REPORT OF NUTRITION AND MORTALITY SURVEY IN RUBKONA, PAKUR AND BANTIU PAYAMS OF RUBKONA COUNTY, NORTHERN LIECH STATE, THE REPUBLIC OF SOUTH SUDAN

December, 2016

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Survey date: Between 28th of November and 8th of December, 2016

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List of Acronyms

C.I	Confidence interval
CMR	Crude Mortality Rate
EBF	Exclusive Breastfeeding
ENA	Emergency Nutrition Assessments
FSL	Food Security and Livelihoods
GAM	Global Acute Malnutrition
GFD	General Food Distribution
HFA	Height for Age
HAZ	Height for Age Z scores
HH	Household
IDPs	Internally Displaced Persons
IOM	International Organization for Migration
IPC	Integrated Phase Classification
IYCF	Infant and Young Child Feeding
KAP	Knowledge Attitude and Practices
LLITN	Long Lasting Insecticide Treated Net
MAM	Moderate Acute Malnutrition
MOH	Ministry of Health
MUAC	Mid Upper Arm Circumference
OTP	Out-Patient Therapeutic Programme
PHCC	Primary Health Care Centre
PHCU	Primary Health Care Unit
PoC	Protection of Civilians
PPS	Probability Proportional to Size
RUSF	Ready to Use Supplementary Food
RUTF	Ready to Use Therapeutic Food
SAM	Severe Acute Malnutrition
SC	Stabilization Centre
SD	Standard Deviation
SFP	Supplementary Feeding Programme
SMART	Standardized Monitoring and Assessment of Relief and Transitions
TSFP	Targeted Supplementary Feeding Program
UNICEF	United Nations International Children's Emergency Fund
U5MR	Under 5 Mortality Rate
VAS	Vitamin A supplementation
WAZ	Weight for Age Z scores
WFA	Weight for Age
WFP	World Food Program
WFH	Weight for Height
WHZ	Weight for Height Z scores
WHO	World Health Organization

Executive Summary

Between 28th of November and 8th of December, 2016 the survey was conducted deploying 6 teams, in 6 field days covering 13 households per day per team, the survey totally covered 468 households as calculated by ENA in **Rubkona, Pakur and Bantiu payams of Rubkona county, Northern Liech State**. This nutrition and retrospective mortality survey utilized the Standardized Monitoring and Assessment of Relief and Transitions (SMART) methodology and gave recommendations on the basis of key nutrition indicators. Both anthropometric and mortality data were collected during the survey. Food security and WASH questionnaires were administered in each selected household, as per the South Sudan Nutrition Cluster guidelines. IYCF information was collected from households with children less than two years using a structured questionnaire. A two-stage cluster sampling with probability proportional to size (PPS) design was employed in this survey.

The sample size for both anthropometric and retrospective mortality survey was determined by using ENA delta July 2015 version. The required data was entered in the planning screen of the ENA delta software. The data used include; estimated prevalence of malnutrition and mortality rate, desired precision, recall period in days, design effect, average household size, percentage of under-five children and non-response households.

Shown below are the key findings of the survey:

Indicator	% (95% CI)	Indicator	% (95% CI)
GAM (<-2 z-score and/or oedema)	20.2% (17.1-23.7 95% CI)	CMR (deaths per 10 000/day)	2.64 (1.87-3.72)
SAM (<-3 z-score and/or oedema)	2.8% (1.5- 5.1 95% CI)	U5MR (deaths in children <5/10 000/day)	1.11 (0.48-2.57)
Proxy GAM using MUAC (< 125 mm and/or oedema)	10.7 % (7.9 - 14.4 95% C.I.)	Morbidity	64% (54.9-73.695% C.I.)
Proxy SAM using MUAC (< 115 mm and/or oedema)	0.7 % (0.2 - 2.2 95% C.I.)	Diarrhoea	13.6% (7.7-19.5 95% C.I.)
Global underweight (<-2 z-score)	24.9% (20.0-30.6 95% CI)	Cough	22.3% (14.3-30.1% 95% C.I.)
severe underweight (<-3 z-score)	8.4% (6.2-11.2 95% CI)	Fever	56.4% (45.3-65.6 95% C.I.)
Global stunting (<-2 z-score)	16.4% (11.8-21.2 95% CI)	Other	7.6% (2.2-13.195% C.I.)
		Percentage of children ever breastfeed	95.8 % (91.7 - 100.0 95% C.I.)
Vitamin A supplementation coverage children 6-59 months	62.1% (50.6-73.595% C.I.)	Early initiation of breastfeeding	94.3 % (90.5 - 98.1 95% C.I.)
Deworming for Children (12-59 months) in the last 3 months	44.2 % (34.3-54.4% 95% C.I.)	Exclusive breastfeeding under 6 months	63.4 % (41.9 - 85.0 95% C.I.)
Measles immunization (card & recall) for	71.3% (58.7-83.9% 95% C.I.)	Continued breastfeeding at 1	100.0 % (100 - 100.0 95% C.I.)

Indicator	% (95% CI)	Indicator	% (95% CI)
children 9-59 months		year	
BCG coverage children 6-59 months	64.5% (53.5-75.495% C.I.)	Continued breastfeeding at 2 years	84.8 % (63.3 - 100.0 95% C.I.)
Headship status		Mean Food consumption Score	35.99 (31.5. – 44.5 95% C.I.)
Male headed	43.9 (35.1. – 55.9 95% C.I.)	**FCS**	
Female headed	52.8 (43.9. – 61.8 95% C.I.)	Poor	21%
Residence status of HH		Borderline	31%
Resident	67.5 (56.2. – 78.8 95% C.I.)	acceptable	49%
Returnee	20.2 (11.1. – 29.4 95% C.I.)	Proportion of households that did not cultivate during this season	64.3%
IDP	10.0 (3.0. – 16.9 95% C.I.)	Proportion of households without livestock holding	76.9%
Average HDDS	7.33 (6.6. – 8.1 95% C.I.)	**Time to obtain drinking water (round trip)**	
General food distribution coverage	93.4 (90.2. – 96.7 95% C.I.)	Less than 30 minutes	71.2% (58.9-83.5 95% C.I.)
Source of drinking water		>30min-<1hr	13.9 (6.8-20.9 95% C.I.)
Improved source	71.4%	>1hr and ≤ 2hr	7.7 (1-14.4595% C.I.)
Borehole/hand pump	43.3% (29.6. – 57.1 95% C.I.)	>2hr and ≥4hr	4.3% (0-9.2 95% C.I.)
Protected shallow well	1. (0.0. – 3.8 95% C.I.)	**Water treatment prior to drinking**	
Piped into dwelling/household connection/stand pipe/tanker	26.2 (13.6. – 38.2 95% C.I.)	No treatment	55.9% (43.0-68.7 95% C.I.)
Non-improved source	27.9%	Boiled	4.8% (1.0-8.6 95% C.I.)
Open shallow well	2% (0.0 – 3.9 95% C.I.)	Strained through cloth	15.3% (8.5-22.7 95% C.I.)
River/stream	25.9% (12.8. – 39.6 95% C.I.)	Ceramic, sand or other filter/letting it settle	6.2% (1.3-11.2 95% C.I.)
Mean water consumption per household (excluding water for washing clothes and drinking animals)	67.1 (58.7-75.4 95% C.I.)	Bleach/chlorine added	16.1% (6.9-25.3 95% C.I.)
Type of toilet/latrine facility			
Undesignated open area	73.7% (63.9-83.4 95% C.I.)		
Designated open area	9% (3.1-14.9 95% C.I.)		
Hole	3.5% (0.6-6.3 95% C.I.)		
Latrine	13.6% (6.7-20.6 95% C.I.)		

Recommendations

- Continue existing CMAM program to meet the expected increase in caseload in the coming months as we go to the lean season. Scale up CMAM to other insecure geographic sites to reach all children who need the service.

- It is interesting to observe that according to the WHO classification, the results of all nutrition surveys in Rubkona (32 surveys) between 2000-2016 show a level of Global Acute Malnutrition considered "critical", all exceeding the 15% threshold. It should be explored whether nutrition is an early or late indicator of food or humanitarian crisis in South Sudan in general and in places like Rubkona in particular. Moreover, in order to monitor the effect of present and future interventions on trends of malnutrition, it is recommended that a careful analysis of available SMART survey data be implemented and key risk factors identified based on context. The findings also show that nutrition information must be complemented by information on food security and livelihoods, as well as information regarding health status and health service provision, to determine the degree of risk being experienced by a population affected by a shock.

- Efforts should be strengthened to improve coverage of vitamin A supplementation and deworming (80% target) to reach and address key concerns including those on:
  - ✓ Raising awareness of mothers on micronutrient supplementation and deworming campaigns;
  - ✓ Strengthening distribution channels of vitamin A and deworming supplies and monitoring and evaluation of campaigns;
  - ✓ Planning the achievement of mass activities around supplementation and deworming at least twice a year

- Child dietary diversity is low (IDDS). Improving dietary diversity needs to be a priority, and would require a range of supporting activities, including contributions from the agriculture sector. The survey has also finds that very few children ages 6 to 23 months are achieving the recommended minimum dietary diversity of 4 different food groups. The findings suggest that IYCF practices are not optimal for child growth in much of the population. Improving these should be an important part of the activities of community and facility health and nutrition workers. This could lead to a substantial drop in child stunting if the most prevalent non-optimal practices are improved.

- Illness during the previous two weeks was 64%. This level of morbidity is very high and it might indicate issues around access to potable water, and poor sanitation and hygiene.

- Food supply indicators (crop production and livestock ownership), social stress indicators (market, exchange rates and migration data) and individual stress indicators (nutritional status and disease) show a converging of factors towards an increasing wasting rate and vulnerability in the coming months. Consider:

    - ✓ Continuously monitor food security conditions, especially in conflict-affected areas, in order to periodically fine-tune the humanitarian emergency strategy and response.
    - ✓ Provide context-appropriate emergency livelihood support for food insecure and displaced households in conflict-affected areas by delivering vegetable seeds and fishing kits.

- The livestock sector is reportedly in tatters following a mass exodus of cattle designed to avoid sequestration by armed groups, with associated export to Sudan, general looting and slaughter of any livestock remaining, especially when territories exchange hands between opposing forces. **Aim** to provide opportunities to rehabilitate livelihoods and strengthen coping mechanisms. The design and implementation of food assistance activities should take into consideration an in-depth analysis of local contexts: in-kind assistance should be considered if the market continues to dysfunction.

- The survey findings revealed that 93% of the population received World Food Programme (WFP) food rations aka GFD and it was the main source of food in the past 3 months preceding the survey. Three percent of surveyed households have reported not to have any humanitarian assistance in past three months. In kind support should continue to mitigate impact of market price fluctuations as well as failing SSP against USD.

- *Vulnerable groups/at risk groups*: Mean FCS is higher than 35 for households with income source of sale of natural resources, salaried work, petty trading, family support and remittances; where us it was between 21 and 35 for other major income sources. Twenty-five per cent of households in the lowest wealth quintile had less than 35 FCS across all income groups and less than 21 FCS in households that depend mainly on sale of crops, sale of livestock and sale of animal products. Similarly, median FCs is the lowest in households that depend mainly on sale of crops, sale of livestock and sale of animal products. Support should be tailored towards the poorest of the poor in continual manner and in continued targeting as the situation is fast changing in the country.

Introduction

Context

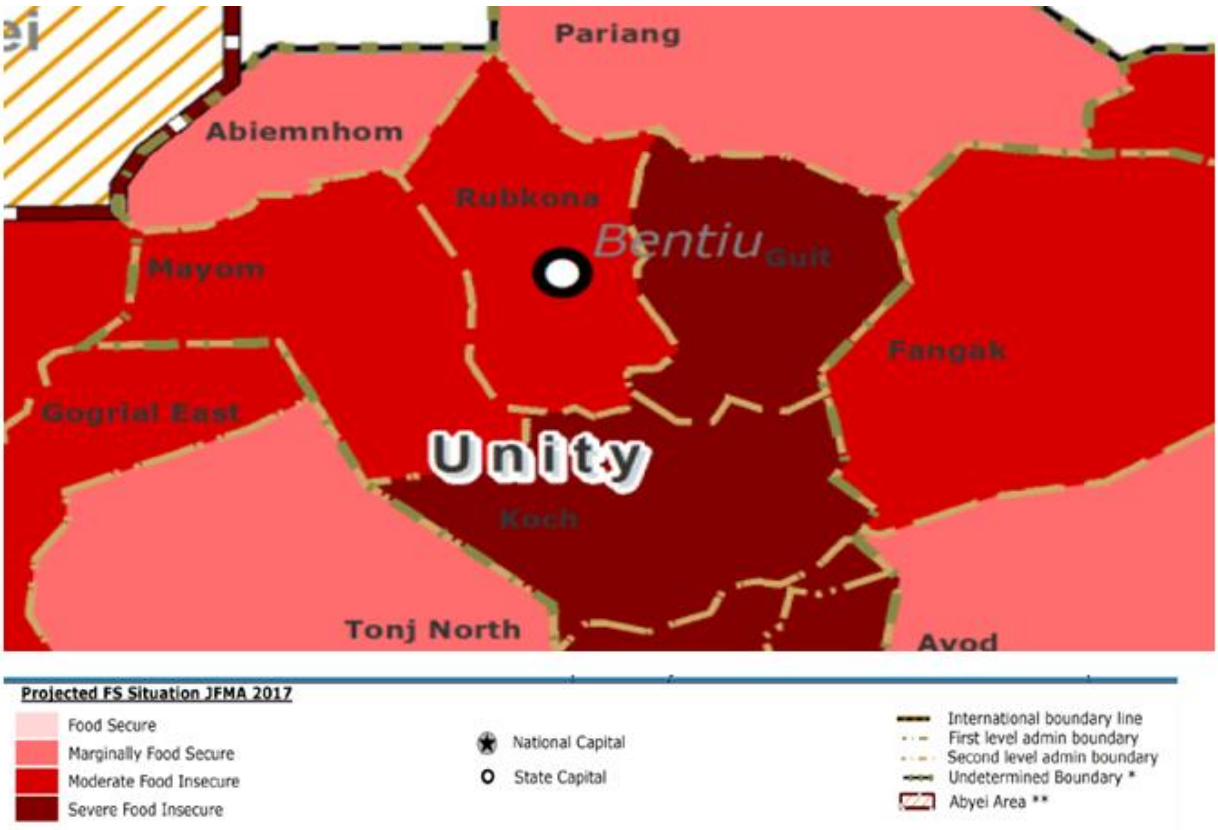
South Sudan's food security situation has been critical for a long time, and deteriorated further during the previous pre-conflict economic crisis resulting from the shutdown of oil production and escalating political tension with Sudan in 2012. Currently, political crisis within the Government of South Sudan (GoSS) which began on 15th December 2013 has spilled over into armed conflict based on ethnic divisions. This crisis resulted in significant population displacement as people have fled their homes to escape fighting. Due to this conflict the food security and nutrition situation in has further deteriorated. The latest July 2016 conflicts has subsequently heightened tensions and renewed clashes across the country and have further aggravated already overwhelming needs.

Recent analysis indicates that an **estimated 3.6 million people to be severely food insecure** between October and December 2016, the highest levels experienced in South Sudan at **harvest time**. Among these, an estimated 600,000 people are in the main urban centres across the country. In both rural and urban areas, the food insecure population has at least doubled compared to the same time last year. The severity of food insecurity is highest in Northern Bahr el Ghazal, with 59 percent of the total population facing severe food insecurity, followed by Unity state with **56 percent**, Western Bahr el Ghazal with 47 percent, and Central Equatoria with 33 percent[1].

The food security and nutrition situation in South Sudan is **likely to worsen between January to April 2017,** corresponding with the dry season and start of the lean season: projection based on trend analysis indicates that **around 4.6 million people are likely to be severely food insecure**. This denotes a 62 percent increase when compared to the same season last year and a 28 percent increase when compared to the current period (October—December 2016). Food and nutrition insecurity is anticipated to **further deteriorate during the peak of the lean season from May to July 2017 to the highest levels ever** in the lean period, unless the humanitarian response is stepped up further to an unprecedented level. The geographic spread of projected food insecurity in the survey area based on CARI (Consolidate Approach to Reporting Indicators of Food Security) is shown in the map in the next page[2].

[1] WFP South Sudan Food and Nutrition Security Update, Special Report — 1 December 2016
[2] **WFP South Sudan** Food and Nutrition Security Update Special Report — 1 December 2016

Figure 1: Projected food insecurity based on CARI (Consolidate Approach to Reporting Indicators of Food Security)



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Geographic description of survey area

Rubkona is among the 9 Counties that constituted the former Unity State. It is made up of ten administrative Payams (Rubkona, Budang, Norlamwel, Ngop, Kaljak, Dhor Bor, Wathjakm, Nhialdiu, Panhiany and Bentiu). Currently, it is situated in northern part of South Sudan in the newly created state of Northern Liech. Rubkona has an area of 3, 597 km^2 and a population density of 28 persons per kilo meter square[4].

Rubkona County has a sub-tropical climate, with a rainy season from May to September and a dry season from October to April. The region is swampy, flooding in the rainy season. Malaria, Kala Azar and Bilharzia are endemic. Most of the population is of Nuer ethnic group, agro-pastoralists for whom cattle are the measure of wealth and prestige.

There are six POCs (including the sixth POC which is recently established due to relocation people from other POCs due to flooding) in Bentiu that currently host 40,500

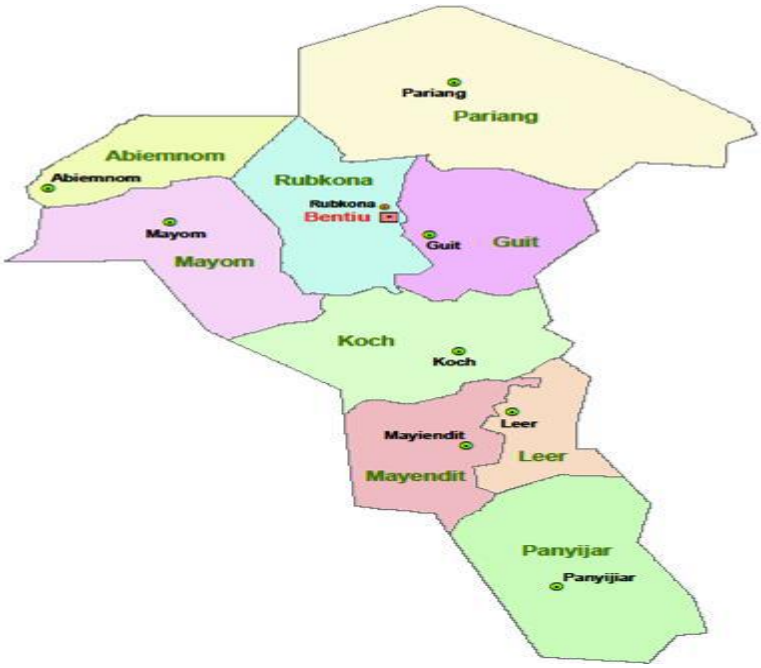
[3] **WFP South Sudan** Food and Nutrition Security Update Special Report — 1 December 2016

[4] South Sudan Centre for Census, statistics and Evaluation, November, 2010

IDPs[5].

Unity State, where Rubkona is part of, is one of the states in which direct military confrontation has persisted throughout the conflict. Though the Sudanese People's Liberation Army (SPLA) has retained control of Bentiu, the capital of Unity State, the SPLA-iO (in Opposition) dominates the southern counties of Mayendit, Panyijar, Koch, and Leer. Even before the political fallout between actors in the GoRSS, Unity State suffered the brunt of conflict resulting from oil production, cattle raids, dry season grazing conflicts the Misseriya/Arab nomads, and internal border conflicts over tracts of land.

Figure 2: Map of Rubkona and other counties of the former unity state



Description of the population

Based on the 2007 Population Census conducted by South Sudan Centre for Census, Statistics and Evaluation, Rubkona has a total population of 100,236 of which 51,630 were male and 48,606 were female, and total household number 14,912 households. However, majority of the inhabitants had been displaced across the county with some moving to Bentiu Protection of civilians (PoCs) due to the protracted conflict situation in the area since December 2013.

In normal times, livestock are very important assets throughout the country, the main species being cattle, goats and sheep raised extensively under transhumant systems of management. The sale of livestock, especially small ruminants, provides significant contribution to incomes and, therefore, household food security of both transhumant pastoralists and sedentary livestock rearers.

In 2014 and 2015, secure access to land throughout the season has again been the defining characteristic of areas-farmed in Greater Upper Nile Region and its bordering states, where large numbers of IDPs sought refuge. Apparently (based only on secondary information) some IDPs have returned home in 2015, and percentages of households

[5] IoM verification in June 2014

farming in counties in Unity states have increased above the very low 2014 levels. However, areas harvested are still smaller than normal due to insecurity, with labor shortages exacerbating reluctance to invest in such uncertain times.

For agriculture, land preparation starts in March-April, followed by planting in April-May, weeding in June-July and the first harvest in late October-November. The second round of weeding and gap filling occurs in August in anticipation of the second harvest in December-January. The lean season falls from May to August, leading some farmers to practice "green harvesting" while livestock keepers sell or barter livestock for sorghum. The terms of trade between livestock and sorghum decline during the dry season when animals lose their body condition. It is worth noting that though sales occur more during the lean season, they are ongoing throughout the year, as livestock producers meet most of their needs from the sale of livestock.

Net cereal production in 2015 from the traditional sector, after deduction of post-harvest losses and seed use, was estimated at 19,316 tons (deficit).

Based on 2015 estimates[6] cereal cultivation area in Rubkona County is estimated at about 850 hectares, with an average cereal farm area of 0.42 ha, and 2,025 farming households (10% of the population). In 2015 gross yield was estimated to be 0.60 tons/hectare and gross cereal production was 408 tons. Based on 2016 mid population the county's need of staples was **19, 724 tons**. Net cereal production in 2015 from the traditional sector, after deduction of post-harvest losses and seed use, was estimated at 19,316 tons (deficit).

Table 1: Rubkona-Estimated settled population, farming households and harvested cereal area in 2015[7]

Population (mid-2015)	201,576
Households (mid 2015)	20,248
Farming households (%)	10%
Farming households-mid 2015(%)	2,025

[6] FAO/WFP CROP AND FOOD SECURITY ASSESSMENT MISSION TO SOUTH SUDAN, 5th April, 2016
[7] FAO/WFP CROP AND FOOD SECURITY ASSESSMENT MISSION TO SOUTH SUDAN, 5th April, 2016

Average cereal area (ha/hh)	0.42
Total cereal(area(ha)	850
2015 gross yield (Tonne/hectare)	0.60
2015 gross cereal production (tonnes)	510
2015 gross cereal production (tonnes)	408
Population mid 2016	207,623
2016 cereal requirement (tonnes)	19,724
2016 (surplus/deficit)	-19,316

Livestock is an integral part of South Sudanese livelihood systems and sales of small ruminants represent an important source of income that largely determines pastoralists' capacity to purchase food items. Normally, the **terms of trade** for pastoralists show great variations across markets due to high market fragmentation. Overall, during 2016, prices of cereals increased more than prices of goats, resulting in a deterioration of terms of trade for pastoralists in most markets. In particular, the equivalent in sorghum of one medium size goat declined from 113 to 89 kg in Juba (-21 percent), from 148 to 94 Kg in Yambio (-37 percent), from 118 to 35 Kg in Aweil (-71 percent). By contrast, in Rumbek, prices of goats increased more than prices of cereals (+57 percent compared to +24 percent) and the equivalent in sorghum of one medium size goat increased from 54 to 68 kg (+26 percent).

Services and humanitarian assistance

The food aid contribution is limited to the three conflict states, Upper Nile, Jonglei and Unity. Within these, food aid importance is variable: it is the major provider of sorghum for 10-25 percent of households in Upper Nile, ***40-50 percent in Unity*** *and 50-60 percent for Jonglei*

Food assistance became a noticeable contribution at the national aggregate level, being the main supplier for about 15 percent of the households. Conversely, the disturbances in market and commodity supply due to conflict, led to a decrease in importance of markets as a supplier of sorghum to households: lean season (February-June) market dependency in 2014 and 2015 has been the lowest since records began. This overall picture hides very considerable variation between states: The food aid contribution is limited to the three conflict states, Upper Nile, Jonglei and Unity. Within these, food aid importance is variable: it is the major provider of sorghum for 10-25 percent of households in Upper Nile, **40-50 percent in Unity** and 50-60 percent for Jonglei. This has been accompanied by a reduction in importance of markets as a sorghum supplier – in Upper Nile, the proportion of households sourcing sorghum from markets around October, fell from 80-90 percent pre-conflict to 40-45 percent post-conflict.

Medicines Sans Frontiers (MSF) operates the only inpatient feeding programme in its hospital while CARE, CONCERN and Action Against Hunger (ACF) provide nutrition feeding program within the five POCs. CARE is one of the leading implementing partners for nutrition in the county running 2 OTP sites in Rubkona, and Bentiu town with Kaljak payam being targeted for another site. Other than the Outpatient therapeutic program, other components of CMAM like Targeted supplementary feeding program, Community outreach and mobilization and Infant and Young child (IYCF) interventions are being implemented.

Table 2: Nutrition intervention by partner in Rubkona as of December 2016

County	Partner	OTP	SFP	IYCF
Rubkona	Care	4	7	4
Rubkona	CWW	6	6	-7
Rubkona	WR	3	3	3
Total		13	16	

Source: South Sudan Nutrition cluster

According to Care's SMART survey conducted in May 2016, high rates of acute malnutrition were found among children in Rubkona at 29.2% (24.5 –34.4 95% CI) GAM, very higher than the World Health Organization's (WHO) emergency threshold of 15%. More strikingly, in the same population, a high Severe Acute Malnutrition (SAM) prevalence of 7.8% (5.2 – 11.4 95% CI) was observed, which is above the 2% SAM threshold used by United Nations Children's Fund (UNICEF) to define a critical nutritional situation and immediate need for intervention.

Quality of roads and access to markets

Before the conflict, Bentiu used to be a vibrant trading hub, with household livelihoods based on oil factories, government employment and livestock. But the civilian massacres

committed by different fighting groups loosely associated with the two parties in the conflict forced most of the civilian population to seek shelter in UNMISS Protection of Civilians sites (POC)[8].

Two small markets are operating in Bentiu and Rubkona. The biggest markets are in the POCs, serving 50,000 people. Almost half of the traders left after the violence; the remaining traders run small-scale businesses.

