Conflict Exposure and Human Capital Formation of Children in Selected Sub-Saharan African countries

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Abstract

Violent conflict in sub-Saharan Africa (SSA) has resulted in population displacement, psychological trauma, and the destruction of livelihoods, which has hindered economic growth. These events have increased in frequency and severity over time in the region. Violent conflict disrupts children's human capital accumulation through widespread malnutrition and the disruption of social and emotional skills that should have been acquired in early childhood. This study aims to estimate the relationship between early-life exposure to violent conflict and children's human capital formation (focusing on child health, nutrition, and schooling) in four selected SSA countries since 2003. Using nationally representative Demographic and Health Surveys (DHS) merged with georeferenced conflict data, the study finds that children exposed to violent conflict, measured by the number of fatalities, experience reduced human capital formation, including stunted growth, underweight status, and lower educational outcomes. Specifically, children in households exposed to violent conflict have higher dropout rates (given their enrollment) and experience delays in completing primary school. Furthermore, the impact of conflict on long-term malnutrition is particularly pronounced among young children and those living in rural areas. Limited access to health facilities during or after conflict, disruptions in livelihoods and/or markets that result in deprivations in the dietary intake of children and mothers, and the place of residence appear to be the underlying mechanisms.

Keywords: Human capital, conflict, nutrition, children, sub-Saharan Africa
JEL codes: D74, I12, J13, J24, O15

1. Introduction

A growing body of literature underscores the pivotal role of human capital in economic development, particularly in African countries (World Bank, 2018; Heckman et al., 2010a). Amidst the region's rich cultural diversity and natural abundance, persistent conflicts have posed formidable challenges to the development and well-being of its people, particularly its most vulnerable: children. To strengthen their human capital basis, many African countries have made large investments. Consequently, human capital has grown in terms of health and education indices, according to a recent report (Bank, 2020). However, sub-Saharan Africa (SSA) continues to lag in the Human Capital Index (HDI), a measure of how well countries invest in the next generation of workers.

In the vast landscape of SSA, the repercussions of conflict are felt deeply, shaping the trajectory of individual lives and the broader societal landscape. Between 1995 and 2015, for instance, armed conflicts caused the deaths of more than 10 million children under the age of five globally (Bendavid et al., 2021). Africa alone witnessed more than 1.3 million deaths in civil conflict events from 1989 to 2018 (Sundberg and Melander, 2013), and billions of wealth have been destroyed. Africa is also home to more than half of the world's unschooled children (about 33 million) (Garin et al., 2016). In many SSA countries, these events have become more frequent and severe, suggesting that their importance for children's human capital formation may have similarly increased (Kadir et al., 2019). Emerging empirical evidence suggests that conflicts harm both physical and human capital, impeding economic development and perpetuating a cycle of violence (Collier and Hoeffler, 2004; Anderson et al., 2021). Given the intensity and dynamics of conflict in SSA, the effects of conflict exposure on the human capital formation of children and the channels through which conflict exposure impacts human capital formation remain unclear.

This article examines the complex interrelationship between violent conflict and the human capital formation of children in SSA, elucidating the mechanisms through which this relationship persists. Motivated by the importance of early life exposure in impacting children's later life outcomes (Piaget, 1945; Heckman et al., 2010a), this paper employs econometric techniques to estimate the relationship between conflict and human capital formation. For this purpose, we used the Demographic and Health Surveys (DHS), georeferenced conflict data from the Uppsala Conflict Data Program (UCDP), and the Armed Conflict Location and Event

Data Project (ACLED) of four SSA countries since 2000: Ethiopia, Nigeria, Rwanda, and Uganda. Specifically, we aim to address the following research questions: How does early childhood exposure to violent conflicts impact children's human capital formation in these countries? What are the potential pathways through which early-life exposure to violent conflict affects children's human capital development?

Early childhood experiences play a crucial role in human capital formation (both quality and quantity), influencing cognitive development, nutritional status, and future economic opportunities (Piaget, 1952; Heckman et al., 2013). Given that SSA has the highest proportion of youth and children (UNDESA, 2019), human-induced shocks, such as violent conflict that reduces or prevents human capital development, will have severe implications for children's development outcomes (Kadir et al., 2019), as well as a detrimental effect on the transformation of economies or lifetime economic opportunities (Heckman, 2012) and economic productivity (Choonara, 2013; Slone and Mann, 2016). For example, empirical evidence shows that early childhood environments have a long-lasting impact during adulthood (Weldeegzie, 2017; Baranyi et al., 2011; Duflo, 2001; Gates et al., 2012).

Conflict impedes countries' structural transformation as it poses a serious global threat to the well-being of children. For instance, conflicts in the Sahel region are increasingly interrelated, highly diffusing, and infecting neighbors (McGuirk and Nunn, 2020). In the presence of armed conflict and political violence, children are the most vulnerable group of society, to be killed, injured, orphaned or separated from their families, sexually abused or recruited into armed groups, as well as drop out of school (UNICEF, 2016; Marquardt et al., 2016). This, in turn, affects both the quantity and quality of human capital formation.

Despite some recent efforts to draw attention to the impact of conflict on human capital formation, empirical evidence on child human capital formation is scarce, particularly in SSA, where conflict is rampant and has complex ramifications for human capital formation and economic growth (Kadir et al., 2019; Collier and Hoeffler, 2004). Moreover, due to a lack of data, less is known about how individuals or households in SSA adapt when faced with violent conflict, limiting the development of evidence-based policies to improve the prospects for recovery. This study focuses on the micro-level perspectives, placing individuals or economic agents such as households and communities at the center of the analyses, in contrast to earlier studies that looked at violent conflict from a macro-

perspective (such as international, regional, and national contexts). Communities and households generally play a vital role in conflict management and the post-conflict recovery process. Recent empirical evidence from 52 African countries, for instance, shows that increases in child mortality primarily emerge through the behavioral response of economic agents (e.g., parents, aid workers, policymakers) to terrorism rather than through the direct effects of terrorism (e.g., distractions of public health infrastructure) (Meierrieks et al., 2022). Although there is growing attention to those of households, there is less attention on shocks affecting early childhood development, and this is more so in the Sahel and East Africa region, where violent conflict has become a contagious, dynamic, and common phenomenon. The study aims to bridge this knowledge gap. Moreover, it is important to understand the impact of conflict on the human capital formation of children and its negative consequences on development and economic growth in both the short and long run to design appropriate policy interventions for conflict resolution and post-conflict recovery pertinent to the transformation of African economies.

Specifically, this paper offers a comprehensive analysis of the multifaceted impact of conflict on children's human capital formation across various demographic and temporal dimensions. For instance, we delve into the nuanced disparities experienced by rural and urban populations, as well as the differential effects on girls and boys. In addition, we explore both short-term and long-term effects of exposure to conflict in early childhood, shedding light on the dynamic interplay between conflict exposure and children's human capital formation. By dissecting these dimensions, our contribution aims to inform targeted interventions and policies to mitigate the adverse long-term consequences of conflict on the most vulnerable members of society. As the study focuses on young children, its findings will inform policy and action to tackle conflict post-recovery and structural transformation, which are essential for achieving the Sustainable Development Goals (SDGs). Furthermore, this paper goes beyond the effects and explores the channels through which these effects operate, an area that has been less researched. As such, it contributes to a large literature that emphasizes the importance of early childhood nutrition and educational outcomes for human capital formation and/or fills the knowledge gap in the areas of child-centered development approaches. Moreover, the study's cross-country analysis from resilient countries will provide insights into designing robust human capital development policies to target conflict-exposed areas.

The remainder of this paper is organized as follows. Section 2 provides a concise overview of the current state of literature, focusing on the potential mechanisms through which conflict exposure affects the human capital formation of children. Section 3 provides study context while Section 4 describes the data and measurement of key variables of interest with descriptive statistics. Section 5 discusses the empirical estimation strategy employed to estimate the relationship between conflict exposure and child human capital formation. Section 6 presents and discusses econometric results as well as explores potential pathways, while Section 7 concludes with potential policy implications.

2. Related Literature

It is well documented in both empirical and theoretical literature (in economics) that early childhood exposure to shocks can have a profound impact on the development of human capital in children, which in turn, has direct consequences for success later in life (Meierrieks et al., 2022; Kinyoki et al., 2017; Huang and Liu, 2023; Heckman, 2006, 2012). For instance, the famous theory "Heckman Curve" coined by Heckman, shows that early childhood development, from birth through age five, directly influences economic, health, and social outcomes for individuals and society (Heckman, 2006). Investing in early childhood development for at-risk children is an effective strategy for reducing social costs, strengthening the economy, driving success in life (fostering cognitive skills), enhancing returns in education, health and productivity, and a cost-effective strategy for promoting economic growth. For instance, using more than 35 years of data on the famous Perry Preschool program, Heckman has shown that quality early childhood education programs for disadvantaged children can dramatically improve outcomes in education, employment, and health (Heckman, 2012). Adverse early environments, however, lead to deficits in skills and abilities - attributes of human capital that can hinder success in life, lower productivity, and increase social costs (G. Araneta et al., 2003). Heckman's groundbreaking work provided an eye-opening understanding as well as the need to invest in early childhood development and underlines the importance of minimizing the vulnerability of children at risk when they face adverse shocks.

From the psychology literature, Piaget's theory is a good baseline to understand the relationship between early childhood exposure and child cognitive development (Piaget, 1952). Piaget determined that children's cognitive

development is important for their understanding of and learning about the world around them. According to Piaget (1952), factors that affect cognitive development include maturation, experience, and social transmission.

In this paper, we consider children's exposure to violent conflicts as our key indicator of adverse early childhood exposure, while we have proxied human capital formation in two ways: nutritional outcomes for children under five and children's schooling. Our brief review, therefore, focuses on these key variables.

The past deadly and frequent violent conflicts in SSA have underlined the importance of human capital development, particularly that of children (Kadir et al., 2019). A synthesis of macro- and micro-level studies on Africa indicates a negative association between violent conflict and children's nutritional outcomes, particularly stunting, underweight, and wasting (Azanaw et al., 2023). For instance, Akresh et al. (2012) examined the impact of the Ethiopian-Eritrean war on the height of young children in Eritrea and found that those exposed to the conflict were, on average, 0.42 standard deviations shorter than the reference population. (Bundervoet et al., 2009) document a similar effect of the Burundian war. Other studies focus on the macroeconomic effects of conflict. For example, Diop et al. (2024) examine the macroeconomic impact of recent political conflicts in Africa and find that political crises have a significant and negative association with economic growth. Novta and Pugacheva (2021) estimated the costs of conflict and showed that the macroeconomic costs of conflict are huge: lower GDP per capita (about 28 percent lower ten years after conflict onset), significant declines in private consumption, dramatic declines in official trade, and induced significant refugee outflows to neighboring underdeveloped countries in the short run. However, a systematic review suggests that existing macro-level evidence is often mixed and inconclusive compared to the micro-level see, for instance, Martin-Shields and Stojetz (2019) for a review of existing evidence. The studies that find a negative effect of conflict on the schooling outcomes of children include Leo´n (2012) in Peru and Akresh et al. (2012) in Rwanda. In contrast, Valente (2014), using data from Nepal, finds conflict intensity is positively associated with school attainment, especially for females.

Violent conflict has direct and indirect effects on the development of human capital in children (Woods et al., 2012). It creates deficits in skills and abilities that drive down productivity and increase social costs — thereby adding to financial deficits borne by the public (Terziæ et al., 2001). The consequences of violent conflict on children's human capital are dire. Conflict deters households'

economic benefits of investing in early childhood development and building skill upon skill to provide greater success to more children and greater productivity, and reduce social spending for society.

Besides its direct effects, violent conflict can worsen children's human capital. This is partly due to the spread of infectious diseases (Charchuk et al., 2016). In utero exposure to conflict is associated with lower infant weight, likely driven by maternal stress and poor nutrition (Dagnelie et al., 2018). Conflict also leads to the destruction of health and school infrastructure and the migration of health workers and teachers from affected areas (Chi et al., 2015; Chukwuma and Ekhator-Mobayode, 2019). Furthermore, the demolition of sanitation, waste, and water treatment facilities (Kirschner and Finaret, 2021) and reduced food supply (Lin, 2022) are expected to contribute to issues such as weight loss and stunting in children (Bendavid et al., 2021).

