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Abstract

Increasing violent conflict has resulted in population displacement and the destruction of livelihoods, thereby hindering economic growth. This study estimates the association between early exposure to Fulani ethnic militia (FEM) conflicts and subsequent child health outcomes in Nigeria. Using nationally representative Nigerian General Household Survey data merged with georeferenced FEM conflict data, the study shows that contemporaneous exposure to FEM conflict is strongly associated with declining child health – measured in terms of WAZ (short-term measure) or HAZ (long-term measure). We also find that in-utero exposure to FEM conflict is weakly associated with declining long-term child health but not with short-term child health. Specifically, this effect is more severe in rural areas compared to urban areas. Furthermore, girls are more affected by contemporaneous FEM conflict exposure in the long-term health outcome, and boys are more susceptible to FEM conflict exposure in the short-term health outcome. Older children are more negatively affected by contemporaneous FEM conflict exposure. Agricultural productivity, food security, and access to sanitary toilet facilities appear to be the primary underlying channels of the estimated effects. Results are robust to including other conflict measures and variations in weather patterns. Findings highlight the need for conflict prevention and peacebuilding efforts to resolve conflicts between farmers and herders.

Keywords: child health, armed conflict, Fulani ethnic militia, in utero, culling, scarring.

1. Introduction

Armed conflicts linked to political agitations and cross-communal frictions have existed for generations. Within-country armed conflict contexts are commonly associated with economic control of natural resources, such as crude oil and coal, and religious agitations amongst others (Ploeg 2011). While this remains a persistent issue across countries, there has been an upsurge in the intensity and coverage of armed conflicts in recent years. A growing body of evidence has shown that exposure to armed conflicts can have severe and persistent consequences on household behaviour due to its effects on local economic productivity (Adelaja and George 2019; George *et al.* 2021a,b; Nnaji *et al.* 2023). Rural households in developing countries that rely heavily on agricultural activities are likely to experience severe consequences from armed conflicts, in particular. The displacement impacts of armed conflict events generate a substantial imbalance in the demographic composition of countries across the world through forced internal and external migration. The capacity of rural households to respond and adapt to shocks from exposure to armed conflict is extremely limited due to the associated forced displacement, among other factors[1] (Minale 2018). This background underscores the policy relevance of our research question. We aim to provide a detailed understanding of the impacts of armed conflicts on household welfare outcomes in rural areas to guide targeted intervention programs through institutional policies.

Conflict incidents have been on the increase in Sub-Saharan Africa (SSA), most especially in Nigeria, with increased levels of instability in both the northern and southern regions of the country. Islamist insurgency and armed banditry violence have ravaged the Northern regions of the country. This complements Fulani Ethnic Militia clashes with the farming communities in the same region and across the middle belt, while political violence, such as the separatist Indigenous Peoples of Biafra (IPOB) ravages the Southern regions. These activities result in increased fatality, displacement of people, as well as widespread insecurity (ACLED, 2022). According to the Armed Conflict Location & Event Data (ACLED) project, there was a 22% increase in political armed conflicts in 2021, resulting in about 9,900 fatalities. However, since 2017, conflicts between sedentary farmers and nomadic pastoralists have escalated, resulting in more fatalities than the Islamist insurgency (ACLED, 2018; 2022). In 2021, armed conflicts involving Fulani Ethnic Militia (FEM) increased exponentially, particularly within the Middle Belt region of the

[1] Households in developing countries are the worst-hit from the negative effects of unanticipated shocks due to incomplete insurance, imperfect credit market, and reliance on informal adaptation strategies.

country claiming the lives of about 800 individuals from farming communities (ACLED, 2022). Resource-driven conflicts like the farmer-herder clashes may have a direct negative consequence on agricultural livelihoods. Hence, this study seeks to investigate how these conflict incidents affect nutritional health outcomes.

In this study, we explore the effect of exposure to early-life local armed conflict on child health outcomes. Our focus is on the Fulani Ethnic Militia (FEM) conflict – a long-running conflict in West Africa with increasing frequency and intensity of attacks. In 2018, fatalities from FEM conflicts surpassed that of well-known terrorist group – Boko Haram – with most FEM violence taking place against civilians[2] (ACLED 2018). Importantly, there is a seasonal pattern to this conflict, as most of it is driven by clashes between pastoralists and farmers. The link between conflict activities and farming practices is embedded within the encroachment of agricultural cultivations relied upon for the economic resources of most rural households[3]. Considering most rural households are subsistent, FEM activities would not only affect their agricultural cultivation, but it would also affect the quantity and quality of food they consume which invariably impacts their nutritional outcomes (Nnaji *et al.* 2022). Pastoralists, typically of Fulani origins, are usually based in the Northern part of the country but issues like climate change stressors and general insecurity in the Sahel have increased their migration from the Northern region to the Central and Southern regions of Nigeria (Buhaug *et al.* 2015). This has increased the propensity for clashes across the country as a result of increased competition over scarce land resources (Eke 2020). It is important to understand the wider implications of this conflict given its increased intensity, frequency, and possible human capital effects[4]. This is particularly important as existing proposals to establish ranches across Nigeria have been rebuffed at the local level, leaving the propensity for violence high.

The overarching objective of this paper is to extend the frontiers of knowledge seeking to understand the effect of early life shocks on child development. In general, we extend recent evidence on the interaction between conflict and child health outcomes (Ekhator-Mobayode and Asfaw 2019; Acharya et al.

[2] FEM has a long history and has existed before the Boko Haram and ISWAP groups but is poorly understood – sometimes interpreted along religious lines of Muslim vs Christian conflict.

[3] In particular, there is extensive evidence that FEM conflict affects agriculture – as it reduces agricultural output, outputs of staple crops, number of cattle holdings, and area harvested (George, Adelaja, and Awokuse, 2021).

[4] Extensive literature across diverse fields of study has revealed that conflicts due to competition over resources are likely to worsen with climate change (Cappelli *et al.* 2023; Mendenhall *et al*. 2020; Nhemachena *et al*. 2020).

2020; Makinde et al., 2023) by providing complementary evidence of the effect of FEM conflict on child nutritional outcomes with a better understanding of both timing and channels of the effect. The timing dimension of our study will help to unveil the persistence of the effects of armed conflict from the period of exposure. This question also provides an important background for the econometrics framework, which models alternative conflict exposures through fetal and contemporaneous pathways vis-à-vis the scarring and culling dimensions for the effect of conflict. Our main hypothesis is to test whether the timing of the exposure to conflict (fetal or contemporaneous) matters for the adverse effect on child health outcomes (captured by anthropometric measures).

This paper uses household information data on children's health and household characteristics from the four waves of the Nigerian Panel General Household Survey (GHS) and conflict record data from ACLED to investigate the trajectory of child health outcomes across households in Nigeria. We use conflict data from ACLED with more extensive coverage for rural areas compared to other conflict databases. To achieve our set objectives, we link important demographic and health variables from the Nigerian Panel General Household Survey (GHS) to FEM conflicts from the ACLED georeferenced event dataset (GED). There are two main stages in the process of data linkage for the analysis in the paper. The first is the exterior linkage between GHS and ACLED, while the second is the interior within the GHS. The interior linkage involves the linkage across individual, household, and agricultural datasets. We focus on both short-term and long-term anthropometric health outcomes for our dependent variables using WAZ and HAZ. We contextualize the scarring and culling effects by adjusting the timelines for yearly variation of FEM conflict exposure data provided by ACLED.

Our results demonstrate a growth-halting trajectory from the culling pathway, through effects from contemporaneous conflict exposure and scarring pathways, through effects from in-utero conflict exposure. This combination shows the importance of both contemporaneous shocks and intergenerational transmission of shocks on the growth patterns of children, which are often isolated in the literature. While the evidence from the contemporaneous conflict exposure shows persistence through a two-year lag, the intrauterine association is related to the year of birth only. These findings show delayed effects of shock exposure regarded as the persistent impact of shocks within the literature (Kreif et al., 2022).

While increasing efforts have been made to address the issue of FEM conflict in Nigeria – including proposal of the Rural Grazing Area (RUGA) policy – our findings firmly place the human capital contexts of FEM conflicts on the policy agenda. Our results find important early-life effects of shocks from FEM conflict and policy guidelines required to address welfare effects of conflicts should encompass interventions to mitigate the effects of these early-life shocks. We provide evidence that extends the body of literature on the effects of armed conflicts on human capital outcomes within SSA. Our research design also highlights the longstanding and recurring post-exposure effects of armed conflicts for low-income countries. Using the fetal period hypothesis, we follow the literature by focusing on the effects surrounding the first 1,000 days of early life.

