The Influence of Conflict on Food Security in Post-Pandemic Northern Nigeria.

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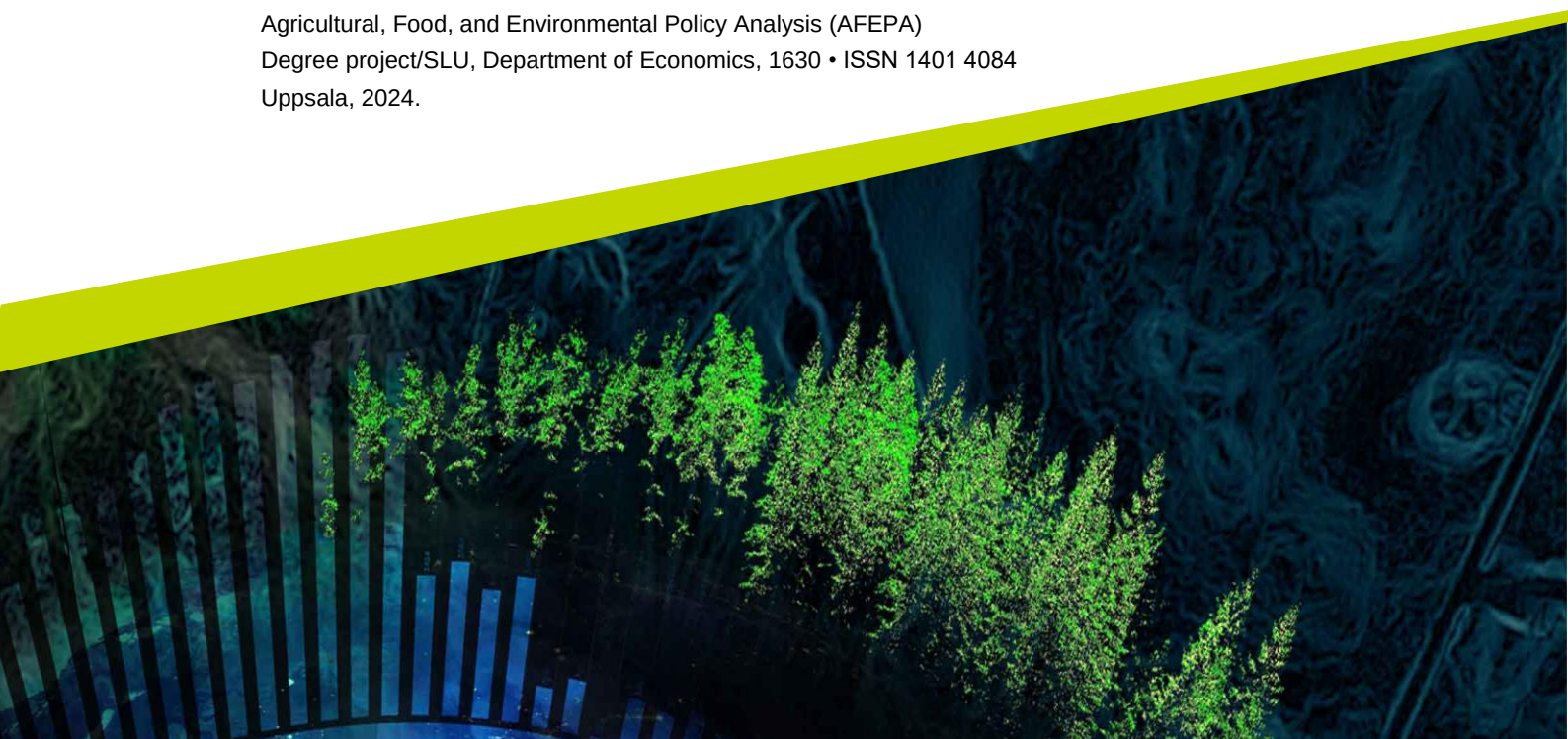

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Ezinne Cynthia Obiora

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Abstract

This study examines the association between conflict, COVID-19, and food security across local government areas (LGAs) in post-pandemic Northern Nigeria. Using an unbalanced two-year panel dataset consisting of 131 LGAs, a fixed-effect model was estimated. The findings indicate a positive association between COVID-19 and food insecurity, but its interaction with conflict is not statistically significant. The results suggest that civilian-initiated conflicts have a significant association with food security compared to those initiated by the largest group of conflict actors, militias. A policy recommendation emerging from this study is the importance of enhancing local capacities for conflict management and resilience building in food systems to limit the effects of such shocks on food security. Future research is needed to understand the long-term impacts of conflict and COVID-19, accounting for the bidirectional complexities and the mechanisms through which households cope and adapt to these challenges.

Keywords: Conflict, Violence, COVID-19, Shocks, Food Security, Climate, Northern Nigeria, Africa, FIES.

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Abbreviations

ACLED	Armed Conflict Location & Event Data
DIEM	Data-in-Emergencies Monitoring
FAO	Food and Agriculture Organisation
FIES	Food Insecurity Experience Scale
LGA	Local Government Area
SDG	Sustainable Development Goal

1. Introduction.

For a long time, conflict in Nigeria has consisted of election disputes, resource and environmental challenges, religious intolerance, and ethnic friction (Kah, 2017). This has been especially evident in cases where the terrorist organisations' goal has been to establish parallel states (Adelaja & George, 2019). Northern Nigeria has been specifically affected by non-state actors (militia and ethnic groups) involved in various forms of conflict. Boko Haram, the lead actor in terrorism, contributed to more than 5.2 million of the over 20 million people negatively affected by conflict (Simmons & Flowers, 2017; Kah, 2017). The region is known for producing staple foods consumed across the country, and conflict there could contribute to national food insecurity (Kah, 2017; Kimenyi *et al.*, 2014). Another recent disruption to food systems in Nigeria and elsewhere is the COVID-19 pandemic. The pandemic resulted in domestic and international control measures that restricted key interactions between food system actors (Ben Hassen *et al.,* 2022). Given the negative effects that both conflict and COVID-19 have contributed to, there is a risk that the Northern Nigerian population's food security status may have deteriorated. This paper aims to investigate if conflict and COVID-19 lockdown measures are associated with a change in the food security status of local government areas (LGAs) in Northern Nigeria. Specifically, this study aims to answer the following research questions:

1. What is the association between conflict and food security in local government areas (LGAs) in Northern Nigeria post-COVID-19?
2. Is there heterogeneity in the influence of each conflict actor on the food security status in these local government areas?

Many countries have shifted from being food secure through food imports to being more dependent on domestic food production for their food security due to the abrupt distortion in the global food supply chain caused by the COVID-19 pandemic and the Russian-Ukrainian war (Nechifor *et al*., 2021; Hellegers, 2022). Nigeria is one of those nations that depends on imports for both its food production and consumption (Salik and Aras, 2020). Research exploring the influence of the pandemic restrictions on Nigerian food systems and its increasing effect on food insecurity, indicates the role of COVID-19 in relation to food security and further justifies its study on Nigeria’s food security status.

The research on conflict and food security in Northern Nigeria can be categorised by actors, as studies often separate between specific militia groups such as Boko Haram, ISWAP, and the Fulani herdsmen (Adelaja, George, & Awokuse, 2021; Adelaja & George, 2019; Kimenyi *et al.*, 2014). After the 2015 elections, terrorism in Northern Nigeria reduced, as major groups began to fragment (Ukoji & Ukoji, 2023; Ayandele & Aniekwe, 2024). But regardless of the extent, type, and cause of conflict, previous

studies demonstrate the influence that these conflicts can have at both the macro and micro levels of an economy and their adverse impacts on food insecurity (Martin-Shields & Stojetz, 2018; Eme *et al.*, 2014). Other research exclusively on conflict has also identified other state and non-state actors such as civil groups, police, and military agencies (Ukoji & Ukoji, 2023; Ojoare, 2023). However, these studies have focused solely on conflict or conflict actors and have yet to consider the influence of other shocks, such as COVID-19, on food security.

The contribution of this thesis is threefold: First, it provides empirical evidence on the association between conflict, COVID-19, and food security, by adopting a fixed-effect model. It analyses the recent 2-year panel survey on over 4000 households by the Food and Agricultural Organisation (FAO) and ongoing conflict data collected by the Armed Conflict Location & Event Data Project (ACLED). This thesis goes beyond the discoveries made by existing studies on data gathered before COVID-19 by considering this association in post-pandemic Nigeria. Previous studies focused solely on conflicts (e.g. Adelaja, George, & Awokuse, 2021; Adesoji and George, 2019; Kafando and Sakurai, 2023; Lin *et al.*, 2022) or COVID-19 (e.g. Aromolaran *et al.*, 2021; Amare *et al.*, 2021), without considering both simultaneously. Second, this thesis focusses on regions severely affected by conflict, which have gathered concerns from local and international institutions. It contributes to the monitoring of conflict and its outcomes in the region. Finally, this study contributes to the reporting of household food security status, particularly in Nigeria, where it remains adamant.

Consistent with the reviewed literature, the study results reveal a significant association between COVID-19 lockdown measures and food insecurity but find the interaction between conflict and COVID-19 measures to be insignificant for food insecurity. It also provides evidence of the significant association between civilian-initiated conflicts and food security. The results are relevant for national and international policymakers' efforts to prevent and manage conflict situations, support post-conflict recovery, and improve food security.

The rest of this study is structured in the following ways: Section two describes the relevant literature and the conceptual arguments underlying the study. Section three describes the research methodology, the data sources, the sampling, and the model specification. Section four provides the results of the empirical analysis. Section five concludes the paper with possible recommendations for policy.