Market functionality is severely limited by the appalling road conditions and widespread insecurity, which effectively make Bentiu an economy under siege. Unsurprisingly, the most important and reliable flow of products comes from Juba on fixed-wing aircraft. This mode of transporting rice, vegetable oil, wheat flour, biscuits and sugar is expensive, sending retail prices sky high.

The large variation in prices across markets confirms inefficiencies and food availability issues. Prices are highest in Bentiu and other conflict-affected areas, eroding the already limited household purchasing power.

The large variation in prices across markets confirms inefficiencies and food availability issues. Prices are highest in Bentiu and other conflict-affected areas, eroding the already limited household purchasing power. Meanwhile, the loss of livelihoods is making humanitarian assistance even more crucial. In-kind food assistance – where delivered in significant amounts – is found to reduce prices by increasing supply, even though in conflict-affected states (i.e. Bentiu) it may crowd out sorghum traders.

There is a large variation in the capacity of markets to secure the food supply and offer a relatively stable market environment to support market-based interventions. Market capacity is low in Akobo, Bentiu and Malakal as a result of the conflict, and in Rumbek because of poor road conditions. Capacity is moderate in Yambio and Bor; moderately high in Aweil, Wau, Nimule; and high in Juba and Torit, where there is a large number of traders and supply is stable.

Conflict has further isolated many communities in the quadrilateral zone formed by the towns of Bor, Bentiu, Malakal and Akobo. There is very little appetite for traders to take any additional risk there: reportedly, crossing from government- to opposition-controlled areas (and vice versa) is too hazardous for traders and no mitigation measures are in place except paying bribes. When conflict escalates, violence becomes indiscriminate and looting the norm. Traders, who have already borne many losses in the past year, are not likely to risk major investments

Additional imports come from Abyei to Bentiu, but insecurity and flooding have dramatically reduced the supply from there. At the time of the assessment, commercial

[8] Emergency Market Mapping and Analysis (EMMA) Report by Mercy corps Unity State, South Sudan

flights from Juba to Bentiu (and to a lesser degree to Malakal) were probably the most important supply source for the area, pushing up prices tremendously[9].

Overall, prices for most foods were higher than their pre-conflict levels. The prices were very high in Malakal and Bentiu; high in Akobo and Rumbek; medium high in Bor and Wau; and low in Juba, Nimule and Torit. These price levels reflected a combination of factors for each market, with conflict judged to be the greatest causal factor in Malakal, Bentiu and Akobo, and to some extent in Bor. The poor access route discussed above was the dominant factor in Rumbek and Wau, but it also applies to varying degrees for most other markets. These factors have affected prices through their initial impact on supply. Other factors affecting prices included high taxes at checkpoints, high transportation costs because of poor road conditions and a low supply of trucks, and scarcity of foreign exchange and its unavailability through official channels. In short, all of these factors have increased the cost of trading, with costs ultimately passed on to consumers.

According to WFP South Sudan market price monitoring bulletin during 1st – 30th September 2016

Due to bulk supply of fuel to Juba during the reporting month, prices of petrol/ diesel in the flourishing black market stabilized in Juba, Kapoeta, Torit, Bor and Minkaman. However, fuel prices went up in the hinterland markets of Yida, Bentiu, Rumbek and more than doubled in Aweil month-on month due to erratic supply and scarcity.

Market dependent consumers got a temporary reprieve as prices of staple grains stabilized or decreased month-on-month in many

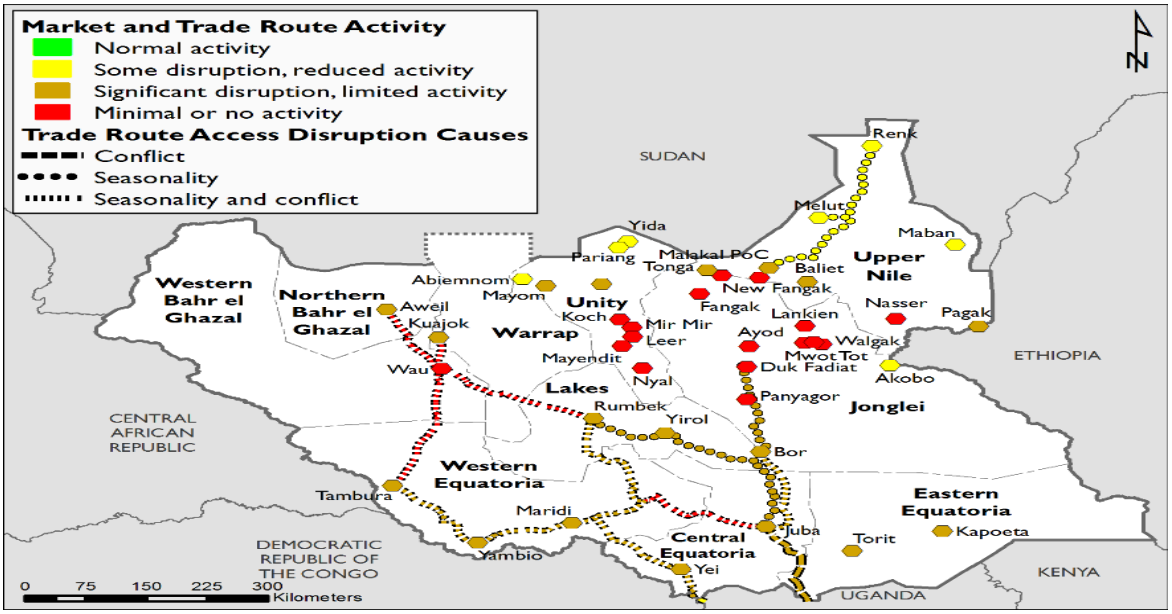
Fuel shortages and impassible roads due to rains and insecurity continued to impede domestic trade flows.

Market dependent consumers got a temporary reprieve as prices of staple grains stabilized or decreased month-on-month in many areas on the backdrop of new harvests and intensified food aid.

The onset of crop harvests in most parts of the country will help in moderating prices of local produce in October-December period. A combination of expected lower crop production and the continuing economic crisis characterized by depreciation in the currency, increasing costs of transportation and reduced imports among other factors will keep the prices of food at higher levels than normal. This will continue to negatively impact on food access by households, especially in food deficit locations that rely highly on markets.

[9] Emergency Market Mapping and Analysis (EMMA) Report by Mercy corps Unity State, South Sudan

Figure 3: market and trade route activity as of September 2016



Source: FEWS NET

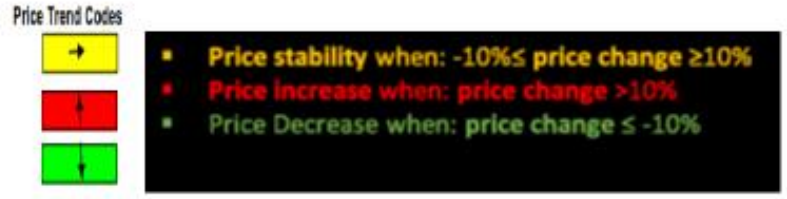
Key drivers of market in the survey area are:

- Localized insecurity in Bentiu, parts of Lower Unity (Leer) and Nassir
- Poor road conditions
- Low volume of imported food
- Poor road conditions
- Low market functionality
- Lack of market access by farmers
- Reduced number of foreign traders
- Restricted commodity flows from Ethiopia and Sudan
- Localized floods in Jonglei and Upper Nile that destroyed crops and displaced people

Table 3: Price trends in Bentiu and Rubkona

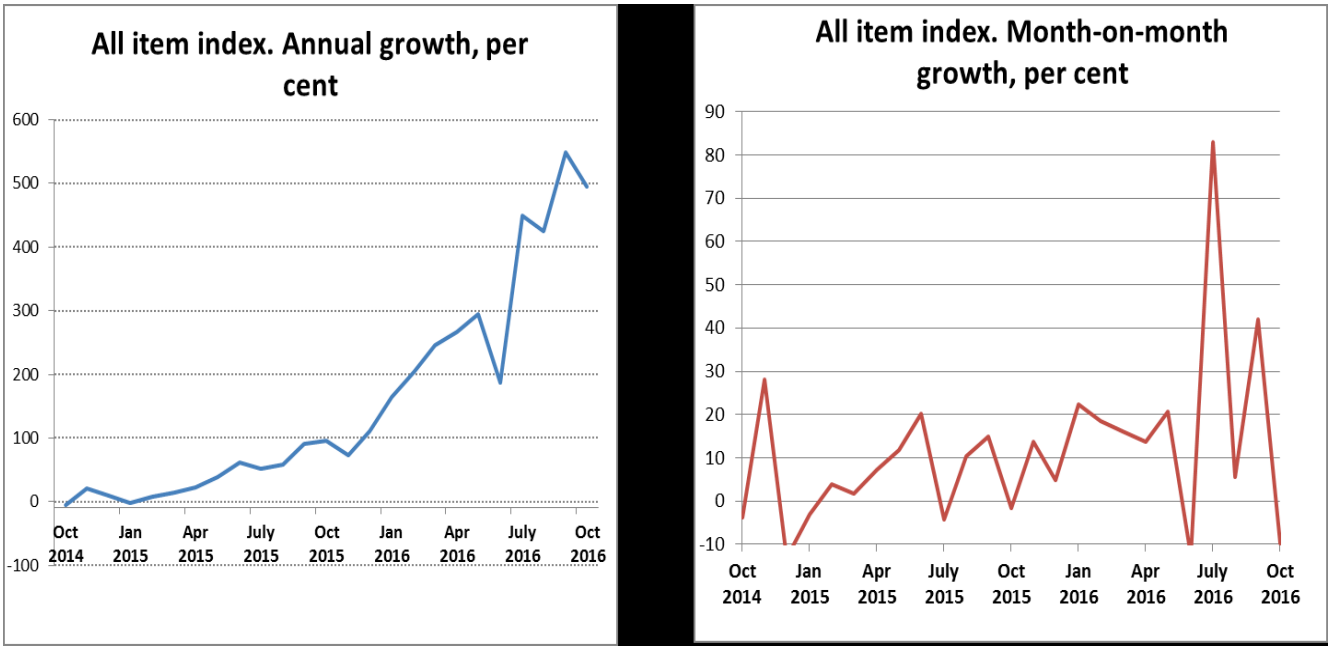
							Price change (%)		
Market	Commodity	Unit	Sep'15	Aug' 16	Sep'16	5 year average	1m	1Y	5 YA
Bentiu	Casual labour	1 day	35	65	135	26	108%	286%	414%
	Field beans	1kg	12.5	75	117	11	56%	833%	937%
	Medium Bull	1 unit	2175	15040	13,500	1816	-10%	521%	643%
	Medium male goat	1 unit	450	2187.5	2250	394	3%	400%	471%
	Medium male sheep	1 unit	452.5	1375	1433	363	4%	217%	295%
	Petrol	1 Litre	17	200	250	14	25%	1371%	1662%

							Price change (%)		
Market	Commodity	Unit	Sep'15	Aug' 16	Sep'16	5 year average	1m	1Y	5 YA
	Veg oil	1 litre	38.75	83.3	113	20	35%	190%	458%
	White sorghum	One 3.5 kg Malwa	19.5	65	60	60	-8%	208%	0%



The annual growth in the CPI for South Sudan increased by 495.0% in October 2016 compared to 95.7% for October 2015. Food and non-alcoholic beverages increased by 449.3% from October 2015 to October 2016, while the prices for heath increased by 1879.4%, restaurants and hotels increased by 337.7% over the same period. The high prices of food and non-alcoholic beverage were mainly driven by higher price of Bread and Cereals[10].

Figure 4: Annual growth in the CPI for South Sudan increased in October 2016



[10] THE REPUBLIC OF SOUTH SUDAN Press release NATIONAL BUREAU OF STATISTICS (NBS)

Survey Objectives

The Overall objective of the SMART assessment is to estimate the current prevalence of acute malnutrition among children 6-59 months of age as well as underlying risk factors contributing to malnutrition such as morbidity, Infant and Young Children Feeding (IYCF) practices and estimate retrospective mortality rates of all persons who live in Rubkona county, Northern Liech state, South Sudan.

Specific objectives

- Estimate the prevalence of acute malnutrition (Global and severe) amongst children aged 6-59 months in Rubkona county, Northern Liech state, South Sudan
- Estimate retrospective crude and under five mortality rates in the entire population of Rubkona County of Unity State, Republic of South Sudan over 90 days preciding the survey
- Estimate the prevalence of morbidity among children 6-59 months in the last two weeks prior to the survey date.
- Estimate of the selective nutrition programme coverage.
- Estimate measles vaccination, deworming and Vitamin A supplementation proportion.
- To establish the prevailing Infant and Young Child Feeding (IYCF) Practices.

Methodology

Sample size Anthropometry

The sample size for the nutrition survey was determined using ENA for SMART software July, 9th, 2015 version. The following assumptions based on the given context were made to obtain the number of children and households to be included in the anthropometric survey.

Table 4: Number of children and households to be included in the nutrition survey

Parameters for Anthropometry	Value	Rationale/ Source
Estimated Prevalence of GAM (%)	24.5%	Based on the result from pre-harvest nutrition and mortality survey conducted by Care in May 2016 in Rubkona County prevalence of acute malnutrition for the population of Rubkona was estimated as 29.2%[11] (24.5 - 34.4 95% CI). The lower confidence interval was used because May 2016 was a pre-harvest survey, hence prevalence at its peak. The survey period is post-harvest season. Post-harvest prevalence level is expected to be lower due to the harvest and on-going health and nutrition interventions.
± Desired precision	4.8%	Based on recommendation of SMART protocol guideline for a GAM prevalence of 20% or more a desired precision of ±5% is used[12]. Also, considerations were made about the objective of the survey, population settlement type and budget
Design Effect	1.16	Based on the nnutrition and mortality survey conducted by Care in May 2016 in Rubkona County (found a design effect of 1.16 (z score < -2)
Children to be included	389	The calculations were made using ENA Software for SMART (July 9th, 2015 version of ENA).
Average HH Size	6.3	Based on the nnutrition and mortality survey conducted by Care in May 2016 in Rubkona County
% Children under-5	19.2%	Based on the nutrition and mortality survey conducted by Care in May 2016 in Rubkona County
% Non-response Households	5%	
Households to be included	377	The calculations were made using ENA Software for SMART (July 9th, 2015 version of ENA).

[11] Nutrition & Mortality SMART survey which was conducted in Rubkona County, South Sudan in May 2016

[12] Measuring Mortality, Nutritional Status and Food Security in Crisis Situations: THE SMART PROTOCOL, Version 1 Final Draft (Jan 2005), http://www.unhcr.org/45f6b2c42.pdf

Sample Size Mortality

The sample size for the retrospective mortality survey was determined using ENA for SMART software (version July, 2015). The following assumptions based on the given context were made to obtain the population and number of households to be included.

Table 5: Number of children and households to be included in retrospective mortality survey

Parameters for Mortality	Value	Rationale/ Source
Estimated death rate per 10 000/day	0.64	Based on Nutrition & Mortality SMART survey which was conducted in Rubkona County, South Sudan in May 2016. The survey found a CMR 1.19 (0.81-1.74CI 95%). However, as per comments from the NIWG the death rate was mainly due to conflict and injuries (53.3%) and death due to illness was only 46.7% of the reported death. Further, CMR was greater than U5MR which was the reverse in most emergency contexts and developing countries. Hence, the U5MR was used as it may reflect the worst case scenario (conservative estimate).
± Desired precision per 10 000/day	0.37%	SMART recommendations where death rates are < 1.0, a precision of ± 0.3 are recommended. Also, considerations are made not to include bias by making the precision too high (0.37 was used)
Design Effect	1.3	A Design Effect of 1.3 was taken as a very small difference in heterogeneity of death is expected. This was assumed by taking the morbidity rate's design effect, mortality design effect of the May 2016 and the fact that survey areas are homogenously covered by health and nutrition programs with very small pockets of non-coverage.
Recall period in days	90	Recommended period during emergencies
Population to be included	2824	The calculations were made using ENA Software for SMART (July 9th, 2015 version of ENA).
Average HH Size	6.3	Average household sizes for the regions based on 2007 population and housing census
% Non-response Households	5%	
Households to be included	472	The calculations were made using ENA Software for SMART (July 9th, 2015 version of ENA).

Survey Sample Size and Response Rates

As the surveys have more than one key indicator of interest (mortality rates and GAM), for each key indicator of interest, we ensured enough precision: we calculated sample size for each indicator.

Key Indicator **Target Population**

Global Acute Malnutrition	Children 6-59 months
Crude Mortality Rate	All individuals

However, the separate sample size calculations had differences: 472 households for mortality survey and 377 households for anthropometry survey. ***The overall sample size for the combined survey was based on the higher sample size i.e. Mortality (472 households).***

Sample size for additional indicators:

- IYCF indicators: 0-23.9 months old children in all 472 households
- WASH indicators: All households (472)
- Food security and livelihoods: all households (472)

Table 6 shows response rates for the Post –harvest SMART nutrition and mortality survey in Rubkona. A total of 468 households were selected for the sample, of which 468 were occupied. Of the occupied households:

- 443 were successfully interviewed for FSL, yielding a response rate of 99 percent.
- In the interviewed households, 428 eligible children were identified for anthropometric measurement;
- 197 eligible children were identified for IYCF assessment (0-23.9months)
- complete interviews were conducted with 446 for mortality, yielding a response rate of 94 percent

.

Table 6: Per cent of households and children 6-59 months included in the survey

	Number of HH planned	Surveyed	response Rate
Anthropometry	472	468	99%
FSL	472	443	94%
Number of children 6-59 months planned	377	428	Over 100%
Mortality	472	446	94%

Number of households per cluster

The number of clusters to be sampled was determined by the following considerations:

- ✓ In order for a cluster sampling to be representative and acceptable it should have a minimum of 25 clusters and a minimum of 30 clusters is recommended. Therefore, this consideration was taken (the cluster number to be selected should be at least 30);
- ✓ The number of households a team can reasonably cover without compromising quality. This factored in combinations of activities like the number of children a team can measure per day, the number of questionnaires, travel time from base to villages and travel time within the selected cluster.
- ✓ The sample size of households as per sample size calculation is described above in sample size calculation section (472 households)
- ✓ Sampling parameter's expected design effect (the design effect of both retrospective mortality and GAM are found to be low as per the May, 2016 survey in Rubkona).

The number of clusters was determined by considering:

- Sample Size= 472 households
- Departure from office at 8am and back at 6pm.
- Travel time to reach the village (two-way travel): 1.5hrs.
- Duration for initial introduction and selection of HH: 0.50hrs.
- Time spent to move from one HH to the next: 5 min.
- Average time in the HH: 30 min.
- Breaks: 2 breaks of 15 min each
- Number of teams for the survey: 6 teams.

Based on these on average the survey was estimated to have 6.4hs **work time**=385min for each cluster. If on average teams spend 30 min in each HH and 5min traveling from one HH to another, each team can comfortably reach 13HH per day. One day in each area (cluster) is assumed.

The total number of households in the sample is 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.

472HH/ 13HH per day = 36.30 clusters ….rounded to 36

Based on these calculations 36 clusters were included in the survey.

Cluster Sampling Strategy

The method that will be applied follows two stages of sampling:

- Stage 1: Random selection of clusters from the total number of geographical units. Selection of clusters was done during the planning stage in the office.
- Stage 2: Random selection of households within the clusters. This stage was done in the field.

First stage sampling- Selection of clusters

At the first stage, all Bomas of Rubkona County (see annex 1) will be used as the sampling frame at the planning stage and the total number of clusters required for the survey was selected using the Assessment (ENA) for SMART software version 2011 (July 9th, 2015). The objective of cluster sampling at first stage sampling was to choose smaller geographic areas (**clusters)** in which simple or systematic random sampling can be done. After selection of clusters using ENA software significant number of villages in were with a higher population size than. Owing to this, the software had selected more than one cluster in a single administrative unit. In this case, the principle of segmentation was employed by the survey manager during each field visit. The procedures of segmentation are:

A. Upon arriving in the selected unit the survey principal leader met the village chief.

B. Explained to him/her the survey objectives and process.

C. Determined the boundaries of the selected unit. Further, the survey manager explained to the chief that the team wishes to select households only from the selected unit.

D. The survey manager and the team asked the chief if he/she has a list of all households in the selected unit or a natural division of the selected village. If he/she does have a list, teams number each household on the chief's list. If no, teams have made a fresh list. They did this by going house to house and marking each household with chalk. Team leaders and supervisors have made sure that the list includes all households in the village, including those of families who have just returned to the village or live there temporarily, persons living alone, elderly couples or persons, and other households which might not contain children less than five years of age. To assist the process the village chiefs provided local guide. Following this, the team has divided the village into the number of required clusters. Segmentation was applied in two cases:

    - Unequal villages: When the village under consideration has more than one cluster selected from it (by the software) and if the village has a large number of households (more than 150-250). In such cases the team leader and survey manager have requested the chief if there are sub-divisions in the village, such as sub-villages, sectors, or neighborhoods. If there are, then the team prepared a table containing each sub-divisions name, the total number of households per sub-division and a cumulative range. If any sub division has fewer than the predetermined number of households per cluster, it gets combined with another sub-division so that the combined number will be greater than the household sample size per village.
    - Equal population size villages: When the sub divisions were with equal

population size then a direct simple random method was applied to segment the villages into the number of required clusters

It should be noted here that the survey has actually covered only 3 payams out of 10 Payams of Rubkona due to security issues. Hence, the result of the survey reflects the situation in Pakur, Robkona and Benitu Payams and it does not reflect/extrapolation to the entire county is not possible.

Second stage sampling- Selection of households

HH definition: during the training household definition was shared with all survey members and discussions were made to contextualize it. The definition used for the survey was: Group of people living under same roof & sharing food from the same pot. In home with multiple wives, those living and eating in different houses are considered as separate HHs. Wives living in different houses and eating from same pot are considered as one Household. The target population was children aged 6 to 59 months, living in Rubkona.

Simple random sampling was used as method of data collection during second stage sampling to select households). To use SRS a fresh list of all households in selected clusters was prepared (listing forms were distributed and received by the survey manager each day). Following these teams had selected 13 households per clusters using random table (random tables were printed and distributed).

Case definitions and inclusion criteria

Age range of the children included in anthropometry survey: weight loss among children aged 6–59 months is usually taken as a proxy indicator for the general health and well-being of the entire community. The nutrition survey included only children aged 6–59 months. Seasonal calendars were developed for each separate community to help illicit age data, when it is difficult to find age in months.

Acute malnutrition/ wasting: measure of “thinness” due to rapid recent weight loss.

Global Acute Malnutrition (GAM): a population indicator that provides an aggregate of moderate and severe malnutrition, i.e. ≤-2 Z-scores and oedema. GAM is divided into moderate and severe acute malnutrition (GAM = MAM+SAM). Teams assessed GAM using weight for height and assessing oedema.

Kwashiorkor - bilateral pitting oedema (nutritional oedema) that is a clinical indicator for SAM. Oedema is the excessive accumulation and abnormal infiltration of serous fluid in connective tissue or in a serious cavity. Classified into 3 grades; + *mild* (both feet, can include ankles), ++ *moderate* (both feet, lower legs, hands or lower arms); +++ *severe* (generalized oedema over whole body including arms and face). Each child in the selected household was assessed for oedema by applying a thumb pressure and counting from 1001-1003.

Malnutrition - a state in which the physical function of an individual is impaired to the point where s/he can no longer maintain adequate bodily performance processes.

Marasmic-Kwashiorkor – a combination of both marasmus and kwashiorkor.

Marasmus - severe weight loss and muscle mass leaving 'skin and bones'. Appearance can manifest as 'old man face' and 'baggy pants'.

Moderate Acute Malnutrition - description of malnutrition level encompassing children 6-59 months with < -2 to ≥-3 z-scores and/or MUAC < 12.5 to 11.5 cm; and PLW with MUAC < 21.0 cm. Persons with MAM have higher morbidity and mortality risks.

MUAC – Low MUAC is an indicator for wasting. For a child 6-59 months, MUAC < 11.5 cm indicates severe wasting or SAM, MUAC 11.5 - < 12.5 cm indicates moderate wasting or MAM. For PLW, MUAC < 21.0 cm indicates MAM. MUAC is a better indicator of mortality risk associated with acute malnutrition than WFH. All children in the sample were measured their mid upper left arm. Also, mothers were measured.

Severe Acute Malnutrition (SAM): description of malnutrition level encompassing children 6-59 months with < -3 z-scores, and/or MUAC < 11.5 cm, and/or bilateral pitting nutritional oedema. Persons with SAM have higher morbidity and mortality risks. Survey teams have referred those children who were found to be SAM cases.

Standard Deviation (SD) or z-score: the deviation of the anthropometric value (weight, height etc.) for an individual from the median value of the reference population.

Stunting - or chronic under-nutrition, is a form of under-nutrition that is defined by a height-for-age (HFA) z-score below two SDs of the median WHO standards. Stunting is a result of prolonged or repeated episodes of under-nutrition often starting before birth.

Supplementary Feeding Program (SFP) - provision of an additional food ration for moderately malnourished individuals through a 'targeted SF'; or to the most nutritionally vulnerable groups (regardless of nutritional status) through 'blanket SF'.

Underweight - Underweight is a composite form of under-nutrition including elements of both stunting and wasting and is defined by a weight-for-age (WFA) z-score below -2 SDs of the median (WHO standards).

WHO Growth Standards (WHO GS 2006) - Developed using data collected in the WHO Multicentre Growth Reference Study in Brazil, Ghana, India, Norway, Oman, and the United States between 1997 and 2003 to generate new curves for assessing the growth and development of children from birth to five years of age under optimal environmental conditions. They are intended to be used to assess children everywhere, regardless of ethnicity, socioeconomic status and type of feeding. Results of this survey are presented in WHO standards in the nutrition survey reported here.

Z-score - Indicates how far a measurement is from the median – also known as the

standard deviation (SD) score. The reference lines on the growth charts (labelled 1, 2, 3, -1, -2, -3) are called **z-score lines**; they indicate how far the measurement is above or below the median (= z-score of 0).

Vitamin A supplementation: Vitamin A deficiency is associated with increased mortality, especially when children have low weight for height. WHO /UNICEF recommend that children living in the developing world and in food insecure conditions should receive a vitamin A supplement twice a year. Data of vitamin A supplementation was collected during the survey.

