SMART survey report in Malakal County, Upper Nile State, South Sudan

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REACH Initiative

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Table of Contents

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List of Tables

List of Figures

List of acronyms

AFI:	Acute Food Insecurity
AMN:	Acute Malnutrition
CDC:	Centers for Disease Control and Prevention
CDR:	Crude Death Rate
CHD:	County Health Department
CM:	Centimeters
CMAM:	Community Management of Acute Malnutrition
CI:	Confidence interval
CMR:	Crude Mortality Rate
DDG:	Digital Data Gathering
DEFF:	Design Effect
ENA:	Emergency Nutrition Assessments
EIBF:	Early Initiation of Breastfeeding
ExBF:	Exclusive Breastfeeding
FCDO:	Foreign, Commonwealth and Development Office
FCS:	Food Consumption Score
FSL:	Food Security and Livelihoods
FSNMS:	Food Security and Nutrition Monitoring System
GAM:	Global Acute Malnutrition
GFD:	General Food Distribution
HFA:	Height for Age
HAZ:	Height for Age Z scores
HH:	Household
HHS:	Household Hunger Scale
IPC:	Integrated Phase Classification
IPC-AMN:	Integrated Phase Classification – Acute Malnutrition
IMC:	International Medical Corps
IYCF:	Infant and Young Child Feeding
LCS:	Livelihood Coping Strategies
MAM:	Moderate Acute Malnutrition
MAD:	Minimum Acceptable Diet
MDD:	Minimum Dietary Diversity
MM:	Millimeter
MOH:	Ministry of Health
MUAC:	Mid Upper Arm Circumference
NIWG:	Nutrition Information Working Group

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OTP:	Out-Patient Therapeutic Programme
PLW:	Pregnant and Lactating Women
PPS:	Probability Proportional to Size
RC:	Reserve Cluster
RDT:	Rapid Diagnostic Test
RRC:	Relief and Rehabilitation Commission
SAM:	Severe Acute Malnutrition
SD:	Standard Deviation (measure of spread around the mean)
SMART:	Standardized Monitoring and Assessment of Relief and Transitions
SMOH:	State Ministry of Health Malakal County
SSD:	South Sudan
TEM:	Technical Error of Measurement
TSFP:	Targeted Supplementary Feeding Programme
U5MR:	Under Five Mortality Rate
UNHCR:	United Nations High Commissioner for Refugees
UNICEF:	United Nations International Children's Emergency Fund
UNS:	Upper Nile State
Vit A:	Vitamin A
WASH:	Water Sanitation and Hygiene
WFH:	Weight for Height
WHO:	World Health Organization
WHZ:	Weight for Height Z Scores

Executive Summary

Between December 11 and 17, 2024, a SMART survey was conducted across all six Payams (Central Malakal (County HQ), Eastern Malakal, Northern Malakal, Southern Malakal, Lelo, Ogot) in Malakal County, Upper Nile State, South Sudan. The survey employed a two-stage sample technique (This is probability sampling, leading to results representative for the conditions of the population researched): first, villages were identified using the proportion to population size (PPS) method of cluster sampling, and second, households were selected using simple random sampling.

Anthropometric data was collected from 537 households in 45 clustered villages in Malakal County and analyzed to determine the nutritional status of 638 children aged 6-59 months. Since the final sample size exceeded the minimum 499 children required as per the applied sampling methodology in the validated protocol, there was no need to activate any reserve clusters.

Table 1: Executive summary table

Category	Indicator	n	N	(%) (95% CI)
Wasting	Prevalence of global malnutrition by WHZ (<-2 z-score and/or oedema)	156	638	24.5 (19.9 - 29.7.8)
	Prevalence of severe malnutrition (<-3 z-score and/or oedema)	29	638	4.5 (3.2 - 6.4)
	Prevalence of global malnutrition by MUAC (< 125 mm and/or oedema)	51	645	7.9 (5.8 - 10.7)
	Prevalence of severe malnutrition (< 115 mm and/or oedema)	4	645	0.6 (0.2 - 1.6)
	Prevalence of combined GAM (WHZ <-2 and/or MUAC < 125 mm and/or oedema)	166	645	25.7 (21.0 - 31.2)
	Prevalence of combined SAM (WHZ < -3 and/or MUAC < 115 mm and/or oedema	31	645	4.8 (3.4 - 6.7)
Stunting	Prevalence of stunting (<-2 z-score)	NA	NA	14.7 with SD of 1
Underweight	Prevalence of underweight (<-2 z-score)	180	637	28.3 (23.6 - 33.4)
	Prevalence of severe underweight (<-3 z-score)	48	637	7.5 (5.4 - 10.3)
Mortality	Crude Death Rate (Deaths/10,000 people/day)	11	537	0.48 (0.26 - 0.88)
	Under-5 Death Rate (Deaths/10,000 children U5/day)	1	537	0.46 (0.14 - 1.45)
Nutrition and Health Service Coverage	Measles card + mother confirmation (9-59 months)	597	607	98.4 (97.2 - 99.3)
	De-worming (children12-59 months)	457	553	82.6 (79.2 - 85.9)
	Vitamin A Supplementation (6-59 months)	623	650	95.8 (94.3 - 97.2)
IYCF Indicators				
Breastfeeding indicators	Ever breastfed (0-23 months)	143	160	89.38 (83.53 - 93.69)
	Early initiation of breastfeeding (0-23 months)	139	160	86.88 (80.64 - 91.69)

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	Exclusive breastfeeding for the first 2 days (0-23 months)	10	160	6.25 (3.04 - 11.19)
	Exclusive breastfeeding under 6 months (0-5 months)	10	160	6.3 (2.5 – 10.6)
	Mixed milk feeding under 6 months (0-5 months)	34	160	21.25 (15.19 - 28.41)
	Continued breastfeeding (12-23 months)	123	142	86.62 (79.9 - 91.75)
Complementary feeding practices	Minimum dietary diversity 6–23 months	73	160	45.63 (37.74 - 53.67)
	Minimum meal frequency 6–23 months	34	160	21.5 (15.19 - 28.41)
	Minimum acceptable diet 6–23 months	27	160	16.88 (11.43 - 23.59)
	Egg and/or flesh food consumption 6–23 months	53	160	33.13 (25.90 - 40.99)
	Sweet beverage consumption 6–23 months	16	160	10 (5.82 - 15.73)
	Zero vegetable or fruit consumption 6–23 months	10	160	6.3 (3.04-11.19)
Food Security and livelihood	Food Consumption Score			
	Acceptable	155	537	28.9 (25.1 - 32.4)
	Borderline	224	537	41.7 (38.0 - 46.0)
	Poor	158	537	29.4 (25.5 - 33.1)
	Household Hunger Scale			
	Little	21	537	3.9 (2.2 - 5.6)
	Moderate	395	537	73.6 (69.6 - 77.3)
	None	117	537	21.8 (18.4 - 25.5)
	Severe	4	537	0.7 (0.2 - 1.5)
	Livelihood Coping Strategies			
	Crisis	27	537	5.0 (3.2 - 7.1)
	Emergency	315	537	58.7 (54.7 - 62.9)
	None	177	537	33.0 (28.7 - 36.7)
	Stress	18	537	3.4 (1.9 - 4.8)
WASH	Water Sources 9Improved and unimproved)			
	Improved	413	537	76.9 (73.2 - 80.4)
	Not Improved	124	537	23.1 19.6 - 26.8)
	Time to collect water			
	1 hour to half day	39	537	7.3 (5.2 - 9.5)
	30 minutes to 1 hour	236	537	43.9 (40.0 - 48.4)
	Inside the compound	5	537	0.9 (0.2 - 1.9)
	Under 30 minutes	257	537	47.9 (43.4 - 51.8)
	Treatment method			
	Boil	23	537	4.3 (2.6 - 6.0)
	Chlorine	371	537	69.1 (65.4 - 73.2)
	Filter cloth	7	537	1.3 (0.4 - 2.2)
	None	129	537	24.0 (20.5 - 27.6)
	Latrine usage			

	None open	286	537	53.3 (49.0 - 57.4)
	Pit slab	154	537	28.7 (24.8 - 32.4)
	Pit slab none	49	537	9.1 (6.7 - 11.7)
	Shared latrine	48	537	8.9 (6.7 - 11.4)
	Soap Access			
	none	427	537	79.5 (76.4 - 83.1)
	Yes confirmed	101	537	18.8 (15.5 - 22.2)
	Yes not confirmed	9	537	1.7 (0.7 - 2.8)

Introduction

South Sudan, the world's youngest country since its independence from Sudan in 2011, has faced internal conflict since 2013. This conflict has led to widespread displacement, disrupted livelihoods, and persistently high levels of acute food insecurity and malnutrition. Although a 2018 peace deal improved security and humanitarian access, as of July 2023, approximately 2.4 million South Sudanese refugees remained in neighboring countries[1]. Recent IPC findings in October 2024, indicate that 6.3 million people (47% of the total population) are in IPC Phase 3 or above, with 1.74 million in IPC Phase 4 and 41,000 in Phase 5. Out of the population 41,000 in Phase 5, 10,000 people are from Malakal County while the remaining 31,0000 are returnees. In South Sudan, by June 2025, 2.075 million children are expected to be acutely malnourished, including 646,362 who may face Severe Acute Malnutrition (SAM) [2].

Malakal County is located in Upper Nile State, with an estimated 2024 population of 201,394. Within this population, 10,000 are in Phase 5, which accounts for 24% of the total population in phase 5 nationwide. It falls under the northern sorghum and livestock livelihood zone, with the White Nile River serving as a key route for transportation and fishing. Since the outbreak of civil war in 2013, the county has hosted the Malakal Protection of Civilians (PoC) site[3] and it borders Sudan, therefore it's affected by the Sudan war that started in April 2023. Over the past year, Malakal County has also seen an influx of Sudanese refugees and South Sudanese returnees, while recent flooding damaged homes and infrastructure, overwhelming the already limited resources.

A September 2023 SMART survey by International Medical Corps (IMC) in Malakal County, indicated a Global Acute Malnutrition (GAM) rate of 20.2%, exceeding the 15% WHO emergency threshold. It also highlighted sub-optimal Infant and Young Child Feeding (IYCF) practices, and found that 83% of households relied on improved drinking water sources while only 7.6% had improved sanitation. The Crude Mortality Rate (CMR) was 0.85 deaths per 10,000 persons per day, nearing the WHO threshold of 1%. Recent IPC reports October 2024, place Malakal in Phase 4 (Critical) from July 2024 through June 2025, with an expectation of increasing severity during this time period of the year.

Within the Malakal PoC site, a September 2022 SMART survey showed a 23.9% GAM, 5.4% Severe Acute Malnutrition (SAM), 24.1% underweight, and 13.9% stunting. Contributing factors include high disease prevalence, poor sanitation, sub-optimal IYCF practices, and food insecurity. Displaced populations living in makeshift camps face food shortages, unsafe water, and poor sanitation, further exacerbating malnutrition, particularly among children and

[1] https://www.worldbank.org/en/country/southsudan/overview
[2] South Sudan IPC Report 2024/25
[3] CSRF South Sudan Malakal - csrf-southsudan.org

pregnant women[4]. In addition, according to WHO data up to November 2024, Malakal County is currently experiencing the highest cholera outbreak after Juba and Renk, with 663 reported cases, 79 positive results from rapid diagnostic tests (RDT), and 11 culture-confirmed cases5 in the month of November.