2. Conceptual Framework and Literature Review.

Research indicates that both conflict and COVID-19 independently influence food security negatively, through the pillars of food availability, accessibility, and stability (Koren and Bagozzi, 2016). This is mainly through disruptions in food systems (food production, market restrictions, and value chain interactions), as summarised in Figure 1. These studies also suggest that increasing sources of income, focussing more on production, or abandoning their lifestyle are key to overcoming food security challenges. This section highlights studies on the influence of both events on food security, explaining their pathways (Figure 1(i-vii)) and their suggestions for overcoming these challenges.

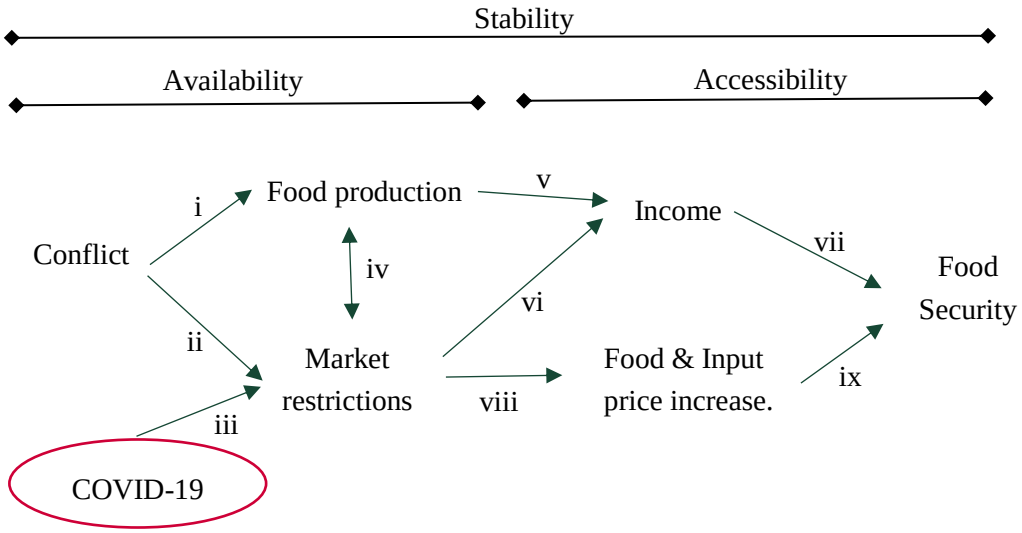

Figure 1. A summary framework linking conflict, COVID-19, and food security (modified from HLPE, 2020, and Ibok et al., 2019[1]).

2.1 Review on Conflict and Food Security.

Beyond Nigeria, Lin *et al*. (2022) captured the association between conflict and food insecurity in the occupied Palestinian territory. The paper studied the complexity of factors that can influence food insecurity. It revealed that post-conflict restrictions, a lack of resources, and the resulting unemployment are part of the political, agricultural, and economic factors that influence dietary diversity and the resulting food insecurity. This is also evident in Sub-Saharan Africa, where Kafando and Sakurai (2023) explored the effect of armed conflicts by separatist' groups on household food insecurity in

[1] HLPE (2020) - https://www.fao.org/3/cb1000en/cb1000en.pdf
Ibok *et al.*, (2019) - https://doi.org/10.1016/j.foodpol.2019.01.011

Burkina Faso. The study observed that the intensity of terrorism negatively influences household dietary diversity and food security, despite the associated increase in food assistance from states and humanitarian agencies. The identified pathways to food insecurity in these regions include food production, investments, and consumption. These conflict-related market disruptions result in the depletion of household total income and expenditures (Figure 1(v)). These results are useful in identifying variables that could have a potential influence on food security. They also highlight that addressing food security issues in conflict areas requires a multi-dimensional approach, and this aligns with my study on both conflict and COVID-19 influence.

Being a fragile state with weak state capacity or legitimacy, Nigeria is set to feel the lasting impact of conflict in the long run (Posthumus *et al.*, 2018; Shemyakina, 2022). Adelaja, George, and Awokuse (2021) studied the impact of conflict between farmers and pastoralist groups known as Fulani Herdsmen, primarily domiciled in Northern Nigeria. Each casualty from their activity reduced overall agricultural output by 0.4 tonnes, particularly affecting staple crops such as maize, tomatoes, potatoes, and beans planted during the grazing season. Livestock production also suffered similar negative effects, with household cattle purchases reducing per casualty. A notable finding is that exposure to conflict prevents households from participating in food production due to the associated fear and uncertainty. As a result, this influences food availability (Figure 1(i)).

Similar studies by Adelaja and George (2019) investigated the impact of conflicts by Boko Haram on agriculture and land use in northeastern Nigeria. It provided results similar to Adelaja, George, and Awokuse (2021), except that off-farm labour was more impacted due to the group's mode of operation in public places. Given that displacement of farmers results in lower food production, the availability of food was at a higher risk. Going further, Adelaja, George, and Weatherspoon (2019) provided evidence that an increase in conflict fatalities initiated by Boko Haram reduced the food consumption scores (FCS) of households in the affected region. This was mainly due to reduced income from low-risk activities on and off-farm, as stipulated in earlier studies (Figure 1(v)). The disruption to the farm input market in affected areas also limited the availability of resources for food production, which influenced income generation (Figure 1(iv)). These studies show the direct and indirect paths that conflict associates with food security and are important for understanding the history of the influence conflict has had on food systems in Northern Nigeria.

2.2 Review of COVID-19 and Food Security.

COVID-19 was an unprecedented event with several adverse impacts on food security and welfare (Laborde *et al.*, 2021; Vos *et al.*, 2022). Economic research has focused on its disruptions and influence in various contexts, highlighting a similar multi-dimensional influence as conflict events. Vos *et al.* (2022) surveyed studies on its effect

on poverty, food, and nutrition security. They found that policy measures adopted to limit the spread of COVID-19, led to food system disruptions and economic damages (Figure 1 (iii)). Food supply chains were disrupted, resulting in food shortages. The non-food sector was reported to have been more impacted by lockdown measures, a sector that is essential to a seamless food system.

In Nigeria, the impacts of the lockdown were also attributed to domestic policies adopted, and international shocks experienced (Andam *et al.* 2020). Amare *et al.* (2021) provide empirical evidence on the implications of the pandemic and its associated measures on food security across the country using 3 out of 8 food insecurity experience indicators. The results of the study indicated that lockdown measures generally increased food insecurity, with a 15% probability of households skipping a meal. They concluded that the pandemic's implications vary considerably across household types and geographic regions. This variation makes it important to study, as this paper focusses on COVID-19 and food security at a sub-regional level.

Aromolaran *et al.* (2021) also assessed food systems and rural livelihood in Nigeria. The study indicated that lockdown measures led to an increase in prices of farm inputs and food (Figure 1(viii)), reducing household access to farm and off-farm business activities and income. However, these negative effects peaked at the start of government restrictions but declined in intensity as the pandemic progressed due to relaxed restrictions. Most households surveyed experienced an increase in the cost of living due to the rise in prices, with an average of 62% claiming that they had to skip a meal due to insufficient money in all three rounds. This explains that households could not afford to feed themselves due to a lower purchasing income and were therefore, food insecure (Figure 1(ix)). This further emphasises the association between COVID-19 and food security via its lockdown measures, which is crucial to the empirical model of this paper.

In essence, COVID-19 seems to have less influence than conflict, as Yegbemey *et al.* (2021), in a study on COVID-19 effects, indicated that farmers in North-West Nigeria preferred production-orientated strategies to market-orientated strategies in overcoming the effects of the shock. This is due to restrictions being focused on markets, a limitation they had no control over. However, for conflict, households subjectively abandon both their farms and market activities.

Given the associated pathways of both events on food security, this paper recognises income as a major variable that explains the food security status of an entity.

3. Data and Methodology.

3.1 Data

3.1.1 Study Area

The focus of this study is on the northeastern and northwestern parts of Nigeria, situated in the Sudan and Sahel vegetative regions of the country. These regions comprise thirteen states, with the majority bordering Niger, Chad, and Cameroon. Of these 13 states, we focus further on 5: Adamawa, Borno, Katsina, Yobe, and Zamfara (Figure 2), with a combined number of 113 local government areas (LGAs).

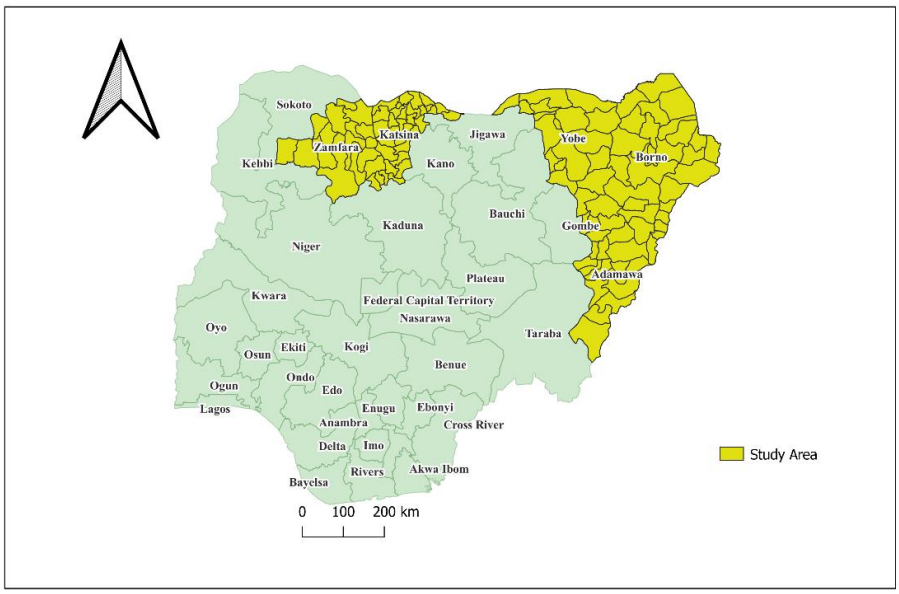

Figure 2. Map of Nigeria highlighting the study area (map by author)

This region is subject to poverty and depends mainly on the agricultural sector. It is known for the commercial production of staple foods such as cowpeas, rice, millet, corn, yams, tomatoes, onions, fish, and livestock (Isah, 2024; Kah, 2017). Three of these states —Adamawa, Borno, and Yobe— were most affected by violence in the region (Azad *et al.*, 2018). An overview of these states is presented in Figure 3.

