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Temporal trends of food insecurity in Chad, 2016–2021

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Introduction: Considering persistently high levels of poverty and food insecurity in Chad, this study examines food insecurity trends from 2016 to 2021 and identifies risk factors for food insecurity in 2020 and 2021.

Methods: Data from six cross-sectional Enquête Nationale sur la Securité Alimentaire (ENSA) surveys from 2016 to 2021 collected in rural areas were used. The linear regressions for food consumption score (FCS), reduced coping strategy index (rCSI), and livelihood coping strategy index (LCSI) and logistic regressions for *"poor food consumption"* were used to estimate the annual rate of change. Risk factor analysis was conducted with demographic, socio-economic, and pandemic-related economic indicators in univariate models, and subsequent multivariate models were used to produce adjusted odds ratios.

Results: At a national level, there was a gradual decrease in FCS (1.16 points per year), an increase in LCSI (0.11 points), and an increase in the proportion of households with poor food consumption from 18.5% to 25.3% (1.55 percentage point) during 2016–2021; a similar trend for FCS and LCSI for worsened food insecurity was observed in the Sudanian zone. There was no significant change in rCSI during that time at the national level, but there was a reduction in the Saharan zone and an increasing trend in the Sahélian zone. Risk factors for poor food consumption in 2020–2021 included lower wealth status, a single income source, an illiterate household head, and Sahelian zone residence. The only characteristic significantly associated with increased coping mechanism use in both years was having a disabled household head.

Discussion: The results provide evidence of worsening food security in Chad in the past 6 years, both nationally and including the agricultural Sudanian zone. Food insecurity was consistently the highest in the Sahelian zone. While some risk factors for poor food consumption and diet-related coping mechanism use were consistent between 2020 and 2021, there were differences among other risk factors, likely a reflection of the impacts of the COVID-19 pandemic. A strategic shift in humanitarian and development programming is required to mitigate the rise in food insecurity at the national and regional levels, with a particular emphasis on the Sahelian zone.

KEYWORDS

COVID-19, Chad, food security, food consumption score, diet-related coping strategy

Introduction

Chad is a landlocked Sahelian country with high levels of poverty and food insecurity. Chad is 190th out of 191 countries on the Human Development Index (HDI), and 42.3% of the population lives in poverty [United Nations Development Programme (UNDP) and Oxford Poverty and Human Development Initiative (OPHI), 2022; United Nations Development Programme (UNDP), 2023]. In 2022, more than 5.3 million people suffered from food insecurity (Hoinathy and Delanga, 2022), and approximately 2.1 million were in

severe food insecurity [Système d'Information sur la Sécurité Alimentaire et d'Alerte Précoce du TCHAD (SISAAP) et al., 2022]. On the Global Hunger Index, Chad is ranked 117th of 121 countries, and 40% of Chadian children are stunted, a marker of chronic undernutrition (Institut National de la Statistique et al., 2014-2015; Global Hunger Index, 2023).

In addition to the high prevalence of poverty, one of the main drivers of food insecurity in Chad has been erratic agricultural production owing to increasing climate change and variability in a context of high dependence on subsistence agriculture (SISAAP, 2022). The Notre Dame Global Adaptation Index ranks Chad as the most vulnerable to climate change, ranked 185th of 185 countries (Notre Dame Global Adaptation Initiative, 2023). There was a continued rise in prices of cereals, up to 30–40% in the past 5 years, which is in part due to erratic production.

The recurrence of shocks and stressors at national and global levels, such as floods, dry spells, and economic shocks, has been frequent, not allowing households enough time to recover between shocks (Système d'Information sur la Sécurité Alimentaire et d'Alerte Précoce du TCHAD, 2020; Hassen and Bilali, 2022).

There was a forced displacement of over 400,000 people (as of December 2021) in some parts of the country due to the presence of non-state armed groups [United Nations High Commissioner for Refugees (UNHCR), 2021]. The violent Boko-Haram insurgency in Northeastern Nigeria resulted in displacements and movement restrictions and disrupted many agricultural activities including major crops such as maize, sorghum, and millet (Musa et al., 2022). Chad is one of the largest refugee-hosting countries, with over 1 million forcibly displaced people and conflict-affected refugees (UNHCR, 2023). The inflow of refugees increased the ongoing food insecurity and put constraints on scarce resources (Médecins Sans Frontières, 2022). Such displacement hinders agricultural production, affects access to employment opportunities, and interferes with market and trade activities.

Globally, the COVID-19 pandemic had immense impacts on food insecurity. Common consequences of the 2020 lockdowns that were enacted by governments to reduce COVID-19 transmission included increased unemployment, loss of household income, and economic recession (Béné et al., 2021). Supply chain disruptions, rising food prices coupled with declining incomes, and movement restrictions collectively contributed to reduced access to both an adequate diet and appropriate health and nutrition services. The Food and Agriculture Organization (FAO) estimated that globally an additional 112 million people fell into undernutrition because of the COVID-19 pandemic, and food insecurity attributed to COVID-19 lockdowns disproportionately affected socio-economically vulnerable groups (FAO et al., 2022). Kang et al. (2023) found that nearly two-thirds of households in Chad reported an income reduction due to the pandemic, which was in turn associated with increased use of livelihood coping strategies. The household economic impacts of the pandemic in Chad were most pronounced in urban areas in 2020, whereas in 2021, there was a geographic shift and household economies in rural areas were more negatively affected (Kang et al., 2023).

Measures taken to alleviate hardship at the household level included the temporary suspension of electricity and water bills, expansion of the national food distribution program, establishment of a youth entrepreneurship fund, and a solidarity fund for the vulnerable population. In 2020, fiscal policies allowed for reductions in business license fees and taxes, agricultural sector subsidies, and simplification of import requirements for food and other necessities. In January 2021, a gradual re-opening included allowing the use of public transportation; re-opening of markets, shops, schools and universities, places of worship, and restaurants for carry-out; and re-opening of land borders and air travel (International Monetary Fund, 2022).

In Chad, by mid-2022, an estimated 2.1 million people faced crisis or above levels of food insecurity largely due to the convergence of the aforementioned factors and the Government declared a state of emergency due to the food crisis in the country [Food Security Information Network (FSIN) and Global Network Against Food Crises, 2022; Tchana et al., 2022].

Many theoretical frameworks showing the pathways through which household food security or local food systems are affected by COVID-19 economic recession are available [Béné et al., 2021; High Level Panel of Experts on Food Security and Nutrition (HLPE), 2021; Ghosh-Jerath et al., 2022]. The theoretical framework of this study is generated by adopting available frameworks (Supplementary Figure 1).

Although food insecurity in Chad has been widely reported, and this is loosely attributed to climate change, conflict, and pandemics, there is a lack of systematic evidence on the long-term trend of food security and the statistical association or risk factors for food insecurity. To this gap, this study examines the long-term spatial and temporal trends of food security among rural households in Chad from 2016 to 2021 and identifies risk factors for food insecurity during the 2020 to 2021 COVID-19 pandemic. We hypothesize that food security in the country has deteriorated over the study period. Given increasing food insecurity, the study is expected to inform the strategic orientation of humanitarian and development programs that can draw on the evidence to holistically address food insecurity and, more broadly, social protection for the most vulnerable.

Literature review

The World Food Summit of 1996 defined food security as a situation that exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996). Food security is a multi-dimensional concept, encompassing physical food availability, economic and physical access to food, food utilization, and stability of the other three dimensions (Peng and Berry, 2019). It is therefore impacted by, among other things, the development of the countries, political instability, and climate change (Brown et al., 2015). Due to Chad's low positioning on social, economic, and climate indicators as earlier described and summarized by the World Bank, 2023, the country faces unique food security challenges in each of the dimensions (World Bank Group, 2023).