The rest of this paper is organised as follows: Section 2 presents a review of the relevant literature, while Section 3 provides a conceptual framework. Section 4 presents the data sources, and Section 5, the empirical strategy. Section 6 presents the results while also highlighting the main findings within the context of relevant papers. Section 7 provides a concluding remark of the paper.

2. Literature Review

There is an extensive body of literature on the impacts of conflicts on human capital outcomes. A significant component of this literature investigates the short-term, long-term, and end-point outcomes of exposure to conflict through unanticipated early life shock events. This includes childhood health outcomes (Wald 2014; Akresh *et al.* 2016; Ekhator-Mobayode and Asfaw 2019), adulthood health outcomes (Akresh et al. 2012, Grimard and Laszlo 2014), mortality (Degomme and Guha-Sapir 2010; Ouili 2017; Dagnelie et al. 2018), schooling and educational outcomes (Ouili 2017; Bertoni et al. 2019), and multiple socioeconomic outcomes (Akbulut-Yuksel 2014). Other perspectives in the literature are the persistence of impacts of exposure to conflicts through human capital accumulation (Leon 2012) and the intergenerational component of long-term impacts (Akresh et al. 2017).

Fetal exposure to armed conflicts can be categorized under unique early life shock timing, similar to exposure to adverse weather events (fetal origin hypothesis). Using birth outcomes, some studies examine the effect of prenatal psychological stress due to terrorism on child health outcomes (Camacho 2008; Nwokolo 2017). Valente (2015) investigates the effect of in-utero exposure to a shock – civil conflict in Nepal – on fetal loss and health at birth. These results complement the established devastating human capital impacts of exposure to early life shocks in fragile states. Recent studies have provided a pathway for conflict's impacts on households' consumption patterns in Northern Uganda (Adong *et al.* 2021). It is important to acknowledge that the impacts of nutrition deficits on birth outcomes are likely to deepen in rural settings where households predominantly depend on rain-fed agricultural activities amidst disruption from conflict events. Also, the literature shows that in the absence of sustainable safety net programs for smallholder households, food insecurity is associated with deteriorating welfare outcomes, including health (Lohmann and Lechtenfeld 2015). The interaction between a lack of support for the nutritional requirements during pregnancy and inefficient healthcare systems may particularly worsen child and maternal health outcomes.

The existing literature also decomposes the mechanisms of the impacts of conflict exposure on health to evidence from culling or scarring. The culling evidence links impacts of conflict exposure to in-utero selection in gendered patterns consequent upon place of residence and spatial distribution of conflicts during the gestational stages of a child. For example, the culling evidence may manifest by creating a gender imbalance in the effects of conflict exposure on infant (0–12 months) mortality as demonstrated by Dagnelie *et al.* (2018). The study shows that conflict significantly increases infant mortality only among girls. On the other hand, scarring evidence is genetically motivated and demonstrated through unnatural asymmetries in live births resulting from exposure to conflict.

The body of literature can be categorised based on the timing of conflict exposure and outcomes of interest. The basis for the timing of shock events is important in consideration of the policy guidelines required to address welfare impacts. While nutrition has been established as the main channel of transmission from conflict exposure to birth outcomes and anthropometric health, there is an existing gap in the understanding of the simultaneity of impacts between fetal and contemporaneous shocks from the same context. Armed conflict shocks disrupting agricultural cycles during the gestation period may distort growth, springing intergenerational effects through birth and short-term health outcomes. While this is an important and plausible pathway to stunting in the short-term, it is important to understand the role of similar contemporaneous conflict exposures during a child's early life periods. This can be investigated by examining child health trajectories around recent conflict exposures in the early life period as well.

3. Conceptual Framework

To investigate the association of FEM conflict incidence and intensity on child nutritional outcome, we model a household-constrained utility maximization in a conflict environment. We follow a pioneer theoretical framework using the interaction of (i) a household utility function, (ii) a child health production function, and (iii) a budget constraint. These three factors underline the constrained utility maximization behaviour of the household as explored by background literature (Rosenzweig and Schultz 1982; Mwabu 2009).

(i) Household utility function

Household utility is a function of both home-produced and market-produced goods and services. In this regard, child quality and quantity are both embedded in the household utility function. Focusing on child quality as the main driver of the child health outcomes captured in this paper, the household utility can be expressed as a function of input variables in Eq. 1 below:

$$U = u\,(X, Y, CH) \qquad (1)$$

Where U denotes the derived utility from household investment, X represents a vector of goods that have no direct effect on child health, while Y represents a vector of goods that affect child health. Finally, CH captures the child's health status measured by anthropometric indicators.

(ii) Child health production function

The household's child health (CH) production function is then extracted from the utility function and projected as a function of fundamental factors in Eq. 2:

$$CH = ch\,(Y, I, C, G) \qquad (2)$$

Where **I** represent health inputs that contribute to household utility only through their effects on child health. **C** represents household exposure to armed conflicts, and **G**, family-specific health endowments known to, but not controlled by the family, such as genetic composition and other non-environmental factors. Notably, Eq. 2 is a subset of Eq. 1 through a further breakdown of CH. This implies that household utility in Eq. 1 can be expressed indirectly as a breakdown of I, C, and G.

(iii) Budget constraint

The household is faced with budget constraints due to limited economic resources. The budget constraint presented in Eq. 3 below for the household in terms of the purchased goods is expressed in monetary units as the sum of monetary values across four items:

$$B = X^*Px + Y^*Py + I^*Pi + C^*Pc \qquad (3)$$

Each component of the budget constraint is expressed as the total value across items; noting that total value of each item is a function of unit price scaled by quantity purchased. X*Px signifies the value of goods that have no direct effect on child health – e.g, household furniture, or non-food and non-medical expenditure. Y*Py denotes the value of goods that affect child health – e.g., food consumption goods, or food expenditure. I*Pi denotes the value of health inputs that affect household utility only through child health – e.g. prenatal healthcare, or recurrent medical expenditure etc. C*Pc conveys the cost of exposure to armed conflict evaluated at the shadow price and level of exposure to armed conflict.

(iv) Constrained utility maximization behaviour of the household

The child health production function can be derived from the constrained utility maximization behaviour of the household. This entails the maximization of the household utility function (Eq. 1), given the child health production function (Eq. 2) and subject to the budget constraint (Eq. 3). This process aims to achieve integrated household utility maximization. However, this can be achieved through a reduced-form demand equation. In summary, the primary components for derivable household utility are (a) health-neutral goods (Y), (b) health-related consumer goods (X), (c) health inputs (I), and (d) aversion to conflict (C).

Incidences of FEM conflicts may affect households' food security and subsequent child nutritional outcomes differently depending on their source of livelihood. This includes, for example, agrarian households (George et al., 2020; Nnaji et al., 2022), place of residence, and household composition (Sánchez-Céspedes, 2017). Farming households may not only have to deal with the direct negative impact on their farm production and productivity (Adelaja & George, 2019; Arias et al., 2019; Nnaji et al., 2023), but there is also an indirect influence on their adaptive capacity via income instability and diversification (Béné et al., 2024; Brück, d'Errico, and Pietrelli, 2019). Non-farming households may also be affected by these armed conflicts through increased uncertainty and anxiety about safety, which may result in suboptimal decisions like the sale of assets (Rockmore, 2020) or the migration from their communities (Abel et al., 2019; Braithwaite et al., 2019; Sánchez-Céspedes, 2017). Likewise, displacement caused by these conflicts may further diminish household resilience, ability to feed adequately, as well as sanitary food preparation (Brück, d'Errico, & Pietrelli, 2019; George & Adelaja, 2020; Muriuki et al., 2023; Nnaji et al., 2022; Verwimp & Muñoz-Mora, 2018). The nature of FEM conflicts vis-à-vis its interaction with food security makes the research questions explored in this paper strategic especially when it relates to under-5 children who are in dire need of sustainable nutrition.

