 1991 and coincided with the end of the Ethiopian civil war in which a coalition of rebel groups – the Ethiopian People's Revolutionary Democratic Front (EPRDF) – overthrew the government and came to power under the leadership of Meles Zenawi. Following a referendum in Eritrea in May 1993, the sovereign state of Eritrea was formed with the EPLF leader Isaias Afwerki as President (EPLF was later renamed the People's Front for Democracy and Justice). The immediate period following Eritrean independence saw generally friendly relations between Eritrea and Ethiopia, in part because the governments had fought together against the previous Marxist government that formerly controlled Ethiopia.

At the time of Eritrean independence, both countries claimed sovereignty over three areas: Badme, Tsorona-Zalambessa, and Bure (see Fig. 1 for a regional map of Eritrea and Ethiopia highlighting these three areas). Confusion over the border demarcation between the two countries was partially due to Ethiopia's 1962 annexation of

[3] In the past 30 years, border wars were fought in Africa (Djibouti and Eritrea in 2008, Mauritania and Senegal starting in 1989, Burkina Faso and Mali in 1985, Ethiopia and Somalia in 1982), Asia (Cambodia and Thailand in 2008, India and Bangladesh in 2001, Israel and Lebanon starting in 2000, India and Pakistan in 1999, Thailand and Laos starting in 1987, India and China in 1987, Pakistan and India starting in 1984, Iran and Iraq starting in 1980, Vietnam and China starting in 1979), and South America (Ecuador and Peru in 1995, Ecuador and Peru in 1981).

[4] The contributions highlighted here are also the key differences between our paper and the most closely related prior work by Bundervoet et al. (2009) who explore the impact of the Burundi civil war on child health. In particular, being able to accurately locate a child's residence during the war ensures that we correctly measure the child's war exposure and addresses the shortcomings of the approach used in the Burundi paper, leading to a more convincing causal estimate of the war's impact on child health.

Fig. 1. Eritrea and Ethiopia regional map indicating conflict sites. Notes: The main fighting between Eritrea and Ethiopia occurred around the areas of Badme, Tsorona-Zalambessa, and Bure, which are noted on the map.
Map source: Constructed by Rafael Garduño-Rivera in ArcGIS.

Eritrea, since at that time the former colonial boundaries were replaced by administrative boundaries within Ethiopia, some of which shifted slightly by 1993 (Global IDP Project, 2004b). A series of continued disputes in these three border areas combined with larger conflicts over trade and other economic issues, however, proved to be a major obstacle to maintaining peace.[5]

2.2. Spatial and temporal intensity of the Eritrea–Ethiopia war

In our analysis of child health, the exact timing and exact location of the fighting play a key role in our identification strategy. In May 1998, fighting broke out between Eritrean soldiers and Ethiopian militia and security police in the Badme area, which was under Ethiopian control. Within a week, the Ethiopian Parliament declared war on Eritrea, and all-out war ensued.[6] Both countries devoted substantial resources to growing their armies, augmenting their military equipment, and fortifying their borders, which included digging extensive trenches. After the initial period of intense conflict, heavy fighting resumed in February 1999 as Ethiopia succeeded, despite high casualties, in retaking the border town of Badme, but the battles around Tsorona-Zalambessa were not conclusive. Both sides initially rejected efforts by regional groups to mediate an end to the conflict, but eventually a Cessation of Hostilities agreement was brokered on June 18, 2000 and a 25-kilometer-wide demilitarized Temporary Security Zone was established along the 1000 km Eritrea–Ethiopia border and patrolled by United Nations peacekeeping forces. A final comprehensive peace agreement was signed December 12, 2000.[7]

The conflict intensity varied across regions within Ethiopia and Eritrea, with regions far from the border zones experiencing no fighting and the most intense clashes taking place in the areas near Badme, Tsorona-Zalambessa, and Bure (see Fig. 1). In Eritrea, the war region includes the regions of Gash Barka, Debub, and Debubawi Keyih Bahri, while in Ethiopia, it includes Tigray and Afar. While there are not

[5] Eritrea's independence in 1993 meant Ethiopia became a landlocked country, with implications for its trade and economic organization.

[6] The Eritrea Ethiopia Claims Commission (2005) states, "The areas initially invaded by Eritrean forces…were all either within undisputed Ethiopian territory or within territory that was peacefully administered by Ethiopia and that later would be on the Ethiopian side of the line to which Ethiopian armed forces were obligated to withdraw in 2000 under the Cease-Fire Agreement of June 18, 2000."

[7] The empirical analysis in this paper treats this as the date the war ended, but our results are consistent if we treat June 2000, the date when the Cessation of Hostilities agreement was brokered, as the time when the war ended.

exact figures of the number of casualties due to the war, most estimates of the total number of fatalities, which were mainly soldiers, range from 70,000 to 100,000 (Human Rights Watch, 2003).

2.3. Civilian impacts of the war

Although most casualties occurred among soldiers, thousands of civilians were displaced, which is the primary mechanism through which conflict may have affected child health. Displaced households suffered large reductions in food production, asset losses, and worsened access to water and health infrastructure. By the end of 1998, estimates suggest approximately 250,000 Eritreans had been internally displaced and another 45,000 Ethiopian citizens of Eritrean origin were deported from Ethiopia (Global IDP Project, 2004a). The Eritrean government and other observers estimate that during the war nearly 1.1 million Eritreans were internally displaced, although this number declined substantially by the war's end (Global IDP Project, 2004a). The Ethiopian government estimates that by December 1998, 315,000 Ethiopians were internally displaced, with the two regions that border Eritrea (Tigray and Afar) having the greatest number of internally displaced persons (IDP). The United Nations Country Team Ethiopia estimates that by May 2000 the number of IDPs in Ethiopia had risen to 360,000 (Global IDP Project, 2004b).[8] By most accounts, households directly affected by the war and those that were internally displaced tended to be located closest to the areas of the clashes.