Food availability

Historical data available through the FAOSTAT database show that between 2000 and 2021, there was an 83% increase in the surface cultivated, a 53% increase in cereal yields, and a 182% increase in overall production, nonetheless marked by some years of deficit agriculture (Food Agriculture Organization, 2023). However, 83% of the increases in production for the period 1990–2016 can be explained by expansions in harvested area (Nilsson et al., 2000). A review of the Cadre Harmonisé (SISAAP, 2022) analyses nonetheless shows that in recent years (2018–2022), there was a notable (10%) reduction in production and there remains a cereal deficit of 276,911 tons, considering imports.

It is widely documented that agricultural production in Chad is primarily subsistence-based (with about 80% of the population engaged in smallholder farming and reliant on agriculture for food security) and rain-fed (GIZ, 2020; CIAT, 2021). Accordingly, food availability has been documented as dependent on rainfall (and overall climate) variability (CIAT, 2021). Notwithstanding, in their analysis of various production data on Chad, Nilsson et al. (2020) found that changes to crop water availability from rainfall are largely decoupled from the long-term increases in crop production. On the other hand, their analysis shows that population changes and international aid can explain differences in long-term changes between Chad's regions. Nilsson et al. (2020) also identified stochastic factors such as farm support programs, market prices, access to new markets, and accommodation of refugees as important to grasp abrupt changes in crop production, potentially explaining (in part) the erratic trends.

Access to food

Poverty in Chad is omnipresent and severe, of which 89% of poor households live in rural areas (The World Bank, 2021). Nonetheless, there was a notable reduction in the national poverty prevalence from 45.5% in 2014 to the present 42.3% (The World Bank, 2021). This inevitably means that fundamentally, a significant part of the population (estimated at 2.4 million people in 2018) is not able to meet basic nutritional needs per day. Further to this, it is notable that Chad has experienced a continuous rise in food prices over the last 2 years, further restraining access to food. The most widely consumed foods experienced increases throughout 2021, with millet, maize, sorghum, and berbere closing the year at 36.2, 36.5, 41.3, and 41.5%, respectively, above the 5-year average (WFP, 2022). The analysis attributes these price increases to, among other things, the drop in cereal production experienced during the 2021/2022 crop year, insecurity in parts of the country causing displacement of people, and production losses that led to a drop in food stocks in households and on the markets (WFP, 2022).

Food utilization

According to a review of the national food security assessment (ENSA) reports (SISAAP, 2022), the quantity and quality of household food consumption have deteriorated continuously since 2016, with a marked difference in the levels between the agroecological zones. For instance, in the Soudanien zone, the food consumption score declined from 66.4 in 2016 to 53.3 in 2022. In terms of quality, the reports show consistently higher consumption of grains, sugar, oil, and vegetables across the years at the expense of the more nutritious foods (SISAAP, 2022).

Food insecurity is the main reason for poor infant and young child feeding practices in Chad (Wuehler and Nadjilem, 2011). This combined with relatively poor sanitary standards in the country as well as the existence of socio-cultural barriers that impede the use of good nutrition practices particularly among children exacerbates poor utilization of food (WFP Chad, 2022). Thus, among children, the percentage of children who meet the minimum acceptable diet remains very low, at 33.8% according to the SMART survey report (Govt. Chad et al., 2023).

The national prevalence of stunting in Chad was staggered high between 32.4% in 2017 and 30.4% in 2021 without improvement (Govt. Chad et al., 2022). A study in N'Djamena with a sample of 881 children of 6–59 months of age (25.5%) reported that household food insecurity (16.6%) was related to child stunting (Gassara et al., 2023). Overall, a synthesis of data presented by the SMART nutrition surveys and the global nutrition report of 2022 indicates that Chad is faced with the triple burden of malnutrition with a high level of global acute malnutrition, a high prevalence of micronutrient deficiencies with anemia prevalence of 60% among children under 5 years, and relatively high prevalence of overweight and obesity, particularly among women, at 32 and 11%, respectively (Global Nutrition Report, 2022).

Food stability

The ND-GAIN index (Notre Dame Global Adaptation Initiative, 2023), which summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience, classifies Chad as the country that is most vulnerable to climate change in the world, ranking 185th of 185 countries.

According to Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) (Funk et al., 2015), there has been an increase in total annual precipitation over the past 40+ years, and the last 6 years have all been above the long-term average with the highest quantity over the last 40 years recorded in 2022. Yet, according to research, all recent decades have been marked by reports of drought in the Sahel (Funk et al., 2015). Chad's unpredictable rainfall patterns, flooding, and droughts cause economic and social problems, exacerbating conflict and contributing to migration and internal displacement (American University, 2021). In addition to climate and conflict-related shocks, a recent study by Kang et al. (2023) showed that the COVID-19 pandemic also significantly affected food security by disrupting livelihoods in both rural and urban areas. As noted by the IMF 2022 (Baptista et al., 2022), successive shocks from the war in Ukraine and the COVID-19 pandemic have increased food prices and depressed incomes, raising the number of people suffering from high malnutrition and unable to meet basic food consumption in sub-Saharan Africa.

Methods

Data source

Secondary analysis was conducted using data from the 2016 to 2021 Enquête Nationale de la Sécurité Alimentaire (hereafter referred to as ENSA), which are national food security surveys conducted annually in the last quarter of the year (Système d'Information sur la Sécurité Alimentaire et d'Alerte Précoce du TCHAD, 2020). The ENSA is organized by the Government of Chad in partnership with WFP, FAO, and NGOs. The original focus of the survey was rural areas; however, in 2020, the ENSA was expanded to include urban populations in N'Djamena. The detailed procedure of data collection in ENSA surveys was described elsewhere (Système d'Information sur la Sécurité Alimentaire et d'Alerte Précoce du TCHAD, 2020). ENSA surveys employ probability-based sampling where each of the 68 departments is a stratum, with two-stage sampling including community and household selection. The ENSA sampling frame consists of the list of villages obtained during the 2009 Chad Population and Housing Census (Système d'Information sur la Sécurité Alimentaire et d'Alerte Précoce du TCHAD, 2020). The ENSA sample size in rural areas (i.e., outside N'Djamena) ranged from 9,165 to 9,544 households between 2016 and 2019 and increased to 13,208 and 14,761 in 2020 and 2021, respectively. Trained enumerators administered a standard questionnaire using the Open Data Kit (ODK) platform in the randomly selected households, interviewing the household head or other adult member present. The household questionnaire covered a range of topics including household assets, agricultural practices, sources of income, level of food stocks, food consumption, expenditures, household shocks, and coping mechanisms.

Outcome variables

The three outcome measures used for analysis were food consumption score (FCS), reduced coping strategy index (rCSI), and livelihoods coping strategy index (LCSI). The FCS reflects the diversity and frequency of household food and nutritional intake consumed in the 7 days preceding the survey and is an indicator used globally (INDDEX Project, 2018). The consumption frequency of eight food groups is assessed in the preceding 7 days, and weighted scores for each food group are summed to calculate the FCS; a higher FCS score indicates better food security. Household food security status is categorized using the following thresholds: 0–28 poor; 28.5–42 borderline; and >42 acceptable. For this analysis, a binary FCS variable (acceptable vs. poor/borderline) was generated and used as an additional outcome measure. The rCSI is a proxy indicator of household food insecurity that reflects both the frequency and severity of coping behaviors in the past week (Maxwell and Caldwell, 2008). The index is calculated based on five food-related coping behaviors including eating less preferred/costly foods; adult reduction of portion size to enable children to eat; reducing portion size at the household level; skipping meals; and borrowing food or relying on help from family/friends. Each question is scored based on frequency in the preceding 7 days, and scores are weighted by severity; a higher rCSI score indicates worse food insecurity. Household coping mechanism use is categorized based on the rCSI score where 0–3 is acceptable, 4–18 crisis, and 19–56 emergency level. For this analysis, a binary rCSI variable (acceptable vs. emergency/crisis) was generated and used as an additional outcome measure. The livelihoods coping strategies index (LCSI) was used to assess the use of livelihood-related coping mechanisms in the preceding month (WFP, 2022) with three severity levels (stress, crisis, and emergency). The LCSI was then computed for each household by weighting by severity level and adding all coping mechanisms used.

