Chapter 9

WORSENING FOOD SECURITY IN SUDAN AMID CONFLICT

Oliver K. Kirui, Khalid Siddig, Alemayehu S. Taffesse, and Hala Abushama

The conflict in Sudan, primarily between the Sudanese Armed Forces (SAF) and the Rapid Support Forces (RSF), has escalated since April 2023 into a significant crisis, affecting the nation's stability and security and worsening humanitarian conditions. The conflict has severely degraded the food security of many Sudanese households, with profound effects on their diets, coping strategies, and overall welfare.

Sudan's food security situation was already precarious before April 2023, due to the combination of deteriorating macroeconomic conditions, economic sanctions, fluctuating agricultural production, and climate-related challenges, such as droughts and floods (Alhelo et al. 2023; Mohamed 2022; Abdalla 2018). Despite abundant arable land and water resources in some parts of the country, Sudan's economic performance has been constrained by underinvestment in agriculture, inadequate infrastructure, and a reliance on food imports. These conditions, coupled with high inflation and a depreciating currency, have made food access increasingly difficult for a significant portion of the population. Moreover, localized conflicts in the Darfur and Kordofan regions and Blue Nile state in the years before the current conflict laid the groundwork for food insecurity by hampering agricultural activities and displacing communities, which increased the vulnerability of some regions to food insecurity (FAO 2022).

Sudan's agriculture sector, the backbone of the economy, has also been severely affected by the conflict. Insecurity and displacement have prevented farmers in many areas from accessing their fields, and in some places, military operations have destroyed crucial agricultural infrastructure (Kirui, Ahmed, Siddig, et al. 2024). As a result, both agricultural output and food availability are expected to decline (FAO 2024; Guo et al. 2024; Kirui et al. 2023). Moreover, the blockade of supply routes and markets has disrupted the distribution of goods, making it challenging for communities, especially in conflict-affected areas, to access food (UNOCHA 2023; Abushama et al. 2023).

The ongoing conflict between the SAF and RSF has also created large populations of internally displaced persons (IDPs). As of February 2026, more than 7 million people are estimated to have been internally displaced, while an additional 4.5 million people have sought refuge in neighboring countries (UNHCR 2026). In short, the humanitarian situation is dire—approximately 21.2 million people across Sudan were experiencing high levels of acute food insecurity (IPC Phase 3 or above) as of September 2025 (IPC 2025). Between June and September 2024, 14 areas in nine states faced a risk of famine (IPC 2024b). Also, in August 2024, the IPC Famine Review Committee reported that the Zamzam camp near El-Fasher in North Darfur state was in IPC Phase 5 (famine), with these conditions projected to persist through October 2024 and likely beyond. The Committee also highlighted similar famine conditions in other IDP sites near El-Fasher, such as the Abu Shouk and Al Salam camps, emphasizing the urgent need to assess food security, nutrition, and health in these areas (IPC 2024a). Other regions in Sudan also remain at risk of famine due to conflict and limited access for humanitarian responders.[1]

The United Nations' humanitarian response plan for Sudan requires US$2.7 billion to provide multi-cluster and protection assistance to 18 million people. However, as of October 2024, the plan remained significantly underfunded, with only 49 percent of the total funding required (UNOCHA 2024).

This chapter contributes to the broader discourse on conflict and food security through an analysis of Sudan's food security before and during the current SAF–RSF conflict. Specifically, the study uses national datasets to measure and compare the severity of and changes in food insecurity among Sudan's rural and urban households before and during the conflict. Our empirical analysis is designed to provide insights on food insecurity dynamics in the context of conflict. We conclude by looking at the implications for the development of strategies and targeted interventions to mitigate the impact of food insecurity on vulnerable populations in conflict-affected areas.

While numerous studies have examined the relationship between conflict and food insecurity globally, there is a notable lack of empirical, real-time analysis focused on Sudan during periods of active conflict. This study helps

1 Adding to the crisis, heavy rains and flooding affected more than 17,000 people in both western and eastern Sudan following the onset of the rainy season in June 2024. In Kassala state, 10,700 people were affected, many of whom had fled recent hostilities in Sennar state. Flooding destroyed homes and schools, further worsening the living conditions of affected populations (UNOCHA 2024b).

address that gap by offering updated, nationally representative evidence from Sudan—a country facing both extreme conflict and limited humanitarian access. Rather than covering the broader food security literature, this chapter provides country-specific insights into the current crisis. Even so, our findings speak to the broader literature by deepening understanding of how conflict disrupts food security across geographic and socioeconomic dimensions.

Drawing on nationally representative data collected both before and during the conflict, this study finds a dramatic deterioration in food security across Sudan since the conflict's outbreak in April 2023. The share of food-secure households has fallen from 49 percent preconflict to between 9 and 20 percent, varying by state. Estimates using the Rasch model (1980) indicate significant increases in moderate-to-severe food insecurity, which has risen from 37 to 59 percent in rural areas and from 32 to 48 percent in urban areas. The impacts are most severe in already vulnerable states such as South Darfur, Blue Nile, and North Darfur, while relatively better outcomes are observed in states such as Northern and Red Sea that have better market access and greater humanitarian presence. Consistent with global evidence, the conflict has disproportionately affected rural populations, large households, and female-headed households. These findings underscore the urgent need for targeted interventions that combine emergency relief with longer-term investments in food systems and infrastructure, particularly in the most affected regions.

This chapter is organized as follows. The next section details the data sources used, including sample characteristics, followed by a discussion of the empirical approach used for measuring household food insecurity, the Food Insecurity Experience Scale (FIES). The results and discussions section presents the raw FIES and Rasch model estimates, explores these estimates by income and by gender of the household head, and compares household FIES data before and during the conflict. The final section summarizes the findings and discusses their broader implications.

Methodology and data sources

Measurements of food security indicators

THE FOOD INSECURITY EXPERIENCE SCALE

FIES is a globally validated tool developed by the Food and Agriculture Organization of the United Nations (FAO) to assess the severity of food insecurity at the household or individual level (FAO 2016). FIES is rooted in the

premise that individuals and households facing food insecurity experience a predictable set of conditions, ranging from anxiety about food access to skipping meals or going without food entirely. The scale is designed for use at global, regional, or national levels (Ballard et al. 2013; Cafiero et al. 2018).

In surveys, the FIES module comprises eight binary (yes/no) questions designed to capture various food insecurity experiences over the previous 30 days or 12 months that reflect the respondent's access to adequate food. These questions include whether the respondent was ever concerned during the recall period about not having enough food, being unable to eat healthy and nutritious food, eating fewer kinds of foods, skipping meals, eating less than needed, running out of food, experiencing hunger but not eating, and going without food for a whole day. An affirmative response to any question in the module indicates the presence of a specific food insecurity condition. The aggregate FIES score for each respondent ranges from 0 to 8, with higher scores indicating more severe food insecurity (Smith et al. 2017).

For the analysis here, descriptive statistics were computed from each survey to summarize the distribution of food insecurity levels across the population, calculating the frequency and percentage of affirmative responses for each FIES question. We categorized households with raw aggregate scores of 0 as "food secure," households with scores between 1 and 3 as experiencing "moderate food insecurity," and those households with scores between 4 and 8 as experiencing "severe food insecurity." Additionally, average raw FIES scores were calculated to summarize the overall severity of food insecurity. This approach provides a straightforward measure of food insecurity among households and aligns with international reporting practices for Sustainable Development Goal (SDG) Indicator 2.1.2 (FAO et al. 2023).