3. Data

3.1. Eritrea 2002 Demographic and Health Survey

To measure the war's impact on child health, we use the 2002 Eritrea Demographic and Health Survey (DHS) data, which is a nationally representative cross-sectional survey that provides information on demographic topics such as fertility, child mortality, health service utilization, and nutritional status of mothers and young children. The 2002 Eritrea DHS collected detailed information on the date of birth and height of 5199 children under five born before, during, or after the war with Ethiopia. Important for the purpose of this study is the fact that the data also indicate the region in which respondents resided at the time the war began. This information is essential for identifying whether a child was exposed to the war, as the region of current residence may not capture such exposure for households that moved during or after the war.[9]

3.2. Health and war variables

Child height conditional on age and gender is generally accepted as a good indicator of the long-run nutritional status of children, as height reflects the accumulation of past outcomes, and children with low height for their age are likely to be on a different growth trajectory for the rest of their life (Thomas et al., 1996). We compute Z-scores for each child's height-for-age, where the Z-score is defined as the difference between the child's height and the mean height of the same-aged international reference population, divided by the standard deviation of the reference population. On average, across households in all regions of Eritrea, children are 1.57 standard deviations below the average height-for-age of a reference child, and 39.7 and 17.4% of children are considered stunted and severely stunted, respectively.[10]

We construct four measures, defined at the region-birth cohort level, of a child's exposure to the Eritrean–Ethiopian war. For each of the four measures, a child's current region of residence is replaced with the region in which the child's family resided during the war. The first measure interacts a binary indicator of residence in a war region (at the time of the war) with a binary variable indicating whether the child was alive during the war (i.e., born before or born during the war) and is defined as $War\ Region_j * Alive\ During\ War_t$. The second measure separately classifies children based on whether they were born during the war or born before the war started. Accordingly, we define the interaction variables ($War\ Region_j * Born\ Before\ War_t$) and ($War\ Region_j * Born\ During\ War_t$). Each of these measures of war exposure exploits variation across two dimensions: spatial (variation across regions in exposure to the war) and temporal (within a given region, the timing of whether a child was born before the war (prior to May 1998), during the war (between May 1998 and December 2000), or after the war ended (after December 2000)). The third measure of a child's exposure to war accounts for how long he or she was alive during the war. We define the duration in months that the child was living in a war region and exposed to the war, setting it equal to zero if the child resided in a region that was not affected by the war or if the child was born after the war had ended.

Finally, since war-induced displacement was an important mechanism through which the conflict impacted child health, we create a measure of war intensity that is defined as the number of IDPs in each region as a fraction of the region's pre-war population to proxy for the war's intensity in that area.[11] The IDP data are obtained from the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) in Eritrea, and they reveal that IDPs are clustered in the country's three war regions (Global IDP Project, 2004a). Since IDP data are only available at an aggregate level for each region, we are not able to determine which specific villages or districts had IDPs. However, there is substantial variation across regions in the number of IDPs per capita, and this represents an important distinction between this variable and the binary war region indicator. In Eritrea, the three war regions had 4, 21, and 26% of the population displaced in Debubawi Keyih-Bahri, Gash-Barka, and Debub, respectively.[12]

3.3. Preliminary observations

Panel A of Table 1 compares characteristics of households in war and non-war regions of Eritrea. Along some dimensions, such as education, urban status, and gender of the household head, non-war regions appear more developed and better off than war regions. For other characteristics, such as average mother's height, there is no significant difference across regions. In Panel B, the observed difference in the

[8] This level of conflict-induced displacement is typical, as currently 27.1 million individuals worldwide are IDPs due to conflict. For example, during the last decade in Africa, the number of IDPs due to conflict reached 3.5 million in Angola, 633,000 in Burundi, 200,000 in Central African Republic, 180,000 in Chad, 150,000 in Congo-Brazzaville, 750,000 in Côte d'Ivoire, 3 million in Democratic Republic of Congo, 359,000 in Guinea, 600,000 in Kenya, 450,000 in Liberia, 550,000 in Nigeria, 600,000 in Rwanda, 70,000 in Senegal, 1.3 million in Sierra Leone, 1.5 million in Somalia, 6.1 million in Sudan, 1.7 million in Uganda, and 1 million in Zimbabwe (IDMC, 2010).

[9] While DHS data are also available for Ethiopia (they were conducted in 2000 and 2005), an important limitation of those data is that no information is provided on the region of residence during the war. This makes it impossible to accurately classify a child as having been exposed to the war and potentially introduces substantial bias in the results. Therefore, the analysis we present in this paper is based solely on data from Eritrea.

[10] Children with height-for-age Z-scores below −2 are considered stunted, while children with height-for-age Z-scores below −3 are considered severely stunted.

[11] Kondylis (2010) finds a strong link between displacement and negative labor market outcomes in Bosnia, with higher unemployment rates and a higher likelihood of dropping out of the labor force for displaced individuals.

[12] To the best of our understanding much of the displacement was within a region (i.e. locally displaced people who were settled in a refugee camp in the same region), but we do not have information on whether specific households in our survey were IDPs, so we are unable to confirm this point.

Table 1
Child and household characteristics in Eritrea (year 2002), by region.
Data source: 2002 Eritrea Demographic and Health Survey.

