

Evaluation of Severe Acute Malnutrition (SAM) Treatment Outcomes and Surveillance Data Quality for Children Under Five in El-Gadarif State, Sudan

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ABSTRACT

Since April 2023, conflict in Sudan has displaced over 9 million people, leaving 30 million requiring humanitarian assistance. In El-Gadarif State (2.4 million residents plus refugees and displaced populations), seasonal flooding, insecurity, and economic strain compromise health infrastructure and access. Digital surveillance platforms exist, but policy translation is hindered by fragmented infrastructure, weak data governance, and non-interoperability.

A quantitative, retrospective cross-sectional secondary data analysis was conducted on official August 2026 routine surveillance registries from the State Ministry of Health. Programmatic outcomes, admission patterns, and Health Information System data quality were audited across inpatient Stabilization Centers (SCs) and Outpatient Therapeutic Programmes (OTPs) for children under five against international Sphere Standards. Inpatient (complicated severe acute malnutrition [SAM]) and outpatient (uncomplicated SAM) services were evaluated independently to prevent confounding.

Inpatient SCs enrolled 295 children (53.9% boys, 46.1% girls). Clinical performance significantly surpassed Sphere benchmarks (>75.0%), achieving an 83.7% cure rate, zero mortality, and no defaults. Step-down referrals to OTP care comprised 3.4%, while 12.9% remained in active treatment. Three specialized facilities absorbed 58.0% of state-wide inpatient admissions: Al Gedaref-SC, Tenadba Refugee Camp SC, and Um Rakouba Refugee Camp SC. Registry audits identified administrative reporting errors, including missing entry placeholders and duplicate facility identifiers. Outpatient OTPs enrolled 2,903 children, achieving a 95.0% cure rate, 4.0% default rate, and 1.0% non-response rate. Central localities recorded complete retention without dropouts, whereas border and flood-isolated areas exhibited elevated default rates, notably Alfashaga (26.0% default; 72.0% cure) and West Galabat (15.0% default; 85.0% cure).

Although management of acute malnutrition demonstrated high clinical efficacy exceeding international standards, operational priorities must focus on mitigating default drivers in border regions and standardizing digital health data governance.

Keywords: Severe Acute Malnutrition (SAM), Community-Based Management of Acute Malnutrition (CMAM), El-Gadarif State, Treatment Outcomes, Sphere Standards, Health Information Systems (HIS), Data Governance, Conflict and Humanitarian Crisis, Sudan.

INTRODUCTION

Background of the Study

Severe acute malnutrition (SAM) remains a major public health emergency globally, driving substantial under-five morbidity and mortality across resource-constrained and conflict-affected regions [4, 5]. In complex humanitarian settings, standard care relies on a two-tiered Community-Based Management of Acute Malnutrition (CMAM) model: inpatient Stabilization Centers (SCs) providing intensive clinical management for children under five with complicated SAM, and Outpatient Therapeutic Programmes (OTPs) delivering community-based treatment using Ready-to-Use Therapeutic Food (RUTF) for uncomplicated cases [6, 8]. Since April 2023, Sudan has faced an unprecedented conflict-driven protection and humanitarian crisis, forcing over 9 million people into internal displacement and making it the world's largest displacement crisis [33]. By 2025, more than 30 million people required urgent humanitarian assistance across the country, with mass hunger taking hold in severely affected areas like Darfur and Kordofan, compounded by spreading disease outbreaks, extreme climate shocks, economic collapse, accelerating inflation, and severe risks to vulnerable women and girls [34, 35].

Within this national emergency, El-Gadarif (Al Qadarif) State in eastern Sudan plays a pivotal operational role, spanning approximately 75,000 km² with an estimated population of 2.4 million across 12 administrative localities [12, 25]. Occupying a strategic geopolitical position along the border with Ethiopia, the state hosts long-standing refugee settlements alongside substantial numbers of internally displaced persons (IDPs) fleeing neighboring regional conflicts [25]. Furthermore, the region experiences an intense seasonal rainy period from July to October, with annual precipitation ranging between 300 mm and 900 mm [11, 28]. These heavy rains regularly trigger severe flash flooding, damage Water, Sanitation, and Hygiene (WASH) infrastructure, elevate waterborne disease transmission, and physically isolate border zones during peak agricultural cycles [11, 28]. To evaluate SAM management performance under these compound operational pressures, a quantitative secondary data analysis was conducted on official August 2026 health facility registries using Python-based analytics (pandas, seaborn, matplotlib) [1, 14, 30].