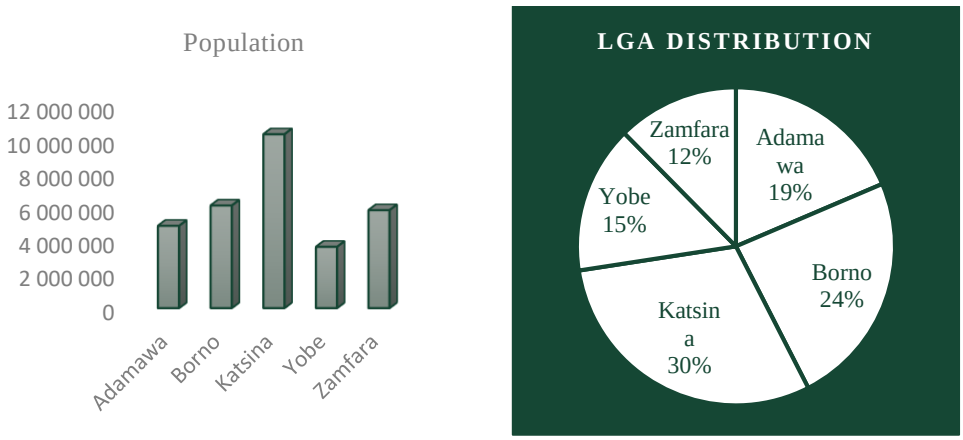

Figure 3. Population[2] and Local Government Area (LGA) Distribution in the Study Area.

3.1.2 Sampling

This study uses a secondary dataset obtained in January 2024 from the Armed Conflict Location and Event Data (ACLED) project. ACLED is a non-governmental organisation that compiles and reports conflict events by different actors in their respective regions (Raleigh *et al.* 2010), and this was collected at the local government level. It was merged with data on shocks, livelihoods, and food security from FAO's Data-in-Emergencies Monitoring (DIEM) first and second rounds obtained in 2021 and 2022. This dataset is periodically collected from randomly sampled households through face-to-face interviews. The dataset was aggregated from household to municipality level because the household IDs could not be matched across the different years. This makes the local government area (LGA) level, the unit of analysis for my empirical analysis.

At the household level, both rounds 1 and 2 of FAO's DIEM are composed of over 4,000 observations, across 113 local government areas[3]. FAO reported that, due to insecurity, some local government areas were not reachable for interviews at the time, resulting in an unbalanced dataset. Since our analysis is focused on 2021 and 2022, the sample size was reduced to 70 local government areas in both years (i.e., 140 observations), and 45 LGAs captured once in both years. This resulted in a sample size of 185 observations. The final dataset, consisting of both conflict and DIEM, has 131 observations due to some local government areas not having any record of conflict within the focus period. These areas were excluded from my analysis.

The first round of DIEM was collected between May and June 2021. The second round was collected between June and July 2022. The conflict dataset focused on the period starting one year before the DIEM data collection, the second quarter of 2020 to 2022. The inclusion of the second quarter of 2020, accounts for the potential delayed

[2] The dataset on the population at the state and local government area (LGA) level was obtained from https://www.citypopulation.de/en/nigeria/admin/

[3] FAO reported that although the criteria of randomness were respected in the sampling process, percentages close to 100% appear to indicate that the sample may have been skewed towards rural households.

association between conflicts and food security. For instance, conflicts occurring in 2020 may have an influence on the food security status in 2021.

3.2 Methodology

3.2.1 Measurement of Variables

Food Security

This study uses the Food Insecurity Experience Scale (FIES) to measure household food insecurity. It shares similarities with the US Household Food Security Survey Module (HFSSM) and the Household Food Insecurity Access Scale (HFIAS). The FIES is a measure of food insecurity that is based on the Rasch model and universally accepted by the United Nations and FAO. It serves as the basis for compiling the SDG indicator 2.1.2, which checks the prevalence of moderate or severe food insecurity in the population (Cafiero & Viviani, 2023). The dichotomous responses of the FIES reveal increasing levels of severity based on the following 8 questions:

During the last 12 months, due to a lack of money or other resources for food, was there a time when:

1. You were **worried** you would not have enough food to eat?
2. You were unable to eat **healthy and nutritious food**?
3. You ate only a **few kinds of food**?
4. You had to **skip a meal**? (because there was not enough money or other resources for food).
5. You **ate less** than you thought you should.
6. Your household **ran out of food**?
7. You were **hungry** but didn't eat? (because there was not enough money or other resources for food).
8. You went **without eating for a whole day**?

Like other experience-based food insecurity scales, the FIES captures the physical and psycho-emotional dimensions of food insecurity. This includes both subjective and objective aspects of food insecurity (Perez-Escamilla & Segall-Correa, 2008; Grimaccia & Naccarato, 2020). An advantage of this measure of food insecurity is its low-cost implementation and use, allowing for decentralisation. This makes it more widespread in use and comparable across regions, unlike country-specific scales such as the HFSSM and HFIAS. A drawback to these experience-based scales is their inability to capture

food safety dimensions, but the FIES directly assesses food access, a key pillar of food security (Perez-Escamilla & Segall-Correa, 2008; FAO, 2014).

Due to the correlation between the individual responses (Figure A1) and a Kaiser-Meyer-Olkin (KMO) statistic of 0.89, a principal component analysis (PCA) was used to create a food insecurity index that represents a normalised linear combination of the 8 FIES indicators (Amare *et al.*, 2021). Using a PCA for the indicators aids in reducing the dimensionality of the data, capturing the key underlying factors without relying on the individual correlated variables (Kassambara, 2017). Before applying this approach, the variables were standardised to ensure that each indicator contributed equally to the analysis, addressing the risk of certain variables dominating the results due to differences in scale (Lever et al., 2017). While the PCA aggregates shared variance across the 8 standardised indicators into a single composite score, this simplification may hide unique contributions of the individual indicators. Still, by focussing on components that explain the most variation, PCA ensures that the essential information from the original variables is retained.

The food insecurity index used in the model, was selected from the first principal component with an axis that captured 53% of the variation across the indicators and represents the projection of the original data onto the new axis. The indicators that contributed the most to this axis include *ATELESS*, *SKIPPED*, *FEWFOODS*, *WORRIED*, *HUNGRY*, and *HEALTHY*, with variations that lie on the negative side of the axis (Figure A4). This FIES index serves as our dependent variable in the analysis.

Conflict

The definition of conflict is "not straightforward," but its dynamics show that violence stems from a disagreement on the allocation of resources between multiple parties (Brobbey, 2022; Martin-Shields & Stojetz, 2018). This study understands conflict as the violent interaction between actors within Northern Nigeria on a small or large scale that results in the unfortunate loss of life. These events range from politically motivated protests and riots by civilians to full-blown insurgencies by militia groups, which are a primary source of instability and disruptions of economic activities in the region (Shemyakina, 2022; Martin-Shields & Stojetz, 2018). This influence can be explored through various means, such as the frequency of conflict events occurring and the number of displacements. However, these measures fail to capture the major consequences of violence (Raleigh *et al*., 2023). The Armed Conflict Location & Event Data Project (ACLED) identifies four conflict indicators to assess severity levels across regions. This study, however, focusses on one of the conflict indicators, the deadliness or fatality count, adopted by Adelaja, George, and Weatherspoon (2019), which measures the direct and immediate human cost of violence.

For the second objective, this study recognises each conflict group (civilians, militias, and security forces) as the primary actor in each conflict event, irrespective of their interactions with other groups, as described by the ACLED data. Civilian groups consist

of rioters, protesters, vigilantes, and ethnic mobs. Militias are identified as recognised armed and violent groups with a collective, common characteristic. Security agencies include the police and local and international military forces in the bordering regions of Nigeria (Niger, Chad, and Cameroon).