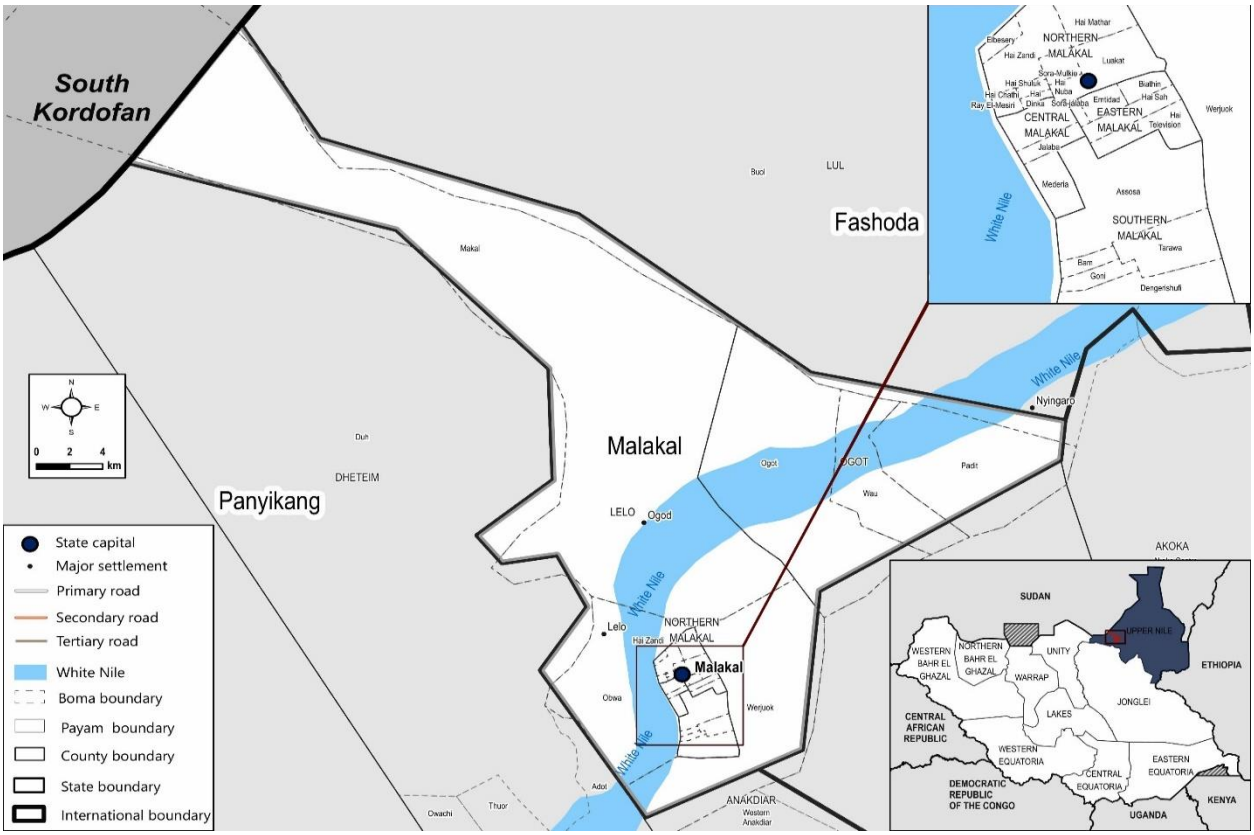
Given these critical needs, coupled with severity of the situation in Malakal – which is projected to remain in Phase 4 for both for AFI and AMN throughout the projection periods from July 2024 to June 2025, in addition to having a pocket of Phase 5 affecting 10,000 people - and an evolving information gap, Malakal was flagged as a priority county for SMART surveys in 2024–2025 by the country's Nutrition Information Working Group (NIWG). REACH Initiative, active in South Sudan since 2012, has been conducting assessments and supporting humanitarian partners. Since 2019, REACH has engaged with the NIWG, participating in IPC Acute Malnutrition workshops and offering technical support for SMART survey implementation.

To address the information gap, REACH Initiative conducted a SMART survey in Malakal County from December 11 to 17, 2024. In order to give program implementers a better understanding of the prevalence of acute malnutrition (AMN) in Malakal County and its main causes, this survey sought to gather anthropometric and mortality data in addition to important multi-sectoral indicators like food security and livelihoods (FSL), water, sanitation, and hygiene (WASH), and health. The findings will update existing data, guide programming decisions, and ensure that resources are effectively allocated to mitigate the county's high malnutrition rates and related vulnerabilities.

[4] South Sudan: Flooding Situation Flash Update No. 5 (As of 25 September 2024)

5 South Sudan: Cholera outbreak situation report, WHO, November 2024

Figure 1: Malakal county reference map



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Survey Objectives

The overall objective of this survey was to determine the prevalence of acute malnutrition among children 6-59 months, and the retrospective mortality rates to inform humanitarian response with practical recommendations.

In particular, the following are the specific objectives of the assessment:

1. To estimate the prevalence of acute malnutrition, stunting and underweight among children (boys and girls) aged 6 – 59 months in Malakal County.
2. To estimate the retrospective Crude Mortality Rate (CMR) for the overall population and Under 5 Mortality Rate (U5MR) in all payams of Malakal County.
3. To estimate the coverage of various immunizations in Malakal County including:
    - Vitamin A supplementation for children aged 6 – 59 months
    - Deworming for children aged 12 to 59 months
    - Measles vaccination coverage among children aged 9 – 59 months.
4. To assess childhood morbidity and health-seeking behaviors among households with children aged 6 – 59 months in Malakal County.
5. To assess the nutritional status of pregnant and lactating women (PLW) in Malakal County.
6. To assess IYCF Practices such as breastfeeding and complementary feeding among mothers who have children under the age of two years in Malakal County.
7. To assess the WASH situation in Malakal County (main water source, distance/time to water source, water treatment status, access to soap, access to latrine).
8. To assess the food security and livelihoods situation in Malakal County [Food Consumption Scores (FCS), Household Hunger Scale (HHS), main livelihoods, and Livelihood Coping Strategies (LCS)].
9. To formulate practical interventions and recommendations for both emergency and long-term programs of Nutrition actors in Malakal County.

Methodology

This is a quantitative survey, that follows the SMART survey protocol, and is representative of the entire population of Malakal county. The detailed sampling is presented below. All villages in Malakal County were included in the sampling frame and their respective population sizes were considered in order to provide each sampling unit with equal chances of being selected.

Sampling strategy

For this survey, a **two-stage cluster sampling** strategy was used to ensure a representative sample, aligning with SMART survey guidelines. In the **first stage**, villages were selected proportionally to their population size (PPS), giving each village a chance of being chosen based on its relative population. In the **second stage**, households were randomly selected within each chosen cluster. The final number of households to be surveyed per cluster was determined by the calculation which factors in the daily capacity of each survey team along with other relevant considerations.

Sampling strategy: selection of clusters

The smallest geographic unit used for this study is referred to as a cluster, which is equivalent to a village from the administrative level in this study. A list of all 24 villages, with populations ranging from 250 to 5,000 individuals, was obtained from the Malakal County Health Department (CHD) and IMC. According to the calculation (see Table 5), 45 clusters were required to achieve the desired precision. Using the Emergency Nutrition Assessment (ENA) software and applying the Probability Proportional to Size (PPS) method, 45 villages were randomly selected as clusters from the list, along with 5 reserve clusters (RC).

For clusters with more than 150 HHs, segmentation was used to select one portion of the cluster that will represent the cluster. Selection of segments were done using either probability proportional to size (PPS) or simple random sampling (SRS) depending on the population sizes of the specific segments[6]. In the selected segment, the process of HH selection was the same used for each cluster to select the 12 HHs to be surveyed within that particular segment/cluster.

The survey teams successfully visited all 45 selected villages and reached a total of 537 households (98.5% of the planned 545) as well as 645 children under five (129% of the 499 needed for representation). As a result, there was no need to activate the reserve clusters, since the minimum required sample for both the number of clusters and children which is 645 was attained, as per the SMART guideline, was achieved.

[6] As per the SMART Guidelines, if the Segments will have almost equal population sizes, then, SRS will be used; but if the population sizes will be different, then PPS method will be used.

Sampling strategy: selection of households

Definition of household for the survey: A household was defined as a group of people living together, who cook and eat from the same cooking pot. Polygamous families were also defined based on the same principle: if each wife had her own pot, even if they were living in the same compound, they were treated as different households.

Household selection techniques: From the selected villages, one of these two methods was used for household listing: (1) a verbal listing from one or more community leaders and, when not possible, (2) a manual house-to-house listing. Twelve households were then randomly selected from the complete list of HHs using a random number generator (RNG) application.

In selected households, all eligible children (aged 6 – 59 months old) were measured for anthropometric indices, and the household questionnaire was administered. Houses found empty or absent with children were re-visited, and the outcome recorded on the cluster control form, which also noted any empty or non-responding households.

Table 2: Targeted Sample size (Anthropometric)

Parameter	Malakal County	Justification
Estimated Prevalence (%)	20.2%	The point estimate of a SMART survey in Malakal County by IMC conducted in September 2023 with GAM 20.2% (16.4 – 24.7, 95% CI) was taken. Recently conducted IPC-AMN analysis indicated the current high malnutrition prevalence will remain similar in the first projection of October 2024 – March 2025.
Desired Precision	4.5	Reasonable precision for the expected prevalence based on the SMART survey Guide.
Design Effect	1.5	This is adjusted because the DEFF of the previous survey was low. This is based on the Global SMART guidance.
Children to be included	**499**	
Average Household Size	5.1	From the 2023 SMART Survey conducted by IMC.
% Children Under-Five	21%	Used the national average as the findings from IMC SMART are very high (28.9%) as per NIWG recommendation.
% Non-Respondents	5%	Anticipated non-response based on past experiences and from the IMC SMART 2023
Households to be included	**545**	

Table 3: Targeted Sample size (Mortality)

Parameter	Malakal County	Justification
Estimated death rate per 10,000/day	0.85	Malakal County SMART survey was conducted in September 2023 by IMC, 0.85 % (0.35 – 2.06, 95% CI). Point estimate taken as no special events have happened since the last survey.
Desired Precision	0.5	A reasonable precision for the mortality rate closer to 1.
Design Effect	1.5	As per SMART guideline and considering the wide CI of 2023 IMC mortality estimates (0.35 - 2.06)
Recall Period	90	From September 15, 2024 (start of Maize harvest) to mid-point of data collection (Dec 14, 2024) was used
Population to be included	**2370**	
Average Household Size	5.1	From Malakal SMART survey conducted by IMC in September 2023.
% Non-Respondents	5%	Anticipated non-response based on past experiences and from the IMC SMART 2023.
Households to be included	**489**	

The maximum sample size was found to be the anthropometry sample size calculation, and this was considered the final sample size, with 545 households in Malakal County to be included in the survey. As the two household sample sizes always produce different numbers, the sample with the highest number of households i.e anthropometry sample size was used for both anthropometry and retrospective mortality survey.

Table 4: Calculation of household average per day

Activity	Estimated Time
Departure from Office	**7:30 AM**
a. Daily morning Briefings	*15 min*
b. Travel to villages	*60 min*
c. Introduction and HH list development	*30 min*
d. Lunch break	*30 min*
e. Total Time from one HH to another	*5 min*
f. Travel back to base	*60 min*
Total time for HH listing, travelling and breaks (a + b + c + d + f)	195 min
Arrival back to Base	**5:30 PM**
Total Available time in a day	10:00 hrs (600 minutes)
Total time per day for field work (7:30am –5:30 pm)Available time for work	600 - 195 minutes = 405 minutes
Time taken to complete one questionnaire	*30 minutes*

Total time per household + e	*35 minutes*

Given the above, the number of households that a team can comfortably visit in a day is calculated as follows:

405 (min) / 35 (min) =**11.6 HHs/per day ~ 12 HHs**

Accordingly, the number of clusters is presented in table 5 below:

Table 5: Number of clusters

The total number of households in the sample was then divided by the number of households to be completed in one day to determine the number of clusters to be included in the survey. The total number of clusters was obtained after dividing the total number of households.

(545/12) = 45.42 clusters.

	Malakal
Total number of HHs based on sample size calculation	545
Total number of HHs to be assessed per day per team	12
Clusters needed	45.42
Clusters needed	**45**

Survey teams, training, data collection and data management

Survey teams: Eight teams of four members (1 Team Leader, 1 measurer, 1 assistant, 1 enumerator) were involved in the collection of the data. In each cluster, a local guide was employed to facilitate data collection at the household level. The survey teams were recruited by REACH Malakal field office with the involvement of the local officials at both Malakal County and city council. To the extent possible, the team members were a mix of both men and women and were recruited from the local communities. Supervisors consisted of a mix of city council, Relief and Rehabilitation Commission (RRC), State Ministry of Health (SMOH), County Health Department (CHD) and REACH staff.

Training: The survey teams were trained for five days between December 6th and 10th, 2024. The training covered various components including basic concepts of malnutrition, taking anthropometric measurements, sampling of households, data collection tools, digital data collection, data quality checks, and standardization exercise, pilot test, among other themes. The training of the enumerators was facilitated by SMART certified staff and staff with experience conducting SMART surveys.

Supervision: The overall management of the survey was done by REACH Initiative. Maximum supervision of the survey teams was ensured to facilitate quality data.

Data entry and management: Data was collected through REACH tablets using IMPACT Kobo account. The data collection tools were programmed and installed in the tablets which were used by the survey teams. The teams uploaded the collected data to a central server on a daily basis for the survey manager to clean and review each day for quality assurance. Feedback was then relayed to the teams each morning.

Data quality

In order to ensure optimal and high data quality, a number of measures were put in place. The main ones included:

a) The survey was done in accordance with the submitted protocol, ensuring the following:
   i. That the training of survey teams was done using standardised material as recommended by SMART Methodology.
   ii. That standardisation test was undertaken as part of the training; taking appropriate steps thereafter based on the performance of the survey teams.
   iii. That appropriate calibration of survey equipment, during the training and on every morning before proceeding to the field for data collection, was followed.
   iv. That plausibility checks were conducted on a daily basis and informed the daily debriefing sessions which were conducted every day.

b) Data was collected through a digital platform, and control checks and skip patterns is to create a logical flow in the HH questionnaire were programmed to improve the data quality.

c) Anthropometry data was auto analysed using Emergency Nutrition Assessment (ENA) software (January 2020) anthropometry section. The same software was also used to analyse the mortality data.