4. Data

Nigerian General Household Survey (GHS)

In this paper, we use four waves of the longitudinal Nigerian GHS. The surveys were collected in the years 2010/2011, 2012/2013, 2015/2016, and 2018/2019. The Nigerian GHS is part of the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMA-ISA), a nationally representative household survey project funded by the Bill and Melinda Gates Foundation (BMGF). This project is implemented by the LSMS team at the World Bank and the Nigerian Bureau of Statistics. Each wave of the survey collects post-planting and post-harvest data on agricultural activities and household welfare in two rounds using a two-stage sampling procedure for nationally representative data. In the first stage, 500 enumeration areas (EAs) are randomly selected, and in the second stage, 10 households are selected from each EA, making a total of 5,000 households for the study. This process enhances the randomisation of selected household units across rural and urban areas with different displacement and weighting allocations to account for attrition bias. The panel component of the Nigerian GHS includes rich information on household demographic and socioeconomic characteristics, dietary diversity, consumption, and plot-level characteristics, amongst others. The survey also collects anthropometric data of children.

The GHS panel links each household located within a cluster to GPS coordinates to facilitate matching to spatial datasets such as weather and conflicts, with displaced factors to preserve the anonymity of survey respondents. Clusters in rural areas are displaced up to 5km due to the sparse distribution of household units in these areas – those in urban areas are displaced up to 2km. For our analysis, we use a clustered dimension of spatial distribution of conflicts linked to survey observations from the four waves, while creating a panel of observations at the enumeration level[5]. These consist of about 584 EAs across the four waves, enabling EA-fixed effects in our analysis. We also use household and Individual-level datasets at various stages of the analysis for a holistic understanding of our results. We focus on a repeated cross-sectional data.

Our main outcome variables are the anthropometric outcomes for children aged 0 to 59 months. These constitute children born across 14 years from 2010

[5] The GPS coordinates enable us to link each cluster to the nearest LGA by taking into consideration the displacement factor across clusters for rural and urban areas.

to 2018[6]. We rely on household-level demographic variables and those specifically relating to mothers and partners for controls in our empirical analysis. For anthropometric health outcomes, we use age-standardized weight (WAZ) and height (HAZ) z-scores as measures of child short- and long-term early-life health indicators. We compute the WAZ and HAZ variables using WHO's computation guidelines. The GHS data provides details on each child's survey dates, age in months at survey, and exact date of birth. We use these details to link each observation/child to diverse conflict exposure measures, namely contemporaneous conflict exposure and fetal conflict exposure indices. We also follow the literature to construct an indicator variable for the occasion of stunting/underweight, which assigns 1 to a child below a threshold of -2 standard deviation units and 0 otherwise.

The Armed Conflict Location & Event Data (ACLED) Project

To measure conflict shocks, we use conflict data from ACLED. This data captures exposure to armed conflict from the Fulani ethnic militia (FEM) group. ACLED documents historic FEM conflict activities across Africa from 2000 to 2021. The archive provides estimates of monthly variation in conflict activities by providing the GPS location of each conflict event. The variables provided include the number of occurrences and reported deaths.

ACLED database has been extensively used for empirical studies on the impacts of conflicts and terrorism on welfare outcomes (Nwokolo 2017, Dagnelie *et al.* 2018, Ouili 2017, Adelaja and George 2019, Bertoni *et al.* 2019, Ige 2019, Odozi and Oyelere 2019, George *et al.* 2021). Alternative conflict, terrorism, and political unrest databases include the Global Terrorism Database (GTD) and the Uppsala Conflict Data Program (UCDP). However, ACLED provides a higher resolution GPS coordinate of locations of armed conflicts required in this study, hence the preference. Another justification for using ACLED is the credible nature of conflict data as demonstrated in other studies (Adelaja and George 2019; George and Adelaja 2022; George *et al.* 2021). This source of data also has extensive coverage for rural areas compared to others, which is quite useful in our current context.

[6] The distribution of the birth periods across survey years overlap to some extent as outlined in the following: i) Survey year 2010 respondents constitute children born between 2005 to 2010 ii) Survey year 2012 respondents are born between 2007 to 2012 iii) Survey year 2015 respondents are born between 2010 to 2015 iv) Survey year 2018 respondents are born between 2015 to 2018.

5. Empirical analysis

Conflict exposure

We measure FEM conflict shocks for each child observation at the enumeration area (EA) level over time. For this measure, we rely on a measure of conflict intensity namely the number of reported fatalities resulting from FEM conflict incidences. Equation (6) presents conflict exposure (CE):

$$conflict\ exposure\ (CE)_{cy} = \ no\ of\ fatalities_{cy} \qquad (6)$$

where $no\ of\ fatalities_{cy}$ denotes the number of deaths resulting from FEM conflict incidences within the specific location. c is cluster, and y represents the exposure year of interest.

Estimation methods

We estimate a reduced-form econometrics model prominently used for estimating the association of early life shocks with child anthropometric health outcomes. This approach follows the extensive literature that investigates the impacts of exposure to conflict and subsequent impacts on child health outcomes (Akresh *et al.* 2012; Akresh *et al.* 2016; Ekhator-Mobayode and Abebe Asfaw 2019; George et al. 2021; Wald 2014). We use an approach that explores the differential timing of the conflict events by using variation in both fetal and contemporaneous conflict shocks for a broader understanding of the main determinant of early life health outcomes. This approach invariably supports the understanding of potential pathways linking conflict exposure to anthropometric outcomes. Equation (7) presents the estimated model for the association of fetal CE on child health.

5.2.1 Fetal conflict exposure

$$\text{Child health}_{ilym} = \alpha_{lm} + \gamma_t + \beta_1 \text{CE}_{c,y} + X_i' \theta_x + Z_{ct}' \theta_z + \varepsilon_{ilym} \qquad (7)$$

Where $\text{Child health}_{ilym}$ represents early life health outcomes for an observation child *i* in an EA *l* for children born in year *y* and month *m*. We use alternative long-term and short-term anthropometric health measures, namely HAZ and WAZ, respectively. α_{lm} is the EA by month–of–birth fixed effects, γ_t is the survey year fixed effects and ε_{ilym} is the error term. We cluster standard errors at the EA level to address the spatial correlation. The parameter of interest β_1 measures the effect of fetal conflict exposure during in utero period to convey transmission of effect from mothers. The estimated effect from eq. (7) denotes intergenerational transmission of conflict effects.

5.2.2 Contemporaneous conflict exposure

$$\text{Child health}_{ilym} = \alpha_{lm} + \gamma_t + \beta_2(\text{CE}_{c,s} + \text{CE}_{c,s-1} + \text{CE}_{c,s-2}) + X_i' \theta_x + Z_{ct}' \theta_z + \varepsilon_{ilym} \tag{8}$$

The parameter of interest in equation (8) is the contemporaneous conflict exposure measure, which interacts with the period of survey. $\text{CE}_{c,s}$ indicates exposure to conflict in the survey year, $\text{CE}_{i,s-1}$ indicates exposure to conflict, measured one year before the survey year, and $\text{CE}_{i,s-2}$ indicates exposure to conflict, measured two years prior. The main difference between equations (7) and (8) is that the sequence of conflict exposure measures is referenced by the year of surveys for each child in the latter. All fixed effects in Equation (7) are included in the above. Our estimation strategy explores progressive expansion in the coverage of FEM activities. This approach relies on the fact that FEM has grown over the four surveys covered in the GHS. Our analysis relies on both intensive and extensive margins of this growth, which has spread over time and across geopolitical zones, originating from the States located in the North Central. The main assumption of the estimation strategy is that expansion in exposure is exogenous to local household characteristics.

In the analysis, we include covariates in our regression models to improve the precision of our coefficients. These include individual-level controls (denoted as *X*) across children and their parents. *Z* is an array of household-level controls, including household size, age of household head, location of household, and an indicator variable for the gender of the head of household. Extant studies have found that boys are more likely to be wasted and undernourished than girls, while children located in rural areas are also more likely to be undernourished (Mertens et al., 2020; Yaya et al., 2022). Being part of a large household also increases the odds of under-five child stunting (Yaya et al., 2022). Children in female-headed households were less likely to be stunted than those in male-headed households (Dorsey et al., 2018). We also control for the distance from the household to the nearest major road and the State capital to account for the effect of household remoteness on child nutrition and health (Lopez et al., 2018). Finally, we include an exposure measure for other localized conflicts to avoid confounding the effects of FEM with these. We focus on Boko Haram conflict data from ACLED using the exposure to it as a control to isolate the effect of our FEM exposure variables as described in Equations (7) and (8). The error term in Equations (7) and (8) is assumed to be identically and independently distributed (iid) across enumeration areas but correlated within each enumeration area due to the spatial correlation of the conflict exposure. To account for this issue, we report standard errors clustered at the EA level. We use an integrated cluster function with the regression commands to account for clustering during the analysis.