COVID-19

There are several ways COVID-19 influenced individuals, such as the number of restrictions, infections, and deaths (Amare *et al.*, 2021). Ongoing conflict with its long-term consequences on food security may have also been impacted by the COVID-19 pandemic through measures limiting movement, access to markets, other economic activities, and households' ability to generate income (Vos *et al.*, 2022). This study quantifies the COVID-19 variables based on the number of lockdown measures and restrictions implemented in Northern Nigeria during the pandemic. This acknowledges that the socioeconomic disruptions caused by lockdown measures may have a substantial association with food security, irrespective of the health outcomes of the virus itself. Based on the FAO data available, COVID-19 variables gathered, measured the experience of households (YES = 1; NO = 0) to contain its spread using the following indicators:

1. Stay at home (*STAYHOME*)
2. Restrictions on gatherings (*GATHERINGS*)
3. Limitations on public transportation (*GOODSTRANSPORT*)
4. Restrictions on closure of markets (*MARKETCLOSED*)
5. Restrictions on external movements (*BORDERCLOSED*)
6. Limitations on daily processes (*PROCESSCLOSED*)

Each indicator provides an insight into the importance of considering the wider implications of pandemic response measures on livelihoods and food systems (Laborde *et al.*, 2020; Swinnen & McDermott, 2020). The PCA technique adopted with the FIES indicators was applied to the variables describing the COVID lockdown measures experienced. This was also due to a correlation across variables (Figure A5) and a KMO statistic of 0.8. The COVID-19 index was selected from a principal component axis that explained 46.4% of the variation and had *GATHERINGS*, *STAYHOME*, and *MARKETCLOSED* contributing the most (over 15% each) to the index (Figure A8). The absolute values of the resulting indexes (food insecurity and COVID-19) were aggregated at the local government area (LGA) level for analysis.

Asides the variables described above; the analysis also adopts other variables to serve as controls in the model specification. They include household income and occupation type, as described in Table 1, included to capture any regional differences across households. To account for exposure to extreme weather events, the variables of

droughts and floods were also included for their potential influence on food insecurity. These variables were considered based on previous studies on conflict and COVID-19 (Abu Hatab *et al.*, 2023; Lin *et al.*, 2022; Amare *et al.*, 2021; Adelaja, George, & Awokuse, 2021; George, Adelaja, & Weatherspoon, 2019; Klomp & Bulte, 2013).

3.2.2 Empirical Model

A fixed effect model was adopted to control for unobserved time-invariant characteristics at distinct levels (i.e., State and LGA), while estimating the association between conflict, COVID-19, and food security. For the first objective, the primary model specification is represented below and includes the interaction between conflict and COVID-19 to consider whether LGAs that were affected by both events had a significant influence on their food insecurity status.

$$F_{imt} = \beta_0 + \beta_1 Fatalities_{imt} + \beta_2 COVID_{imt} + \beta_3(\text{Fatalities}_{imt} * COVID_{imt}) + V_{imt} + S_i + T_t + U_m + \varepsilon_t \quad (1)$$

The second objective explores heterogeneity across conflict actors to examine if the association between conflict and food security differs across the respective actors. To investigate this, the model includes an interaction term between conflict (fatalities) and each conflict actor group, denoted as 'k' (civilians, militias, and security forces). The model specifications for this objective, are as follows:

$$F_{imt} = \beta_0 + \beta_1 Fatalities_{imt} + \beta_2(\text{Fatalities}_{imt} * ConfAct_{kimt}) + \beta_3 COVID_{imt} + V_{imt} + S_i + T_t + U_m + \varepsilon_t \quad (2)$$

where:

F_{imt}	= aggregated food insecurity index at time (t).
$Fatalities_{imt}$	= total number of deaths per LGA (aggregated).
$COVID_{imt}$	= aggregated COVID-19 index at time (t).
$ConfAct_{kimt}$	= initiator of conflict event at time (t)
V_{imt}	= vector of control variables
S_i	= State fixed effects
T_t	= Time fixed effects
U_m	= LGA fixed effects
ε_t	= error term

A common issue in studies on conflict and food security is reverse causality, where food insecurity could potentially lead to conflict, although minimal at a sub-regional level of analysis (George, Adelaja, and Weatherspoon, 2019; Kafando and Sakurai, 2023). This

could introduce endogeneity, and therefore I interpret my findings as correlations rather than causal effects.

3.3 Descriptive statistics

Table 1 presents the descriptive statistics, indicating the percentage of the sample affected by each variable at the household (HH) level and the value at the LGA level. It shows that a total of 2,427 conflict events were registered between 2020 and 2022. Militias were responsible for over 50% of the conflicts. The type of violence ranges from civilian protests to battles between militia groups or between militias and security agencies. During this period, civilian groups were responsible for 5% of conflict events. 34 different militia groups were active in conflicts with themselves or security forces consisting of the Nigerian Police Force and the armed forces of Nigeria, Niger, Chad, and Cameroon. The main type of conflict event, battles, peaked in the third quarter of 2020, i.e., during the 8-month COVID-19 lockdown. A total of 11,202 fatalities were recorded during this period.

The data also reveals that the major means of income in the study area is agriculture (86%), with 41% of those households engaging in more than one form of food production (livestock and crop). The average quarterly income households earn per local government area (LGA) sits at about 255,900 naira (600 USD)[4] with 18% having up to 3 income streams. In contrast to Kah (2017) and IOM's 2023 report on displacement, 97% of the households captured were permanent residents in their LGAs, that is, they had not been forcefully displaced. Finally, 16% of sampled local government areas (LGAs) were unaffected by the lockdown measures during the COVID-19 pandemic, with an average of 9 households per local government area (LGA) not experiencing the effects of these measures.

Prior to the analysis, a variance inflation factor (VIF) test was conducted for all variables used in the analysis, to avoid issues of multicollinearity[5]. Figure A10 highlights low VIF values (less than 10), supporting the use of these variables in the analysis.

[4] An average exchange rate of 426 naira to 1 USD was utilised based on the Central Bank of Nigeria's (CBN) monthly average exchange rate in 2020, obtained from https://www.cbn.gov.ng/rates/exrate.asp?year=2020

[5] The household variables on gender and education were dropped by the model due to the correlation between both variables.

Table 1. Descriptive Statistics

Variables	Definition	% at household level	Value per LGA			
Conflict Variables (Source: ACLED)			**Min**	**Mean**	**SD**	**Max**
Conflict Fatalities	Number of deaths per conflict event.		0	60	81	397
Conflict Actors (Civilians)	The number of civilian groups in total conflict actors.	5	0	~ 1	1.1	7
Conflict Actors (Militias)	The number of separatist groups, cultists, and other non-civilian actors in total conflict actors.	65	0	8	10	58
Conflict Actors (Security)	The number of Nigerian and International security forces (police and military) in total conflict actors.	28	0	3	5	27
Food Insecurity Index (PCA of 8 FIES questions)						
Worried	Observations of households (HH) that responded positively to a specific FIES question due to a lack of money or other resources for food.	68	0	17	23	156
Healthy		71	0	18	23	157
FewFoods		72	0	18	24	167
Skipped		60	0	15	19	139
Ateless		66	0	16	22	155
Ranout		45	0	11	19	132
Hungry		43	0	11	17	104
Wholeday		23	0	6	10	55

Variables	Definition	% at household level	Value per LGA			
COVID-19 index (PCA of 6 measures placed)			**Min**	**Mean**	**SD**	**Max**
Market Closed	Households (HH) affected by lockdown measures.	31	0	8	16	106
Goods Transport		39	0	10	17	105
Process Closed		7.5	0	2	4	26
Gatherings		24	0	6	12	80
Stay at home		47	0	12	25	167
Border Closed		10	0	2	5	34
Other Variables						
Total HH Income (naira)	Average quarterly income earned.	237,780	6,669	255,956	315,302	283,566
HH Gender (Male)	Male-headed households.	93	2	23	35	246
Education of the head of HH (%)	Household heads with at least tertiary education.	48	0	9	15	110
No agricultural activity	Households (HH) not involved in agricultural production.	13.8	0	3	10	85
Specialised agricultural activity	Households involved in only 1 form of agricultural production.	50.4	0	12	21	162
Mixed agricultural activity	Households involved in more than 1 form of agricultural production.	35.7	0	8	9.5	55
Shocks						
Natural Flood	Households that experienced flood.	8.2	0	2	4	23
Drought	Households that experienced drought.	2	0	1	1	7

4. Results.

4.1 Conflict, COVID-19, and Food Insecurity

Table 2 presents the estimates of the analysis. It shows the association between conflict, COVID-19, and food insecurity. The final model in column (xi) shows that neither fatalities nor its interaction with COVID-19 are significantly correlated with food insecurity. A possible explanation for this could be a form of adaptation to conflict, given that conflict in this region has spanned several years compared to the abrupt presence of COVID-19. Households in these LGAs could have built up resilience with coping mechanisms that smoothed their consumption patterns in these periods, such as reaching out to self-help groups and relying on assistance from external parties (Shemyakina, 2022; Martin-Shields & Stojetz, 2018).

The result also revealed that COVID-19 is positively related to food insecurity by 0.76%, which means a percentage increase in COVID-19 measures experienced in an LGA, results in a higher severity of food insecurity. Based on Table 2, the inclusion of this variable significantly increases the explanatory power of the model, given the sharp rise in R^2 from 2% to 83%. This suggests that the pandemic is strongly correlated with food insecurity, with a correlation coefficient of 0.92 (Figure A9). This highlights how it intensified vulnerabilities in food systems and aligns with the results that lockdown disruptions contributed to household food insecurity (Bloem & Farris, 2022; Amare *et al.*, 2021; Aromolaran *et al.*, 2021).