BCG vaccinations: are usually given during routine work on an expanded program of immunization (EPI), and hence the rate may give an indication of how well the primary health care system is working – if the rate is very low EPI might not be strong. Survey team assessed BCG vaccination by looking for a scar on the upper arm. The scar[13] is normally on the right arm, but may be on the left, so teams checked both by observing the on child's arm. Not every individual who has been vaccinated with BCG develops a scar and there is some evidence that if children are vaccinated in infancy a significant proportion do not have a permanent scar. It is likely that BCG scar therefore underestimates vaccination.

Water and Sanitation: Inadequate access to clean water poses a major nutritional risk in all settings. When people are displaced or living in overcrowded conditions, poor sanitation also poses a major risk. Ideally, all people should have safe and equitable access to a sufficient quantity of water for drinking, cooking, and personal and domestic hygiene. Public water points should be sufficiently close to households to enable the use of the minimum water requirement. People should have adequate numbers of latrines, sufficiently close to their dwellings, to allow them rapid, safe and acceptable access at all times of the day and night. Latrines should be sited, designed, constructed and maintained in such a way as to be comfortable, hygienic and safe to use. More specific guidelines are given by The Sphere Project (2010). A series of questions were asked to assess water and sanitation condition in the survey population.

Morbidity: Questions about symptoms (usually diarrhea, fever and cough/difficult breathing) were included. Case definitions were prepared for each illness. For measles the definition was: 'any person in whom a clinician suspects measles infection or any person with fever, and maculopapular rash (i.e., non-vesicular), and cough, coryza (ie, runny nose) or conjunctivitis (ie, red eyes).'The definition of diarrhoea for children over six months is three or more loose stools per day. Mother was asked whether or not the child has suffered from these symptoms at any time during the past 14 days.

Dietary diversity is defined as the number of different foods or food groups eaten over a reference time period, not regarding the frequency of consumption.

Food frequency, in this context, is defined as the frequency (in terms of days of

[13]The scar has been described as a round, slightly depressed area with irregular edges, 4–7 mm in diameter. Occasionally it is raised a few millimeters above the skin as a result of fibrous tissue formation and is hard to the touch or healing may be accompanied by a retracted scar (PAHO,1986).

consumption over a reference period) that a specific food item or food group is eaten at the household level.

Condiment, is this context, refers to a food that is generally eaten in a very small quantity, often just for flavor. An example would be a 'pinch' of fish powder, a teaspoon of milk in tea, spices, etc.

Food consumption score: The frequency weighted diet diversity score or "Food consumption score" is a score calculated using the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. The FCS is considered as a proxy indicator of current food security. FCS is a composite score based on dietary frequency, food frequency and relative nutrition importance of different food groups. *Dietary diversity* is the number of individual foods or food groups consumed over the past seven days. *Food frequency* is the number of days (in the past 7 days) that a specific food item has been consumed by a household. Household food consumption is the consumption pattern (*frequency * diversity*) of households over the past seven days. Calculation of FCS and household food consumption groups follows these steps:

1. Using standard 7-day food frequency data, group all the food items into nine specific food groups.
2. Sum all the consumption frequencies of food items of the same group, and recode the value of each group above 7 as 7.
3. Multiply the values obtained for each food group by its weight and create new weighted food group scores.
4. Sum the weighed food group scores, thus, creating the food consumption score (FCS). The most diversified and best consumption with maximal FCS at 112 means that all food groups are eaten 7 days a week.
5. Using the appropriate thresholds, recode the variable food consumption score, from a continuous variable to a categorical variable, to calculate the percentage of households of poor, borderline and acceptable food consumption.

Food Items, Food Group and Weight applied:

Table 7: Food items, food groups and weight applied

No	Food groups	Weight
1	Cereals *(bread, rice, maize, barley)* and tubers *(potatoes, sweet potatoes)*	2
2	Pulses and nuts (*beans, lentils, peas, peanuts, etc.)*	3
3	Vegetables	1
4	Fruits	1
5	Meat and fish (*all types*)	4
6	Dairy products *(milk, yoghurt, cheese, other milk's products)*	4
7	Sugar, honey	0.5

8	Oil, fat, butter	0.5

Food Consumption Score thresholds: The FCS is calculated based on the past 7-day food consumption recall for the household and classified into three categories: **poor consumption (FCS = 1.0 to 21); borderline (FCS = 21.1 to 35); and acceptable consumption (FCS = >35.0).** The FCS is a weighted sum of food groups. The score for each food group is calculated by multiplying the number of days the commodity was consumed and its relative weight.

The following thresholds of FSC are used to categorize households into three food consumption groups – Poor, Borderline and Acceptable:

Table 8: food consumption thresholds

Food consumption groups	Food Consumption Score	Description
Poor	1-21	An expected consumption of staple 7 days, vegetables 5-6 days, sugar 3-4 days, oil/fat 1 day a week, while animal proteins are totally absent
Borderline	21.1 -35	An expected consumption of staple 7 days, vegetables 6-7 days, sugar 3-4 days, oil/fat 3 days, meat/fish/egg/pulses 1-2 days a week, while dairy products are totally absent
Acceptable	> 35	As defined for the borderline group with more number of days a week eating meat, fish, egg, oil, and complemented by other foods such as pulses, fruits, milk

The results are presented based on WHO standards.

Questionnaire, training, survey teams, supervision

Recruitment of fieldworkers

Highly motivated, well-trained field workers are essential for a successful survey. SMART utilizes a team approach to data collection. Usually, each nutrition survey team is composed of a Team leader, measurer and assistant measurer. The selection of the field workers is the first step to obtaining high-quality data.

Recruitment: The goal of the recruitment process was to identify the best possible candidates for the SMART survey field work. Below are a few of the characteristics set to identify in potential candidates:

- Candidates fluent in the language used for training (English) and the language of the target population of the survey (Nuer)
- Candidates that have the equivalent of at least a secondary education.

- Previous survey experience.
- Candidates that are/must be available to work full time the entire period of field work. They should be willing to work on evenings and weekends.
- Field work is physically demanding and candidates should be able to walk long distances and carry questionnaires and other equipment.
- Maturity, responsibility, a friendly and respectful attitude, appropriate appearance and demeanor, curiosity, attention to detail, and an interest in the survey are all qualities that a strong candidate will exhibit.

In addition to new recruitment from Rubkona PoCs, Rubkona town and Bentiu permanent staffs of Care International were used in the survey.

Training

A total of 28 people were trained. They attended 3 days of theoretical training on assessment methodology, measurement, questionnaires and other assessment tools (event calendar). SMART methodology training modules were followed during training. Theory was completed by various practical exercises. In addition, a standardization test took place in order to evaluate and guarantee the enumerators' accuracy and precision in taking measurements. The field team manager used post-training and standardisation test results to determine optimal team composition.

The training was completed with a one-day field test on non-selected children to recreate real work conditions and enable each team to become familiar with all work aspects (introduction/ survey explanation, finding of selected children, questionnaire completion, anthropometric measurement, team organization). Children included in the field test were not part of the survey sample.

Table 9: Training schedule

	In class training on questionnaires	Height and weight measurement	Field practice	Standardization	Total length of training
	1 day	1 days	1 day of practice and discussion	1 day	~ 4 days

Field Practice: Practice interviewing is perhaps the most significant part of training. Towards the end of the training session, one day was set aside for practice in the field. The field practice was conducted at the end of the training period so that participants

benefit from administering the entire questionnaire including anthropometric measurements. Time was allocated for classroom discussion following field practice interview sessions to answer questions and discuss problems. During the feedback the trainees had received feedback on their performance.

Before deployment, survey teams were informed that their performance was monitored for quality throughout field work, that supervisors were periodically spot-check households, and that the survey manager reviewed all completed questionnaires.

The survey had six teams. Each team was composed of two measurers, one team-leader and one Care staff as a supervisor. One set of guidelines with the survey's main instructions and a materiel kit was provided to each team member.

Fieldwork supervision

Each interviewer and team was observed by supervisors during the first two days of field work. The supervisor team included Care staff, care nutrition manager, the survey manager/consultant, 2 MoH staff and 2 RRC staff. Supervisors, government staff, and senior care staff do a continuous follow up from day one and have sit in on interviews and gave immediate feedback to interviewers.

Questionnaires were thoroughly edited within a day of the interview or at least before the team moved to the next cluster, data were entered and feedback was given immediately. Supervisors shared the task to ensure that all questionnaires are thoroughly scrutinized and all errors are tactfully discussed with the interviewer. Also, based on data entry result/plausibility check, feed-back on age distribution, digit preference and measurements' errors was given and re-measurements were planned and conducted as required.

Questionnaire

The SMART nutrition and mortality survey used four questionnaires, namely, a Household Food security and Livelihood Questionnaire, a child's Questionnaire, IYCF Questionnaire and a Mortality Questionnaire. These questionnaires were based on the models developed by the Nutrition cluster of south Sudan (NIWG), but additions and modifications were made to the model questionnaires to adapt them to specific situations and the lexicon of Rubkona.

Child's Questionnaire (anthropometric questionnaire)

For each eligible child aged 6 to 59 months, the following data were collected:

- Age: whenever available, the child's age was copied from his/her birth certificate and cross-checked with a local events calendar. Gender: the sex of each child was recorded as "M" for male/boys and "F" for female/girls.

- Weight: children were weighed to the nearest 100g with a 25kg Salter brand hanging scales. All scales were equilibrated daily by using a standard 5 kg weight, and were adjusted to "0" with an empty pair of weighing pants attached before each measurement, as per SMART methodology[14]. Children were weighed with a minimum of clothes (as per last year's SMART survey technique).

- Height/Length: each child was measured to the nearest 1mm with a standard wooden anthropometric height-board. Children below 87 cm were measured lying down and those equal to or above 87 cm were measured upright.

- Oedema: the presence of oedema was diagnosed by applying moderate thumb pressure for at least three seconds to the upper side of both feet. The level of oedema was not recorded. Only children with bilateral pitting oedema (a visible persisting dent in both feet after the above-mentioned pressure) were recorded as having nutritional oedema.

- MUAC: MUAC was measured to the nearest 1mm, at the midpoint of the unflexed left upper arm (between the tips of shoulder and elbow) using a standard coloured MUAC ribbon.

- Vitamin A supplementation: administration of vitamin A capsules within the last 6 months was considered, and verified with the caretaker by means of showing a capsule sample.

- Measles vaccination: immunization against measles was checked, and a vaccination card requested in the case of a positive response. Coding was as follows: "0" when the child was not vaccinated, "1" when vaccination was confirmed by a vaccination card, "2" when vaccination was only able to be confirmed verbally, and "3" when the respondent did not know.

Weight-for-height z-score was not calculated in the field, to avoid possible introduction of bias in measurement, seeing as admission to the OTP program is considered desirable by some members of the population in question. Nevertheless, an SCI staff or volunteer accompanied any child suspected of SAM to Care's OTPs with a survey referral slip.

IYCF questionnaire

IYCF data was collected from children between the ages of 0-23.9 months in sample households. EBF, continued breast feeding, feeding practices, meal frequency and individual diversity score data were included on the IYCF tool. The tool is a standardized one and it is prepared by the nutrition cluster of South Sudan.

[14] SMART. April 2006. SMART methodology version 1

FSL questionnaires

Similarly, WASH and Food Security and Livelihoods (FSL) surveys data was collected using the standard questionnaire that was prepared by the South Sudan NIWG. Food consumption score, household food diversity, income, humanitarian assistance, WASH, residential status questions were included.

Mortality questionnaire

Before beginning the survey in a household, teams have identified the respondent according to the survey protocol and obtain their consent (verbal). The survey has used the individual mortality questionnaire. The questionnaire has three major sections:

A. Current household members.
B. Household members that have left since the start of the recall period, and
C. Household members that have died since the start of the recall period.

Teams have filled out each section in its entirety before moving on to subsequent sections. For each section, they began by listing information about the respondent, followed by spouse(s), parents, siblings, children and then other current household members. For children less than 1 year of age, they have indicated '0' under the column for age (column 04).

Section A: Household members that are currently living in the household

- ✓ The head of the household to list the names, sex (m/f), and age (in years) of all household members that are currently living in the household.
- ✓ Once the listing is completed, ask the respondent which of the individuals listed were present at the beginning of the recall period. Indicate 'Y' in column five (05) for anyone who was not present at the beginning of the recall period. Marking a Y indicates that they joined after the start date of the recall period. If the individual was present at the beginning of the recall leave column five (05) blank.
- ✓ For every child whose age is indicated as '0', ask the head of the household if the child was born on or after the beginning of the recall period. Indicate 'Y' under column seven (07) if the child was born on or after the beginning of the recall period.
- ✓ Once section A is completed, read the information back to the respondent. Ensure that no household member that is currently living the household was forgotten. Move onto section B.

Section B: Household members that have left since the beginning of the recall period

- ✓ Ask the head of the household to list the names, sex (m/f), and age (in years) of

all individuals that were part of the household but have left since the beginning of the recall period. List them under section B.

- ✓ Ask the respondent if anyone listed in section B was present at the beginning of the recall period. Indicate 'Y' in column five (05) for anyone who was not present at the beginning of the recall period. Marking a Y indicates that they joined after the start date of the recall. If the individual was present at the beginning of the recall leave column five (05) blank.
- ✓ For every child whose age is indicated as '0', ask the head of the household if the child was born on or after the beginning of the recall period. Indicate 'Y' under column seven (07) if the child was born on or after the beginning of the recall period.
- ✓ The column for left (column 06) has been prefilled with the letter Y in section B. Do not write anything in column 6.
- ✓ Once section B is completed, read the information back to the respondent. Ensure that no household member that is currently living the household was forgotten. Move to section C.

Section C: Household members that have died since the beginning of the recall period

- ✓ Ask the head of the household to list the names, sex (m/f), and age (in years) of all individuals that were part of the household but have died since the beginning of the recall period. List them under section C.
- ✓ Ask the respondent if anyone listed in section C was present at the beginning of the recall period. Indicate 'Y' in column five (05) for anyone who was not present at the beginning of the recall period. Marking a Y indicates that they joined after the start date of the recall. If the individual was present at the beginning of the recall leave column five (05) blank.
- ✓ For every child whose age is indicated as '0', ask the head of the household if the child was born on or after the beginning of the recall period. Indicate 'Y' under column seven (07) if the child was born on or after the beginning of the recall period.
- ✓ If the survey is collecting cause and/or location of death, ask respondents about the circumstances of the death. Indicate the cause of death (column 09) and location of death (column 10) using the codes provided in the questionnaire for everyone listed as died in section C.
- ✓ Once section C is completed, read the information back to the respondent. Ensure that no household member that is currently living the household was forgotten.

Pregnancies

- ✓ Ask the respondent if anyone in the household was pregnant at the start of the recall period. If the respondent answers yes, record the number of women who were pregnant at the beginning of the recall and ascertain the outcome of each pregnancy. Make sure that births and possibly deaths that resulted from these pregnancies are reflected in sections A, B or C.

- ✓ Ensure that any neonatal death is recorded on the form. A neonatal death is defined as any child who was born (live birth: **the child took at least**

one breath) and died within the recall period. A neonatal death should be recorded as BOTH a birth and a death. Pregnancies that do not result in a live birth (abortions, miscarriage, and still births) are not counted as births or deaths.

*Quality scoring for overall data quality for this survey is 2% and it is rated as of an 'Excellent' survey in terms of its **overall reliability of the data.***

Data quality and analysis

Data collected were entered by one data entry officer and checked by another every evening using the latest version of ENA software (9th July 2015), for daily data quality analysis and SMART/ WHO Flags identification. The team went back to re-measure children with abnormal data (weight, height, MUAC in addition to a second age estimation). Possible data entry errors were also checked.

Analysis then was performed using ENA, Excel (version 2010) and EPI INFO version 3.4.1, using Chi^2 tests to explore statistical linkages between parameters where relevant. Except WFH, HFA, and WFA all standard deviations were generated using EPI INFO version 3.4.1 advanced statistics option

Weight-for-height z-score was not calculated in the field, to avoid possible introduction of bias in measurement. When a child was identified as acutely malnourished during the data entry stage, the respective surveyors were questioned to ensure that the child had been referred to the nearest treatment services.

Overall data quality was only available after completion of all samples (full plausibility check reports available in appendix 1).

The overall reliability of the data*:* From the statistics that are generated from the data, an overall Score for the survey quality was generated (plausibility check) by weighing the various factors in terms of their ability to distort the correct answer. The table presenting "penalty points" for different data quality tests, and the overall quality score of the survey are presented in the "*Overall data quality*" table at the top of page 1 of the Plausibility report (see annex 1). Quality scoring for overall data quality for this survey is 2% and it is rated as of an '*Excellent'* survey in terms of its **overall reliability of the data.**

The overall sex ratio and expected age ratio of children 6-29 to 30-59 months of age are evaluated using a Chi-squared test. The expected age ratio of children 6-29 months of age to children 30-59 months of age of the survey was 1. This value is not statistically different from the expected value of 0.85 (p-value = 0.103 (as expected)). Therefore, there is a balanced representation of younger (6-29 months) children versus older children (30-59 months) in the dataset. The overall sex ratio in the sample population is also as expected: p-value = 0.226 (boys and girls equally represented). Both of the chi-squared tests for overall sex ratio and expected ratio of younger (6-29 months) versus older (30-59 months) children is not statistically significant (p>0.05). Neither the sex ratio

(p=0.226) nor the age ratio of 6-29 months to 30-59 months (p=0.103) significant differences.

It is generally expected that the standard deviations of the weight-for-height z-scores (WHZ) and the weight-for-age (WAZ) will be smaller than the standard deviations of the height-for-age (HAZ) z-scores because the latter is associated with measurement error in age and height that tend to have higher error than measurements of weight. In this survey, the HAZ showed the greatest dispersion, with an SD ranging 1.78 (without exclusion) compared to the standard deviations of the other two scores. The wide dispersion is partly due to heterogeneity but also reflects age assessment challenges and measurement error. Determining how much of the dispersion can be attributed to heterogeneity and how much to measurement error is an ongoing data quality issue.

Table 10 shows the SDs of the HAZ, WAZ, and WHZ z-scores. Stunting is found to have HAZ SDs that was above 1.2. These high SDs can indicate a data quality problem, although population heterogeneity may be another possible explanation. With accurate age assessment and anthropometric measurements, the SDs of the observed height-for-age, weight-for-age, and weight-for-height Z-score distributions should be relatively constant and close to the expected value of 1.0 for the reference distribution. The range of acceptable standard deviations for SMART surveys is 0.8 to 1.2[15]. The standard deviation result on Table 10 also shows that the standard deviation for WFH fall within these acceptable ranges even before exclusion of flags. If the SD for WHZ has been very high, then the prevalence of GAM may be overestimated due to the fact that a larger proportion of the area under the curve would fall below WHZ<-2.

Table 10: Evaluation of standard deviation using the 3 exclusion (Flag) procedures

WHZ	No exclusion	Exclusion from reference mean	Exclusion from observed mean
Standard Deviation SD:	1.08	1.06	1.05
Prevalence (< -2)			
observed[16]:	20.3%	20.1%	20.2%
calculated with current SD[17]	19.4%	18.6%	18.6%
calculated with a SD of 1[18]	17.6%	17.3%	17.5%
HAZ			

[15] Michael Golden and Yvonne Grellety, 2002. Population Nutritional Status During Famine This study was based on NCHS Standards http://www.nutrisurvey.de/ena_beta/documents.htm.

[16] Observed (counted) prevalence of wasting (WHZ<-2): Children with WHZ<-2 /total children in the survey. The only data used is whether child is < or > -2 z-score (no edema).

[17] Calculated prevalence with survey SD: Area under the curve below -2 z-score /total area under the curve. Numerical values of each child used. It has increased power of assessment.

[18] Calculated prevalence with a SD of 1.0: Area under the curve below -2 z-score /total area under the curve. Can be used only if data is normally distributed (see Shapiro-Wilk Test).

Standard Deviation SD:	1.78	1.73	1.25
Prevalence (< -2)			
observed:	23.4%	23.4%	22.1%
calculated with current SD	26.5%	26.3%	21.7%
calculated with a SD of 1	13.1%	13.6%	16.4%
WAZ			
Standard Deviation SD:	1.22	1.22	1.11
Prevalence (< -2)			
observed:	25.2%	25.2%	25.1%
calculated with current SD	26.9%	26.9%	25.9%
calculated with a SD of 1	22.6%	22.6%	23.7%

Note: Exclusion criteria: The "no exclusion" column is based on the analysis of the entire dataset without exclusion of flagged cases; "exclusion from reference mean (WHO flags)" excludes from analysis all WHZ values outside of ± 5 Z-scores from the mean of the reference population (0 Z). Exclusion ranges for WHO flags are slightly different for HAZ (+/-6) and WAZ (-5 to +6). "Exclusion from observed mean (SMART flags)" excludes from analysis all values outside ± 3 Z-scores.

However, the standard deviation for weight for age (1.22) and Height for Age (1.78) are out of the expected range. The SD of "Exclusion from Observed mean (SMART Flags)" is below 1.2 for underweight and **higher**/above 1.2 for stunting. Hence, the WFA data are of sufficient quality to report the *observed* prevalence. Nonetheless, the SD of "Exclusion from Observed mean (SMART Flags)" is **higher** than 1.2 for stunting (HFA) meaning that the data may have too many mistakes and the prevalence observed is most likely an over-estimation. Due to this it is not reported here as it does not represent the true situation in the survey area. Because the mean does not change substantially with random errors, and is thus a much more robust (reliable) statistic of the nutritional state of the population, SMART recommends that the data should not be abandoned or only the conventional analysis reported. SMART strongly suggest that the calculated prevalence (with an SD of one) should be reported in the final survey.

As can be seen from the screen clipping below stunting level of observed mean is 23.4%, 23.4% and 22.1% for without exclusion, WHO flag and SMART flag, respectively. The stunting level for prevalence calculated with SD of 1, is however, 13.1%, 13.6% and 16.4% for without exclusion, WHO flag and SMART flag, respectively. This is used as the true stunting level for the surveyed population.

HAZ			
Standard Deviation SD:	1.78	1.73	1.25
Prevalence (< -2)			
observed:	23.4%	23.4%	22.1%
calculated with current SD	26.5%	26.3%	21.7%
calculated with a SD of 1	13.1%	13.6%	16.4%
WAZ			
Standard Deviation SD:	1.22	1.22	1.11
Prevalence (< -2)			
observed:	25.2%	25.2%	25.1%
calculated with current SD	26.9%	26.9%	25.9%
calculated with a SD of 1	22.6%	22.6%	23.7%

In this report, exclusion of z-scores from Observed mean SMART flags was used for WHZ (-3 to 3); and WAZ -3 to 3, while exclusion of z-scores from calculated with SD of 1SMART flags was used for HFA.

Results

Anthropometry

Distribution of the sample according to sex and age

A distribution of the sample according to sex allows verifying that both sexes are equally distributed, and that no selection bias has occurred. The total ratio should be between 0.8 and 1.1 if there was no sex bias in the selection. An age–sex breakdown of the survey sample is presented on Table 11 and Figure 5. The overall sex ratio of the sample population was within the range of 0.8 to 1.1. Further, statistical test using chi-square statistics shows that boys and girls are equally represented (Overall sex ratio: p-value = 0.226 (boys and girls equally represented)). This shows that there was no selection bias.