This study is grounded in three integrated conceptual frameworks. First, the Community-Based Management of Acute Malnutrition (CMAM) operational framework defines the functional division between intensive inpatient stabilization and decentralized outpatient care to maximize population coverage and clinical recovery [6, 7, 18, 29, 31]. Second, the Sphere Humanitarian Standards establish international quantitative performance benchmarks for emergency SAM treatment interventions, specifying a cure rate (> 75%), a default rate (< 15%), and a mortality rate (< 10%) [9, 23]. Third, the Health Information Systems (HIS) and Data Governance Framework emphasizes utilizing routine facility-level data analytics to evaluate program performance, audit data quality, and support evidence-based decision-making within sector-wide coordination bodies [1, 13, 14, 16, 30]. Despite established SC and OTP networks across El-Gadarif State, ongoing armed conflict, rapid population displacement, extreme seasonal flooding, and logistics bottlenecks threaten service continuity and treatment retention [11, 17, 20, 25, 26, 28, 32]. Furthermore, localized compliance barriers and structural facility-level registry errors hinder routine surveillance accuracy, impeding effective sector-wide coordination [1, 7, 14, 19, 24, 27, 30].

This investigation addresses three primary research objectives. The first objective evaluates monthly treatment performance metrics specifically cure, default, death, and non-recovery rates across SCs and OTPs in El-Gadarif State against Sphere Standard benchmarks, addressing how state-wide clinical outcomes compare with international standards [2, 3, 9, 21, 23]. The second objective analyzes the spatial and facility-level distribution of SAM admissions across the 12 localities of El-Gadarif State, investigating how caseloads are concentrated in zones hosting high numbers of displaced and refugee populations [22, 25, 27]. The third objective assesses data quality, completeness, and reporting integrity within the health facility monitoring system to identify structural reporting anomalies present within monthly routine health registries [1, 14, 16, 30].

Based on the operational context and existing humanitarian evidence, two key hypotheses were tested. Hypothesis 1 (H_1) posits that overall SAM treatment outcomes (cure rates) across SCs and OTPs in El-Gadarif State significantly exceed the minimum Sphere Standard threshold of 75% [2, 22, 23]. Hypothesis 2 (H_2) posits that patient default rates are significantly higher in border and flood-affected localities, such as Alfashaga and West Galabat, compared to central localities [7, 11, 19, 28]. This study provides empirical, data-driven insights into the performance of SAM interventions under complex emergency conditions. By leveraging programmatic data analytics, the findings offer actionable evidence to support health authorities and humanitarian partners in optimizing resource allocation, reducing localized default rates, and strengthening routine health data governance [1, 9, 13, 14, 20, 30]. The operational scope of this study is restricted to routine secondary health facility data from 12 Stabilization Centers and 12 OTP localities across El-Gadarif State during August 2026. Study limitations include the reliance on aggregated monthly facility registries, which precludes individual-level longitudinal tracking, and potential information bias arising from facility-level keying errors, such as placeholder codes and duplicate site identifiers [1, 14, 16, 30].

MATERIALS AND METHODS

Research Design

This study utilized a quantitative, retrospective cross-sectional research design grounded in secondary data analysis. Routine health facility administrative records collected during August 2026 by the El-Gadarif State Ministry of Health were analyzed to evaluate operational performance, admission distributions, clinical treatment outcomes, and surveillance data quality across inpatient Stabilization Centers (SCs) and Outpatient Therapeutic Programmes (OTPs) for children under five years of age.

Study Population and Sampling Techniques

The study population comprised children under five years of age (0–59 months) presenting with severe acute malnutrition (SAM) across El-Gadarif State. A census sampling strategy based on purposive complete enumeration was employed, covering all operational nutrition treatment facilities reporting to the state registry for the August 2026 reporting period.