The observed trend in conflict indicates that increasing counts of fatalities are positively associated with the severity of food insecurity. George, Adelaja, and Weatherspoon (2019) observed similar results as fatalities reduced household food consumption scores (FCS). A reduced FCS indicates lower diet diversity and an increase in food insecurity. This outcome also aligns with Kafando and Sakurai (2023), who highlight that the intensity of terrorism reduces household food consumption scores in Burkina Faso. This resulting outcome seems intuitive, as conflict is known to affect pathways of production and income generation (George, Adelaja, & Weatherspoon, 2019; Martin-Shields & Stojetz, 2018). Kimenyi *et al.* (2014) highlighted that farmers tend to diversify or completely switch to less risky income-earning activities as a coping mechanism for surviving the conflict and maintaining food security. Another factor could be the abandonment of homes and farmsteads for safer regions, which could influence the measurement of food insecurity experience (Adelaja, George, & Weatherspoon, 2019; Martin-Shields & Stojetz, 2018), but given that only 3% of the household sample had been displaced, this gives room for further analysis. Finally, other forms of assistance provided through remittances or aid organisations in conflict-prone areas could very much

have influenced the reduced food insecurity severity (Simmons & Flowers, 2017). This could indicate that aid efforts in these regions could be alleviating the conditions resulting from intense conflict (Shemyakina, 2022). The model revealing the positive association between COVID-19, and food insecurity aligns with Amare *et al.* (2021), who observed household income as one of the most important pathways through which COVID-19 can affect food insecurity. This indicates that the food security status of these LGAs was influenced by the lockdown measures put in place.

Table 2. The influence of conflict (fatality count) and COVID-19 on severity of food insecurity.

	Food Insecurity Index (natural log)										
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	**(xi)**
Fatalities	-0.002 – (0.001)	-0.00007 (0.0005)	-0.0003 (0.001)	0.0002 (0.001)	0.0002 (0.001)	0.0002 (0.0001)	0.0001 (0.001)	0.0001 (0.001)	0.0001 (0.001)	0.002 (0.002)	**0.001 (0.002)**
COVID-19 Index (natural log)		0.81*** (0.04)	0.80*** (0.05)	0.68*** (0.05)	0.67*** (0.05)	0.67*** (0.05)	0.67*** (0.05)	0.67*** (0.05)	0.68*** (0.05)	0.76*** (0.84)	**0.76*** (0.085)**
Conflict * COVID-19			0.0001 (0.0005)	-0.0003 (0.0004)	-0.0003 (0.0004)	-0.0003 (0.0004)	-0.0002 (0.0004)	-0.0002 (0.0004)	-0.0002 (0.0004)	-0.0001 (0.0007)	**0.00013 (0.001)**
Specialised agric. production				0.013*** (0.002)	0.013*** (0.003)	0.013*** (0.003)	0.012*** (0.003)	0.012*** (0.003)	0.012*** (0.003)	0.012** (0.004)	**0.012** (0.004)**
Mixed agric. production					0.0005 (0.006)	0.0008 (0.006)	0.006 (0.005)	0.004 (0.005)	0.006 (0.006)	0.007 (0.008)	**0.007 (0.008)**
Total Income (natural log)						-0.06 (0.13)	-0.03 (0.13)	-0.028 (0.13)	-0.053 (0.15)	-0.58* (0.23)	**-0.58* (0.232)**
Natural flood							-0.017 – (0.009)	-0.02* (0.009)	-0.019* (0.01)	-0.066** (0.023)	**-0.07** (0.024)**
Drought								0.05** (0.02)	0.056** (0.021)	0.10** (0.036)	**0.103** (0.036)**
Constant	3.39*** (0.11)	0.91*** (0.14)	0.93*** (0.17)	1.15*** (0.15)	1.15*** (0.15)	1.49* (0.70)	1.29 – (0.71)	1.30 – (0.70)	-	-	-
Year fixed effects	No	No	No	No	No	No	No	No	Yes	Yes	**Yes**
LGA fixed effects	No	No	No	No	No	No	No	No	No	Yes	**Yes**
State fixed effects	No	No	No	No	No	No	No	No	No	No	**Yes**
Adjusted R^2	0.022	0.83	0.82	0.87	0.87	0.87	0.87	0.87	0.86	0.89	**0.88**
Observations (LGAs)	131	131	131	131	131	131	131	131	131	131	**131**

Note: Column (xi) is the preferred model estimate.
Standard errors are in parenthesis and clustered at the local government area (LGA) level,
***, **, * and – represents a p-value less than 0.1%, 1%, 5%, and 10% respectively.

Other control variables that have a significant association with food insecurity include household participation in agricultural activities, household income, and shocks from drought and natural floods, which serve as environmental factors that influence food availability (Kah, 2017). Engaging in either crop or livestock production increases food insecurity by 1.2%, which is 0.5% higher than the 0.7% estimate for households involved in both crop and livestock production. Increasing income is key to overcoming the effects of shocks and ensuring food security, as this could reduce food insecurity by about 0.6%. It is evident that diversifying agricultural production is set to reduce production risks and protect against income loss when unplanned events such as conflict occur (Kimenyi *et al.*, 2014), as compared to investing in either crop or livestock production.

Shocks arising from climatic changes seemed to have an opposite correlation with food security with drought increasing food insecurity by 10.3%. Natural floods, however, reduce food insecurity by about 7%. External natural shocks also provide input on how they affect crop production and livelihood, given that the vegetative conditions in the focus area and hot temperatures can reduce productivity (Shemyakina, 2022; Kah, 2017; Klomp & Bulte, 2013). While the encroaching drought is negatively associated with food insecurity, natural floods reduce food insecurity and might alleviate the drought conditions to improve the region's productivity (Kimenyi *et al.*, 2014). The influence of these shocks, particularly drought, is set to make resources scarce, resulting in forced displacement, potential conflict, and food insecurity, as observed in conflict cases between Fulani herdsmen and farmers (Kugbega & Aboagye, 2021; Adelaja, George, & Awokuse, 2020).

The household variables on gender and education were dropped due to missing values that reduced the sample size to below 85 and due to the presence of collinearity.

4.2 Conflict Actor Heterogeneity and Food Security

In this section, the correlation between various conflict actors and food insecurity is analysed and compared. The results are presented in individual tables to allow for a clear comparison of correlations and their significance. The findings reveal a slight heterogeneity across interaction estimates. For civilian actors, the final model in column (vii) of Table 3 highlights that conflict has a 0.3% correlation with food insecurity at a 10% significance level, but civilian-initiated conflicts have a positive correlation with food insecurity, although insignificant. However, their interaction with fatalities significantly reduces the correlation with food insecurity by 0.3%. This estimate is likely, given that the nature and objectives of civilian-initiated conflict are less destructive as they are usually at the receiving end of violence and

aim at expressing grievances while unarmed (Raleigh *et al.*, 2010; Brück *et al.*, 2019).

Table 3. The influence of civilian-initiated conflict on severity of food insecurity.

	Food Insecurity Index (natural log)						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	**(vii)**
Fatalities	-0.002** (0.001)	-0.002** (0.001)	-0.0001 (0.0005)	0.0001 (0.001)	-0.00001 (0.0006)	0.003 – (0.001)	**0.003** – **(0.001)**
Civilians		0.041 (0.045)	0.027 (0.027)	0.072 (0.05)	0.074 (0.05)	0.11 (0.077)	**0.11** **(0.079)**
COVID-19 Index (natural log)			0.65*** (0.04)	0.66*** (0.043)	0.68*** (0.05)	0.81*** (0.072)	**0.81***** **(0.073)**
Fatalities * Civilians				-0.0001 (0.0004)	-0.0006 (0.0004)	-0.003* (0.001)	**-0.003*** **(0.001)**
Constant	2.57* (1.12)	2.60* (1.12)	1.36– (0.72)	1.33– (0.70)	-	-	-
Household and shock controls	Yes	Yes	Yes	Yes	Yes	Yes	**Yes**
Year fixed effects	No	No	No	No	Yes	Yes	**Yes**
LGA fixed effects	No	No	No	No	No	Yes	**Yes**
State fixed effects	No	No	No	No	No	No	**Yes**
Adjusted R^2	0.64	0.64	0.87	0.87	0.87	0.90	**0.89**
Observations (LGAs)	131	131	131	131	131	131	**131**

Note: Column (vii) is the preferred model estimate.
Standard errors are in parenthesis and clustered at the local government area (LGA) level,
***, **, * and – represents a p-value less than 0.1%, 1%, 5%, and 10% respectively.

Furthermore, the parameter estimates for COVID-19, remain statistically significant across all actors, increasing food insecurity by over 0.75% per percentage increase in the number of COVID-19 measures experienced. This further indicates a strong and consistent association between COVID-19 and food insecurity during the study period.

In contrast, examining the association between other conflict actors and food insecurity reveals a different dynamic. Conflicts initiated by militias and security agencies are positively correlated with food insecurity by 0.5% and 0.3%, as indicated in the final column (vii) in Table 4 and Table 5, respectively. However, the interaction between these groups and fatality counts does not show any significant association.

Although only the interaction variable of civilian actors presented significant empirical evidence of their respective influence on food insecurity, the analysis generally suggests that there is little heterogeneity in the association between conflict and food insecurity based on the conflict actor. Given that civilians are the smallest group, they have a higher association with food insecurity compared to the large group of active militias. Based on the data, these conflict events by civilians span mainly across riots, protests, and other clashes within and beyond this group.

Militias having less impact on food insecurity than civilian groups could mean that the activities of militias may have over time considered the importance of food access that limits their destructive activities (Kah, 2017). Aside from battling with security forces, militia activities have focussed on theft, kidnappings, and forced disappearances to raise ransoms as a source of funding (Ojoare, 2023; Carboni, 2023). While concerns over the pattern adopted by security actors grow in terms of effect on civilians, it is vital to note that their efforts have not impeded the food security status of LGAs in Northern Nigeria. Finally, there is a possibility that the interaction between these actors (militias and security agencies) and fatalities may be more complex and not fully captured by the models.