HOUSEHOLD FOOD INSECURITY MEASURES BASED ON THE RASCH MODEL

The Rasch model enhances the measurement of food insecurity by addressing limitations inherent in the raw FIES scores. It provides a robust framework for assessing the severity of food insecurity across different populations (Owino et al. 2014; Bond and Fox 2015; Boone 2017). The Rasch model assumes a logistic function, where the probability of an affirmative response depends on the difference between the severity of an individual's or household's food insecurity (person ability) and the difficulty of a given food insecurity condition (item difficulty) (Bond and Fox 2015; Boone 2017). Unlike raw FIES scores, the Rasch model produces interval-level measures that allow for more accurate comparisons across demographic groups, regions, and time periods (Coleman-Jensen et al. 2015).

For assessing household food insecurity, the Rasch model estimates are preferred to raw FIES scores because they are an objective measure independent of the sample and specific items used, which can be used for longitudinal and cross-sectional analyses. Additionally, the model identifies which of the eight questions are most informative for detecting food insecurity, information which then can be used in guiding targeted interventions (Nord et al. 2016).

COMPARATIVE ANALYSIS

We also conducted a comparative analysis to evaluate food security before and during the conflict at the state level. This involved comparing average FIES scores and the distribution of food insecurity levels between these periods, highlighting significant changes attributable to the conflict. Combining raw scores and Rasch model estimates provided a robust cross-validation of findings. While raw scores offered a straightforward understanding of prevalence, Rasch estimates allowed for deeper insights into the severity and progression of food insecurity across diverse populations.

Estimating the household correlates of food insecurity

Empirical model and specification

To analyze the factors associated with household food insecurity in Sudan, a semi-nonparametric extended ordered probit (SNEOP) model was employed (Gallant and Nychka 1987). The SNEOP model relaxes the restrictive distributional assumptions of a traditional ordered probit model by allowing for greater flexibility in capturing the relationship between explanatory variables and the ordinal dependent variable, which is the food insecurity category of the household. This flexibility is particularly valuable in contexts like Sudan, where heterogeneity in socioeconomic conditions and conflict-induced shocks may lead to nonstandard distributions of food insecurity. Several previous studies have analyzed food insecurity using ordinal and semi-nonparametric models. Studies by Cafiero, Viviani, and Nord (2018) emphasize the relevance of FIES in quantifying food insecurity. Similarly, Gallant and Nychka (1987) and Stewart (2004) provide the theoretical foundation for employing SNEOP in contexts where traditional ordered probit models fail to capture distributional complexities.

The dependent variable in this study is the food insecurity level, measured as an ordinal variable based on the FIES score-based categories: (1) food secure,

(2) moderately food insecure, and (3) severely food insecure. The SNEOP model estimates the latent variable Y_i^*, defined as:

$$Y_i^* = \beta X_i + \epsilon_i \quad (1)$$

where Y_i represents the food insecurity level of household i; X_i is a vector of explanatory variables, including demographic characteristics such as household size, education, employment status, and conflict exposure; β is the vector of coefficients to be estimated; and is ϵ_i the error term, following a flexible, semi-nonparametric distribution.

The observed categories of food insecurity Y_i are linked to the latent variable Y_i^* through thresholds τ_j where:

$$Y_i = \begin{cases} 1, \text{ if } Y_i^* \leq \tau_1, \\ 2, \text{ if } \tau_1 < Y_i^* \leq \tau_2, \\ 3, \text{ if } Y_i^* > \tau_2. \end{cases} \quad (2)$$

The SNEOP model extends the ordered probit framework by approximating the distribution of using a series of Hermite polynomials, enabling more accurate estimation in the presence of non-normality (Gallant and Nychka 1987; Stewart 2004). The SNEOP model is estimated using maximum likelihood methods. We posit here that conflict exposure increases the probability of severe food insecurity, while household-level variables, such as education, employment status, and access to basic services, mitigate the risk of food insecurity. The reduced form equation includes explanatory variables capturing demographic, socioeconomic, and contextual factors affecting food insecurity, as described in Table 9.1.

Data sources and sample characteristics

The data used in this study originate from three sources: the 2022 Sudan Labor Market Panel Survey (SLMPS) for the preconflict period (Krafft and Assaad 2023), the 2023/24 Sudan Rural Household Survey (SRHS) (Kirui, Ahmed, Taffesse, et al. 2024), and the 2024 Sudan Urban Household Survey (SUHS) (IFPRI and UNDP 2024b) for the conflict period (Table 9.2).

The 2022 Sudan Labor Market Panel Survey

The 2022 SLMPS provides a detailed snapshot of labor market dynamics in Sudan and is the first nationally representative labor market survey since 2014. Conducted by the Economic Research Forum in partnership with Sudan's

TABLE 9.1 Variables used in the analysis: Definitions and a priori expectations

Variable	Definition (SI units / coding)	Expected sign (a priori hypothesis on household food insecurity)
Age	Continuous variable: age of household head in years	Negative at lower ages, positive at higher ages (nonlinear relationship)
Age squared	Squared term of household head's age (years^2)	Positive (older age increases likelihood of food insecurity after a threshold)
Female-headed household	Binary (0 = male-headed; 1 = female-headed)	Positive (female-headed households more vulnerable to food insecurity)
Housing adequacy	Binary (0 = inadequate; 1 = adequate housing)	Negative (adequate housing reduces food insecurity risk)
Migration	Binary (0 = no movement; 1 = household moved)	Positive (migration, especially conflict-induced, increases food insecurity)
Access to safe water	Binary (0 = no; 1 = yes)	Negative (access to safe water lowers food insecurity)
Education level	Categorical (Low, Medium, High, based on years of schooling of household head)	Negative (higher education reduces household food insecurity)
Household size	Continuous (number of household members)	Positive (larger households more likely to face food insecurity)
Employment status	Binary (0 = unemployed; 1 = employed household head)	Negative (employment lowers risk of food insecurity)
SAF/RSF conflict exposure	Binary (0 = no; 1 = exposed to conflict)	Positive (conflict exposure increases food insecurity)
Decline in household income since conflict	Binary (0 = no; 1 = reported income decline)	Positive (income loss raises food insecurity)

Source: Authors' compilation.

TABLE 9.2 Summary of survey data used in the study

Survey	Sudan Labor Market Panel Survey	Sudan Rural Household Survey	Sudan Urban Household Survey
Coverage	Nationwide, all 18 states	Rural areas nationwide	Urban centers nationwide
Conflict context	Low-level generalized conflict; before April 2023 start of SAF/RSF conflict	During SAF/RSF conflict	During SAF/RSF conflict
Sample unit	Household and individual	Household	Household
Household sample	4,878	4,505	3,000
Urban / Rural	Both rural and urban	Rural	Urban
Data collection modality	In-person	Computer-assisted telephone interviewing	Computer-assisted telephone interviewing
Data collection period	June–September 2022	November 2023–January 2024	May–July 2024

Source: Authors' compilation based on Krafft et al. (2023); Kirui et al. (2024); and IFPRI and UNDP (2024b).

Central Bureau of Statistics, the survey sampled 4,878 households nationwide, who were selected using random stratified cluster sampling. Despite significant challenges posed by political unrest and economic instability, interviews with SLMPS sample households were conducted in person between June and September 2022. Given the survey's focus on employment, migration, and socioeconomic conditions, it oversampled vulnerable populations, including refugees and IDPs (Krafft and Assaad 2023). The survey addressed a wide range of topics, including violence and climatic shocks, migration patterns, household demographics, educational attainment, housing conditions, and access to essential services such as health and education.

The 2022 SLMPS was the first wave of a planned longitudinal study aimed at understanding human resource development and deployment in Sudan. The survey was modeled after similar labor market surveys conducted in Egypt, Jordan, and Tunisia, and includes modules focusing on gender-disaggregated asset, employment, and entrepreneurship data. The data were designed to be representative at the national level, for urban and rural areas, and across all regions of Sudan. The surveys collected information on all household members ages five years and above, as well as data on all enterprises run by the household.

