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Health and Nutrition Services in Sudan: A Situational Analysis of South and East Darfur States (2023–2024)

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Abstract

Background: This study assessed the health and nutritional services available to households in South and East Darfur States, with a focus on maternal and newborn child health services, infant and young child feeding practices, and overall nutritional status.

Methods: A cross-sectional quantitative approach was utilized for data collection, including household surveys. A total of 1,285 households participated in the study, and a nutrition assessment was conducted on 1,374 children aged 6–59 months.

Results: Access to healthcare services remains a significant challenge in South and East Darfur, where over 80.0% (80.9% SD, 80.9% ED) of households reported difficulties in obtaining the necessary healthcare services. Statistics revealed that only 25.2% (28.4% SD, 21.9% ED) gave birth at a health facility, highlighting the challenging maternal healthcare gaps. Vaccination rates also demonstrate disparities; while BCG coverage reached 59.4% (44.1% SD, 74.6% ED), polio dose O at birth vaccination coverage stood at 65.6% (52.5% SD, 78.6% ED). Childhood illness management through Integrated Community Case Management (iCCM) revealed alarming prevalence rates of malaria (43.9% [48.9% SD, 38.9% ED]), while 39.1% (49.8% SD, 28.3% ED) had ARI, with only 53.3% (63.0% SD, 43.6% ED) able to seek and access proper treatment/management. Furthermore, malnutrition rates were critical, with Global Acute Malnutrition at 19.9% in South Darfur and 15.5% in East Darfur. Stunting was prevalent in 36.6% of children aged 6–59 months in South Darfur, emphasizing the dire health and nutrition situation.

Conclusions: Overall, the findings underscore the urgent need for targeted interventions to improve access to healthcare services, address healthcare-seeking behaviors, and enhance nutrition practices and service delivery in South and East Darfur. Efforts should be made to strengthen nutrition programs and support caregivers in promoting optimal health and nutrition for their children.

Keywords

Healthcare, Newborn, Breastfeeding, Vaccination, Malnutrition, Stunting

Background

After years of prolonged crisis, Sudan entered an escalated armed conflict in mid-April 2023, marked by intense clashes between the Sudan Armed Forces (SAF) and the Rapid Support Forces (RSF) [1]. The ongoing conflicts and subsequent displacement have precipitated a critical food insecurity crisis and significant shortfalls in access to essential services,

including healthcare, nutrition, and water, sanitation, and hygiene (WASH) [2]. The recent surge of violence has also culminated in a high number of civilian casualties, extensive destruction of vital infrastructure, and mass displacement, with over 7.4 million people forced to flee their homes in search of safety, both within Sudan and across its borders [3]. Additionally, when combined with the 3.8 million Internally Displaced Persons (IDPs) from prior conflicts, Sudan is currently grappling with the largest IDP crisis globally, as well as the most significant crisis concerning displaced children, with over 3 million minors displaced both internally and externally [4]. Almost one in three individuals in Sudan is currently experiencing acute food insecurity, while the already vulnerable healthcare system is severely compromised, facing the threat of disease outbreaks, including a concerning cholera outbreak, alongside dengue fever, measles, and malaria [5].

Over 14.7 million people in Sudan face critical challenges in accessing essential healthcare, compounded by a reduction in functioning health facilities, shortages of medical supplies, and an increase in attacks on healthcare infrastructure. Malnutrition rates in Sudan are alarming, with a global acute malnutrition prevalence of 14.1% in children under five [6]. This has led to approximately 570,000 children suffering from severe acute malnutrition and 2.2 million children affected by moderate acute malnutrition [7]. Malnutrition is also linked to diarrhea, a common cause of child mortality in Sudan, particularly due to poor WASH conditions. Access to hygiene services, sanitation, and clean water is crucial; yet over 5 million people lack adequate hygiene services, 3.7 million lack sanitation facilities, and 1.4 million lack access to basic water services [8].

Of over 7 million IDPs across the 18 states of Sudan, South Darfur (SD) and East Darfur (ED) combined account for the highest proportion, reported at 15% [9]. Equally, refugees from the Central African Republic living in remote areas face challenges accessing public services and specialized health and nutrition services. In such a situation, food, medical care, and safe water are top priorities, with a significant portion of households struggling to earn regular income and access healthcare services due to transportation challenges [10].

Households in South and East Darfur face persistent challenges in accessing healthcare services, with many walking long distances to reach the nearest facility. Health facility-based deliveries remain low, and many mothers report recurrent child illnesses such as fever and diarrhea, particularly in areas with limited access to clean water [11]. Despite the clear burden of poor health and nutrition outcomes, there is limited recent evidence on the functionality and accessibility of health and nutrition services in these conflict-affected states. Most existing data are aggregated at the national level and do not capture local disparities in service delivery, care-seeking practices, or nutrition status. This information gap constrains effective planning and prioritization of interventions by government and humanitarian actors, as current evidence does not adequately highlight what is missing in the existing knowledge or response [12].

Given the challenges faced by households in South and East Darfur, this study assesses the availability and accessibility of health and nutrition services in these regions, focusing on maternal and child health, infant feeding practices, and nutritional status, to identify service gaps and inform targeted interventions.