Table 4. The influence of militia-initiated conflict on severity of food insecurity.

	Food Insecurity Index (natural log)						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	**(vii)**
Fatalities	-0.002** (0.0001)	-0.002 (0.001)	0.0003 (0.0001)	0.001 (0.0001)	0.001 (0.0008)	0.005 – (0.003)	**0.005** – **(0.003)**
Militias		0.002 (0.01)	-0.007 (0.005)	0.0001 (0.006)	0.001 (0.006)	0.01 (0.02)	**0.01** **(0.02)**
COVID-19 Index (natural log)			0.66*** (0.042)	0.66*** (0.041)	0.68*** (0.05)	0.75*** (0.067)	**0.75***** **(0.068)**
Fatalities * Militias				-0.0001 (0.00002)	-0.0001** (0.00002)	-0.0002 (0.0002)	**-0.0002** **(0.0002)**
Constant	2.56* (1.12)	2.54* (1.15)	1.41– (0.73)	1.35– (0.70)	-	-	-
Household and shock controls	Yes	Yes	Yes	Yes	Yes	Yes	**Yes**
Year fixed effects	No	No	No	No	Yes	Yes	**Yes**
LGA fixed effects	No	No	No	No	No	Yes	**Yes**
State fixed effects	No	No	No	No	No	No	**Yes**
Adjusted R^2	0.64	0.64	0.87	0.87	0.87	0.90	**0.89**
Observations (LGAs)	131	131	131	131	131	131	**131**

Note: Column (vii) is the preferred model estimate.
Standard errors are in parenthesis and clustered at the local government area (LGA) level,
***, **, * and – represents a p-value less than 0.1%, 1%, 5%, and 10% respectively.

Table 5. The influence of security-initiated conflict on severity of food insecurity.

	Food Insecurity Index (natural log)						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	**(vii)**
Fatalities	-0.002** (0.0007)	-0.0001 (0.001)	0.0001 (0.001)	0.0004 (0.001)	0.001 (0.0009)	0.003 (0.002)	**0.003** **(0.002)**
Security		-0.04 (0.03)	-0.008 (0.012)	0.001 (0.017)	0.008 (0.017)	-0.05 (0.06)	**-0.05** **(0.061)**
COVID-19 Index (natural log)			0.65*** (0.043)	0.65*** (0.043)	0.66*** (0.05)	0.76*** (0.063)	**0.76***** **(0.064)**
Fatalities * Security				-0.000 (0.00001)	-0.000 (0.00001)	-0.000 (0.0003)	**-0.000** **(0.0004)**
Constant	2.57* (1.12)	2.54* (1.11)	1.33– (0.71)	1.32– (0.70)	-	-	-
Household and shock controls	Yes	Yes	Yes	Yes	Yes	Yes	**Yes**
Year fixed effects	No	No	No	No	Yes	Yes	**Yes**
LGA fixed effects	No	No	No	No	No	Yes	**Yes**
State fixed effects	No	No	No	No	No	No	**Yes**
Adjusted R^2	0.64	0.65	0.87	0.87	0.87	0.90	**0.89**
Observations (LGAs)	131	131	131	131	131	131	**131**

Note: Column (vii) is the preferred model estimate.
Standard errors are in parenthesis and clustered at the local government area (LGA) level,
***, **, * and – represents a p-value less than 0.1%, 1%, 5%, and 10% respectively.

4.3 Study Limitations

This study was constrained in its analysis by the available dataset. While FAO's DIEM on households in Northern Nigeria is available for two rounds, I was unable to match household IDs across panel waves due to inconsistencies in household IDs. Because of this, I had to aggregate my data to the municipality level, which reduced my dataset from about 4,400 household-level observations to 131 municipality-level observations. The dataset was also inconsistent in capturing certain variables that could have served as controls, such as household size and age, as some of these were captured in only one round. This made it challenging to create a panel dataset without losing these variables. Also, available variables in the dataset consisted of missing values at the household level. The issue of missing values could not be addressed for certain categorical variables when aggregated at the municipality level, which further reduced the sample size during analysis. It is expected that these discrepancies may be addressed for future research studies as the data is released.

While this study focusses on the associations between conflict, COVID-19, and food security, factors such as reverse causality and omitted variable bias could influence the observed results due to the complex interplay across the three concepts. Finally, the study does not empirically consider the adaptive strategies and resilience mechanisms that could influence the region's food security outcomes.

5. Conclusion.

In this paper, I analyse the association between conflict and the food security status of local government areas in post-pandemic Northern Nigeria, taking the influence of COVID-19 into account. Using an unbalanced two-year panel data consisting of 131 local government areas sourced from ACLED and FAO, the study adopted a fixed-effect model to estimate the influence of key variables, COVID-19 and conflict (fatality and actors), on food insecurity. The findings show that across LGAs, a higher fatality rate does not significantly influence the increase in severity of food insecurity with and without COVID-19. This remains positive when interacted with the initiators of said conflict event, civilians, militias, and security agents. A change in the fatality count for civilian-initiated conflict significantly increases the severity of food insecurity. Although the number of conflict events initiated by militia groups remain supreme, civilian-backed conflict contributes the most to food insecurity. Finally, this paper provides statistically significant evidence on the association between COVID-19 and the increasing severity of food insecurity in Northern Nigeria.

Based on the study's findings, it is recommended that local capacities be enhanced to manage and mitigate conflict-related disruptions, particularly those involving civilian and militia groups. The activities of these groups are shown to have more influence on the food insecurity in the region. Literature suggests that investments in conflict resolution and peace-building initiatives at the community level, prior to conflict events, could reduce the frequency and severity of conflicts. Subsequently, emergency responses and rehabilitation strategies during and after conflict, should be tailored to improving the resilience of food systems. This can be done by addressing challenges related to maintaining food and input supply and ensuring continuous access to markets. These measures will benefit households by stabilising food availability and accessibility during and after conflict events.

This study was limited by a few factors, mainly data related. These factors span across inconsistencies in the secondary data adopted from the FAO on limited household variables and missing values. Also, aggregating two datasets is bound to have some effects on the total sample size in the study. Further research could explore conflict and COVID-19 associations with specific crops or livestock mainly produced in the region, covering access to inputs and the ability to produce and sell farm outputs. The coping mechanisms of these households can also be studied to understand if they have a true influence on household food security. In addition, exploring the potential reverse association between conflict and food security while accounting for causality could provide more insights into their complex dynamics. It is expected that the FAO releases more data rounds on the DIEM-Hub, which leaves room for future research studies on the long-term post-COVID-19 influence of conflict on household livelihood in Northern Nigeria for more significant recommendations.

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Appendix.

Appendix 1 – Food Insecurity Experience Scale (FIES).

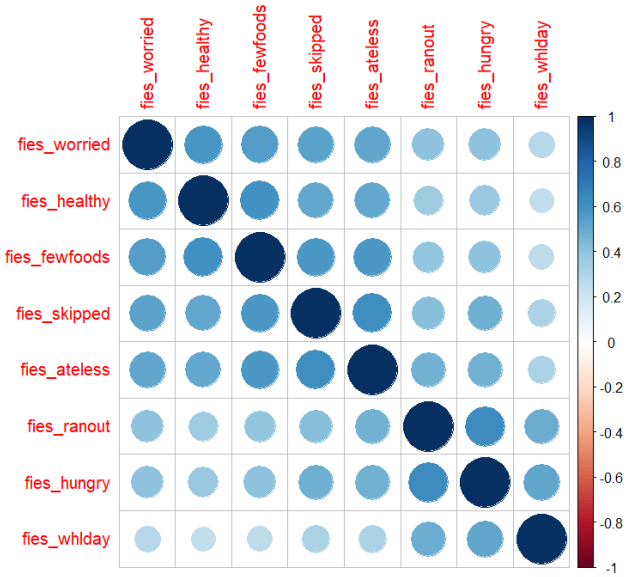


Figure A1. Correlation matrix between individual FIES responses.

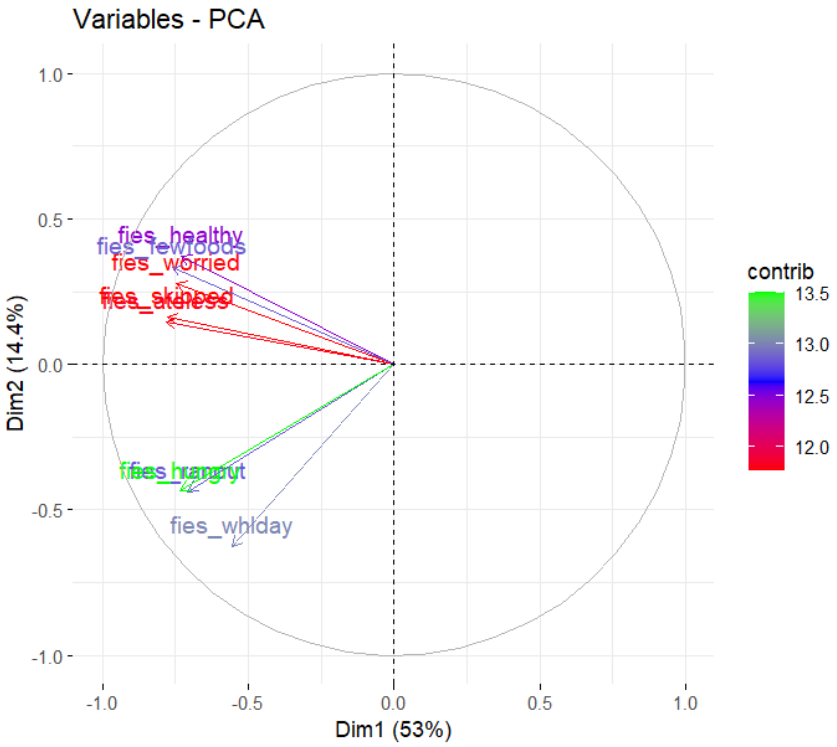


Figure A2. Biplot of PCA representing the quality of representation of FIES responses.