Questionnaire

The survey was conducted using structured data collection tools which have been developed by the Global SMART Team for both anthropometric and mortality surveys using KOBO. Other indicators were collected using the modules in line with current Food Security and Nutrition Monitoring System (FSNMS) questionnaires as much as possible.

Data collected

1. **Anthropometry children 6-59 months.**
   - **Age:** determined using birth/health cards/records when available and the local calendar of events (see Appendix 4) which were jointly developed by local leaders and survey enumerators.

- **Sex:** Male or female
- **Weight:** Children's weights were taken without clothes using mother and child digital weighing scales (SECA scales with precision of 100gm).
- **Height/length:** Children were measured using the wooden UNICEF measuring boards (precision of 0.1cm). Children less than 2 years of age were measured lying down while those 2 years of age or older were measured standing up.
- **Mid-upper arm circumference:** MUAC measurements were taken at the mid-point of the left upper arm using both the child and adult MUAC tapes (precision of 0.1cm) for children 6-59 months and for pregnant and lactating women.
- **Bilateral pitting oedema:** Bilateral pitting oedemas were assessed by the application of normal thumb pressure on both feet for 3 seconds.

2. **Demographics and mortality:** Every current household member's age in years, their sex, place of birth, and the date they joined the household were all variables gathered throughout the recall period. The age in years, the sex, and whether the household member was born into the family were gathered for those household members who departed during the recall period of 90 days. Age in years, sex, whether the deceased was born or joined the household during the recall period, estimated cause of death, and place of death were all variables recorded for those who passed away during the recall period of 90 days.

3. **Health interventions data:** Vitamin A supplementation, deworming, and measles immunization data were collected through health cards (when available) or recall of 6 months prior to data collection.

4. **Morbidity:** Two-week retrospective morbidity data was collected from mothers/caregivers of all children (of 6-59 months old) included in the anthropometric survey.

5. **Food Security Indicators:**
    a. **Food Consumption Scores (FCS):** An indicator of the general quantity and quality of foods being consumed in a household, based on how many days any household member has consumed 9 distinct food groups within a 7-day recall period. Households were categorized into categories of severity based on their responses. FCS is often used as a proxy for quality of food consumed. Standard FCS thresholds are <21 for 'poor', 21 to <=35 for 'borderline' and 35+ for 'acceptable'.
    b. **Household Hunger Scale (HHS):** Measures the perceived hunger by asking the frequency a household has experienced three common experiences associated with hunger in the past 30 days (no food in the house, slept hungry, gone whole day and night without food). HHS is often used as a proxy for quantity of food consumed. Thresholds and categories used for analysis are those used for IPC Acute Food Insecurity (AFI) in South Sudan[7].

[7] Household hunger scale categories are 1. Little to no hunger (0-1), 2. Moderate hunger (2-3) and Severe hunger (4-6)

c. **Livelihood Coping Strategies (LCS):** Measures behaviours or actions households are taking to cope with not having enough food or resources to get food for the recall period of 30 days. Ten coping strategies were probed for and then categorized as Emergency, Crisis, or Stress strategies.

6. **WASH** – indicators on main drinking water source, access to latrines, distance/time to water source, and water treatment were asked.

Referral: During the collection of these anthropometric data, all children whose measurements indicated they were acutely malnourished, and who were not already enrolled in nutrition treatment programs, were referred to the relevant partners using referral forms to existing Targeted Supplementary Feeding Programme (TSFP) and Outpatient Therapeutic Programme (OTP) programs in the area.

Classifying malnutrition

Individual classification of nutritional status

Individual classifications for nutritional status by different anthropometric measurements are summarized in table 6 below for wasting, stunting, and underweight.

Table 6: Individual malnutrition classifications by WHO

Type of Malnutrition	Grade of Malnutrition	Anthropometric Indicators and Cutoffs
Wasting	Global Acute Malnutrition (GAM) Moderate & severe wasting	<-2 z-scores weight-for-height (WFH) and/or oedema
		<125mm mid-upper arm circumference and/or oedema
		Presence of bilateral pitting oedema
	Severe Acute Malnutrition (SAM) Severe wasting	<-3 z-scores weight-for-height (WFH) and/or oedema
		<115mm mid-upper arm circumference and/or oedema
		Presence of bilateral pitting oedema
Stunting	Global Chronic Malnutrition Global Stunting	<-2 z-scores height-for-age (HFA)
	Severe Chronic Malnutrition Severe Stunting	<-3 z-scores height-for-age (HFA)
Underweight	Global Underweight	<-2 z-scores weight-for-age (HFA)
	Severe Underweight	<-3 z-scores weight-for-age (HFA)

Population cut-offs for malnutrition

Table 7 below defines the population cut-offs for determining the severity of malnutrition when the prevalence of acute and chronic malnutrition is known. These levels are internationally agreed upon and provide an objective basis for developing responses to increased levels of acute and chronic malnutrition[8]. To interpret proportions at a population level with meaning, absolute numbers are also necessary.

Table 7: WHO/UNICEF Classification for Severity of Malnutrition by Prevalence among Children 6-59 months[9]

LEVELS	PREVALENCE OF THRESHOLDS %		
	WASTING	UNDERWEIGHT	STUNTING
Very low	<2.5%	<2.5%	<2.5%
Low	2.5- <5%	2.5- <5%	2.5- <10%
Medium	5- <10%	5- <10%	10- <20%
High	10- <15%	10- <15%	20- <30%
Very high	>=15%	>=15%	>=30%

Table 8: integrated Phase Classification of Acute malnutrition (IPC AMN) classifications for severity of malnutrition prevalence among children 6-59 months[10]

<table>
<tr><th rowspan="2">IPC AMN Phase Classification</th><th colspan="3">PREVALENCE OF THRESHOLDS %</th></tr>
<tr><th>WASTING by GAM by Weight for Height z-score</th><th>WASTING by GAM by Mid-Upper Arm Circumference[11]</th><th>Priority Response Objective</th></tr>
<tr><td>Acceptable</td><td><5%</td><td rowspan="2"><5%</td><td>Maintain the low prevalence of acute malnutrition</td></tr>
<tr><td>Alert</td><td>5- <10%</td><td rowspan="3">Strengthen existing response capacity and resilience. Address contributing factors to acute malnutrition. Monitor conditions and plan response as required</td></tr>
<tr><td>Serious</td><td>10- <15%</td><td rowspan="2">5 - <10%</td></tr>
<tr><td>Critical</td><td>15- <30%</td><td rowspan="2">10 - <15%</td><td>Urgently reduce acute malnutrition levels through scaling up of treatment and prevention of affected populations</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

[8] *Physical Status: The use and interpretation of Anthropometry. Report of a WHO expert committee, 1995. Chapter 5, p208 & 212*

[9] *Threshold classification according to WHO 2018*

[10] *Threshold classification according to IPC Acute Malnutrition reference tables*

[11] IPC AMN classification by MUAC should only be done in the absence of GAM by WHZ data. Whether a higher or lower IPC AMN Phase is classified depends on the historical relationship between WHZ and MUAC in the unit of analysis. See IPC AMN Guidance for more details.

		>= 15%	Urgently reduce acute malnutrition levels through significant scale up and intensification of treatment and protection activities to reach additional population reached
Extremely Critical	>=30%		Urgently reduce acute malnutrition levels through addressing widespread acute malnutrition and disease epidemics by all means

Data cleaning and analysis

The anthropometric and mortality data was analysed using ENA for SMART (January 2020 version). The other additional data (immunization, maternal nutrition, morbidity etc.) were analysed using R. Various statistics were computed on the data, including percentages, means, and medians among others. The analysed data was presented in both tabular and graphical form. The preliminary datasets were made available within 7 days after the last day of data collection, and the preliminary report within 14 days. The preliminary report goes through REACH validation processes and was also submitted to the Nutrition Information Working Group (NIWG) for validation. During the data collection exercise, daily quality checks were performed to ensure the process was running smoothly and that enumerators were well trained on the procedures to be performed. Moreover, specific checks on the anthropometric and mortality results were carried out, specifically the following:

- **Verify flagged children's data –** Input the anthropometric data into ENA and run the plausibility report. This should identify children without key measurements and, consequently, z-scores for further verification. If the data of a flagged child cannot be corrected, the entry remains in the dataset as it contributes to overall quality score of the data.
- **Cleaning extreme MUAC values –** MUAC values <5cm or >20cm or probable errors were removed for children 6-59 months.
- **Cleaning reported deaths –** If date of death is available, removing reported deaths that occurred outside of the recall period of interest which was 90 days.

Results

A total of 537 households, representing 2,457 individuals, were included in the survey, with an average household size of 4.6 people. Among the surveyed households, 83% had children under five years old, resulting in 645 children included in the survey. Female-headed households made up 74% of the sample, while 26% were male-headed. Since the minimum required number of children was reached, as per SMART guidelines, reserve clusters were not activated.

Table 9: Survey target, sample and non-response

	Target	Achieved		Absent		Refused	
	N	N	% of Target	N	% of Target	N	% of Target
Children	499	645	129	5	0.8	0	0
Households	545	537	98	8	1.5	1	0.2
Villages	45	45	100	N/A	N/A	N/A	N/A

Anthropometric Results

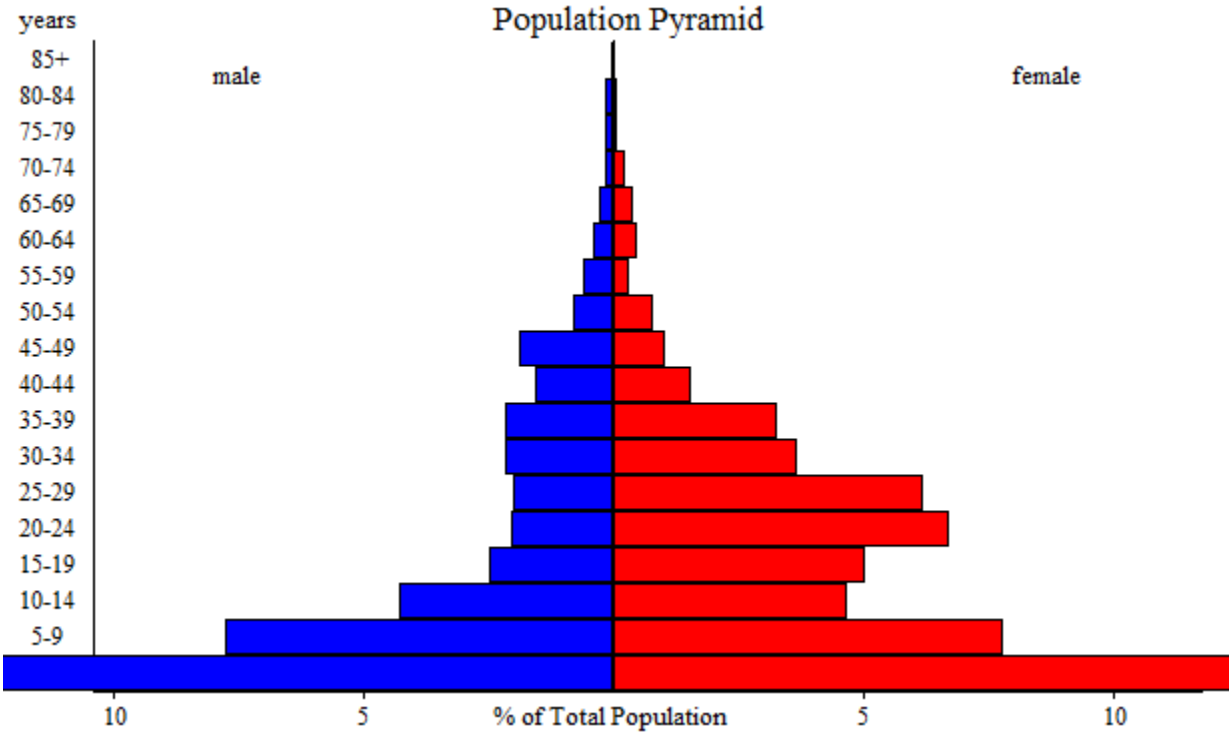
Of the 45 villages surveyed in Malakal County, 645 children aged 6 – 59 months (321 boys and 324 girls) were measured to assess malnutrition status.

To identify outliers, the data were checked at ±3 standard deviations from the observed mean; any values flagged as not plausible for height, weight, or age by the SMART software were excluded from the analysis (though retained in the dataset). These SMART flags were excluded from the analysis but not from the data. **In total, 7 data points were flagged for the weight-for-height z-score, hence, 638 children were analyzed. Similarly, 637 children were analyzed for weight-for-age excluding 8, and 602 for height-for-age excluding 43.** This analysis was conducted using WHO 2006 standards.