Methods

Study Area:

The study was carried out in 14 localities within the South and East Darfur states of Sudan. The specific localities included Dimso, Rahed El Birdi, Umdafog, Gerida, Alradoum, Mershing, and East Jabal Marra in South Darfur [13], alongside Abu Karinka, Abu Jabara, Bahar Alarab, El Firdous, Yassin, Shearia, and Assalaya in East Darfur [14]. These were selected due to the high IDP populations.

Study setting:

The study specifically focused on Internally Displaced Persons (IDPs), returnees, and host communities in the target localities, as each of these groups presents different vulnerabilities in their living conditions.

Study Population:

The primary data collection for the household survey

focused on mothers and children under five years of age. In instances where the mother was not present, the caregivers of children aged 6–59 months who were most readily available were interviewed as the study participants.

Inclusion and Exclusion Criteria:

All pregnant and lactating women, children aged 6–59 months, children aged 0–24 months, and caregivers of these children in the absence of the mother were included in the survey. All households whose occupants had not been in the area for the last 90 days were excluded.

Study Design:

A cross-sectional quantitative household survey was conducted. Probabilistic and non-probabilistic sampling methods were employed to determine the sample size, with the Lot Quality Assurance Sampling (LQAS) [30] technique applied to facilitate sampling for quantitative data collection. Each locality served as a catchment area, and five supervision areas/communities were designated. A sample of 19 households was selected from each community, resulting in n = 95 for each district at a 95% confidence interval. Quantitative data were gathered through household surveys. LQAS was suitable because of its operational feasibility and its ability to classify areas by performance threshold at a 95% confidence interval.

The Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology was used, providing a basic integrated method for assessing nutritional status. In this regard, the survey employed a two-stage cluster sampling approach. Stage 1 was the selection of clusters based on Probability Proportional to Size (PPS), while Stage 2 involved the selection of households within the selected clusters using simple random sampling. Villages were considered the smallest geographical units (clusters), and the sample sizes for anthropometry were calculated using ENA for SMART software (January 11th, 2020 version).

Sampling:

The localities to be studied were purposively selected based on the fact that project interventions were already targeted or being implemented in these localities and villages. For household selection, a household list was provided to conduct simple random sampling using random numbers.

A total of 1,285 respondents participated in the data collection process, yielding a response rate of 96.6% (96.2% SD, 96.9% ED). Nutritional anthropometry and assessment were conducted on 1,374 children aged 6–59 months, primarily from the sampled households (694 SD, 680 ED).

Sample Size Determination for SMART:

ENA for SMART software was used to calculate the sample sizes for anthropometry and retrospective mortality. Based on the context, the following assumptions were considered in order to determine the sample size for anthropometry and retrospective mortality (**Table-1**).

Table-1: Sample Size for Anthropometry

Parameter	Value	Rationale
Estimated prevalence	15.70%	Upper confidence limit of September 2023 SMART survey conducted by Care in Al day'n Locality [12.3 % (9.6 - 15.7 95%CI)] is used with assumption of deteriorated food security and nutrition situation in the Localities. Al day'n Locality is the nearest adjacent locality as such, the recent SMART survey findings for Al day'n Locality is used for sample size estimation.
Desired precision	4	According to SMART Survey recommendation for prevalence between 15-20%.
Design effect	1.5	ENA default figure used.
Average household size	7.7	SMART survey in Al day'n Locality by CARE International in Sudan during September 2023
Percent of under five children	19.1	SMART survey in Al day'n Locality by CARE International in Sudan during September 2023
Percent of non-respondent	3	Anticipated non-response rate
Children to be included	519	Calculated from ENA for SMART software

Access and Quality Assurance Assumptions (**Table-2**):

1. That the sample size of 519 was calculated for each state to ensure integration into LQAS.
2. An additional 32.4% was added to the original sample to ensure extended coverage; hence, the total sample for the two states was 1,374.

Data Collection and Quality Assurance:

Quantitative data were collected using a questionnaire administered to caregivers of children aged 6–59 months. Body measurements, including height, weight, and Mid-Upper Arm Circumference (MUAC), were taken from children aged 6–59 months. Quantitative data collection was facilitated using smartphones and the Kobo mobile data collection platform. Quality assurance measures were implemented at each stage of data collection to ensure accuracy and reliability.

Data Analysis and Management:

The survey data were obtained from the Kobo mobile data collection server in Comma-Separated Value (.csv) format. Data processing and analysis were performed using the Statistical Package for Social Sciences (SPSS) version 25. Specifically, descriptive statistical analysis was employed for the quantitative data. The study measures assessed are included in **(Table-3)** below. Representative quantitative data collection at the household level was based on a 95% confidence level and a 5% margin of error.

Ethical Consideration

Ethical approval for the study was obtained from the Sudan National Health Research Ethics Committee and registered under certificate number (6-12-22), which deemed it a non-interventional systems assessment. Participants provided written informed consent prior to participating in the study, following a clear explanation of its purpose. They were also informed of their right to withdraw from the study at any time, and this right was strictly upheld in compliance with the Helsinki Declaration.