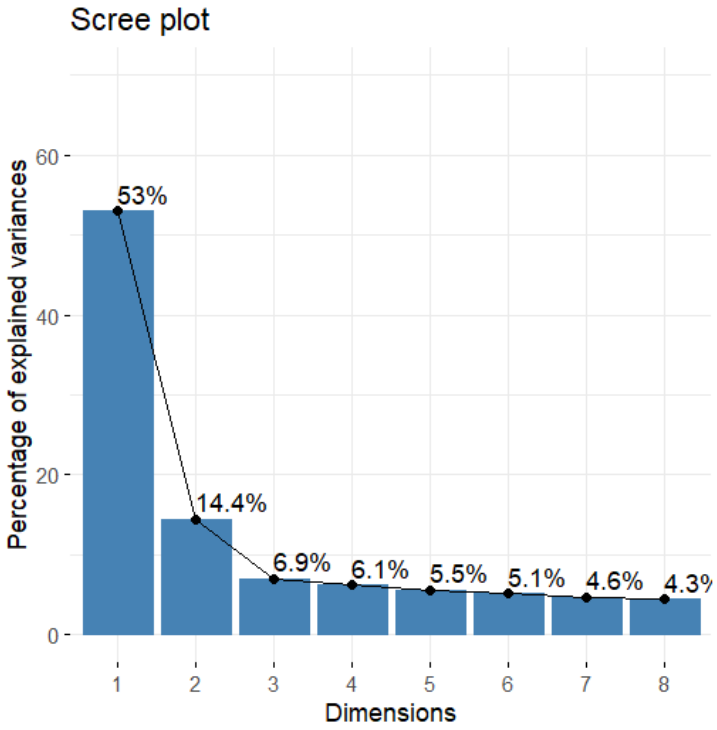


Figure A3. Scree plot indicating the percentage of explained variance across the principal components for the FIES responses.

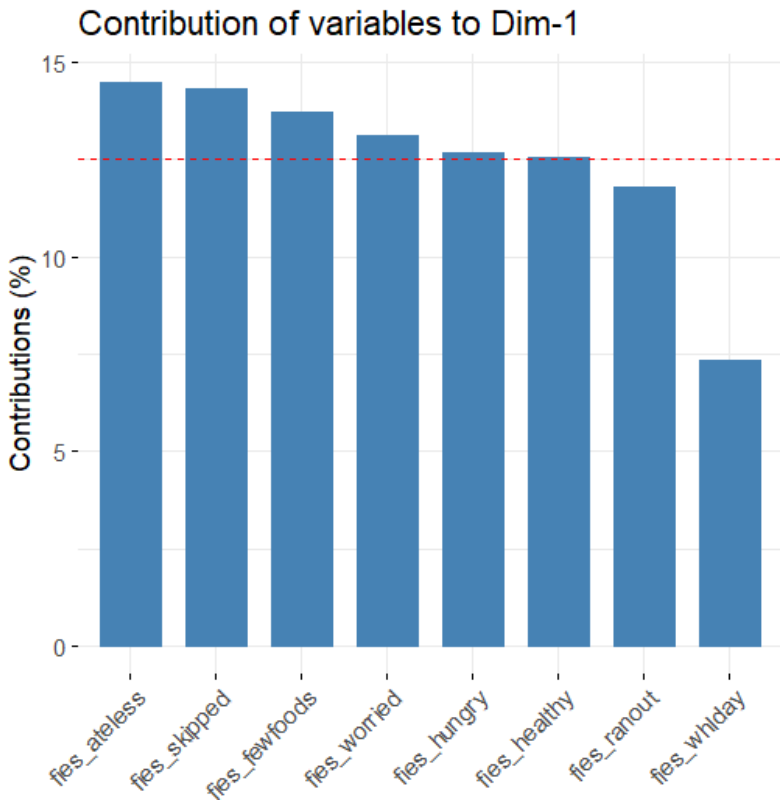


Figure A4. Contribution of each FIES variable to the first principal component selected.

Appendix 2 – COVID-19 Measures

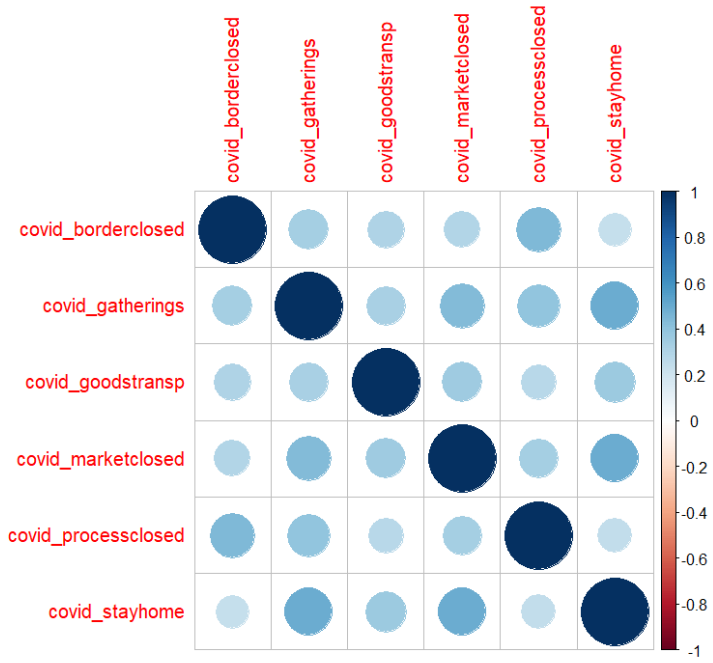


Figure A5. Correlation matrix between responses to COVID-19 measures

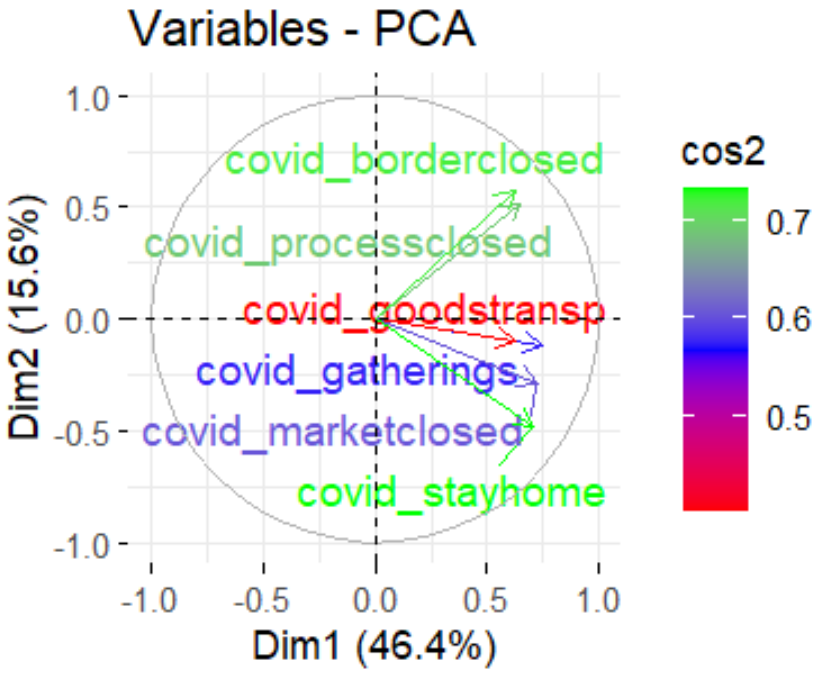


Figure A6. Biplot of PCA representing the quality of representation of the responses from the selected COVID-19 measures.

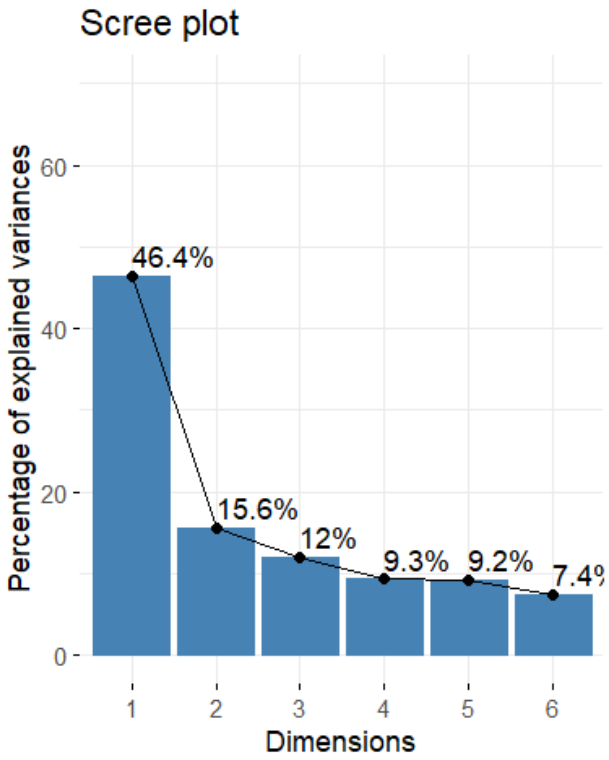


Figure A7. Scree plot indicating the percentage of explained variance across the principal components for COVID-19 measures.