It should also be noted that the impact of conflict on human capital formation such as the nutritional status of a child depends on the nature of the conflict, its duration and/or intensity, how it affects livelihoods, and the coping strategies adopted by the households or communities (FAO, 2016; Azanaw et al., 2023). It may take several months or years to observe a conflict's full impact on a child's human capital (Kinyoki et al., 2017; WHO, 1995). For instance, past studies in SSA show that compared to the pre-conflict periods, recent conflict is associated with high rates of undernutrition and under-5 mortality, and an increased risk of low birth weight (Guha-Sapir and van Panhuis, 2004; O'hare and Southall, 2007). These studies imply that different types and forms of conflict have heterogeneous effects on children's human capital formation across space and time (e.g., recent and long-term conflict). Thus, it is important to take into account the nature and forms of conflict across space and time in the analysis of the effects of conflict on individual- and household-level outcomes. It is also important to note that the effects of conflict have been compounded by other factors, such as concurrent drought and other long-term environmental determinants that predispose children to the deterioration of the different dimensions of human capital.

War creates trauma, and the trauma children experience during their early life determines the quality of their human capital, vital for future earnings (Woods et al., 2012; Ramirez and Haas, 2021). The trauma children experience during conflict can be enduring and can, in turn, negatively affect infant weight and social and emotional skills, other indicators of a child's human capital. For instance, several empirical studies find that in-utero exposure to conflict is associated with low

infant weight, and this effect is likely caused by maternal stress and poor nutrition (Quintana-Domeque and Ro´denas-Serrano, 2017). For this reason, it is important to understand both the effects and mechanisms through which the effects materialize. A recent study across 52 African countries shows that the impact of terrorism on child mortality primarily emerges through behavioral responses. For example, households may react with intimidation, fear, or even sexual violence. Additionally, policymakers adjust public spending on children's healthcare, schools, and social protection measures. These behavioral and policy responses have a greater impact than the direct destruction of health and school infrastructure (Cevik and Ricco, 2020; Meierrieks et al., 2022). This pattern is especially pronounced in Africa.

Conflict affects people's health and well-being by disrupting food production, increasing food insecurity, causing population movement and the establishment of internally displaced person camps (IDP) (Salama et al., 2004; Egal, 2006). Infectious illnesses would be worsened by the destruction of health infrastructure and the condition in IDP camps (Manoncourt et al., 1992; Kandala et al., 2009). Additionally, both hardship and hunger have direct and indirect effects on health, affecting people's ability to produce food. The overall effect would be deterioration or poor capital formation, especially among children and pregnant women (UNICEF, 2016). As a result, conflicts have complex economic and social consequences (Artuc et al., 2022).

Conflict affects schooling outcomes both directly and indirectly by affecting nutrition outcomes, thereby decreasing lifetime income. For instance, Martorell (1999) shows that poor nutrition during the early years of life is correlated with delayed motor development and poor cognitive and social skills. Deadly conflicts have left many children academically behind where they would typically be (Poirier, 2012). War/violent conflict also causes children to suffer from the social and emotional consequences as a result of their lives being threatened. In contrast, others have seen their physical health deteriorate during the war because of the direct physical damage caused by the conflict or because of a lack of opportunities to access healthcare and physical activities (Reese Masterson et al., 2014). Failure to develop these skills and abilities as quickly as usual can have lifelong consequences. Many studies show that cognitive development in early childhood is important for adult outcomes such as earnings (Heckman et al., 2010a). Also, more empirical evidence suggests the importance of emotional development (e.g., self-control and emotional regulation) and social skills in

determining adult outcomes such as employment and earnings (Daniel et al., 2020). In addition, limited social and emotional skills are strong predictors of poor adult mental health and physical health (Attanasio et al., 2020).

In line with our discussion, we aim to test the following hypotheses:

Hypothesis 1: Exposure to early childhood conflicts reduces the formation of human capital in children.

Hypothesis 2: The intensity and duration (i.e., short-term versus long-term exposure) of early childhood conflict are significantly associated with variations in children's human capital formation. Specifically, higher intensity and prolonged conflict exposure will result in poorer short-term and long-term human capital outcomes.

Hypothesis 3: The impact of early childhood conflict exposure on human capital formation is moderated by age group and place of residence, as well as availability of healthcare facilities. Children in rural areas and those in younger age groups will experience more adverse effects compared to urban children and older age groups. The availability of healthcare facilities reduces these adverse effects.

3. Background

Recent studies indicate that in 2018, approximately 41.3 million people were internally displaced due to violent conflicts, with 29.4 million being refugees. Additionally, around 600 million young people reside in conflict-affected areas (Vos et al., 2020). Although the conflicts in the four countries share many similarities, there are also distinct differences, and each has encountered distinctive yet sequential trajectories concerning conflicts. For example, differences in conflict intensity, spatial and temporal distribution, duration, and their impact on economic impact exist. Below, we provide a brief description of the nature of conflicts in each of the four countries we are focusing on.

Ethiopia: Ethiopia, the second most populous country in Africa after Nigeria, has a diverse ethnic composition and a complex history. Internal tensions and ethnopolitical dynamics have periodically escalated into conflicts, resulting in both localized disputes and broader confrontations. Since 2000, Ethiopia has experienced several deadly conflicts resulting in loss of life. In 2018, Ethiopia had the highest number of new IDPs associated with conflict (about 2.9 million IDPs according to the 2018 Global Report on Internal Displacement). These conflicts have been both internal and external. The deadliest conflict with the external is

the Ethio-Eritrean conflict, which ended in 2000. The country has also faced internal conflicts and insurgencies in various regions (Oromia, Amhara, Somali, Tigray, SNNP), driven by ethnic, political, economic, and social grievances. These conflicts have resulted in widespread displacement, humanitarian crises, and violations of human rights. As such, these conflicts have had significant humanitarian, socio-economic, and political implications, resulting in detrimental effects on the country's stability and development efforts. Of particular concern is the impact on human capital formation, especially regarding the education and well-being of children. For example, some studies document the negative effect of conflict on food security (Muriuki et al., 2023), the Ethio-Eritrean war on childhood health (Weldeegzie, 2017).

Nigeria: Nigeria, with a population of more than 220 million, is the most populous country in Africa and has the largest economy measured by GDP. Since gaining its independence, ethnicity and religion have been factors in conflicts throughout Nigeria's history. During the study period, between 2000 and 2018, Nigeria experienced a sharp increase in conflict, and violence in different regions has taken various forms. The North East region of the country has been particularly affected by the Boko Haram insurgency and experienced high levels of religious and ethnoreligious violence. Northcentral and south (in the Niger Delta area) are other regions that have been most affected by conflict and have seen an increase in conflict levels since 2010 and nearly 2.1 million people fled their homes during the height of the conflict (Kaila and Azad, 2023). Several interrelated factors have contributed, conflict over resources such as land and water access (between agricultural households and pastoralists in the North Central region) and the oil industry (in the Niger Delta area), the Boko Haram insurgency (in the northeast), the growth of human settlements in the north and droughts (the degradation of pastures in the north) and demand for a more equitable redistribution such as oil resources.

Rwanda: Rwanda has faced relatively fewer instances of conflict during our study period (2002-2015), although inter-ethnic tensions that resulted in brutal ethnic conflict between the

The Hutu majority and Tutsi minority have marked their history that may have long-term impacts (Serneels and Verpoorten, 2015). For example, Serneels and Verpoorten (2015) find that households and localities that experienced more intense conflict in the early 1990s lagged in terms of consumption six years after

the conflict. Such effects have long-term consequences, such as on cognitive development or labor market outcomes.

Uganda: Conflict in Uganda mainly predates the emergence of the Lord's Resistance Army (LRA) in 1986. However, the rise of the LRA from the remnants of Alice Lakwena's short-lived rebellion-initiated a near-continuous cycle of violence in the region. In terms of spatial distribution, most of the conflicts are concentrated in Northern Uganda. For instance, in 2004, 25 percent of Northern communities suffered attacks by the LRA (Rockmore, 2016). Several studies documented the economic impacts of these conflicts on post-conflict outcomes such as education (Blattman and Annan, 2010; Rockmore, 2016), consumption (Adong et al., 2021). In Uganda, conflict often involved the permanent abduction of youths into the LRA, while others were temporarily used as porters or guides. Prolonged violence also resulted in several types of migration, of which children and women are the main ones. Since 2002, the government relocated a large number of individuals, primarily from conflict areas to IDP camps.

All these conflicts impede the human capital formation of children, negatively impacting their nutritional, physical, and cognitive development as a result of large-scale physical destruction (Akbulut-Yuksel, 2014) as well as psychological trauma.

4. Data and Methods

Data sources

The study area covers four purposefully selected sub-Saharan African countries, namely Ethiopia, Nigeria, Rwanda, and Uganda, where conflicts have become periodic and devastating (Figure 1). The following criteria were used to select the four countries: i) conflict hotspots (both intensity, frequency, and nature) and dynamics of a high level of undernutrition such as stunting; ii) geographical dispersion between West (Nigeria) and East Africa (Ethiopia, Rwanda, and Uganda) that enable spatial comparison given the degree and frequency of conflicts; iii) SDG score, specifically SDG3 (health and wellbeing) and SDG4 (education), among others.[2]

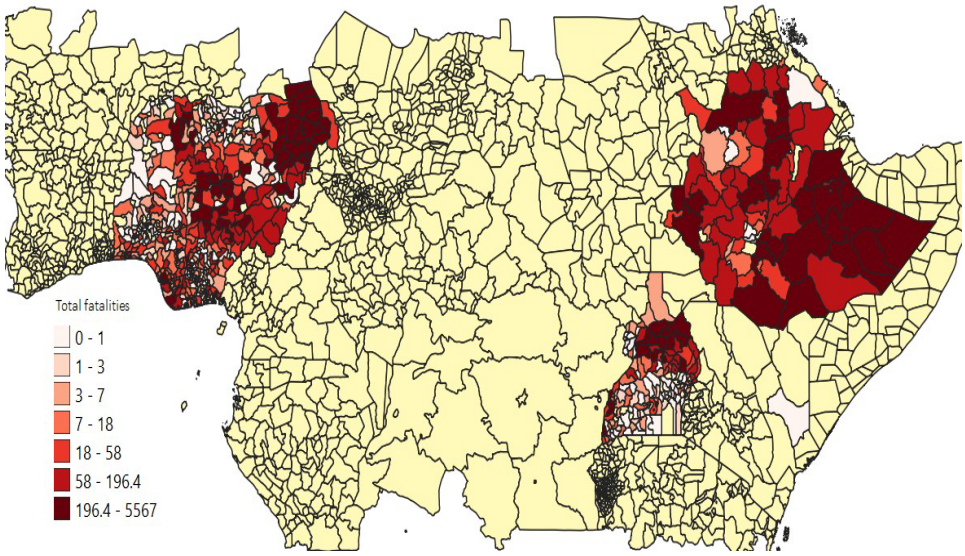
In our setting, conflict refers to all forms of organized violence that are assumed to be harmful to a child's human capital development. However, non-violent activities such as peaceful protests, demonstrations, and strikes are excluded from this definition as they are less likely to have an impact on our outcome measures. A child's human capital is a set of skills and abilities that help them succeed in life (Heckman et al., 2010b). Although the measurement of children's human capital is not straightforward, we use two broad categories of children's human capital indicators: cognition indicators (a child's educational outcomes for those under 18 years of age), and health and nutrition outcomes (such as stunting and underweight for under 5 years of children).

The data set for the study comes from different sources: Demographic and Health Surveys (DHS), a nationally representative longitudinal household survey, and the Uppsala Conflict Data Program (UCDP).[3] The conflict data set is georeferenced and can be disaggregated at the lower administrative unit of the study countries, enabling the merging process with the geocoded DHS data. Since the UCDP data set and the DHS survey collected GPS coordinates of enumeration areas, we use this geospatial information to extract and merge geocoded conflict data from UCDP by enumeration area in the DHS survey. The GPS coordinates in the DHS data and the UCDP conflict enable the matching process.

[2] During the biannual conference in Nairobi, 24-25 November 2022, our resource person suggested that we focus on selected countries.

[3] We also used the Armed Conflict Location and Event Data Project (ACLED) as a robustness check.