Statistical analysis

Statistical analysis was conducted using STATA/SE 17.0. Descriptive statistics included means, proportions, and confidence intervals which were analyzed separately for each survey to account for survey design and sampling weights, with trends over time illustrated at the national and ecological zone levels. Continuous outcome variables were checked for normality by quantile–quantile (Q-Q) plot and Shapiro–Wilk test (all $p > 0.05$).

Temporal trend analysis

For the temporal trend analysis with continuous FCS, rCSI, and LCSI outcomes, linear regression models with a time variable (survey year) were first fitted to estimate the annual change in these outcomes ($y_i = \beta_0 + \beta_1^* time_t + \ldots. + e_t$). A binary outcome (poor/borderline food consumption) was first specified by a logistic regression model (logit $y_i = \beta_0 + \beta_1^* time_t + \ldots. + e_t$). Second, quadratic models were fitted by adding a quadratic variable of time for the continuous outcomes ($yi = \beta 0 + \beta 1^* time_t^* time_t + \ldots. + et$) and the binary outcome (logit $yi = \beta 0 + \beta 1^* time_t^* time_t + \ldots. + e_t$).

In the quadratic models, the average marginal effect of the time that averaged the slopes of the change across six data points (years) was used to estimate the annual change in the score of continuous outcomes or an annual rate of change for the binary outcome. The average marginal effect of time (absolute percentage points) is approximately equal to the β1 coefficient when a model is fitted with a linear probability model. The annual score/rate change from the linear or logistic models was generally consistent with the results from time quadratic models.

One advantage of our approach is that the annual rate of change in the outcomes is estimated from the average marginal effect of time. The average marginal effects account for any variability or non-linearity in changes for the study period, by averaging the slopes of the change in outcome rates across all six rounds of survey data points.

The percentage change per year was estimated at the country level and for each agroecological zone (Saharan Zone, Sahelian Zone, and Sudanian Zone) (Figure 1). All linear, logistic, and quadratic regression models at the national level were adjusted for the ecological zone, literacy, gender, and age of household head, family structure, and wealth. A wealth quintile was generated using propensity score analysis based on assets.

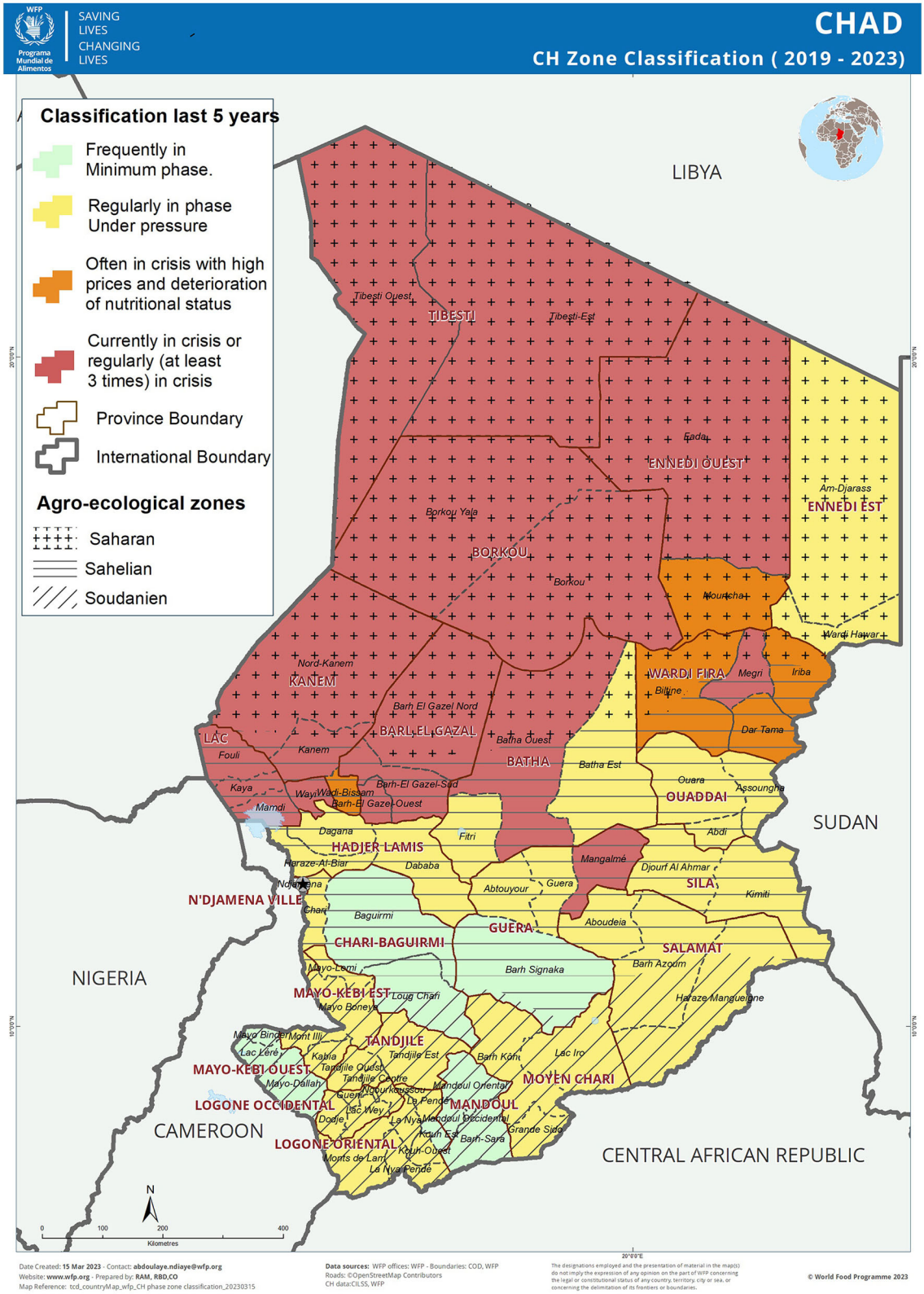

FIGURE 1
Map of the ecological zones and food security status in Chad.

Risk factor analysis

Univariate logistic regressions were first conducted to test the association between each of the potential risk variables and outcome variables in 2020 and 2021 (poor/borderline food consumption and diet-related coping mechanism use). Potential risk variables to be tested in univariate logistic regression included the household head's age, gender, marital status, literacy, disability, and occupation, family size, family structure (monogamous/polygamous/divorced), living conditions (dwelling type; energy, cooking sources and type of drinking water), three agroecological zones, change in COVID-related income, change in the number of income sources, primary income source, and LCIS. If there was a significant relationship in univariate regression models ($p < 0.10$), the variable was included in the multivariate regression analysis. The variables that presented significance ($p < 0.05$ or 95% CI not including 1.0) at multivariable analysis were considered significant risk factors. Differences in the factors between 2020 and 2021 were described separately for urban and rural populations for each year. The values of the variation inflation factor (VIF) for the final multivariate models were between 1.17 and 1.21, which indicated low multicollinearity. There was no heteroskedasticity for the final regression models tested by the Breusch–Pagan test ($p > 0.05$).