2023/24 Sudan Rural Household Survey

The SRHS was conducted by IFPRI in collaboration with the United Nations Development Programme (UNDP) and World Food Programme (WFP). The respondents were interviewed using computer-assisted telephone interviewing (CATI) survey administration methods between early November 2023 and early January 2024 (that is, about six months after the onset of the SAF/RSF conflict). This survey provided the first nationwide data on rural households following the eruption of conflict. It provides baseline data on the economic activities and food security of rural households, forming part of a planned longitudinal study involving regular rural household survey rounds (IFPRI and UNDP 2024a).

2024 Sudan Urban Household Survey

The SUHS covered 3,000 urban households and was implemented by IFPRI in partnership with UNDP in May and July 2024, just over one year after the onset of the conflict. Like the SRHS, the SUHS was implemented using CATI. The survey sample was designed to provide both national and state-level estimates for urban households across Sudan (IFPRI and UNDP 2024b). Like the SRHS, the SUHS is also the first round of a planned panel survey program designed to enable longitudinal studies of urban households in Sudan.

The sampling strategies for the 2023/24 SRHS and the 2024 SUHS were crafted to account for the unpredictability associated with telephone surveys, including factors such as inactive numbers in the telephone number databases used for selecting the sample and interruptions to network connectivity.[2] While CATI facilitated data collection under difficult conditions, it introduced some limitations, including reduced depth of interaction in interviewing. Perhaps most importantly, disparities in phone ownership in the population potentially introduced bias in the survey estimates. In particular, the samples for both surveys implemented during the conflict likely underrepresented low-income households, as they are less likely than other household groups to have telephone access.

Results and discussions

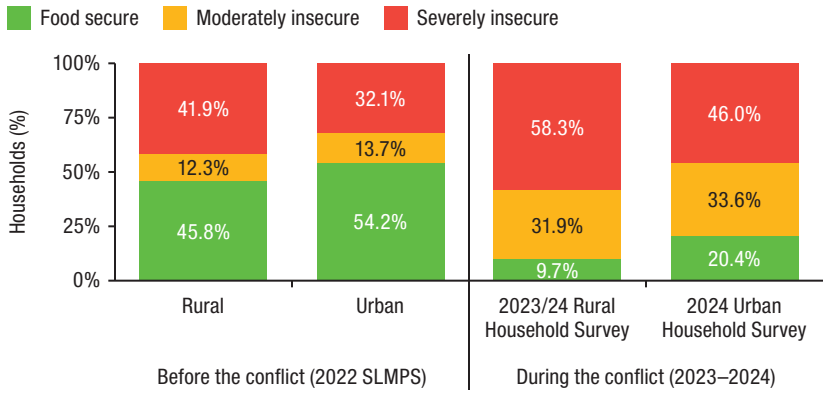
Food security status: Food Insecurity Experience Scale raw score estimates

Although the two survey sampling frames are not strictly comparable, major differences in the FIES scores reported by the surveys indicate a significant decline in food security in Sudan following the onset of the conflict in April 2023 (Figure 9.1). Overall, prior to the conflict, about half of Sudanese households were food secure. In contrast, during the conflict, about 90 percent of rural households and 80 percent of urban households were estimated to be experiencing moderate or more severe levels of food insecurity. This high probability of household food insecurity highlights the conflict's profound impact on agricultural productivity and household livelihoods, especially in regions traditionally seen as major food production sources.

Rural areas, in particular, have felt the greatest impact of the conflict (FIES scores of "food secure" falling from of 45.8 to 9.7 percent). Many of these areas have suffered from reduced food production as insecurity and displacement caused by the conflict have hampered access to farmland. In addition, market disruptions have hindered the distribution of what food is available. Urban areas have also seen increased food insecurity, though they are less dependent on agriculture. The share of urban households with FIES food-secure scores fell from 54.2 to 20.4 percent. Rising prices and diminished

2 See Kirui et al. (2024b) for details of the methodology used to obtain accurate and reliable inferences, despite the inherent challenges of data collection in a conflict setting.

FIGURE 9.1 Household food security status based on Food Insecurity Experience Scale raw scores



Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, and 2024 SUHS.

household purchasing power, reflecting the economic fallout of the fighting, are likely major factors contributing to this decline. This pattern mirrors findings in Yemen, where conflict led to similar production and market disruptions that created severe food shortages and increased prices in urban settings (World Bank 2024b).

State-level analysis reveals widespread severe food insecurity during the conflict (Table 9.3). States including West Kordofan, Blue Nile, South Kordofan, White Nile, North Darfur, Kassala, Khartoum, and Sennar are estimated to have food insecurity levels significantly above the national average, highlighting the extensive and severe nature of the food crisis. Most of these states were already severely food insecure before the conflict, particularly in the Darfur and Kordofan regions, and the data show exacerbated levels of food insecurity with the outbreak of the conflict. Notably, 97 percent of households in River Nile state and 71 percent in East Darfur state were estimated to be food secure before the conflict. Measures of food security deteriorated sharply during the conflict, however, with the share of households estimated to be food secure falling sharply to just 17 percent in River Nile and 5 percent in East Darfur.

These findings align with earlier studies, which identified these regions as particularly prone to food insecurity due to their historical marginalization and weak infrastructure (IPC 2024b). Conversely, states such as Northern and Red Sea, which have benefited from better market access and

TABLE 9.3 Household food security status based on Food Insecurity Experience Scale raw scores, by state (percentage of households in each category)

State	Before the conflict (2022 SLMPS)						During the conflict (2023–2024)					
	Rural Households			Urban Households			2023/24 Rural Households			2024 Urban Households		
	Food secure	Moderately insecure	Severely insecure	Food secure	Moderately insecure	Severely insecure	Food secure	Moderately insecure	Severely insecure	Food secure	Moderately insecure	Severely insecure
Khartoum	41.9	11.4	46.7	40.1	13.3	46.6	6.6	29.8	63.6	21.3	29.5	49.3
Central Darfur	47.7	11.4	40.9	34.0	20.0	46.0	3.7	42.0	54.3	31.5	22.2	46.3
East Darfur	71.3	13.9	14.9	71.5	14.6	13.8	5.2	39.3	55.6	16.7	22.2	61.1
North Darfur	40.0	23.4	36.6	53.8	15.4	30.8	7.5	26.1	66.4	5.9	31.5	62.6
South Darfur	29.8	4.1	66.1	48.7	10.1	41.3	3.8	36.8	59.4	9.2	32.5	58.3
West Darfur	70.3	21.6	8.1	60.1	16.1	23.8	3.4	49.0	47.7	11.1	41.4	47.5
North Kordofan	70.6	8.4	21.0	57.2	6.2	36.6	11.9	31.5	56.6	16.4	44.3	39.3
South Kordofan	30.6	9.5	59.9	25.7	40.0	34.3	7.9	22.2	69.8	17.9	29.8	52.4
West Kordofan	16.6	11.7	71.8	30.6	16.1	53.2	7.4	21.9	70.7	17.2	46.7	36.1
Sennar	45.9	17.2	36.9	62.3	18.8	18.8	10.8	29.5	59.7	23.1	33.3	43.6
Gedaref	22.7	18.2	59.1	37.7	21.7	40.6	11.7	30.9	57.4	27.8	36.1	36.1
Blue Nile	35.2	9.3	55.6	47.9	9.4	42.7	6.3	24.4	69.3	13.7	31.6	54.7
White Nile	33.9	10.9	55.2	43.6	19.1	37.2	10.7	28.2	61.1	25.6	32.1	42.3
Northern	66.0	12.4	21.6	63.9	17.5	18.6	20.4	35.4	44.2	24.0	29.3	46.7
River Nile	100.0	0.0	0.0	95.7	4.3	0.0	16.7	33.9	49.4	22.5	35.0	42.5
Aj Jazirah	52.0	14.9	33.1	48.2	14.2	37.6	12.1	36.3	51.6	28.8	32.0	39.2
Kassala	52.5	5.8	41.7	69.4	10.8	19.8	12.9	32.0	55.2	26.4	29.5	44.2
Red Sea	60.3	17.6	22.1	70.6	14.1	15.3	23.6	35.0	41.4	33.3	26.9	39.8
Total	45.8	12.3	41.9	54.2	13.7	32.1	9.7	31.9	58.3	20.4	33.6	46.0

Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, 2024 SUHS.

humanitarian aid, have not experienced such severe declines in the percentages of food secure households. Similar patterns were also observed by Guo and colleagues (2024) in other conflict zones.