Figure 1: Conflict distribution in 2000-2018



The DHS data helps us to identify highly spatially disaggregated health outcomes, such as anemia, diarrhea, fever, and dimensions of anthropometrics (height-for-age, weight-for-age, and height-for-weight) as well as educational outcomes. Thus, we will use and estimate the number of different dependent variables broadly classified as indicators of human capital formation of children of different types across space and time. We used DHS surveys conducted after 2003 and for conflict since 2000 (three years before the DHS surveys). See Table A1 for a summary of the specific years of the DHS survey and conflict data used in the four countries. The UCDP data set is up-to-date and publicly available. It contains the geo-coordinates of the incidences, types, and duration of the conflict, number of events, and fatalities, among others, over time (dates, months, and years).

Key variables

In the section below, we briefly describe the construction of two key variables used in this analysis: conflict exposure and human capital formation of children.

Conflict exposure

We capture children's conflict exposure in three ways: the total number of fatalities within a 10 km or 20 km radius from a conflict-related fatality in the 12, 24, or 36 months prior to the

DHS survey periods, the number of conflict events within a 10 km or 20 km radius in the 12, 24, or 36 months before the DHS survey periods, and a binary variable indicating whether homes of children in the enumeration area were located within a 10 km or 20 km radius of conflict zones in the last 12, 24, or 36 months preceding the DHS survey periods. For example, a buffer is created for households (enumeration area) within a 20 km radius. The total number of deaths within this radius is then computed and matched with the average child's human capital indicators, such as child nutrition and education outcomes, at the enumeration level (see Figure 1, for instance). This shall form our definition of treatment: how many conflicts (intensity) have occurred within the stated scope of reference for the months specified? Thus, the spatial and temporal conflict measures we compute through these techniques can easily be combined with enumeration area-level human capital indicators as well as other key variables of interest. This linking procedure is an important innovation to ensure spatial overlap between our key variables of interest for an effect to be detected. The consideration of conflict events or deaths that occurred within the last 12 or 36 months before the DHS survey periods is motivated by the fact that conflict may take some time to significantly impact a child's human capital outcomes. Additionally, the use of different radii helps to capture and examine the heterogeneous consequences of early childhood conflict exposure across space. In our main analyses, we use the number of fatalities as a measure of the intensity of conflict events and report the results of the other two measures in Appendix A.

Human capital of children

The DHS records the height and weight of all children under the age of five who are listed on the household roster. The birth certificate or the mother's report of age was used to calculate the child's age. The nutritional status of children under the age of five is often computed using anthropometric measures. Using the revised WHO child growth criteria, sex-specific anthropometric indices of height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), and weight-for-height (WHZ) were generated for each child based on height and weight measurements

(Group, 2006). From this, we computed the prevalence rate (proportion) of under-five children stunting, wasting, and underweight at the enumeration area.

For a child to be considered stunted, underweight, or wasted based on z-scores, the child must be at least 2 standard deviations (SD) below the median WHO growth standards for children. Similarly, severely stunted, underweight, and wasted are defined as HAZ, WAZ, WAH <-3 SD, respectively. These indices were already present in the DHS dataset.

Stunting (a low HAZ) is a cumulative sign of sluggish physical growth and implies long-term malnutrition (Glewwe et al., 2001; Leroy and Frongillo, 2019). On the other hand, underweight (a low WAZ) is used to detect chronic and acute malnutrition (Gray et al.,
2006).

We also provided a set of other health outcome indicators, including fever and diarrhea prevalence outcome indicators, to assess a child's health and/or to assess the mechanisms through which conflict exposure affects these health outcomes. Data on the health of children under the age of five were obtained in the last two weeks preceding the survey.

Another child human capital indicator we use is child schooling, which we capture in four ways: (i) schooling completed by individuals aged between 6 and 18 years, (ii) whether a child dropped out of school compared to their previous schooling, (iii) whether or not a child ever attended school, and (iv) delayed primary school enrolment or completion, which is defined as the current child's age minus completed years of schooling minus the official primary school starting age(Alderman et al., 2001).[4]

Descriptive statistics

Table 1 introduces the descriptive statistics of the main variables used in our regression analysis for the pooled sample. The summary statistics of the variables by country are presented in Table A2, while a detailed description of the variables is presented in Table in the Appendix. The descriptive statistics suggest that the majority of households in our sample are male-headed. The average family size is 7, and the average child age is 28 months. About half of the sampled children were

[4] Official primary school starting age (the age at which students would enter primary education) varies between Ethiopia and other countries. For instance, in Ethiopia, the official primary school starting age is 7 years, while in Nigeria, Rwanda, and Uganda combined, it is 6 years (UNESCO, 2022). Here we also assume that there are no repeat grades and exclude children not enrolled in school.

female, and 13 percent of the children had experienced diarrhea in the previous two weeks before the survey.

Disaggregating child nutrition outcomes by country and survey year provides additional interesting insights. As can be seen in Figure 2, while the proportion of undernourished children decreased across the four countries between 2003 and 2018, the change in these outcomes varies across countries. For instance, although the prevalence of child undernutrition is high across the study countries, child stunting (an indicator of long-term malnutrition) is the highest in Rwanda compared to other countries (Figure 2). Additionally, change in chronic and acute malnutrition (underweight) and wasting during the period decreased in Ethiopia, Rwanda, and Uganda, while it had relatively increased in Nigeria between 2003 and 2013. Furthermore, child undernutrition is generally higher in Ethiopia and Rwanda than in Nigeria and Uganda.

Table 1: Summary statistics for nutrition sample

	Mean	SD	Min	Max	N
Stunting: Yes = 1	0.38	0.49	0.00	1.00	99,630
Underweight: Yes = 1	0.25	0.43	0.00	1.00	104,288
Wasted: Yes = 1	0.12	0.32	0.00	1.00	99,236
Diarrhea: Yes = 1	0.13	0.34	0.00	1.00	104,985
Fever: Yes = 1	0.20	0.40	0.00	1.00	104,590
Cough: Yes = 1	0.18	0.38	0.00	1.00	104,545
Child age (months)	28.03	17.25	0.00	59.00	104,985
Child female: Yes = 1	0.49	0.50	0.00	1.00	104,985
Mother's age	29.47	6.84	15.00	49.00	104,985
Mother's years of education	4.23	4.88	0.00	22.00	104,945
Female-headed: Yes = 1	0.14	0.34	0.00	1.00	104,985
Household head age	39.83	11.93	15.00	97.00	104,835
Household size	6.72	3.21	2.00	43.00	104,985
Rural cluster: Yes = 1	0.73	0.44	0.00	1.00	104,985
Wealth index	2.80	1.42	1.00	5.00	104,985
Distance (km) to cities of 250k population	1.25	1.04	0.00	5.62	104,985

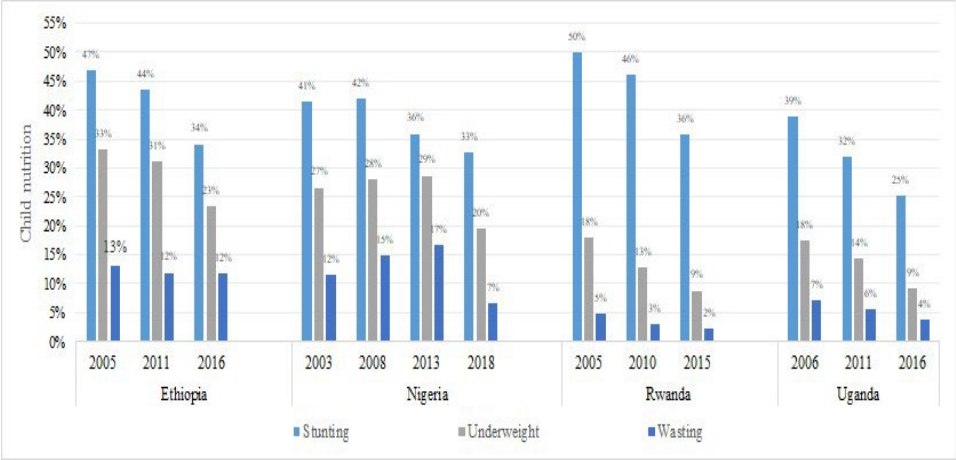
Standardized values of temp average	0.38	0.95	-2.82	1.75	104,985
Standardized values of rainfall	-0.11	1.04	-2.49	2.79	104,985
Within 10km buffer zone					
No. of conflict events (past year)	0.29	3.66	0.00	118.00	7,607
No. of conflict events (past two years)	0.49	5.65	0.00	193.00	7,607
No. of conflict events (past three years)	0.68	6.79	0.00	211.00	7,607
No. of fatalities (past year)	2.22	18.05	0.00	355.00	7,607
No. of fatalities (past two years)	3.81	28.09	0.00	1012.00	7,607
No. of fatalities (past three years)	6.42	59.76	0.00	1645.00	7,607
Within 20km buffer zone					
No. of conflict events (past year)	0.49	4.40	0.00	119.00	7,607
No. of conflict events (past two years)	0.87	6.69	0.00	194.00	7,607
No. of conflict events (past three years)	1.22	8.43	0.00	212.00	7,607
No. of fatalities (past year)	3.36	22.03	0.00	360.00	7,607
No. of fatalities (past two years)	6.28	35.54	0.00	1012.00	7,607
No. of fatalities (past three years)	10.36	75.38	0.00	2011.00	7,607

Table 2: Summary statistics education sample

	Mean	SD	Min	Max	N
Delayed years of grade	2.48	2.64	0.00	11.00	220,000
Delayed in grade: Yes = 1	0.41	0.49	0.00	1.00	360,000
Dropping out of school: Yes = 1	0.10	0.30	0.00	1.00	62,462
Age (in years)	11.26	3.72	6.00	18.00	360,000
Female: Yes = 1	0.50	0.50	0.00	1.00	360,000
HH head level of education	0.92	0.95	0.00	3.00	360,000
Female-headed HH: Yes = 1	0.22	0.41	0.00	1.00	360,000
Household head age	46.98	13.44	9.00	99.00	360,000
Household size	7.23	3.37	1.00	43.00	360,000
Rural cluster: Yes = 1	0.74	0.44	0.00	1.00	360,000
Distance (km) to cities of 250k population	1.30	1.05	0.00	5.62	360,000
Standardized values of rainfall	-0.05	0.97	-2.49	2.79	360,000

Within 10km buffer zone					
No. of conflicts (past year)	0.29	3.65	0.00	118.00	7,662
No. of conflict events (past two years)	0.49	5.63	0.00	193.00	7,662
No. of conflict events (past three years)	0.69	6.76	0.00	211.00	7,662
No. of fatalities (pastyear)	2.25	18.08	0.00	355.00	7,662
No. of fatalities (past two years)	3.85	28.09	0.00	1012.00	7,662
No. of fatalities (past three years)	6.45	59.59	0.00	1645.00	7,662
Within 20km buffer zone					
No. of conflicts (past year)	0.49	4.39	0.00	119.00	7,662
No. of conflict events (past two years)	0.87	6.67	0.00	194.00	7,662
No. of conflict events (past three years)	1.22	8.40	0.00	212.00	7,662
No. of fatalities (past year)	3.39	22.03	0.00	360.00	7,662
No. of fatalities (past two years)	6.37	35.87	0.00	1012.00	7,662
No. of fatalities (past three years)	10.44	75.38	0.00	2011.00	7,662

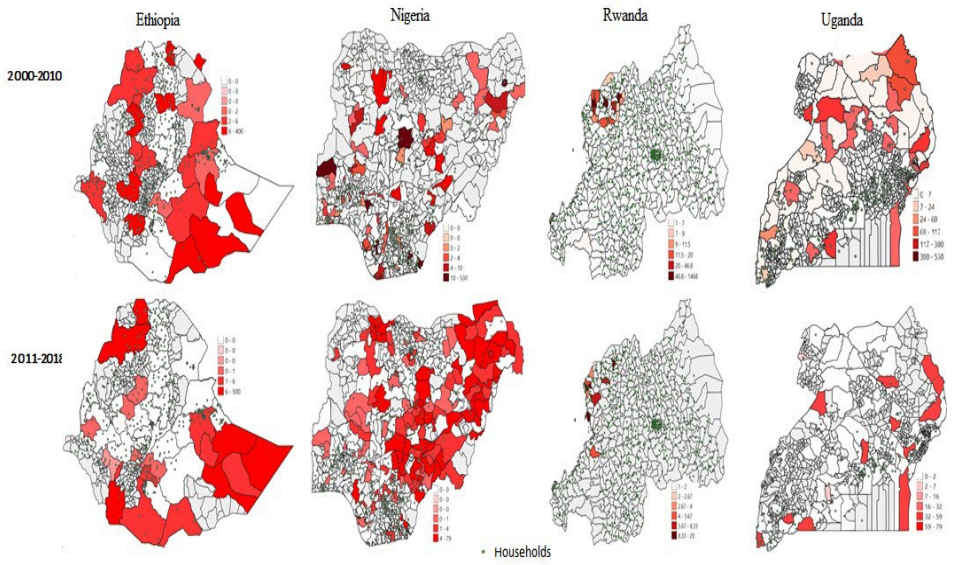
Figure 2: Child nutrition outcomes by country, over survey periods (2003-2018).