Ethical clearance

This study was reviewed by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board and deemed to be exempt because it involved only secondary data analysis of acronymized data.

Results

Descriptive statistics for rural households participating in the 2016 to 2021 ENSA are presented in Table 1. The sample was concentrated in Sahelian and Sudanian zones, which is reflective of the population distribution. Mean household size ranged from 7.1 to 8.0, and 39.4% to 48.1% of households were considered large (defined as 8+ members) each year. Most households were monogamous (58.3–62.3%), though polygamous families (26.4–32.9%) were also common, and, to a lesser extent, households headed by divorced/widowed/single individuals (8.4–12.4%). The age distribution of household heads was relatively consistent across years with similar proportions (~22–28%) of household heads in the 25–34 year, 35–44 year, and 45–55 year age groups; older (>55 years) and younger (<25 years) household heads accounted for ~18–21% and 5–7% of the sample, respectively. The proportion of female-headed households was slightly lower in 2016 (15.6%) and 2021 (17.9%) as compared to other years when female-headed households comprised 21.2–21.9% of the sample. The proportion of illiterate household heads was higher in 2016–2019 (41.6–44.3%) and decreased to 36.6–37.3% in 2020/21.

Trends in food security and coping mechanism use, 2016–2021

We present the average marginal effect of time based on quadratic models as the annual change in FCS, CSI, and LCSI or annual rate change in the prevalence of poor/borderline food consumption (Table 2). The mean FCS significantly decreased from 60.3 points in 2016 to 54.9 points in 2021, indicating a declining trend in food security with an average reduction of 1.16 points in the FCS annually ($p < 0.01$). When examined by zone, there was no statistically significant change in FCS in the Saharan and Sahelian zones. However, there was a notable peak in poor food consumption in 2020 in the Sahelian Zone. In contrast, households in the Sudanian zone had a statistically significant decline in food security, with mean FCS decreasing from 66.4 in 2016 to 59.6 in 2021, which translates to a yearly reduction of 1.23 points in FCS ($p < 0.01$).

Similarly, the proportion of poor or borderline food consumption increased from 18.5% in 2016 to 25.3% in 2021 at the national level, which equates to a 1.55% (CI: 0.31–2.79%; $p = 0.014$) increase per year ($p = 0.014$; Table 2 and Supplementary Table 1). In the Sudanian zone, the proportion of households with poor/borderline food consumption increased significantly from 7.9% to 16.7%, which translates to an average annual increase of 1.33% (CI: 0.44–2.25%; $p = 0.01$). There was no statistically significant change over time in the proportion of households with poor/borderline food consumption in the Sahelian and Saharan zones (Figure 2).

The mean CSI score did not show any significant change between 2016 and 2021 at the national level ($p = 0.15$ and $p = 0.19$, respectively; Table 2, Figure 3, and Supplementary Table 1). There was a statistically significant annual improvement in CSI score with an average of 0.57 in the Sahelian zone and worsening with an average of 0.38 score per year in the Saharan zone. There was no significant time trend in CSI in the Sudanian zone. This trade-off trend of rCSI between Saharan and Sahelian zones resulted in no significant change at the national level.

The mean LCSI-Livelihoods-related coping mechanism use worsened over the years with a 0.11 score increase per year at the national level (Table 2, Figure 4, and Supplementary Table 1). The worsening in LCSI was significant in Sahelian with an annual increase of 0.14 score ($p = 0.004$) and in the Sudanian zone with an annual increase of 0.08 in LCSI; $p = 0.01$). There was no significant change in the Saharan zone. There was a peak in livelihood-related coping mechanism use in Feb 2021.

Risk factors for poor food consumption

Household characteristics that were significantly associated with increased risk of poor food consumption in both 2020 and 2021 included having an illiterate household head, being in a lower wealth quintile, having a single income source, and residence in the Sahelian zone (Table 3). The likelihood of poor food consumption increased with poorer wealth quintiles in a dose–response manner in both years and had the strongest association. As compared to the top quintile, in 2020 and 2021, households in

TABLE 1 General characteristics of the rural ENSA survey population in Chad, 2016–2021.

Survey date	Oct-16[1]	Oct-17[1]	Oct-18[1]	Oct-19[1]	Oct-20[1]	Oct-21[1]
Sample size	9,456	9,019	9,443	9,483	13,208	14,730
Geographic distribution of households						
Agroecological zone						
Saharan zone	4.4%	8.1%	8.7%	6.8%	3.4%	6.0%
Sahelian zone	48.7%	48.6%	48.9%	45.6%	46.4%	46.3%
Sudanian zone	46.9%	43.4%	48.9%	47.7%	50.2%	47.7%
Household demographic characteristics						
Household size						
Mean	7.7	8.0	7.6	7.1	7.1	7.7
Large (8+ members)	45.9%	48.1%	45.1%	43.1%	39.4%	44.2%
Household structure						
Monogamy	58.5%	58.7%	58.3%	61.2%	62.3%	62.3%
Polygamy	32.6%	32.9%	31.6%	26.4%	26.7%	28.7%
Divorced/widowed/single	9.0%	8.4%	10.1%	12.4%	11.1%	9.0%
Household head characteristics						
Household head age						
<25y	6.9%	6.5%	7.2%	5.7%	6.2%	4.9%
25–34y	26.9%	26.0%	24.5%	23.1%	23.8%	22.4%
35–44y	26.3%	25.7%	27.5%	28.1%	25.7%	28.5%
45–54y	21.7%	21.9%	21.5%	23.1%	22.8%	23.1%
≥55y	18.2%	19.9%	19.3%	19.9%	21.5%	21.2%
Female household head	15.6%	19.6%	21.9%	21.2%	21.9%	17.9%
Illiterate household head	42.7%	44.8%	41.6%	44.3%	36.6%	37.3%
Disabled household head	–	–	–	–	10.2%	8.3%

the poorest quintile were 4.64 and 3.68 times more likely to have poor food consumption, respectively ($p < 0.01$ for both years). All other quintiles had significantly increased odds of poor food consumption in both years as well ranging from 3.00 to 3.75 for the 2nd quintile, 2.33 to 2.75 for the 3rd quintile, and 1.35 to 1.86 for the 4th quintile. All quintiles had larger odds ratios in 2020 as compared to 2021, which aligns with the 2020 peak in poor food consumption at the national level. The agroecological zone was also very strongly associated with increased risk of poor/borderline food consumption, where households in the Sahelian zone had a 2.61 (CI: 1.47–4.61) and 2.51 (CI: 1.54–4.10) odds of poor food consumption in 2020 and 2021, respectively, as compared to households in the Sudanian zone which was consistently the most food secure. In 2020, when there was a peak in poor food consumption and coping mechanism use in the Saharan zone, households were 4.16 (CI: 1.58–11.0) times more likely to have poor food consumption as compared to those in the Sudanian zone, but in 2021, the situation resolved.

Apart from wealth quintile and residence location, household characteristics significantly associated with increased risk of poor food consumption in both years were having a single income source and an illiterate household head. In 2020 and 2021, respectively, households with a single income source were 1.83 (CI: 1.38–2.34) and 1.43 (CI: 1.11–1.85) times more likely to experience poor food consumption compared to those with multiple income sources. Households with illiterate heads were 1.48 (CI: 1.10–1.99) and 1.34 (CI: 1.03–1.75) times more likely to have poor/borderline food consumption in 2020 and 2021, respectively, as compared to households with literate heads. The only characteristic that was protective against poor/borderline food consumption in both years was an increase in the number of household income sources. Households reporting diversification of income (compared to the preceding year) were one-third less likely to have poor/borderline food consumption in both 2020 and 2021 (2020 OR = 0.68, CI: 0.52–90; 2021 OR = 0.67, CI: 0.48–0.95).