Table 10: Distribution of age and sex of sample

	Boys		Girls		Total		Sex Ratio
Age (mo)	**N**	**%**	**N**	**%**	**N**	**%**	Boy:girl
6-17	69	45.1	84	54.9	153	23.7	0.8
18-29	84	53.8	72	46.2	156	24.2	1.2
30-41	87	53.4	76	46.6	163	25.3	1.1
42-53	64	48.5	68	51.5	132	20.5	0.9
54-59	17	41.5	24	58.5	41	6.4	0.7
Total	321	49.8	324	50.2	645	100.0	1.0

Figure 2: Surveyed population pyramid for age and sex



GAM by WHZ

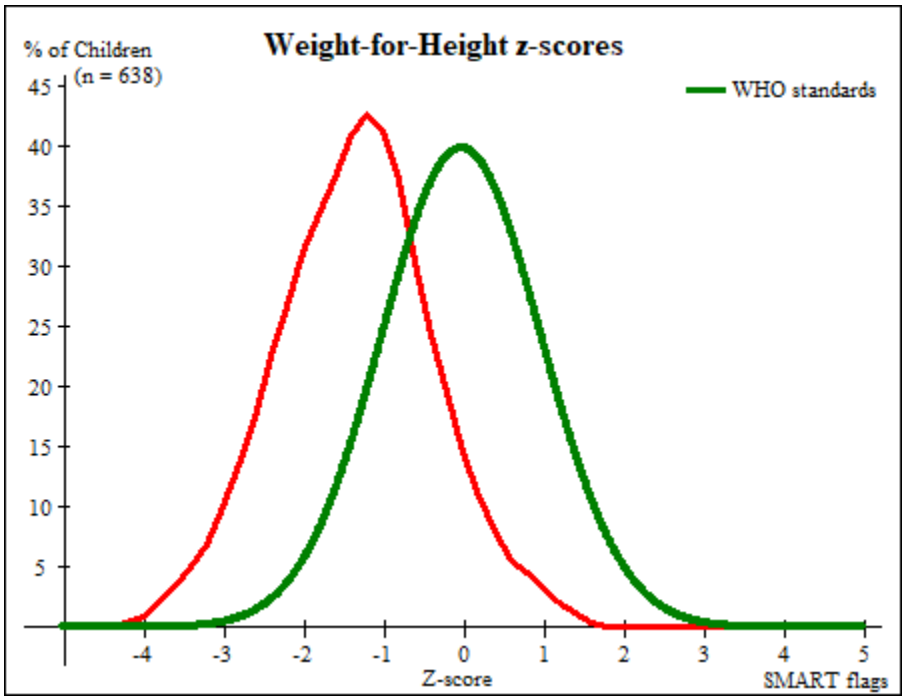
The prevalence of Global Acute malnutrition (GAM) defined as weight-height Z-score (WHZ) (WHZ<-2 and/or oedema) among children 6-59 months old was estimated at 24.5% (19.9 - 29.7, 95% CI) (see table 11 below), which categorizes as "Critical" level as per IPC AMN classification[12]. Correspondingly, a GAM rate falling in the Critical phase requires significant scale-up and intensification of treatment and protection activities to reach additional population affected[13]. In addition, the prevalence of Severe Acute Malnutrition (SAM) per WHZ among children 6-59 months old was 4.5% (3.2 - 6.4, 95% CI). No nutritional bilateral oedema case was observed during the assessment.

The latest SMART survey conducted in September 2023 by IMC had an estimated GAM rate of 20.2% (16.4 - 24.7, 95% CI) while a current GAM rate of 24.5% (19.9 - 29.7, 95% CI) was estimated through this survey. In order to compare the GAM rates from both surveys, it is necessary to understand if the change is statistically significant. Because the confidence intervals of the GAM rates of both surveys overlapped, the change in the overall GAM rate might not be significant. Statistical testing was further deployed to confirm significance using the CDC statistical calculator which showed that the difference between the GAM rates was, in fact, not statistically significant with a p-value of 0.180. Therefore, we cannot conclude that the current

[12] Integrated Phase Classification (IPC) Technical Manual Version 3.1
[13] ibid

nutritional status of children under five in Malakal County has deteriorated significantly since September 2023.

Figure 3: Gaussian curve for Weight-for-Height z-scores



The Weight-for-Height Z-score mean and standard deviation were -1.33 and 0.96, respectively, indicating a higher prevalence of malnourished children compared to the WHO reference population. Measurement quality fell within the recommended range of 0.8 – 1.2 standard deviation, as outlined in the SMART guidelines. The surveyed community demonstrated heterogeneity, with a Design Effect (DEFF) of 2.04. Skewness and kurtosis values of 0.03 and -0.06, respectively, suggesting normal distribution.

Table 11: Prevalence of acute malnutrition based on weight-for-height z-scores (and/or oedema) and by sex

	All n = 638		**Boys** n = 318		**Girls** n = 320	
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Prevalence of global malnutrition (<-2 z-score and/or oedema)	156	24.5 (19.9 - 29.7)	84	26.4 (20.5 - 33.4)	72	22.5 (17.1 - 29.0)
Prevalence of moderate malnutrition	127	19.9 (15.9 - 24.6)	67	21.1 (15.6 - 27.8)	60	18.8 (13.8 - 25.0)

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(<-2 z-score and >=-3 z-score, no oedema)						
Prevalence of severe malnutrition (<-3 z-score and/or oedema)	29	4.5 (3.2 - 6.4)	17	5.3 (3.5 - 8.1)	12	(3.8 (2.1 - 6.7)

The prevalence of oedema is 0.0 %

The overall Global Acute Malnutrition (GAM) rate was 24.5% (with a 95% confidence interval of 19.9% to 29.7%). Notably, the prevalence of both SAM and Moderate Acute Malnutrition (MAM) appeared slightly higher among boys compared to girls. The overall findings for boys and girls exceed the 15% threshold set by the World Health Organization (WHO) for a "critical," situation and fall within the 15% to 29.9% range, corresponding to Phase 4 according to the Integrated Food Security Phase Classification (IPC).

Table 12: Prevalence of acute malnutrition by age, based on weight-for-height z-scores and/or oedema

		Severe wasting (<-3 z-score)		Moderate wasting (>= -3 and <-2 z-score)		Normal (> = -2 z score)		Oedema	
Age (mo)	**N**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
6-17	150	12	8.0	40	26.7	98	65.3	0	0.0
18-29	155	6	3.9	38	24.5	111	71.6	0	0.0
30-41	162	4	2.5	20	12.3	138	85.2	0	0.0
42-53	130	6	4.6	18	13.8	106	81.5	0	0.0
54-59	41	1	2.4	11	26.8	29	70.7	0	0.0
Total	**638**	**29**	**4.5**	**127**	**19.9**	**482**	**75.5**	**0**	**0.0**

When examining the results by age category, children aged 6–29 months were most affected by both severe and moderate wasting, accounting for around 62.1% and 61.4% of overall cases, respectively. This outcome may suggest poor complementary feeding practices, as children in this age group require additional calories beyond breastfeeding.

GAM by MUAC

Table 13: Distribution of acute malnutrition and oedema based on weight-for-height z-scores

	<-3 z-score	**>=-3 z-score**
Oedema present	Marasmic kwashiorkor n=0 (0.0 %)	Kwashiorkor n=0 (0.0 %)
Oedema absent	Marasmus n=31 (4.8 %)	Not severely malnourished n=611 (95.2 %)

The Global Acute Malnutrition (GAM) rate by Mid-Upper Arm Circumference (MUAC) was 7.9% (95% CI: 5.8%–10.7%), while Severe Acute Malnutrition (SAM) stood at 0.6% (95% CI: 0.2%–1.6%). Both SAM and Moderate Acute Malnutrition (MAM) by MUAC were notably more prevalent among children aged 6–17 months. However, it should be noted that MUAC measurement tends to detect malnutrition more readily in younger children.

Table 14: Prevalence of acute malnutrition based on MUAC cut off's (and/or oedema) and by sex

		All n = 645		**Boys** n = 321		**Girls** n = 324
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Prevalence of global malnutrition (< 125 mm and/or oedema)	51	7.9 (5.8 - 10.7)	18	5.6 (3.5 - 8.8)	33	10.2 (7.0 - 14.5)
Prevalence of moderate malnutrition (< 125 mm and >= 115 mm, no oedema)	47	7.3 (5.3 - 9.9)	17	5.3 (3.2 - 8.5)	30	9.3 (6.2 - 13.5)
Prevalence of severe malnutrition (< 115 mm and/or oedema)	4	0.6 (0.2 - 1.6)	1	0.3 (0.0 - 2.3)	3	0.9 (0.3 - 2.9)

Table 15: Prevalence of acute malnutrition by age, based on MUAC cut off's and/or oedema

		Severe wasting (< 115 mm)		Moderate wasting (>= 115 mm and < 125 mm)		Normal (> = 125 mm)		Oedema	
Age (mo)	**N**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
6-17	153	3	2.0	22	14.4	128	83.7	0	0.0
18-29	156	1	0.6	19	12.2	136	87.2	0	0.0
30-41	163	0	0.0	2	1.2	161	98.8	0	0.0
42-53	132	0	0.0	3	2.3	129	97.7	0	0.0
54-59	41	0	0.0	1	2.4	40	97.6	0	0.0
Total	645	4	0.6	47	7.3	594	92.1	0	0.0

This survey confirms that weight-for-height (WHZ) measurements identified more children with acute malnutrition (wasting) than Mid-Upper Arm Circumference (MUAC) measurements. The overall prevalence of malnutrition detected via MUAC was consistently lower than what was found through WHZ. In both methods, severe and moderate wasting were most often found in children aged 6-29 months.

In fact, only 6.4% (41 cases) of acute malnutrition instances were detected by both methods (see Table 17). Moreover, **WHZ** measurements captured **115 cases** of acute malnutrition, whereas **MUAC** detected only **10 cases**, indicating that WHZ was more easily detect acute malnutrition in this survey.

Table 16: Prevalence of combined GAM and SAM based on WHZ and MUAC cut off's (and/or oedema) and by sex*

		All N = 645		**Boys** N = 321		**Girls** N = 324
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Prevalence of combined GAM (WHZ <-2 and/or MUAC < 125 mm and/or oedema)	166	25.7 (21.0 - 31.2)	87	27.1 (21.0 - 34.2)	79	24.4 (18.8 - 31.0)

Prevalence of combined SAM (WHZ < -3 and/or MUAC < 115 mm and/or oedema	31	4.8 (3.4 - 6.7)	17	5.3 (3.5 - 8.0)	14	4.3 (2.5 - 7.2)

*With SMART or WHO flags a missing MUAC/WHZ or not plausible WHZ value is considered as normal when the other value is available

Table 17: Detailed numbers for combined GAM and SAM

	GAM		SAM	
	n	**%**	**n**	**%**
MUAC	10	1.6	2	0.3
WHZ	115	17.8	27	4.2
Both	41	6.4	2	0.3
Oedema	0	0.0	0	0.0
Total	166	25.7	31	4.8

*Total sample size (N)= 645

GAM by WAZ

Underweight, as a nutritional indicator, assesses a child's weight relative to their age. According to the WHO 2006 growth standards, which formed the basis of this analysis, a weight-for-age Z-score falling under -2 SD and above -3 SD is classified as moderate underweight, while a Z-score below -3 SD is considered severe underweight. Study findings here revealed an overall underweight prevalence (both moderate and severe) of 28.3% (95% CI: 23.6 - 33.4), with detailed age and sex breakdowns presented in Tables 18 and 19 respectively. According to WHO standards, the reported prevalence of underweight, at 28.3% (95% CI: 23.6 - 33.4), falls within the high classification range (20% to <30%)[14].