Table-2:

LQAS classification outcomes per supervision area		
Decision Rule (d)	13	If 13 or more households meet the criteria, the village is accepted (high coverage). If 12 or fewer households meet the criteria, the village is rejected (low coverage/needs intervention).
Sample Size ((n))	19	Per supervision area, which allows a 95% confidence interval of +/_10 when aggregating multiple areas.
Performance Bands	2 stage	Upper Threshold (P_u): The target coverage level (90%).
		Lower Threshold (P_l): The minimum acceptable coverage level (50%).

Table-3: Study Variables and Measures

Indicator	Definition
Maternal health care services	Maternal health refers to the health of women during pregnancy, childbirth, and the postnatal period. The health care services that women receive during pregnancy, childbirth and after delivery, important for the survival and well-being of both the mother and the infant.
Facility based delivery	Mothers of children aged 0-23 months who gave birth from a hospital or health facility during their most recent or last pregnancy
Post-natal care	Care provided by a healthcare provider during the first 48 hours of giving birth until 6 weeks after delivery.
Newborn care	Newborns that received healthcare from a recommended health practitioner e.g nurses, doctor or midwife within the first 4 weeks after birth.
Early initiation of breastfeeding	The start of Breastfeeding the newborn child within the first one hour of giving birth
Complementary feeding	Complementary feeding marks the transition from exclusive breastfeeding to the introduction of family foods beginning at the age of six months as recommended by WHO.
Prevalence of malaria	Children under 5 years of age who had fever 2 weeks prior to the data collection period
Prevalence of diarrhea	A situation where a child under 5 years of age has more than three loose, watery and runny stools per day, leading to dehydration in the 2 weeks preceding the Survey

Prevalence of Acute Respiratory Infection (ARI)	A situation where a child under 5 years of age has trouble breathing or breathing faster than usual with quick, short breaths with in 2 weeks preceding the survey
Nutrition status of children	The results presented in this study applied the WHO growth reference standards of 2006. The estimates of malnutrition are presented for children from 6-59 months of age
Global Acute Malnutrition (GAM)	Global Acute Malnutrition (GAM) A measurement of Nutritional status of a population. (children between 6 and 59 months in this study). It's an aggregate of moderate and Severe acute malnutrition cases, using metrics like weight-for-height, mid-upper arm circumference (MUAC), and the presence of nutritional edema. The condition signifies a recent and severe weight loss, often due to a lack of food or infectious disease.
Underweight	Refers to low weight for age, when a child is too thin for his or her age. Defined as the percent of children aged 6-59 months whose weight for age is less than minus two standard deviations from the median (WAZ) for the international reference population ages 6–59 months. It's a combined indicator of nutritional status reflecting both chronic and acute malnutrition, identified by inadequate weight for age
Stunting	A child that experiences impaired growth and development manifested low height for age. Defined as the percent of children aged 6-59 months whose height-for-age is below minus two standard deviations from the median (or less than two standard deviations below the median) as determined by the WHO Child Growth Standards
Access to health services	The timely use of health services to achieve the best health outcomes
Transport to the health service	The entire process and available means for moving individuals to a location where they can receive medical services.
Distance to the services	The average distance to a health facility that varies by location and type of facility. In many developing regions, where distance is a significant barrier to care, a 10 km increase in travel can lead to higher neonatal mortality and lower use of essential maternal health services.
Vaccination	The process of administering vaccines to children to protect them from serious and potentially life-threatening infectious diseases like measles, polio, and whooping cough.
Care seeking for malaria. Diarrhoea, and ARI	Refers to the actions a caregiver takes to get medical attention for a sick child. This process involves recognizing the child is unwell, deciding to seek help, and then getting care from a formal or informal provider, such as a doctor, clinic, or pharmacy.
Proper management of Diarrhoea	Watery stool in last 2 weeks, and treated with ORS + Zinc within 24–48 hours;
Proper management of ARI	Fast breathing in the last 2 weeks and treatment with Amoxicillin Dispersible Tablets
Proper management of Malaria	Fever in last 2 weeks, tested with mRDT and treated with ACT within 24–48 hours
Source of food	Refer to how food becomes available in a community or household through domestic production, imports, food aid, or stocks. These sources are a component of food availability, one of the four pillars of food security.
Food consumption Score	Measures a household's food intake based on the frequency and diversity of food groups consumed over the past seven days. It uses standard weights to represent the relative nutritional value of different food groups, with more nutritious foods getting higher weights.
Number of meals consumed	Is used as a proxy indicator for food access and availability, often reflecting the quantity of food consumed. It provides a simple, direct measure of the frequency of food intake at the household or individual level over a specific period, usually the previous day or week
Dietary diversity score	is a measure of household food access that counts the number of different food groups consumed in a given period, usually the past 24 hours. It's calculated by adding points for each food group, such as cereals, vegetables, meat, and dairy, consumed by a household
Household hunger Scale	Is a measure of the severity of food deprivation in a household, derived from responses to a short series of questions about hunger experiences over the past 30 days. It is used to classify households into categories of no hunger, moderate hunger, and severe hunger and is most effective in areas with high levels of food insecurity.
Reduced copping Strategies index	Is a food security indicator that measures the frequency and severity of five standard behavioral strategies households use to cope with food shortages. It is a simplified, quick, and widely comparable measure for assessing how households manage a lack of food or money for food over a seven-day period

Results

Social and Demographics:

A total of 1,285 participants were involved in the study, which took place across fourteen localities in South (SD) and East Darfur (ED) States of Sudan. Most respondents were female, 75.9% (75.9% SD, 75.8% ED).