Descriptive statistics

Table 1 presents the summary statistics of key variables. Our key outcome variables are the anthropometric indicator proxies for child health – height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), stunting, and underweight. The average HAZ is -0.369 with a stunting rate of 22 per cent. The average WAZ is -0.219 with an underweight rate of 8.7 per cent. The main explanatory variables capturing the influence of FEM conflict exposure on child nutrition are the fetal and contemporaneous variables. The fetal conflict variable captures exposure to FEM conflict during the year of birth of a child. The mean age of children in our sample is about 32 months, and approximately half of the children are male. About 75 per cent of children in our sample reside in rural areas.

Table 1: Summary Statistics of key variables

Variables	Definition	Mean	SD	Min	Max
Key outcome variables					
HAZ	Height-for-Age Z-scores for children under five years of age.	-0.369	2.068	-5	4.99
Stunted	1 if child is stunted, 0 otherwise.	0.220	0.415	0	1
WAZ	Weight-for-Age Z-scores for children under five years of age.	-0.219	1.495	-5	5
Underweight	1 if child is wasted, 0 otherwise.	0.087	0.282	0	1
Key explanatory variables					
In utero death exposure	Number of FEM conflict fatalities during the child's year of birth.	7.851	15.115	0	100
Contemporaneous death exposure	Number of FEM conflict fatalities within three years of the survey year.	21.489	24.290	0	150
Control Variables					
Household size	Number of household members.	8.524	3.749	2	33
Boy child	1 if the child is a boy, 0 otherwise.	0.514	0.500	0	1
Location	1 if household resides in a rural area, 0 otherwise.	0.746	0.435	0	1
Religion	1 if household is Christian, 0 otherwise.	0.036	0.186	0	1
Gender	1 if household head is male, 0 otherwise.	0.938	0.241	0	1
Age of household head	Age of household head (years).	44.500	11.426	18	102
Age of child	Age of child (months).	32.511	15.826	0	60
Distance to road	Distance to nearest major road (km).	8.548	12.180	0	106.6
Distance to capital	Distance to State capital of residence (km).	61.494	55.708	0.2	309
Boko Haram States	1 if household is located in a Boko Haram state, 0 otherwise.	0.232	0.422	0	1

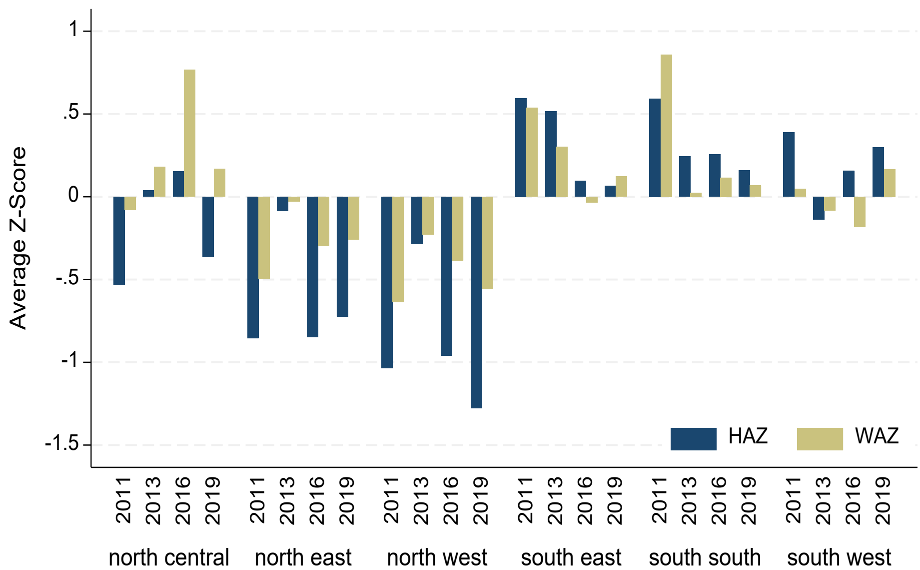
Table 2 shows the mean distribution of the key variables by gender and age group of the child. On average, boys are more stunted and overweight than girls. Similarly, children aged 30 months and above are more stunted and overweight than children younger than 30 months. In our sample, boys were significantly more located in Boko haram states compared to girls. Children aged less than 30 months had significantly more exposure to in utero conflict, while those aged 30 months and above had more exposure to contemporaneous conflict. Furthermore, older children are part of larger households and reside farther away from main roads and state capital of residence compared to younger children. There are no significant gender differences in terms of in-utero and contemporaneous conflict exposure, household size, location, religion, gender and age of household head, distance to road, and state capital.

Table 2: Mean distribution of key variables by gender and age group

	Gender			***Age***		
	Girls	*Boys*	*Diff*	*0-29 months*	*30-60 months*	*Diff*
HAZ	-0.292	-0.411	0.118***	0.09	-0.697	0.786***
Stunted	-0.045	-0.163	0.117***	0.243	-0.403	0.645***
WAZ	0.206	0.237	-0.032***	0.19	0.246	-0.057***
Underweight	0.087	0.114	-0.028***	0.083	0.12	-0.038***
In-utero death exposure	7.16	7.463	-0.302	7.681	3.908	3.773***
Contemporaneous death exposure	21.407	21.302	0.104	20.758	21.727	-0.969***
Household size	8.428	8.421	0.007	8.256	8.566	-0.309***
Location	0.745	0.75	-0.006	0.738	0.748	-0.01
Religion	0.033	0.036	-0.003	0.044	0.022	0.022***
Gender	0.939	0.943	-0.005	0.942	0.939	0.003
Age of household head	44.205	44.041	0.165	43.572	45.391	-1.819***
Distance to road	61.367	62.358	-0.991	58.143	65.757	-7.614***
Distance to capital	9.01	9.19	-0.179	9.284	9.884	-0.6***
Boko Haram States	0.211	0.233	-0.022***	0.227	0.228	-0.001

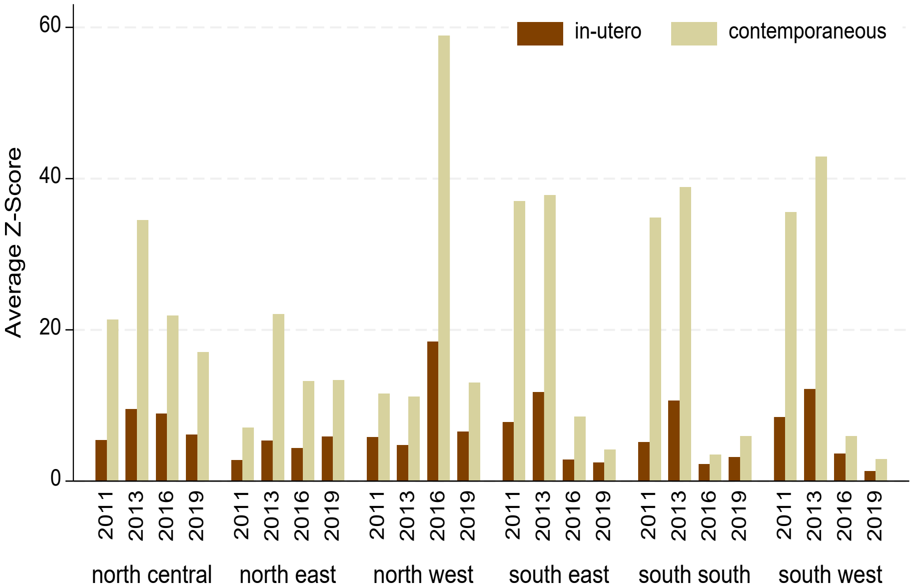
Figures 1 and 2 present the mean distribution of child nutritional outcome and FEM conflict exposure by survey period and geopolitical zone. Regarding HAZ and WAZ scores, children in the country's northern regions rank below the mean height and weight compared to children in the southern regions on average. This suggests that children in the northern regions are more malnourished.