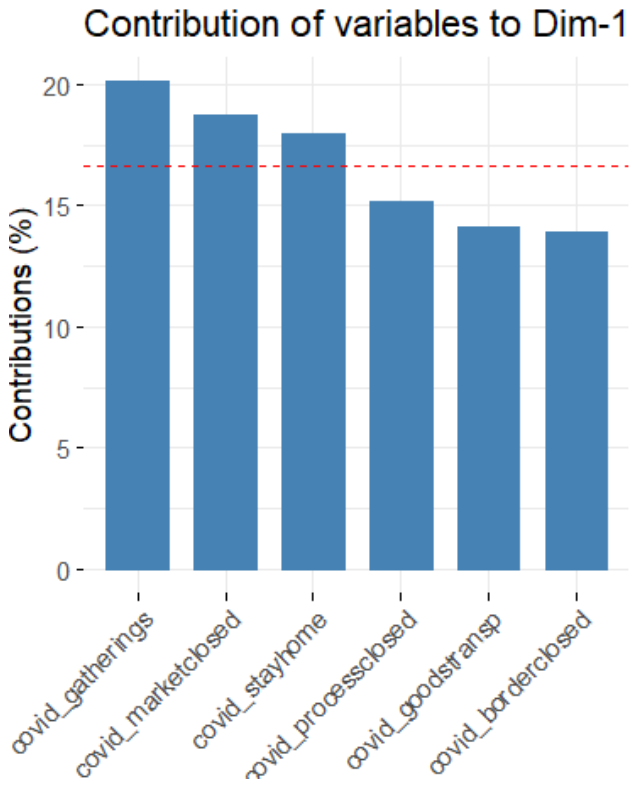


Figure A8. Contribution of each COVID-19 variable to the first principal component selected.

Appendix 3 – Model Specification

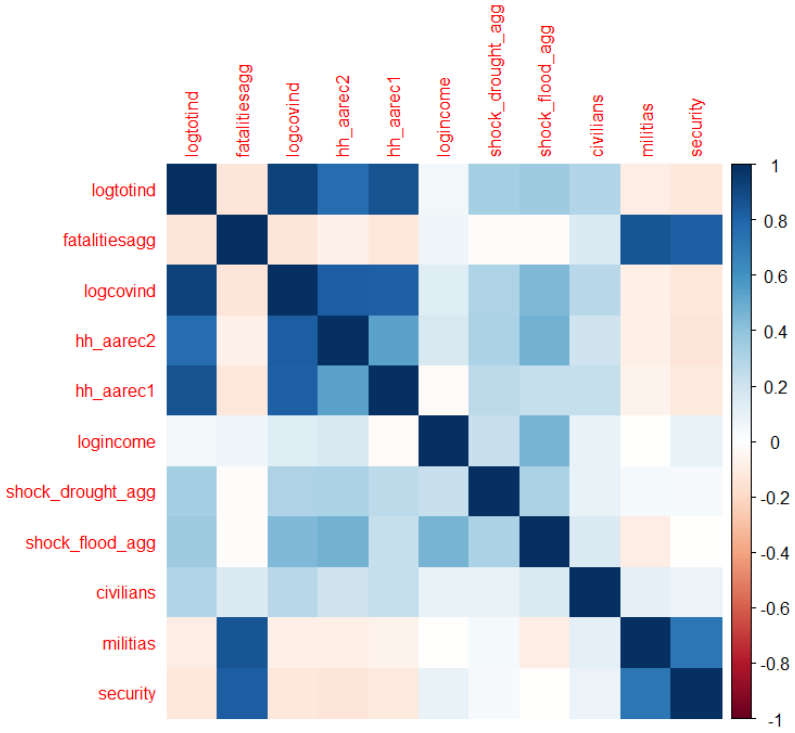


Figure A9. Correlation matrix between variables used in the model specification.

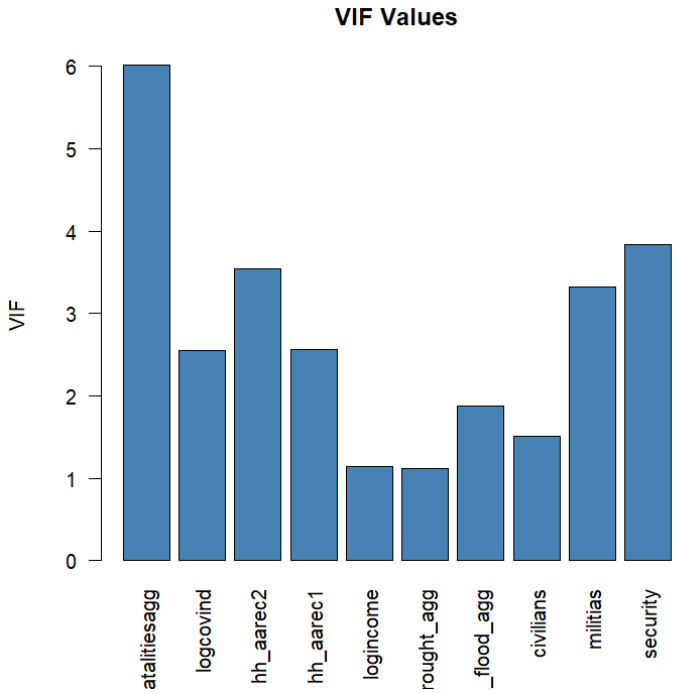
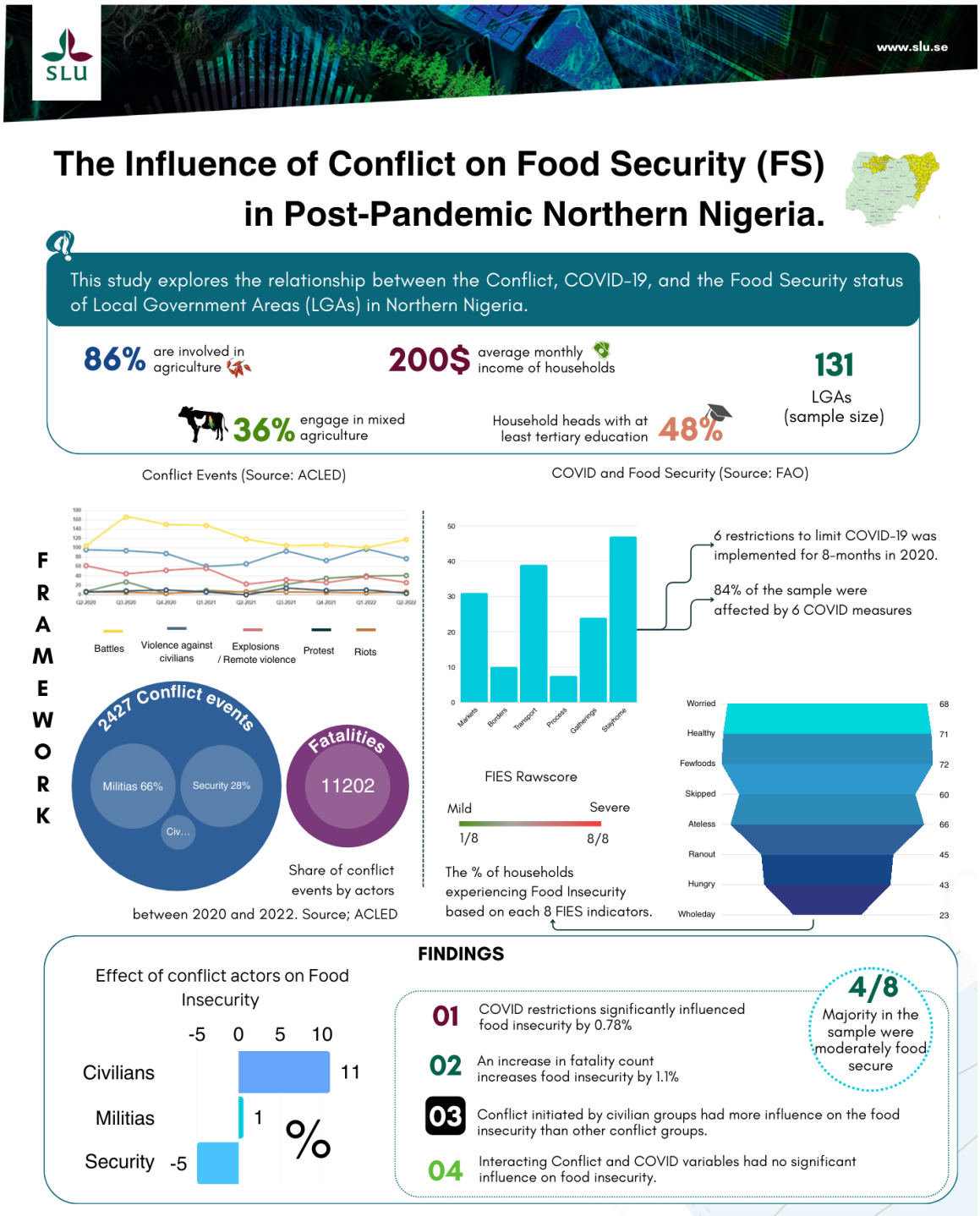


Figure A10. Variance Inflation Factor (VIF) of each explanatory variable on the food insecurity index.

Popular science summary



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SCIENCE AND EDUCATION FOR SUSTAINABLE LIFE

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