More household characteristics were significantly associated with poor food consumption in 2020 as compared to 2021. In 2020, polygamous household structure (OR = 1.24, CI: 1.01–1.54) and non-agricultural income sources including skilled/unskilled labor (OR = 1.49, CI: 1.04–2.13) and households reliant on humanitarian assistance and remittances (OR = 2.16, CI: 1.35–3.45) faced an increased risk of poor food consumption. In contrast, being in a larger household with eight or more members was protective (OR = 0.72, CI: 0.55–0.94).

TABLE 2 Trends in food consumption and diet-related coping mechanism use from ENSA surveys, 2016–2021.

Survey date	Oct-16	Oct-17	Oct-18	Oct-19	Oct-20	Oct-21	Annual rate of change[a]			
N	9,456	9,019	9,443	9,483	13,208	14,730	Linear model[a]		Quadratic model[b]	
Food consumption score (mean, 95% CI)							Adjusted ß[f]	*p*-value	Adjusted ß[f]	p-value
National level	60.3	58.9	55.7	56.3	58.3	54.9	**−1.16**	**<0.01**	**−1.16**	**<0.01**
	(57.8, 62.9)	(56.3, 61.6)	(53.0, 58.4)	(55.3, 60.2)	(56.3, 60.4)	(52.6, 57.3)	**(−1.88, −0.43)**		**(−1.88, −0.43)**	
Saharan zone	65.4	62.5	58.7	56.8	48.2	49.9	−2.46	0.14	−2.46	0.14
	(50.0, 80.8)	(54.2, 70.8)	(51.5, 65.9)	(54.4, 59.3)	(38.4, 58.0)	(46.6, 53.2)	(−5.73, 0.81)		(−5.73, 0.81)	
Sahelian zone	54.1	52.7	51.6	52.7	54.4	50.8	−1.02	0.13	−1.02	0.13
	(50.1, 58.0)	(48.7, 56.6)	(46.8, 56.5)	(48.2, 57.1)	(51.3, 57.5)	(47.0, 54.5)	(−2.33, 0.29)		(−2.33, 0.29)	
Sudanian zone	66.4	65.3	59.8	62.8	62.6	59.6	**−1.24**	**<0.01**	**−1.23**	**<0.01**
	(63.7, 69.1)	(62.3, 68.3)	(56.9, 62.7)	(60.2, 65.4)	(60.1, 65.1)	(56.2, 63.1)	**(−1.99, −0.48)**		**(−1.99, −0.48)**	
Diet-related coping mechanism use—rCSI (mean, 95% CI)							Adjusted ß[f]	*p*-value	Adjusted ß[f]	*p*-value
National level	3.8	5.1	5.1	4.3	4.3	4.3	0.15	0.19	0.15	0.19
	(3.1, 4.6)	(4.1, 6.1)	(4.0, 6.1)	(3.2, 5.4)	(3.4, 5.3)	(3.6, 5.1)	(−0.07, 0.37)		(−0.07, 0.37)	
Saharan zone	6.1	3.4	3.2	3.8	5.6	2.8	−0.57	0.02	−0.57	0.02
	(5.1, 7.2)	(2.6, 4.2)	(1.6, 4.8)	(2.6, 5.1)	(3.6, 7.6)	(1.6, 4.0)	(−1.05, −0.09)		(−1.05, −0.09)	
Sahelian zone	3.6	5.2	4.6	4.5	4.5	5.1	0.39	0.01	0.38	0.01
	(2.9, 4.3)	(3.8, 6.5)	(3.6, 5.6)	(3.5, 5.6)	(3.3, 5.7)	(3.8, 6.3)	(0.08, 0.69)		(0.07, 0.69)	
Sudanian zone	3.9	5.3	6.0	4.2	4.1	3.9	0.01 (−0.34, 0.36)	0.98	0.10 (−0.35, 0.36)	0.98
	(2.6, 5.1)	(3.7, 6.9)	(3.8, 8.2)	(2.2, 6.2)	(2.7, 5.5)	(2.8, 4.9)				
Livelihoods-related coping mechanism use—LCSI (mean, 95% CI)							Adjusted ß[f]	*p*-value	Adjusted ß[f]	*p*-value
National level	0.71	1.28	1.53	0.99	0.79	1.25	**0.11**	**<0.001**	**0.11**	**<0.001**
	(0.61, 0.82)	(1.01, 1.55)	(1.09, 1.97)	(0.74, 1.23)	(0.61, 0.96)	(1.00, 1.51)	**(0.06, 0.17)**		**(0.06, 0.17)**	
Saharan zone	0.72	0.91	1.73	1.03	1.29	1.95	0.17		0.17	0.12
	(0.41, 1.03)	(0.68, 1.14)	(0.86, 2.61)	(0.85, 1.21)	(0.20, 2.79)	(0.62, 3.28)	(−0.04, 0.37)	0.12	(−0.04, 0.37)	
Sahelian zone	0.75	1.52	1.39	0.79	0.79	1.32	**0.14**	**0.004**	**0.14**	**0.004**
	(1.04, 1.79)	(1.08, 1.97)	(0.95, 1.83)	(0.60, 0.97)	(0.60, 0.97)	(1.00, 1.65)	**(0.05, 0.23)**		**(0.05, 0.23)**	
Sudanian zone	0.67	1.19	1.50	0.59	0.75	1.10	**0.08**	**0.01**	**0.08**	**0.01**
	(0.56 0.78)	(0.74, 1.64)	(0.62, 2.39)	(0.31, 0.88)	(0.47, 1.04)	(0.71, 1.49)	**(0.02, 0.15)**		**(0.02, 0.15)**	
							Logistic model[c]		Quadratic model[d]	
Poor or borderline food consumption (percent, 95% CI)							Adjusted OR[f]	*p*-value	Adjusted ß[f]	*p*-value
National level	18.8	22.0	25.1	22.2	18.2	25.3	**1.11**	**0.02**	**1.55**	**0.01**
	(15.0, 23.3)	(18.3, 26.2)	(20.6, 30.3)	(18.1, 27.0)	(14.6, 22.4)	(20.9, 30.2)	**(1.02, 1.22)**		**(0.31, 2.79)**	
Saharan zone	14.5	18.0	17.3	18.8	44.5	21.6	1.16	0.42	1.81	0.39
	(2.7, 50.6)	(8.9, 32.9)	(8.8, 31.0)	(15.1, 23.0)	(26.1, 64.5)	(13.4, 32.9)	(0.81, 1.66)		(−2.37, 5.99)	
Sahelian zone	29.8	32.3	36.5	33.9	26.5	34.6	1.09	0.19	1.64	0.18
	(23.1, 37.4)	(26.1, 39.2)	(28.2, 45.8)	(26.1, 42.7)	(19.9, 34.3)	(25.8, 44.6)	(0.96, 1.23)		(−0.76, 4.05)	
Sudanian zone	7.9	11.1	13.6	11.5	8.7	16.7	**1.17**	**0.01**	**1.33**	**0.01**
	(4.7, 12.8)	(8.0, 15.3)	(9.9, 18.4)	(8.1, 16.3)	(6.0, 12.6)	(12.9, 21.2)	**(1.03, 1.33)**		**(0.41, 2.25)**	

[a] Bold text denotes statistical significance in adjusted models.

[b] Fitted to linear regression models with a time variable (each survey year).

[c] Fitted to quadratic models with an additional square term of the time variable (each survey year*each survey year) to the linear regression. The average marginal effect was derived by differentiating dy/dx.

[d] Fitted to logistic regression models with a time variable (each survey year).