Data from the preconflict period (2020 to 2022) from the WFP's Consolidated Approach for Reporting Indicators of Food Security show similar patterns (Table 9.4). In this survey, about three-fourths of households were food secure, while only about 4 percent were classified as severely food insecure. However, severe food insecurity increased between 2021 and 2022, possibly indicating growing vulnerabilities even before the current conflict, driven by economic, social, and environmental pressures.

Persistent hotspots and emerging challenges

Data from the three surveys show both the persistence of food insecurity in historically vulnerable states and the emergence of new hotspots caused by the widespread and uneven impact of the conflict. Several states, including South Darfur, Blue Nile, North Darfur, and Central Darfur, consistently ranked among the most food-insecure regions both before and during the conflict. For example, households in South Darfur experienced a jump in moderate and severe food insecurity from 60.8 percent preconflict to 93.5 percent during the conflict, reflecting worsening conditions in an already vulnerable area (Table 9.5). Other states with only moderate levels of food insecurity preconflict saw dramatic escalations in food insecurity levels. For example, in West Darfur, 34.8 percent of households were estimated to be food insecure preconflict, but during the current conflict, that rate rose to 92.8 percent—the third highest prevalence of household food insecurity among Sudan's states. Similarly, Khartoum and Sennar, which had relatively low preconflict food insecurity rates of 59.0 percent and 45.9 percent, respectively, reported alarming levels of 86.1 percent and 83.1 percent during the conflict (Table 9.5).

Food security status: Rasch model estimates

To further assess food insecurity severity, we used the Rasch model to classify household food security status on a probabilistic scale (Reise and Revicki 2015). The model estimates show a sharp increase after the start of the conflict in the probability of moderate to severe food insecurity, particularly in rural areas where agricultural disruptions and displacement have been most acute. During the conflict period, about 59 percent of rural and 46 percent of urban households in Sudan were estimated to be experiencing moderate or severe food insecurity, a significant increase from about 41 percent and 32 percent, respectively, in 2022 (Figure 9.2).

TABLE 9.4 Prevalence of household food insecurity in Sudan between 2020 and 2022 using WFP data (percentage)

Year	Food secure	Moderately food insecure	Severely food insecure
2020	74.5	22.1	3.4
2021	77.3	20.1	2.6
2022	73.1	22.0	4.9

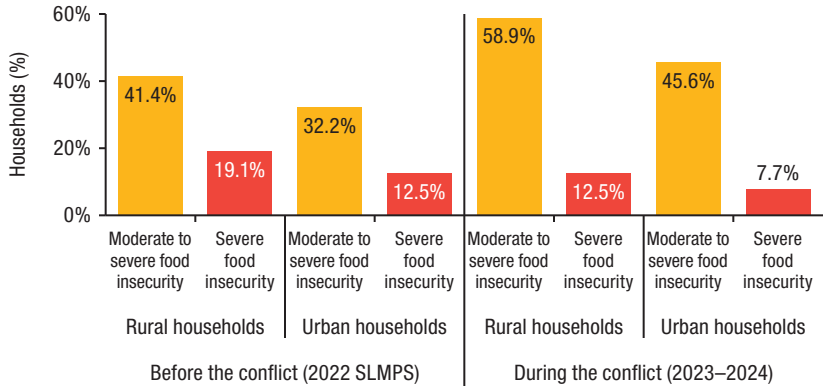
Source: Authors' analysis of WFP (n.d.).

TABLE 9.5 Rank of states by household prevalence of moderate and severe food insecurity in the preconflict period and during the conflict

Before the conflict 2022 SNLPS		During the conflict 2023/24 SRHS and 2024 SUHS	
State	% of households	State	% of households
West Kordofan	76.4	South Darfur	93.5
South Kordofan	71.8	North Darfur	93.3
Gedaref	69.8	West Darfur	92.8
White Nile	61.2	Blue Nile	90.0
South Darfur	60.8	East Darfur	89.1
Central Darfur	59.1	West Kordofan	87.7
Khartoum	59.0	South Kordofan	87.1
Blue Nile	58.5	Khartoum	86.1
North Darfur	53.1	North Kordofan	85.8
Aj Jazirah	49.9	Sennar	83.1
Sennar	45.9	Central Darfur	82.4
Kassala	39.1	White Nile	81.8
North Kordofan	36.1	River Nile	80.4
Northern	35.1	Kassala	80.4
West Darfur	34.8	Gedaref	80.2
Red Sea	34.6	Aj Jazirah	79.6
East Darfur	28.6	Northern	77.8
River Nile	2.2	Red Sea	71.5

Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, 2024 SUHS.

FIGURE 9.2 Rasch model estimates: Prevalence of moderate-to-severe and severe food insecurity among rural and urban households before and during the conflict in Sudan



Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, and 2024 SUHS.

In urban areas, where rising food prices and reduced incomes have diminished the purchasing power of households, food insecurity has significantly increased, a result that is consistent with the findings of Siddig and colleagues (2023).

State-level analysis of food insecurity using the Rasch model reveals a stark escalation in food insecurity across Sudan following the onset of the conflict (Table 9.6). Both rural and urban households have experienced a marked increase in the probability of moderate to severe food insecurity. Particularly notable in this respect are the states of Blue Nile, East Darfur, and South Kordofan, which exhibit some of the highest increases in food insecurity probabilities. These trends underscore the deepening crisis in regions already vulnerable due to preexisting socioeconomic challenges. The disparities in food insecurity across states, with states such as Blue Nile and South Kordofan seeing the highest increases in food insecurity, are also in line with global patterns observed in conflict-affected regions, where preexisting vulnerabilities, such as limited market access and poor infrastructure, exacerbate the effects of conflict (Cappelli et al. 2024).

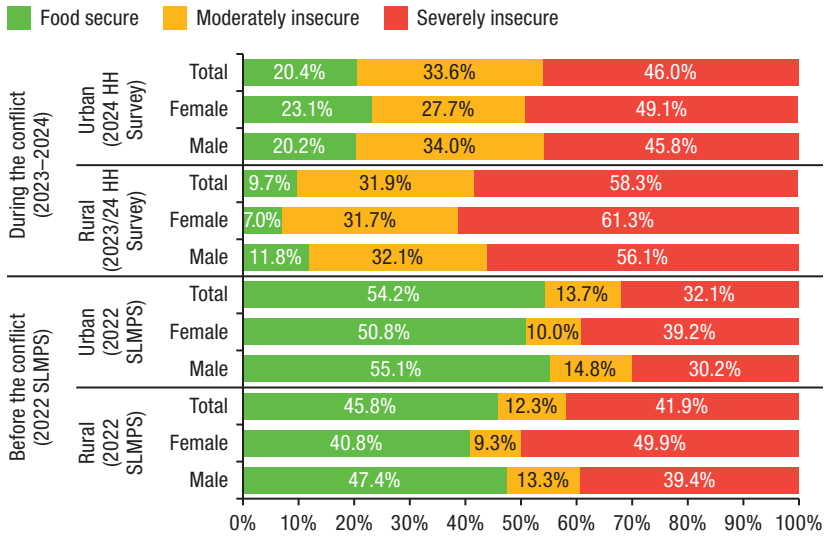
In contrast, states with better access to markets and humanitarian aid, such as Northern and Red Sea, experienced relatively smaller increases in food insecurity, suggesting possible mitigating effects of such factors (Table 9.6). For example, although Northern state's probability of severe food insecurity increased after the start of the conflict, it remains lower than in more