[14] Nutrition Landscape Information System (NLiS), WHO, 2025

Figure 4: Gaussian curve for Weight-for-Age z-scores

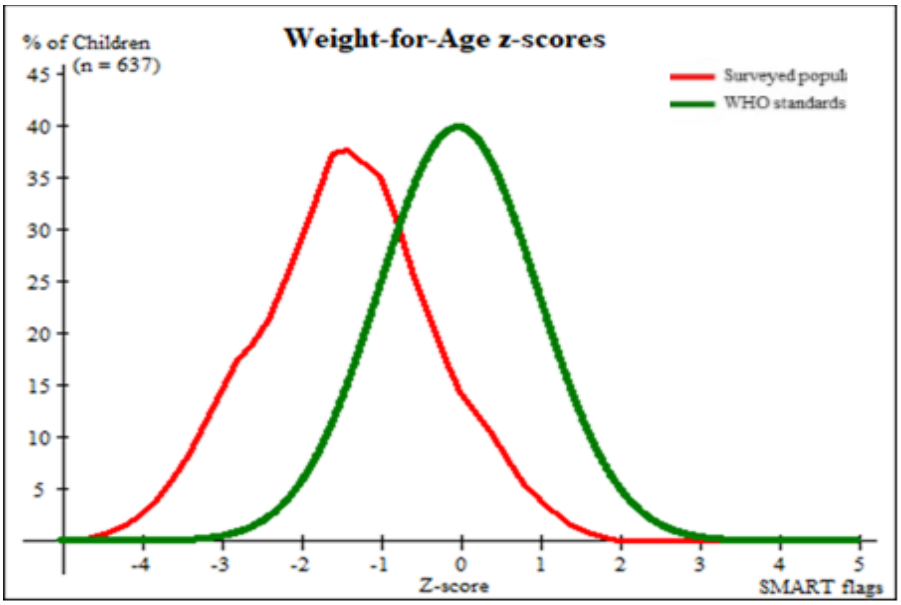

Table 18: Prevalence of underweight based on weight-for-age z-scores by sex

		All n = 637		**Boys** n = 317		**Girls** n = 320
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Prevalence of underweight (<-2 z-score)	180	28.3 (23.6 - 33.4)	103	32.5 (26.7 - 38.9)	77	24.1 (18.8 - 30.2)
Prevalence of moderate underweight (<-2 z-score and >=-3 z-score)	132	20.7 (17.0 - 25.0)	81	25.6 (20.4 - 31.5)	51	15.9 (11.9 - 21.1)
Prevalence of severe underweight (<-3 z-score)	48	7.5 (5.4 - 10.3)	22	6.9 (4.8 - 9.9)	26	8.1 (5.1 - 12.7)

Table 19: Prevalence of underweight by age, based on weight-for-age z-scores

		Severe underweight (<-3 z-score)		Moderate underweight (>= -3 and<-2 z-score)		Normal (> = -2 z score)		Oedema	
Age (mo)	**N**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
6-17	150	12	8.0	32	21.3	106	70.7	0	0.0
18-29	152	23	15.1	38	25.0	91	59.9	0	0.0
30-41	162	5	3.1	34	21.0	123	75.9	0	0.0
42-53	132	6	4.5	21	15.9	105	79.5	0	0.0
54-59	41	2	4.9	7	17.1	32	78.0	0	0.0
Total	637	48	7.5	132	20.7	457	71.7	0	0.0

The findings on underweight prevalence suggest a more pronounced impact among younger children (aged 6–29 months), who comprise over half (58%) of the cases, compared to older children (aged 30–59 months).

Prevalence of Stunting

The survey revealed a stunting rate of 14.8% calculated with a SD of 1, which is classified as medium severity (10 to <20%) according to the UNICEF/WHO 2021 classification of stunting. The analysis of stunting based on height for age z-scores was based on a total of 602 children after the exclusion of 42 children, whose z-scores were out of range.

Table 20: Prevalence of stunting based on height-for-age z-scores and by sex

		All n = 602		**Boys** n = 298		**Girls** n = 304
	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Prevalence of stunting (<-2 z-score)	127	21.1 (17.3 - 25.5)	74	24.8 (19.8 - 30.6)	53	17.4 (12.6 - 23.7)
Prevalence of moderate stunting (<-2 z-score and >=-3 z-score)	91	15.1 (12.1 - 18.7)	57	19.1 (14.7 - 24.5)	34	11.2 (7.5 - 16.3)
Prevalence of severe stunting (<-3 z-score)	36	6.0 (4.2 - 8.5)	17	5.7 (3.5 - 9.2)	19	6.3 (3.8 - 10.0)

*****Calculated prevalence of stunting with an SD of 1 is 14.8%*

The following table (Table 21) presents an analysis of anthropometric data for each indicator, including the design effect, means, standard deviation, and scores outside the expected range. The survey successfully attained the anticipated standard deviation (0.8 – 1.2) for weight-for-height and weight-for-age z-scores.

Table 21: Mean z-scores, Design Effects and excluded subjects

Indicator	n	Mean z-scores ± SD	Design Effect (z-score < -2)	z-scores not available*	z-scores out of range
Weight-for-Height	638	-1.33±0.96	2.04	3	4
Weight-for-Age	637	-1.42±1.08	1.88	1	7
Height-for-Age	602	-0.96±1.28	1.51	1	42

* contains for WHZ and WAZ the children with oedema.

Mortality results

The survey, encompassing 2,457 individuals across all surveyed households, collected mortality data over a 90-day recall period. Specifically, the recall period spanned from September 15, 2024 — identified by the enumerators as the start of the maize harvest — to December 14, 2024, which is the midpoint of data collection. During the interviews, participants were asked to retrospectively report any deaths that occurred in their households during this timeframe.

Table 22: Mortality rates

CMR (total deaths/10,000 people/day): 0.48 (0.26-0.88, 95% CI)
U5MR (deaths in children under five/10,000 children under five/day): 0.46 (0.14-1.45, 95% CI)

During the established recall period, participants reported 11 deaths, including 3 deaths among children under five. This corresponds to a Crude Death Rate (CDR) of 0.48 (95% CI: 0.26–0.88) and an under-five mortality rate of 0.46 (95% CI: 0.14–1.45). These figures are well below the official emergency thresholds (1/10,000 deaths per day for the total population and 2/10,000 deaths per day for children under five), suggesting that the overall health status of the population in Malakal County is currently stable.

Table 23: General demographic information on mortality sample

Indicator	Results
Average Household Size	4.6
Mid-Interval Population	2,457
% of children Under-5 years	29.5
Birth Rate	1.23
In-Migration Rate (Joined)	1.01
Out-Migration Rate (Left)	3.11
Design Effect for CDR	1

Table 24: Broad Causes of Death

Cause of death	%
Illness	90.9
Trauma/Injury	9.1

Table 25: Location of death

Location of reported deaths	%
Place of Current Residence	90.9
During Migration	9.1
Place of Last Residence	0
Other	0

A large majority (90.9%) of the reported deaths occurred in the respondent's current place of residence. Similarly, 90.9% of these deaths were attributed to illness, while the remaining 9.1% were linked to trauma or injury.

Child Morbidity and Access to Health Care

To examine the prevalence of common diseases among children aged 6-59 months, we gathered retrospective morbidity data using information from caregivers' responses. This data was collected across a two-week recall period. The survey disclosed that 17.5% (95% CI: 14.8 - 20.5) of these children experienced at least one overall illness episode in the two weeks before data collection. Fever and cough emerged as the most common illnesses, representing 79.8% and 67.5% of all reported cases, respectively.

Table 26: Prevalence of reported illness in children in the two weeks prior to interview (n=114)

Child Illness overall	Prevalence
Prevalence of reported illness	17.5% (14.8 – 20.5, 95% CI)

Table 27: Symptom breakdown among children for whom illness was reported in the two weeks prior to interview (n=114)

Illness type	Prevalence
Fever	79.8% (72.8 – 86.8, 95% CI)
Cough	67.5% (58.8 – 76.3, 95% CI)
Diarrhoea	32.5% (24.6 – 41.2, 95% CI)
Suspected malaria	14.0% (11.5 – 16.6, 95% CI)
Others	0.9% (0.0 – 2.6, 95% CI)

Table 28: Health care seeking behavior reported by caretakers of sick children 6-59 months of age (n=114)

Treatment Sought	Response
No treatment sought	2.6% (0.0 – 5.3, 95% CI)
Primary Health Care Centre	17.5% (10.5 – 24.6, 95% CI)
Hospital	78.9% (71.9 – 86.0, 95% CI)
Mobile clinic	0.9% (0.0 – 2.6, 95% CI)

Children 6-59 months who had been sick in the two weeks prior to data collection were more likely to be malnourished than their counterparts who had not been ill. Generally, ill children are more at risk of malnutrition than healthy children due to reasons such as reduced food intake, nutrient losses, diseases like measles and malaria, diarrheal diseases and health care access and care practices, etc.[15].

However, in the case of Malakal, only a small percentage (17.5%, n=114) of the total 650 surveyed children aged 6–59 months, who had been ill during the two weeks prior to data collection, were reportedly taken to a health facility by their respective caretakers for treatment. The choice of facility varied based on distance and accessibility. The most common response was to visit a hospital (78.9%) followed by a primary health care center (17.5%), whereas only 2.6% were not brought to health facilities by their caretakers for treatment.

[15] National Library of Medicine

Nutrition and Health Program Coverage

Table 29: Measles vaccination coverage for children 9-59 months n=597

	Measles (with card) = 39.2%	Measles (with card or confirmation from mother) = 98.4%
YES	n=238 (39.2%) (35.1 – 43.2, 95% CI)	n=336 (98.4%) (97.2 – 99.3, 95% CI)

During the assessment, measles immunization status was assessed for children aged 9-59 months by checking for measles vaccination on EPI cards or by the mother or caregiver's recall. As shown above in the table, 238 children (39.2%, 35.1 – 43.2, 95% CI) were confirmed as vaccinated by EPI card, while 336 children (98.4%, 97.2 – 99.3, 95% CI) were confirmed as vaccinated either by card or by caregiver recall.

Table 30: Vitamin A (children 6-59 months) and deworming treatment (children 12-59 months) coverage

	Vitamin A Supplementation last 6 months	Deworming Treatment last 6 months
YES	n=623 (95.8%) (94.2 – 97.4, 95% C.I.)	n=457 (82.6%) (79.2 – 85.9, 95% C.I.)

To obtain information, the survey team asked caregivers whether their children had received vitamin A capsules or deworming tablets in the six months prior to the assessment. As shown in Table 29 and 30 above, 95.8% of children aged 6-59 months (n=623, 95.8%, 95% CI: 94.2 – 97.4) had reportedly received vitamin A supplementation. On the other hand, approximately 82.6% of children aged 12-59 months (n=457, 82.6%, 95% CI: 79.2 – 85.9) received deworming capsules in the six months preceding data collection. The high level of vaccination coverage is likely attributed to the health campaign which was still ongoing before the week of the data collection by IMC and partners all over the county.

Infant and Young Child Feeding Practice (IYCF)

Undernutrition is estimated to be associated with 2.7 million child deaths annually or 45% of all child deaths globally. Infant and young child feeding is a key area to improve child survival and promote healthy growth and development. The first 2 years of a child's life are particularly

important, as optimal nutrition during this period lowers morbidity and mortality, reduces the risk of chronic disease, and fosters better development overall.[16].

The findings of the survey are presented in the following tables, graphs, and discussions. Information on child feeding practices was gathered for all children aged 0–23 months and analyzed as described below. The sample sizes obtained for Infant and Young Child Feeding (IYCF) practices in this survey were small (N=160), so the results should only be viewed as indicative rather than representative of the broader population's knowledge and practices.

In this survey, mothers/caretakers of 95 children aged 0–23 months were interviewed regarding their children's IYCF practices, following the revised indicators for assessing IYCF practices by WHO & UNICEF (2021) [17]. The survey's findings are presented in the tables, graphs, and discussions that follow.

Ever Breastfed

When mothers were asked whether their children were ever breastfed, out of 160 children surveyed, 89.4% (n=143) reported that they had breastfed their children aged 0-23 months at some point in their lifetime. In addition, 86.9% (n=139) had reportedly been initiated to breastfeeding immediately within one hour of birth, as per WHO recommendation.

Exclusive breastfeeding (EBF)

The WHO Global Strategy for Infant and Young Child Feeding (IYCF) recommends exclusive breastfeeding for infants up to six months of age. Exclusive breastfeeding provides infants with a uniquely tailored, safe, and accessible food source, protecting them from a variety of health risks. Research indicates that infants in low- and middle-income countries who receive mixed feeding (both breast milk and other foods or liquids) before six months are nearly three times more likely to die than those who are exclusively breastfed[18]. Exclusive breastfeeding also protects against diarrhea, lower respiratory infections, acute otitis media, and childhood overweight and obesity[19].

In Malakal, only 6.3% (n=10, 95% CI: 2.5–10.6) of children aged 0–5 months were exclusively breastfed. This figure is substantially lower than the UNHCR's minimum standard for emergency contexts, which requires that at least 70% of infants aged 0–5 months be exclusively breastfed.

Continued breastfeeding

Continued breastfeeding is also vital during illness; while sick children often have little appetite for solid food, continued breastfeeding can help prevent dehydration while also providing the nutrients required for recovery[20].

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[16] Infant and Young Child Feeding, WHO, December 2023.
[17] Indicators for assessing infant and young child feeding practices (WHO 2021)
[18] Guidelines on optimal feeding of low birth-weight infants in low- and middle-income countries (who.int)
[19] ibid.
[20] ibid

Accordingly, children aged 12-23 months were assessed based on the recall period of the previous 24 hours and results showed the majority of children or 86.6% (n=123, 95% CI: 81.0 – 92.3) had received continued breastfeeding.

Minimum Dietary Diversity

WHO guiding principles recommend that children aged 6-23 months are fed a variety of foods to ensure that nutrient needs are met.[21] Food group diversity is associated with improved linear growth in young children. A diet lacking in diversity can increase the risk of micronutrient deficiencies, which may have a damaging effect on children's physical and cognitive development.

In this regard, the survey findings showed that 45.6% (n=73 95% C.I 37.74%-53.67%) of surveyed children received food from at least 5 of the 8 food groups (including breast milk) during the indicated recall period of 24 hours, as per the Infant and Young Child Feeding (IYCF) guideline recommendation. These findings suggest that meals were likely not adequately diverse for most of the children aged 6-23 months, indicating limited nutrient diversity.