Table 11: Distribution of age and sex of the anthropometric survey sample

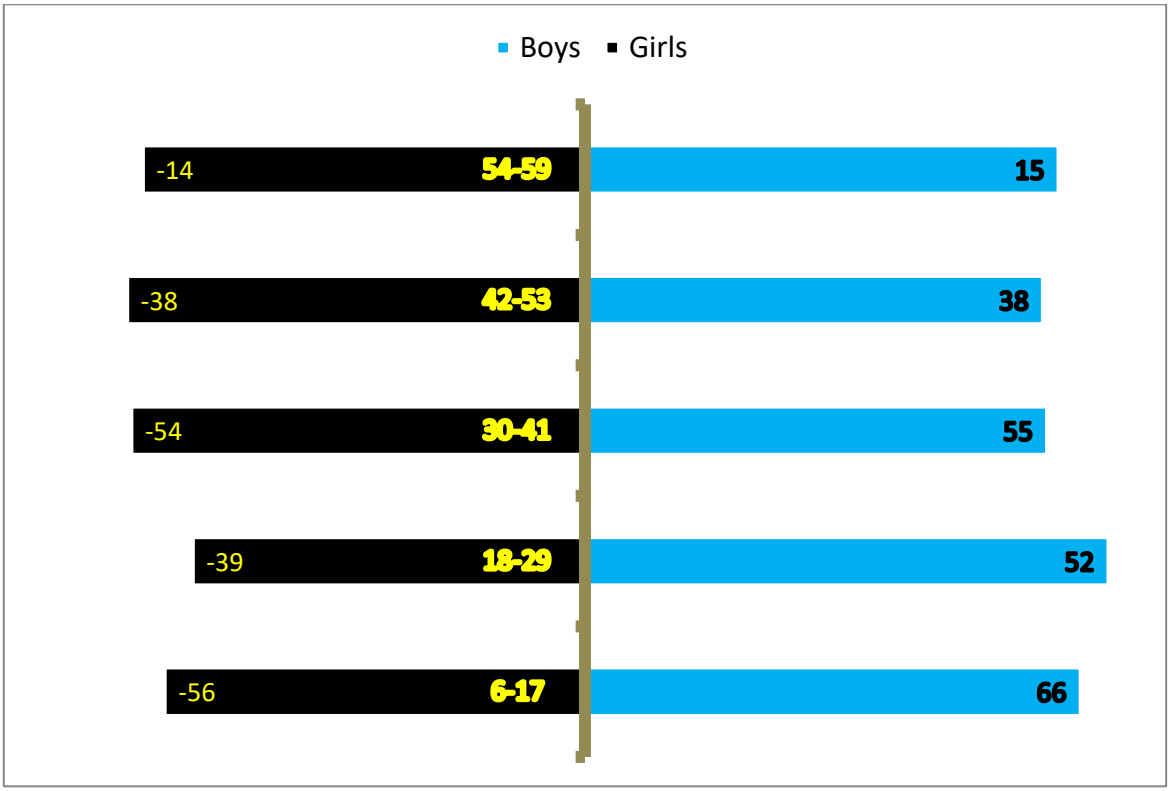
	Boys		Girls		Total		Ratio
AGE (mo)	**no.**	**%**	**no.**	**%**	**no.**	**%**	**Boy:girl**
6-17	66	54.1	56	45.9	122	28.6	1.2
18-29	52	57.1	39	42.9	91	21.3	1.3
30-41	55	50.5	54	49.5	109	25.5	1.0
42-53	38	50.0	38	50.0	76	17.8	1.0
54-59	15	51.7	14	48.3	29	6.8	1.1
Total	226	52.9	201	47.1	427	100.0	1.1

The distribution according to age shows the sample did not under- or over-represents any particular age group. An underrepresentation of an age group may reflect higher mortality

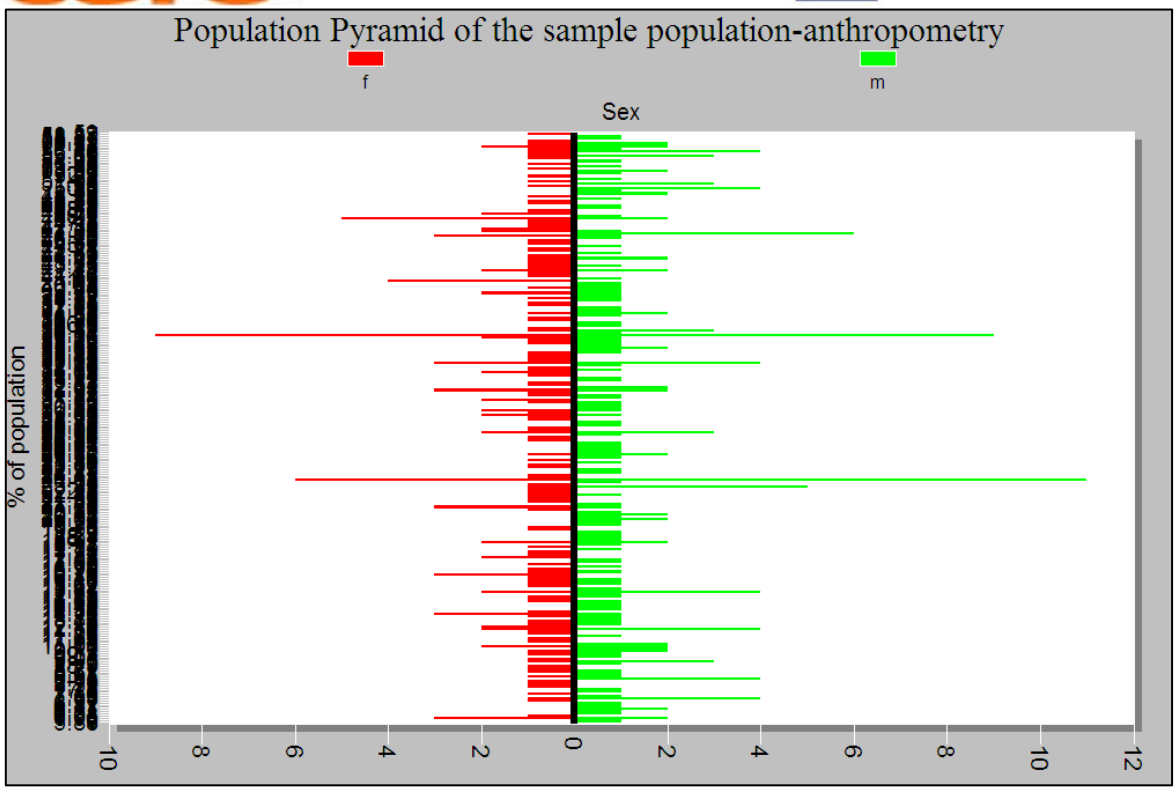
in that age group, or a bias in the survey. The age sub-groups used here were 6–17 months, 18–29 months, 30–41 months, 42–53 and 54–59 months. Each age group except the 54-59 months old group holds 12 months. The 54-59 month group holds 6 months. The population pyramid should have relatively uniform distribution across the youngest four age-bands with a top age-band about half the size of the others. This assumes a normal distribution by age group (for a population aged 6–59 months in the developing world). The 54–59 months age group has a lower percentage than the other groups shown because this group only covers a six-month band and the other groups all cover a 12-month band.

Similarly, age ratio of 6-29 months to 30-59 months was as expected. The value should be around 0.85. Similarly, overall age distribution for age groups 6–17 months, 18–29 months, 30–41 months, 42–53 and 54–59 months show an acceptable distribution.

Figure 5: Population age and sex pyramid of the sample population-Anthropometry



For each age group the population pyramid is shown below on Figure 5b below



Acute malnutrition

Acute malnutrition using weight for height z-scores

In this report, acute malnutrition (wasting) is estimated according to the Weight-for-Height (W/H) of each child and/or the presence of oedema. Weight-for-height expressed in z-score (WHZ) is calculated by comparing the anthropometric measurements of the sample to the WHO's 2006 standard population.

Acute malnutrition is classified at individual level as normal, moderate acute and severe acute malnutrition. At population level, the prevalence of malnutrition is expressed as severe acute malnutrition and global acute malnutrition. Global acute malnutrition expresses the sum of severe acute malnutrition and moderate acute malnutrition. This could be summarized:

- *Global acute malnutrition prevalence:* Proportion of children with WFH <–2 z-scores and/or oedema
- *Moderate acute malnutrition prevalence:* Proportion of children with WFH <–2 z-scores and WFH > = –3 z-scores
- *Severe acute malnutrition prevalence:* Proportion of children with WFH <–3 z-scores and/or oedema

Table 11 shows WHO's classification of public health significance or target for Weight-For-Height is shown on Table 6 below.

Table 12: Classification of the situation for weight-for-height (WHO)

Cut-off point	Classification of the situation
GAM >15%	Critical (Very High)
GAM > 10%-14%	Serious (High)
GAM >5%-9%	Poor (medium)
GAM <5	Normal (low)

During this survey, 426 children were included in the analysis. As highlighted in the Table 13 below 20.2% (17.1-23.7 95% CI) of children are wasted, and 2.8% (1.5- **5.1** 95% CI) of the children are severely wasted. These prevalence levels are classified as ***critical (very high)*** as per WHO public health significance classification.

Table 13: Prevalence of acute malnutrition based on weight-for height z-scores (and/or oedema) and by sex

	All n = 428	**Boys** n = 227	**Girls** n = 199
Prevalence of global malnutrition (<-2 z-score and/or oedema)	(86) 20.2% (17.1-23.7 95% CI)	(50) 22.0 % (16.6 - 28.6 95% C.I.)	(36) 18.1% (13.7-23.6 95% CI)
Prevalence of moderate malnutrition (<-2 z-score and >=-3 z-score, no oedema)	(74) 17.4% (14.6-20.6 95% CI)	(42) 18.5 % (13.5 - 24.9 95% C.I.)	(32) 16.1% (11.9-21.4 95% CI)
Prevalence of severe malnutrition (<-3 z-score and/or oedema)	(12) 2.8% (1.5- 5.1 95% CI)	(8) 3.5 % (1.7 - 7.3 95% C.I.)	(4) 2.0% (0.6- 6.6 95% CI)

The prevalence of oedema is 0.0 %

The distribution of WFH z-scores of the survey was plotted on a graph (red) and compared with the WHO standard population (green). Distribution curves of z-scores (Figure 6) give a complete picture of the nutrition status of the whole population, which can be compared with that of the WHO standard population. If the sample population's WHZ distribution (red) shifted to the left of the WHO standard population it means the population in our Rubkona are malnourished compared with the standard population, if the sample population's WHZ distribution (red) shifted to the right of the WHO standard population it means the population in our survey location are well nourished compared with the standard population, and if the sample population's WHZ distribution (red) exactly overlaps to the WHO standard population (green) it means the nutritional status of population in our survey locations and the standard population have similar nutritional status, implying the population in our survey locations are nutritionally good/healthy. In Figure 6 we can see that the sample population's WHZ distribution (red) has slightly shifted to the left compared with the standard population (green). This indicates that the population in Rubkona is malnourished compared with the standard population.

During this survey, 426 children were included in the analysis. As highlighted in the Table 13 below 20.2% (17.1-23.7 95% CI) of children are wasted, and 2.8% (1.5- **5.1** 95% CI) of the children are severely wasted. These prevalence levels are classified as ***critical (very high)*** as per WHO public health significance classification.

Figure 6: Frequency distribution of weight for height z score for the WHO standard population and sample population

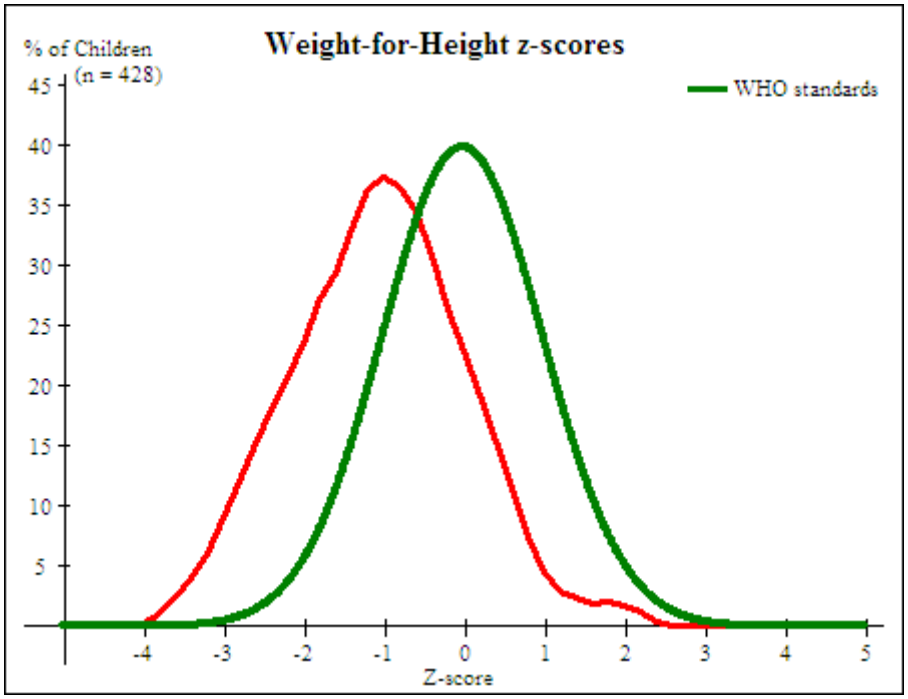


Table 14 shows the distribution of WFH with respect to the presence of oedema. This allows for the differentiation of children presenting with kwashiorkor from those presenting with marasmic kwashiorkor. Children with marasmic kwashiorkor are at greater risk of death than those with either marasmus or kwashiorkor alone. During this survey, the survey did not find a child with oedema. There were no children with marasmic kwashiorkor.

Table 14: Distribution of acute malnutrition and oedema based on weight-for-height z-scores

	<-3 z-score	**>=-3 z-score**
Oedema present	Marasmic kwashiorkor No. 0 (0.0 %)	Kwashiorkor No. 0 (0.0 %)
Oedema absent	Marasmic No. 13 (3.0 %)	Not severely malnourished No. 415 (97.0 %)

Age-specific prevalence of malnutrition (WFH z-scores of wasting, stunting and underweight)

Prevalence of malnutrition may be higher in one age group than another. Survey results are reported in Figure 7 for age specific prevalence of malnutrition defined by WFH z-scores and/or oedema. Children with oedema have their own column. The standard age groups are: 6–17 months, 18–29 months, 30–41 months, 42–53 months and 54–59 months. These age groups are centered on whole years – 12, 24, 36 months, etc. This is

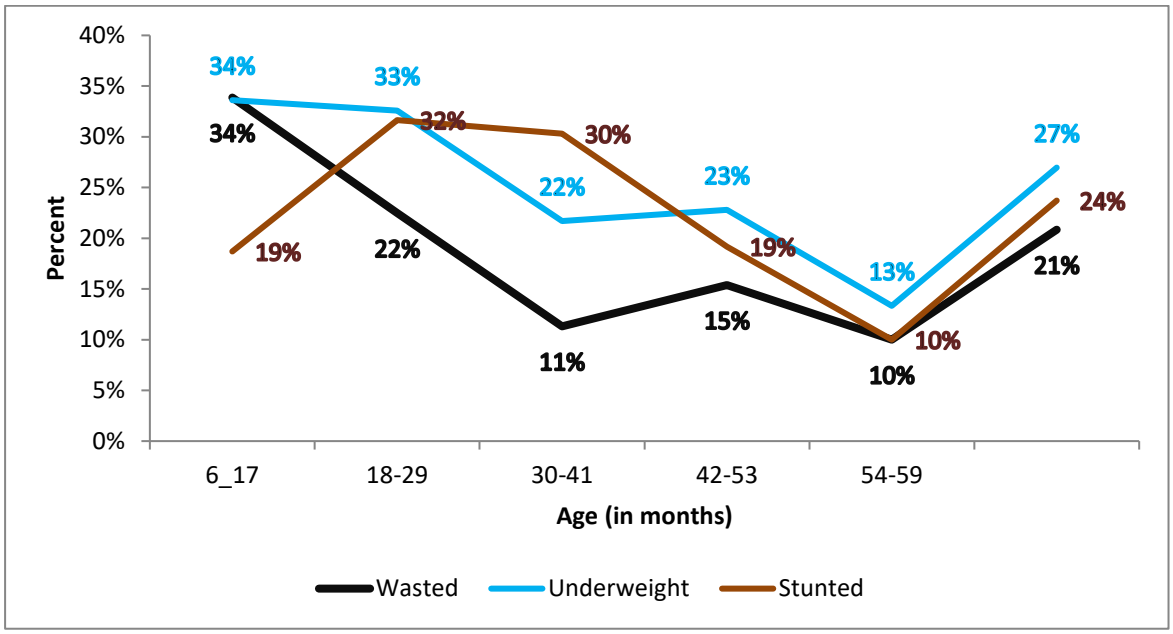
intended to balance the bias towards the reporting of age in whole years.

Wasting is highest (34 percent) in children age 6-17 months and lowest (10 percent) in children under age 54-59 months.

Stunting is highest (49 percent) in children age 18-29 months and lowest (10 percent) in children under age 54-99 months.

Underweight is highest (34 percent) in children age 18-29 months and lowest (13 percent) in children age 54-59 months.

Figure 7: Prevalence of wasting, stunting and underweight



Analysis of the indicators by age group shows that

Wasting is highest (34 percent) in children age 6-17 months and lowest (10 percent) in children under age 54-59 months. Severe wasting shows a somewhat similar trend, although stunting peaks later at 18-29 months (6.7 percent) and is lowest at 54-59 months (1.3 percent).

Stunting is highest (49 percent) in children age 18-29 months and lowest (10 percent) in children under age 54-99 months. Severe stunting shows a similar trend, stunting peaks at 18-29 months (8.9 percent) and is lowest at 54-59 months (0 percent).

Underweight is highest (34 percent) in children age 18-29 months and lowest (13 percent) in children age 54-59 months.

Acute malnutrition using MUAC

The weight for height index is used to quantify and qualify the prevalence of wasting in a population in emergency situations, where acute forms of malnutrition are the predominant pattern. However, the Mid-Upper Arm Circumference (MUAC) is a useful tool for rapid screening of children and detection of those who are at high risk of death.

Table 15 below summarizes the classification of malnutrition using MUAC according to

latest WHO recommendations and SPHERE standards[19] for children over 6 months of age.

Table 15: Acute malnutrition classification according to MUAC cut-off

MUAC in mm	Classification
≥135mm	Well nourished
125 – 134 mm	At risk of malnutrition
115 – 124 mm	moderate acute malnutrition
< 115 mm	severe acute malnutrition

Prevalence of proxy global acute malnutrition using MUAC cut-offs is 10.7% (7.9-14.4 95% CI) in Rubkona. The prevalence of proxy severe acute malnutrition (< 115 mm and/or oedema) was below the critical threshold of 1% (0.7%), (Table 16).

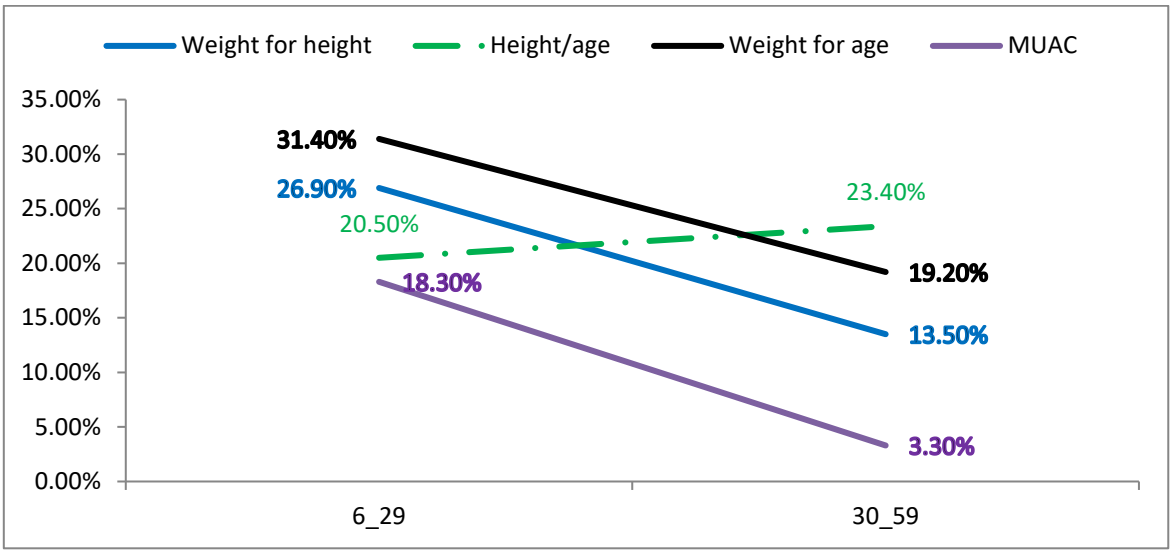
Table 16: Prevalence of acute malnutrition based on MUAC cut-off (and/or oedema) and by sex

	All n = 428	**Boys** n = 227	**Girls** n = 201
Prevalence of global malnutrition (< 125 mm and/or oedema)	(46) 10.7 % (7.9 - 14.4 95% C.I.)	(18) 7.9 % (5.3 - 11.8 95% C.I.)	(28) 13.9 % (9.8 - 19.5 95% C.I.)
Prevalence of moderate malnutrition (< 125 mm and >= 115 mm, no oedema)	(43) 10.0 % (7.5 - 13.3 95% C.I.)	(17) 7.5 % (5.0 - 11.1 95% C.I.)	(26) 12.9 % (9.2 - 17.9 95% C.I.)
Prevalence of severe malnutrition (< 115 mm and/or oedema)	(3) 0.7 % (0.2 - 2.2 95% C.I.)	(1) 0.4 % (0.1 - 3.2 95% C.I.)	(2) 1.0 % (0.2 - 4.0 95% C.I.)

There was a statistically significant relation between age and acute malnutrition (6-29 versus 30-59 months) using both MUAC and z-score criteria. The youngest age group (6-29 months) is more wasted than the oldest (30-59 months). Similarly, there was a statistically significant difference for underweight for the age groups between 6-29 and 30-59 months.

19 The SPHERE project, 2011

Figure 8: Prevalence of under nutrition for youngest and oldest group of children (6-29 and 30-59)



Underweight

Weight-for-age is a composite index of height-for-age and weight-for-height. It takes into account both chronic and acute malnutrition. A child can be underweight for his/her age because he or she is stunted, wasted, or both. Weight-for-age is an overall indicator of a population's nutritional health. At individual level, children with weight-for-age below minus two standard deviations (−2 SD) are classified as underweight. Children with weight-for-age below minus three standard deviations (−3 SD) are considered severely underweight.

At population[20] level, a global WFA ≧ 30% in a population is considered critical (very high), between 20%-29% high, between 10%-19% medium and less than 10% low (normal).

Table 17 shows that between 25.1% of under-age five children are underweight (have low weight-for-age) in Rubkona. The prevalence of weight-for-age in the survey location is classified as ***high*** level (between 20%-29% high).

20As per WHO classification

Table 17: Prevalence of underweight based on weight-for-age z-scores by sex

	All n = 418	**Boys** n = 222	**Girls** n = 196
Prevalence of underweight (<-2 z-score)	(105) 25.1% (20.2-30.8 95% CI)	(60) 27.0% (20.2-35.1 95% CI)	(45) 23.0% (17.6-29.4 95% CI)
Prevalence of moderate underweight (<-2 z-score and >=-3 z-score)	(70) 16.7% (12.8-21.6 95% CI)	(42) 18.9% (13.1-26.6 95% CI)	(28) 14.3% (10.1-19.9 95% CI)
Prevalence of severe underweight (<-3 z-score)	(35) 8.4% (6.2-11.2 95% CI)	(18) 8.1% (5.2-12.4 95% CI)	(17) 8.7% (5.8-12.8 95% CI)

Stunting

Children whose height-for-age Z-score is below minus two standard deviations (−2 SD) from the median of the WHO reference population are considered short for their age (stunted), or chronically malnourished. Children who are below minus three standard deviations (−3 SD) are considered severely stunted. Stunting reflects failure to receive adequate nutrition over a long period of time and is affected by recurrent and chronic illness. Height-for-age, therefore, represents the long-term effects of malnutrition in a population and is not sensitive to recent, short-term changes in dietary intake.

WHO classifications for stunting at a population level are: ≧ 40% critical (very high), 30%-39% high, 20%-29% medium and < 20% low.

Table 18: Prevalence of stunting based on height-for-age z-scores and by sex

	All n = 388	**Boys** n = 206	**Girls** n = 182
Prevalence of stunting[21] (<-2 z-score)	16.4% (11.8-21.2 95% CI)	15.8% (10.2-21.4 95% CI)	17.2% (11.2-23.3 95% CI)

Table 18 shows the overall and gender prevalence of stunting. The survey result showed that in Rubkona 22.1% of children under age five are stunted, and 8.9% of children are severely stunted. However, as illustrated in data quality section the stunting level is overestimated as revealed by high SD even after exclusion of flags from the analysis. Hence, the user is advised here that stunting is16.4. It is generally expected that the

[21] calculated with a SD of 1:

standard deviations of the weight-for-height z-scores (WHZ) and the weight-for-age (WAZ) will be smaller than the standard deviations of the height-for-age (HAZ) z-scores because the latter is associated with measurement error in age and height that tend to have higher error than measurements of weight. In this survey, the HAZ showed the greatest dispersion, with an SD ranging from 1.78 to 1.25 using no exclusion and both WHO and SMART exclusion criteria (all above 1.2) compared to the standard deviations of the other two scores. The wide dispersion is partly due to heterogeneity but also reflects measurement error caused by the difficulty in measuring age of children under five years. Determining how much of the dispersion can be attributed to heterogeneity and how much to measurement error is an ongoing data quality issue. To avoid overestimation of stunting, calculated area with SD 0f 1 (as opposed to count) was used. The results show that, overall, 16.4 percent of children under age 5 are stunted. Based on thresholds of WHO for stunting, the prevalence height-for-age is classified as ***low*** level (stunting< 20% low). When z-scores of stunting are disaggregated for children under 24 months of age and children 24 months of age and over, a clear distinction in the SDs is seen. SD was 1.99 for children under 24 months where us it was 1.63 for children 24 months of age and over. In other words SD was above 1.2 in both age groups. Had height been the problem, the pattern may have been an acceptable SD for above 24 months and high SD for under 24 months (due to the difficulty of measuring the youngest children, who are lying down). Therefore may be due to the heterogeneity of the population, but it may also indicate poor age data quality. The index of dispersion is not significant (p >0.05) it means that the distribution conforms to a Poisson distribution (HAZ < -2: ID=1.38 (p=0.066)). Since the ID is above 1 it shows heterogeneity.

The mean z-score is used as a way to describe the nutrition status of a population like WFH, MUAC, HFA and WFA prevalence. It measures acute, chronic and underweight malnutrition. The mean z-score is the statistical mean of the individual WHZ, WFH and WFA values in a group. It indicates the overall nutritional status in the group. This indicator provides a summary of the nutrition status values of all children in a group. The mean does not also change substantially with random errors, and is thus a much more robust (reliable) statistic of the nutritional state of the population, It provides an average figure and may be useful to compare the nutrition status of groups of children over time or between different groups of children. The mean z-score (mean Weight-for-Height, mean Weight-for-Age and mean Height-for-Age) [22]is different from the acute, chronic and underweight prevalence as it describes the nutritional status of the **entire population** directly without resorting to a subset of individuals below a set cut-off.

Mean weight-for-height z-score value of the survey is slightly above the critical level (-1) as per WHO guidelines[23], indicating the population as a whole is affected. Bench-marks of levels of wasting used to guide intervention declare a mean weight-for-height z-score > -1 as critical[24]. Mean stunting is -0.88 and underweight is -1.22.

22The mean WHM or WHZ cannot be used to define malnutrition in individuals. There are no internationally accepted cut-offs for mean WHM or WHZ.

23Mean weight-for-height less than -1 is classified as a critical situation in the population

24 WHO and UNICEF joint statement, 2000

Extreme mean z-scores of height-for-age and weight-for-age are indicatives for an intervention for the entire community, not just those who are classified as "malnourished" by the cut-off criteria (i.e. HFA and WFA).

Mortality

Demographic characteristics of the survey population

This sub-section summarizes demographic and socioeconomic characteristics of the population in the households sampled in the 2016 Post-Harvest SMART nutrition and mortality survey in Rubkona (three Payams).. It is helpful to understand that in the survey a household was defined as a person or a group of persons, related or unrelated, who live together and who share a common source of food. Information was collected from all of the usual residents of each selected household and from visitors who had stayed in the selected household the night before the interview. Those persons who stayed in the selected household the night before the interview (whether usual residents or visitors) represent the de facto population; usual residents alone constitute the de jure population.

Population by age and sex

Age and sex are important demographic variables and are the primary basis of demographic classification. Table 20 shows the distribution of the de facto household population in the 2016 post-Harvest SMART survey by age groups, according to sex and demographic variables. A total of 2,764 individuals were residing in the sampled households; 1,515 were female (**55 percent**), and 1,249 were male (**45 percent**). There are more persons in the younger age groups than in the older age groups for both sexes, with those under age 17 accounting for more than half of the population (52% of overall population, 59% of male and 46% of female).