In terms of conflict exposure and considering households with children under 5 years old, we see that on average there are about 0.30 conflict events and 2.22 deaths within a 10 km radius of their residence in the past 12 months (representing about 11 percent of our sample) (Table 2). Expanding the conflict buffer zone to within 20 km raises the number of conflict events and deaths to 0.50 and 3.36, respectively. Moreover, both the intensity and prevalence of conflict show a

consistent increase across countries (Figure B2). Figure 3 further presents the intensity of conflict exposure (regardless of conflict type) in the four study countries using UCDP data from 2000 to 20218. As can be seen, we observe that children's intensity of conflict exposure varies significantly within and across the study countries, as well as over the study periods (Figure 3), with the highest conflict fatalities observed in Nigeria and Ethiopia. Our sample of households with children between the ages of 6 and 18 exhibits similar patterns and trends (Table 2). In terms of children's schooling outcomes, we find that the average years of delay in completing or enrolling in primary school for our sample is 2.48 years (about 41% of our sample experienced a delay in completing primary school). In addition, about 10 percent of our sample had dropped out of school compared to their previous schooling.

Figure 3: Conflict-related fatalities, 2000-2018



5. Estimation Strategy

As to our estimation strategy, we estimate the number of different dependent variables that can be broadly classified as indicators of children's human capital

formation computed at the individual level. The reduced main empirical model is presented as follows:

$$Y_{iject} = \beta_0 + \beta_1 ConflictIntensity_{ect-s} + \beta_3 X_{ijct} + \lambda_t + v_c + \epsilon_{iject} \quad (1)$$

where Y_{iject} denotes the respective outcome variables of interest for individual *i* (e,g., child undernutrition and education outcomes) living in household *j* (within 10km or 20km radius) in enumeration areas *e*, country *c*, and survey year *t*; $Conflictintensity_{ect-s}$ denotes conflict intensities reported in the UCDP dataset within either 10 or 20km radius (for enumeration area) in the last 12, 24 or 36 months preceding the DHS survey but excluding riots and protests. In other words, conflict in *t-s* refers to conflict exposure that occurred prior to one year, two years, and three years prior to each survey round. Not only the intensity but also the duration of exposure to conflict matters when it comes to long-term child outcomes such as stunting and schooling outcomes because prolonged exposure to conflict can have a cumulative and increasingly detrimental effect on children's nutritional and schooling outcomes. First, as discussed in Section 2 and Section 6.3, conflict in general, and protracted conflict in particular, often results in the destruction or damage of infrastructure and livelihoods on which households depend for their livelihoods. Second, the longer children are exposed to violent conflict, the more likely they are to suffer trauma and other psychological stress, including within their families, which in turn can affect children's nutrition and schooling outcomes. Third, protracted conflict can lead to displacement and migration, which can disrupt children's nutrition and education. Therefore, we also examine whether or not conflict in the last 2 or 3 years prior to the DHS survey has an impact. β_1 represents the impact of conflict exposure on human capital indicators; x_{ijct} is a vector of individual, household, and community level and environmental control variables for year *t*, including birth-year times birth-month fixed effects; λ_t captures survey effects; v_c and ϵ_{ijct} denote average individual's, household's (group level fixed effects) and country time-invariant fixed effects, and mean zero random error, respectively. A similar empirical strategy was used in (Brown et al., 2019) in analyzing the effects of community violence in Mexico on individual outcomes using repeated cross-sectional data. A similar research design is also used by Bertoni et al. (2019), who analyze the effects of Boko Haram on educational outcomes, where the authors used 20km as a radius of conflict exposure. Unlike others, we use a different radius.

Direct OLS, Probit estimation, or the two-way fixed effects estimates of Equation (1) can result in biased estimates since conflict exposure is purely endogenous to both observable and unobservable child/household characteristics (De Chaisemartin and d'Haultfoeuille, 2022). Endogeneity in our setting may arise from three sources: omitted variable bias, measurement error in conflict exposure, and reverse causation (conflict exposure may not only adversely affect the health of children, but children's health may also affect conflict). To tackle these potential endogeneity concerns, we control for an extensive set of variables, including spatial-level fixed effects, leaving minimal variation to be explained by additional confounders. Furthermore, we run various robustness checks to examine whether our results are robust to various definitions/measurements of conflict exposure across space (10 km radius vs 20 km radius) and time (in the past 2 or 3 years). Although our main measure of conflict exposure is conflict intensity, we also use the traditional definition of the conflict variable, which is a dummy indicating whether or not our focus areas have experienced conflict, as a further robustness check.[5]

Subgroup analysis

We run the same regression as in Equation 1 for two groups to analyze whether the effects on child nutrition outcomes vary across the two age groups among children under five years. In doing so, we divide our sample into two groups: younger children aged under 24 months and older children aged above 24 months.[6]

The impact of conflict exposure on children's human capital, such as nutritional outcomes, may vary according to their place of residence. To examine whether this is the case, children are classified according to whether they live in rural or

[5] We tried to instrument early childhood conflict exposure using protest but after conducting several IV tests, we have concluded that this instrument is not suitable for our purposes. Therefore, we thought of focusing on a more straightforward analysis and exploring alternative mechanisms as one of our RP also suggested. As such, our results do not have a causal interpretation but provide valuable insights into the relationship between child human capital formation and conflict and the pathways through which this relationship prevails.

[6] Children experience more rapid growth when they are younger, and this growth stabilizes after the age of two. Consequently, it may be statistically easier to detect changes in anthropometric measures for younger children. However, this age group may be less affected by alterations in their living environment. Children under two years of age are often breastfed, and those under six months are exclusively breastfed, which can provide some protection against fluctuations in the household's food availability. This suggests that various factors influence how conflict affects these distinct age groups.

urban clusters. Children in rural areas are disadvantaged compared to their urban peers in terms of access to health facilities, diverse and nutritious food, and other important resources for coping with the adverse effects of conflict. Equation 1 is run for each cluster to understand how the relationship between conflict and child nutrition outcomes varies by place of residence.

6. Econometric Results and Discussions

In Tables 3 - 5, Panels A, B, and C display the regression results for three different time lags (time horizons), that is, 12 months, 24 months, and 36 months prior to the DHS survey, respectively. For the sake of brevity, this section focuses on the estimation results of the effects of conflict-related fatalities on human capital indicators, namely, children's nutritional and schooling outcomes for the 20 km buffer zone. However, to assess the robustness of our results to the choice of a 20 km buffer zone, we present estimates from Equation 1 in section 6.6, where conflict intensity (measured by fatalities) is calculated over radii ranging from 10 to 100 km, increasing in 5 km increments. In addition, we report an alternative measure of conflict exposure using a 10 km buffer zone in detail in Tables A7 - A9 in Appendix A.

Effect of conflict exposure (fatalities) on nutrition outcomes

Table 3 shows the results of the effects of conflict exposure (of fatalities that captures intensity) on child health and nutrition outcomes for the two buffer zones using OLS estimation methods. Regardless of the time horizons considered before the survey period and buffer zones, our estimates consistently indicate that conflict-related fatalities increase the probability of poor child nutrition outcomes. For instance, we find that an additional conflict-related fatality within a 20 km radius leads to a 0.01, 0.07, 0.07 percentage point increase in the probability of a child being stunted, underweight, and wasted respectively, and these results are statistically significant at a 1 percent level (Columns 1–3, Panel A of Table 3).

Considering that 38 percent of children were stunted at the time of the survey, the related increases amount to a 3 percent (0.01/0.38*100) from the average. The corresponding increase amounts to a 58 percent (0.07/0.12*100) increase from the average for wasted. Interestingly, these estimates are robust to consideration of different time lags (time horizons) prior to the survey: 24 months and 36 months before the DHS survey (Panels B & C of Table 3). Additionally, we noted that some of these effects seem to concentrate at the lower end of the nutritional status

distribution (extremely stunted, underweight, and wasted) (results not reported here).

Moreover, the propensity to be stunted (long-term nutritional status) is not affected substantially compared to the other two indicators of nutritional status of under-five children, indicated by the weak statistically (in)significant coefficients (Column 1, Panels A, B, & C of Table 3). This is unsurprising because height is a stock variable, which does not fluctuate in response to sudden shocks. Instead, it changes gradually over time in response to persistent alterations in nutrition or prolonged illness. Compared to other studies from other countries, such as Cameroon, which find no significant effect, our estimates suggest a negative significant effect of conflict exposure on the long-term nutritional status of children under five.

To ensure the robustness of our findings, we reduced the exposure radius to a 10 km buffer zone, ran the same model, and presented the results in Tables A7, A8, and A9 in the Appendix. The results remain consistent regardless of the chosen buffer zone.

To better contextualize the effects, we also show the average effect, which we compute by multiplying the number of average fatalities and the estimated coefficients. We present the result for one lag (12 months prior to the survey). These exercises suggest that the average effects on short-term nutritional status are more substantial than on long-term nutritional status. Altogether, the results raise an important concern for the long-term human capital formation of children in conflict-affected areas, as children suffer from the causes of both short-term and long-term low cumulative nutritional status throughout their lives. Put differently, the immediate and/or later effects of household exposure to conflict can accumulate over time, further worsening nutritional outcomes that eventually deter the quality of human capital formation.

Finally, since the fatality numbers reported in UCDP are based on publicly accessible sources (reports from NGOs and UN, case studies, and other sources of information) and note all events are reported publicly due to a lack of available information in many conflict zones, it is quite likely that there are more fatalities than given in the best estimate media sources, hence the data are likely to provide low estimates - attenuation bias. Our anthropocentric indicators, specifically that of stunting, are also subjected to measurement errors due to misreporting of child age in surveys. Since both anthropometric indicators and conflict fatalities come

from different data sources, we do not expect these measurement errors to be correlated.[7]

Table 3: Impact of conflict exposure on child nutrition outcomes, using conflict intensity

	(1)	(2)	(3)
	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)
Panel A: Past one year			
Number of fatalities	0.0001*	0.0007***	0.0007***
	(0.000)	(0.000)	(0.000)
R-squared	0.100	0.090	0.050
F-statistics	224.84	148.57	97.61
Prob > F	0.000	0.000	0.000
Panel B: Past two years			
Number of fatalities	0.0000	0.0004***	0.0004***
	(0.000)	(0.000)	(0.000)
R-squared	0.100	0.090	0.050
F-statistics	225.07	147.57	97.44
Prob > F	0.000	0.000	0.000
Panel C: Past three years			
Number of fatalities	0.0000	0.0001**	0.0001**
	(0.000)	(0.000)	(0.000)
Observations	99334	103974	98946
Mean of dependent var	0.38	0.20	0.12
Number of clusters	7604	7604	7600
R-squared	0.100	0.090	0.050
F-statistics	225.130	145.716	97.186
Prob > F	0.000	0.000	0.000

[7] However, it could be likely that measurement error in controls and conflict outcomes may be correlated given that the data sources are the same DHS survey, and this can have implications for both the sign and magnitude of the bias.

Notes: Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities in the past one year prior to the DHS survey. Panels B and C indicate the number of fatalities within 20 km in the past 2 and 3 years before the DHS survey, respectively. Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Heterogeneity by age group

We also analyze whether the effects on child nutrition outcomes observed earlier vary across different age groups of under-five children. Estimation results are shown in Table 4. We observed three interesting results. First, we find that the two age groups are affected by conflict if the exposure is in the past 12 months (Panel A, Table 4). Second, the magnitude of the effects varies by age group. We find that the effects of conflict-related fatalities on the propensity to be stunted is higher and statistically significant in children aged under 24 months than in older children (Columns 1 & 4, Panel A of Table 4). For instance, additional fatality increases the propensity of being stunted for children below 24 months by 0.03 percentage points, and the effect is statistically significant at the 1 percent level. This is very alarming, as child growth at a younger age could have a rampant effect on child development over time. However, the probability of being underweight and wasted is higher among the older group than among the younger age group (columns 2-3, 5-6, Table 4). The age group 6 to 24 months is the critical age for child development, and, hence, more vulnerable to acute malnutrition. Third, immediate conflicts (conflicts that occurred 12 months before the survey) have a higher impact on the two age groups than conflicts that occurred before 24 or 36 months.