Minimum Acceptable Diet

The minimum acceptable diet (MAD) is a measurement of how well children aged 6–23 months are fed. It's a combination of minimum dietary diversity and minimum meal frequency. According to the survey results in Malakal, 16.9% (n=27, 95% CI: 11.3–23.1) of surveyed children aged 6–23 months received a minimum acceptable diet, while 21.3% (n=34, 95% CI: 15.0–27.5) met the minimum meal frequency in the 24 hours prior to data collection. These findings should be interpreted with caution due to the small sample size of N=160 children assessed. Summary of findings is presented in table 31 below

Table 31: Proxy IYCEF practices

S/N	Indicator	N	n	%	95% CI
Breastfeeding indicators					
1	Ever breastfed (0-23 months)	160	143	89.38	83.53-93.69
2	Early initiation of breastfeeding (0-23 months)	160	139	86.88	80.64-91.69
3	Exclusive breastfeeding for the first 2 days (0-23 months)	160	10	6.25	3.04-11.19
4	Exclusive breastfeeding under 6 months (0-5 months)	160	10	6.3%	2.5–10.6
5	Continued breastfeeding (12-23 months)	142	123	86.62	79.9-91.75
Complementary feeding practices					

[21] WHO (2005): Guiding principles for feeding non-breastfed children 6-24 months of age

7	Minimum dietary diversity 6–23 months	160	73	45.63	37.74-53.67
8	Minimum meal frequency 6–23 months	160	34	21.25	15.19-28.41
9	Minimum acceptable diet 6–23 months	160	27	16.88	11.43-23.59
10	Egg and/or flesh food consumption 6–23 months	160	53	33.13	25.90-40.99
11	Sweet beverage consumption 6–23 months	160	16	10	5.82-15.73
12	Zero vegetable or fruit consumption 6–23 months	160	10	10	3.04-11.19

Women's Nutritional Status by MUAC

A total of 126 pregnant and lactating women (PLW) were measured using MUAC to determine their nutritional status. This is particularly critical because malnourished PLW may be unable to meet the nutritional needs of infants, particularly those under six months of age. Among all PLW assessed, about 68.3% were lactating, 31.0% were pregnant, and 0.8% were both pregnant and lactating. As shown in Table 32, 22.2% of women surveyed (n=28) had a MUAC measurement below 230 mm, indicating a critical nutritional status, while the remaining 77.8% of PLW displayed a normal nutritional status.

Table 32: MUAC status among PLW

	MUAC for PLWs	n	Proportion (%)
Severe Acute Malnutrition	<21.0 cm	2	1.6 %
Moderate Acute Malnutrition	<23.0 cm	26	20.6 %
Normal	>23.0 cm	98	77.8 %

Contributing Factors

Water, Sanitation, and Hygiene (WASH)

Source of Drinking Water

Unsafe water can cause diarrhea, which can prevent children from getting the nutrients they need to survive, ultimately leading to malnutrition. Malnourished children are also more vulnerable to waterborne diseases like cholera. Inadequate access to minimum water, hygiene, and sanitation is estimated to account for around 50 percent of global malnutrition[22].

[22] 4 Things You Should Know About Water and Famine, UNICEF, March 2023

During the assessment, households were asked a series of systematically organized, closed-ended questions to determine whether their water sources were improved or unimproved, with responses automatically coded in the database. In Malakal County, most households (76.9%, n=413, 95% CI: 73.2–80.4) reported fetching water from improved sources. Among these sources, the majority of respondents (71.5%) indicated a public tap as their primary water source.

Table 33: - Improve water source (n=413)

	n	Percent	95% Confidence Interval
Piped compound	4	0.7	0.2-1.5
Piped dwelling	13	2.4	1.3-3.9
Protected wells	12	2.2	1.1-3.5
Rainwater col	1	0.2	0.0-0.6
Surface water	82	15.3	12.3-18.4
Tank truck	33	6.1	4.1-8.4
Public tap	384	71.5	67.6-75.2
Unprotected well	8	1.5	0.6-2.6
Total	537	100.0	100.0-100.0

Time to collect water

Another significant indicator considered for the source of drinking water is the time it takes households to collect water. It is important to note that queuing time and variations between villages in terms of distance were not included or taken into account during the analysis.

Nearly half of the respondents (47.9%) reported being able to access their main household's water source in under 30 minutes. This was followed by 43.9% of households stating they could reach their source within 30 minutes to under 1 hour. However, 7.3% of households reported having to travel for more than an hour to half a day to obtain water from their main source.

Water treatment used

In Malakal, 69.1% interviewed households (n=371, 95% CI: 65.4–73.2) reported using chlorine to treat their water before consumption—likely due to chlorine distribution linked to the recent cholera outbreak in the county[23]. Meanwhile, a considerable portion (24%, n=129, 95% CI: 20.5–27.6) indicated not doing anything to treat the water they collect, regardless of whether it comes from an improved or unimproved source. A small number of households (4.3%) reported boiling their water, and very few (1.3%) use cloth filtration as a water treatment method.

[23] South Sudan: Cholera Outbreak Situation Report, WHO, November 2024

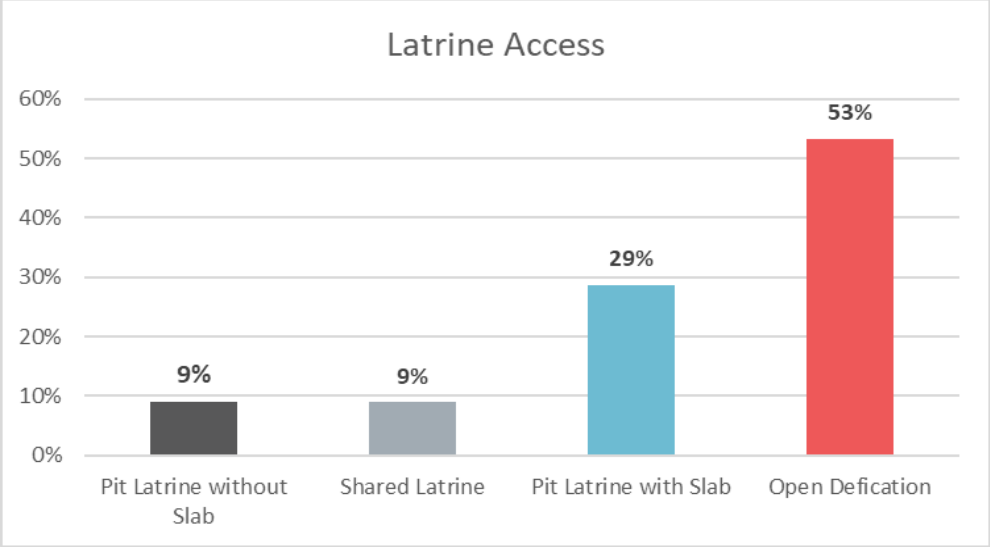
Hygiene and sanitation

This composite indicator gauges the population's access to a sufficient number of suitably located latrines with functional handwashing facilities, a key element for maintaining proper sanitation and preventing disease. The absence of safe, household-level latrines remains a major contributor to elevated rates of malnutrition and mortality.

When households were asked about their latrine access, 53.3% (n=286, 95% CI: 49.0–57.4) reported not having access to safe latrine facility and thus practiced open defecation. This was followed by 28.7% (n=154, 95% CI: 28.8–32.4) using pit latrines with slabs. The remaining households used pit latrines without slabs (9.1%, n=49, 95% CI: 6.7–11.7) or shared latrines (8.9%, n=48, 95% CI: 6.7–11.4). Please refer to Figure 6 for more details.

Similarly, handwashing with soap can disrupt the cycle of diarrhea and undernutrition[24] and is particularly crucial for study participant to adapt given the current cholera outbreak in Malakal. According to the survey findings, nearly one-fifth (18.8%, n=101, 95% CI: 15.5–22.2) of households reported having soap available for use, confirmed by enumerators; only 1.7% (n=9, 95% CI: 0.7–2.8) indicated having soap without enumerator verification. Unfortunately, a large majority (79.5%, n=427, 95% CI: 76.4–83.1) reported no access to soap, which is particularly concerning considering the ongoing cholera outbreak.

Figure 5: Percentage of households per type of latrine they reported having access to



[24] Why Handwashing. Global Handwashing Partnership

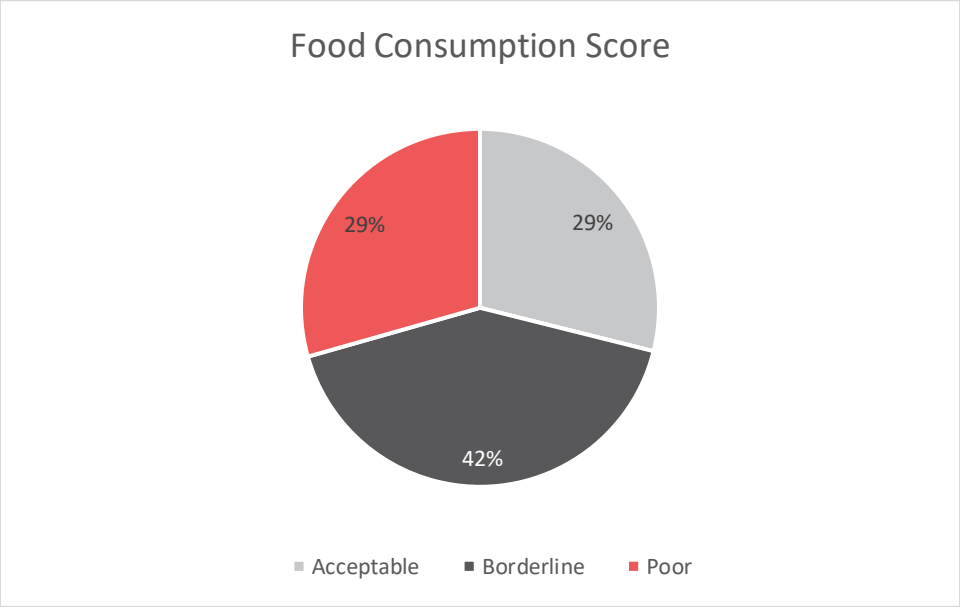
Food Security and Livelihoods (FSL)

Food Consumption Score

The Food Consumption Score (FCS) is a food security indicator that measures a household's food consumption by considering the frequency and diversity of foods consumed, as well as the nutritional value of those foods. This indicator is calculated based on the number of food groups a household has consumed over a recall period of the past 7 days, and is categorized into three groups: poor consumption (FCS = 0 to 21), borderline consumption (FCS = 21.5 to 35), and acceptable consumption (FCS > 35.0).

Out of 537 households surveyed, only 28.9% (n=155) of respondents had an acceptable food consumption score. A larger proportion, 41.7% (n=224), fell under the borderline category, while the remaining 29.4% (n=158) had a poor food consumption score.

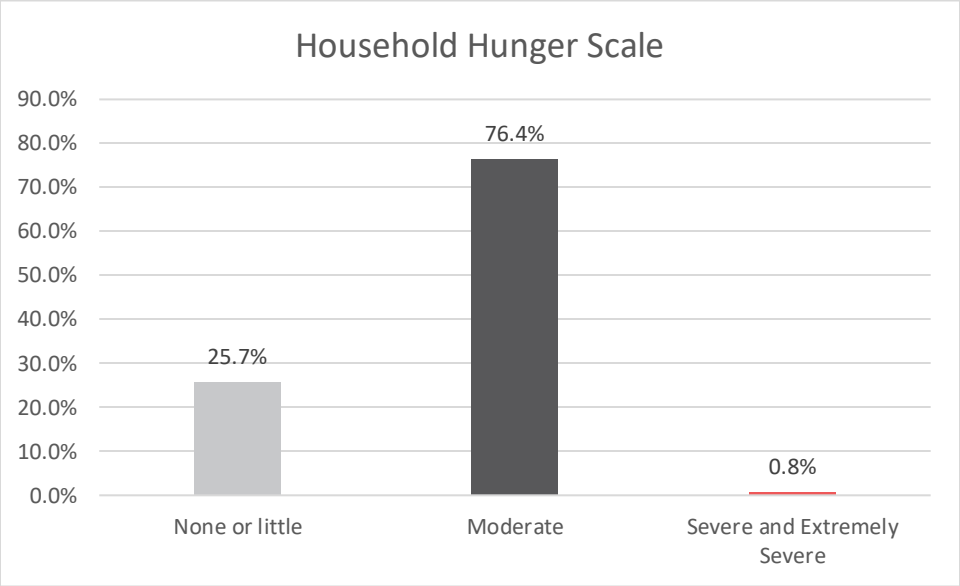
Figure 6: Percentage of households per FCS category



Household Hunger Scale (HHS)

A 30-day (4-week or 1-month) recall period was employed to gauge the Household Hunger Scale, which revolves around three questions regarding households' perceptions of hunger at varying degrees (never, rarely/sometimes, or often). As illustrated in Figure 8 below, the majority of households (76.4%) reported experiencing moderate hunger, while only a small fraction (0.8%) indicated severe or extremely severe hunger in the 30 days prior to the survey.