TABLE 9.6 Rasch model estimates: Probability of households being food insecure by state (percent of households in each category)

State	Before the conflict				During the conflict			
	Rural Households (2022 SLMPS)		Urban Households (2022 SLMPS)		2023/24 Rural Household Survey		2024 Urban Household Survey	
	Probability of moderate or severe food insecurity	Probability of severe food insecurity	Probability of moderate or severe food insecurity	Probability of severe food insecurity	Probability of moderate or severe food insecurity	Probability of severe food insecurity	Probability of moderate or severe food insecurity	Probability of severe food insecurity
Khartoum	46.6	25.0	45.4	18.3	63.6	13.7	49.5	11.7
Central Darfur	41.3	24.5	45.5	23.3	55.6	4.7	42.5	6.8
East Darfur	15.2	5.0	15.5	4.5	59.3	11.7	58.2	8.4
North Darfur	38.3	13.0	30.1	8.3	63.7	15.3	60.4	10.4
South Darfur	65.9	42.1	41.9	23.3	59.6	6.9	57.2	8.3
West Darfur	12.0	0.3	24.6	5.4	53.6	5.4	47.0	4.9
North Kordofan	21.0	2.6	36.9	19.6	55.9	10.5	40.1	4.6
South Kordofan	60.0	38.1	38.6	8.7	69.0	17.7	52.8	12.5
West Kordofan	71.5	34.2	54.6	27.7	70.5	20.9	36.7	5.6
Sennar	37.6	18.5	20.0	3.8	59.7	13.1	41.8	5.7
Gedaref	56.5	12.5	40.2	16.0	57.5	10.3	36.3	5.7
Blue Nile	49.1	5.0	41.0	6.6	68.7	19.0	53.2	7.5
White Nile	54.0	30.4	40.3	21.5	62.7	16.2	41.8	7.3
Northern	18.8	1.8	18.8	3.3	46.7	10.6	46.5	5.1
River Nile	0.0	0.0	0.5	0.0	50.3	8.2	43.7	6.9
Aj Jazirah	32.4	13.8	36.7	12.0	52.4	11.2	38.9	6.0
Kassala	41.0	24.1	19.7	11.3	57.4	13.8	45.3	9.6
Red Sea	18.7	0.4	15.3	2.5	43.5	8.9	38.4	7.6
Total	41.4	19.1	32.2	12.5	58.9	12.5	45.6	7.7

Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, and 2024 SUHS.

FIGURE 9.3 Households estimated as experiencing moderate or severe food insecurity, before and during current conflict, by gender of household head (percentage)



Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, and 2024 SUHS.

conflict-affected areas. Such findings are consistent with a hypothesis that infrastructure and external support play a critical role in buffering the impacts of conflict. At the national level, the probability of moderate-to-severe food insecurity rose from 36.8 percent to 58.9 percent, and severe food insecurity decreased slightly from 15.8 percent to 12.5 percent. This overall trend reflects the broader impact of the conflict on Sudan's food security landscape.

Food security status and selected household demographic characteristics

Our analysis of the three household surveys shows that demographic factors also significantly influence food insecurity. In particular, female-headed households and larger households are disproportionately affected by the conflict (Figure 9.3). This pattern for female-headed households is consistent with findings from Somalia and the Democratic Republic of the Congo, where these households were found to be particularly vulnerable to food insecurity during conflict. Likewise, the trend toward higher food insecurity among larger households has also been observed in other conflict zones, such as Somalia, due to their increased needs (World Bank 2024a).

TABLE 9.7 Descriptive statistics of explanatory variables

Variable	Before the conflict (2022)				During the conflict (2023–2024)			
	Rural		Urban		Rural		Urban	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Age (years)	46.02	15.68	47.98	14.43	36.05	12.57	45.31	12.01
Age squared	2363.3	1591.46	2509.6	1476.65	1458	1045.73	2197.4	1138.24
Female head	23.9	42.6	21.5	41.1	42.78	50.78	5.9	77
Education Level								
Low	4.65		4.3		50.83		21.51	
Medium	32.55		35.56		33.24		50.25	
High	62.8		60.14		15.92		28.24	
Housing adequacy	49.6	50	76.1	42.6	29.3	45.5	52.9	49.9
RSF/SAF conflict exposure	—	—	—	—	11.1	31.4	14	34.7
Migration	23.3	42.3	35.7	47.9	23.8	42.6	36.4	48.1
Access to safe water	12.24	21.86	8.34	17.19	3.58	2.24	4.11	3.94
Household size (members)	5.13	2.45	5.3	2.42	10.41	6.12	8.85	4.24
Employment status	57.1	49.5	67.7	46.8	64.8	47.8	69.0	72.0

Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, and 2024 SUHS.

Empirical results

Descriptive statistics of explanatory variables

The descriptive statistics reveal clear shifts in household characteristics before and during the conflict. In the preconflict period (2022), household heads were older on average in both rural (46 years) and urban (48 years) areas, compared with 2024, when rural heads were much younger (36 years) and urban heads slightly younger (45 years) (Table 9.7). Female-headed households were more common in rural areas before the conflict (24 percent) than in urban areas (22 percent), and this share rose sharply to 43 percent in rural areas during the conflict, while falling in urban settings. Education levels also changed markedly: in 2022, most household heads reported medium or high levels of education, while in 2024 the share with low or no education rose to more than half in rural areas and one-fifth in urban areas. Housing adequacy was higher in urban than rural areas, both before and during the conflict, but declined substantially in rural areas during the crisis. Conflict exposure was reported by 11 percent of rural and 14 percent of urban households in 2024. Access to safe

water dropped sharply during the conflict in both settings. Household sizes increased dramatically during the conflict, averaging 10.4 members in rural areas and 8.9 in urban areas, compared to about 5 members in both contexts preconflict. Employment remained relatively stable overall, though somewhat higher in urban areas. These descriptive results point to worsening vulnerabilities, particularly in rural areas, where conflict, displacement, and household crowding have coincided with deteriorating living conditions.

Determinants of household food insecurity before and during the conflict

Table 9.8 presents the SNEOP estimates[3] for rural households in Sudan in the preconflict period (2022). The results indicate several strong and statistically significant associations between household characteristics and food insecurity. The age of the household head shows a nonlinear effect: while increases in age reduce the likelihood of food insecurity, the positive and significant age-squared term suggests diminishing returns at older ages. Female-headed households are significantly more likely to be food insecure, while households with adequate housing are less likely to experience food insecurity. Migration is positively and significantly associated with a higher probability of severe food insecurity, reflecting the vulnerabilities of displaced households. Access to safe water reduces the probability of being severely food insecure, while larger household size increases vulnerability. Education of the household head is associated with reduced food insecurity, although the effect is relatively modest. Employment status of the household head shows no significant effect in rural areas.

Table 9.8 shows the SNEOP estimates for urban households in the same preconflict period. Compared to rural areas, the relationships are weaker and less consistently significant. Age again shows a nonlinear pattern, with younger household heads associated with reduced food insecurity, but the age-squared term indicating rising risk at older ages. Female-headed households are significantly more food insecure in urban areas, while households with adequate housing are better protected. Migration again significantly increases the probability of severe food insecurity, suggesting that displacement is a critical driver regardless of setting. Access to safe water reduces severe food

3 Model comparisons revealed that the extended semi-nonparametric specification outperformed the standard ordered probit model in all cases, as indicated by log-likelihood ratio tests (as recommended by Stewart, 2004). The default polynomial order of three was rejected, and order four was selected for the datasets. The Wald test further demonstrated that the included variables were jointly significant, meaning they significantly explained variations in food security outcomes. The log pseudolikelihood values and chi-squared statistics further support the reliability of the fitted models.