Heterogeneity by rural-urban cluster

We also analyze whether the effect of conflict-related fatalities on child nutrition outcomes varies by place of residence. Overall, we find that while the effect of conflict exposure on the long-term nutritional status of under-five children (stunting) is substantially higher among rural clusters than in urban clusters, the effect on wasting (short-term nutrition status indicator) is higher for urban clusters than rural clusters (Table 5). For instance, the propensity to be stunted for rural clusters increases by 0.07 percentage points (Column 1, Panel A of Table 4: Impact of conflict exposure on child nutrition outcomes by age group zone.

Table 4: Impact of conflict exposure on child nutrition outcomes by age group zone

	Under 24 months			Older than 24 months		
	(1)	(2)	(3)	(4)	(5)	(6)
	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)
Panel A: Past one year						
Number of fatalities	0.0003***	0.0006***	0.0004***	0.0002*	0.0009***	0.0009***
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
R-squared	0.060	0.070	0.040	0.110	0.100	0.040
F-statistics	70.24	79.94	48.37	128.19	91.09	28.13
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Past two years						
Number of fatalities	0.0000	0.0001	0.0001	0.0004	0.0008	0.001
	(0.000)	(0.000)	(0.000)	(0.0004)	(0.0006)	(0.001)
R-squared	0.060	0.070	0.040	0.110	0.100	0.040
F-statistics	70.14	79.84	48.25	128.18	90.69	27.96
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Panel C: Past three years						
Number of fatalities	0.0002	0.0002	-0.0002	0.0003	0.0006	0.0007
	(0.0002)	(0.0003)	(0.002)	(0.0002)	(0.0004)	(0.0005)
Observations	43816	46540	43516	36418	37506	36334
mean of dependent var	0.300	0.200	0.200	0.400	0.300	0.100
Number of clusters	7377	7389	7363	7161	7163	7152
R-squared	0.060	0.070	0.040	0.110	0.100	0.040
F-statistics	70.14	79.83	48.22	128.23	90.67	27.90
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities in the past one year prior to the DHS survey. Panel B and C indicate number of fatalities within 20 km in the past 2 and 3 years before the DHS survey, respectively. Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Table 5), while that of urban clusters increases by 0.01 percentage points only (Column 4, Panel A of Table 5), and the effects are statistically significant at 5 and 10 percent, respectively. Nonetheless, the likelihood of being wasted increases by

0.01 percentage points for rural clusters (Column 3, Panel A of Table 5), whereas for urban clusters, it increases by 0.08 percentage points (Column 6, Panel B of Table 5). Importantly, this effect is statistically significant only for urban clusters. These findings suggest that conflict exposure has a disproportionately negative impact on rural children, which, in turn, leads to a widening gap in human capital development between rural and urban clusters. This situation may exacerbate the inequalities between rural and urban areas, ultimately resulting in long-lasting consequences for the well-being and future opportunities of these affected children. The results also suggest that in urban areas markets and better health infrastructure or economic conditions might help to address the short-term shocks resulting from conflict.

Table 5: Impact of conflict exposure on child nutrition outcomes by rural-urban

	Rural			Urban		
	(1)	(2)	(3)	(4)	(5)	(6)
	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)
Panel A: Past one year						
Number of fatalities	0.0007**	0.0006***	0.0006***	0.0000	0.0008***	0.0007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.060	0.080	0.040	0.080	0.090	0.050
F-statistics	101.84	117.50	54.73	42.02	26.40	18.97
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Past two years						
Number of fatalities	0.0001	0.0003	0.0004**	0.0000	0.0005***	0.0004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.060	0.080	0.040	0.080	0.090	0.050
F-statistics	101.82	117.21	54.45	41.89	26.88	18.83
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Panel C: Past three years						
Number of fatalities	0.0001	0.0001	0.0002**	0.0000	0.0001**	0.0001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	72574	76194	72490	26760	27780	26456

Mean of dependent var	0.400	0.300	0.100	0.300	0.200	0.100
Number of clusters	5218	5217	5216	2386	2387	2384
R-squared	0.060	0.080	0.040	0.080	0.080	0.040
F-statistics	101.80	117.01	54.11	41.91	26.92	18.30
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

Notes*:* Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities in the past one year prior to the DHS survey. Panels B and C indicate the number of fatalities within 20 km in the past 2 and 3 years before the DHS survey, respectively. Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Effect on schooling

Table 6 presents the effects of conflict exposure on children's educational outcomes, specifically using delayed grade completion (in years) and whether a child dropped out of school compared to their previous schooling. If there was an increase in rates of school dropout compared to their previous schooling, we could hypothesize that conflict exposure during schooling age led to pulling children entirely out of school during the school year. As expected, we find that conflict exposure increases the propensity to drop out of school (Column 2, Table 6). More worrisome is that conflict exposure (measured using either intensities or conflict events) increases the propensity of delay in grade completion (Columns 1 & 3, Table 6). For instance, considering that 41 percent of children experienced a delay in their current grade given their age at the time of the survey, an additional 10 conflict fatalities within a 10 km radius increase the propensity of delay in current grade completion by about 7.3 percent (0.03/.41*100) from the average grade attained given age (Column 1, Table 6). Using conflict events, the propensity of delay in the current grade given age increases to 22 percent (0.09/.41*100) for an additional conflict event on average (Column 3, Table 6). When analyzed by country, Nigeria appears to show the greatest impact compared to the other three (results not reported here).

Conflict can affect children's educational outcomes in several ways. It disrupts regular schooling due to the displacement of children and their families, exposes children to trauma and psychological distress, creates economic hardships that hinder families from affording school expenses, increases the recruitment of child soldiers, and damages educational infrastructure. These effects lead to reduced

school attendance, increased dropout rates, delays in school enrollment or completion, heightened gender disparities, and a decline in educational quality. Furthermore, the long-term consequences of conflict-induced educational disruption can affect children's future employability, cognitive development, and overall well-being. Both intensity and duration of exposure to conflict play a critical role, as prolonged exposure can have a cumulative and increasingly detrimental effect on children's access to and success in education.

As discussed in Sections 2 and 5 and further elaborated in Section 6.3, conflict—particularly prolonged conflict—has severe consequences for children's education. First, it often leads to the destruction or damage of educational infrastructures, making regular schooling attendance challenging. Second, extended exposure to violent conflict increases the likelihood of trauma and psychological distress among children and their families, which can impair concentration and academic performance. Third, prolonged conflict frequently results in the loss of livelihoods, compelling children to drop out of school to work and alleviate the financial burden on their families. Fourth, displacement and forced migration disrupt children's education, as they are often required to move from one location to another. Finally, prolonged conflict can lead to a shortage of qualified teachers, further compromising the quality of education.

Generally, the longer children are exposed to conflict, the more profound and lasting its impact on their educational outcomes, ultimately affecting their future opportunities and broader societal development. To fully capture these effects, it is crucial to analyze the impact over the last 24 to 36 months preceding the DHS survey. This study specifically examines children aged 6 to 18 years, who are expected to be enrolled in school, to assess the extent of conflict-induced educational disruptions. A recent estimate suggests that at least two-thirds of the world's youth do not reach basic skill levels, ranging from 24% in North America to 89% in South Asia and 94% in sub-Saharan Africa (Gust et al., 2024). This raises serious concerns for the human capital formation of Africa, essential for economic development.

Underlying mechanisms

Addressing the negative effects of conflict exposure requires understanding the specific mechanisms through which conflict impacts children's human capital formation. This knowledge is essential for designing effective policies to protect children from the negative effects of conflict. In this section, we attempted to explore some of the potential pathways.

Although there are potentially various channels through which conflict exposure affects children's human capital formation (Kadir et al., 2019; Kaila and Azad, 2023; Minoiu and Shemyakina, 2014), we explore two main ones to better understand what drives the results: socioeconomic and psychological or behavioral channels. In doing so, we supplement our analysis with previous studies on the focus countries. The mechanism analysis focuses on Ethiopia rather than the entire sample due to data limitations.

The first socioeconomic channel is related to the direct effect of conflict on access to health facilities, encompassing both disruptions in accessing medical care and the distraction of available health facilities due to conflict. To see if this holds, we analyze the effect of conflict exposure (both at intensive and extensive margins) on mothers' and children's access to health services (healthcare utilization) along different radii: treatment for diarrhea, antenatal visits for pregnancy, vaccination, and treatment of fevers or cough. We present these results in Table 7. Here, we run a regression for these outcomes on the number of health facilities, conflict exposure, and their interaction at different radii.

Table 6: Impact of conflict exposure on education outcomes

	(1)	(2)	(3)	(4)
	Delayed in grade: (Yes=1)	Dropping Out of school: (Yes=1)	Delayed in grade: (Yes=1)	Dropping out of school: (Yes=1)
Number of fatalities: Past two years	0.0003***	0.0001*		
	(0.000)	(0.000)		
Number of fatalities: Past three years	0.0001***	0.0001*		
	(0.000)	(0.000)		
Number of conflict events: Past two years			0.0009***	0.0003
			(0.000)	(0.001)
Number of conflict events: Past three years			0.0008***	0.0008
			(0.000)	(0.001)
Observations	359820	62389	359820	62389
Mean of dependent var	0.400	0.100	0.400	0.100
Number of clusters	7662	2491	7662	2491
R-squared	0.240	0.100	0.240	0.100
F-statistics	3264.50	139.85	3270.53	139.05

Prob > F	0.000	0.000	0.000	0.000

Notes*:* Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities in the past one year prior to the DHS survey. Panels B and C indicate the number of fatalities within 20 km in the past 2 and 3 years before the DHS survey, respectively. Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Panel A presents the results for a 20 km radius, while Panel B presents the results for a 20 km radius when conflict exposure is in the past two years. Panel C extends the radius for both healthcare facilities and conflict exposure to a 50 km radius. We conducted the latter to understand how exposure to conflict affects access to healthcare services in remote areas.

Although it can be expected that the availability of healthcare facilities would increase access to healthcare services, it is evident that conflict hinders this access. The selection of these radii is based on previous studies of access to health services in SSA. These studies suggest that about 43.3 of the global population cannot reach healthcare facilities on foot within one hour (Weiss et al., 2020).

The analysis reveals that antenatal pregnancy visits are reduced for mothers residing in areas experiencing high levels of conflict. The findings indicate that as the intensity of conflict increases, evidenced by the number of fatalities, the frequency of antenatal care attendants declines (Column 2, Table 7). In other words, women who live in areas with extremely high levels of prolonged conflict (in this case 20 km) exhibit a lower frequency of healthcare visits compared to those who live in areas with low levels of conflict or no conflict. For example, we find that each additional contemporaneous fatality results in a 1-percentage-point decrease in the frequency of antenatal visits during pregnancy. This effect becomes more pronounced when considering exposure over the past two years (Column 2, Table 7). The effects are statistically significant at a 1 percent significance level.

We observe a similar impact of conflict exposure on the likelihood of receiving vaccinations and medical treatment for cough or fever (Columns 3 & 4, Table 7). Furthermore, our findings indicate that while the availability of healthcare facilities improves access to medical services for both mothers and children, whether near (up to 20 km radius) or farther away (up to 50 km radius), conflict significantly disrupts or limits their utilization. Even when healthcare facilities are present (see the effect of health facilities and the interaction with conflict in Table

7, ongoing violence further restricts households' ability to seek essential medical care for mothers (during pregnancy) and children. It could also be because violent conflicts frequently result in the destruction or impairment of healthcare infrastructure, leaving communities without access to adequate medical services. Prolonged conflict often displaces people into overcrowded refugee camps with poor sanitation and healthcare, increasing the risk of disease outbreaks. However, these conditions may also prompt governments and NGOs to allocate more resources for health interventions. The positive effect of the interaction term on the likelihood of a child ever being vaccinated supports this argument (Column 3, Table 7). Previous studies have also shown that conflicts led to a reduction in healthcare utilization, which prolonged and aggravated fever and diarrhea in Cameroon (Kaila et al., 2021), and antenatal care visits in the Democratic Republic of the Congo (Weiss et al., 2020).