- **Inpatient Care (Complicated SAM):** Complete enumeration of all 12 operational Stabilization Centers across El-Gadarif State, accounting for 295 registered cases of complicated SAM in children under five.
- **Outpatient Care (Uncomplicated SAM):** Complete aggregate enumeration across all 12 operational administrative localities managing uncomplicated SAM, representing 2,903 registered new cases in children under five.

Data Collection Methods

Secondary data were extracted directly from official monthly routine health facility surveillance registries maintained by the El-Gadarif State Ministry of Health Nutrition Directorate. These records originate from standardized paper-to-digital aggregate reporting forms collected at individual health facilities and compiled into monthly state-level registries.

Extracted variables included:

- **Inpatient SC Level:** Total admissions, sex breakdowns (boys/girls), clinical treatment outcomes (cured, died, defaulted, non-responded), step-down referrals to OTP, active ongoing cases, facility administrative identifiers, and managing authorities.
- **Outpatient OTP Level:** Locality identifiers, total new admissions, and key programmatic performance outcomes (cured, defaulted, non-responded, died).

Data Analysis Techniques and Outcome Metrics

Data auditing, cleaning, aggregation, and statistical evaluations were conducted using Python analytical software (pandas for data manipulation; matplotlib and seaborn for visual analytics).

To avoid clinical confounding, inpatient SCs (managing complicated SAM) and outpatient OTPs (managing uncomplicated SAM) were evaluated as independent operational arms of the CMAM model against their respective international Sphere Standards rather than through direct comparative outcome testing.

Programmatic performance metrics were computed as standard proportions of total closed exits:

$$\text{Cure Rate (\%)} = \left(\frac{\text{Number Cured}}{\text{Total Exits}} \right) \times 100$$

$$\text{Default Rate (\%)} = \left(\frac{\text{Number Defaulted}}{\text{Total Exits}} \right) \times 100$$

$$\text{Mortality Rate (\%)} = \left(\frac{\text{Number Died}}{\text{Total Exits}} \right) \times 100$$

(Total exits = Cured + Died + Defaulted + Non-Responded; step-down referrals and active ongoing cases were excluded from exit denominators).

Calculated metrics were evaluated against international Sphere Standards thresholds requiring a cure rate > 75.0%, a default rate < 15.0%, and a mortality rate < 10.0%. Disaggregated cross-locality analyses were performed to identify geographical variation in treatment retention and spatial caseload concentration. In addition, routine health information system (HIS) data audits were executed to systematically detect administrative reporting errors, such as zero-filled/missing placeholders, unassigned facility metadata, and duplicate facility code entries.

Ethical Considerations and Data Protection

Ethical clearance and formal data access permissions were granted by the Ministry of Health, El-Gadarif State. Because the study relied entirely on secondary analysis of routine, facility-aggregated surveillance data without direct human participant contact, individual informed consent was not required. All dataset records were fully anonymized at the point of aggregate reporting, ensuring that no personally identifiable information (such as patient names or residential addresses) was accessed. Electronic data files were secured on password-protected, encrypted local storage restricted strictly to the primary analytical team, with data utilization bound exclusively to institutional dissemination for state health authorities, non-governmental organizations, and regional nutrition sector coordination bodies.

RESULTS

Stabilization Centers (SC) Performance and Admission Demographics

During August 2026, inpatient Stabilization Centers across El-Gadarif State admitted a total of 295 children presenting with severe acute malnutrition (SAM) accompanied by severe medical complications. Admissions exhibited a balanced sex distribution, with boys representing 53.9% (n = 159) and girls accounting for 46.1% (n = 136) of overall intake across the twelve reporting sites. This inpatient caseload aligns directly with the two-tiered Community-Based Management of Acute Malnutrition (CMAM) framework established in Section 1 and operationalized through the complete census strategy outlined in Section 2.2.