	Non-war region [1]	War region [2]	Difference [1]−[2]=[3]
Panel A: household characteristics			
Household head is male	0.650	0.591	0.059**
	[0.017]	[0.017]	[0.024]
Household head age	41.684	40.711	0.973*
	[0.368]	[0.377]	[0.518]
Household head years school	2.196	1.517	0.680***
	[0.196]	[0.138]	[0.233]
Urban area	0.351	0.198	0.152***
	[0.036]	[0.029]	[0.044]
Mother's height (centimeters)	156.122	156.396	−0.273
	[0.234]	[0.171]	[0.289]
Panel B: child characteristics			
Height-for-age Z-score	−1.526	−1.615	0.090
	[0.051]	[0.038]	[0.062]
Proportion stunted	0.380	0.414	−0.033*
	[0.015]	[0.011]	[0.019]
Proportion severely stunted	0.173	0.177	−0.004
	[0.011]	[0.008]	[0.014]
Age in years	2.055	2.019	0.036
	[0.024]	[0.024]	[0.034]
Male	0.523	0.516	0.007
	[0.010]	[0.010]	[0.014]
Panel C: height-for-age Z-score by birth cohorts			
Born after the war	−0.704	−0.738	0.035
	[0.064]	[0.058]	[0.085]
Born during the war	−1.902	−2.093	0.191**
	[0.063]	[0.046]	[0.077]
Born before the war	−1.756	−1.824	0.068
	[0.076]	[0.057]	[0.095]
Observations	2563	2636	

Note: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. Children with a height-for-age Z-score below −2 are considered stunted, while children with a height-for-age Z-score below −3 are considered severely stunted.

proportion stunted for children in the two types of regions could be due to the conflict and therefore should not necessarily be viewed as pre-existing differences (we present preliminary evidence supporting this point in Panel C). Such differences between war and non-war regions are important to note, but as we discuss in Section 4, our identification strategy uses region fixed effects to control for these differences and overcome potential bias resulting from pre-existing regional differences in health and economic development.

To further explore the relationship between child height-for-age Z-scores across war and non-war regions, in Panel C we present these Z-scores broken down by whether a child's birth cohort was born after, during, or before the war. There is no difference in Z-scores across regions for those children born after the war ended. For those children born during the war, we see large and statistically significant differences across regions with children in the war regions having lower Z-scores. These simple descriptive statistics will form the basis for the identification strategy that we discuss next.[13]

[13] It is well-known that in developing countries, height-for-age Z-scores have a non-linear relationship with age, with older children having lower Z-scores than younger children, as nutritional and other deficits accumulate with age (Martorell and Habicht, 1986). In Eritrea, those children born after the war are younger than those born during or before the war, and we subsequently observe, in war and non-war regions, the typical relationship between age and height with older children having lower Z-scores than younger children. In the subsequent regression analysis, we control for age by including year of birth fixed effects.

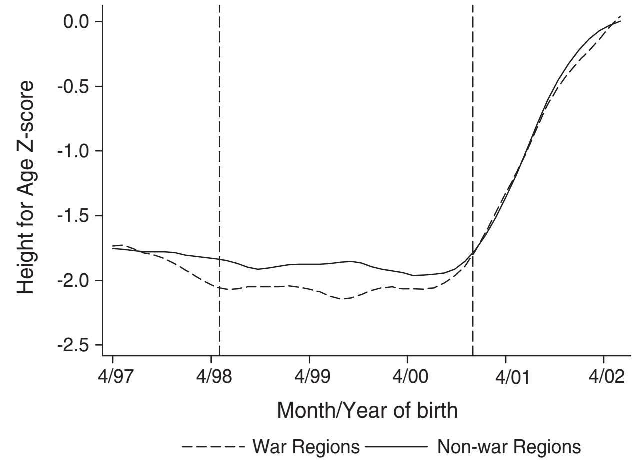

Fig. 2. Height-for-age Z-scores by Month and Year of Birth and War Exposure in Eritrea in 2002 (War and Post-War Period). Notes: Kernel-weighted local polynomial regression (using Epanechnikov kernel) of height-for-age Z-score on month and year of birth. Dashed line indicates children living in war regions. Solid line indicates children living in non-war regions. Vertical dashed lines show the starting (May 1998) and the ending dates (December 2000) of the war. Birth cohorts were either born before the war started, during the war, or after the war ended.
Data source: 2002 Eritrea Demographic and Health Survey.

4. Empirical identification strategy

We illustrate the primary empirical identification strategy of the paper in Fig. 2, which shows kernel-weighted local polynomial regressions of height-for-age Z-scores on date of birth using an Epanechnikov kernel. The dashed lines indicate children living in war regions, while the solid lines indicate children living in non-war regions. Vertical dashed lines show the starting (May 1998) and ending (December 2000) dates of the war. Fig. 2 shows results using the 2002 Eritrea DHS data with the initial birth cohort in the data born in April 1997. For all children, the figure shows the expected relationship with older children having lower Z-scores than younger children. Children born during the war in the war regions have lower height-for-age Z-scores than children born during the war in the non-war regions. We observe a similar result for the cohorts of children born before the war and therefore who were young children during the war. In the figure and all of the regressions, we replace a household's current region of residence at the time of the survey with its region of residence at the time of the war, which allows us to accurately represent a child's geographic war exposure.