[e] Fitted to quadratic models with an additional square term of the time variable (each survey year*each survey year) to the logistic regression. The average marginal effect is derived by differentiating dy/dx.

[f] All regression models were adjusted for household head's literacy, marital status, sex, and age, household wealth status, family size, main income source, energy source, and wall materials of household building.

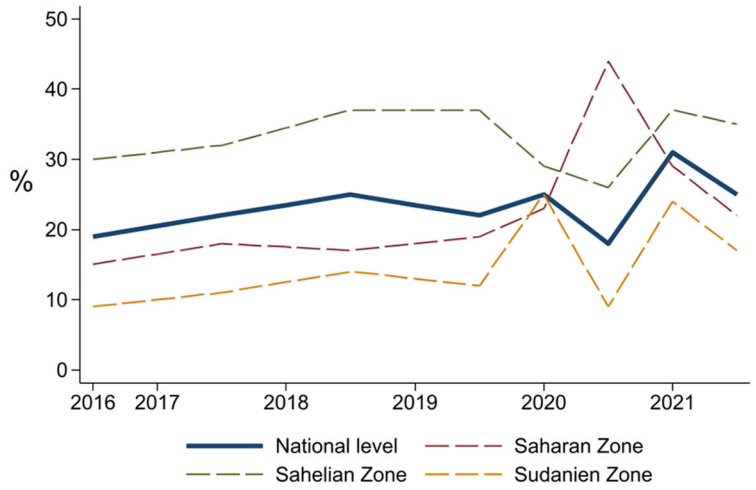

FIGURE 2
Temporal trends in the proportion of households with poor or borderline food consumption 2016–2021.

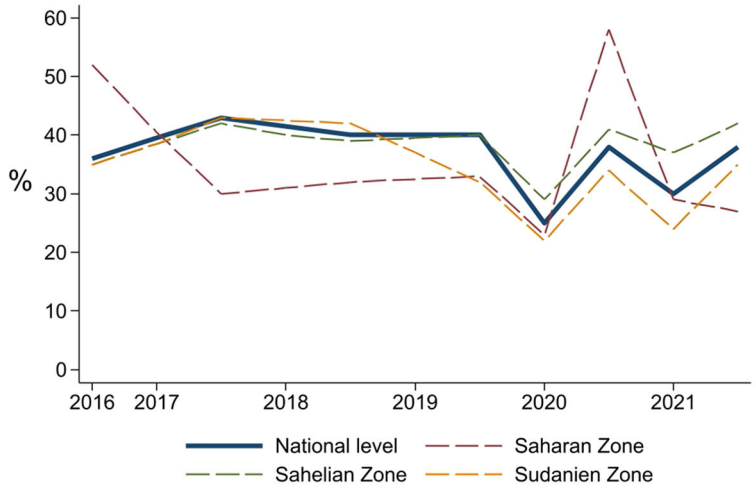

FIGURE 3
Temporal trends in diet-related coping mechanism use in Chad, 2016–2021.

Risk factors for diet-related coping mechanism use

There was little consistency in risk factors for diet-related coping mechanism use in 2020 and 2021 (Table 4). The only household characteristics significantly associated with increased coping mechanism use in both years were having a disabled household head and the livelihoods coping strategy index score. In 2020, polygamous family structure (OR = 1.21; CI: 1.01, 1.46), having a disabled household head (OR = 1.42; 95% CI: 1.02, 1.97), and the use of an unimproved drinking water source (OR = 1.59; CI: 1.17, 2.17) were associated with an increased risk of using diet-related coping mechanisms. The household economic characteristics associated with increased use of diet-related coping mechanisms in 2020 included belonging to the poorest wealth quintile (OR = 1.78, CI: 1.17–1.21) and a decrease in the number of income sources compared to the preceding year (OR = 1.61, CI: 1.21, 2.14). While the livelihood coping strategy index score was positively associated with diet-related coping mechanism use (OR = 1.59, CI: 1.20, 2.12), the use of emergency livelihood coping mechanisms, which include begging and selling land or the last breeding stock, was protective against the use of diet-related coping mechanisms (OR = 0.38, CI: 015, 0.95).

Similar to 2020, households with disabled heads were more likely to use diet-related coping mechanisms (OR = 1.36, CI: 1.03, 1.79). In 2021, older household head age was significantly associated with lower diet-related coping mechanism use. Compared to the 25–34 years age group, household heads aged 35–44 years (OR = 0.87, CI: 0.76, 0.99) and >55 years (OR = 0.84, CI: 0.73, 0.97) were less likely to use diet-related

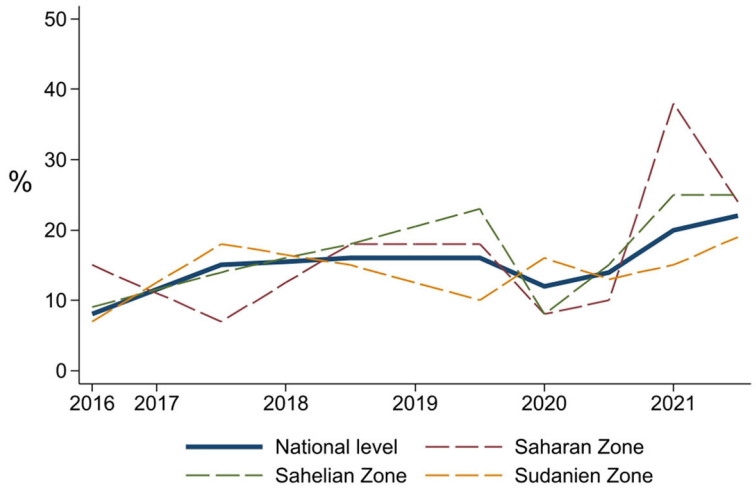

FIGURE 4
Proportion of households using emergency/crisis livelihoods coping strategies in Chad, 2016–2021.

coping mechanisms. The use of a non-electric energy source (OR = 2.65, CI: 1.65, 4.28) and reliance on external aid (OR = 1.44, CI: 1.06, 1.97) were also positively associated with the use of diet-related coping mechanisms in 2021 (but not 2020). Both LCSI (OR = 1.29, CI: 1.09, 1.54) and the use of crisis-level coping mechanisms (OR = 3.07, CI: 1.61, 5.87), including harvesting immature crops, removing children from school, and reducing health and education spending, were positively associated with diet-related coping mechanisms.

Discussion

This study examined spatial and temporal trends of food consumption and diet-related coping mechanisms use from 2016 to 2021 in Chad and identified risk factors related to these food security outcomes. At the national level, there were significant declines in food security during the 5-year evaluation period, including in the pre-COVID period. The proportion of households with poor or borderline food consumption increased by 6.8% between 2016 and 2021, with an average annual increase of 1.3%; food consumption scores decreased by an average of 1.16 points during this period. In examining trends over time, the proportion of households with poor and borderline food consumption rose from 18.8% in October 2016 to 22.2% in October 2019, before the pandemic. There were no significant trends in rCSI at the national level. However, a significant temporal trend in rCSI was observed with an average decrease of 0.57 points per year in the Saharan zone (improving) and an increase of 0.38 points per year in the Sahelian zone (worsening) during this period. The trend of LCSI was consistent with FCS, overall worsening at the national level and the Saharan and Sahelian zonal levels. The observed decline in food security occurs within a deteriorating macroeconomic situation which is attributed to political instability and efforts to combat terrorism; declining oil prices, trade revenues, and investment; and high food prices [Famine Early Warning Systems (FEWS) Network, 2021; Food Security Information Network (FSIN) and Global Network Against Food Crises, 2022].