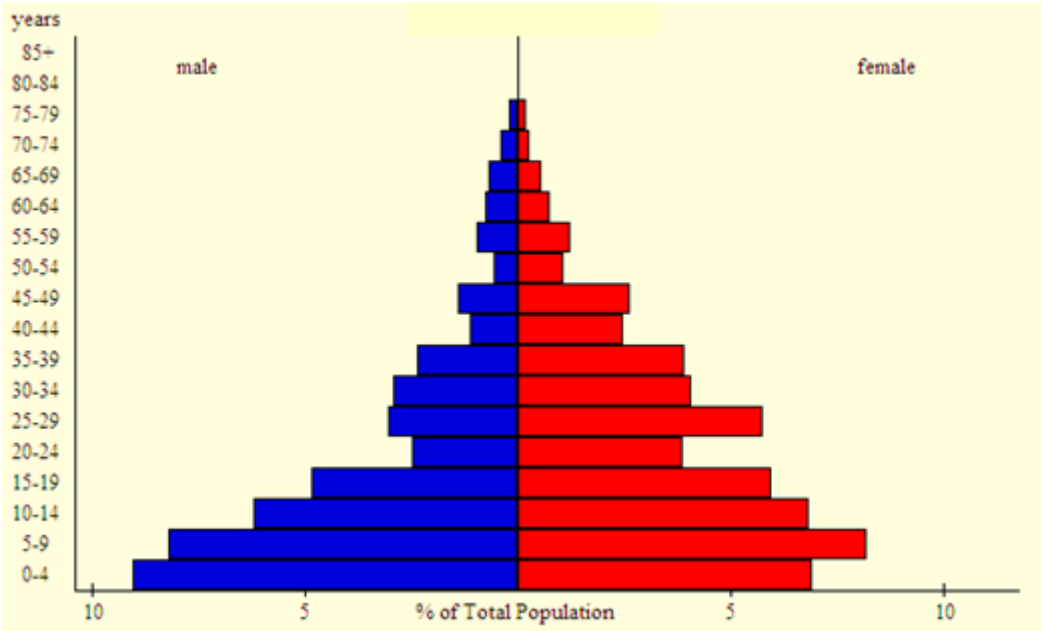
Table 19: Percent distribution of the de facto household population by age groups, according to sex and demographic variables, Rubkona County, December 2016

Years	Popul.	male	female	joined	left	Births	Deaths
0-4	**441.5**	250	191.5	13	18	17	5
'5-11	**595**	296	299	16	26		4
'12-17	**401**	190.5	210.5	22	48		4
'18-49	**1114.5**	413.5	701	57	211		37
'50-64	**147**	62.5	84.5	8	34		6
'65-120	**65**	36.5	28.5	3	15		12
Sum:	**2764**	**1249**	**1515**	**119**	**352**	**17**	**68**

Figure 9 illustrates the age-sex structure of the survey population, in a population pyramid. The share of the population under age 17 make about 52 percent; people age 15 and older make up 48% percent of the total survey household population. The pyramid has a wide base, indicating that a large proportion of the population is under age 17. One

important deviation is that between the age of 15 and 49 more female are observed in the sample population than male. These are due to the fact that this male age group has moved either to PoCs or joined armed groups. These are further confirmed by the unusually larger female household headship than male.

Figure 9: Population Pyramid



Composition of households in surveyed population

Table 21 presents information on key aspects of the composition of households, including the sex of the household head and the size of the household. These characteristics are important because they are associated with the welfare of the household. Households headed by women, for example, are typically poorer than households headed by men. In large households economic resources are often more limited than in small ones. Moreover, where the size of the household is large, crowding can lead to health problems.

The data for household composition show that women head 56 percent of households, a higher proportion than observed in most developing countries including South Sudan. There are big differences in out (14.15%) and in migrations (4%), out migrants are 3 times larger than in migrants. The data also show that the mean size of a household is 6.2 persons, the same as the May, 2016 pre harvest SMART survey in Rubkona.

Table 20: Household composition, percent distribution of households by sex of head of household, mean size of the household, and rates of in and out migration and birth rate

Total number of HHs	446
Total number of HHs with children under	278

five	
Average household size	6.2
Mid Interval Population Size	2764
Percentage of children under five	16.9
Birth Rate	0.68
In-migration Rate (Joined)	4.78
Out-migration Rate (Left)	14.15
Household headship	
Male	44%
Female	*56%*

Mortality rates

Crude and under-5 mortality rates are key indicators to evaluate the magnitude of a crisis, and a doubling of non-crisis (baseline) mortality is taken to define an emergency situation. Mortality is normally reported in two ways: crude mortality rate (CMR) and under-five mortality rate (U5MR). These rates are defined as:

- CMR: the rate of death in the entire population, including both sexes and all ages (total deaths/10,000 people/day
- U5MR: the rate of death among children below five years of age in the population 9deaths in children under five/10,000 children under five/day)

Baseline, non-crisis CMRs in most of Sub-Saharan Africa are in the range 0.3-0.6 per 10,000 per day, with a probable current average of 0.44.[25] Based on this, in 1990 Toole and Waldman suggested an approximate doubling of Crude Mortality Rate (to 1 per 10,000 per day) as a useful threshold for formally declaring an emergency, from a health stand point. This simple threshold has since been adopted widely and incorporated into various humanitarian guidelines.[26]

A summary of mortality benchmarks for defining crisis situations is presented on Table 22. It is very important not to lose sight of the fact that any such threshold is merely an arbitrary value, whose role is primarily to provide a framework for evaluating the magnitude of an emergency, and for justifying the implementation of a relief operation. Also, it should be stressed here that the mortality rate refers to the recall period (90 days before the survey date).

[25]Centers for Disease Control, 'Famine-affected, Refugee, and Displaced Populations: Recommendations for Public Health Issues', *MMWR Recomm* Rep, 1992;41(RR-13):176; Sphere Project, Sphere Handbook, revised ed., 2004, www.sphereproject.org

[26]M.J.Toole and R.J.Waldman, Prevention of Excess Mortality in Refugee and Displaced Populations in developing Countries', JAMA, 1990;263(24):3296-302

Table 21: Mortality benchmarks for defining crisis situations[27]

Agencies	Assumed baseline	Emergency thresholds
CDC, MSF, Epicenter, Academia	CMR:0.5/10,000/day	CMR≥ 1/10,000/day or
	U5MR: 1/10,000/day	U5MR≥ 2/10,000/day
UNHCR	CMR:0.5/10,000/day	CMR> 1/10,000/day: 'very serious CMR> 2/10,000/day: 'out of control' CMR> 5/10,000/day: 'major catastrophe'
	U5MR: 1/10,000/day	Double for U5MR thresholds
Sphere Project Note: If baseline is not known, Sphere goal is CMR< 1/10,000/day	Context-specific CMR (U5MR)	
	Sub Saharan Africa (CMR=0.44, U5MR=1.14)	

Mortality rates were calculated retrospectively over a 90 day recall period. In terms of absolute number of deaths over a 90-day recall period was a total of 68 deaths (of which only 5 were under-5 years children's death and 63 were adult deaths). The retrospective crude and U5 mortality rates**) for the 90 days preceding the survey** were **2.64 (1.87-3.72)** and **1.11 (0.48-2.57),** respectively.

Table 22: Retrospective mortality rates of surveyed Payams in Rubkona during September 2-December 2, 2016

Parameters for Mortality	Results (CI 95%)	Design effect
CMR (deaths per 10 000/day)	2.64 (1.87-3.72)	2.01
U5MR (deaths in children <5/10 000/day)	1.11 (0.48-2.57)	1
Age specific mortality		
'0-4	1.11 (0.48-2.57)	1
'5-11	0.75 (0.27-2.04)	1

[27]Adapted from Checchi and Roberts, 2005

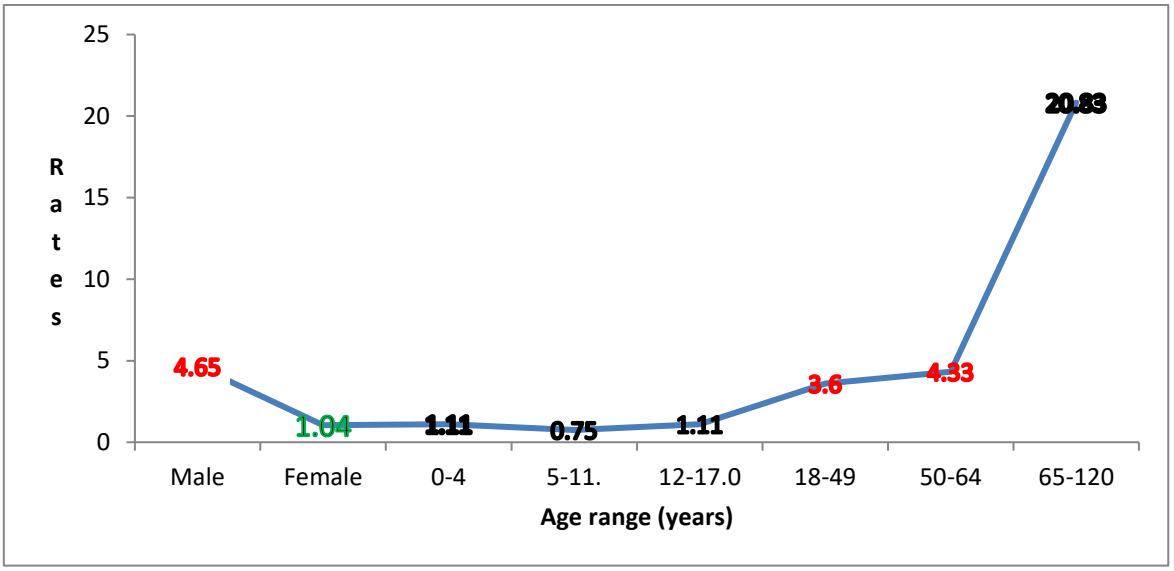
'12-17	1.11 (0.42-2.86)	1
'18-49	3.60 (2.22-5.79)	2.13
'50-64	4.33 (2.04-8.96)	1
'65-120	20.83 (9.39-40.65)	1.94
Sex specific mortality		
Male	4.65 (3.13-6.86)	2.08
Female	1.04 (0.59-1.85)	1.2

Cause of death	
Unknown	19.1%
Injury/Traumatic	8.8%

Location of death	
1] In current location	7.4%
2] During migration	7.4%
3] In place of last residence	10.3%

Nonetheless, Figure 10 shows that the death is predominantly during the 18-59 years and for men. Male mortality rates as four times higher than women's and child mortality is the lowest when compared to other age groups.

Figure 10: Age and specific mortality, Rubkona, December 2016



Immediate causes of malnutrition: Children's morbidity

The immediate cause of malnutrition, operating at the individual level, is an imbalance between the amount of nutrients absorbed by the body and the amount of nutrients required by the body. When the body's requirements are not met, malnutrition can occur. This happens as a consequence of consuming too little food or having an infection which either increases the body's requirements or causes the body not to absorb the food consumed. In practice, these two problems often occur at the same time because one can lead to another (the infection and malnutrition cycle).

Most mortality in the initial period of an emergency is caused by four infectious diseases: gastro-enteritis (for example, shigellosis and cholera), acute lower respiratory infections, measles and malaria. These diseases often occur alongside malnutrition. Different infections interact differently with nutrition. The interaction depends on the infection itself and on the extent of malnutrition.

Interpretation of results of the anthropometry survey, need indicators on immediate causes of malnutrition. To this effect, in the anthropometric questionnaire mothers were asked whether any of their children under age five had illness at any time during the two-week period preceding the survey. The validity of these indicators is affected by the mother's perception of diarrhea/fever/cough/measles as an illness and her capacity to recall the events. Thus, these variables should be interpreted with caution.

Table 24 shows that 64.0% of children under age five had illness at any time during the two weeks-period preceding the survey.

Table 23: Prevalence of reported illness in children in the two weeks prior to interview (n=428)

	6-59 months	Design effect
Prevalence of reported illness	64% (54.9-73.695% C.I.)	3.9

Those mothers who reported illness in the past 14 days were further asked to describe the symptoms at any time during the past 14 days. Fever was most common (56.4%) followed by cough (22.3%), and diarrhoea (13.6%), Table 25.

Table 24: Symptom breakdown in the children in the two weeks prior to interview (n=428)

	6-59 months
Diarrhoea (n=41)	13.6% (7.7-19.5 95% C.I.)
Cough (n=67)	22.3% (14.3-30.1% 95% C.I.)
Fever (n=70)	56.4% (45.3-65.6 95% C.I.)
Other (n=23)	7.6% (2.2-13.195% C.I.)

For children who had illness in the two weeks preceding the survey, mothers were asked what they did to treat the illness. Table 26 shows the percentage of children with illness who received specific treatments. Overall, 95% percent of the children with illness were taken to a health care facility or provider where advice or treatment was sought.

Table 25: Among children (6-59 months) who had illness in the two weeks preceding the survey, the percentage for whom advice or treatment was sought from a health facility or provider

Treatment sought (n=267)	*Results (CI 95%)*
Hospital (n=122)	45.7% (30.8-60.5 95% C.I.)
PHCC/U (n=112)	41.9% (27.6-56.3 95% C.I.)
Mobile/outreach clinic (n=14)	5.2% (0.0-10.9 95% C.I.)
CBD (n=2)	0.8% (0.0-2.8 95% C.I.)
Private clinic (n=6)	2.3% (0.0-4.5 95% C.I.)
Traditional practioners (n=3)	1.1% (0.0-2.8 95% C.I.)
None (n=8)	2.9% (0.7-5.3 95% C.I.)

Dehydration caused by severe diarrhoea is a major cause of morbidity and mortality among young children, although the condition can be easily treated with oral rehydration

therapy (ORT). A simple and effective response to dehydration is a prompt increase in fluid intake. Exposure to diarrhoea-causing agents is frequently related to the use of contaminated water and to unhygienic practices in food preparation and disposal of excreta.

To help reduce dehydration and minimize the adverse consequences of diarrhea on the child's nutritional status, mothers are encouraged to continue feeding their child the same amount of food as they would if the child did not have diarrhea, and are also encouraged to increase the child's fluid intake. All mothers were asked whether they gave their child with diarrhoea less, somewhat less, the same amount, or more fluids and food than usual wen EVER their child had diarrhoea before. Table 27 shows the percent distribution of children under age 5 who had ever diarrhoea by the feeding practices. The results show that 9 percent of children with diarrhoea were given the same amount of liquids as usual, and 48 percent were given more liquids than they are normally given. It is of concern that 20 percent of the children were given somewhat less to drink than usual, and 20 percent were given much less to drink during the diarrhoea episode.

Table 26: Feeding practice during diarrhoea

Diarrhoea treatment	Mothers were asked what they will do to treat the illness when their children who had diarrhoea (hypothetical question to elicit health seeking behaviour). They responded they give liquids	More than usual	47.6%
		Same as usual	9%
		Less than usual	20%
		Nothing at all	20%

Malaria is endemic in south Sudan and a major public health problem, as the entire population is at risk of developing the disease. *Plasmodium falciparum* is the dominant parasite mainly responsible for all severe cases and over 90 percent of uncomplicated cases. However, there are also cases of clinical malaria caused by *Plasmodium malariae and ovale* or a mixture of these and *falciparum.* Malaria transmission is largely determined by climatic factors, including temperature, humidity, and rainfall. Transmission is high and stable with seasonal peaks at the beginning and end of the rainy season.

Global and regional political commitment to prevent and control malaria has steadily increased in the past decade. The African Union heads of state jointly manifested this commitment in 2000 under the Abuja Declaration by calling for universal access to HIV/AIDS, tuberculosis, and malaria services by 2010 for all Africans.[28]

Age is an important factor in determining levels of acquired immunity against malaria. In the first six months of life, children are protected against malaria by the antibodies they acquired from their mother. As children age, however, the immunity is gradually lost as they begin to develop their own immunity. For this reason, children under age 5 are most vulnerable to severe complications of malarial infection due to their reduced immunity. Table 28 presents use of mosquito nets by children under age 6-59. Ninety-five percent of all children (95 percent) slept under a mosquito net the night before the survey.

[28] Roll Back Malaria (RBM) Partnership Secretariat, World Health Organization (WHO). 2003. The Abuja Declaration and the Plan of Action. WHO/CDS/RBM/2003.46. http://www.rbm.who.int/docs/abuja_declaration.pdf.

Table 27: Use of mosquito net by 6-59 months old children in the household

Did the child sleep under a mosquito net last night? n=425	Results (CI 95%)
Yes (n=407)	95.8% (93.3-98.2 95% C.I.)
No (n=18)	4.2% (1.2-1.8 95% C.I.)

Underlying causes (public health): immunization coverage and vitamin a supplementation

Information on BCG and measles vaccinations, vitamin A supplementation and deworming coverage were collected during an anthropometric survey because of their relationship with mortality and malnutrition.

The survey collected information on vaccination and supplementation coverage in three ways: from vaccination cards shown to the interviewer, from mothers' verbal reports, and by checking BCG scars. For each of these children, mothers were asked to provide their health card. When interviewers could see these health cards, the data of vaccinations were copied from the card onto the questionnaire. The reference period for these indicators was the past six months. If the interviewer did not see the card or if a vaccine had not been recorded on the card as being administered, the mother was asked to recall the specific vaccines given to her child. The vaccination coverage is based on both the information copied from the health cards and the information obtained from the mothers' reports. If the cards were available, the interviewer copied the vaccination data directly onto the questionnaire. When there was no vaccination card for the child or if a vaccine had not been recorded on the card as being given, the respondent was asked to recall the vaccines given to her child.

Table 29 show BCG vaccination coverage and vitamin A supplementation in children aged 6-59 months, measles immunization for 6-59 months and deworming for 12-59 months, in the six months prior to the survey period. In general, low percentage of children received vitamin A supplementation and immunizations.

Table 28: Vaccination coverage: BCG for 6-59 months and measles for 9-59 months, Vit A 6-59 months and deworming for 12-59 months

Vit A n=427	BCG n=425	Dewormed n=364	Measles (with card) n=387	Measles (with card or confirmation from mother)

				n=387
(266) 62.1% (50.6-73.595% C.I.)	(274) 64.5 % (53.5-75.495% C.I.)	(161) 44.2 % (34.3-54.4% 95% C.I.)	(227) 58.7% (44.4-72.9% 95% C.I.)	(276) 71.3% (58.7-83.9% 95% C.I.)

Programme coverage

Coverage is a measure of program impact, as it indicates the proportion of the eligible population who has accessed the program. An eligible child is defined as a child who should be enrolled in the program. For example, a severely malnourished child with MUAC <115mm should be enrolled for an OTP and hence would be eligible for that type of program. The coverage estimate was calculated for those children that were found by the survey to be severely malnourished using a MUAC cut-off (MUAC<115) and WFH z-scores.

Table 30 shows selective program coverage for both supplementary and therapeutic feeding programs in Rubkona. Both coverage rates were below 50%. Sphere minimum standard recommends selective feeding program coverage level should be >50%.

Note: It should be emphasized here that the sample size calculated for an anthropometric survey allows the prevalence of acute malnutrition to be estimated with reasonable precision, but the sample size available to estimate coverage depends on the prevalence of acute malnutrition found by the survey. To estimate the coverage of feeding program for severe acute malnutrition (OTP), the sample size is too small to estimate coverage with reasonable precision.

Table 29: Selective feeding program coverage

Programme type	***Coverage***	***Remark***	***Design effect***
Supplementary feeding programme coverage (n=92)	(18)19.6% (8.4-30.7% 95% C.I.)	A total of 92 cases of MAM were identified by either MUAC or z-score criteria of which 18 were in SFP and 20 were in OTP. Overall, 38 of MAM cases out of 92 were either in SFP or in OTP programs	1.7
Therapeutic feeding programme coverage (n=16)	(4) 25% (2.3-47.7% 95% C.I.)	Of the 16 SAM cases using both MUAC and z-score, criteria 4 were in OTP and another 4 were in	1.27

		SFP program.	

Underlying causes (the social and care environment): IYCF

Suboptimal infant and young child feeding practices increase vulnerability to under-nutrition, disease and death. The risks are heightened in disasters and the youngest are most vulnerable. Optimal feeding practices that maximize survival and reduce morbidity in children under-24 months are early initiation of exclusive breastfeeding, exclusive breastfeeding for 6 months, continued breastfeeding to 24 months or beyond, and introduction of adequate, appropriate and safe complementary foods at 6 months.

Timely initiation of breast feeding is the Initiation of breast feeding immediately or within one hour after delivery. It also includes the provision of colostrum and avoidance of prelacteals such as water, other liquids, and ritual fluids. This indicator is based on historic recall.

Infant and young child feeding practices reported in this survey include early initiation of breastfeeding, continued breastfeeding at 1 year, continued breastfeeding at 2 years, children ever breastfed, introduction of solid, semi-solid or soft foods and the diversity of food groups fed to children age 6-23 months.

The survey has used standard guideline of WHO to analyze infant and young feeding practices.[29]Early initiation of breastfeeding was calculated by dividing children born in the last 24 months who were put to the breast within one hour of birth over children born in the last 24 months. Continued breastfeeding at 1 year was calculated by dividing children 12–15 months of age who received breast milk during the previous day over Children 12–15 months of age. Continued breastfeeding at 2 years was calculated using Children 20–23 months of age who received breast milk during the previous day over Children 20–23 months of age. Children ever breastfed (proportion of children born in the last 24 months who were ever breastfed) was calculated by dividing Children born in the last 24 months who were ever breastfed over children born in the last 24 months

Table 31 shows the percentage of children who started breastfeeding within one hour, percentage of children who are exclusively breast feed, percentage of children Continued breastfeeding at 1 year and 2 year, Minimum individual dietary diversity, Minimum meal frequency, Mean meal frequency and percentage of Children ever breastfed.

Table 30: Percentage of children aged 6-23.9months living with their mother by IYCF practices

IYCF indicator	Definition	%
Percentage of children ever breastfeed (n=197)		(187) 95.8 % (91.7 - 100.0 95% C.I.)
Early initiation of	Proportion of children born in the last 24 months	(182) 94.3 %

[29]Indicators for assessing infant and young child feeding practices, Part 2 Measurement, WHO, USAID, FANTA II, IFPRI, Unicef

IYCF indicator	Definition	%
breastfeeding (n=197)	who were put to the breast within one hour of birth.	(90.5 - 98.1 95% C.I.)
Exclusive breastfeeding under 6 months (n=43)	Proportion of infants 0–5 months of age who are fed exclusively with breast milk.	(26) 63.4 % (41.9 - 85.0 95% C.I.)
Continued breastfeeding at 1 year (n=41)	Proportion of children 12–15 months of age who are fed breast milk.	(41) 100.0 % (100.0 - 100.0 95% C.I.)
Continued breastfeeding at 2 years (n=33)	Continued breastfeeding at 2 years was calculated using Children 20–23 months of age who received breast milk during the previous day over Children 20–23 months of age	(28) 84.8 % (63.3 - 100.0 95% C.I.)
Minimum meal frequency (n=136)	Proportion of breastfed and non-breastfed children 6–23 months of age, who receive solid, semi-solid, or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more.	90%
Mean meal frequency (n=136)	The average frequency of feeding within the last 24 hours	2.074 (1.66. - 2.49 95% C.I.)

Underlying causes (the social and care environment): food security, water, sanitation and livelihood

The survey collected data based on the Food and Nutrition Security Conceptual Framework which considers food availability, food access and utilization as core pillars of food security and link these to households' livelihood strategies and assets. The Food Security questions looks at three key sets of indicators to define the ***current*** state of food security among the surveyed population:

- Food assistance-related issues,
- Household dietary diversity
- Agricultural situation to access food

It aims to measure the following core indicators at the household level:

- Access to food assistance
- Level of household dietary diversity
- Food security condition in coming months

The analysis used 2 measures as proxy indicators to assess household food security which are Food Consumption Score (FCS) and Dietary Diversity (HDDS). The survey collected data from 443 households out of planned 472.

Food security sample information

Household data	*Planned*	*Actual*	*% target*
Total households surveyed for Food Security	*472*	*443*	*94%*

The FSL questionnaire finds that 43.9% of households were headed by males and 52.8% by females; 67.5% of the households were residents, 20.2% returnees and 10% IDPs.

Characteristics (n=441)	*Result (95% C.I)*
Headship status	
Male headed	*43.9 (35.1. – 55.9 95% C.I.)*
Female headed	*52.8 (43.9. – 61.8 95% C.I.)*
Residence status of HH	
Resident	*67.5 (56.2. – 78.8 95% C.I.)*
Returnee	*20.2 (11.1. – 29.4 95% C.I.)*
IDP	*10.0 (3.0. – 16.9 95% C.I.)*

Main results of the FSL assessment are presented below.

Food Consumption Score (FSC)

The FCS is considered as a proxy indicator of current food security. FCS is a composite score based on dietary frequency, food frequency and relative nutrition importance of different food groups. Dietary diversity is the number of individual foods or food groups consumed over the past seven days. Food frequency is the number of days (in the past 7 days) that a specific food item has been consumed by a household. Household food consumption is the consumption pattern (frequency * diversity) of households over the past seven days. The prevalence of households with poor and borderline food consumption provides essential information on people's current diets and is helpful in deciding the most appropriate type and scale of food security intervention as well as the right target group for the assistance.

The mean Food Consumption Score of the overall surveyed population was 35.9, (Table 32). The overall current food security status of the whole population is classified as ***acceptable***.

Table 31: Mean Food Consumption Score

	Mean (95% C.I)
Mean Food consumption Score (n=440)	*35.99 (31.5. – 44.5 95% C.I.)*

Based on FCS classification criteria 21% of households are currently classified as having a ***poor*** food security status, 31% are with a ***borderline*** level of food security and almost half of the surveyed population are currently with ***acceptable*** food security status, (Table 33).