In SD, the distribution of respondents included 30.2% from the host community, 22.3% identified as IDPs, and 47.5% as returnees. Conversely, in ED, the majority (80%) were from host communities, followed by 17.5% returnees and 2.5% IDPs.

The largest age group among the respondents was 19–30 years (41.7%; 39.5% SD and 43.9% ED). Additionally, a significant proportion of respondents, 36.7% (36.4% SD, 37.1% ED), were reported not to have attended any formal education.

A considerable majority of the respondents were married, 81.9% (83.1% SD, 80.8% ED). Analysis of the economic status of the households revealed that 37.1% (32.2% SD, 42.0% ED) of households had at least one adult over the age of 18 years earning a regular income to support their needs. Furthermore, analysis of household expenditure revealed that food constituted the largest portion, accounting for 91.6% (96.1% SD, 87.0% ED) of household expenditures.

Access to Health Services:

Over three-quarters of households faced challenges in accessing healthcare services, as reported by 81.0% (80.9% SD, 80.9% ED) of respondents. Transportation to health facilities remains a significant obstacle for many households, with 60.9% (61.9% SD, 60.0% ED) of respondents reporting that they had to walk to access healthcare services.

Regarding the distance to the nearest health facility, the majority (93.1%; 86.2% SD, 94.9% ED) of respondents were able to access facilities within one hour. However, 6 out of 10 respondents (60.0%; 52.3% SD, 67.6% ED) reported that they had to pay to access healthcare services.

Access to health services was characterized by unaffordability, given the limited household income available to meet basic needs. On average, households paid 5,347 Sudanese Pounds (SDG) per visit (approximately 11 USD) (5,271 SD, 5,405 ED). Further details are presented in **(Table-4)**.

Newborn Care:

The findings show that 25.2% (28.4% SD, 21.9% ED) of mothers interviewed gave birth to their youngest child at a health facility. The situation is particularly challenging in East Darfur, where nearly all assessed localities reported that fewer than 25% of mothers delivered their youngest child at a health facility.

Regarding postnatal and newborn care, 77.9% (83.9% SD, 71.9% ED) of the mothers interviewed reported that they immediately dried their newborn babies. Less than half, 44.6% (43.4% SD, 45.7% ED), reported not applying anything to the umbilical cord before it fell off.

Table-4: Household Experience in Accessing Healthcare Services

Access to healthcare (N:1,285)	South Darfur (N:640)	East Darfur (N:645)	Overall
Easy to access	19.00%	19.10%	19.10%
Difficult to access	80.90%	80.90%	81.00%
Pay to access health	52.30%	67.60%	60.00%

Table-5: Management of Newborn Care

Indicator	South Darfur(N:640)	East Darfur(N:645)	Overall
Facility based delivery	28.40%	21.90%	25.20%
Post-natal care	83.90%	71.90%	77.90%

Additionally, 28.1% (21.1% SD, 35.0% ED) of mothers used traditional herbs on the cord before it fell off. Only 23.6% (32.5% SD, 14.7% ED) applied modern medicine, particularly iodine, to the cord before it fell off. Further details are presented in **(Table-5)**.

Vaccination Status:

Data on immunization status were collected through verification of children's health cards, and those without cards were excluded. The results show that 59.4% (44.1% SD, 74.6% ED) of children had received BCG, while 65.6% (52.5% SD, 78.6% ED) had received the Polio dose o vaccine at birth at the appropriate age (**Table-6**).

Integrated Community Case Management (iCCM):

The study investigated the prevalence of and healthcare-seeking behavior for childhood illnesses, including presumed malaria, diarrhea, and acute respiratory infections. More details are presented in **(Table-7)**.

Table-6: Vaccination of Children

Vaccine type	South Darfur(N:640)	East Darfur(N:645)	Overall
BCG	44.10%	74.60%	59.40%
Polio dose o at birth	52.50%	78.60%	65.60%

Table-7: Childhood Illnesses

Infection	Period Prevalence	Appropriate Health Seeking	Proper Management/Treatment
Malaria (N:564)	43.9% (48.9% SD, 38.9% ED)	65.3% (60.4% SD, 70.1% ED)	79.4% (78.6% SD, 80.1% ED)
Diarrhea (N:312)	24.3% (29.5% SD, 19.1% ED)	59% (54.0% SD, 66.7% ED)	32.7% (34.4% SD, 30.1% ED)
ARI (339)	39.1% (49.8% SD, 28.3% ED)	62.6% (56.0% SD, 69.2% ED)	53.3% (63.0% SD, 43.6% ED)

Seeking Healthcare Services for Malaria:

The survey results show that 43.9% (48.9% SD, 38.9% ED) of children from the assessed households had malaria or exhibited high fever. Among those, a significant majority sought health services from Primary Healthcare Units (PHUs), as confirmed by 64.7% (60.4% SD, 70.1% ED) of respondents. The remaining caregivers either opted to remain at home or consulted traditional healers.