During the earlier part of the pandemic in October 2020, the proportion of households with poor/borderline food consumption declined to a 5-year low of 18.2% in October 2020 before jumping drastically to a 5-year high of 30.7% in February 2021, after which there was a decline to 25.3% in October 2021 (the final time point in the analysis). The early pandemic low in food insecurity could be partially related to the scaling of the national food distribution program and other government fiscal and policy interventions (International Monetary Fund, 2022). It should also be noted that the negative impacts of the pandemic on household economies were most pronounced in urban areas in 2020 and rural areas in 2021, which aligns with our finding of deteriorating food insecurity in the rural ENSA coverage areas in 2021 (Kang et al., 2023).

Examination of food consumption at a regional level showed that the Sudanian zone had the highest levels of food consumption, yet it was the only zone to have a statistically significant decrease in food consumption, where the proportion of households with poor/borderline food insecurity rose by 8.8% over the 5-year period with an average annual increase of 1.3%. Despite the decreasing trend in food consumption, the proportion of households with poor/borderline food insecurity in 2021 in the Sudanian zone (16.7%) was approximately half that of the Sahelian zone, where more than one-third (34.6%) of households had poor/borderline food consumption. This is probably due to relatively higher agricultural production in the Sudanian zone hence relatively higher household food availability and access. However, the increasing climate variability and the fact that this zone is prone to weather extremes such as flooding likely affect production which is progressively negatively impacting household food security. Roughly half of the survey participants from the Sahelian zone belonged to the poorest quintile, and this region is particularly affected by climate change and limited natural resources [Food Security Information Network (FSIN) and Global Network Against Food Crises, 2022]. The Sahelian zone consistently had the lowest

TABLE 3 Risk factors for poor or borderline food consumption during the COVID-19 pandemic in Chad[a].

	October 2020			October 2021		
	Adjusted OR	(95% CI)	*p*-value	Adjusted OR	(95% CI)	*p*-value
Household demographic characteristics						
Large household 8+ Members (Ref:≤7)	**0.72**	**(0.55, 0.94)**	**0.02**	1.01	(0.88, 1.16)	0.87
Households structure (Ref: Monogamous)	1.00			1.00		
Polygamous	**1.24**	**(1.01, 1.54)**	**0.05**	0.92	(0.78, 1.08)	0.31
Divorced/widowed/single	0.97	(0.75, 1.27)	0.85	1.23	(0.95, 1.60)	0.11
Household head characteristics						
Household head age (Ref: 25–34 years)				1.00		
<25 years	–			1.09	(0.89, 1.34)	0.42
35–44 years	–			1.05	(0.90, 1.24)	0.50
45–54 years	–			1.13	(0.89, 1.43)	0.30
≥55 years	–			1.09	(0.88, 1.37)	0.42
Female household head sex	0.92	(0.68, 1.24)	0.59	0.82	(0.59, 1.14)	0.23
Illiterate household head	**1.48**	**(1.10, 1.99)**	**0.01**	**1.34**	**(1.03, 1.75)**	**0.03**
Disabled household head				1.29	(0.99, 1.67)	0.06
Residence location and living conditions						
Agroecological zone (Ref: Sudanian)	1.00			1.00		
Sahelian zone	**2.61**	**(1.47, 4.61)**	**<0.01**	**2.51**	**(1.54, 4.10)**	**<0.01**
Saharan zone	**4.16**	**(1.58, 11.0)**	**<0.01**	0.91	(0.44, 1.90)	0.80
Non-electric/gas energy source	**1.56**	**(1.06, 2.29)**	**0.02**	1.45	(0.87, 2.40)	0.15
Low-quality wall materials	0.76	(0.55, 1.04)	0.09	1.19	(0.81, 1.74)	0.37
Household economy						
Wealth quintiles (Ref: 5th/wealthiest)	1.00			1.00		
4th	**1.86**	**(1.21, 2.84)**	**0.01**	**1.35**	**(1.01, 1.82)**	**0.05**
3rd	**2.75**	**(1.82, 4.17)**	**<0.01**	**2.33**	**(1.81, 3.00)**	**<0.01**
2nd	**3.75**	**(2.38, 5.93)**	**<0.01**	**3.00**	**(2.21, 4.08)**	**<0.01**
1st	**4.64**	**(3.05, 7.07)**	**<0.01**	**3.68**	**(2.57, 5.26)**	**<0.01**
COVID-related income decrease[b]	1.26	(0.98, 1.62)	0.08	1.28	(0.98, 1.68)	0.07
Change in number of income sources[b]	1.00			1.00		
Increased	**0.68**	**(0.52, 0.90)**	**0.01**	**0.67**	**(0.48, 0.95)**	**0.03**
Decreased	0.95	(0.73, 1.24)	0.71	0.87	(0.60, 1.26)	0.45
Only one income source	**1.83**	**(1.38, 2.43)**	**<0.01**	**1.43**	**(1.11, 1.85)**	**0.01**
Primary income source (Ref: Agriculture)[c]	1.00			1.00		
Livestock	0.87	(0.55, 1.35)	0.52	0.68	(0.44, 1.04)	0.08
Small trade	1.13	(0.72, 1.79)	0.58	1.04	(0.64, 1.70)	0.86
Skilled/unskilled/artisanal labor	**1.49**	**(1.04, 2.13)**	**0.03**	1.00	(0.68, 1.48)	1.00
Humanitarian aid/remittances	**2.16**	**(1.35, 3.45)**	**<0.01**	1.36	(0.86, 2.15)	0.18
Others	**3.68**	**(1.94, 6.96)**	**<0.01**	1.25	(0.84, 1.86)	0.26
Livelihoods coping strategies index score	1.06	(0.99, 1.14)	0.08	–		
Crisis coping mechanism use (any)[d]	–			–		
Emergency coping mechanism use (any)[d]	–			–		

[a]Only covariates significant at the $p < 0.10$ level in univariate models are included in multivariate models; bold text denotes statistical significance in adjusted models.
[b]Compared to the preceding year.
[c]Included if reported as one of the top three household income sources.
[d]Crisis coping mechanisms include harvesting immature crops, removing children from school, and reducing health and education spending; emergency coping mechanisms include begging and selling land or the last breeding stock.

TABLE 4 Risk factors for emergency/crisis coping strategy use during the COVID-19 pandemic in Chad[a].