The other potential socioeconomic mechanism that could explain poor nutrition and education outcomes is disruptions in supply chains (business) that are important to the flow of commodities. Conflict disrupts agricultural production, market access (Zetter et al., 2013), investment decisions and employment opportunities (Gonza´lez and Lopez, 2007), and food aid distribution, leading to food shortages and rising food prices. This is particularly the case in Nigeria (Gray et al., 2006; George et al., 2021; Odozi and Uwaifo Oyelere, 2021), Ethiopia (Sakketa et al., 2023), and Uganda (Rockmore, 2016; Adong et al., 2021), as documented in previous studies. As a result, families can struggle to afford or access nutritious food, leading to malnutrition. Specifically, the disproportionate effect of conflict exposure between rural and urban groups points to the importance of market access. Households in urban areas mainly depend on market purchases, and conflicts hinder market access and increase the price of important commodities. As a result, households in urban areas become food insecure and likely reduce their consumption during these periods. In this regard, we examine the effect of the intensity of conflict on the prices of staple crops such as cereals. As shown in Table 8, frequent conflict exposure is positively correlated with average cereal prices. For example, the occurrence of one additional conflict event within a 10-kilometer radius is associated with a 19.3 percent increase in the price of cereals.[8]

[8] Although both conflict intensities and events have similar effects on prices, we prefer to use the number of conflicts as a measure of conflict exposure. This is because the number of conflict events better captures disruptions in agricultural supply than fatalities.

The impact of conflict exposure on prices suggests that such disruptions not only drive price increases but also influence mothers' dietary consumption, our indicator of psychological or behavioural channels. If this holds true, we would expect conflict-induced price increases to affect the variety of foods consumed. To examine this, we compare maternal dietary diversity scores between conflict-affected and non-conflict areas. Our findings indicate dietary diversity is relatively lower among mothers in conflict-affected areas compared to those in non-conflict-affected areas (see Figure 4). Conflict-induced disruption in food systems can restrict access to diverse foods and reduce economic opportunities, making it significantly harder for mothers to maintain a varied and nutritious diet. This decline in dietary diversity increases the risk of malnutrition and other health issues for both mothers and their children and may contribute to higher school dropout rates. In contrast, non-conflict areas, where conditions are stable, offer better access to diverse foods, leading to improved dietary outcomes for mothers.

Table 7: Impact of conflict exposure on utilization of healthcare services

	(1)	(2)	(3)	(4)
	Diarrhea:medical treatment	Antenatal visits for pregnancy	Evermad vaccination	Fever/cough: medical treatment
Panel A: 20km radius				
Health facilities (counts)	0.00014	0.0047***	0.0004***	0.0005***
	(0.0002)	(0.0008)	(0.0001)	(0.0001)
Number of fatalities (past 1 year)	-0.00014	-0.0082***	-0.0015***	-0.00006
	(0.0004)	(0.0021)	(0.0004)	(0.0004)
Health facilities X number of fatalities	0.0000	-0.0000	0.000***	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	9767	51863	49924	17593
Number of clusters	3150	4589	3855	3929
Panel B: Health facilities with 20km & conflict within past 2 years				
Health facilities (counts): 20km radius	0.0001	0.0046***	0.0005***	0.00046***
	(0.0002)	(0.0009)	(0.0001)	(0.0001)
Number of fatalities (past 2 years): 20km radius	-0.0012	-0.0084*	-0.0014***	-0.0017**
	(0.0008)	(0.0046)	(0.0005)	(0.0008)
Health facilities X Number of fatalities	0.0000	-0.0003***	0.0000	0.0000**
	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Observations	9767	51863	49924	17593
Number of clusters	3150	4589	3855	3929
Panel C: Health facilities with 50km & conflict event within 50km				
Health facilities (counts): 50km radius	0.0003***	0.0044***	0.0001	0.00036***
	(0.0001)	(0.0007)	(0.0001)	(0.0001)
Conflict (Yes=1)	0.0415	-0.0762	-0.0731**	0.0348
	(0.0311)	(0.2081)	(0.0314)	(0.0215)
Health facilities X Conflict	-0.0004***	-0.0009	0.0002***	-0.00034***
	(0.0001)	(0.0008)	(0.0001)	(0.0001)
Observations	9767	51863	49924	17593
Mean of dependent var	0.411	4.072	0.690	0.445
Number of clusters	3150	4589	3855	3929

Notes: Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities within 20 km radius. Panel B indicates fatalities within the past 2 years, while Panel C indicates conflict fatalities within 50 km radius, respectively.

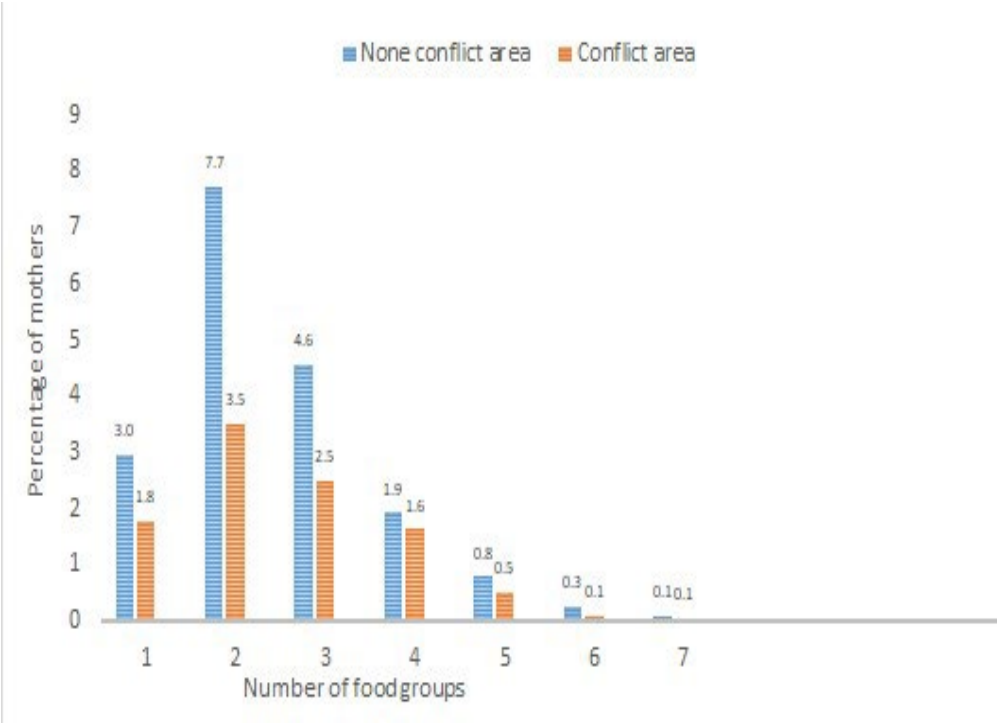
Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Table 8: Effect of conflict on staple food prices for the Ethiopia sample, using conflict events

	(1)	(2)
	Log(cereal price)	Log(cereal price)
Number of conflicts: 10km radius	0.1930***	
	(0.0257)	
Number of conflicts: 20km radius		0.1051***
		(0.0136)
DHS survey year 2011	0.0925	0.0851
	(0.0761)	(0.076)
DHS survey year 2016	0.6838***	0.6265***
	(0.0674)	(0.0678)
Observations	2124	2124
R-squared	0.0817	0.0830

Notes: Robust standard errors clustered at the enumeration area level are reported in parentheses. Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Figure 4: Mothers' dietary diversity score (in the past 7 days) by conflict status, within 20km radius



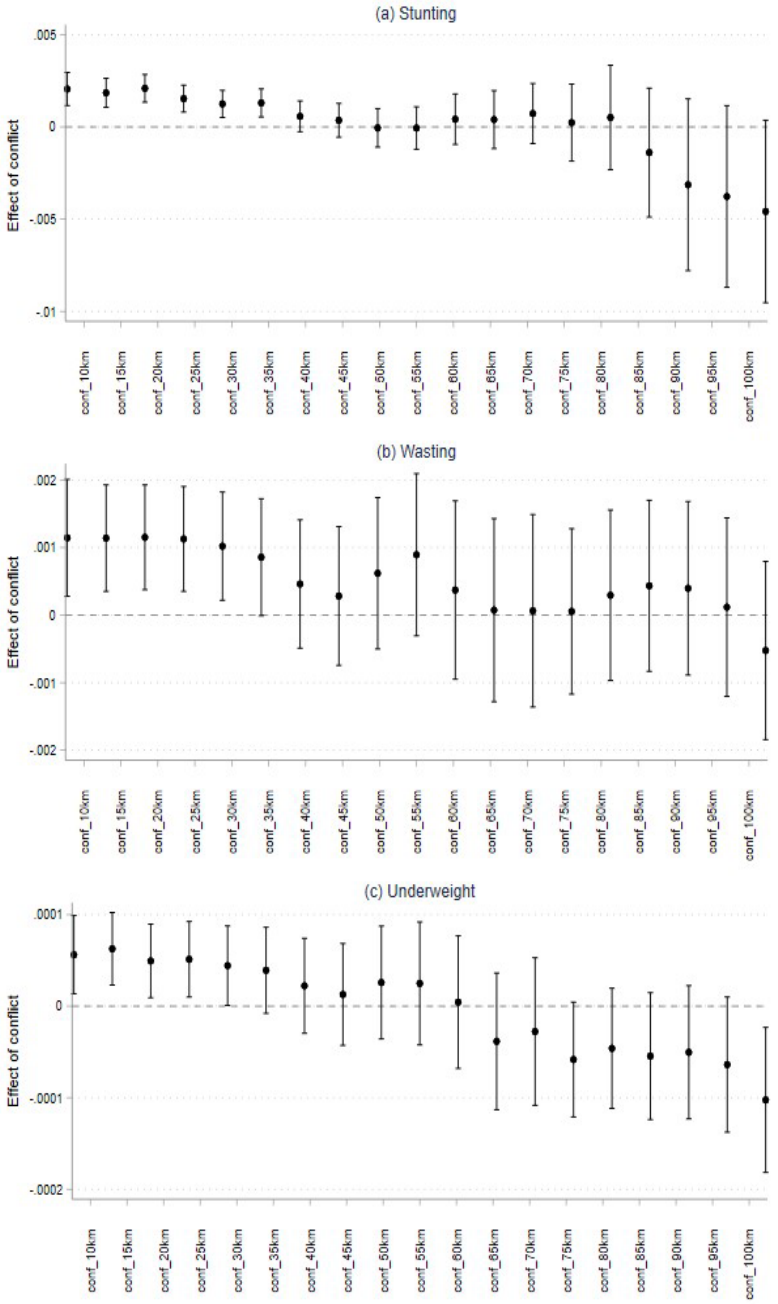
Beyond economic and social disruptions, the psychological impact of war — particularly its effects on mental health and exposure to physical violence — must not be overlooked. However, due to data limitations, we are unable to empirically assess this impact. Conflict-induced psychological stress affects both children and their parents, leading to behavioural and emotional challenges, household tensions from food insecurity, feelings of shame, and guilt. For example, in 2022, more than half of the 800 children and adolescents in conflict-affected areas of Ethiopia, the Amhara region, reported experiencing physical violence. Additionally, nearly 67 percent faced multiple incidents of psychological trauma, while 12 percent reported experiencing sexual violence (Biset et al., 2023). Such conditions severely undermine household and child economic well-being, impairing children's success and achievement. The effects on cognitive and socio-emotional development have both immediate and long-term consequences, ultimately impacting national economies and the long-term economic growth of affected countries.

Sensitivity analysis

At this point, we have demonstrated that conflict exposure affects both child health and educational outcomes—Key indicators of human capital. We have also shown that the effects vary depending on the radius we used to define the UCDP-based conflict measures. While our choice of radius is informed by existing empirical studies on conflict and related outcomes in SSA, it remains somewhat arbitrary. To assess the robustness of our results to this choice, we present estimates from Equation 1 in Figure 5, where conflict intensity (measured by fatalities) is calculated over radii ranging from 10 to 100 km, increasing in 5 km increments.