The empirical identification strategy relies on a comparison of height-for-age Z-scores of similarly aged children in war and non-war regions. The implicit assumption is that differences across birth cohorts (those born before, during, or after the war ended) in average height-for-age Z-scores would be similar across war and non-war regions in the absence of the conflict. Based on the non-parametric regressions, we first estimate the following regression with region and birth cohort fixed effects:

$$HAZ_{ijt} = \alpha_j + \delta_t + \beta_1 \left(WarRegion_j * AliveDuringWar_t \right) + \lambda X_{ijt} + \varepsilon_{ijt}. \quad (1)$$

HAZ_{ijt} is the height-for-age Z-score for child i born in time period t in region j, α_j are region fixed effects, δ_t are year of birth cohort fixed effects, X_{ijt} are parental and household characteristics, and ε_{ijt} is a random, idiosyncratic error term. The war region interaction term is as defined in Section 3.2. The coefficient β_1 measures the war's impact on children's height-for-age Z-scores for children who were alive during the war in war-affected regions. We also estimate the following equation in order to separately determine the effect of the war on children born before or during the war:

$$HAZ_{ijt} = \alpha_j + \delta_t + \beta_2\left(WarRegion_j * BornBeforeWar_t\right) + \beta_3\left(WarRegion_j * BornDuringWar_t\right) + \lambda X_{ijt} + \varepsilon_{ijt}. \quad (2)$$

In Eq. (2), the coefficient β_2 measures the war's impact on children's height-for-age Z-scores for children who were born before the war in war-affected regions, while the coefficient β_3 measures the impact of the war on children's height-for-age Z-scores for children born during the war in war-affected regions.

In addition to estimating the effect based on whether a child was born before or during the war, we also estimate fixed effects regressions with a continuous measure of war exposure:

$$HAZ_{ijt} = \alpha_j + \delta_t + \beta_4\left(MonthsofWarExposure_{jt}\right) + \lambda X_{ijt} + \varepsilon_{ijt}. \quad (3)$$

Months of War Exposure$_{jt}$ measures the months of exposure to the war for a child living in a war region (it equals zero for a child living in a non-war region or born after the war ended). The coefficient β_4 measures the effect of an additional month of war exposure on children's height-for-age Z-scores.

The empirical strategy in Eqs. (1), (2), and (3) assumes that, in the absence of war, the difference between the height-for-age Z-scores of children born before and after the war ended in war-affected regions would have been the same as the difference for children living in non-war regions. To address the potential for differential time trends in height-for-age Z-scores across regions, we add region-specific time trends to each of the previous equations as follows (the case of Eq. (2) is shown here):

$$HAZ_{ijt} = \alpha_j + \delta_t + \beta_2\left(WarRegion_j * BornBeforeWar_t\right) + \beta_3\left(WarRegion_j * BornDuringWar_t\right) + \lambda X_{ijt} + \mathrm{RegionTrend}_{jt} + \varepsilon_{ijt} \quad (4)$$

where the variables are as previously defined and *Region Trend*$_{jt}$ is a region-specific time trend that isolates the variation in children's outcomes that diverge from region time trends. The inclusion of this time trend buttresses the argument that changes in average height-for-age Z-scores in these regions would have been similar in the absence of the war.

The results from estimating the region fixed effects equations above assume that apart from the war, there are no other events that might have coincided with the war and independently affected children's health. This assumption may be violated, and as a result we might incorrectly attribute a decline in children's health to the war. To address this possibility and to corroborate that the observed health differences across regions and birth cohorts are in fact due to the war, we estimate regressions that use the per capita number of IDPs in a region as a measure of the war's intensity in that region:

$$HAZ_{ijt} = \alpha_j + \delta_t + \beta_5\left(WarIntensity_j * BornBeforeWar_t\right) + \beta_6\left(WarIntensity_j * BornDuringWar_t\right) + \lambda X_{ijt} + \mathrm{RegionTrend}_{jt} + \varepsilon_{ijt}. \quad (5)$$

War Intensity$_j$ measures the number of IDPs per capita in region *j*. Negative coefficients for the interaction terms would suggest that previous results are indeed due to the war rather than other events.[14] This approach allows us to better identify the effect of the war, as we compare regions with higher IDPs per capita to regions with fewer IDPs per capita. The change in the health status of children born after the war ended in high war intensity regions relative to low war intensity regions serves as a control for what the change in the health status of children born before the war ended would have been if the war did not occur.

A final approach that we use to identify the effects of the war takes advantage of the fact that households often have multiple children under age five, with some children born before the war and others born during or after the war. This provides an opportunity to estimate the effects of the war based on within-household variation in a child's war exposure. We estimate Eqs. (4) and (5) with mother fixed effects, which allows us to control for characteristics of the child's mother that do not vary across siblings and that may influence height-for-age Z-scores. Since mothers with multiple children under age five may have different characteristics than those with only one child under age five, in order to make a proper comparison of the results with this approach, we also estimate Eqs. (4) and (5) without mother fixed effects for the sample of mothers with more than one child.

5. Empirical results

5.1. Difference-in-differences estimation (war region and war intensity)

Table 2 presents results from our baseline specifications for estimating the war's impact on height-for-age Z-scores, as outlined in Eqs. (1) to (3), and includes region-specific time trends to control for the possibility of differential trends across regions.[15,16] All regressions include region and year of birth fixed effects as well as controls for the child's gender. Regressions in columns 2, 4, and 6 also include controls for whether the household lives in an urban area, mother's height, and the head of household's years of education, gender, and age. We first examine the effect of exposure to the war on the pooled group of children born before or during the war (i.e. alive during the war). We find that height-for-age Z-scores are 0.45 standard deviations lower for children residing in war regions and alive during the war and that the effect of the war is similar with and without household and mother characteristics (columns 1 and 2).

In the remainder of Table 2, we examine the differential impacts on children born before or during the war as well as the impacts of months of war exposure. Not only were children born during or before the war of different ages when the height measurements took place, they also were of different ages when exposed to the conflict. The estimates in column 4 indicate that children born during the war in war regions have 0.42 standard deviations lower height-for-age Z-scores, while children born before the war in war regions have 0.34 standard deviations lower Z-scores. The magnitude and levels of statistical significance are comparable with those in column 3 that do not include parent characteristics.[17] To test whether

[14] Results (not shown) are also consistent when we estimate the regression using the absolute number of IDPs as the war intensity measure.

[15] In the regressions estimated without time trends, the magnitude of the impacts and the levels of statistical significance are consistent, although the results suggest that in the war impacted regions children's health status was actually improving.