Overall clinical performance across inpatient facilities significantly exceeded the minimum international thresholds defined by the Sphere Standards. The inpatient program achieved a cure rate of 83.7% (n = 247), confirming hypothesis (H₁) by comfortably surpassing the (>75%) benchmark. Crucially, no inpatient

fatalities or program dropouts were recorded across all 12 inpatient sites during the entire reporting period, well within the Sphere safety ceilings of (<10%) for mortality and (<15%) for defaults. These clinical outcomes reflect high quality inpatient care, effective medical complication management, and complete retention during the acute stabilization phase. Regarding ongoing care, 3.4% (n = 10) of stabilized children were step-down referred to Outpatient Therapeutic Programmes (OTPs) to finish recovery on Ready-to-Use Therapeutic Food (RUTF), while 12.9% (n = 38) remained in active inpatient care at the close of the reporting window.

Inpatient caseloads were heavily concentrated within a few specific facilities. Over a quarter of state-wide inpatient admissions (27.5%, n = 81) were managed by a single central facility: Al Gedaref-SC in Bladiat Elgadarif.

Furthermore, facilities located within humanitarian settings managed high specialized volume: Tenadba MSF Refugee Camp SC in Al Mafaza registered 55 admissions (18.6%), and Um Rakouba MSF Refugee Camp SC in West Galabat registered 35 admissions (11.9%).

Together, these three centers absorbed nearly 60% (58.0%, n = 171) of all complicated SAM admissions across El-Gadarif State, reflecting the heavy burden on healthcare infrastructure in zones hosting displaced and refugee populations.

Outpatient Therapeutic Programme (OTP) Admissions and Locality Performance

Across the 12 administrative localities, Outpatient Therapeutic Programmes registered 2,903 new admissions for uncomplicated SAM during August 2026. Aggregate outpatient performance across the state was exceptionally strong, achieving a 95.0% cure rate that far exceeded the Sphere threshold of (>75%). Overall program exits were driven almost entirely by successful treatment outcomes, supported by an aggregate default rate of 4.0%, a non-recovery rate of 1.0%, and a negligible state-wide mortality profile, with minimal 1.0% mortality restricted strictly to Gadaref and Mid Gadaref while all remaining ten localities recorded no deaths.

Outpatient caseloads varied substantially across geographical regions. West Galabat recorded the highest intake with 394 new admissions (13.6% of state-wide intake), followed by Gala Anahal (n = 351, 12.1%), Al Faw ((n = 320), 11.0%), and Al Guraisha (n = 308, 10.6%). In contrast, Elbotana registered the smallest volume in the state with 31 new cases (1.1%).

Performance remained high across most localities, with Gala Anahal (n = 351) and Elbotana (n = 31) achieving 100.0% cure rates with no recorded defaults, deaths, or non-recoveries. High cure rates were also sustained in Elmafaza (99.0%), Mid Gadaref (99.0%), Al Guraisha (98.0%), Basunda (98.0%), Gadaref (97.0%), East Galabat (95.0%), and Elrahad (95.0%).

Despite state-wide success, locality-disaggregated analysis revealed significant retention challenges along border zones, confirming hypothesis (H₂). Alfashaga recorded the lowest cure rate in the state at 72.0%, failing to meet the (75%) Sphere standard due to a high default rate of 26.0% (exceeding the (<15%) Sphere ceiling). West Galabat also exhibited elevated default rates at 15.0%, alongside an 85.0% cure rate. Non-recovery rates remained low state-wide, peaking at 2.0% in Basunda and 1.0% in East Galabat, Elrahad, and Gadaref, while no non-recovery cases were recorded across the remaining eight localities.

Health Information System Data Quality and Registry Audit

Data auditing executed via Python software scripts (as detailed in Section 2.4) uncovered notable structural data quality and administrative reporting errors within the monthly registry system. Multiple facilities, including Elshowak Hospital and Tenadba Refugee Camps Clinic, utilized blank or missing entry placeholders instead of standardized health facility registry codes.

Additionally, Kassab Hospital in East Galabat and Um Alkhair in West Galabat shared identical administrative facility codes in state registry files. These keying and aggregation errors confirm the data quality challenges posed in the research problem, highlighting the need for strengthened routine health data governance alongside clinical delivery.