Our estimates remain small and precisely measured at small and large radii, with significant effects observed only at shorter distances (10—35 km). Given the study context and the nature of our conflict exposure indicator (i.e., the intensity of exposure), the intensity of conflict remains relatively low within any radius. Therefore, it is unsurprising that we observe small but statistically significant effects at shorter distances. The results are remarkably stable for the three nutritional outcomes up to approximately 30 km, with no observable effects beyond 40 km. Furthermore, the findings demonstrate that child nutrition outcomes are largely insensitive to variations in radius magnitude, maintaining statistical significance for radii below 35 km. The relative stability of our estimates within the 10—35 km range—where essential services such as health facilities and other socioeconomic resources are accessible—reinforces our confidence that an arbitrary choice of radius does not drive the results but rather reflects meaningful impacts of conflict exposure.

Figure 5: Conflict measurement radius sensitivity



Notes: Estimates display results from Table 3 columns 4 to 6 over a radius that increases iteratively with a 5 KM step size.

7. Conclusions and Policy Implications

Human capital is a fundamental driver of economic development. Recognizing its importance, many African countries have made significant investments in improving the quality of human capital formation over the past three decades. However, these gains are increasingly at risk due to persistent conflict, the COVID-19 pandemic, and other adverse shocks such as climate change.

This study examines the relationship between early-life exposure to violent conflict and children's human capital—focusing on child health, nutrition, and educational outcomes—in four selected SSA countries since 2003. Using nationally representative geocoded DHS survey data merged with the UCDP dataset, the findings indicate that early childhood exposure to conflicts significantly hinders human capital formation. Affected children are more likely to experience stunted growth, undernutrition, and lower educational attainment. The negative effects are more pronounced in rural areas than in urban areas and particularly severe for children under the age of two. Children from households with higher exposure to violent conflict completed fewer grades for their age and are less likely to finish primary education, even if enrolled. These results remain robust across different conflict exposure measures. Key underlying mechanisms include increased incidence of diarrhea due to damaged or limited health infrastructure, displacement, disruptions in input and out markets, place of residence, and maternal dietary deprivation.

Our findings align with existing evidence on the negative impact of conflict on child nutrition. However, our study provides additional insights into the underlying mechanisms, the duration (short- vs. long-term), and intensity/severity of conflicts, the type of human capital most affected by conflict, cross-country comparison using micro-level data, the heterogeneous spatial impact of conflict, as well as potential policy interventions to mitigate long-term consequences of conflict.

Given the fundamental importance of education for economic development and its centrality to achieving the other 16 SDGs, it is clear that education serves as the foundation of global development efforts. However, our findings suggest that the rising incidence of conflict in Africa threatens progress towards universal quality education and improved child health and nutrition. This, in turn, leaves a significant portion of Africa's children and youth without the basic skills needed to participate in modern economies, posing serious challenges to economic growth

and development. Our results underscore the urgent need for targeted and timely interventions—such as humanitarian assistance and cash transfers—to circumvent the long-term consequences of early childhood exposure to violent conflicts. Additionally, ensuring adequate resource allocation for achieving the SDGs is crucial. Recovery efforts should also prioritize conflict-affected countries like Ethiopia and Nigeria, where multiple ongoing conflicts pose substantial risks to sustainable development.

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A Appendix A: List of Tables

Table A1: DHS survey years by country

Country	DHS survey year				Relevant conflict year											
Ethiopia	2005	2011	2016		2003	2004	2005	2009	2010	2011	2014	2015	2016			
Nigeria	2003	2008	2013	2018	2001	2002	2003	2006	2007	2008	2011	2012	2013	2016	2017	2018
Rwanda	2005	2010	2015		2003	2004	2005	2008	2009	2010	2013	2014	2015			
Uganda	2006	2011	2016		2004	2005	2006	2009	2010	2011	2014	2015	2016			

Table A2: Ethiopia: Summary statistics

	Mean	SD	Min	Max	N
Stunting: Yes = 1	0.40	0.49	0.00	1.00	21,144
Underweight: Yes = 1	0.28	0.45	0.00	1.00	21,765
Wasted: Yes = 1	0.12	0.33	0.00	1.00	21,167
Diarrhea: Yes = 1	0.14	0.35	0.00	1.00	21,819
Fever: Yes = 1	0.17	0.38	0.00	1.00	21,780
Cough: Yes = 1	0.18	0.38	0.00	1.00	21,795
Delayed years of grade	2.03	2.46	0.00	10.00	37394
Delayed in grade: Yes = 1	0.30	0.46	0.00	1.00	75003
Dropping out of school: Yes = 1	0.04	0.19	0.00	1.00	7876
Child age (months)	28.88	17.36	0.00	59.00	21,819
Child female: Yes = 1	0.49	0.50	0.00	1.00	21,819
Mother's age	29.27	6.63	15.00	49.00	21,819
Mother's years of education	1.73	3.37	0.00	22.00	21,819
Female-headed: Yes = 1	0.18	0.38	0.00	1.00	21,819
Household head age	37.85	11.69	15.00	97.00	21,819
Household size	6.13	2.23	2.00	22.00	21,819
Rural cluster: Yes = 1	0.85	0.36	0.00	1.00	21,819
Wealth index	2.68	1.50	1.00	5.00	21,819
Distance (km) to cities of 250k population	2.49	1.10	0.01	5.62	21,819
Standardized values of temp average	-0.61	1.01	-2.82	1.75	21,819
Standardized values of rainfall	-0.60	0.80	-2.49	1.12	21,819
Within 10km buffer zone					
No. of conflict events (past year)	0.07	0.36	0.00	9.00	1,669
No. of conflict events (past two years)	0.11	0.46	0.00	11.00	1,669
No. of conflict events (past three years)	0.27	0.79	0.00	14.00	1,669
No. of fatalities (past year)	0.26	4.01	0.00	120.00	1,669
No. of fatalities (past two years)	1.13	18.61	0.00	426.00	1,669
No. of fatalities (past three years)	1.49	19.12	0.00	426.00	1,669

Within 20km buffer zone					
No. of conflict events (past year)	0.20	0.82	0.00	13.00	1,669
No. of conflict events (past two years)	0.31	1.12	0.00	21.00	1,669
No. of conflict events (past three years)	0.53	1.45	0.00	28.00	1,669
No. of fatalities (past year)	0.48	5.52	0.00	131.00	1,669
No. of fatalities (past two years)	1.61	19.77	0.00	426.00	1,669
No. of fatalities (past three years)	2.35	21.55	0.00	426.00	1,669

Table A3: Nigeria: Summary statistics

	Mean	SD	Min	Max	N
Stunting: Yes = 1	0.38	0.48	0.00	1.00	61,602
Underweight: Yes = 1	0.27	0.44	0.00	1.00	65,471
Wasted: Yes = 1	0.14	0.35	0.00	1.00	61,213
Diarrhea: Yes = 1	0.12	0.32	0.00	1.00	66,077
Fever: Yes = 1	0.18	0.38	0.00	1.00	65,741
Cough: Yes = 1	0.13	0.34	0.00	1.00	65,675
Delayed years of grade	2.74	2.82	0.00	11.00	110,000
Delayed in grade: Yes = 1	0.37	0.48	0.00	1.00	180,000
Dropping out of school: Yes = 1	0.02	0.16	0.00	1.00	35,301
Child age (months)	27.71	17.25	0.00	59.00	66,077
Child female: Yes = 1	0.49	0.50	0.00	1.00	66,077
Mother's age	29.43	6.91	15.00	49.00	66,077
Mother's years of education	4.95	5.28	0.00	22.00	66,040
Female-headed: Yes = 1	0.10	0.30	0.00	1.00	66,077
Household head age	41.16	11.93	16.00	96.00	65,937
Household size	7.09	3.57	2.00	43.00	66,077
Rural cluster: Yes = 1	0.67	0.47	0.00	1.00	66,077
Wealth index	2.83	1.39	1.00	5.00	66,077
Distance (km) to cities of 250k population	0.89	0.69	0.00	3.26	66,077
Standardized values of temp average	0.96	0.27	-0.80	1.65	66,077

Standardized values of rainfall	0.01	1.16	-2.15	2.79	66,077
Within 10km buffer zone					
No. of conflict events (past year)	0.55	5.34	0.00	118.00	3,481
No. of conflict events (past two years)	0.88	8.19	0.00	193.00	3,481
No. of conflict events (past three years)	1.18	9.78	0.00	211.00	3,481
No. of fatalities (past year)	3.38	24.64	0.00	355.00	3,481
No. of fatalities (past two years)	5.77	36.50	0.00	1012.00	3,481
No. of fatalities (past three years)	11.01	85.48	0.00	1645.00	3,481
Within 20km buffer zone					
No. of conflict events (past year)	0.85	6.28	0.00	119.00	3,481
No. of conflict events (past two years)	1.42	9.28	0.00	194.00	3,481
No. of conflict events (past three years)	1.94	11.60	0.00	212.00	3,481
No. of fatalities (past year)	5.31	30.00	0.00	360.00	3,481
No. of fatalities (past two years)	9.46	44.18	0.00	1012.00	3,481
No. of fatalities (past three years)	16.97	105.60	0.00	2011.00	3,481

Table A4: Rwanda: Summary statistics

	Mean	SD	Min	Max	N
Stunting: Yes = 1	0.45	0.50	0.00	1.00	8,263
Underweight: Yes = 1	0.14	0.35	0.00	1.00	8,360
Wasted: Yes = 1	0.04	0.19	0.00	1.00	8,253
Diarrhea: Yes = 1	0.14	0.35	0.00	1.00	8,376
Fever: Yes = 1	0.22	0.41	0.00	1.00	8,364
Cough: Yes = 1	0.30	0.46	0.00	1.00	8,367
Delayed years of grade	2.58	2.45	0.00	11.00	28412
Delayed in grade: Yes = 1	0.56	0.50	0.00	1.00	38777
Dropping out of school: Yes = 1	0.29	0.45	0.00	1.00	8787
Child age (months)	28.54	16.97	0.00	59.00	8,376
Child female: Yes = 1	0.50	0.50	0.00	1.00	8,376
Mother's age	30.91	6.67	15.00	49.00	8,376

Mother's years of education	4.06	3.34	0.00	19.00	8,373
Female-headed: Yes = 1	0.19	0.39	0.00	1.00	8,376
Household head age	37.46	11.09	16.00	95.00	8,376
Household size	5.60	2.00	2.00	22.00	8,376
Rural cluster: Yes = 1	0.83	0.38	0.00	1.00	8,376
Wealth index	2.87	1.41	1.00	5.00	8,376
Distance (km) to cities of 250k population	0.45	0.21	0.00	0.97	8,376
Standardized values of temp average	-1.12	0.36	-1.79	-0.49	8,376
Standardized values of rainfall	-0.04	0.46	-0.66	1.02	8,376
Within 10km buffer zone					
No. of conflict events (past year)	0.00	0.06	0.00	1.00	1,053
No. of conflict events (past two years)	0.06	0.26	0.00	2.00	1,053
No. of conflict events (past three years)	0.08	0.37	0.00	4.00	1,053
No. of fatalities (past year)	0.06	0.98	0.00	16.00	1,053
No. of fatalities (past two years)	0.20	1.16	0.00	16.00	1,053
No. of fatalities in the past 3yrs before DHS survey	0.27	1.37	0.00	16.00	1,053
Within 20km buffer zone					
No. of conflict events (past year)	0.02	0.14	0.00	1.00	1,053
No. of conflict events (past two years)	0.12	0.36	0.00	2.00	1,053
No. of conflict events (past three years)	0.17	0.55	0.00	4.00	1,053
No. of fatalities (past year)	0.25	1.96	0.00	16.00	1,053
No. of fatalities (past two years)	0.48	2.08	0.00	16.00	1,053
No. of fatalities (past three years)	0.65	2.35	0.00	16.00	1,053

Table A5: Uganda: Summary statistics

	Mean	SD	Min	Max	N
Stunting: Yes = 1	0.30	0.46	0.00	1.00	8,621
Underweight: Yes = 1	0.13	0.33	0.00	1.00	8,692
Wasted: Yes = 1	0.05	0.22	0.00	1.00	8,603
Diarrhea: Yes = 1	0.24	0.43	0.00	1.00	8,713
Fever: Yes = 1	0.41	0.49	0.00	1.00	8,705