[16] Correlation among the error terms of children living in the same local environment and experiencing similar events that affect health might bias the OLS standard errors downward, so in all regressions we cluster the standard errors by enumeration area, which corresponds to local clusters of villages (Moulton, 1986).

[17] As a robustness check, we estimate the regressions using enumeration area fixed effects (instead of region fixed effects), and the magnitude of the impacts and levels of statistical significance are consistent with those in Table 2. When we estimate the regressions including month of birth fixed effects, given the relatively small sample size, we lack adequate statistical power to estimate the effect of the war precisely with so many additional fixed effects, and results are no longer robust. However, the impact of the war remains negative and statistically significant when we include month of birth fixed effects for children less than one year of age (the time period during which one month indicator variables are likely to be most important as the variation in height is greatest for this age group) and year of birth fixed effects for children older than one year.

Table 2
Measuring the impact of war exposure on children's height-for-age Z-score.
Data source: 2002 Eritrea Demographic and Health Survey.

Dependent variable: height-for-age Z-score	[1]	[2]	[3]	[4]	[5]	[6]
War Region ⁎ Alive During War	−0.454***	−0.447***				
	[0.106]	[0.103]				
War Region ⁎ Born During War			−0.425***	−0.421***		
			[0.112]	[0.110]		
War Region ⁎ Born Before War			−0.334*	−0.340*		
			[0.192]	[0.188]		
Months of war exposure					−0.038***	−0.036***
					[0.010]	[0.010]
Child is male	−0.023	−0.006	−0.023	−0.007	−0.017	0.000
	[0.037]	[0.036]	[0.037]	[0.036]	[0.037]	[0.036]
Mother's height (cm)		0.046***		0.046***		0.046***
		[0.004]		[0.004]		[0.004]
Head of household years of school		0.046***		0.046***		0.046***
		[0.007]		[0.007]		[0.007]
Head of household is male		−0.073		−0.073		−0.076
		[0.052]		[0.052]		[0.053]
Head of household age		0.003		0.003		0.003
		[0.002]		[0.002]		[0.002]
Urban		0.197***		0.197***		0.199***
		[0.073]		[0.073]		[0.073]
P-value testing equality between born during and born before war			0.458	0.503		
Child age fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5199	5199	5199	5199	5199	5199

Notes: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. All specifications include child age fixed effects, region fixed effects, region-specific time trends, and child gender controls. Regressions in columns 2, 4, and 6 also include controls for household and mother characteristics. In all regressions, the child's current region of residence is replaced by their region of residence at the start of the war to accurately capture war exposure. This change affects 12% of children. The war regions in Eritrea are Gash Barka, Debub, and Debubawi Keyih Bahri. "War Region ⁎ Alive During War" indicates a child living in a region affected by the war who was alive during the war. "War Region ⁎ Born During War" indicates a child living in a region affected by the war who was born during the war. "War Region ⁎ Born Before War" indicates a child living in a region affected by the war who was born before the war started. "Months of War Exposure" measures the number of months a child was alive during the war in a region affected by the war.

children born during the war experience a significantly different impact of war exposure than children born before the war started, in columns 3 and 4 we present the p-values for the test of the null hypothesis that the effect on the two groups is identical (that is, that $\beta_2 = \beta_3$ in Eq. (2)). Although the results indicate a larger impact for children born during the war in the war regions compared to those born before the war, we are not able to reject the equality of coefficients. In columns 5 and 6, we examine the impact of the number of months of war exposure and find that each additional month results in a significant reduction of 0.04 in the Z-score.[18] The impact of the conflict on those children born during the war in war regions represents a decline of 22% compared to the average height-for-age Z-score of children born during the war in a non-war region.[19] In all of these regressions, by using a child's geographic location at the time of the war to accurately capture geographic war exposure, the estimated negative impacts of exposure to conflict are 13% larger than they would have been if we used the child's location at the time of the survey (results not shown).

Since the war occurred mainly in the border areas between the two countries, the identification strategy used so far likely correctly identifies the impact of the war on children's health status. However, during the same time period other events may have occurred that might be correlated with both the war's occurrence and changes in children's health status. If this were the case, we might be incorrectly attributing the observed decline in health status to the war. Table 3 examines this potential source of bias. We estimate a difference-in-differences regression using each region's number of IDPs per capita as a measure of war intensity. All specifications include region and child age fixed effects, region-specific time trends, and child gender. Regressions in columns 2 and 4 also include household and mother characteristics.

Results indicate that children alive during the war in higher war intensity areas have lower height-for-age Z-scores and results are statistically significant. An increase in the per capita number of IDPs in a region by 1 percentage point significantly lowers the Z-scores for children alive during the war by 0.019 (in column 1 without parent controls) or 0.017 (in column 2 with parent controls) standard deviations. Results indicate that children born during or before the war in higher war intensity areas experience similar magnitude negative impacts (results in column 3 without parent controls and in column 4 with parent controls). Increasing the per capita number of IDPs in a region by 1 percentage point lowers the Z-scores for children born during the war by 0.017 standard deviations and by 0.016 standard deviations for children born before the war (column 4).

These impacts are large and meaningful, particularly when considering the per capita number of IDPs in Eritrea. In Eritrea, a child born during the war in a region experiencing the mean war intensity (average percentage of IDPs per capita across all regions in Eritrea is 9.59) has a height-for-age Z-score that is 0.163 lower. This negative impact represents a decline of 8.6% relative to the average height-for-age Z-scores of children born during the war in the non-war regions. A child born before the war in a region experiencing the mean war intensity has a height-for-age Z-score that is 0.153 standard deviations lower, a decline of 8.7% relative to the average height-for-age Z-scores of children born before the war in the non-

[18] We also estimate regressions in which we replace the months of war exposure variable with three binary variables to indicate exposure for 1 to 10 months, 11 to 20 months, or 21 or more months. We find evidence of a non-linear impact, with the effect of 11 months or greater exposure being twice as large as that of 1 to 10 months of exposure.