Notably, over three-quarters of caregivers administered medications to their children who had fever or were presumed to have malaria, with 79.4% (78.6% SD, 80.1% ED) confirming that their children received proper treatment for malaria.

Seeking Healthcare Services for Diarrhea:

The prevalence of diarrhea was 24.3% (29.5% SD, 19.1% ED). More than half of the caregivers (59.0%; 54.0% SD, 66.7% ED) sought treatment for their children with diarrhea from PHUs.

Additionally, 31.4% (29.6% SD, 34.1% ED) of caregivers reported providing water to their children suffering from diarrhea. Furthermore, 32.7% (34.4% SD, 30.1% ED) provided fluids prepared from oral rehydration salts and zinc (ORS), while 14.1% (14.8% SD, 13.0% ED) provided only water to the sick child.

On the other hand, 21.8% (21.2% SD, 22.8% ED) of caregivers reported that they were unable to provide any fluids to their children experiencing diarrhea, which may be associated with a lack of knowledge on how to effectively manage diarrhea episodes.

Seeking Healthcare Services for Acute Respiratory Infection:

More than a quarter of children in South Darfur exhibited cough symptoms within the two weeks preceding data collection. Among these, 39.1% (49.8% SD, 28.3% ED) experienced difficulty breathing or rapid, shallow breaths during the same period.

Regarding pneumonia, 62.6% (56.0% SD, 69.2%

ED) sought medical attention from PHUs. Conversely, 22.5% (27.0% SD, 17.9% ED) pursued care from traditional healthcare providers for the pneumonia episode.

Moreover, 53.3% (63.0% SD, 43.6% ED) of caregivers administered medication for acute respiratory infection (ARI). Nevertheless, 23.8% (29.7% SD, 17.8% ED) cited socio-cultural barriers as a limitation to accessing health services.

Nutrition Status:

Global Acute Malnutrition (GAM):

In South Darfur, the prevalence of global acute malnutrition was 19.9% (21.8% boys, 18.2% girls). Moderate acute malnutrition was 13.7% (15.5% boys, 12.2% girls), while severe acute malnutrition was 6.2% (6.4% boys, 6.0% girls).

The situation in East Darfur was similar, with global acute malnutrition at 15.5% (15.3% boys, 15.7% girls). Moderate acute malnutrition was 9.9% (9.6% boys, 10.1% girls), while severe acute malnutrition was 5.6% (5.6% boys, 5.6% girls).

All estimates are reported at a 95% confidence interval (CI). Further details are presented in **(Table-8)**.

Underweight:

The prevalence of underweight was reported at 31.9% in South Darfur, with 38.4% among boys and 25.8% among girls. In East Darfur, the prevalence of underweight was 24.8%, with 25.7% among boys and 23.7% among girls.

The prevalence of moderate underweight was reported at 20.5% in South Darfur, with 14.6% among boys and 8.3% among girls. In East Darfur, the prevalence of moderate underweight was 17.3%, with 17.3% among both boys and girls.

Regarding severe underweight, South Darfur reported a prevalence of 11.4%, affecting 14.6% of boys and 8.3% of girls. In East Darfur, the prevalence of severe underweight was 7.5%, with 6.3% among boys and 8.4% among girls. Further details are presented in (**Table-9)**.

Stunting:

In South Darfur, the prevalence of stunting was 36.6%, with 40.9% among boys and 32.5% among girls. Among these, 21.9% were classified as moderately stunted (22.3% boys and 21.6% girls), and 14.7% as severely stunted (18.7% boys and 10.9% girls).

Table-8: Prevalence of acute malnutrition based on weight-for-height z-scores and by sex

South Darfur			
Prevalence of [19]	All n = 682	Boys n = 330	Girls n = 352
Global Acute Malnutrition	(136) 19.9 %	(72) 21.8 %	(64) 18.2 %
(<-2 z-score and/or oedema)	(15.2 - 25.6 95% C.I.)	(14.3 - 31.8 95% C.I.)	(13.4 - 24.2 95% C.I.)
Moderate Acute Malnutrition	(94) 13.8 %	(51) 15.5 %	(43) 12.2 %
(<-2 z-score and >=-3 z-score, no oedema)	(10.9 - 17.2 95% C.I.)	(10.3 - 22.6 95% C.I.)	(10.3 - 14.5 95% C.I.)
Severe Acute Malnutrition	(42) 6.2 %	(21) 6.4 %	(21) 6.0 %
(<-3 z-score and/or oedema)	(3.0 - 12.3 95% C.I.)	(2.8 - 13.6 95% C.I.)	(2.6 - 13.0 95% C.I.)
East Darfur			
Prevalence of [19]	All n = 676	Boys n = 301	Girls n = 375
Global Acute Malnutrition	(105) 15.5 %	(46) 15.3 %	(59) 15.7 %
(<-2 z-score and/or oedema)	(11.6 - 12.4 95% C.I.)	(10.3 - 22.7 95% C.I.)	(10.4 - 23.2 95% C.I.)
Moderate Acute Malnutrition	(67) 9.9 %	(29) 9.6 %	(38) 10.1 %
(<-2 z-score and >=-3 z-score, no oedema)	(5.0 - 18.7 95% C.I.)	(4.3 - 20.1 95% C.I.)	(4.8 - 20.0 95% C.I.)
Severe Acute Malnutrition	(38) 5.6 %	(17) 5.6 %	(21) 5.6 %
(<-3 z-score and/or oedema)	(1.7 - 17.1 95% C.I.)	(1.3 - 20.8 95% C.I.)	(1.6 - 17.9 95% C.I.)