Figure 7: Percentage of households per HHS category



Household Income Source

Over the last three months, the most common income-generating activities reported by households were selling collected firewood or charcoal and selling agricultural products, accounting for over one-fourth of the responses (27%, n=145) and (25.1%, n=135) respectively, followed by daily labor in agriculture (20.1%, n=108) of the responses.

More than half (57.7%) of the sampled households reported experiencing some type of shock in the six months preceding the survey. Of these, the most common were flood-related shocks (23%, n=72), loss of employment (22.6%, n=70), reduced income (21.9%, n=68), unusually high food prices (13.9%, n=43), and disease outbreaks (10.3%, n=32).

Discussion

Nutritional status

The December 2024 SMART survey conducted in Malakal County indicates a worsening nutritional situation compared to the previous assessment conducted in September 2023. The prevalence of Global Acute Malnutrition (GAM) among children aged 6-59 months was found to be 24.5% (95% CI: 19.9 – 29.7%), placing the county in the "Critical" category according to WHO emergency thresholds. The Severe Acute Malnutrition (SAM) prevalence was recorded at 4.5% (95% CI: 3.2 – 6.4%). Although the GAM rate has increased slightly compared to the previous survey (20.2% GAM in September 2023), statistical tests reveal that this difference is not significant.

The primary contributing factors to malnutrition in Malakal County include a high incidence of child morbidity (17.5% reported illness in the two weeks preceding the survey), sub-optimal Infant and Young Child Feeding (IYCF) practices, and poor WASH conditions, with 24% of respondents not treating their water and 53% practicing open defecation amid an ongoing cholera outbreak. Only 6.3% of infants aged 0-5 months were exclusively breastfed, and just 16.9% of children aged 6-23 months received a Minimum Acceptable Diet (MAD), highlighting significant gaps in nutrition practices and as well as high malnutrition prevalence among pregnant and lactating women (PLW), where the GAM rate stood at 22%.

There are indications of potential geographical clustering in the data collected by some teams worked exclusively on the west bank of the Nile, where relatively higher malnutrition cases have been observed. This area is largely isolated, separated from the main towns by water, with inaccessible basic services and a partially submerged primary health care center (PHCC). Notably, REACH's FSL team visited Warjok and Wau Shilluk bomas in the same region covered by Team 2, where the IPC reported potential IPC Phase 5 conditions between September-November 2024 and again in April-July 2025. The qualitative findings from the published brief support these observations, suggesting that the severe malnutrition rates may be linked to these extreme conditions.

Qualitative information obtained from discussions during the assessment with partners in Malakal further underscores the challenges faced in delivering nutrition services. Partners noted stock-outs of Ready-to-Use Supplementary Food (RUSF) at Assosa PHCC, Bam PHCC, Wau Akhot outreach site, Bulukat transit site, and Malakal Teaching Hospital (which only had OTP supply) since mid-November 2024. Additionally, there has been no CSB++ supply since October 2024. While OTP (TSFP) supplies were available at Malakal Teaching Hospital, Bam, Bulukat, and Wau Akhot, they were not available at Assosa PHCC. These stock-outs and supply chain issues are likely to have exacerbated the already critical nutritional situation in the county. International Medical Corps (IMC) is the primary health and nutrition actor in Malakal County, working closely with the County Health Department, State Ministry of Health, and supported by UN agencies such as UNICEF and WFP to deliver essential health and nutrition services.

Mortality

The Crude Death Rate (CDR) was recorded at 0.48 deaths per 10,000 people per day (95% CI: 0.26 – 0.88), and the Under-5 Mortality Rate (U5MR) was 0.46 deaths per 10,000 children under five per day (95% CI: 0.14 – 1.45). Both rates remain below the emergency thresholds, suggesting relative stability in mortality trends. Additionally, the survey recorded an average household size of 4.6, which is slightly lower than the 5.1 recorded in the September 2023 survey by IMC. This may be attributed to population movements reported around July to August 2024, likely resulting in temporary changes in household composition.

Child Health and Program Coverage

The survey found that 98.4% of children aged 9-59 months had received measles vaccination, 95.8% had received Vitamin A supplementation, and 82.6% had been dewormed within the last six months. Despite high coverage rates for these essential health services, the persistent high prevalence of malnutrition underscores the need for more integrated health and nutrition interventions.

WASH and Food Security

The WASH indicators reveal that only 69.1% of households reported treating their drinking water, 53.3% of households practiced open defecation and almost half (42.9%) of the households reported that they do not have access to soap. These poor sanitation practices, coupled with the ongoing cholera outbreak, heighten the risk of waterborne diseases, which can exacerbate malnutrition.

Regarding food security, 71.1% of households had poor or borderline Food Consumption Scores (FCS), and 76.4% reported experiencing moderate hunger according to the Household Hunger Scale (HHS). Additionally, the economic impact of regional instability and the influx of refugees and returnees from Sudan on top of the IDPs have strained local resources. Limited nutrient diversity, especially for children 6-23 months, may lead to chronic malnutrition. The higher standard deviation in HAZ scores may be attributed to the genetic tall stature in the Dinka, Nuer, and Shilluk tribes, which can result in data outliers, or age estimation issues. The report noted that 22% of the children did not have exact birthdates instead had their ages estimated using local event calendar. The recalculation after removing 43 observations showed a standard deviation of 1, suggesting the excluded observations were out of range.

Conclusions

The December 2024 SMART survey results confirm that Malakal County remains in a critical nutritional state, with a GAM rate of 24.5% and a SAM rate of 4.5%. While mortality rates remain below emergency thresholds, the high prevalence of acute malnutrition, poor dietary diversity, inadequate WASH conditions, high child morbidity and ongoing food insecurity indicate significant vulnerability within the population.

Comparing these results with the September 2023 survey, there is no statistically significant difference in the nutritional status; however, the high GAM rate, coupled with poor IYCF practices, stock-outs of essential nutrition supplies, and sub-optimal sanitation, suggests that urgent, multi-sectoral interventions are required to prevent further deterioration.

Recommendations and priorities

Nutrition

1. **Expand Community Management of Acute Malnutrition (CMAM) services**: Scale up CMAM programs to increase coverage and ensure timely treatment of malnourished children and provide nutrition education for caregivers.
2. **Implement Blanket Supplementary Feeding Programs (BSFP):** Provide supplementary food rations to vulnerable populations during the lean period.
3. **Enhance IYCF promotion:** Conduct community-based campaigns to promote exclusive breastfeeding and appropriate complementary feeding practices.
4. **Strengthen supply chains:** Ensure consistent availability of essential nutrition supplies, including RUSF and CSB++, by improving supply chain management and pre-positioning supplies ahead of the lean season.
5. **Mobile outreach programs:** There's a critical need for mobile outreach activities in the West bank areas of Malakal to address the high rates of malnutrition. Mobile clinics can provide essential health services, including nutrition support, to hard-to-reach communities.

Health

1. **Strengthen routine health services**: Ensure consistent availability of essential health services, including immunizations, deworming, and Vitamin A supplementation.
2. **Improve disease surveillance**: Strengthen mechanisms for early detection and management of common childhood illnesses.

WASH:

1. **Promote safe water practices**: Increase community sensitization on water treatment and safe storage practices.
2. **Improve sanitation infrastructure**: Support latrine construction and promote the Community-Led Total Sanitation (CLTS) approach to reduce open defecation.
3. **Enhance hygiene education:** Promote handwashing with soap at critical times through mass awareness campaigns.

Food Security and Livelihood:

1. **Strengthen social protection programs**: Advocate for cash-based transfers and food distribution to improve household food security.
2. **Support agricultural activities**: Provide seeds, tools, and training to enhance household food production and dietary diversity.

Coordination and Monitoring:

1. **Strengthen multi-sectorial coordination**: Enhance collaboration among government bodies, humanitarian agencies, and local communities to ensure a coordinated response.
2. **Continue regular monitoring**: conduct periodic SMART surveys and integrated rapid need assessments (IRNA) to track changes in the nutritional status and guide planning.

Implementing these recommendations will require sustained support from local authorities, humanitarian partners, and donors to address the immediate nutritional crisis and build long-term resilience in Malakal County.

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We are immensely grateful to the Malakal community, including village chiefs and randomly selected individuals, who participated in the survey. We deeply appreciate the mothers and caregivers for responding to the questionnaire and allowing their children to be assessed, despite their household duties.

Finally, we commend all survey participants—supervisors, team leaders, enumerators, and drivers—whose dedication ensured the successful collection of quality data, even in remote areas requiring hours of travel on foot.

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Appendices

Plausibility check for: REACH_Malakal_County_SMART_Dec_2024.as

Standard/Reference used for z-score calculation: WHO standards 2006

(If it is not mentioned, flagged data is included in the evaluation. Some parts of this plausibility report are more for advanced users and can be skipped for a standard evaluation)

Overall data quality

Criteria	Flags*	Unit	Excel.	Good	Accept	Problematic	**Score**
Flagged data	Incl	%	0-2.5	>2.5-5.0	>5.0-7.5	>7.5	
(% of out of range subjects)			0	5	10	20	**0** (0.6 %)
Overall Sex ratio	Incl	p	>0.1	>0.05	>0.001	<=0.001	
(Significant chi square)			0	2	4	10	**0** (p=0.906)
Age ratio(6-29 vs 30-59)	Incl	p	>0.1	>0.05	>0.001	<=0.001	
(Significant chi square)			0	2	4	10	**0** (p=0.318)
Dig pref score - weight	Incl	#	0-7	8-12	13-20	> 20	
			0	2	4	10	**0** (5)
Dig pref score - height	Incl	#	0-7	8-12	13-20	> 20	
			0	2	4	10	**2** (8)
Dig pref score - MUAC	Incl	#	0-7	8-12	13-20	> 20	
			0	2	4	10	**2** (8)
Standard Dev WHZ	Excl	SD	<1.1	<1.15	<1.20	>=1.20	
.			and	and	and	or	
.	Excl	SD	>0.9	>0.85	>0.80	<=0.80	
			0	5	10	20	**0** (0.96)
Skewness WHZ	Excl	#	<±0.2	<±0.4	<±0.6	>=±0.6	
			0	1	3	5	**0** (0.03)
Kurtosis WHZ	Excl	#	<±0.2	<±0.4	<±0.6	>=±0.6	
			0	1	3	5	**0** (-0.06)
Poisson dist WHZ-2	Excl	p	>0.05	>0.01	>0.001	<=0.001	
			0	1	3	5	**5** (p=0.000)
OVERALL SCORE WHZ =			0-9	10-14	15-24	>25	**9** %

The overall score of this survey is 9 %, this is excellent.

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Appendix 2 - Assignment of Clusters

Payam	Village	Estimated Population size	Clusters
Eastern Malakal	Hai Saha	2500	1,2,3
Eastern Malakal	Hai TV	1500	4,5
Central Malakal	Jalaba	5000	6,7,8,9,RC,RC,10
Central Malakal	Sora Jalaba	3700	11,RC,12,13,14
Central Malakal	Hai Mudria	1500	15,RC
Central Malakal	Hai Rei	1500	16,17
Northern Malakal	Hai Malakia	2720	18,19,20,21
Northern Malakal	Sora Malakia	500	22
Northern Malakal	Hai Shaasi	1500	23,24
Southern Malakal	Assossa	5000	25,26,27,28,29,30,31
Southern Malakal	Hai Tarawa	250	
Southern Malakal	Hai Shohada	1000	32,33
Southern Malakal	Bam	1000	34
Southern Malakal	Dengere Shufu	1000	35
Southern Malakal	Wun Akhot	1300	36,37
Lelo	Warjwok West	1500	38,39
Lelo	Lelo	1000	40,41
Lelo	Makal	1000	RC
Lelo	Ditang	300	
Ogod	Wau Shilluk	1500	42,43,44
Ogod	Pathau	250	
Ogod	Ogod	350	
Ogod	Padiet	500	45
Ogod	Pamath	305	