Cough: Yes = 1	0.44	0.50	0.00	1.00	8,708
Delayed years of grade	2.20	2.41	0.00	11.00	48453
Delayed in grade: Yes = 1	0.52	0.50	0.00	1.00	64854
Dropping out of school: Yes = 1	0.24	0.43	0.00	1.00	10498
Child age (months)	27.83	17.19	0.00	59.00	8,713
Child female: Yes = 1	0.50	0.50	0.00	1.00	8,713
Mother's age	28.85	6.76	15.00	49.00	8,713
Mother's years of education	5.16	3.89	0.00	21.00	8,713
Female-headed: Yes = 1	0.25	0.43	0.00	1.00	8,713
Household head age	37.03	11.73	16.00	94.00	8,707
Household size	6.42	2.72	2.00	27.00	8,713
Rural cluster: Yes = 1	0.84	0.37	0.00	1.00	8,713
Wealth index	2.79	1.43	1.00	5.00	8,713
Distance (km) to cities of 250k population	1.65	0.90	0.01	3.78	8,713
Standardized values of temp average	-0.07	0.44	-1.79	0.74	8,713
Standardized values of rainfall	0.21	0.40	-1.08	1.09	8,713
Within 10km buffer zone					
No. of conflict events (past year)	0.14	1.19	0.00	28.00	1,404
No. of conflict events (past two years)	0.31	2.38	0.00	63.00	1,404
No. of conflict events (past three years)	0.40	3.21	0.00	88.00	1,404
No. of fatalities (past year)	3.26	15.10	0.00	149.00	1,404
No. of fatalities (past two years)	4.84	23.05	0.00	343.00	1,404
No. of fatalities (past three years)	5.53	26.22	0.00	420.00	1,404
Within 20km buffer zone					
No. of conflict events (past year)	0.32	2.46	0.00	39.00	1,404
No. of conflict events (past two years)	0.75	5.10	0.00	80.00	1,404
No. of conflict events (past three years)	1.05	6.81	0.00	107.00	1,404
No. of fatalities (pas year)	4.32	18.25	0.00	197.00	1,404
No. of fatalities (past two years)	8.30	38.16	0.00	500.00	1,404
No. of fatalities (past three years)	10.77	48.31	0.00	589.00	1,404

Table A6: Effect on diarrhea (under-five children: Pooled sample)

	Diarrhea
Number of fatalities: Past one year	-0.0019
	(0.001)
Number of fatalities: Past two years	0.0034***
	(0.0007)
Number of fatalities: Past three years	0.0021**
	(0.001)
Observations	53262
Mean of dependent var	0.134
Number of clusters	7648

Notes: All models include the gender of the household head(female), the age of the mother (years), household size, mother's education (in single years), age of the child(in months), gender of the child (a dummy indicating the child is female) and place of residence (a dummy indicating rural). Robust standard errors are in parentheses. Statistical significance* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Table A7: Impact of conflict exposure on child nutrition outcomes - 10km buffer zone

	(1)	(2)	(3)
Panel A: Past one year	Stunting: Yes=1	Underweight: Yes=1	Wasted: Yes=1
Number of fatalities	0.0001*	0.0007***	0.0007***
	(0.000)	(0.000)	(0.000)
R-squared	0.100	0.090	0.050
F-statistics	224.87	145.73	96.57
Prob > F	0.000	0.000	0.000
Panel B: Past two years			
Number of fatalities	0.0001*	0.0004**	0.0004***
	(0.000)	(0.000)	(0.000)
R-squared	0.100	0.090	0.050
F-statistics	225.19	145.77	96.68
Prob > F	0.000	0.000	0.000
Panel C: Past three years			
Number of fatalities	0.0000	0.0001**	0.0001**
	(0.000)	(0.000)	(0.000)
Observations	99334	103974	98946
Mean of dependent var	0.400	0.200	0.100
Number of clusters	7604	7604	7600
R-squared	0.100	0.090	0.050
F-statistics	225.177	145.671	96.911
Prob > F	0.000	0.000	0.000

Notes*:* Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities in the past one year prior to DHS survey. Panel B and C indicate number of fatalities

within 20 km in the past 2 and 3 years before DHS survey, respectively. Statistical significance: * p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01.

Table A8: Number of fatalities and child nutrition outcomes by age group - 10km buffer zone

	Under 24 months			Between 24 - 36 months			Older than 36 months		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Past one year	Stunting: 1=yes	Underweight: 1=yes	Wasted: 1=yes	Stunting: 1=yes	Underweight: 1=yes	Wasted: 1=yes	Stunting: 1=yes	Underweight: 1=yes	Wasted: 1=yes
Number of fatalities	0.0001	0.0005**	0.0003*	-0.0001	0.0009***	0.0011***	-0.0003***	0.0008***	0.0010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.060	0.080	0.040	0.100	0.130	0.050	0.110	0.100	0.040
F-statistics	70.34	79.91	48.25	71.30	73.58	20.07	128.13	92.06	28.37
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Past two years									
Number of fatalities	0.0001	0.0002	0.0001	-0.0001*	0.0005**	0.0006**	-0.0002***	0.0006***	0.0006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.060	0.070	0.040	0.100	0.120	0.050	0.110	0.100	0.040
F-statistics	70.36	79.91	48.18	71.22	73.62	20.00	128.04	91.71	28.20
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Panel C: Past three years									
Number of fatalities	0.0001*	0.0000	0.0000	-0.0001*	0.0002*	0.0002***	-0.0000	0.0002***	0.0002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	43816	46540	43516	19100	19928	19096	36418	37506	36334
Mean of dependent var	0.300	0.200	0.200	0.500	0.300	0.100	0.400	0.300	0.100
Number of clusters	7377	7389	7363	6317	6357	6319	7161	7163	7152
R-squared	0.060	0.070	0.040	0.100	0.120	0.050	0.110	0.100	0.040
F-statistics	70.41	79.93	48.14	71.25	73.70	19.96	128.30	91.09	27.90
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes*:* Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities within 20 km radius. Panel B

indicates fatalities within the past 2 years, while Panel C indicates conflict fatalities within 50 km radius, respectively.

Statistical significance: * p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01.

Table A9: Conflict Exposure

	Rural			Urban		
Panel A: Past one year	(1) Stunting: 1=yes	(2) Underweight: 1=yes	(3) Wasted: 1=yes	(4) Stunting: 1=yes	(5) Underweight: 1=yes	(6) Wasted: 1=yes
Number of fatalities	0.0007**	0.0006*	0.0001	0.0001*	0.0008***	0.0008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.06	0.08	0.04	0.08	0.09	0.05
F-statistics	102.29	116.10	53.75	42.02	26.54	19.02
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Past two years						
Number of fatalities	0.0003	0.0001	0.0003	0.0001	0.0004**	0.0004**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.06	0.08	0.04	0.08	0.09	0.05
F-statistics	101.84	116.09	53.87	41.83	27.01	18.83
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Panel C: Past three years						
Number of fatalities	0.0002*	0.0000	0.0001**	0.0000	0.0001**	0.0001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	72574	76194	72490	26760	27780	26456
Mean of dependent var	0.400	0.300	0.100	0.300	0.200	0.100
Number of clusters	5218	5217	5216	2386	2387	2384
R-squared	0.06	0.08	0.04	0.08	0.08	0.04
F-statistics	101.85	116.34	53.99	41.78	26.89	18.32
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities within 20 km radius. Panel B indicates fatalities within the past 2 years, while Panel C indicates conflict fatalities within 50 km radius, respectively.

Statistical significance: * p ≤ 0.10, ** p ≤ 0.05, *** p ≤ 0.01.

Table A10: Effect of conflict event on child nutrition outcomes

	Within 10 km radius			Within 20 km radius		
	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)	Stunting: (Yes=1)	Underweight: (Yes=1)	Wasted: (Yes=1)
Panel A: Past one year						
Conflict (Yes = 1)	0.0281***	0.0158	0.0324**	0.0236***	0.0097	0.0253***
	(0.008)	(0.012)	(0.010)	(0.006)	(0.008)	(0.007)
Observations	99334	103974	98946	99334	103974	98946
Number of clusters	7604	7604	7600	7604	7604	7600
Model F-stat	292.12	174.94	105.43	291.97	174.63	105.61
Adj.R2	0.090	0.080	0.040	0.090	0.080	0.040
Panel B: Past two years						
Conflict (Yes = 1)	0.0222**	0.0109	0.0164*	0.0193***	0.0091	0.0156**
	(0.007)	(0.008)	(0.007)	(0.005)	(0.006)	(0.005)
Observations	99334	103974	98946	99334	103974	98946
Number of clusters	7604	7604	7600	7604	7604	7600
Model F-stat	291.29	175.70	105.39	291.09	175.39	105.51
Adj.R2	0.090	0.080	0.040	0.090	0.080	0.040
Panel C: Past three years						
Conflict (Yes = 1)	0.0196**	0.0055	0.0106	0.0165**	0.0064	0.0137**
	(0.006)	(0.007)	(0.006)	(0.005)	(0.006)	(0.005)
Observations	99334	103974	98946	99334	103974	98946
Mean of dependent var	0.400	0.200	0.100	0.400	0.200	0.100
Number of clusters	7604	7604	7600	7604	7604	7600
Model F-stat	291.03	175.11	105.23	291.10	174.43	105.58
Adj.R2	0.090	0.080	0.040	0.090	0.080	0.040

Notes: Robust standard errors clustered at the enumeration area level are reported in parentheses. All regressions include controls for household head age and gender, household size, wealth index, mother's age and years of education, age of the child and gender, Birth-year x birth-month fixed effects, distance to the city of 250k population (km), total precipitation, average temperature, country and survey year fixed effect. Panel A indicates a number of fatalities within 20 km radius. Panel B indicates fatalities within the past 2 years, while Panel C indicates conflict fatalities within 50 km radius, respectively.

Statistical significance: * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

B Appendix B: List of Figures

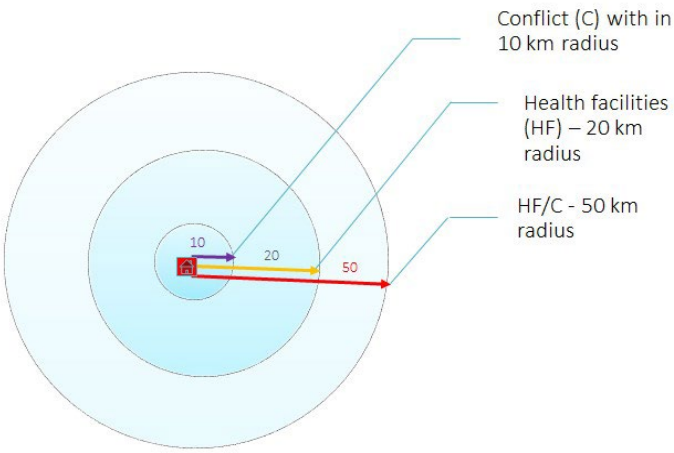
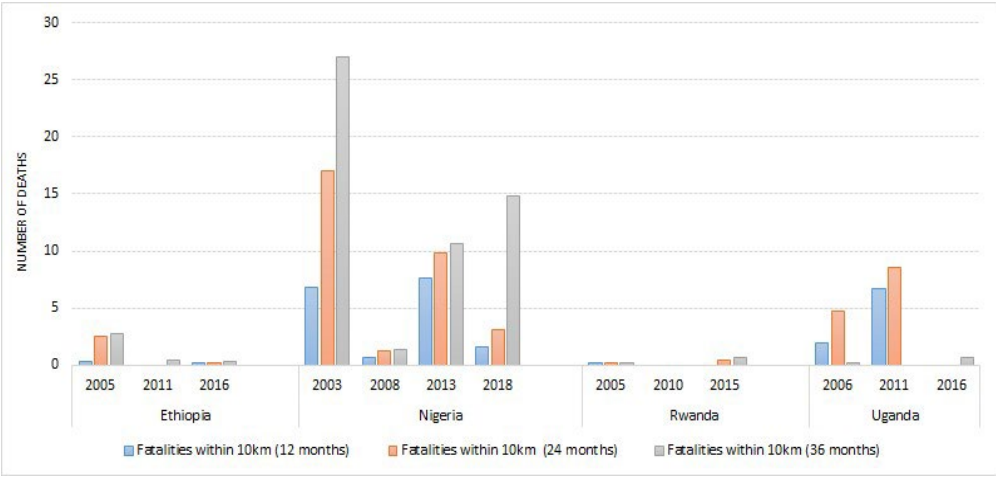


Figure B1: Radius choice: conflict and health outcomes

Figure B2: Fatalities by country and over survey periods (2003-2018)



Mission

To strengthen local capacity for conducting independent,
rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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