Table-9: Prevalence of underweight based on weight-for-age z-scores by sex

South Darfur			
Prevalence of [20]	All n = 677	Boys n = 328	Girls n = 349
Underweight	(216) 31.9 %	(126) 38.4 %	(90) 25.8 %
(<-2 z-score)	(22.5 - 43.0 95% C.I.)	(26.9 - 51.3 95% C.I.)	(16.9 - 37.2 95% C.I.)
Moderate underweight	(139) 20.5 %	(78) 23.8 %	(61) 17.5 %
(<-2 z-score and >=-3 z-score)	(14.7 - 27.9 95% C.I.)	(17.3 - 31.8 95% C.I.)	(11.3 - 26.1 95% C.I.)
Severe underweight	(77) 11.4 %	(48) 14.6 %	(29) 8.3 %
(<-3 z-score)	(6.9 - 18.2 95% C.I.)	(7.5 - 26.6 95% C.I.)	(5.2 - 12.9 95% C.I.)
East Darfur			
Prevalence of [20]	All n = 670	Boys n = 300	Girls n = 370
Underweight	(166) 24.8 %	(71) 23.7 %	(95) 25.7 %
(<-2 z-score)	(13.5 - 41.0 95% C.I.)	(13.6 - 37.9 95% C.I.)	(13.2 - 43.9 95% C.I.)
Moderate underweight	(116) 17.3 %	(52) 17.3 %	(64) 17.3 %
(<-2 z-score and >=-3 z-score)	(11.0 - 26.1 95% C.I.)	(10.2 - 28.0 95% C.I.)	(11.1 - 25.9 95% C.I.)
Severe underweight	(50) 7.5 %	(19) 6.3 %	(31) 8.4 %
(<-3 z-score)	(2.5 - 20.3 95% C.I.)	(2.0 - 18.1 95% C.I.)	(2.6 - 23.8 95% C.I.)

Table-10: Prevalence of stunting based on height-for-age z-scores and by sex

South Darfur			
Prevalence of [21]	All n = 694	Boys n = 337	Girls n = 357
Stunting	(254) 36.6 %	(138) 40.9 %	(116) 32.5 %
(<-2 z-score)	(25.7 - 49.1 95% C.I.)	(27.3 - 56.2 95% C.I.)	(23.5 - 43.0 95% C.I.)
Moderate stunting	(152) 21.9 %	(75) 22.3 %	(77) 21.6 %
(<-2 z-score and >=-3 z-score)	(15.3 - 30.3 95% C.I.)	(13.7 - 34.1 95% C.I.)	(16.2 - 28.1 95% C.I.)
Severe stunting	(102) 14.7 %	(63) 18.7 %	(39) 10.9 %
(<-3 z-score)	(9.8 - 21.4 95% C.I.)	(11.6 - 28.8 95% C.I.)	(6.6 - 17.6 95% C.I.)
East Darfur			
Prevalence of [21]	All n = 680	Boys n = 304	Girls n = 376
Stunting	(197) 29.0 %	(90) 29.6 %	(107) 28.5 %
(<-2 z-score)	(16.2 - 46.2 95% C.I.)	(18.4 - 43.9 95% C.I.)	(14.4 - 48.4 95% C.I.)
Moderate stunting	(119) 17.5 %	(54) 17.8 %	(65) 17.3 %
(<-2 z-score and >=-3 z-score)	(10.2 - 28.4 95% C.I.)	(11.7 - 26.0 95% C.I.)	(8.8 - 31.1 95% C.I.)
Severe stunting	(78) 11.5 %	(36) 11.8 %	(42) 11.2 %
(<-3 z-score)	(6.3 - 20.1 95% C.I.)	(6.8 - 19.8 95% C.I.)	(5.5 - 21.3 95% C.I.)

In East Darfur, the stunting rate based on height-for-age measurements was 29.0%, with 29.6% among boys and 28.5% among girls. The severity of stunting in this region showed that 17.5% were moderately stunted (17.8% boys and 17.3% girls), and 11.5% were severely stunted (11.8% boys and 11.2% girls). Further details are presented in **(Table-10)**.

Breastfeeding:

At least 30.5% of mothers in South Darfur and 46.6% in East Darfur with eligible children reported initiating breastfeeding within the first hour of delivery, while 55.2% in South Darfur and 42.5% in East Darfur initiated breastfeeding immediately after delivery.