Appendix 3 – Standardization Test Results

Standardisation test results					Precision				Accuracy		OUTCOME			
Weight		subjects	mean	SD	max	Technica	TEM/mea	Coef of re	Bias from	Bias from median			From	From
		#	kg	kg	kg	TEM (kg)	TEM (%)	R (%)	Bias (kg)	Bias (kg)			Supervisor	Median
	Supervisor	10	11.7	2.8	0.4	0.14	1.2	99.7	0	0.05	TEM poor	R value good	Bias good	Bias acceptable
	Enumerator 1	10	11.6	2.9	1.8	0.42	3.6	97.9	0.14	0.13	TEM reject	R value accept	Bias poor	Bias poor
	Enumerator 2	10	11.7	2.8	0.4	0.18	1.6	99.6	0.11	0.11	TEM poor	R value good	Bias poor	Bias poor
	Enumerator 3	10	11.7	2.8	0.4	0.13	1.1	99.8	0.1	0.07	TEM poor	R value good	Bias acceptab	Bias acceptable
	Enumerator 4	10	11.7	2.8	0.3	0.12	1.1	99.8	0.07	0.04	TEM poor	R value good	Bias acceptab	Bias acceptable
	Enumerator 5	10	11.7	2.8	0.2	0.09	0.7	99.9	0.06	0.05	TEM acceptal	R value good	Bias acceptab	Bias acceptable
	Enumerator 6	10	11.7	2.8	1.2	0.29	2.5	98.9	0.11	0.11	TEM reject	R value accept	Bias poor	Bias poor
	Enumerator 7	10	11.7	2.8	0.2	0.08	0.7	99.9	0.05	0.06	TEM acceptal	R value good	Bias acceptab	Bias acceptable
	Enumerator 8	10	11.8	2.8	0.4	0.12	1	99.8	0.07	0.04	TEM poor	R value good	Bias acceptab	Bias good
	Enumerator 9	10	11.6	2.8	1.7	0.4	3.4	98	0.16	0.14	TEM reject	R value accept	Bias poor	Bias poor
	Enumerator 10	10	11.7	2.7	0.3	0.14	1.2	99.7	0.07	0.08	TEM poor	R value good	Bias acceptab	Bias acceptable
	Enumerator 11	10	18.2	30.2	131.2	29.34	161	5.7	6.73	6.7	TEM reject	R value reject	Bias reject	Bias reject
	Enumerator 12	10	11.7	2.8	1	0.28	2.4	99	0.77	0.78	TEM reject	R value good	Bias reject	Bias reject
	Enumerator 13	10	11.7	2.8	0.3	0.12	1	99.8	0.12	0.15	TEM poor	R value good	Bias poor	Bias poor
	enum inter 1st	13x10	11.7	2.8	-	0.26	2.2	99.1	-	-	TEM reject	R value good		
	enum inter 2nd	13x10	12.7	12.1	-	11.53	90.6	9.1	-	-	TEM reject	R value reject		
	inter enum + sup	14x10	12.2	8.5	-	5.68	44.7	57.4	-	-	TEM reject	R value reject		
	TOTAL intra+inter	13x10	-	-	-	11.52	94.4	-72.6	-	-	TEM reject	R value reject		
	TOTAL+ sup	14x10	-	-	-	11.1	91.2	-71.4	-	-	TEM reject	R value reject		
Height		subjects	mean	SD	max	Technica	TEM/mea	Coef of re	Bias from	Bias from median			From	From
		#	cm	cm	cm	TEM (cm)	TEM (%)	R (%)	Bias (cm)	Bias (cm)			Supervisor	Median
	Supervisor	10	90.9	12.2	3.1	0.73	0.8	99.6	0	0.38	TEM poor	R value good	Bias good	Bias good
	Enumerator 1	10	90.8	12	4.2	1.58	1.7	98.3	0.56	0.58	TEM reject	R value accept	Bias acceptab	Bias acceptable
	Enumerator 2	10	90.7	12.2	1.5	0.52	0.6	99.8	0.7	0.42	TEM acceptal	R value good	Bias acceptab	Bias acceptable
	Enumerator 3	10	91.1	12.2	1.7	0.48	0.5	99.8	0.64	0.29	TEM acceptal	R value good	Bias acceptab	Bias good
	Enumerator 4	10	90.1	11.8	11	3.32	3.7	92.1	1.9	1.6	TEM reject	R value poor	Bias reject	Bias reject
	Enumerator 5	10	91.7	12.4	2.8	1	1.1	99.4	0.9	0.91	TEM poor	R value good	Bias poor	Bias poor
	Enumerator 6	10	91	11.9	6.4	1.77	1.9	97.8	0.98	0.78	TEM reject	R value accept	Bias poor	Bias acceptable
	Enumerator 7	10	91.1	12	0.9	0.24	0.3	100	0.6	0.44	TEM good	R value good	Bias acceptab	Bias acceptable
	Enumerator 8	10	90.7	12.6	2.6	0.89	1	99.5	0.7	0.47	TEM poor	R value good	Bias acceptab	Bias acceptable
	Enumerator 9	10	91.4	12.5	1.7	0.59	0.6	99.8	0.61	0.5	TEM acceptal	R value good	Bias acceptab	Bias acceptable
	Enumerator 10	10	90.7	12.3	1.7	0.66	0.7	99.7	0.61	0.37	TEM poor	R value good	Bias acceptab	Bias good
	Enumerator 11	10	91	12.3	2.5	0.65	0.7	99.7	0.44	0.36	TEM poor	R value good	Bias acceptab	Bias good
	Enumerator 12	10	90.2	12	8.1	1.9	2.1	97.5	1.4	1.13	TEM reject	R value accept	Bias reject	Bias poor
	Enumerator 13	10	90.6	12.2	6.4	1.5	1.7	98.5	1.07	0.7	TEM reject	R value accept	Bias poor	Bias acceptable
	enum inter 1st	13x10	91.1	12	-	1.31	1.4	98.8	-	-	TEM poor	R value acceptable		
	enum inter 2nd	13x10	90.6	11.9	-	1.52	1.7	98.4	-	-	TEM reject	R value acceptable		
	inter enum + sup	14x10	90.9	11.9	-	1.38	1.5	98.6	-	-	TEM poor	R value acceptable		
	TOTAL intra+inter	13x10	-	-	-	2.01	2.2	97.2	-	-	TEM reject	R value acceptable		
	TOTAL+ sup	14x10	-	-	-	1.96	2.2	97.3	-	-	TEM reject	R value acceptable		

MUAC		subjects	mean	SD	max	Technica	TEM/mea	Coef of re	Bias fron	Bias from median			From	From
		#	mm	mm	mm	TEM (mm	TEM (%)	R (%)	Bias (mm	Bias (mm)			Supervisor	Median
	Supervisor	10	140.1	5.3	3	1.05	0.7	96.1	0	0.5	TEM good	R value accept	Bias good	Bias good
	Enumerator 1	10	142.9	6.3	7	2.66	1.9	82	3.1	2.85	TEM acceptal	R value reject	Bias reject	Bias poor
	Enumerator 2	10	139.7	6	8	2.02	1.4	88.5	1.41	1.59	TEM acceptal	R value reject	Bias acceptab	Bias acceptable
	Enumerator 3	10	140.5	5.9	6	1.87	1.3	89.9	1.14	1.06	TEM good	R value reject	Bias acceptab	Bias acceptable
	Enumerator 4	10	139.4	5.6	4	1.1	0.8	96.2	1.71	1.41	TEM good	R value accept	Bias acceptab	Bias acceptable
	Enumerator 5	10	142.5	6.8	14	5.92	4.2	24.1	2.77	2.74	TEM reject	R value reject	Bias poor	Bias poor
	Enumerator 6	10	136.7	5.9	3	1.52	1.1	93.4	3.68	3.97	TEM good	R value poor	Bias reject	Bias reject
	Enumerator 7	10	140.6	6.8	6	2.33	1.7	88.4	2.82	2.55	TEM acceptal	R value reject	Bias poor	Bias poor
	Enumerator 8	10	144.5	5	6	2	1.4	83.9	4.68	4.35	TEM good	R value reject	Bias reject	Bias reject
	Enumerator 9	10	142.4	5.7	7	2.99	2.1	72.8	3.12	2.69	TEM poor	R value reject	Bias reject	Bias poor
	Enumerator 10	10	141	6.1	9	3.08	2.2	74.1	1.61	1.27	TEM poor	R value reject	Bias acceptab	Bias acceptable
	Enumerator 11	10	140.8	5.8	9	2.42	1.7	82.5	1.21	0.98	TEM acceptal	R value reject	Bias acceptab	Bias good
	Enumerator 12	10	138.4	7.3	14	4.43	3.2	63.4	1.87	2.05	TEM reject	R value reject	Bias acceptab	Bias poor
	Enumerator 13	10	140.2	5.4	10	2.86	2	72.2	1.09	1.4	TEM poor	R value reject	Bias acceptab	Bias acceptable
	enum inter 1st	13x10	141.1	6.1	-	3.13	2.2	73.4	-	-	TEM poor	R value reject		
	enum inter 2nd	13x10	140.3	6.4	-	3.59	2.6	68.6	-	-	TEM reject	R value reject		
	inter enum + sup	14x10	140.7	6.2	-	3.25	2.3	73	-	-	TEM poor	R value reject		
	TOTAL intra+inter	13x10	-	-	-	4.49	3.2	48.3	-	-	TEM reject	R value reject		
	TOTAL+ sup	14x10	-	-	-	4.34	3.1	50.6	-	-	TEM reject	R value reject		

Suggested cut-off points for acceptability of measurements

Parameter		MUAC mr	Weight K	Height cm
individua	good	<2.0	<0.04	<0.4
TEM	acceptable	<2.7	<0.10	<0.6
(intra)	poor	<3.3	<0.21	<1.0
	reject	>3.3	>0.21	>1.0
Team TEI	good	<2.0	<0.10	<0.5
(intra+in	acceptable	<2.7	<0.21	<1.0
and Tota	poor	<3.3	<0.24	<1.5
	reject	>3.3	>0.24	>1.5
R value	good	>99	>99	>99
	acceptable	>95	>95	>95
	poor	>90	>90	>90
	reject	<90	<90	<90
Bias	good	<1	<0.04	<0.4
	acceptable	<2	<0.10	<0.8
	poor	<3	<0.21	<1.4
	reject	>3	>0.21	>1.4

Appendix 4 – Local Event Calendar

MONTH OF YEAR	ANNUAL SEASONS	2020	2021	2022	2023	2024
January	New year and 9th CPA	59	47	35	23	11
		New year and 9th CPA	New year and 9th CPA	New year and 9th CPA	New year and 9th CPA	New year and 9th CPA
Feb.	St Bakhita day	58	46	34	22	10
		opening of schools	St Bakhita day and opening of schools	St Bakhita day and opening of schools	opening of schools and the coming of Pope to South Sudan.	St Bakhita day and opening of schools
March	International Women day	57	45	33	21	9
		International Women Day, Beginning of lad preparation and Ramadan Starts.	International Women Day, Beginning of lad preparation and Ramadan Starts.	International Women Day, Beginning of lad preparation and Ramadan Starts.	International Women Day, Beginning of lad preparation and Ramadan Starts.	International Women Day, Beginning of lad preparation and Ramadan Starts.
April	Easter Season and First Rain Started in Tonj North, Eid ul-Fitr	56	44	32	20	8
		Easter Season and First Rain Started in Tonj North, Eid ul-Fitr and COVID -19 and beginning of planting period.	Easter Season and First Rain Started in Tonj North, Eid ul-Fitr and COVID -19 and beginning of planting period	Easter Season and First Rain Started in Tonj North, Eid ul-Fitr and COVID -19 and beginning of planting period	Easter Season and First Rain Started in Tonj North, Eid ul-Fitr and COVID -19 and beginning of planting period	Easter Season and First Rain Started in Tonj North, Eid ul-Fitr and COVID -19 and beginning of planting period
May	16th May SPLM/A day Celebration and cultivation	55	43	31	19	7
		16th May SPLM/A day Celebration and cultivation	16th May SPLM/A day Celebration and cultivation	16th May SPLM/A day Celebration and cultivation	16th May SPLM/A day Celebration and cultivation and fighting at the PoC	16th May SPLM/A day Celebration and cultivation
June	Weeding and cattle movement from Toch, Eid ul-Adha	54	42	30	18	6
		Weeding and cattle movement from Toch, Eid ul-Adha	Weeding and cattle movement from Toch, Eid ul-Adha	Weeding and cattle movement from Toch, Eid ul-Adha	Weeding and cattle movement from Toch, Eid ul-Adha	Weeding and cattle movement from Toch, Eid ul-Adha
July	9th July Independence Day and Martyrs Day	53	41	29	17	5
		9th July Independence Day and Martyrs Day	9th July Independence Day and Martyrs Day	9th July Independence Day and Martyrs Day	9th July Independence Day and Martyrs Day	9th July Independence Day and Martyrs Day
August	Harvesting of Maize Began	52	40	28	16	4
		Harvesting of Maize Begins	Harvesting of Maize Begins	Harvesting of Maize Begins	Harvesting of Maize Begins	Harvesting of Maize Begins
September	Harvesting of maize and Sorghum	52	39	27	15	3
		Harvesting of maize and Sorghum and flooding	Harvesting of maize and Sorghum and flooding	Harvesting of maize and Sorghum and Flooding	Harvesting of maize and Sorghum and Flooding	Harvesting of maize and Sorghum and Flooding, the Juba Arch Deosis Bishop visited Malakal
October	St Daniel Comboni Day	50	38	26	14	2
		St Daniel Comboni Day	St Daniel Comboni Day	St Daniel Comboni Day	St Daniel Comboni Day	St Daniel Comboni Day
November	16th Days of activism	49	37	25	13	1
		16th Days of activism	16th Days of activism	16th Days of activism	16th Days of activism,	16th Days of activism cholera outbreak
December	Christmas Celebration	48	36	24	12	0
		Christmas Celebration	Christmas Celebration	Christmas Celebration	Christmas Celebration	Christmas Celebration