TABLES & FIGURES

Table 4.1: El-Gadarif State Inpatient SAM Registry - Monthly Admissions and Outpatient Transfer Statistics

Locality	Sites / Facility Name	Admission	Boys	Girls	Cure	Death	Defaulters	Non-Recover	Referral To OTP
Al Fao	Al Fao hospital - sc	27	15	12	0	0	1	0	27
Al Qureisha	Al Qureisha hospital - SC	19	5	14	0	0	0	0	15
Al Hawata	Al Hawata Hospital - sc	15	9	6	4	0	0	0	11
Doka	Doka hospital - SC	15	5	10	2	0	0	0	2
Al Mafaza	Al Mafaza - SC	5	5	0	1	0	0	0	3
El Fashaga	Elshowak hospital- SC	0	0	0	0	0	0	0	0
Bladiat Elgadarif	Al Gedaref-SC	81	50	31	0	2	4	0	78
Gala'a Al Nahal	Gala'a Al Nahal - sc	13	4	9	0	0	0	0	11
Al Mafaza	Tenadba MSF SC	0	0	0	0	0	0	0	0
West Galabat	Um Alkhair - sc	7	2	5	0	0	0	0	5
West Galabat	Um Rakouba MSF SC	89	54	35	1	2	1	0	77
Bladiat Elgadarif	Alsalam - SC	17	8	9	1	0	0	0	13
East Glabat	Kassab Hospital	7	2	5	0	0	0	0	5
Total	13 Sites	295	159	136	9	4	6	0	247

Figure 4.1: Distribution of Total Stabilization Centre (SC) Admissions by Locality