[19] We also estimate several placebo-type regressions in which non-war regions were labeled as if they were war regions and then compared to the other non-war regions. Results show no significant impact on height-for-age Z-scores in these non-war regions.

Table 3
Measuring the impact of war exposure on children's height-for-age Z-score, using war intensity.
Data source: 2002 Eritrea Demographic and Health Survey.

Dependent variable: height-for-age Z-score	[1]	[2]	[3]	[4]
War Intensity * Alive During War	−0.019***	−0.017***		
	[0.005]	[0.005]		
War Intensity * Born During War			−0.018***	−0.017***
			[0.005]	[0.005]
War Intensity * Born Before War			−0.016*	−0.016*
			[0.009]	[0.009]
Child is male	−0.023	−0.006	−0.022	−0.006
	[0.037]	[0.036]	[0.037]	[0.036]
Mother's height (cm)		0.046***		0.046***
		[0.004]		[0.004]
Head of household years of school		0.046***		0.046***
		[0.007]		[0.007]
Head of household is male		−0.072		−0.072
		[0.053]		[0.053]
Head of household age		0.003		0.003
		[0.002]		[0.002]
Urban		0.196***		0.196***
		[0.073]		[0.073]
P-value testing equality between born during and born before war			0.726	0.884
Child age fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes
Observations	5199	5199	5199	5199

Notes: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. All specifications include child age fixed effects, region fixed effects, region-specific time trends, and child gender controls. Regressions in columns 2 and 4 also include controls for household and mother characteristics. In all regressions, the child's current region of residence is replaced by their region of residence at the start of the war to accurately capture war exposure. This change affects 12% of children. The war regions in Eritrea are Gash Barka, Debub, and Debubawi Keyih Bahri. "War Intensity" indicates for each region the number of internally displaced individuals as a percentage of the region's pre-war population. Displacement data for Eritrea come from the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA).

war regions. The true impact on war-exposed children is even larger, as the mean war intensity in the above calculation is averaged across all regions, some of which had no IDPs. Using the average percentage of IDPs per capita only from the war regions of Eritrea (18.45) shows negative impacts of 0.314 standard deviations for children born during the war, representing a 16.5% decline compared to the average Z-scores of children born during the war in the non-war regions, and 0.295 standard deviations for children born before the war, a decline of 16.8% compared to the average Z-scores of children born before the war in the non-war regions.

While overall we find large negative impacts of exposure to war, it is important to know whether these effects are experienced equally by boys and girls. Table 4 examines specifically whether the impact of the conflict differed by gender. Unlike the literature on early childhood development that generally finds a large negative bias against girls, we find here that both boys and girls are negatively impacted by exposure to the war. Boys and girls born during the conflict and living in a war region at the time of the war have significantly lower height-for-age Z-scores. The magnitude of the negative impact is larger for boys, although in a fully interacted model, we cannot reject the equality of coefficients for boys and girls. Thus, the results here provide no evidence of girls having disproportionately suffered the consequences of the war.[20]

[20] We also estimate regressions in which households were divided into poor and non-poor groups based on the education of the household head. Results (not shown) suggest that the negative impact of the war is similar among children in poor and non-poor households.

Table 4
Measuring the impact of war exposure on children's height-for-age Z-score, by gender.
Data source: 2002 Eritrea Demographic and Health Survey.

Dependent variable: height-for-age Z-score	Boys	Girls	Boys	Girls
	[1]	[2]	[3]	[4]
War Region * Born During War	−0.500***	−0.333**		
	[0.158]	[0.157]		
War Region * Born Before War	−0.386	−0.278		
	[0.245]	[0.283]		
War Intensity * Born During War			−0.018***	−0.015**
			[0.007]	[0.008]
War Intensity * Born Before War			−0.017	−0.015
			[0.011]	[0.013]
P-value testing equality between born during war and born before war	0.458	0.775	0.846	0.971
Household and maternal controls	Yes	Yes	Yes	Yes
Child age fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes
Observations	2701	2498	2701	2498

Notes: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. All specifications include child age fixed effects, region fixed effects, region-specific time trends, and controls for household and mother characteristics (mother's height, head of household years of school, head of household gender, head of household age, and urban status). In all regressions, the child's current region of residence is replaced by their region of residence at the start of the war to accurately capture war exposure. This change affects 12% of children. The war regions in Eritrea are Gash Barka, Debub, and Debubawi Keyih Bahri. "War Region * Born During War" indicates a child living in a region affected by the war who was born during the war. "War Region * Born Before War" indicates a child living in a region affected by the war who was born before the war started. "War Intensity" indicates for each region the number of internally displaced individuals as a percentage of the region's pre-war population. Displacement data for Eritrea come from the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA).

Table 5
Measuring the impact of war exposure on children's height-for-age Z-score, including mother fixed effects.
Data source: 2002 Eritrea Demographic and Health Survey.