In terms of complementary feeding, 40.7% of mothers in South Darfur introduced complementary food at 6 months, while 34.2% introduced complementary food after 6 months. In East Darfur, 27.2% of mothers introduced complementary food at 6 months, compared to 52.4% who introduced complementary food after 6 months.

Food and Dietary Diversity:

More details of the results are presented in **(Table-11)**.

Table-11: Food and Dietary Diversity

1	Household main sources of food [31]	**Admin units**	**Own production**	**Market purchases**	**Relief/food aid**	**Borrowing**	**Kinship support**
		South Darfur (N:640)	31.60%	56.70%	10.50%	0.50%	0.80%
		East Darfur (N:645)	16.30%	75.80%	7.10%	0.50%	0.30%
2	Household food consumption score [32]	**Admin units**	**Poor food consumption**	**Borderline food consumption**		**Acceptable food consumption**	
		South Darfur(N:640)	40.30%	26.90%		32.80%	
		East Darfur(N:645)	17.70%	23.60%		58.80%	
3	Average number of meals eaten at the household [33]	**Admin units**	**Three times**	**Two times**	**Once**	**Others**	
		South Darfur(N:640)	39.20%	56.70%	3.30%	0.80%	
		East Darfur(N:645)	30.50%	65.30%	4.00%	0.20%	
4	Household Dietary Diversity [32]	**Admin units**	**Less than four food groups**		**Four or more food groups**		
		South Darfur(N:640)	39.40%		60.60%		
		East Darfur (N:645)	26.40%		73.60%		
5	Household hunger scale [31]	**Admin units**	**Little to no hunger in the household**	**Moderate hunger in the household**		**Severe hunger in the household**	
		South Darfur(N:640)	70.80%	24.60%		4.70%	
		East Darfur(N:645)	80.20%	14.90%		4.90%	
6	Household coping strategies index [33]	**Admin units**	**No to low coping**	**Medium coping**		**High coping**	
		South Darfur(N:640)	20.00%	35.20%		44.80%	
		East Darfur(N:645)	35.00%	19.50%		45.40%	

Sources of Food:

Over half (56.7%) of households in South Darfur depend on market purchases as their main source of food. A similar situation is reported in East Darfur, where three-quarters of households depend on market purchases as their primary source of food. With very limited or no household engagement in food production, household food security challenges remain difficult to address. Furthermore, the minimal income levels reported among households present a significant threat to household food access and resilience.

Food Consumption Score (FCS):

The results show that the proportion of households with an acceptable food consumption score was low at 32.8% in South Darfur, while 40.3% of households were categorized under the poor food consumption threshold. Conversely, 58.8% of households in East Darfur were categorized as having an acceptable food consumption score.

Number of Meals Consumed:

The results indicate that most households consumed two meals per day: 56.7% in South Darfur and 65.3% in East Darfur. Additionally, 78.0% of adults in South Darfur consumed two or fewer meals on the day preceding the survey, while 71.0% of adults in East Darfur reported the same.

Regarding the number of meals consumed by children during the day and night preceding the survey, only 32.0% of children in South Darfur consumed the recommended number of meals, while 38.9% of children in East Darfur consumed at least three meals.

Dietary Diversity Score (DDS):

The results show that the mean household DDS was 4.6 (4.2 SD, 5.0 ED), with a standard deviation of 1.9. The findings imply that at least 6 out of 10 households consumed food from at least four food groups. In line with dietary diversity standards, 67.1% (60.6% SD, 73.6% ED) of households consumed four or more food groups.

Household Hunger Scale:

Overall, 70.8% of households in South Darfur experienced little to no hunger, 24.6% experienced moderate hunger, and 4.7% experienced severe hunger. In East Darfur, 80.2% of households experienced little to no hunger, 14.9% experienced moderate hunger, and 4.9% experienced severe hunger during the 30 days preceding data collection.

The most affected months of food shortage were reported to be July to September.

Reduced Coping Strategies Index:

Overall, a coping strategy index of 10 was reported in South Darfur and 9 in East Darfur. The results demonstrate a high adoption of negative coping strategies. These included relying on less preferred and less expensive foods, limiting portion sizes at mealtimes, reducing the number of meals eaten per day, borrowing food or relying on help from relatives or friends, and restricting adult consumption to allow small children to eat.

Additionally, 44.8% of households in South Darfur and 45.4% in East Darfur reported a high adoption of negative coping strategies.

Discussion

The findings reveal that access to healthcare services poses significant challenges for households in the Darfur region, with a very high proportion (81%) of respondents reporting difficulties in accessing healthcare. This overarching finding paints a worrying picture for population survival, particularly within this fragile context. This is not an unexpected finding, as it is well established that conflict affects all components of a country's health system, including infrastructure, human resources, and financial capacity. Furthermore, conflict-affected states often had weak health systems even before conflict escalated. As a result, conflict-affected states like Sudan have among the worst health indicators and weakest health systems globally [15].