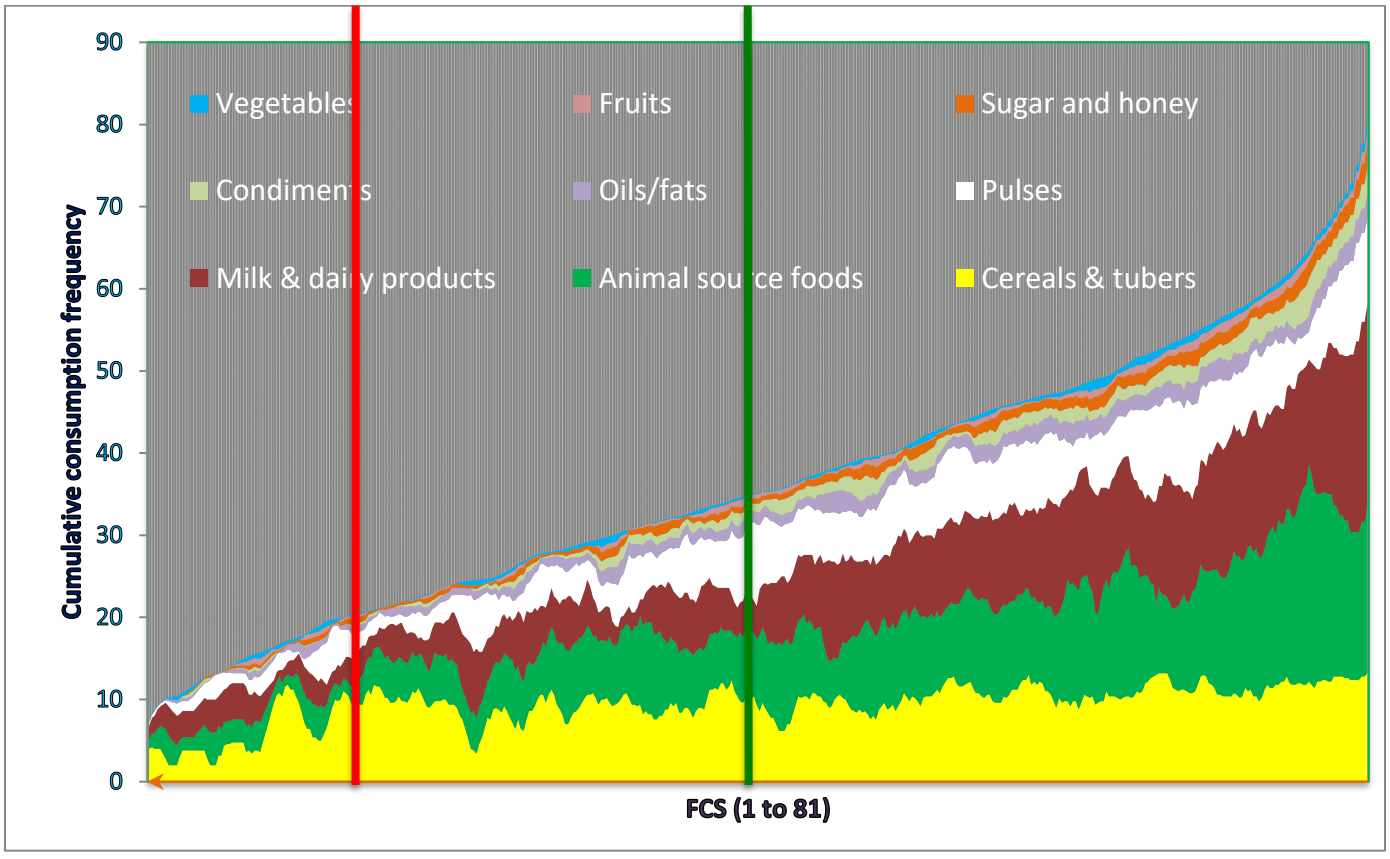
Table 32: Profiles of the surveyed population based on FCS classification criteria

FCS threshold range	Profiles/classification	Number of households	% of households

0-21	Poor	91	21%
21.5-35	Borderline	135	31%
>35	acceptable	214	49%

Figure 11 shows food consumption score type of food consumed in past seven days preceding the survey. Across all FCs groups' cereals (staple), milk and milk products and animal protein heavily featured (check out yellow, green and red area graphs on Figure 11). A commonly encountered complication when calculating FCs is found in populations where consumption of sugar and/or oil is frequent among nearly all households surveyed, even when the consumption of other food groups is rare and the food score is otherwise low. It is clear here that a score of 21 reflects mainly consumption of starches, animal protein and dairy. Hence, the use of the cut-off points at 21 threshold for FCs score is justified. If the population is found to homogeneously consume oil and sugar nearly daily, the thresholds for the three consumption groups can be raised from 21 and 35 to 28 and 42 (by adding 7 to each threshold, this accounts for the daily consumption of oil and sugar which gives 7 points to the FCS). Here, the alternate cut-off of 28 was not used as frequent consumption of oil, sugar, and starches is few and heterogeneous and there is a slightly higher average consumption of other food groups. More over figure 11 reveals that consumption of consumption of vegetables and fruits is rare across all FCS scores,

Figure 11: Food consumption Score with frequency of the food groups consumed during seven days preceding the survey



Sources of food for the past seven days (the FCS recall period) were gathered in order to obtain a more comprehensive understanding of the HH food availability and access. Also, this helps verification of findings of the FCS results**. (See discussion section in this report for their relationship with FCS.)**

Table 34 shows main source of food for consumption in the past 7 days. Own production (26%), food aid (25.7%), and market purchase (21%) almost account for three fourth of the main source. Overall, only a quarter of surveyed households source their food in the past 7 days from their own production. As the survey period is a period immediately after harvest post-harvest season), this is a low proportion. Eight percent of surveyed households depended on Gifts from neighbors, and 8% had to borrow to meet their food consumption in the seven days preceding the survey (15% have to opt for stressful means of acquiring food).

Table 33: Main source of food for consumption in the past 7 days (n=420)

Primary source of food	*Number*	*%* *(95% C.I)*
Own production	110	*26%* *(16.9. – 35 95% C.I.)*
Work for food	13	*3%* *(0.0 – 6.8 95% C.I.)*
Gifts from neighbours	34	*8%* *(4.3. – 11.8 95% C.I.)*
Market/shop purchase	92	*21.9%* *(13.3. – 30.5 95% C.I.)*
Borrowing/debts	32	*7.6%* *(3.7. – 11.6 95% C.I.)*
Food aid	108	*25.7%* *(15.4. – 35.9 95% C.I.)*
Hunting	4	*1%* *(0.0. – 1.5 95% C.I.)*
Fishing	4	*1%* *(0.02. – 1.9 95% C.I.)*
Gathering	16	*3.8%* *(0.5 – 7.1 95% C.I.)*

Table 35 shows that 65% of the surveyed population did not harvest during this season and 3 in four households did not own livestock at all. The surveyed community is basically a pastoralist community with marginal activities of agriculture. The proportion of households without livestock is alarming. Respondents reported that their cattle were taken away during the conflict. Further, it is known that livestock is a signature of wealth

and status in pastoralist communities. Additionally, livestock provides the most important diet of pastoralists (milk and milk products). Having been stripped of these key assets the surveyed population is stripped off their key livelihood means.

Table 34: Agricultural harvest and production indicators

Proportion of households that did not cultivate during this season	64.3%
Proportion of households without livestock holding	76.9%

Household dietary diversity

Household dietary diversity - the number of different food groups consumed over a given reference period - is an attractive proxy indicator for the following reasons:[30]

- A more diversified diet is an important outcome in and of itself.
- A more diversified diet is associated with a number of improved outcomes in areas such as birth weight, child anthropometric status, and improved hemoglobin concentrations.
- A more diversified diet is highly correlated with such factors as caloric and protein adequacy, percentage of protein from animal sources (high quality protein), and household income. Even in very poor households, increased food expenditure resulting from additional income is associated with increased quantity and quality of the diet.

To reflect a quality diet, the number of different food groups consumed is calculated. To calculate the HDDS, this survey included a question on the household questionnaire the following set of 12 food groups:

- Cereals
- Root and tubers
- Vegetables
- Fruits
- Meat, poultry, offal
- Eggs
- Fish and seafood
- Pulses/legumes/nuts
- Milk and milk products
- Oil/fats
- Sugar/honey

To better reflect a quality diet, the number of different *food groups* consumed is calculated, rather than the number of different *foods* consumed. Knowing that households consume, for example, **an average of four different food groups implies that their**

[30] Hoddinott, John and Yisehac Yohannes. Dietary Diversity as a Household Food Security Indicator. Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington, D.C. 2002. As viewed at www.fantaproject.org/publications/dietdiversity1.shtml.

diets offer some diversity in both macro- and micronutrients. This is a more meaningful indicator than knowing that households consume four different foods, which might all be cereals.

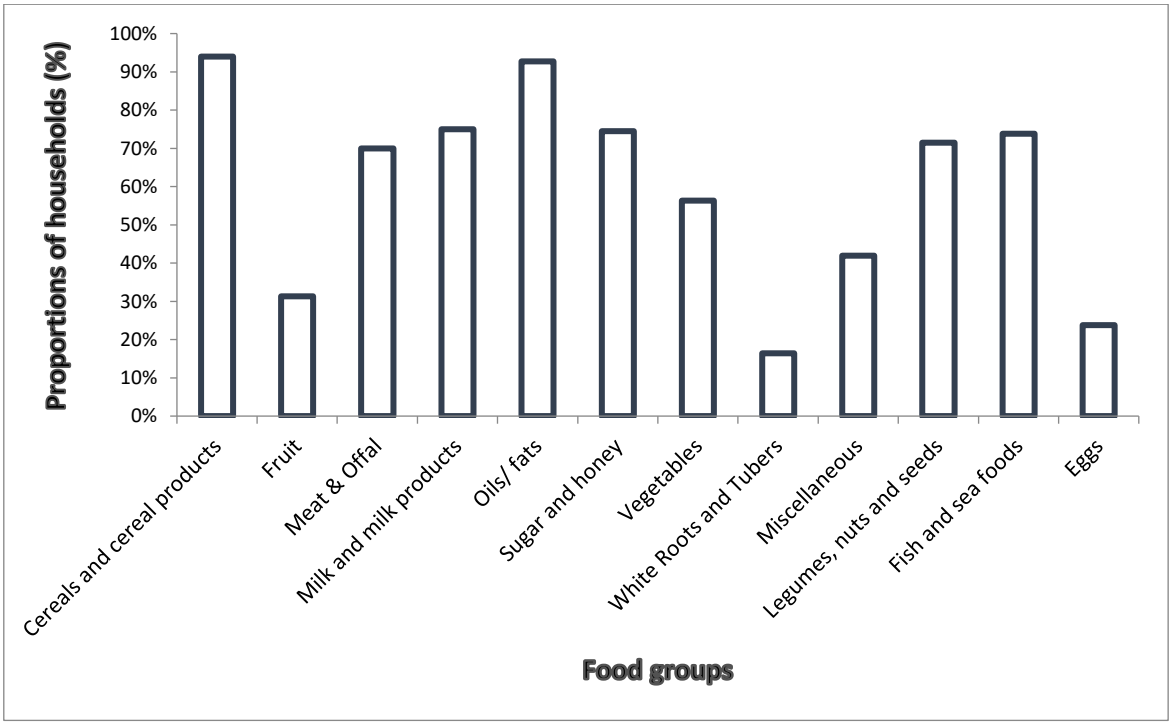
Table 36 presents the average household diversity for 24 hours preceding the survey. On average household consumed 7.3 food groups out of 12.

Table 35: Average HDDS

	Mean (95% C.I)
Average HDDS (n=428)	*7.33 (6.6. – 8.1 95% C.I.)*

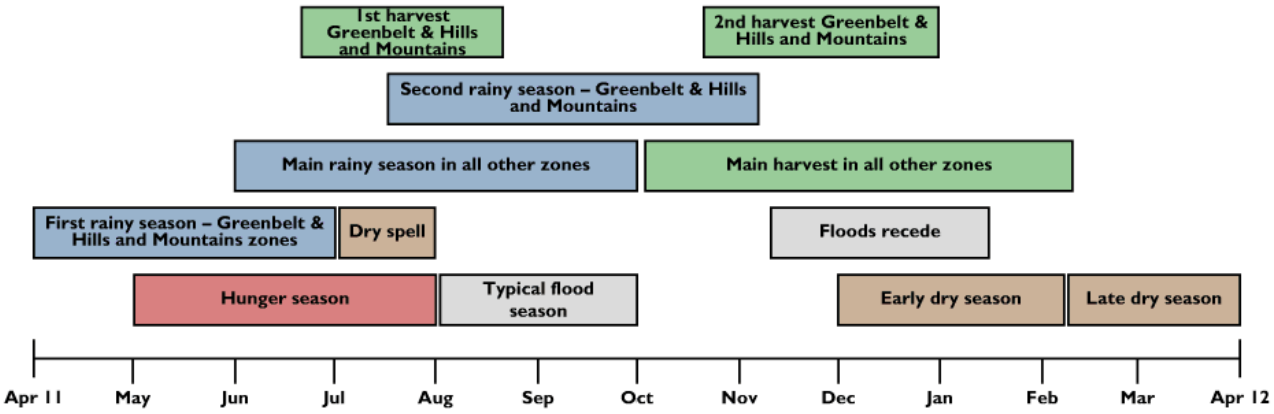
Figure 12 shows proportions of households consuming different food groups within last 24 hours. Over nine in ten households eat Cereals and oils/fats during the 24-hour period before the survey, over 70% of households eat Milk and milk products, Sugar and honey, Fish and sea foods, Legumes, nuts and seeds, and Meat & Offal during the 24-hour period before the survey, and over 95 percent of surveyed households eat according to minimum standards of food diversity (four or more food groups). Overall, cereals and consumption of protein rich foods and consumption of iron rich foods is high by all while eggs (24%), Vegetables (31%) and White Roots and Tubers (16%) is low for all.

Figure 12 Proportions of households consuming different food groups within last 24 hour, Rubkona, Dec, 2016



The survey was conducted during the annual harvest season, during which the overall food availability is better. It is hence likely that the household dietary diversity score is higher than it would be e.g. lean season. Under normal circumstances the food security situation generally improves during the main harvest in South Sudan. Although many other factors influence the food security situation in the country, it is interesting to see that within this context the average scores of the two food security indicators (HDDS and FCS) move in opposite directions during the main harvest.

Figure 13: ***Seasonal calendar and critical events timeline for food security in South Sudan***



Source: (USAID FEWSNet, 2013)

Access to food assistance

Three distinct variables are essential to the attainment of food security: 1) Food Availability: sufficient quantities of appropriate, necessary types of food from domestic production, commercial imports or donors like WFP are consistently available to the individuals or are within reasonable proximity to them or are within their reach; 2) Food Access: individuals have adequate incomes or other resources to purchase or barter to obtain levels of appropriate food needed to maintain consumption of an adequate diet/nutrition level; 3) Food Utilization: food is properly used, proper food processing and

storage techniques are employed, adequate knowledge of nutrition and child care techniques exist and is applied, and adequate health and sanitation services exist.

The survey findings revealed that 93% of the population received World Food Programme (WFP) food rations aka GFD and it was the main source of food in the past 3 months preceding the survey. Three percent of surveyed households have reported not to have any humanitarian assistance in past three months.

Table 36: Access to food assistance in the past three months before the survey date

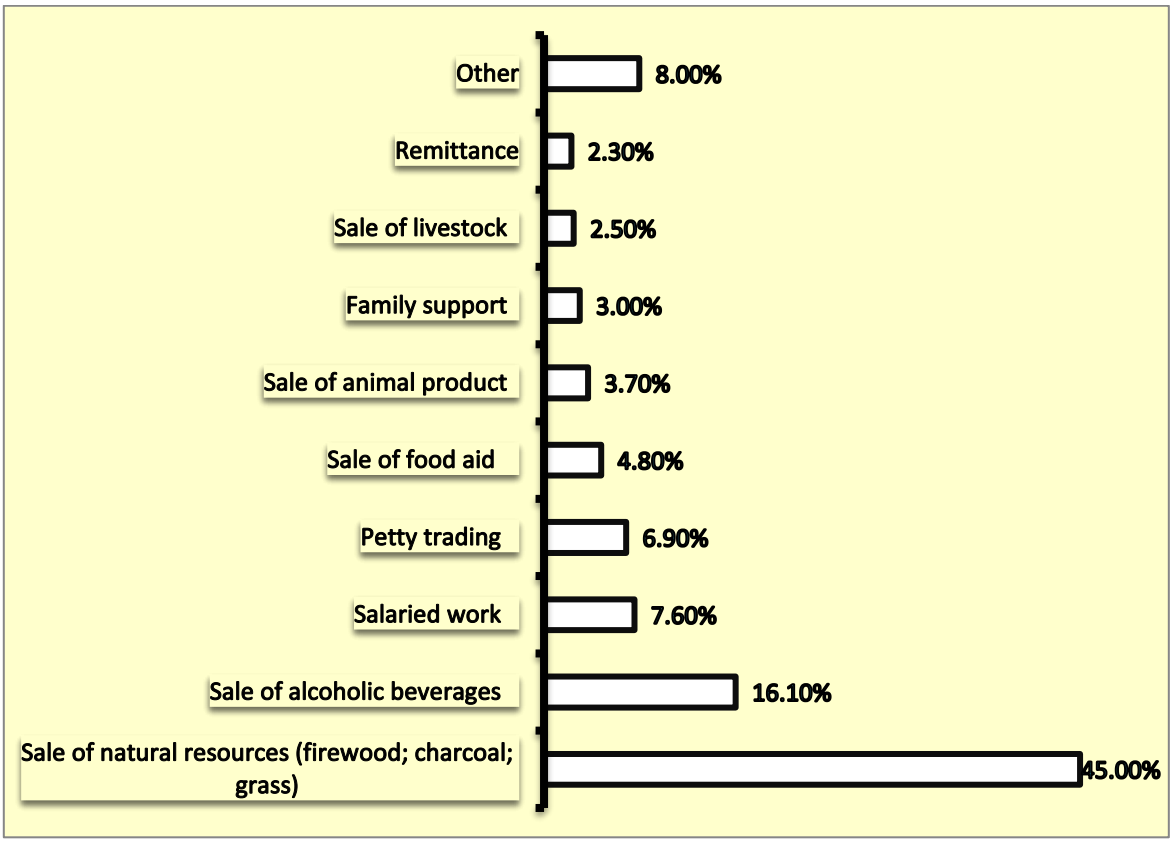
General food distribution coverage (n=441)	*93.4 (90.2. – 96.7 95% C.I.)*

The general food distribution usually lasts more than a month and is organized by family size, hence the surveyed households will be at different times of the cycle which may have an impact on the HDDS results and this needs to be considered in interpreting the data.

Source of income

Since the conflict, rural and urban populations face movement restrictions, and therefore have little access to cash, land or other productive assets. Main markets and business centres also remain inaccessible, limiting opportunities for work, and leading to an increase in commodity prices for most goods. All communities within the area have seen an increase in food prices. Questions on source of income for the surveyed households in a month preceding the survey date revealed that 45% of households were dependent in production and sale of charcoal, 16% on sale of alcohol, 7.6% on salary, 6.9% on petty trade whereas income from livestock, sale of livestock products and sale of own produced crops was insignificant (less than 3%). Source of income as other includes no income, Sale of crops, Sale of fish, Casual Labour and Skilled labour.

Table 37: Source of income in a month preceding the survey



WASH

The health environment is affected by access to potable water and sanitation, the presence of malaria breeding sites, the quality of shelter and consequent level of cold, stress, overcrowding and the health of fellow community members. Insufficient water provision, in terms of both quantity and quality, increases the risk of diarrheal diseases and other water-borne diseases. Water is an important consideration for all populations, although the consequences of poor sanitation and hygiene in crowded camps for displaced people may be worse as they can lead to epidemics of cholera, etc. Assessment of sanitation facilities (access to and number of latrines) and practices (collection and disposal of solid waste) is very important in a camp situation.

Table 39 includes a number of indicators that are useful in monitoring household access to improved drinking water. The source of drinking water is an indicator of whether it is suitable for drinking. Sources that are likely to provide water suitable for drinking are identified as improved sources in Table 2.1. They include a piped source within the dwelling or plot, public tap, tube well or borehole, protected well or spring, and rainwater[31]. Lack of ready access to a water source may limit the quantity of suitable

[31] World Health Organization/United Nations Children's Fund (WHO/UNICEF). 2010. Joint Monitoring

drinking water that is available to a household. Moreover, even if the household obtains water from an improved source, water that must be fetched from a source that is not immediately accessible to the household may be contaminated during transport or storage. Another factor in considering the accessibility of water sources is that the burden of going for water often falls disproportionately on female members of the household. Finally, home water treatment can be effective in improving the quality of household drinking water.

Table 38 shows that seven out of ten households in surveyed Payams of Rubkona (71 percent) get drinking water from an improved source. Among the improved sources, Borehole/hand pump account for the highest proportion (43.3 percent) of households, followed by improved category piped into dwelling/household connection/stand pipe/tanker (26 percent).

Twenty-eight percent of surveyed households get their drinking water from a non-improved source, mainly surface water from lakes, streams, and rivers (26 percent) and open shallow well (2 percent).

Households were asked how long it takes to fetch water. Seventy-one percent of households are within 30 minutes of the source of their drinking water. About a quarter of households (25 percent) travel 30 minutes or longer to obtain their drinking.

All households also were asked whether they treat their water prior to drinking. Majority (56 percent) of households do not treat their drinking water. Notably, 42% used some kind of method to treat their water before drinking.

Table 38: Percent distribution of households by source of drinking water, time to obtain drinking water, amount of water consumption per day, and treatment of drinking water (n=443)

Characteristic	*Per cent (95% C.I)*
Source of drinking water	
Improved source	**71.4%**
Borehole/hand pump	43.3% (29.6. – 57.1 95% C.I.)
Protected shallow well	1.9% (0.0. – 3.8 95% C.I.)
Piped into dwelling/household connection/stand pipe/tanker	26.2 (13.6. – 38.2 95% C.I.)
Non-improved source	**27.9%**
Open shallow well	2% (0.0 – 3.9 95% C.I.)
River/stream	25.9% (12.8. – 39.6 95% C.I.)
Time to obtain drinking water (round trip)	

Programme for Water Supply and Sanitation and Drinking Water: 2010 Update. Geneva, Switzerland: WHO.

Characteristic	*Per cent (95% C.I)*
Less than 30 minutes	71.2% (58.9-83.5 95% C.I.)
>30min-<1hr	13.9 (6.8-20.9 95% C.I.)
>1hr and ≤ 2hr	7.7 (1-14.4595% C.I.)
>2hr and ≥4hr	4.3% (0-9.2 95% C.I.)
Water treatment prior to drinking	
No treatment	55.9% (43.0-68.7 95% C.I.)
Boiled	4.8% (1.0-8.6 95% C.I.)
Strained through cloth	15.3% (8.5-22.7 95% C.I.)
Ceramic, sand or other filter/letting it settle	6.2% (1.3-11.2 95% C.I.)
Bleach/chlorine added	16.1% (6.9-25.3 95% C.I.)
Mean water consumption	
Mean water consumption per household (excluding water for washing clothes and drinking animals)	67.1 (58.7-75.4 95% C.I.)

A household is classified as having an improved toilet if the toilet is used only by members of one household (i.e., it is not shared) and if the facility used by the household separates the waste from human contact[32].

As Table 40 shows, only 17 percent of households use an improved toilet facility. Overall, 83 percent of households have no toilet facility at all.

Table 39: Percent distribution of households by type of toilet/latrine facilities (n=433)

Type of toilet/latrine facility	*Per cent (95% C.I)*
Undesignated open area	73.7 (63.9-83.4 95% C.I.)
Designated open area	9 (3.1-14.9 95% C.I.)
Hole	3.5 (0.6-6.3 95% C.I.)
Latrine	13.6 (6.7-20.6 95% C.I.)

Washing hands with soap and water is the ideal hygienic practice. Research shows the substantial potential that hand washing with water and soap (or a non-soap cleansing agent such as ash or sand) has for reducing the transmission of diarrhoea, respiratory

[32] World Health Organization/United Nations Children's Fund (WHO/UNICEF). 2010. Joint Monitoring Programme for Water Supply and Sanitation and Drinking Water: 2010 Update. Geneva, Switzerland: WHO.

infections, and other illnesses[33]. Table 41 shows the finding of the survey for hand washing practices.

Table 40: Hand washing practices

Characteristic (n=431)	*Per cent (95% C.I)*
Hand Washing practice (when do you wash your hands?)[34]	
After cleaning the baby	11%
Before feeding the baby	21%
Before eating	43%
Before cooking	61%
After defecating	68%
No practice of hand washing	4%
Use of soap and other cleansing agents for hand washing (what do you use to wash hands)	
Water + Ash	21.6 (14.1-29.0 95% C.I.)
Water+Soap	24.1 (15.3-32.9 95% C.I.)
Water only	27.4 (17.5-37.2 95% C.I.)
Both Water + Ash and Water+Soap	9.1 (1.4-16.7 95% C.I.)
Water only and Water +ash	1.9 (0.0-4.3 95% C.I.)
Water only and Water +ash	2.3 (0.0-4.9 95% C.I.)
Nothing	13.2 (5.4-21.9195% C.I.)

Discussion and Conclusions

Nutritional Status

Prevalence of Acute Malnutrition

GAM rates in the Rubkona, Pakur and Bantiu payams of Rubkona are concerning, particularly in light of the below-mentioned aggravating factors, and the continued reliance on humanitarian organisations for food aid, access to WASH, and health services. Results in Rubkona, Pakur and Bantiu payams of Rubkona County indicated a GAM rate of 20.2% (17.1-23.7 95% CI), with 17.4% (14.6-20.6 95% CI) MAM and 2.8% (1.5- 5.1 95% CI) SAM. The GAM result is over WHO's 15% emergency threshold in the absence of aggravating factors[35]. This is a critical level when one considers the presence of aggravating factors such as the on-going risk of an epidemic of measles or other communicable diseases remains real and in light of sub-optimal vaccination rates. High

[33] Ensink, J. and V. Curtis. 2008. Health Impact of Hand washing with Soap. WELL Factsheet. May 2008. http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/Handwashing.htm.
[34] Respondents may report multiple hand washing so the sum may exceed 100 percent.
[35] WHO. 1995. The management of nutrition in major emergencies

morbidity rates are also worth remembering. Finally, it is worth remembering that this survey was done during the post-harvest season, when the lowest annual levels of malnutrition are expected. These prevalence levels are classified as ***critical (very high)*** as per WHO public health significance classification.

Analysis of the indicators by age group shows that wasting is highest (34 percent) in children age 6-17 months and lowest (10 percent) in children under age 54-59 months, severe wasting shows a somewhat similar trend, although wasting peaks later at 18-29 months (6.7 percent) and is lowest at 54-59 months (1.3 percent). There was also a statistically significant relation between age and acute malnutrition (6-29 versus 30-59 months) using both MUAC and z-score criteria. The youngest age group (6-29 months) is more wasted than the oldest (30-59 months).

Although the WHZ indicator is more rigorously verifiable with SMART survey methodology, MUAC is also a recognized SAM indicator. In this survey, the MUAC rates were 10.7% (7.9- 14.4 95% CI) <125 mm (GAM), with 0.7% (0.2- 2.2 95% CI) < 115mm (SAM). These acute malnutrition rates according to MUAC are way lower than those using the WFH index in this survey. The level of variation between these indicators depends on the location; certain populations' common body-types demonstrate malnutrition more or less precociously via MUAC than WHZ. Secondly, mass screening for malnutrition is done via MUAC in these target populations, and the majority of cases admitted to OTP are done via MUAC. It is therefore possible that malnutrition as identified by MUAC is identified and treated more quickly than those defined via WHZ, resulting in lower malnutrition rates when defined via MUAC[36].