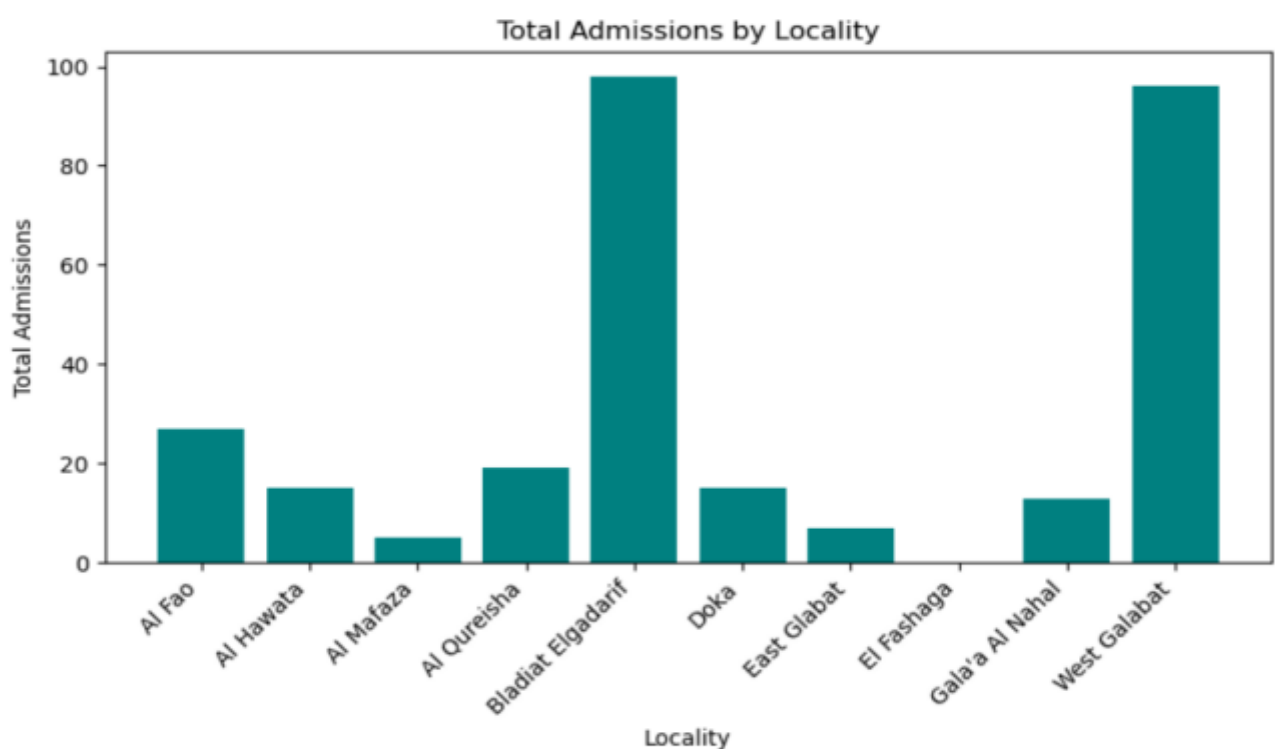
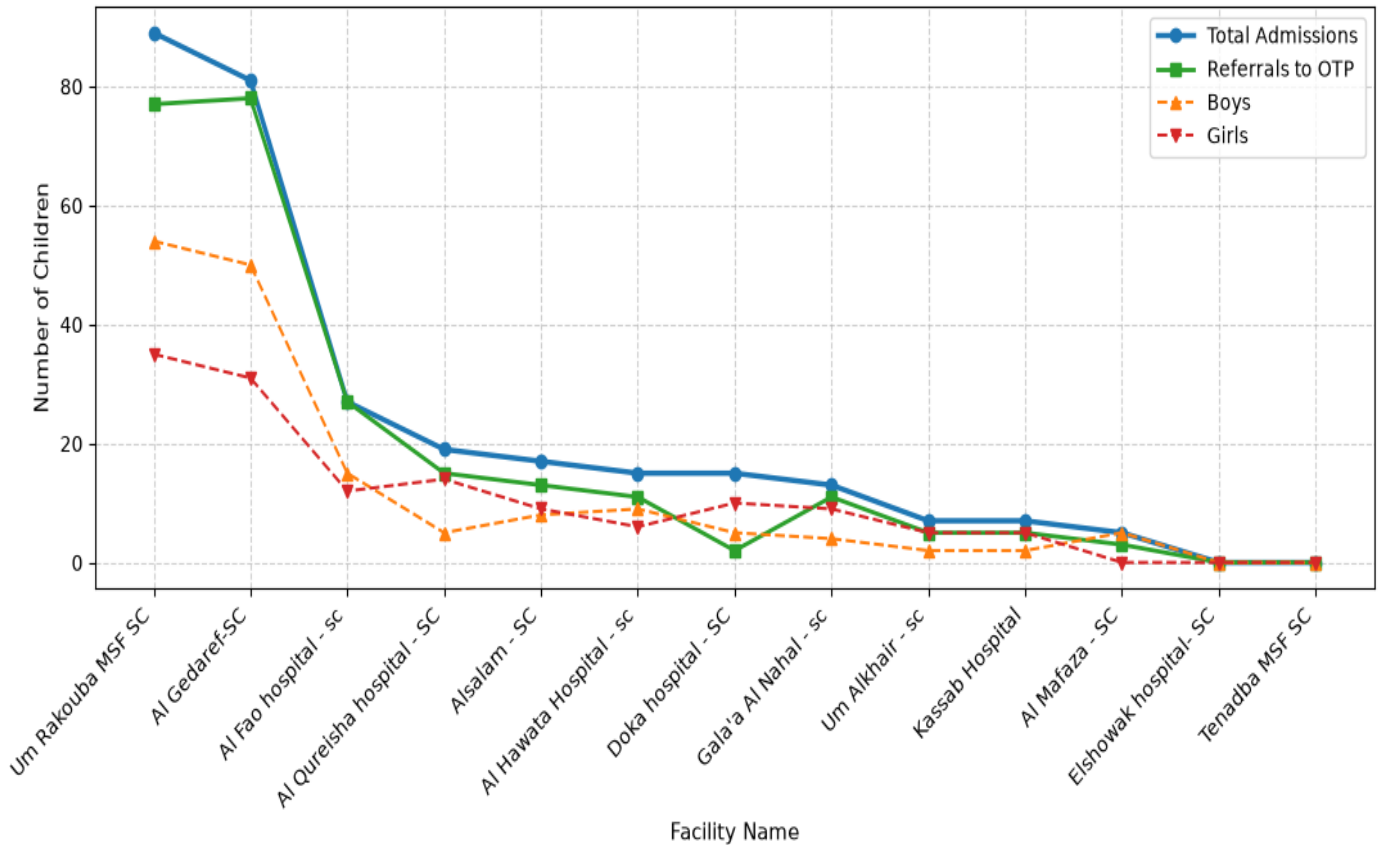