TABLE 9.8 Semi-nonparametric extended ordered probit for rural households in the preconflict period, 2022

	Estimates		Marginal effects					
			Food secure		Moderately food insecure		Severely food insecure	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Age of HH head, years	−0.022***	0.008	0.008***	0.000	−0.001***	0.000	−0.007***	0.000
Age squared	0.000**	0.000	−0.000***	0.000	0.000***	0.000	0.000***	0.000
Female-headed household, 0/1	0.286***	0.082	−0.100***	0.001	0.011***	0.001	0.089***	0.001
Adequate housing, 0/1	−0.175**	0.076	0.072***	0.001	−0.014***	0.001	−0.057***	0.001
Migrated, 0/1	0.182**	0.076	−0.064***	0.001	0.008***	0.001	0.056***	0.001
Safe water access, 0/1	0.029***	0.003	−0.006***	0.000	−0.001***	0.000	0.008***	0.000
Education of HH head	−0.080	0.051	0.026***	0.001	−0.002***	0.000	−0.024***	0.001
Household size, no.	0.025*	0.013	−0.009***	0.000	0.001***	0.000	0.008***	0.000
Employed HH head, 0/1	0.003	0.064	0.001	0.001	−0.001**	0.001	0.001	0.001
cut2 constant	0.322***	0.055	0.423***	0.005	0.173***	0.003	0.403***	0.003
b1_constant	1.360***	0.508						
b2_constant	−0.157***	0.092						
b3_constant	−0.517	0.137						
Observations	2258		2258		2258		2258	
Chi-squared	244.960							
P	0.000		0.000		0.000		0.000	

Source: Authors' analysis of 2022 SLMPS, 2023/24 SRHS, and 2024 SUHS.

Note: Robust standard errors in parentheses. For dummy variables, the discrete change from 0 to 1 is used. *p < 0.1, **p < 0.05, ***p < 0.01. Estimates are reported as 0 in the table when they are smaller than (1 × 10−5) in absolute value and insignificant. HH = household.

insecurity, though with smaller magnitude compared to rural areas. Education of the household head shows mixed effects, with weak protective associations, while larger households are significantly more vulnerable to food insecurity in urban areas. Employment of the household head has only limited protective effects, with significance at the margin.

Overall, the preconflict analysis demonstrates that socioeconomic and demographic characteristics had structured and significant relationships with household food insecurity, though with stronger and more consistent effects in rural areas than in urban areas. These findings highlight the importance

TABLE 9.9 Semi-nonparametric extended ordered probit for urban households in the preconflict period, 2022

	Estimates		Marginal effects					
			Food secure		Moderately food insecure		Severely food insecure	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Age of HH head, years	−0.027	0.023	0.010***	0.000	−0.001***	0.000	−0.009***	0.000
Age squared	0.000	0.000	−0.000***	0.000	0.000***	0.000	0.000***	0.000
Female-headed household, 0/1	0.230	0.217	−0.085***	0.001	0.004***	0.001	0.082***	0.001
Adequate housing, 0/1	−0.315	0.260	0.118***	0.001	−0.004***	0.001	−0.113***	0.001
Migrated, 0/1	0.413	0.357	−0.154***	0.001	0.007***	0.001	0.147***	0.000
Safe water access, 0/1	0.009	0.008	−0.003***	0.000	−0.000***	0.000	0.003***	0.000
Education of HH head	0.024	0.059	−0.008***	0.000	0.000	0.000	0.008***	0.000
Household size, no.	0.100	0.084	−0.037***	0.000	0.002***	0.000	0.035***	0.000
Employed HH head, 0/1	−0.052	0.107	0.019***	0.001	−0.001*	0.001	−0.017***	0.001
cut2 constant	0.466	0.403	0.446***	0.003	0.147***	0.003	0.407***	0.002
b1_constant	−0.020	0.160						
b2_constant	0.117	0.415						
b3_constant	0.008	0.046						
Observations	2278		2278		2278		2278	
Chi-squared	2.657							
P	0.976		0.000		0.000		0.000	

Source: Authors' analysis of 2022 SLMPS.

Note: Robust standard errors in parentheses. For dummy variables, the discrete change from 0 to 1 is used. *p < 0.1, **p < 0.05, ***p < 0.01. Estimates are reported as 0 in the table when they are smaller than (1 × 10−5) in absolute value and insignificant. HH = household.

of household-head demographics, gender, housing conditions, migration, and basic services access as critical correlates of food insecurity in Sudan before the outbreak of the 2023 conflict.

For the regression analysis of rural households during the conflict period (Table 9.10), key factors influencing food security include the age of the household head, housing adequacy, conflict exposure, education, and income dynamics. The impact of the household head's age on food security is nonlinear, with older individuals more likely to experience severe food insecurity; however, this effect diminishes as age increases. Housing adequacy

TABLE 9.10 Semi-nonparametric extended ordered probit for rural households during the conflict period, 2023/24

	Estimates		Marginal effects					
			Food secure		Moderately food insecure		Severely food insecure	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Age of HH head, years	0.014	0.012	−0.003***	0.000	−0.003***	0.000	0.005***	0.000
Age squared	0.000	0.000	0.000***	0.000	0.000***	0.000	−0.000***	0.000
Female-headed household, 0/1	0.219	0.181	−0.031***	0.000	−0.050***	0.000	0.081***	0.000
Adequate housing, 0/1	−0.432	0.333	0.073***	0.001	0.092***	0.000	−0.165***	0.000
Migrated, 0/1	0.002	0.048	0.000	0.001	0.000	0.000	0.001**	0.000
Safe water access, 0/1	0.037	0.027	−0.005***	0.000	−0.008***	0.000	0.014***	0.000
Education of HH head	−0.031	0.041	0.005***	0.000	0.007***	0.000	−0.012***	0.000
Household size, no.	0.025	0.019	−0.003***	0.000	−0.006***	0.000	0.009***	0.000
Employed HH head, 0/1	−0.042	0.055	0.006***	0.000	0.009***	0.000	−0.015***	0.000
SAF/RSF conflict, 0/1	0.325	0.316	−0.043***	0.001	−0.076***	0.001	0.119***	0.000
Income decline, 0/1	0.095	0.077	−0.014***	0.000	−0.021***	0.000	0.036***	0.000
Constant			0.234***	0.002	0.583***	0.002	0.182***	0.001
cut2 constant	0.869	1.050						
b1_constant	0.094	0.257						
b2_constant	0.015	0.413						
b3_constant	−0.029	0.023						
Observations	4,485		4,485		4,485		4,485	
Chi-squared	4.211							
p	0.9630		0.0000		0.0000		0.0000	

Source: Authors' analysis of 2023/24 SRHS.

Note: Robust standard errors in parentheses. For dummy variables, the discrete change from 0 to 1 is used. *p < 0.1, **p < 0.05, ***p < 0.01. Estimates are reported as 0 in the table when they are smaller than (1 × 10−5) in absolute value and insignificant. HH = household.

significantly reduced the likelihood of severe food insecurity, while exposure to conflict increased it. Education and income stability were also critical, with more educated individuals and households experiencing fewer income shocks and being less likely to face severe food insecurity. Household size and employment also showed significant effects, with larger households facing higher probabilities of severe food insecurity but also benefiting slightly from resource pooling.