Figure 1: Average child nutrition outcome by survey period and geopolitical zone



Source: LSMS-ISA Survey Data

Figure 2: Average in-utero and contemporaneous conflict exposure by survey period and geopolitical zone



Source: LSMS-ISA Survey Data

In terms of in-utero and contemporaneous FEM conflict exposure, Figure 2 shows that on average contemporaneous conflict exposure was higher than in-utero conflict exposure. Also, the children in the southern region were exposed to more contemporaneous conflict than children in the north.

6. Results

Effect of FEM conflict exposure on child health outcomes

This section presents the estimation results from equations (7) and (8) for anthropometric child health outcomes captured by the HAZ and WAZ. Tables 2 and 3 report baseline results for the association between conflict exposure through in-utero or contemporaneous shock pathways, respectively. Panels A and B in Table 3 report estimated coefficients of in-utero FEM conflict exposure from Equation 7 using HAZ and WAZ as the dependent variables. These results are estimated from the in-utero model specified in Equation (7) with staggered inclusion of covariates, survey year fixed effects, and EA by month–of–birth fixed effects to attain full specification in Column 4. All columns represent the estimated effect of FEM conflict exposure with EA by month–of–birth fixed effects. Including EA by month–of–birth fixed effects help to control for conditions around the period of birth that may affect short-term health outcomes. Column (2) includes all covariates used as control variables, as highlighted in section 5 above. Column (3) includes survey year fixed effects, while Column (4) includes additional control from exposure to Boko Haram insurgency. All regressions are clustered at the enumeration area level.

Panel A Column 1 shows a statistically insignificant coefficient for the association between in-utero conflict exposure and HAZ with EA by month–of–birth fixed effects. The coefficient estimate increased significantly and was precisely estimated for Columns 2 – 4. The coefficient estimates range from -0.0059 to -0.0061 across the models. These coefficients are significant at the 10 percent level, respectively. The direction of the coefficients suggests that an increase in in-utero conflict exposure decreases average HAZ across under-five year children by 0.0059 – 0.0061 standard deviation units. There is no observable difference in results for the selection of covariates used in our models (individual and household characteristics) and the survey year. The results can be interpreted as declining long-term health outcome due to in-utero exposure to FEM conflict. Panel B of Table 3 reports results for the short-term outcome – WAZ. The results show an insignificant relationship between intrauterine FEM conflict exposure and short-term child development. This suggests that in-utero conflict may not be considered responsible for inhibiting short-term child development.

Table 3: Association between in-utero conflict exposure and children's anthropometric outcomes

Variables	(1)	(2)	(3)	(4)
Panel A – HAZ				
In utero Conflict exposure	0.0000	-0.0059*	-0.0061*	-0.0061*
	(0.0035)	(0.0033)	(0.0032)	(0.0032)
Constant	-0.1227***	2.0394***	1.9180***	1.9243***
	(0.0277)	(0.3546)	(0.4943)	(0.4997)
Observations	2,398	2,396	2,396	2,396
R-squared	0.4625	0.5423	0.5442	0.5442
Panel B – WAZ				
In utero Conflict exposure	0.0023	-0.0028	-0.0031	-0.0031
	(0.0029)	(0.0026)	(0.0025)	(0.0025)
Constant	0.1469***	1.5944***	2.2996***	2.3085***
	(0.0224)	(0.3247)	(0.3819)	(0.3866)
Observations	2,801	2,799	2,799	2,799
R-squared	0.4060	0.4950	0.4995	0.4995
MOB-YOB	YES	YES	YES	YES
Controls	NO	YES	YES	YES
Year FE	NO	NO	YES	YES
Boko Haram	NO	NO	NO	YES

Notes: Table 3 presents the results for in utero conflict exposure (equation 6). Model 1 presents parsimonious estimates for in utero conflict exposure with child month-of-birth fixed effects, Model 2 includes other control variables, Model 3 includes survey year fixed effects while Model 4 controls for States affected by Boko-Haram insurgency violence. Other covariates include household, household head, and child characteristics. See section 5 for a list of covariates included in the regression models. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

In Table 4, we present estimation results of the association between contemporaneous FEM conflict exposure and child anthropometric outcomes. Here, the models capture estimated effects for cumulative years, including the survey year of each child. This approach underscores the importance and relevance of both immediate and recent periods in documenting contemporaneous exposure to FEM conflicts in the literature. On average, exposure of a child to contemporaneous FEM conflict decreases an average child's HAZ by -0.0082 to -0.0100 (Table 4 Panel A). Coefficient estimates are much smaller for WAZ outcomes at -0.0059 to -0.0064 (Table 4 Panel B). All results are statistically significant at 1 percent. Also, the main difference between the estimated results reported in Table 4 and those presented in Table 3 is that parsimonious models in column 1 is precisely estimated in Table 4. This implies that contemporaneous exposure to FEM conflict has a nonnegligible association with child health outcomes. In general, the findings presented in Tables 3 and 4 are consistent with those of Ekhator-Mobayode and Asfaw (2019) and Ige (2019), who reported that an increase in exposure to Boko Haram insurgency adversely affects under five child anthropometric outcomes in Nigeria . Akresh et al. (2022) and Dagnelie et al. (2018) also report similar findings.

Heterogenous effects

Gender

In Table 5, we present heterogeneous effects of FEM conflict pathways by gender. We find an interesting pattern of gendered effects across different types of FEM conflict exposure. Results show a statistically significant set of results for the contemporaneous FEM conflict pathway. Notably, estimated effects are stronger for girls with HAZ (Column 2) while estimated effects are stronger for boys with WAZ (Column 4). This implies that the baseline result reported in Table 4 Panel B is driven by the estimated effect on the girls' sample, while results presented in Table 4 Panel A are driven by the boys' sample. Invariably, this means girls are more affected by contemporaneous FEM conflict exposure in the long-term health outcome relative to boys while boys are more susceptible to FEM conflict exposure with short-term health outcomes. Comparing in-utero FEM conflict results in columns (1) and (3) shows that coefficient estimates are significant for only boys. Even though the estimates for the sample of girls in Panel B have comparable magnitudes to those reported for boys in Panel A, the lack of statistical precision undermines this pattern. This indicates an asymmetry in the effect of in-utero FEM shock and can be interpreted as boys being more fragile to in-utero conflict exposure relative to girls. This pattern persists for both short- and long-term child health outcomes. This finding supports the Trivers–Willard hypothesis that male foetuses are more fragile than females.

Studies have found that in-utero exposure to conflict shock results in either a miscarriage or a female birth (Valente, 2015; Veller et al., 2016). This implies that adverse intrauterine conflict shocks result in a sex ratio skewed in favour of girls, which confirms our culling hypothesis in Section 3. The result in Table 5 can be interpreted as transitional gendered-differential asymmetric heterogeneous effects demonstrated across pathways and outcome measures.

Table 5: Heterogeneous effects across gender

	Dependent variables:			
	HAZ		WAZ	
	In utero	Contemporaneous	In utero	Contemporaneous
Variables	(1)	(2)	(3)	(4)
Panel A: Boys				
Conflict exposure	-0.0097**	-0.0090***	-0.0081**	-0.0069***
	(0.0047)	(0.0021)	(0.0041)	(0.0022)
Constant	2.3020***	1.8889***	1.9642***	1.9592***
	(0.8246)	(0.5610)	(0.6027)	(0.4530)
Observations	898	2,507	1,068	2,783
R-squared	0.5881	0.5195	0.5933	0.4811
Panel A: Girls				
Conflict exposure	-0.0081	-0.0112***	-0.0051	-0.0038**
	(0.0069)	(0.0020)	(0.0040)	(0.0017)
Constant	1.5425	1.7712***	2.4801***	2.2620***
	(1.0270)	(0.6327)	(0.5640)	(0.4119)
Observations	808	2,255	958	2,512
R-squared	0.5857	0.4913	0.6000	0.5002
MOB-YOB	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Boko Haram	YES	YES	YES	YES

Notes: Table 5 presents heterogeneous results for in utero and contemporaneous conflict exposures (equations 6 and 7) by gender. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

Age groups

We explore the heterogeneity of FEM conflict exposure by age group. To decompose our total sample analysis, we use a 12-month threshold concurrent with the reported age of children at the time of the survey for all children in our sample. This exercise aims to examine potential differences in estimated effects between younger and older children. In this regard, the sample of under-five children observations were decomposed to 0 to 12 months, 13 to 24 months, 25 to 36 months, 37 to 48 months, and 49 to 60 months. This analysis helps to unveil the heterogeneous effects across these five groups for policy targeting. We repeat regressions for the fully specified models in Tables 2 and 3 for each sub-sample. Heterogeneous results for age groups are reported in Table 6. Coefficient estimates in Table 6 present the progressive effects of contemporaneous FEM conflict exposure on HAZ and WAZ from the first age group – 0 to 12 months – to the last age group – 48 to 60 months. Generally, coefficients for contemporaneous exposure in the last two sub-groups are much larger than baseline estimates reported for HAZ and WAZ in Tables 2 and 3. There is no unique pattern for the estimated results of in-utero FEM conflict exposure (Columns 1 and 3). The size of estimated coefficients of the contemporaneous FEM conflict exposure for the older sub-group (37 – 60 months) signifies that there is persistence in early life FEM conflict effects in this age group which seems to be subdued in the younger group. Also, larger estimates than the baseline estimates for contemporaneous exposure suggest that children in this age group respond disproportionately to early life shocks after they have been born.