Wasting is highest (34 percent) in children age 6-17 months and lowest (10 percent) in children under age 54-59 months; severe wasting shows a somewhat similar trend. There was also a statistically significant relation between age and acute malnutrition (6-29 versus 30-59 months) using both MUAC and z-score criteria. The youngest age group (6-29 months) is more wasted than the oldest (30-59 months).

The SMART survey conducted by Care in May 2016 of this year (pre harvest survey) in Rubkona estimated GAM at 29.2% (24.5-34.4) and the SAM at 7.8% (5.2-11.4). This was much higher than the 5.4% GAM and 1.4% SAM rates found in this survey. This was during the pre-harvest season. Statistical tests using the two survey calculator, to know the probability that the prevalence estimate from post-harvest survey is significantly different from that of a pre-harvest survey, shows that we are 99.5% sure that there is a significant difference between those two prevalence estimates (p<0.00).The result also

[36] For more on this refer here: http://www.ennonline.net/fex/52/diagnoseacutemalnutrition, https://www.cambridge.org/core/services/aop-cambridge-core/content/view/S1368980015000737, and http://brixtonhealth.com/GrelletyE.PHN2015.pdf

shows that there has been a decrease in prevalence of GAM since the May 2016 survey (we're 99.7% sure that the prevalence from the pre-harvest survey is higher than from the post-harvest survey (see box 1). Also, the confidence intervals of the two estimates do not overlap.

Box 1: Screen clipping of statistical test using CDC two survey calculators (for clusters)

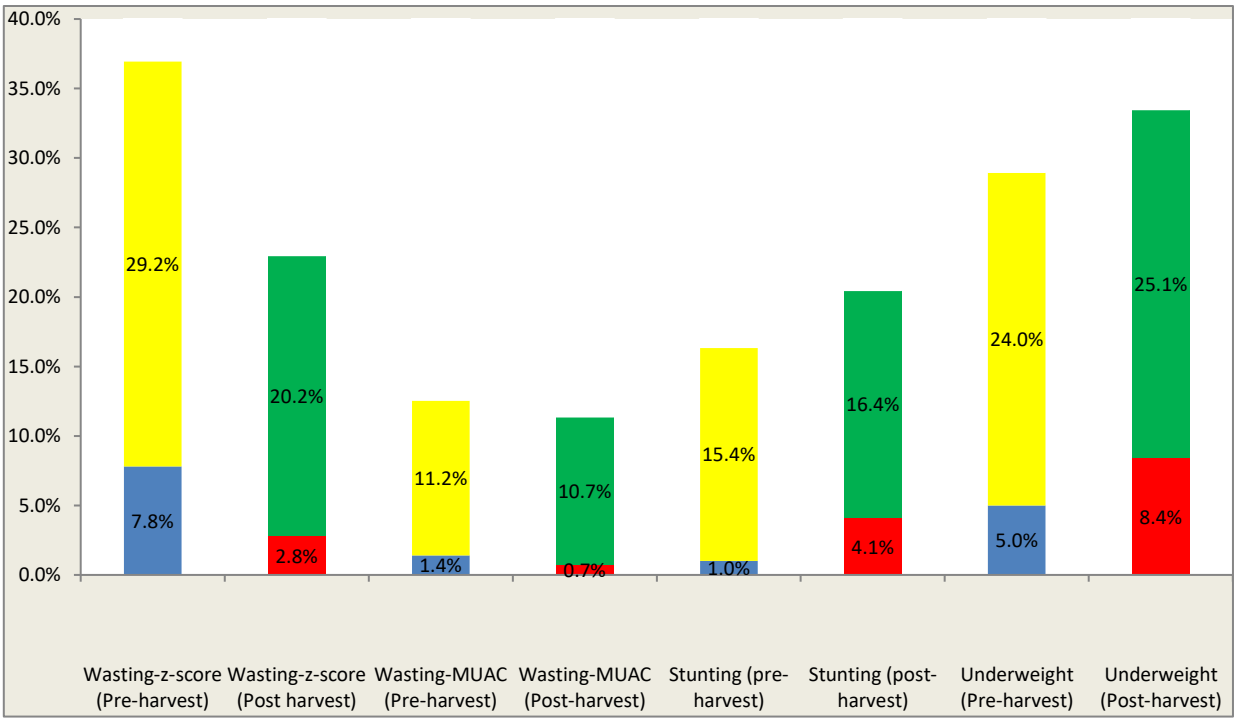
n1		p1	Deff1	C1	$s1^2$	se
411		29.10%	1.16	32	0.000582	0.024131
Survey 2						
Total Sample Size		Prevalence	Design Effect	Number of Clusters	Estimated Variance	
n2		p2	Deff2	C2	$s2^2$	se
426		20.20%	1.00	36	0.000378	0.019452
p1-p2	Pooled Variance	t	p	DF	2 sided	1 sided
8.90%	3.10%	2.87	0.0055	66	99.5%	99.7%

It should be remembered here again that the post-harvest-survey population is a sub set of the pre-harvest survey. However, the design effects of both surveys are very low (DEFF: 1.16 for pre-harvest survey and 1 for post-harvest survey). This indicates the population in the county is uniformly affected in terms of malnutrition. As this is a post-harvest survey, the reduction might be due to production being coming in as well as improvements in other indicators (availability of water, better Pasteur, availability of fish etc.).

Figure 14 shows trends of prevalences of global and severe wasting (using both MUAC and z scores), underweight, and stunting between pre and post-harvest periods. It can be seen here that prevalences of wasting level using proxy MUAC, stunting and underweight remained stable while wasting (z-scores) has significantly declined between the two periods (between seven months).

Figure 14: Trends in wasting, stunting and underweight prevalence in children 6-59 months,

(May 2016 vs. December 2016)



Case study: Seasonal baseline prevalences of acute malnutrition and long term observed trends of Wasting in Rubkona County

Nutrition trend data allows comparisons to be made over time and in combination with other indicators can help to predict crises. Nutritional status changes as a result of a number of factors which are highly complex and context-specific. It only by understands the context in terms of the underlying causes of malnutrition that it is possible to determine what these changes indicate in terms of food security. There are instances where nutritional decline precedes a crisis by some months and other instances where nutritional status can remain stable as the situation is deteriorating. Seasonal hunger cycles are driven by climatic patterns as well as economic, political and social fragility. Seasonal variation has an impact on many of the underlying causes of undernutrition, including inadequate care practices, poor public health and food insecurity. Nutrition trend data has the following potential roles:

- It can provide early warning of a crisis in combination with other data (e.g. food security, mortality, morbidity and care factors)
- It allows prediction of a likely sequence of events based on past experience
- It promotes in-depth understanding of particular communities as repeated visits are made to the same community

SMART survey conducted by Action Contre la Faim (ACF) in in Rubkona and Bentiu during 2000-2008[37] combined with this year's care survey found the following results:

Overall, 32 surveys were done in Rubkona and Bentiu between years 2000 and 2016. Individual global wasting (WFH z-scores) value for each month (survey) and the monthly averages are presented below.

Table 41: Trends in wasting prevalence (<-2SDs WFH) in children 6-59 months old. Rubkona County, 2000-2016

	Apr	May	Jun	Jul	Sep	Oct	Dec	Feb
	Lean season				Harvest season			
	20.8%	29.2%	28.2%	28.6%	20.1%	20.7%	20.1%	30.9%
			21.9%	23.9%	17.2%		18.8%	16.4%
				16.3%			20.2%	17.9%
								18.2%
	25.6%	29.2%	39.2%	17.8%		22.5%	20.2%	20.7%
			24.3%	30.4%		20.1%	19.0%	16.4%
							18.9%	26.1%
							19.8%	
MEAN GAM/month	23.20%	29.20%	28.40%	23.40%	18.70%	21.10%	19.60%	20.90%
Range/month		29.20%	21.9%-39.2%	16.3%-30.4%	17.2%-20.1%	20.1%22.5%	18.8%20.2%	16.4%-30.9%

Summary of the trend analysis found that the baseline prevalences of child malnutrition (<-2 SD weight for height) were above the WHO standard levels of malnutrition in in all seasons in Rubkona county. Mean post-harvest wasting levels were 20.2% individual values ranging from 19.4% to 30.9%; whereas mean wasting levels during lean season were 25.8% with prevalence values ranging from 16.3% to 25.8%. The summary of 32 surveysshows that levels of wasting among under-fives is high and has remained unchanged for over 15 years.

Table 42: summary of wasting leves during pre and post-harvest seasons in Rubkona between years 2000-2016 (based on 32 SMART surveys)

	Post-Harvest WHZ levels (Sep-Dec), (n=19)	**Pre-harvest WHZ levels (Apr-Aug), (n=13)**
MEAN GAM	20.2%	25.8%
Range of GAM	19.4%-30.9%	16.3%-39.2%

The seasonal calendar for a typical year in South Sudan shows that the dry season runs from December through April, with the main harvest taking place between October and February. The rainy season runs from April through October, with the lean season

[37] Preliminary results Nutritional anthropometric and retrospective mortality surveys Children aged 6-59 months Rub Kona County, Unity State, SOUTH SUDAN, 13th – 25th of August 2008, ACF

(hunger season) stretching from May through August in most parts of the country. The time of the survey is post-harvest hence food is expected to be more bountiful during the harvest season. Hence, the proportion of food insecure population is a point of concern at this time of the year.

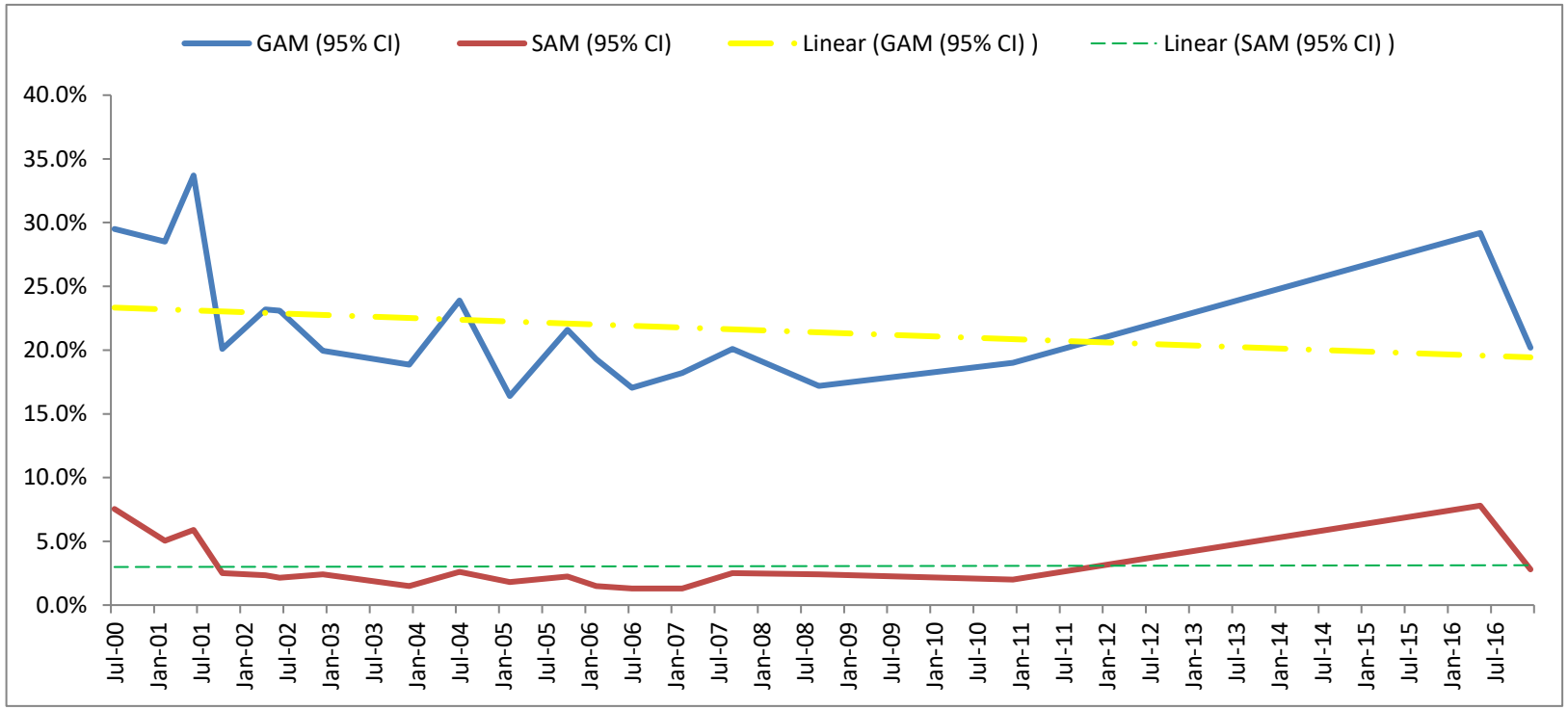
The result of the analysis shows a clear relationship between malnutrition and all three food security indicators with annual trends occurring in concert and a clear relationship between rainfall and malnutrition in Rubkona. This finding is in harmony with Global acute malnutrition (GAM) in Bahr el Ghazai and Upper Nile is regularly above 20 percent and above the 15 percent threshold. Malnutrition peaks prior to the traditional hunger gap. Mortality rates during periods of peace are stable and well below emergency thresholds. Sustained, high levels of acute malnutrition result from poor health environments, unhealthy behaviors and caring practices[3839]

> Mean post-harvest wasting levels were 20.2% individual values ranging from 19.4% to 30.9%; whereas mean wasting levels during lean season were 25.8% with prevalence values ranging from 16.3% to 25.8%. The summary of 32 surveysshows that levels of wasting among under-fives is high and has remained unchanged for over 15 years.

[38] South Sudan Anthropometric Surveys 1998 to 2006: Trends based on conflict and immediate post conflict data McDowell S. 2006.: http://www.ennonline.net/fex/31/chronicmalnutrition

[39] South Sudan Updated Nutrition Cluster Response Plan – August 2014Nutrition Cluster. 2014. Humanitarian Response http://www.humanitarianresponse.info/system/files/documents/files/SSudan%20Updated%20Nutrition%20Cluster%20Response%20Plan%20-%20Final%20Draft%201%20Sep.doc

Figure 15: Trends in wasting prevalence (<-2SDs WFH) in children 6-59 months old. Rubkona County, 2000-2016



Underweight

Global underweight prevalence is between 20%-29%, which is classified as high based on WHO emergency threshold[40]**.** The prevalence of underweight is 25.1% (20.2-30.8 95% CI). Underweight is highest (34 percent) in children age 18-29 months and lowest (13 percent) in children age 54-59 months. Similarly, there was a statistically significant difference for underweight for the age groups between 6-29 and 30-59 months. The May, 2016 survey has also found a strikingly similar level of overall underweight level at 24.0% (19.4-29.3)

Stunting

The survey result showed that in Rubkona 22.1% (17.7-27.3 95% CI) of children under age five are stunted. However, as illustrated in data quality section the stunting level is overestimated as revealed by high SD even after exclusion of flags from the analysis. Hence, based on SMART suggestion the calculated prevalence (with an SD of one) is reported in this survey report. The calculated prevalence of stunting (with an SD of one) shows that 16.4% percent of children under age 5 are stunted, while 6 percent are severely stunted. Based on thresholds of WHO for stunting, the prevalence height-for-age is classified as ***low*** level (< 20%). Stunting is highest (49 percent) in children age 18-29 months and lowest (10 percent) in children under age 54-99 months. Severe stunting shows a similar trend, stunting peaks at 18-29 months (8.9 percent) and is lowest at 54-59 months (0 percent). Based on May 2016 SMART survey global stunting was estimated 15.4% (11.6-20.0) and severe stunting was estimated at 1.0% (0.4- 2.6). Here again, the two survey results of stunting are comparable. It is known that stunting is not affected by seasonal variations.

Morbidity and Vaccination/ Supplementation Coverage

Morbidity

Illness during the previous two weeks was **64%.** This level of morbidity is very high and it might indicate issues around access to potable water, and poor sanitation and hygiene. diarrhea can cause undernutrition through a loss of nutrient intake, mal-absorption and the effect of the inflammatory process[41]; on the other hand, malnutrition may also increase the severity of diarrhea, as it leads to reduced immunity and, therefore, to frequent enteric infections[42]. Since 71% of households in survey population still do not have access to improved water sources, strengthening strategies to increase the provision of water and sanitation interventions is crucial for the health of children.

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[40] WHO. 1995. The management of nutrition in major emergencies

[41] Richard, S.A.; Black, R.E.; Gilman, R.H.; Guerrant, R.L.; Kang, G.; Lanata, C.F.; Molbak, K.; Rasmussen, Z.A.; Sack, R.B.; Valentiner-Branth, P.; et al. Diarrhea in Early Childhood: Short-term Association With Weight and Long-term Association With Length. Am. J. Epidemiol. 2013, 178, 1129–1138. [CrossRef] [PubMed]

[42] Rice, A.; Sacco, L.; Hyder, A.; Black, R. Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. Bull. World Health Organ. 2000, 78, 1207–1221. [PubMed]

*Illness during the previous two weeks was **64%.** This level of morbidity is very high and it might indicate issues around access to potable water, and poor sanitation and hygiene.*

Childcare practices and caretaker absence may also play a role, particularly in an unclean environment; if small children are frequently unsupervised or not prohibited from putting things in their mouth, it creates an easy entry point for disease. Variability in access to primary healthcare services may also have an impact on length and virulence of the infection and thus nutritional status. Those mothers who reported illness in the past 14 days were further asked to describe the symptoms at any time during the past 14 days. Fever was most common (56.4%) followed by cough (22.3%), and diarrhoea (13.6%). Finally, it is worth bearing in mind that the SMART survey was conducted outside of the rainy season; morbidity rates would be expected to increase with the onset of the dry and lean season in coming months.

Mothers/carers were asked what they will do to treat the illness when their children had diarrhoea (hypothetical question to elicit health seeking behavior). Only 47% responded they give more liquids than usual.

Measles vaccination coverage was 71.1%, only 62.1% of children were supplemented for Vitamin a in the last six months, only 44% of 12-59 month all children were dewormed while 64.5% of 6-59 months had received BCG in the last six months.

Vaccination/ Supplementation Coverage

In this survey, measles vaccination coverage was 71.1%; below the 80% minimum recommended by WHO to prevent epidemics as well as the national minimum. Only 62.1% of children were supplemented for Vitamin a in the last six months, here again the supplementation rate fall short of national and international guidelines. The survey also found only 44% of 12-59 month all children were dewormed while 64.5% of 6-59 months had received BCG in the last six months. It should be emphasized that 'blanket' Vitamin A Capsule distribution is intended as a stopgap measure in situations of high levels of Vitamin A deficiencies and should be phased as alternative prevention strategies, e.g. Vitamin A fortification of cooking oils, are put in place.

Selective Programme coverage

Both coverage rates were below 50%. Sphere minimum standard recommends selective feeding program coverage level should be >50%. Also, the assessment found that there is a significant overlap between the two programs i.e. SAM cases in SFP and MAM cases in OTP. This might be due to the use of two inclusion criteria (MUAC and WHZ).

Mortality

Rates of overall adult mortality are unrepresentative as rates based on a subset of the population revealed that the 18-49 years age group contributes for over 50% of the reported death during 3 months before the survey. Additionally, sex specific mortality rates revealed that risk of death during the recall period is 4 times more likely to female than male

Mortality is the ultimate outcome of health and nutrition conditions and provides an overall picture of a population's health status. While the cause of mortality go beyond those related to malnutrition, there is evidence to show that malnutrition is among causes of mortality in emergencies. Mortality rates were calculated retrospectively over a 90 day recall period. A crude mortality rate (CMR) of 1/10,000 per day is taken to indicate an emergency situation (this assumes a doubling of the baseline situation in the absence of baseline data), while rates of 2/10,000 per day are taken to indicate a severe situation. Under-five thresholds are 2/10,000 per day and 4/10,000 per day respectively.

The retrospective crude and U5 mortality rates were **2.64 (1.87-3.72)** and **1.11 (0.48-2.57),** respectively. However, the CRUDE mortality rate is found not to reflect the overall population and it does not provide an overall picture of a population's health status as per objective of the survey (the objective is to link nutritional status to mortality levels).

Evaluation of the representativeness and stability of overall crude mortality using age specific and sex-specific death rates: Mortality rates are calculated by dividing the number of deaths in each age group of women and men by the total person-years of exposure to the risk of dying in that age group during 90 days period preceding the survey. The following table shows age specific mortality. It can be seen on the table that rates of overall adult mortality are unrepresentative as rates based on a subset of the population revealed that the 18-49 years age group contributes for over 50% of the reported death during 3 months before the survey. Additionally, sex specific mortality rates revealed that risk of death during the recall period is 4 times more likely to female than male: Male=4.64 (3.12-6.85), Female=1.04 (0.59-1.85).

Table 43: Number and % of deaths by age group

'Years	Deaths	% of death
'0-4	5	7%
'5-11	4	6%
'12-17	4	6%
'18-49	**37**	**54%**
'50-64	6	9%
'65-120	12	18%
Sum:	68	100%

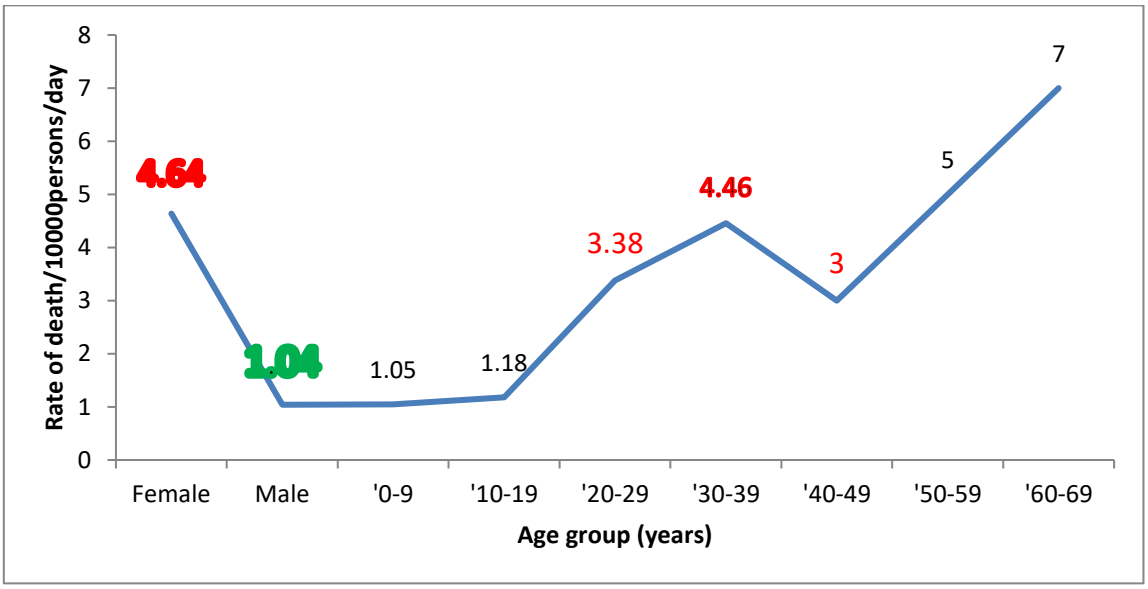
Nevertheless, age-specific mortality rates obtained in this manner are subject to **considerable sampling variation**. To allow for more samples per estimate a ten year period was used to minimize the level of sampling error. Here again, age groups above year of 20 showed a very high mortality rate. It should be noted here that these age

specific rates are for both sexes. If one has to filter out females, the mortality rates for these age groups increases substantially. It should also be factored in here that the population is significantly biased towards women than men and this is truer for age groups with high death rate.

Rate	Value	Design Effect
Crude Death Rate (95% CI)	2.64 (1.87-3.72)	2.01
Sex specific mortality		
'Male	4.64 (3.12-6.85)	2.08
'Female	1.04 (0.59-1.85)	1.2
'Years		
'0-9	1.05 (0.49-2.23)	1.27
'10-19	1.18 (0.52-2.68)	1.16
'20-29	3.38 (1.68-6.67)	1.55
'30-39	4.46 (2.52-7.80)	1.22
'40-49	3.00 (1.34-6.55)	1
'50-59	5.01 (2.11-11.45)	1
'60-69	7.12 (2.40-19.49)	1.43
'70-79	26.82 (11.95-50.73)	1.06
'80-120	111.10 (0.00-0.00)	1

It is automatically clear that the death rate is biased towards men and towards the economically active age group. Also, mortality rates for age groups over 49 years are implausible as evidenced by the confidence intervals. Similarly males are 4 times more likely to die than female during the recall period. Therefore, the deaths are related with conflict than health and nutrition status of the population.

Figure 16: Age specific mortality of the survey population



However, child mortality rate is still useful to explain the survey (**1.11 deaths per 10, 000 per day (0.48-2.57).** Possible combinations of mortality and malnutrition are:

The overall death rate is biased towards men and towards the economically active age group. Also, mortality rates for age groups over 49 years are implausible as evidenced by the confidence intervals. Similarly males are 4 times more likely to die than female during the recall period. Therefore, the deaths are related with conflict than health and nutrition status of the population.

- High rates of mortality and high prevalence of malnutrition (Likely cause: acute food insecurity and failure to cope high levels of infection arising from uncontrollable epidemic and major disruption to care environment such as displaced bottle-feeding population),
- high prevalence of malnutrition and typical rates of mortality (Likely causes: Acute food insecurity, disruption to care environment resulting from damaging coping strategies, no major outbreaks),
- high rate of mortality and typical prevalence of malnutrition (Likely causes: high rates of infection not typically associated with malnutrition (e.g., malaria epidemics), mortality directly caused by acute disaster, possible outbreak of micro-nutrient deficiency),
- typical prevalence of malnutrition and typical rates of mortality (either no major causes of malnutrition or mortality resulting from emergency, or causes which have yet to have an impact on malnutrition and mortality).

In surveyed population there is high rate of under-five children mortality and high rate of acute malnutrition. High mortality rates can mask a deteriorating nutritional situation. If the severely malnourished children die, and the survivors are the better nourished, the malnutrition rate may stabilize or even improve because of drop-out phenomenon. These

are replacement malnutrition and survivor bias. Therefore, the GAM rate should also been seen against this background as high rates of mortality might be explained by on-going nutritional deterioration ('replacement malnutrition') among surviving children. However, research suggests that the replacement malnutrition/survivor bias will only be seen in populations with a very elevated CMR of more than 10/10,000/day.