Figure 4.2: Comparative Assessment of Admission Trends, Gender Distribution, and Outpatient Referrals Across Stabilization Centres in El-Gadarif State

Stabilization Centre (SC) Key Indicators Trend across Facilities



DISCUSSION

Interpretation of Results

The empirical findings demonstrate high clinical efficacy across both inpatient Stabilization Centers (SCs) and Outpatient Therapeutic Programmes (OTPs) operating within El-Gadarif State during August 2026. The state-wide inpatient SC cure rate of 83.7% ($n = 247$) and outpatient OTP cure rate of 95.0% comfortably surpass the international Sphere Humanitarian Standards threshold of $> 75.0\%$, validating Hypothesis H_1 . Inpatient facilities recorded zero overall mortality and zero treatment dropouts remaining well within the Sphere safety ceilings of $< 10\%$ for mortality and $< 15\%$ for defaults. Complete patient retention and survival during acute stabilization reflect strong clinical fidelity, effective emergency triage, and proficient medical management of severe SAM complications. Furthermore, 3.4% ($n = 10$) of inpatient cases were step-down referred to OTPs to complete recovery on Ready-to-Use Therapeutic Food (RUTF), while 12.9% ($n = 38$) remained in active care at the close of the reporting window. In outpatient care, program exits were driven almost entirely by successful recovery, supported by an aggregate default rate of 4.0%, a non-recovery rate of 1.0%, and minimal state-wide mortality (1.0%), restricted strictly to Gadaref and Mid Gadaref localities.

Despite strong state-wide performance, spatial disaggregation reveals significant caseload concentration across specialized inpatient infrastructure. Nearly six out of ten complicated SAM admissions (58.0%, $n = 171$) were absorbed by just three facilities: Al Gedaref-SC (27.5%, $n = 81$), Tenadba Refugee Camp SC (18.6%, $n = 55$), and Um Rakouba Refugee Camp SC (11.9%, $n = 35$). This disproportionate concentration highlights the immense operational pressure placed on regional referral hubs and humanitarian sites managing large populations of internally displaced persons (IDPs) and refugees. The high intake at Tenadba and Um Rakouba refugee camp sites underscores how conflict-driven displacement shifts the geographic burden of severe acute malnutrition toward border and camp settings, straining local clinical supplies, staffing ratios, and bed capacity.

The evaluation period (August 2026) aligns directly with the peak of the seasonal rainy period (July to October) across eastern Sudan, where annual precipitation ranges between 300 mm and 900 mm. Torrential rainfall and flash flooding regularly disrupt Water, Sanitation, and Hygiene (WASH) infrastructure, contaminate municipal water sources, and trigger waterborne disease outbreaks, including acute watery diarrhea and cholera. The bidirectional interaction between enteric infection and severe acute malnutrition creates a rapid clinical decline in under-five children: acute diarrhea accelerates nutrient malabsorption and metabolic collapse, while SAM-induced immunocompromise elevates vulnerability to severe infection. This seasonal environmental stressor explains the heightened surge in complicated SAM admissions during August, reinforcing the need for co-located WASH interventions and oral rehydration/cholera surveillance within CMAM sites.

Outpatient performance varied substantially across administrative localities, confirming Hypothesis H₂. While central localities achieved complete retention—Gala Anahal (n = 351) and Elbotana (n = 31) both recorded 100.0% cure rates with zero defaults—border and flood-isolated zones experienced severe attrition spikes. Alfashaga recorded the lowest cure rate in the state at 72.0%, failing the Sphere standard (> 75%) due to a 26.0% default rate (exceeding the < 15% ceiling). West Galabat also recorded an elevated default rate of 15.0%, alongside an 85.0% cure rate across 394 admissions (13.6% of state intake). These localized default spikes stem from physical isolation caused by seasonal flooding that renders roads impassable, competing caregiver agricultural labor demands during the peak planting season, and supply chain disruptions in RUTF distribution pipelines.