Table 6: Heterogenous effects across age groups

	Dependent variables:			
	HAZ		WAZ	
	In utero	Contemporaneous	In utero	Contemporaneous
Variables	(1)	(2)	(3)	(4)
Panel A: Age 0 – 12 months				
Conflict exposure	-0.0145*	-0.0084*	-0.0034	-0.0057**
	(0.0087)	(0.0047)	(0.0046)	(0.0028)
	1.6156*	1.5729*	2.4329***	2.4379***
Constant	(0.9234)	(0.9186)	(0.5486)	(0.5467)
Observations	705	708	957	960
R-squared	0.5997	0.5984	0.7056	0.7069
Panel B: Age 13 – 24 months				
Conflict exposure	-0.0040	-0.0094**	-0.0006	-0.0062
	(0.0084)	(0.0037)	(0.0062)	(0.0038)
	2.4271	2.6445	0.5079	0.6919
Constant	(1.6445)	(1.6326)	(1.2869)	(1.3028)
Observations	568	586	606	626
R-squared	0.4770	0.4904	0.5059	0.5180
Panel C: Age 25 – 36 months				
Conflict exposure	0.0501	-0.0076**	0.0726**	-0.0125***
	(0.0353)	(0.0035)	(0.0296)	(0.0033)
	-0.8847	0.4053	-0.6764	0.1082
Constant	(1.5197)	(0.8456)	(1.4106)	(0.9180)
Observations	160	717	180	753
R-squared	0.5263	0.5412	0.5558	0.4919
Panel D: Age 37 – 48 months				
Conflict exposure	NA	-0.0119***	NA	-0.0059**
		(0.0026)		(0.0028)
		2.0984**		-1.5914
Constant	NA	(0.9417)	NA	(0.9962)
Observations	NA	745	NA	792
R-squared	NA	0.5577	NA	0.4919
Panel E: Age 49 – 60 months				
Conflict exposure	NA	-0.0129***	NA	-0.0121***
		(0.0029)		(0.0029)
		0.2478		-0.2051
Constant	NA	(1.2493)	NA	(0.9583)
Observations	NA	165	NA	179
R-squared	NA	0.5912	NA	0.6181
MOB-YOB	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Boko Haram	YES	YES	YES	YES

Notes: Table 6 presents heterogeneous results for in utero and contemporaneous conflict exposures (equations 6 and 7) by age groups. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively. NA denotes not available because associated age categories have insufficient observations.

Socioeconomic classification for residential location

Table 7 presents results by socioeconomic classification for place of residence using rural and urban classification. Panel A reports estimated effects for children residing in a rural location, while Panel B reports results for urban dwellers. We observe that coefficient estimates for the rural sample are generally stronger than their counterparts in urban areas. The results are also precisely estimated in all cases for the rural sample while only contemporaneous FEM exposure for HAZ is statistically significant for the urban sample. These results demonstrate clear asymmetric patterns in the effects of FEM exposure across conflict pathways between rural and urban dwellers. There is a clear indication that the baseline results (in Tables 2 and 3) are driven by estimated effects for the rural sample. The results are consistent with a priori expectations. This is because the effect of FEM conflicts on anthropometric health outcomes is designated through the food security (nutrition) channel. It is unlikely that this channel will hold for urban households who do not necessarily rely on agricultural cultivation for nutritional resources.

Table 7: Heterogenous effects across socioeconomic classification for place of residence

	Dependent variables:			
	HAZ		WAZ	
	In utero	Contemporaneous	In utero	Contemporaneous
Variables	(1)	(2)	(3)	(4)
Panel A: Rural				
Conflict exposure	-0.0078*	-0.0107***	-0.0058**	-0.0064***
	(0.0043)	(0.0017)	(0.0029)	(0.0022)
Constant	1.0882*	1.3921***	1.8119***	1.7569***
	(0.6079)	(0.4276)	(0.4882)	(0.3566)
Observations	1,785	4,527	2,109	4,974
R-squared	0.5405	0.4597	0.5506	0.4430
Panel A: Urban				
Conflict exposure	-0.0045	-0.0066**	-0.0066	-0.0032
	(0.0062)	(0.0025)	(0.0053)	(0.0023)
Constant	1.4922	1.0789	2.2836***	1.9937***
	(1.0178)	(0.6734)	(0.8119)	(0.6463)
Observations	496	1,306	557	1,432
R-squared	0.6149	0.5019	0.5929	0.4746
MOB-YOB	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Boko Haram	YES	YES	YES	YES

Notes: Table 7 presents heterogeneous results for in utero and contemporaneous conflict exposures (equations 6and by place of residence. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

Investigating channels of FEM conflict-health nexus.

Our results suggest that FEM conflict exposure during in-utero and early stages of life simultaneously affects children's anthropometric health measures. We further provide additional evidence of the disproportionate effects of each conflict exposure on the rural sample relative to urban (Table 7). This composition signals a high potential for disruption to the agricultural production pathway. To investigate this further, we examine a collection of household economic resources to unravel the channels through which FEM conflict affects child health. Figure A1 provides a diagrammatic illustration of the potential linkages between conflict and selected socioeconomic characteristics as channels for health outcomes.

We focus on household socioeconomic characteristics with the potential for linking FEM conflicts to health outcomes. These include agricultural productivity variables such as area of farmland cultivated, food security indicators, and access to sanitary lavatories. Households that have been exposed to armed conflict are more likely to report higher food insecurity than those that have not been exposed (Nnaji et al., 2022b). This highlights the channel through which agricultural production may be distorted, leading to food insecurity. The Nigerian GHS panel data reports several food insecurity indicators. Household heads were asked if they had to rely on less preferred food or limit the variety of food consumed in the last seven days due to food scarcity. We use these indicators as a measure of food insecurity to evaluate the nutrient loss associated with FEM conflict exposure across children. Other channels underlying the transmission of FEM conflict to health outcomes are access to sanitary toilets (Geere and Hunter, 2020). These may directly affect health, mostly plausible within rural areas where inadequate access to hygienic lavatories can further increase the risk of fecal-food cross-contamination, which will invariably have dire consequences for health outcomes.

We report the results of the estimation of contemporaneous FEM conflict exposure on each of the channel outcomes at the household level. The results of the potential channels are presented in Table A4 and mainly highlight an association between FEM in-utero conflict exposure and food security measures alongside the area of cultivated farmland and access to hygienic toilet facilities. Conversely, the food security indicators are insignificant for contemporaneous FEM conflict exposure. Reasons for the lack of this effect for postnatal exposure of armed conflict may be because of the localized nature and timing of the conflict (Maystadt and Ecker, 2014), postnatal food interventions, and humanitarian aid (Maxwell et al., 2012), as well as established household resilience and coping strategies to sustain nutrition

(Béné et al., 2014). While the interaction of food security and conflict is extensively documented in the literature, there is no paper on the role of sanitation. Our explanation for the established linkage in our result is that conflict events simultaneously breed a disease environment. Similarly, the pathway here may be interpreted as resulting from a restrictive environment during conflicts with little access to basic hygiene facilities such as flush toilets.