The analysis of urban households during the conflict period (Table 9.11) likewise found housing adequacy to be a critical factor, significantly correlated with the probability of being food secure. Conflict exposure greatly worsened food security, with substantial positive effects on the likelihood of severe food insecurity. The household head being employed was notably associated with a reduced probability of severe food insecurity. Age and education of the household head also had significant, albeit smaller, impacts. The nonlinear relationship of the age of the household head with food security was observed here as well, and higher education levels were associated with a reduction in severe food insecurity.

Conclusions and implications

The ongoing conflict in Sudan has had a profound and far-reaching impact on food security, drastically reducing the number of food-secure households in both rural and urban areas. This study, which draws on nationally representative data from the preconflict 2022 SLMPS and from the 2023/24 SRHS and 2024 SUHS conducted during the conflict, shows a sharp decline in food security since the start of the conflict in April 2023. Before the conflict, approximately 49 percent of households were considered food secure; this figure has now dropped to between 9 and 20 percent, depending on the state. The probability of moderate-to-severe food insecurity, as estimated by the Rasch model, has surged from 37 to 59 percent in rural areas and from 32 to 48 percent in urban areas, illustrating the conflict's widespread impact on food availability and access.

At the state level, the conflict has deepened existing vulnerabilities, particularly in regions such as South Darfur, Blue Nile, North Darfur, and Central Darfur, where preconflict conditions were already challenging due to poor infrastructure and limited access to markets. These areas have seen some of the most significant increases in food insecurity, highlighting how the conflict has compounded existing socioeconomic difficulties. In contrast, states such as Northern and Red Sea, which have better market access and humanitarian

TABLE 9.11 Semi-nonparametric extended ordered probit for urban households during the conflict period, 2024

	Estimates		Marginal effects					
			Food secure		Moderately food insecure		Severely food insecure	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Age of HH head, years	0.036**	0.018	−0.010***	0.000	−0.003***	0.000	0.013***	0.000
Age squared	−0.000**	0.000	0.000***	0.000	0.000***	0.000	−0.000***	0.000
Female-headed household, 0/1	0.024	0.092	−0.003*	0.002	−0.006***	0.002	0.009***	0.001
Adequate housing, 0/1	−0.517***	0.137	0.136***	0.001	0.059***	0.001	−0.196***	0.000
Migrated, 0/1	0.034	0.046	−0.006***	0.001	−0.006***	0.001	0.013***	0.000
Safe water access, 0/1	0.016**	0.007	−0.004***	0.000	−0.002***	0.000	0.006***	0.000
Education of HH head	−0.102**	0.044	0.027***	0.001	0.009***	0.001	−0.037***	0.000
Household size, no.	0.030***	0.009	−0.006***	0.000	−0.004***	0.000	0.011***	0.000
Employed HH head, 0/1	0.106***	0.034	−0.028***	0.000	−0.011***	0.000	0.039***	0.000
SAF/RSF conflict, 0/1	0.503***	0.142	−0.110***	0.001	−0.074***	0.001	0.184***	0.000
Income decline, 0/1	0.101**	0.047	−0.029***	0.001	−0.007***	0.001	0.036***	0.000
Constant			0.490***	0.006	0.441***	0.006	0.069***	0.002
cut2 constant	1.187***	0.253						
b1_constant	−0.019	0.189						
b2_constant	−0.010	0.129						
b3_constant	0.008	0.020						
Observations	2,999		2,999		2,999		2,999	
Chi-squared	15.927							
P	0.144		0.000		0.000		0.000	

Source: Authors' analysis of 2024 SUHS.

Notes: Robust standard errors in parentheses. For dummy variables, the discrete change from 0 to 1 is used. *p < 0.1, **p < 0.05, ***p < 0.01. Estimates are reported as 0 in the table when they are smaller than (1 × 10−5) in absolute value and insignificant. HH = household.

support, have fared somewhat better. This contrast underscores the importance of infrastructure and external aid in buffering the effects of conflict.

The findings from this study align with global research on the impact of conflict on food security. As seen in similar contexts, such as Yemen and South Sudan, disrupted livelihoods, market failures, and mass displacement have driven food insecurity to unprecedented levels, with rural populations and vulnerable groups, including female-headed households and large families, disproportionately affected. These trends reinforce the need for targeted, context-specific interventions to address both the immediate and structural drivers of household food insecurity.

Given current trends, targeted interventions are urgently needed to address immediate food insecurity and its root causes. Policymakers and humanitarian actors should prioritize aid delivery in the hardest hit areas while supporting agricultural production and market access in safer regions. A coordinated strategy that combines emergency relief with long-term investments, such as farm support and infrastructure, will be key to stabilizing food systems and enabling recovery. Ultimately, lasting impact will depend on promoting regional stability and addressing the conflict's underlying drivers.

The crisis in Sudan has significant implications that extend beyond its borders, underscoring the urgent need for stronger regional and international engagement. At the regional level, neighboring countries and organizations such as the Intergovernmental Authority on Development and the African Union all have a critical role to play in facilitating dialogue, supporting peacebuilding initiatives, and coordinating cross-border humanitarian assistance to displaced populations. Globally, the scale of food insecurity in Sudan highlights the importance of sustained support from international actors, including the United Nations, international financial institutions, and humanitarian agencies, to address both immediate relief and longer-term resilience needs. Increased humanitarian aid must be coupled with diplomatic efforts to secure a negotiated resolution to the conflict, as sustainable improvements in food security will only be possible in an environment of peace and stability. Lessons from other protracted crises, such as Yemen and South Sudan, point to the necessity of a dual approach that combines emergency food assistance with investments in restoring livelihoods, rebuilding agricultural systems, and ensuring access to markets and services. Without coordinated regional and global action, the impacts of Sudan's conflict on hunger, displacement, and instability risk spilling over to neighboring states, threatening wider regional security, and undermining progress toward global food security targets, including SDG 2 (Zero Hunger).

Limitations and future research

This study has several limitations that warrant acknowledgment. First, reliance on CATI data may introduce selection bias, as households without reliable phone access are likely underrepresented. Second, the analysis relies on a single food security indicator, the FIES, which, while widely validated, does not capture all dimensions of food security such as dietary diversity, nutrition adequacy, or food utilization. Third, the econometric approach provides valuable insights into correlates of household food insecurity but does not fully address potential endogeneity between conflict dynamics and welfare outcomes. Future research should expand on this work by incorporating multiple indicators of food security, applying mixed methods designs, and using longitudinal or experimental approaches to better capture the causal pathways linking conflict and household food insecurity.

References

Abdalla, R. 2018. *Food Security in Sudan: Challenges and Prospects*. Khartoum University Press.

Abushama, H., D. Resnick, K. Siddig, and O.K. Kirui. 2023. "Political and Economic Drivers of Sudan's Armed Conflict: Implications for the Agri-Food System." Sudan SSP Working Paper 15. IFPRI. https://hdl.handle.net/10568/137896

Alhelo, A., K. Siddig, and O.K. Kirui. 2023. "The Architecture of the Sudanese Agricultural Sector and Its Contribution to the Economy between 1990 and 2021." IFPRI Discussion Paper 02191. IFPRI. https://hdl.handle.net/10568/131415

Ballard, T.J., A.W. Kepple, and C. Cafiero. 2013. *Political and Economic Drivers of Sudan's Armed Conflict: Implications for the Agri-Food System*. FAO. https://openknowledge.fao.org/handle/20.500.14283/as583e

Bond, T.G., and C.M. Fox. 2015. *Applying the Rasch Model: Fundamental Measurement in the Human Sciences*. Third ed. Routledge.