Dependent variable: height-for-age Z-score	[1]	[2]	[3]	[4]
War Region * Born During War	−0.676**	−0.478***		
	[0.310]	[0.154]		
War Region * Born Before War	−1.027**	−0.459*		
	[0.496]	[0.264]		
War Intensity * Born During War			−0.036**	−0.022***
			[0.014]	[0.007]
War Intensity * Born Before War			−0.052**	−0.022*
			[0.024]	[0.013]
P-value testing equality between born during war and born before war	0.193	0.907	0.223	0.996
Mother fixed effects	Yes	No	Yes	No
Region fixed effects	No	Yes	No	Yes
Household and maternal controls	No	Yes	No	Yes
Child age fixed effects	Yes	Yes	Yes	Yes
Region-specific time trends	Yes	Yes	Yes	Yes
Observations	3165	3165	3165	3165

Notes: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. Regressions in columns 1 and 3 include mother fixed effects, while regressions in columns 2 and 4 include region fixed effects but are restricted to the mother fixed effects sample. All specifications include child age fixed effects, child gender controls, and region-specific time trends. In all regressions, the child's current region of residence is replaced by their region of residence at the start of the war to accurately capture war exposure. This change affects 12% of children. The war regions in Eritrea are Gash Barka, Debub, and Debubawi Keyih Bahri. "War Region * Born During War" indicates a child living in a region affected by the war who was born during the war. "War Region * Born Before War" indicates a child living in a region affected by the war who was born before the war started. "War Intensity" indicates for each region the number of internally displaced individuals as a percentage of the region's pre-war population. Displacement data for Eritrea come from the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA).

5.2. Robustness checks

In addition to the previous approaches using a difference-in-differences strategy, we estimate the war effects based on within-household variation in a child's exposure to war. In Table 5, we estimate Eqs. (4) (war region) and (5) (war intensity) by replacing region fixed effects with mother fixed effects. This allows us to control for characteristics of the child's mother that do not vary across siblings. Identification is driven by comparing children of the same mother, some of whom were born before the war, some born during the war, and some born after the war. Results in columns 1 and 3 indicate large negative impacts for children who were born during or before the war in a war region or higher war intensity area. In the mother fixed effects specifications, the magnitude of the negative impact is larger for children born before the war compared to born during the war, although we are not able to reject the equality of the coefficients. In these mother fixed effects regressions, only mothers who have multiple children under age five would be included. Since mothers with multiple children under age five may have different characteristics than those with only one child under age five, columns 2 and 4 of Table 5 enable a proper comparison by showing the results from regressions without mother fixed effects for the sample of mothers with more than one child. Results still indicate large negative and statistically significant impacts of exposure to the war on children's height. The magnitude of the effect of the war is smaller in the specifications that do not contain mother fixed effects, which highlights the importance of controlling for mothers' characteristics that could differ across households even within a region.

Furthermore, factors such as selective migration, fertility, and mortality are among the major reasons why the results presented so far might not accurately capture the true causal effects of the war. In the rest of this section, we examine the role of each of these issues and present evidence that the main results are unlikely to be strongly influenced by them.

We first examine the issue of endogenous migration. Due to the war, thousands of people were internally displaced in Eritrea and Ethiopia. Migration of this nature, particularly if people moved across regions, would bias our estimates because we would incorrectly determine a child's war exposure based on the child's current region of residence. For example, if well-off households with healthier children migrated from war to non-war regions, our results would over-estimate the impact of the conflict. Alternatively, if children from poorer areas and poorer households fled the conflict and moved from war to non-war regions, our results would underestimate the war's impact. The unique survey data in Eritrea allow us to correct the bias induced by this geographic misclassification. We use a child's region of residence at the start of the war instead of their residence at the time of the 2002 DHS, and this leads to a location change for 12% of children in the sample. Based on results that are not presented, we find that the estimated negative impacts of exposure to conflict are 13% larger when we use the location at the time of the war than they would be if we use the child's location at the time of the survey.

To address the concern about endogenous fertility, we use birth history data to calculate, for each of the three time periods (before, during, and after the war), the percentage of children who were born in war and non-war regions. We find that the proportion of children born in war regions is smaller during the war compared to before the war (49.7 compared to 53.6% in Eritrea). This suggests that women in war regions had fewer births during the war. However, as Appendix Table 1 shows, we find no significant differences between war and non-war regions across most characteristics of women who had a child during the war (we examined mother's education, number of births, height, and age, as well as household head's age and gender).

Differences in child mortality between war and non-war regions may also result in a biased estimate of the impacts of the war. Here, it is likely that the deceased children were those with poorer health (and from poorer households) to begin with, which means that we would underestimate the impact of the conflict. In Appendix Table 2, we use birth history data for every mother to directly examine the impact of war exposure on child mortality. The regression samples include all children ever born during the 60 months prior to the survey, and the dependent variable indicates whether a child died prior to the survey. The war exposure variables are measured as in Table 2 (war region interacted with born during or before war and war intensity interacted with born during or before war). The results show that overall there is no significant increase in the likelihood of child mortality due to war exposure. This lack of relationship between war exposure and mortality should be understood in the context of an environment with already extremely high under-5 mortality (pre-war under-5 mortality rates in Eritrea are 121 deaths per 1000 live births).

5.3. Discussion of the war impact mechanisms

Understanding the specific mechanisms by which conflict impacts child health is critical for developing adequate policy responses to protect children from the negative effects of war. In order to fully answer this question, we would require detailed household level data on crop production and assets, information on the extent and duration of displacement (including changes in nutrition and exposure to disease and unclean water), and detailed conflict event data at the household level to accurately measure war exposure. Despite the lack of such data, our results provide some suggestive indication of the likely mechanisms by which war impacts child health.

A first possible mechanism is that the war hindered the provision of food aid distributed by the international community. However, there is evidence that donors did not restrict food aid provision, and in fact, some countries began to help these nations for the first time (Biles, 2000). Reports also indicate the war did not interfere with food aid distribution. While we do not have data on the amount of relief aid disaggregated by region, if such aid was targeted disproportionately to war-affected regions, then this paper's results would underestimate the true impact of the conflict. A second possible mechanism, one that is more common in civil wars in Africa, is the theft of assets, including livestock. Since it takes time to reverse such a loss, poverty generated by asset theft would affect all children in the household, regardless of if they are born during or after the war. Our results suggest this mechanism might not have been salient, as only children born before the war ended are impacted. In addition, there is some anecdotal evidence of stray Eritrean cattle returned by the Ethiopian army and vice versa.