Our results on the potential transmission channels – agricultural production, food security, and sanitation – have implications for policy interventions capable of addressing the consequences of FEM conflict. Investments in sustainable agriculture and resilient farming techniques can help mitigate food insecurity in the long term, even amidst recurring conflicts. Public health campaigns and infrastructure investments in hygiene and sanitation facilities in conflict-affected communities that focus on ensuring access to safe and hygienic toilet facilities for households with young children are crucial to preventing the spread of disease and improving overall child health. Our results highlight the need for policies that offer incentives for peaceful coexistence between farmers and herders, such as creating protected ranches and grazing zones for herders and improving land tenure security for farmers. Investing in agricultural infrastructure, such as irrigation and storage facilities or agricultural extension support, can also help restore productivity and improve food security in conflict-affected areas. Implementing early warning systems and conflict mediation dialogue platforms for farmers and herders can help defuse tensions before they escalate into violence, ultimately protecting households and children from the adverse effects of conflict. Conflict prevention and peaceful resolution efforts must be integrated into development programs to address the root causes of violent conflicts and ensure long-term resilience for affected communities.

Discussions

The first observation from the pattern of association between exposure periods is the asymmetry in the HAZ and WAZ coefficients within in-utero and contemporaneous conflict exposure designations. Exposed children experience a higher magnitude of HAZ decline during the contemporaneous exposure period compared to the in-utero exposure relative to the unexposed group; the reverse is the case with WAZ estimations. More specifically, the magnitude of the FEM conflict exposure coefficient estimates for HAZ strengthened by approximately 40 percent between in utero and contemporaneous FEM exposure from -0.0061 (Panel A, 3 Column 4) to -0.0100 (Panel A, Table 4 Column 4), while those for WAZ was insignificant for in utero exposure (Panel B, Table 3 Column 4) but -0.0059 and significant at 1% for contemporaneous exposure (Panel B, Table 3 Column 4). This pattern suggests asymmetric effects of in-utero and contemporaneous conflict shocks and hence, highlights the need to estimate the effects of exposure at different timelines to understand the dynamics of FEM conflicts better. Second, the effect of contemporaneous FEM conflict shocks is better established as indicated by statistical significance from the parsimonious model.

Table A1 reports the results of associated effects on health outcomes for stunting and underweight. These estimated coefficients are consistent with expected patterns and higher average stunting and underweight levels with increased exposure to FEM conflict (Chaudhry & Mir, 2021). Estimated coefficients for the effect of in-utero and contemporaneous FEM conflict exposure on the probability of stunting and being underweight are positive and statistically significant. These results agree with our main findings in Tables 3 and 4 and are important for policy guidelines. An increase in the likelihood of stunting or being underweight for children exposed to in-utero FEM conflict relative to the unexposed group suggests that in-utero FEM conflict may have the potential to scar long-term health. In-utero or prenatal conflict is most likely to influence mothers' prenatal healthcare, like routine prenatal care visits, immunizations, and medications, which will subsequently have implications for the child's birth weight and consequent health. Similarly, contemporaneous exposure to armed conflict is also likely to influence neonatal and postnatal child healthcare negatively, further exacerbating adverse nutritional outcomes. Also, the significant effect of FEM exposure on the area of land cultivated suggests shortfalls in agricultural production as a result of FEM conflict, which invariably increases the risk of food insecurity for agricultural households and the subsequent decline in child nutritional outcomes. Notwithstanding, the persistence in the effects of the main outcomes between in-utero and contemporaneous shocks is also important for policy.

Spillover effects

There is extensive literature on the interaction of armed conflicts across groups, especially when conflicts are observed within the same geographic location and timeframe. In Nigeria, there is evidence of temporal and spatial relationships between Boko Haram attacks and violent farmer-herder conflicts (Odozi & Oyelere, 2019; George *et al.,* 2021). This literature shows that an increase in Boko Haram attacks increases the incidence of FEM attacks suggesting that terrorist violence has spillover effects via an increase in violent farmer-herder conflicts. This implies that Boko Haram events may partly drive our estimated results. To address this concern, we control for Boko Haram activities across the country. We use the data on the propensity of exposure to

Boko Haram activities by controlling for Boko Haram-affected states in our regression using dummies. This approach captures a sensitivity test for actions of concurrent conflict exposure that may bias our initial estimates. To conduct this sensitivity test, we report estimated coefficients for adjusted regression for full specification of baseline results in Tables 3 and 4 (Column 4). Estimated coefficients with and without the Boko Haram indicator are very similar across FEM exposure pathways and outcomes.

FEM conflict and Boko Haram insurgency

Secondly, we conduct further sensitivity tests on the baseline results reported in Tables 3 and 4. The intensity of FEM conflict activities is more widespread in the Northern part of Nigeria, precisely in North East, North West and North Central regions. Including GHS children's observations across the whole country may enhance the representation of exposure. Using the ACLED datasets, we identified the exact states across the geopolitical zones with early exposure for our analysis. The States with conflict data for our period of interest are Adamawa, Bauchi, Benue, Ekiti, Kaduna, Kogi, Nasarawa, Plateau, and Taraba. Observations from these nine states account for 25 percent of the children surveyed. For the exposure sensitivity test, we regress a new set of results focusing on the nine states where we believe the exposure distribution does not credibly reflect variation for the entire country over the period. Table A2 presents the estimated result for this sample of children. These results are weaker and statistically imprecise relative to baseline results. The size of the effects here suggests that the inclusion of no-conflict states truly depicts the expansion of exposure to FEM conflicts over the period.

FEM conflict and weather patterns

The effect of FEM activities may be complementary to exogenous shocks such as weather events. This includes drought regimes, flood events, and extreme heat shocks that may directly influence long-term health outcomes for both exposure periods. To address this concern, we include a secondary covariate for weather shocks by controlling for rainfall and temperature deviations for each exposure period in the regression process. The results of this regression process are reported in Table A3. Estimated coefficients for FEM conflict exposure across periods remain the same. Outcomes of these robustness checks show stability in our estimated coefficients for the effect of FEM conflict exposure on long-term health outcomes.

Falsification test

Finally, we conduct falsification tests on the baseline results reported in Tables 3 and 4. Table 8 presents estimated coefficients for both in utero and contemporaneous placebo FEM conflict exposure. The placebo variables are computed in contrast to appropriate referencing methods that we designed to capture matching with relevant periods. For example, we capture placebo in utero exposure as the FEM measure before the year of birth of children. Also, we measure FEM exposure within three to four years before the survey year. These are irrelevant periods for capturing nutrition pathways as they do not capture in utero shock or contemporaneous shocks, in stark contrast to our baseline framework. Each Panel for Table 8 reports results for the placebo regressions for HAZ and WAZ, where Panel A presents in utero placebo and Panel B, the contemporaneous placebo. The coefficient estimates are smaller than baseline estimates across baseline full specifications (Column 4 of Tables 3 and 4). These are also statistically insignificant indicating that the baseline results are aligned with the nutrition channel established in our conceptual framework.

Table 8: Falsification tests for baseline FEM exposure results

	Dependent variables:	
	HAZ	WAZ
Variables	(1)	(2)
Panel A:		
Placebo in utero exposure	-0.0005	0.0014
	(0.0077)	(0.0051)
Constant	0.5461	1.7574***
	(0.6019)	(0.5219)
Observations	1,417	1,784
R-squared	0.5282	0.5508
Panel B:		
Placebo contemporaneous exposure	-0.0444	-0.0264
	(0.0641)	(0.0518)
Constant	2.1372***	1.7631***
	(0.6093)	(0.5203)
Observations	1,331	1,575
R-squared	0.5701	0.5807

MOB-YOB	YES	YES
Controls	YES	YES
Year FE	YES	YES
Boko Haram	YES	YES

Notes: Table 8 presents falsification test results. The models use placebo in utero and contemporaneous conflict exposures. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

7. Conclusion and Policy Implications

In this paper, we examine the effects of exposure to Fulani Ethic Militia (FEM) conflicts on anthropometric health outcomes using nationally representative repeated cross-sectional data from four waves of the Nigerian General Household Survey merged with conflict data from ACLED. We capture short- and long–term health outcomes using the weight-for-age and height-for-age z-scores. Our findings show that the association between FEM conflict and health outcomes is complementary across prenatal and postnatal exposure, suggesting persistence in the effects of early-life FEM conflict exposure. The effect is more severe in rural areas compared to urban areas. Also, girls are more affected by contemporaneous FEM conflict exposure in the long-term health outcome relative to boys, while boys are more susceptible to FEM conflict exposure with the short-term health outcome. Older children are more negatively affected by contemporaneous FEM conflict exposure (postnatal exposure). Agricultural productivity, food security, and access to sanitary toilet facilities were found to be established pathways of FEM conflict effect on child health and nutrition.