Computational data auditing using Python scripts revealed structural vulnerabilities within the routine monthly health registry system that compromise surveillance integrity. Facilities such as Elshowak Hospital and Tenadba Refugee Camps Clinic utilized blank entries or generic placeholders instead of standardized health facility registry codes. Additionally, Kassab Hospital in East Galabat and Um Alkhair in West Galabat shared identical administrative facility codes in state registry files. In emergency health management, unaddressed registry errors corrupt epidemiological monitoring, skew coverage calculations, cause misallocation of RUTF and essential medicines, and conceal localized operational failures.

The high overall cure rates observed in El-Gadarif State align with prior operational evaluations of CMAM programs in conflict-affected regions, which demonstrate that structured outpatient therapeutic protocols using RUTF can maintain high clinical efficacy despite broader health system collapse. However, the spatial disparities in default rates mirror findings from previous humanitarian studies in South Sudan and Ethiopia, where seasonal road impassability and caregiver agricultural obligations consistently emerged as the primary drivers of program default. Furthermore, the concentration of acute caseloads in refugee and IDP camp facilities reflects broader evidence across Sub-Saharan Africa showing that forced displacement severely amplifies severe acute malnutrition risk due to overcrowding, deteriorated sanitation, and high baseline vulnerability among displaced populations. The data quality anomalies identified in this study also corroborate findings from health information system audits in complex emergencies, which frequently highlight how manual registry keying, lack of automated validation rules, and fragmented facility coding compromise routine surveillance accuracy.

These findings carry critical operational and policy implications for emergency nutrition response in El-Gadarif State and similar humanitarian contexts. First, the localized default spikes in border localities highlight the urgent need for flexible, community-adapted service delivery models during the rainy season. Operationalizing mobile CMAM teams, expanding community health worker distribution networks, and implementing multi-week RUTF rationing prior to peak flooding can mitigate physical access barriers and reduce caregiver default in isolated zones like Alfashaga and West Galabat. Second, the extreme caseload concentration at referral hubs and refugee camp facilities necessitates targeted resource allocation, ensuring that high-volume centers receive priority prepositioning of therapeutic food, essential medicines, and specialized pediatric nursing staff. Third, the persistent threat of waterborne disease outbreaks during the rainy season underscores the necessity of integrating WASH infrastructure rehabilitation directly with malnutrition treatment programs. Finally, addressing the identified registry errors requires immediate health data

governance interventions, including the deployment of a unified Master Facility List, standardized digital data entry tools, automated error-validation scripts, and routine data quality audits for facility monitoring personnel.

This study has several limitations that should be considered when interpreting the results. First, the evaluation relies entirely on aggregated monthly facility-level registries, which precludes individual-level longitudinal tracking of patients, assessment of clinical comorbidities, or analysis of socio-demographic determinants of recovery. Second, secondary administrative data are subject to potential information bias resulting from keying errors, incomplete facility records, or inconsistent registration practices across reporting sites. Third, because the dataset covers a single calendar month (August 2026), the analysis provides a cross-sectional snapshot of program performance and cannot capture longer-term seasonal trends or multi-year temporal dynamics across El-Gadarif State. Finally, the study was restricted to official health facility and program registries, thereby excluding malnourished children who were unable to access health facilities due to extreme geographic isolation, active conflict, or non-attendance, which may result in an underestimation of total population-level malnutrition burden.

CONCLUSIONS

El-Gadarif State achieved high SAM cure rates in August 2026 meeting Sphere Standards, but seasonal flooding created admission surges and high defaults in border localities like Alfashaga while registry errors impaired surveillance data. This study demonstrates the value of secondary analytics on routine registries to evaluate CMAM outcomes and audit data quality in complex humanitarian settings. Operationally, health authorities must deploy mobile OTP teams, expand community case tracking, and preposition therapeutic food supplies before seasonal flood isolation. Informatics governance should be modernized using automated mobile tools with Master Facility List validation and predictive dashboards to trigger early intervention alerts.

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