	October 2020			October 2021		
	Adjusted OR	(95% CI)	*p*-value	Adjusted OR	(95% CI)	*p*-value
Household demographic characteristics						
Households structure (Ref: Monogamous)						
Polygamous	**1.21**	**(1.01, 1.46)**	**0.04**	0.88	(0.73, 1.05)	0.15
Divorced/widowed/single	1.02	(0.78, 1.34)	0.86	1.01	(0.76, 1.33)	0.96
Household head characteristics						
Household head age (Ref: 25–34 years)	–					
<25 years	–			0.87	(0.72, 1.06)	0.16
35–44 years	–			**0.87**	**(0.76, 0.99)**	**0.04**
45–54 years	–			0.91	(0.75, 1.09)	0.29
≥55 years	–			**0.84**	**(0.73, 0.97)**	**0.02**
Female household head sex	1.26	(0.93, 1.70)	0.14	1.00	(0.77, 1.32)	0.97
Disabled household head	**1.42**	**(1.02, 1.97)**	**0.04**	**1.36**	**(1.03, 1.79)**	**0.03**
Residence location and living conditions						
Agroecological zone (Ref: Sudanian)						
Sahelian zone	1.07	(0.56, 2.02)	0.84	–		
Saharan zone	1.56	(0.76, 3.21)	1.59	–		
Non-electric/gas energy source	1.23	(0.91, 1.67)	0.18			
Inefficient cooking source	4.74	(0.95, 23.8)	0.06	**2.65**	**(1.65, 4.28)**	**<0.001**
Low-quality wall materials	0.96	(0.71, 1.31)	0.81	–		
Unimproved drinking water source	**1.59**	**(1.17, 2.17)**	**<0.01**	–		
Household economy						
Wealth quintiles (Ref: 5th/wealthiest)						
4th	0.97	(0.77, 1.23)	0.81	1.04	(0.78, 1.38)	0.78
3rd	1.03	(0.78, 1.35)	0.85	0.79	(0.58, 1.09)	0.15
2nd	1.28	(0.92, 1.77)	0.14	0.92	(0.63, 1.34)	0.65
1st	**1.78**	**(1.17, 2.71)**	**0.01**	1.23	(0.77, 1.96)	0.39
COVID-related income decrease[b]	1.13	(0.87, 1.47)	0.34	1.21	(0.89, 1.64)	0.21
Change in number of income sources[b]						
Increased	0.91	(0.58, 1.43)	0.67	–		
Decreased	**1.61**	**(1.21, 2.14)**	**0.01**	–		
Only one income source	1.32	(0.93, 1.85	0.12	–		
Primary income source (Ref: Agriculture)[c]						
Livestock	–			0.82	(0.60, 1.11)	0.20
Small trade	–			1.06	(0.77, 1.44)	0.73
Skilled/unskilled/artisanal labor	–			1.26	(0.92, 1.73)	0.15
Humanitarian aid/remittances	–			**1.44**	**(1.06, 1.97)**	**0.02**
Others	–			0.93	(0.61, 1.42)	0.73
Livelihoods coping strategies index score	**1.59**	**(1.20, 2.12)**	**0.01**	**1.29**	**(1.09, 1.54)**	**0.01**
Crisis coping mechanism use (any)[d]	1.05	(0.48, 2.33)	0.90	**3.07**	**(1.61, 5.87)**	**0.01**
Emergency coping mechanism use (any)[d]	**0.38**	**(0.15, 0.95)**	**0.04**	0.64	(0.31, 1.34)	0.24

[a]Only covariates significant at the $p < 0.10$ level in univariate models are included in multivariate models; bold text denotes statistical significance in adjusted models.
[b]Compared to the preceding year.
[c]Included if reported as one of the top three household income sources.
[d]Crisis coping mechanisms include harvesting immature crops, removing children from school, and reducing health and education spending; emergency coping mechanisms include begging and selling land or the last breeding stock.

food consumption scores and the highest proportion of the population with poor/borderline food consumption (26.5–37.4%). The exception was in October 2020 when food insecurity peaked in the Saharan zone, and the proportion of households with poor/borderline food consumption spiked to 44.5%. During this time frame, the northernmost areas of the country moved from stress to crisis levels of food insecurity, which aligns with the end of a severe pastoral lean season [Famine Early Warning Systems (FEWS) Network, 2021].

In the risk factor analysis for poor food consumption, having an illiterate household head, being in a lower wealth quintile, having a single income source, and Sahelian zone residence were significantly associated with poor/borderline food consumption in both 2020 and 2021. Households with illiterate household heads have been shown to have reduced income, limited access to information on jobs and prices, and increased expenses, which lead to higher food insecurity (Asesefa Kisi et al., 2018; Park et al., 2020). Additional characteristics associated with poor/borderline food consumption only in 2020 included being in a smaller (<7 members) or polygamous household, or a household [Food Security Information Network (FSIN) and Global Network Against Food Crises, 2022] that relied on skilled/unskilled labor or humanitarian assistance/remittances as a primary income source were observed during the peak of the COVID-19 pandemic in 2020. Similar to this study, FCS was predicted by job status/income levels and socio-economic status, age group within the context of the COVID-19 pandemic in both Ethiopia and Lao PDR (Gonella et al., 2022; Head et al., 2022). Consistent with findings from this analysis, there is substantial evidence that low-wage and low-skilled workforce lost their jobs or experienced income reduction during the initial lockdowns of COVID-19 (Nechifor et al., 2021). Without significant home production, it follows that laborers are more likely to face challenges accessing food than farming households that produce and sell or consume staple grains (Kang et al., 2021). In the 2020 ENSA, large household size was related to having multiple income sources; thus, larger household size was protective against food insecurity during COVID-19. In Nigerian agricultural households, polygamous families had better dietary diversity due to having more women engaged in farming activities pre-COVID-19 (Owoo, 2018). A similar casual pathway may exist in Chad, where at the national level in 2020, larger households were less vulnerable to food insecurity due to having more labor available and greater diversity in income sources. Interestingly, female-headed households were not at increased risk for poor food consumption or diet-related coping mechanism use in this analysis which is inconsistent with global trends (FAO et al., 2022).

Limitations

First, the ENSA collects a variety of food security indicators, but not all measures (e.g., household food insecurity access scale, household hunger score, or individual dietary diversity) are collected; thus, food security status as measured by FCS could not be crossed-checked against other dimensions such as access, stability, or sustainability [High Level Panel of Experts on Food Security and Nutrition (HLPE), 2021]. Second, although the sampling approach was consistent over time, it is possible that access issues may have influenced the representativeness of the sample in given years and that some of the temporal variations in food security indicators could be attributed to such sampling errors. Third, the short 7-day recall period of the rCSI may have been inadequate to fully assess a diet-related coping mechanism use, particularly given that this is likely to vary greatly in relation to household income flows and harvests. Fourth, the generalizability of findings is limited to the rural population of the country as urban households were included in the ENSA survey from 2020.

Finally, while the ENSA dataset provides repeat observations over time and incorporated an additional module on COVID-19 modules in 2020 and 2021, the scope of questions on COVID-19 impacts was limited; however, the dataset remains unique in that it provides a perspective on food insecurity both pre- and post-COVID.

Conclusion

The observed trends in food consumption suggest a small and gradual increase in food insecurity that began before the COVID-19 pandemic, and substantial variability in food insecurity in 2020 and 2021, both by region but also with respect to profiles of households at risk for poor food consumption. Many of the risk factors observed in 2020 were mitigated in 2021 as the pandemic impacts began to subside.

In a context where the driving factors of food insecurity persist, a strategic shift in humanitarian and development programming is needed to reverse the trend. The national response plan to food insecurity during the lean season typically prioritizes short-term assistance to food-insecure populations in the form of food and nutrition assistance and livelihood support. While this is vital, evidence in this study suggests that it is insufficient to meet the objectives. Notably, food insecurity being higher among the poorer quintiles and among households with illiterate household heads suggests the need for longer-term responses that address both chronic and acute food insecurity. Applying a social protection lens to interventions could enable the required strategic shift, potentially encompassing predictable safety nets that are shock-responsive, as well as school-based interventions and labor market programs.

Future policy should consider not only long-term trends but also risk factors for food insecurity within the most current years for which data are available. In addition to social protection and humanitarian assistance programs that focus on meeting immediate basic needs, longer-term development projects and policies that consider the challenges of the current economic environment and the impacts of climate change and also systematically promote social investment are urgently needed to enable more households to move out of poverty and food insecurity.

Data availability statement

The datasets presented in this study may be made available with the permission of World Food Programme, Chad (https://www.wfp.org/countries/chad).

Ethics statement

Ethical approval was not required for the study involving human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants in accordance with the national legislation and the institutional requirements.

Author contributions

SD and EW conceptualized the study and were involved in obtaining funding. YK led data curation and analysis with support from MA, AB, and KE. YK led the drafting of the manuscript. EW, KE, MA, AB, and SD provided support during manuscript development and critical review. All authors participated in data analysis, review, and decision-making around the presentation of findings. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1197228/full#supplementary-material

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