Our findings are consistent with evidence from other countries on the negative impact of violence and conflict on child nutrition. This study provides additional insight into the effect of multiple FEM conflict exposure pathways – potential channels of the effect of FEM conflict events using micro-level evidence – and probable policy interventions to address such exposure. The findings of this study have significant implications for policy interventions aimed at mitigating the effects of FEM conflict on child health, particularly in regions where such conflicts are prevalent. Timely and targeted prenatal interventions within the first 1000 days of a child are essential to break the chain of adverse impacts from exposure to armed conflict. Government and non-governmental development organizations should prioritize food aid programs and interventions for children and pregnant women in conflict-affected areas. This may alleviate micronutrient nutritional deficiencies due to reduced agricultural productivity.

Given the inherent significance of good health and well-being for economic development, the findings of this study suggest that the continuous risk of FEM conflict (increased incidence and severity) will have adverse consequences for improved short- and long-term health. This signals for the need for policies and interventions targeted at conflict prevention and peaceful resolution to foster sustainable agricultural productivity, sanitation, and subsequent health and well-being. One area for future research is to explore the effects of FEM on birth outcomes. For example, results from birth weight will provide further evidence of the generational pathway to fetal conflict exposure that we started in this paper.

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Appendix Figures and Tables

Figure A1 Potential channels of the impact of conflict on early life health outcomes

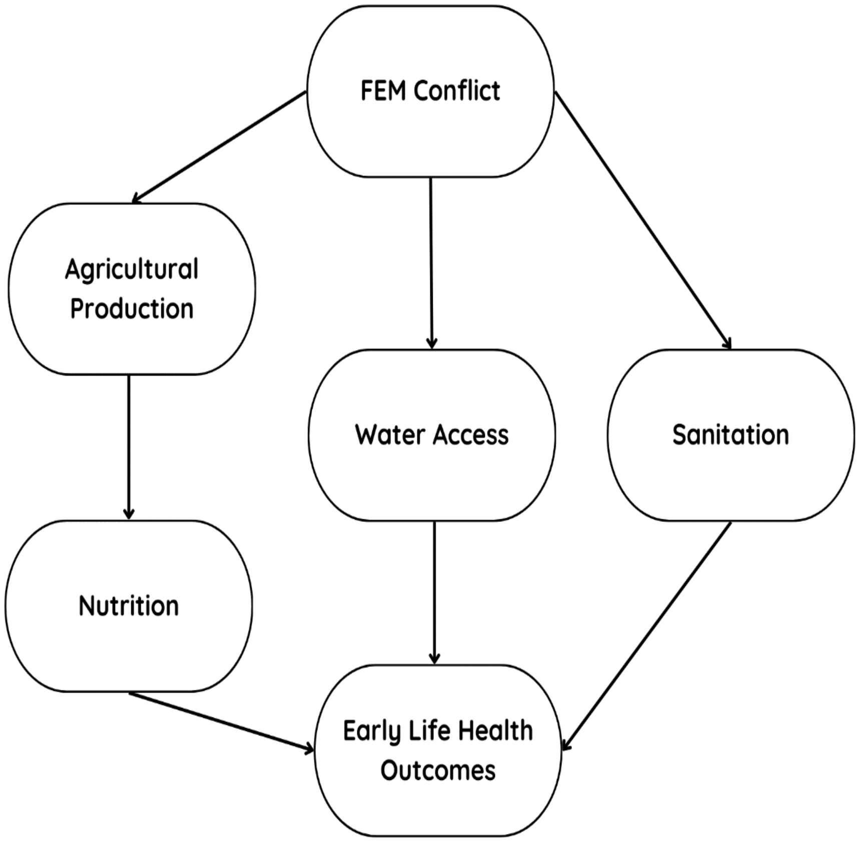

Table A1: Effect of FEM exposure on stunting and underweight indicators

	Dependent variables:	
	Stunting	Underweight
Variables	(1)	(2)
Panel A:		
in utero exposure	0.0086***	0.0069*
	(0.0030)	(0.0038)
Constant	-3.1245***	-4.2576***
	(0.4529)	(0.5087)
Observations	4,006	5,221
Pseudo R-squared	0.0653	0.0648
Panel B:		
contemporaneous exposure	0.0146***	0.0067***
	(0.0015)	(0.0020)
Constant	-2.8927***	-3.8191***
	(0.3576)	(0.4182)
Observations	7,892	9,011
Pseudo R-squared	0.0684	0.0346
MOB-YOB	YES	YES
Controls	YES	YES
Year FE	YES	YES
Boko Haram	YES	YES

Notes: Table A1 above repeats the full specification on column 4 of Tables 3 and 4 for stunting and underweight, respectively, for HAZ and WAZ. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

Table A2: Effect of FEM exposure on children's anthropometric outcomes for states with the most FEM conflict incidences.

	Dependent variables:	
	HAZ	WAZ
Variables	(1)	(2)
Panel A:		
in utero exposure	-0.0101	0.0096
	(0.0153)	(0.0125)
Constant	0.9152	2.6968***
	(1.1429)	(0.6589)
Observations	638	737
R-squared	0.5396	0.5713
Panel B:		
contemporaneous exposure	-0.0123**	-0.0094
	(0.0058)	(0.0069)
Constant	1.6329**	2.7208***
	(0.7391)	(0.5681)
Observations	1,683	1,854
R-squared	0.4404	0.4676
MOB-YOB	YES	YES
Controls	YES	YES
Year FE	YES	YES
Boko Haram	YES	YES

Notes: Table A2 above repeats the full specification on column 4 of Tables 2 and 3 for HAZ and WAZ anthropometric measures with restrictions to early exposed states. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

Table A3: Sensitivity Tests for baseline results controlling for weather patterns

	Dependent variables:	
	HAZ	WAZ
Variables	(1)	(2)
Panel A:		
in utero exposure	-0.0072**	-0.0053**
	(0.0034)	(0.0024)
Constant	-3.1880	2.7555
	(2.1708)	(1.8832)
Observations	2,396	2,799
R-squared	0.5539	0.5447
Panel B:		
contemporaneous exposure	-0.0088***	-0.0050***
	(0.0015)	(0.0017)
Constant	-2.6899	1.8645
	(1.8271)	(1.2838)
Observations	6,117	6,711
R-squared	0.4710	0.4386
MOB-YOB	YES	YES
Controls	YES	YES
Year FE	YES	YES
Boko Haram	YES	YES
Weather variables	YES	YES

Notes: Table A3 above includes additional weather covariates using annual mean temp. (°C*10), annual precipitation and annual mean rainfall across locations to capture confounding effects from relevant weather variation. See Table 3 for additional notes. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

Table A4: Pathway of effect: FEM exposure on different measures of Household food security and sanitation

	Dependent variables			
	Limit variety of food	Less preferred food	Cultivated farmland	Toilet type
Variables	(1)	(2)	(3)	(4)
Panel A:				
in utero exposure	-0.0015***	-0.0016***	-0.0052**	-0.0014***
	(0.0006)	(0.0006)	(0.0021)	(0.0004)
Constant	2.3375***	2.8705***	-3.8075***	0.4702***
	(0.5933)	(0.7811)	(1.0391)	(0.0756)
Observations	2,251	2,250	2,525	3,503
R-squared	0.0629	0.0506	0.2248	0.2084
Panel B:				
contemporaneous exposure	-0.0006	-0.0005	-0.0020*	-0.0011***
	(0.0006)	(0.0007)	(0.0012)	(0.0003)
Constant	1.6437***	1.5729***	-2.6950***	0.4833***
	(0.1431)	(0.2418)	(0.7941)	(0.0418)
Observations	3,350	3,346	3,624	5,204
R-squared	0.0730	0.0680	0.2159	0.2108
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Boko Haram	YES	YES	YES	YES

Notes: Table A4 presents result estimates for the potential channels of FEM conflict effect via household limit variety and less preferred food security indicators, cultivated agricultural land and household access to flush toilet facilities. The models control for Boko haram affected states, survey year fixed effects, and other household-level control variables. Standard errors are clustered at the EA level. ***, **, * Coefficient is statistically significant at the 1%, 5%, and 10% level, respectively.

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