While displacement of households within regions might be a key mechanism by which the war impacted children's health status, the absence of detailed household-level survey information on the reasons for household movement limits our ability to examine this issue thoroughly. Many families were internally displaced in both countries due to the war. Because of this, households could have been directly worse off through loss of harvests and assets, disruption of businesses, and reduced access to medicines and clean water. Consistent with our results, a child exposed to displacement would be worse-off compared to a non-exposed child, and the impact should be larger the longer the child is exposed to these events. There were also effects on children who were not displaced by the war but were residing in areas with many displaced individuals (Baez, 2011; Maystadt and Verwimp, 2009). The similarity between our main results and the results for the sample of children whose households report that they have never moved suggests that displacement due to the war may indeed have affected both displaced and non-displaced children.

6. Conclusion

This is the first paper to measure the impacts of exposure to conflict on children's health based on an accurate representation of a child's geographic location during the war. We find that without this information exposure to the war would be incorrectly classified for 12% of children in Eritrea, and estimates of the impact of the war would thus be biased. The 1998–2000 war between Eritrea and Ethiopia led to thousands of people being displaced from their homes, as is the case for many conflicts in sub-Saharan Africa. Our identification strategy exploits exogenous variation in the conflict's geographic extent and timing and the subsequent exposure of different children's birth cohorts to the fighting. Using alternative measures of war exposure and conflict intensity, we find that war has a large negative impact on height-for-age Z-scores of children. Our main results indicate that children born during the war and living in a war region have 0.42 standard deviations lower height-for-age Z-scores. War impacts are of similar magnitude for boys and girls, and our results are robust to consideration of various issues such as endogenous migration, fertility, and mortality among war-affected households.

A critical reason for studying the impact of war on children's height is that this health indicator is known to influence future health, education, and economic outcomes. Based on other estimates of the links between height-for-age Z-scores and schooling attainment and wages, we can speculate on the long-term consequences that follow from our estimates of a negative health impact of the Eritrea–Ethiopia war. Specifically, we base our calculation on the estimate that a one standard deviation reduction in height correlates with 0.678 fewer grades completed in Zimbabwe (Alderman et al., 2006) and that the return to an extra year of school in Ethiopia is 15% (Krishnan et al., 1998). Using these estimated links and the magnitude of the impacts discussed above, we find that for children born during the war in Eritrea, wages in adulthood will be 4.3% lower.

The results in this paper contribute to a growing literature that estimates the welfare impacts of wars. Our ability to more accurately estimate war exposure and measure the magnitude of the potential bias introduced by not doing this correctly strengthens our confidence in the results and confirms that wars often result in adverse effects on young children. The findings in this paper also help improve our understanding of a broader issue, which are the long-term growth and development consequences of wars. As undernourishment during early years has been linked to worse economic outcomes in adulthood, the long-term legacy of war is a problem that may need to be addressed with various educational and economic interventions in the future.

Appendix Table 1. Endogenous fertility: characteristics of women having a child during war

Data source: 2002 Eritrea Demographic and Health Survey.

Dependent variables	Women's characteristics				Household heads' characteristics	
	Years of education [1]	Number of births [2]	Height in centimeters [3]	Age [4]	Age [5]	Gender [6]
War Region*Has a Child Born During War	−0.281	0.259	−0.219	1.009**	0.065	−0.061*
	[0.224]	[0.173]	[0.404]	[0.510]	[0.925]	[0.032]
War Region	−0.775***	0.071	0.247	−0.613	−1.238	0.002
	[0.298]	[0.145]	[0.393]	[0.432]	[0.829]	[0.031]
Has a Child Born During War	−0.264	0.611***	−0.269	0.352	−0.951	0.044*
	[0.186]	[0.124]	[0.295]	[0.370]	[0.672]	[0.024]
Constant	2.402***	3.490***	156.372***	30.182***	42.627***	0.592***
	[0.251]	[0.103]	[0.305]	[0.320]	[0.647]	[0.023]
Observations	4069	4071	4025	4071	4056	4071

Notes: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. In Eritrea, the war regions are Gash Barka, Debub, and Debubawi Keyih Bahri.

Appendix Table 2. Measuring the impact of war exposure on child mortality

Data source: 2002 Eritrea Demographic and Health Survey.

Dependent variable: child mortality	[1]	[2]
War Region*Born During War	−0.010	
	[0.024]	
War Region*Born Before War	−0.025	
	[0.043]	
War Intensity*Born During War		0.000
		[0.001]
War Intensity*Born Before War		0.000
		[0.002]
Household and maternal controls	Yes	Yes
Child age fixed effects	Yes	Yes
Region fixed effects	Yes	Yes
Region-specific time trends	Yes	Yes
Observations	5684	5684

Notes: Robust standard errors in brackets, clustered at the enumeration level. * significant at 10%, ** significant at 5%, and *** significant at 1%. The regression samples include all children ever born during the 60 months prior to the survey, and the dependent variable indicates whether the child died prior to the survey. All specifications include child age fixed effects, region fixed effects, region-specific time trends, child gender controls, and controls for household and mother characteristics. In all regressions, the child's current region of residence is replaced by their region of residence at the start of the war to accurately capture war exposure. In Eritrea, the war regions are Gash Barka, Debub, and Debubawi Keyih Bahri. "War Region*Born During War" indicates a child living in a region affected by the war who was born during the war. "War Region*Born Before War" indicates a child living in a region affected by the war who was born before the war started. "War Intensity" indicates for each region the number of internally displaced individuals as a percentage of the region's pre-war population. Displacement data for Eritrea come from the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA).

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