Access to healthcare is essential for newborn wellbeing. Using zero-dose vaccines as a proxy indicator, the study revealed that 40.6% of newborns did not receive the BCG vaccine, while 34.5% missed the Polio dose 0 vaccine at birth. It is important to note that only households with verified child health cards were included in this assessment. This is a concerning situation because missing zero-dose vaccines leaves newborns and young children highly susceptible to severe illness, lifelong disability, and death from preventable infectious diseases such as polio and tetanus [16]. Missing zero-dose vaccination also results in a growing population of unvaccinated children, contributing to gaps in herd immunity and increasing the risk of outbreaks with potentially large-scale mortality [17]. This situation calls for enhanced outreach, mobile vaccination campaigns, and strengthened immunization systems in the region.

Community-based initiatives are critical for ensuring survival of children under five years in Africa. In Darfur, the period prevalence of malaria was 43.9%, yet up to 35.3% of affected children did not access healthcare. The prevalence of watery diarrhea was 24.3%, and up to 67.3% of cases did not receive care. Although 39.1% of children experienced acute respiratory infection (ARI), up to 46.7% did not access healthcare services. For all three diseases, prevalence levels were alarming while access to care remained inadequate. Weak Integrated Community Case Management (iCCM) contributes to increased morbidity and mortality among children under five, who are particularly vulnerable to common but treatable conditions. Delayed or absent treatment increases the risk of severe illness, death, and long-term physical and cognitive consequences [18].

The nutrition situation among children under five in Darfur is critical and exceeds recommended thresholds. The prevalence of Global Acute Malnutrition (GAM) ranged from 15.5% to 19.9% (<5% acceptable, 5–9.9% alert, 10–14.9% serious, 15–29.9% critical, ≥30%

extremely critical) [19]. The prevalence of underweight ranged from 24.8% to 31.9% (<20% low, 20–29% medium, 30–39% high, ≥40% very high) [20]. Stunting rates ranged from 29.0% to 36.6% (<2.5% very low, 2.5–<10% low, 10–<20% medium, 20–<30% high, ≥30% very high) [21]. These levels suggest insufficient implementation of interventions aligned with the global "First 1000 Days" principles [22], which emphasize nutrition from conception to two years of age as a critical window for growth and development. Malnutrition during the first 1000 days has detrimental effects on growth, cognitive development, school performance, immune function, and increases the risk of non-communicable diseases and premature death later in life [23].

Breastfeeding practices in the region are also concerning. Up to 69.5% of newborns did not benefit from early initiation of breastfeeding (EIBF) within the first hour of birth. Early initiation prevents neonatal infections, reduces deaths due to sepsis, pneumonia, diarrhea, and hypothermia, and supports sustained breastfeeding. Delaying breastfeeding beyond the first hour doubles the risk of neonatal mortality [24]. Although breastfeeding is low-cost and highly cost-effective, access to information and maternal decision-making autonomy are limited, particularly in conflict settings. Limited maternal involvement in newborn care decisions may contribute to delayed initiation of breastfeeding, as evidence shows that informed and empowered mothers are less likely to delay breastfeeding initiation [25].

Household food insecurity remains severe. Up to 75.5% of households rely on market purchases for food, and 40.3% reported poor food consumption. Only 39.2% consumed at least three meals per day. Limited food consumption contributes to poverty cycles, poor health outcomes, reduced economic productivity, and social instability. Adequate food intake is essential for a functional and healthy population [26]. These findings align with global trends showing rising hunger since 2015 due to pandemics, climate change, inequality, and conflict [27], as observed in Darfur.

Dietary diversity was also low, with only 39.4% of households consuming at least four food groups and 45.5% reporting high coping strategy use. Common coping mechanisms included reliance on less preferred foods, reduced portion sizes, meal skipping, and selling assets. Evidence from other contexts shows that over 60% of food-insecure households rely on cheaper and less preferred foods, while others reduce meal size [28]. Low dietary diversity is associated with malnutrition, dyslipidemia, cardiovascular risk, and metabolic syndrome. Inadequate dietary variety is also strongly associated with stunting and severe stunting [29].

Strengths and Limitations

The main strength of this study is the extensive data collected across multiple domains, including healthcare access, newborn vaccination, childhood illnesses, and nutrition. This provides a comprehensive assessment of health challenges in the region.

However, the study provides only a cross-sectional snapshot and lacks longitudinal data to assess trends over time, limiting predictive interpretation of intervention outcomes. The large geographical coverage and absence of complete household lists posed methodological challenges for simple random sampling. Additionally, vaccination estimates were based solely on card verification and may therefore overestimate true population coverage.

Conclusion

The findings illustrate substantial barriers to healthcare access in South and East Darfur, with transportation challenges and low facility utilization reflecting systemic weaknesses. Particularly concerning are low vaccination coverage, suboptimal newborn care practices, high prevalence of childhood illnesses, and critical levels of malnutrition.

Urgent and coordinated interventions are required to improve healthcare accessibility, strengthen nutrition programs, and prioritize maternal and child health services to improve outcomes in these vulnerable communities.

Conflict of Interest

The authors have read and approved the final version of the manuscript and declare no conflicts of interest.

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