Boone, W.J. 2017. "Rasch Analysis for Instrument Development: Why, When, and How?" *CBE: Life Sciences Education* 15:rm4. https://doi.org/10.1187/cbe.16-04-0148

Cafiero, C., S. Viviani, and M. Nord. 2018. "Food Security Measurement in a Global Context: The Food Insecurity Experience Scale." *Measurement* 116:146–152. https://doi.org/10.1016/j.measurement.2017.10.065

Cappelli, F., V. Costantini, M. D'Angeli, G. Marin, and E. Paglialunga. 2024. "Local Sources of Vulnerability to Climate Change and Armed Conflicts in East Africa." *Journal of Environmental Management* 355:120403. https://doi.org/10.1016/j.jenvman.2024.120403

Coleman-Jensen, A., C. Gregory, and A. Singh. 2015. *Household Food Security in the United States in 2013*. USDA-ERS Economic Research Report No. 173. USDA. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2504067

FAO (Food and Agricultural Organization of the United Nations). 2016. *Methods for Estimating Comparable Rates of Food Insecurity Experienced by Adults Throughout the World*. FAO. https://openknowledge.fao.org/handle/20.500.14283/i4830e

FAO. 2022. *Special Report – 2021 FAO Crop and Food Supply Assessment Mission to the Sudan*. FAO. https://openknowledge.fao.org/handle/20.500.14283/cb9122en

FAO. 2024. "5 Things You Should Know About How Conflict in Sudan Is Devastating Agriculture and People's Food Security." *FAO News* (blog). April 15. https://www.fao.org/emergencies/resources-repository/news/detail/5-things-you-should-know-about-how-conflict-in-sudan-is-devastating-agriculture-and-people%27s-food-security/en

FAO, IFAD (International Fund for Agricultural Development), UNICEF, WFP (World Food Programme), and WHO (World Health Organization). 2023. *The State of Food Security and Nutrition in the World 2023: Urbanization, Agrifood Systems Transformation and Healthy Diets across the Rural–Urban Continuum*. FAO. https://openknowledge.fao.org/handle/20.500.14283/cc3017en

Gallant, R.A., and D.W. Nychka. 1987. "Semi-Nonparametric Maximum Likelihood Estimation." *The Econometric Society* 55 (2):363–390. https://doi.org/10.2307/1913241

Guo, Z., H. Abushama, K. Siddig, O.K. Kirui, K. Abay, and L. You. 2024. "Monitoring Indicators of Economic Activities in Sudan Amidst Ongoing Conflict Using Satellite Data." *Defence and Peace Economics* 35 (8):992–1008. https://doi.org/10.1080/10242694.2023.2290474

IFPRI and UNDP (United Nations Development Programme). 2024a. *Livelihoods in Sudan Amid Armed Conflict: Evidence from a National Rural Household Survey*. IFPRI and UNDP. https://www.undp.org/sudan/publications/livelihoods-sudan-amid-armed-conflict

IFPRI and UNDP. 2024b. *The Socio-Economic Impact of Armed Conflict on Sudanese Urban Households*. IFPRI. https://hdl.handle.net/10568/159599

IPC (Integrated Food Security Phase Classification). 2024a. *Famine Review Committee: Combined Review Of: (i) the Famine Early Warning System Network (FEWS NET) IPC Compatible Analysis for IDP Camps in El Fasher, North Darfur; and (ii) the IPC Sudan Technical Working Group Analysis of Zamzam Camp (North Darfur), Sudan. Conclusions and Recommendations*. IPC. https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Famine_Review_Committee_Report_Sudan_July2024.pdf

IPC. 2024b. *Sudan: IPC Acute Food Insecurity Analysis June 2024 - February 2025 Report*. IPC. https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Sudan_Acute_Food_Insecurity_Jun2024_Feb2025_Report.pdf

IPC. 2025. *Sudan: Acute Food Insecurity Situation September 2025 – May 2026.* Integrated Food Security Phase Classification. https://reliefweb.int/report/sudan/sudan-ipc-acute-food-insecurity-analysis-september-2025-may-2026-issued-november-2025

Kirui, O.K., M.O.M. Ahmed, K. Siddig et al. 2024. *Food Security and Social Assistance in Sudan during Armed Conflict: Evidence from the First Round of the Sudan Rural Household Survey (November 2023–January 2024).* A joint report by the International Food Policy Research Institute (IFPRI) and the World Food Programme (WFP). IFPRI. https://hdl.handle.net/10568/145388

Kirui, O.K., M. Ahmed, A.S. Taffesse, H. Abushama, and K. Siddig. 2024. "Sudan Rural Household Survey 2023: Sampling and Implementation Procedures for the First Round." Sudan SSP Working Paper 18. IFPRI. https://hdl.handle.net/10568/141598

Kirui, O.K., K. Siddig, M. Ahmed, H. Abushama, and A.S. Taffesse. 2023. "Impact of the Ongoing Conflict on Smallholder Farmers in Sudan: Evidence from a Nationwide Survey." " Sudan SSP Working Paper 17. IFPRI. https://hdl.handle.net/10568/140241

Krafft, C., and R. Assaad. 2023. "Introducing the Sudan Labor Market Panel Survey 2022." ERF Working Paper No. 1647. ERF (Economic Research Forum). https://erf.org.eg/publications/introducing-the-sudan-labor-market-panel-survey-2022/?tab=undefined&c=undefined

Mohamed, E.S.E. 2022. "Climate Change, Agricultural Production, and Food Security in Sudan." *Journal of Economics and Research* 3 (1):1–19. https://doi.org/10.53280/jer.1082393

Nord, M., C. Cafiero, and S. Viviani. 2016. "Methods for Estimating Comparable Prevalence Rates of Food Insecurity Experienced by Adults in 147 Countries and Areas." *Journal of Physics: Conference Series* 772 (1):012060. https://doi.org/10.1088/1742-6596/772/1/012060

Owino, A., R. Wesonga, and F. Nabugoomu. 2014. "Determining Food Insecurity: An Application of the Rasch Model with Household Survey Data in Uganda." *International Journal of Food Science* 2014 (1):121269. https://doi.org/10.1155/2014/121269

Rasch, G. 1980. *Probabilistic Models for Some Intelligence and Attainment Tests*. University of Chicago Press.

Reise, S.P., and D.A. Revicki. 2015. *Handbook of Item Response Theory Modeling: Applications to Typical Performance Assessment*. Routledge.

Siddig, K., M. Raouf, and M.O.M. Ahmed. 2023. "The Economy-Wide Impact of Sudan's Ongoing Conflict: Implications on Economic Activity, Agrifood System and Poverty." Sudan SSP Working Paper 12. IFPRI. https://hdl.handle.net/10568/140293

Smith, M.D., M.P. Rabbitt, and A. Coleman-Jensen. 2017. "Who Are the World's Food Insecure? New Evidence from the Food and Agriculture Organization's Food Insecurity Experience Scale." *World Development* 93:402–412. https://doi.org/10.1016/j.worlddev.2017.01.006

Stewart, M.B. 2004. "Semi-Nonparametric Estimation of Extended Ordered Probit Models." *The Stata Journal* 4 (1):27–39. https://doi.org/10.1177/1536867X0100400102

UNHCR (United Nations High Commissioner for Refugees). 2026. *Sudan Situation Map Weekly Regional Update – 02 February 2026.* UNHCR. https://data.unhcr.org/en/documents/details/120945

UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs). 2023. *Sudan Humanitarian Needs and Response Plan 2024*. UNOCHA. https://reliefweb.int/node/4025287

UNOCHA. 2024. *Sudan Humanitarian Update (1 October 2024)*. UNOCHA. https://www.unocha.org/publications/report/sudan/sudan-humanitarian-update-1-october-2024

WFP (World Food Programme). n.d. "2020-2022 WFP Consolidated Approach for Reporting Indicators of Food Security data." Unpublished dataset.

World Bank. 2024a. *Livelihoods Lost - Findings from Two Rounds of the Somalia Displacement Phone Survey (2022)*. World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099062824105528285

World Bank. 2024b. *Yemen Country Climate and Development Report*. World Bank. https://hdl.handle.net/10986/42274