Infant and young child feeding practices

IYCF practices are assessed in relation to the recommended age for the practice. The survey finds that:

- Early initiation of breast feeding is universal with 94.3% of children 6 to 23.9 months put to breast within an hour of birth
- EBF is sub-optimal with only six in ten infants 0–5 months of age were fed exclusively with breast milk (63%).
- An overwhelming 100% and 84% of children continuing BF at 1 and 2 years, respectively.

Dietary diversity is low. The survey has also finds that very few children ages 6 to 23 months are achieving the recommended minimum dietary diversity of 4 different food groups. The findings suggest that IYCF practices are not optimal for child growth in much of the population.

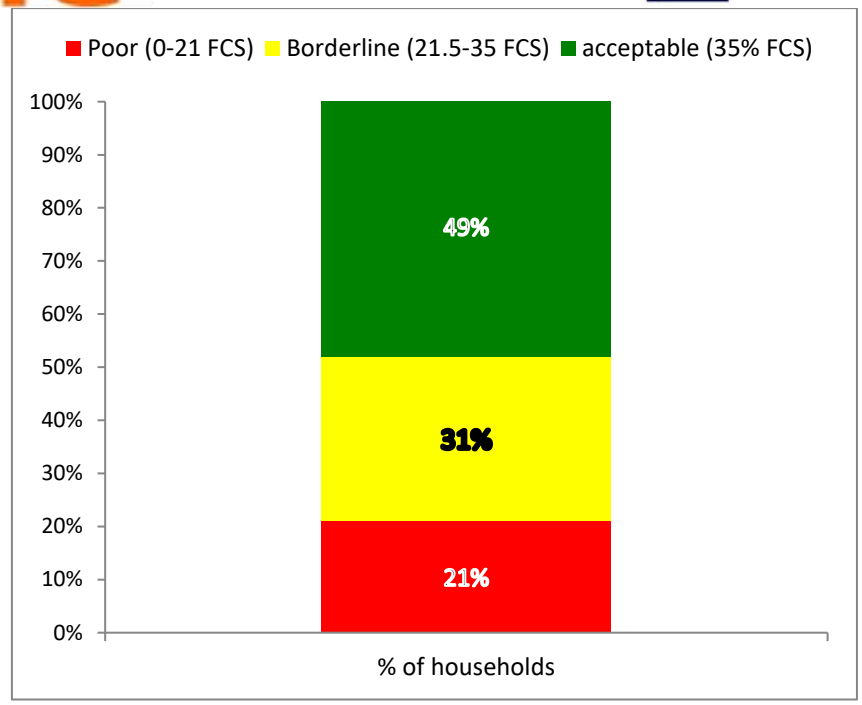
FSL and WASH

FCS

Displacement and household statuses may help in explaining wasting levels. In general, it is assumed that returnees, IDPs and female headed households are worse off in terms of nutritional and health outcomes. The FSL survey finds out that 44% of households are male headed and 53% female headed. Also, 67% of the survey population were residents, 20% returnees and 10% IDPs.

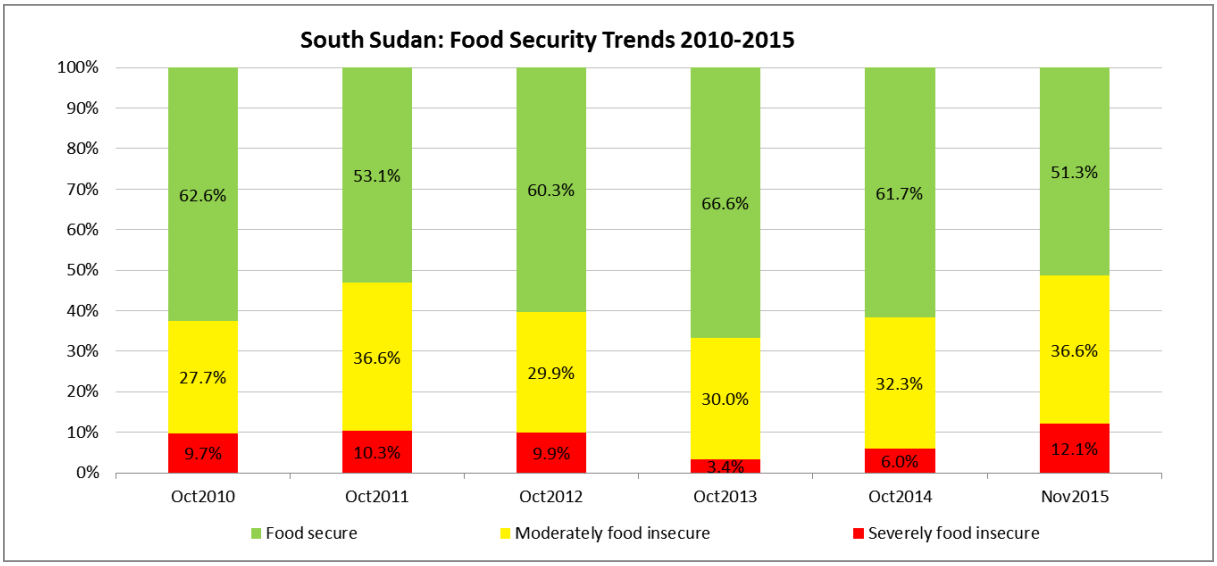
The mean Food Consumption Score of the overall surveyed population was 35.9. The overall **current** food security status of the whole population is classified as ***acceptable***. Based on FCS classification criteria 21% of households are currently classified as having a ***poor*** food security status, 31% are with a ***borderline*** level of food security and almost ha-lf of the surveyed population are currently with ***acceptable*** food security status, figure 17.

Figure 17: classification of the survey population by FCS groups



The level of households with poor FCS score in the survey area is twice higher than the average for South Sudan for the past 5 year's period.

Figure 18: South Sudan Food Security trends (2010-2015)[43]



[43] Source: WFP

Food sources during the 7 days of the FCS recall period were analyzed. Overall, only a quarter of surveyed households source their food in the past 7 days from their own production. As the survey period is a period immediately after harvest (post-harvest season), this is a low proportion. Eight percent of surveyed households depended on Gifts from neighbors, 1 in 5 households depended on the market for accessing their food in the past seven days, 7% had to borrow to meet their food consumption, and a quarter of surveyed households were dependent on food assistance to meet their food consumption needs in the seven days preceding the survey. In the face of hyperinflation in south Sudan the number of households dependent on the market for sourcing food and those who opt for stress indicators of food source shows the depth of food insecurity for the survey population. CSFAM's report for 2015 agricultural year reported that for South Sudan, markets are the dominant supplier of sorghum/food to households, except at harvest time (October) in years of good production. Otherwise, households rely mostly on markets for their sorghum supplies (up to between 60 to 70 percent of the households in June), as most of them exhaust their stocks a few months after harvest[44]. Moreover,

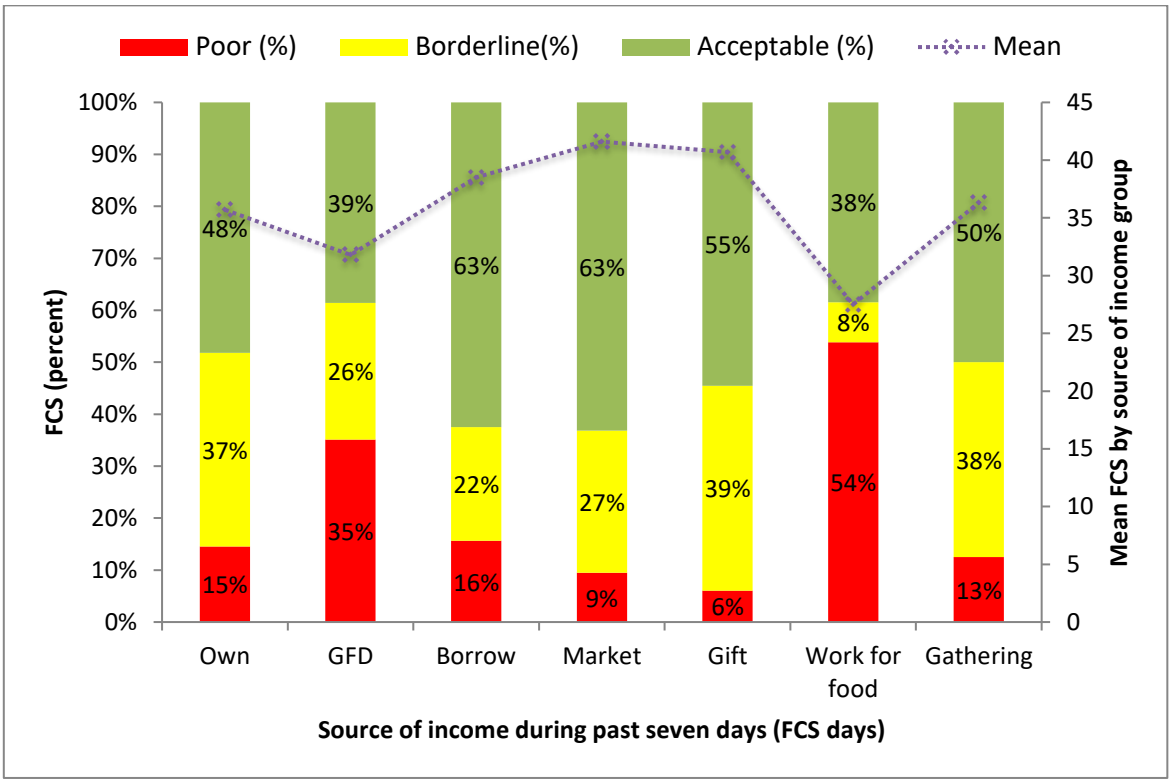
CSFAM reports that the food aid contribution is limited to the three conflict states, Upper Nile, Jonglei and Unity. Within these, food aid importance is variable: it is the major provider of sorghum for 10-25 percent of households in Upper Nile, 40-50 percent in Unity and 50-60 percent for Jonglei. This has been accompanied by a reduction in importance of markets as a sorghum supplier – in Upper Nile, the proportion of households sourcing sorghum from markets around October, fell from 80-90 percent pre-conflict to 40-45 percent post-conflict. Dependency on markets remains lowest in Western Equatoria State at about 25 percent of households and highest in Northern Bahr el Ghazal State, where more than 90 percent of households use markets as the main supplier after harvest time. In other states this dependency varies between 40 to 60 percent. This indicates that rural households in South Sudan are highly exposed to price shocks in particular during the lean period. The current tendency for very high market prices provides pessimistic perspectives for the food security status of South Sudan population.

Only a quarter of surveyed households source their food in the past 7 days from their own production, eight percent depended on Gifts from neighbors, 1 in 5 households depended on the market for accessing their food in the past seven days, 7% had to borrow to meet their food consumption, and a quarter of surveyed households were dependent on food assistance to meet their food consumption needs in the seven days preceding the survey.

Cross tabulation of FCS by source of income in the past seven days (same days as the FCS recall) revealed that the percent of people that fall below the 21 threshold of FCS is higher in those households with a food source of GFD (35% poor) and work for food (54%).

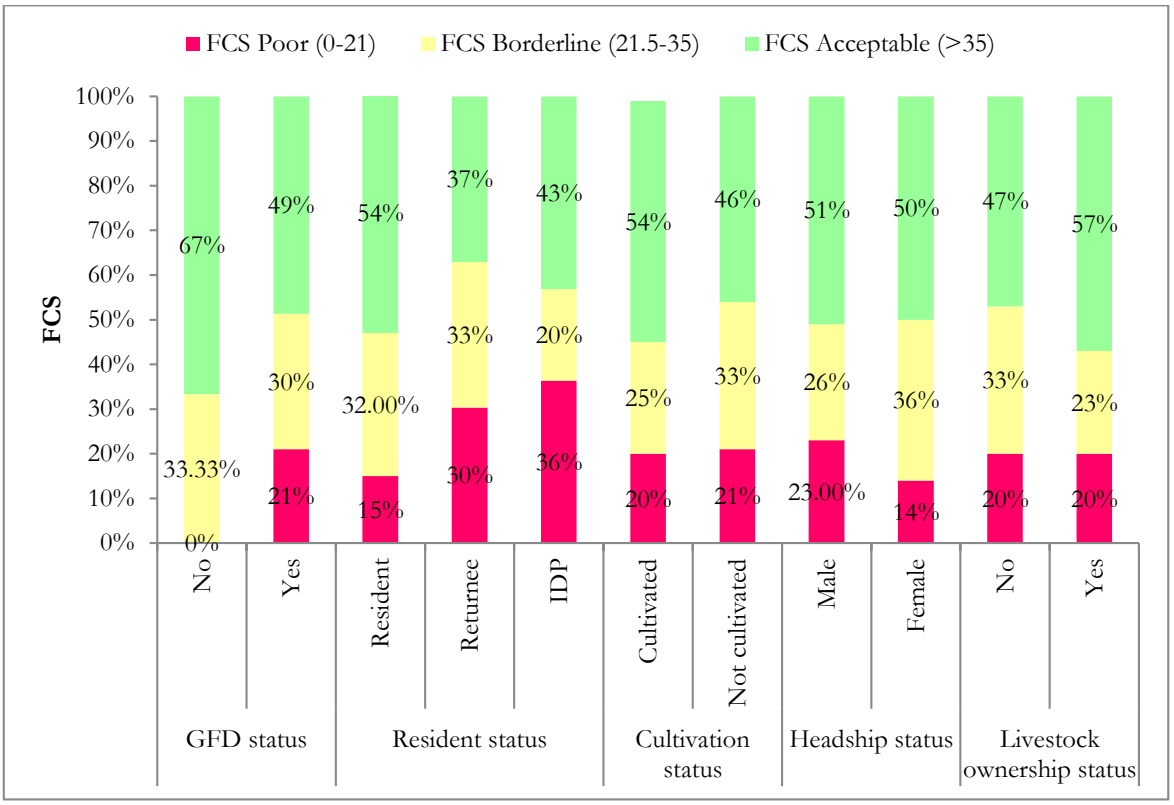
[44] CSFAM 2016 report

Figure 19: FCS by source of income



Like food source, to verify/validate FCS classification, analysis other proxy indicators of food consumption, food access, and food security were compared. The result shows that GFD recipient households were with high FCS than no GFD households, cross tabulation of FCs by displacement/residence status revealed that the proportion of households with poor FCS is higher in IDPs followed by returnees, somehow those who cultivated/harvested this season has the same level of proportion of households with poor FCs but households who harvested this season high a higher acceptable FCS (54% vs. 46%), similar trends in FCs proportion was observed between those who reported to own livestock and the have not's as the harvested households and not harvested households, and FCS cross tabulation with headship status revealed a counter intuitive result as female headed households were with a better FCS than male headed ones.

Figure 20: FCS by proxy indicators of wealth and current food security status of surveyed population



GFD recipient households were with high FCS than non GFD households, the proportion of households with poor FCS is higher in IDPs followed by returnees, somehow those who cultivated/harvested this season has the same level of proportion of households with poor FCs but households who harvested this season high a higher acceptable FCS (54% vs. 46%), similar trends in FCs proportion was observed between those who reported to own livestock and the have not's as the harvested households and not harvested households, and FCS cross tabulation with headship status revealed a counter intuitive result as female headed households were with a better FCS than male headed ones.

Results of the survey on household dietary diversity show on average households consumed 7.3 food groups out of 12 in 24 hours preceding the survey. Over nine in ten households eat Cereals and oils/fats during the 24-hour period before the survey, over 70% of households eat Milk and milk products, Sugar and honey, Fish and sea foods, Legumes, nuts and seeds, and Meat & Offal during the 24-hour period before the survey, and over 95 percent of surveyed households eat according to minimum standards of food diversity (four or more food groups). Overall, cereals and consumption of protein rich foods and consumption of iron rich foods is high by all while eggs (24%), Vegetables (31%) and White Roots and Tubers (16%) is low for all.

The survey findings revealed that

93% of the population received World Food Programme (WFP) food rations aka GFD and it was the main source of food in the past 3 months preceding the survey. Three percent of surveyed households have reported not to have any humanitarian assistance in past three months.

Questions on source of income for the surveyed households in a month preceding the survey date revealed that 45% of households were dependent in production and sale of charcoal, 16% on sale of alcohol, 7.65 on salary, 6.9% on petty trade whereas income from livestock, sale of livestock products and sale of own produced crops was insignificant (less than 3%).

Table 44: Source of income in a month preceding the survey by FCS

Source of income	Number of HHs	Mean FCS	25% quartile FCS	Median FCS
Sale of crops	7	25	19.5	19.5
Sale of livestock	10	33.5	12	30.
Sale of animal product	16	22.1	10	10.5
Sale of alcoholic beverages	70	32.7	23	32
Sale of natural resources (firewood;	194	37.1	24.5	35
Sale of food aid	21	34.8	22	33
Salaried work	33	39.8	32	37.5
Petty trading	30	42.1	33.5	43
Family support	13	46	31	44
Remittances	10	45.9	28	48.25

Vulnerable groups/at risk groups: Mean FCS is higher than 35 for households with income source of sale of natural resources, salaried work, petty trading, family support and remittances; where us it was between 21 and 35 for other major income sources. Twenty-five per cent of households in the lowest wealth quintile had less than 35 FCS across all income groups and less than 21 FCS in households that depend mainly on sale of crops, sale of livestock and sale of animal products. Similarly, median FCs is the lowest in households that depend mainly on sale of crops, sale of livestock and sale of animal products.

Recommendation

For all conflict-affected populations, in collaboration with MoH and other relevant government bodies:

- Closely monitoring food stocks and trade behaviors in the main markets and facilitate the distribution of food from surplus to deficit areas, taking into

consideration local market dynamics, as well as along the main corridors for both commercial and humanitarian commodities.

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Immediate

- To ensure access to the Therapeutic Feeding Programme (TFP) in order to cope with the high caseload of SAM children, including an Out Patient Therapeutic Programme (OTP) meeting international standards with active case-finding, close nutritional and medical follow up, ensured access/referral to the nearest in-patient treatment facility (SC) and support in care practices and infant and young child feeding.
- To ensure access to a TSFP to cope with the high caseload of MAM children, and to expand current services to the treatment of PLW suffering from MAM also.
- To continue and reinforce IYCF activities with quality one-to-one counselling tailored to the individual, peer-led support groups, interactive mass-media events, and implication/ capacity-building of health decision-makers at the community and family level for larger IYCF messaging and behaviour change.
- To restart/strengthen routine immunization, deworming and supplementation, to impact on morbidity and avoid disease outbreaks such as measles or polio.
- To maintain the General Food Distribution (GFD)

Medium term

- To ensure that all nutrition services are tailored to the causes of malnutrition most prevalent in that particular target population with culture/ age/ gender-specific interventions.
- To advocate for the need for development initiatives to link with humanitarian services, to address and restore the livelihoods lost due to the conflict
- To ensure that children have access to safe, relevant development via adapted education and child protection services.
- To provide tailored FSL interventions, in light of the persisting lack of access to income-generating opportunities, in a way that fosters appropriate childcare practices
- To ensure that all humanitarian interventions have a conflict-sensitive approach and an effective communication/ participation strategy with surrounding populations, using advocacy in a way that provides durable solutions.
- To advocate for significant increase in freedom of movement so that conflict-affected people can restore their livelihoods and have adequate access to essential services.

Annexes

Annex 1: Selected Clusters

Geographical unit	Population size	Cluster
Shilak East	630	1,2,RC
Shilak West	396	3,4
Mankuai A	466	5,6
Mankuai B	467	7,8,9
Hiselam	581	10,RC,11
Suksitah	400	12,13
Mater	323	14
Tong	150	15
Ngonp	200	RC
Pakur	200	16
Dengdeng	400	17,18
Juach	200	19
Ngapngoang	200	20
Nyeleaka	250	21
Daer A	550	22,23,24
Daer B	75	25
Dhiepah	162	
Biemruoh	115	26
Market 7	94	
Suckchabe	233	27,28
Hai Engas	590	29,30,31
Nyuenyphiu	123	
Kordapdap	29	
Naifasha	610	32,33,34,35
Khalibalek	287	36
Kuerbona	159	RC

Annex 2: Plausibility Report

Plausibility check for: SSudan_30112016_Roubkona_CARE.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** (0.5 %)
Overall Sex ratio	Incl	p	>0.1	>0.05	>0.001	<=0.001	
(Significant chi square)			0	2	4	10	**0** (p=0.226)
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=0.103)
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** (11)
Dig pref score - MUAC	Incl	#	0-7	8-12	13-20	> 20	
			0	2	4	10	**0** (6)
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** (1.05)
Skewness WHZ	Excl	#	<±0.2	<±0.4	<±0.6	>=±0.6	
			0	1	3	5	**0** (0.07)
Kurtosis WHZ	Excl	#	<±0.2	<±0.4	<±0.6	>=±0.6	
			0	1	3	5	**0** (-0.14)
Poisson dist WHZ-2	Excl	p	>0.05	>0.01	>0.001	<=0.001	
			0	1	3	5	**0** (p=0.969)
OVERALL SCORE WHZ =			0-9	10-14	15-24	>25	**2** %

The overall score of this survey is 2 %, this is excellent.

There were no duplicate entries detected.

Percentage of children with no exact birthday: 46 %

Age/Height out of range for WHZ:

MONTHS:
Line=105/ID=7: 5.88 mo

Anthropometric Indices likely to be in error (-3 to 3 for WHZ, -3 to 3 for HAZ, -3 to 3 for WAZ, from observed mean - chosen in Options panel - these values will be flagged and should be excluded from analysis for a nutrition survey in emergencies. For other surveys this might not be the best procedure e.g. when the percentage of overweight children has to be calculated):

Line=13/ID=13: HAZ (3.119), Age may be incorrect

Line=15/ID=15: HAZ (-5.370), WAZ (-4.568), Age may be incorrect
Line=22/ID=6: HAZ (7.470), WAZ (2.853), Age may be incorrect
Line=28/ID=1: HAZ (-4.120), Age may be incorrect
Line=30/ID=3: HAZ (-4.123), Age may be incorrect
Line=37/ID=10: HAZ (5.595), WAZ (2.396), Age may be incorrect
Line=46/ID=10: HAZ (3.430), Age may be incorrect
Line=63/ID=6: HAZ (3.437), Age may be incorrect
Line=88/ID=11: HAZ (2.298), Age may be incorrect
Line=109/ID=11: **WHZ (1.937)**, HAZ (-5.885), Height may be incorrect
Line=132/ID=11: HAZ (-5.355), Age may be incorrect
Line=140/ID=8: HAZ (-4.679), WAZ (-4.416), Age may be incorrect
Line=141/ID=9: HAZ (-4.665), WAZ (-4.566), Age may be incorrect
Line=159/ID=14: HAZ (3.656), WAZ (2.385), Age may be incorrect
Line=160/ID=15: HAZ (5.001), WAZ (2.651), Age may be incorrect
Line=171/ID=26: HAZ (5.329), WAZ (2.074), Age may be incorrect
Line=176/ID=5: HAZ (3.077), Age may be incorrect
Line=177/ID=6: HAZ (3.675), Age may be incorrect
Line=179/ID=8: HAZ (4.720), WAZ (2.227), Age may be incorrect
Line=182/ID=11: HAZ (2.584), Age may be incorrect
Line=215/ID=6: HAZ (2.620), Age may be incorrect
Line=222/ID=1: HAZ (3.244), Age may be incorrect
Line=227/ID=2: HAZ (-5.182), Age may be incorrect
Line=229/ID=4: HAZ (2.341), Age may be incorrect
Line=230/ID=5: HAZ (2.942), Age may be incorrect
Line=244/ID=12: HAZ (-5.459), Age may be incorrect
Line=252/ID=7: HAZ (2.460), Height may be incorrect
Line=268/ID=2: HAZ (-4.083), Age may be incorrect
Line=275/ID=3: HAZ (-5.102), Age may be incorrect
Line=324/ID=1: HAZ (2.955), Age may be incorrect
Line=326/ID=3: **WHZ (-5.698)**, HAZ (5.066), Height may be incorrect
Line=346/ID=2: HAZ (2.188), Age may be incorrect
Line=347/ID=3: HAZ (2.335), Age may be incorrect
Line=352/ID=8: HAZ (3.376), WAZ (1.999), Age may be incorrect
Line=354/ID=10: HAZ (-3.938), Age may be incorrect
Line=363/ID=5: HAZ (2.404), Height may be incorrect
Line=399/ID=10: HAZ (-3.885), Age may be incorrect
Line=422/ID=16: HAZ (2.654), Age may be incorrect
Line=426/ID=20: HAZ (-4.688), Age may be incorrect

Percentage of values flagged with SMART flags:WHZ: 0.5 %, HAZ: 9.1 %, WAZ: 2.3 %

Age distribution:

Month 6 : #########
Month 7 : ################
Month 8 : ########
Month 9 : ###################
Month 10 : ####

Month 11 : ####
Month 12 : ############
Month 13 : ###
Month 14 : #########
Month 15 : ##############
Month 16 : ############
Month 17 : ########
Month 18 : ##########
Month 19 : ##
Month 20 : #########
Month 21 : #######
Month 22 : #####
Month 23 : #######
Month 24 : ######################
Month 25 : ##
Month 26 : ########
Month 27 : ######
Month 28 : #########
Month 29 : ######
Month 30 : ####
Month 31 : #######
Month 32 : ##########
Month 33 : ###
Month 34 : ###
Month 35 : ################
Month 36 : ##################################
Month 37 : ##########
Month 38 : #####
Month 39 : #####
Month 40 : ##
Month 41 : ########
Month 42 : ######
Month 43 : ###
Month 44 : ######
Month 45 : ###
Month 46 : ###
Month 47 : ################
Month 48 : ##############
Month 49 : ######
Month 50 : #####
Month 51 : ####
Month 52 : ##
Month 53 : ######
Month 54 : ##
Month 55 : ####
Month 56 : ########
Month 57 : ####
Month 58 : #####
Month 59 : #######

Age ratio of 6-29 months to 30-59 months: 1.00 (The value should be around 0.85).: p-value = 0.103 (as expected)

Statistical evaluation of sex and age ratios (using Chi squared statistic):

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	66/52.4 (1.3)	56/46.6 (1.2)	122/99.1 (1.2)	1.18
18 to 29	12	52/51.1 (1.0)	39/45.5 (0.9)	91/96.6 (0.9)	1.33
30 to 41	12	55/49.6 (1.1)	54/44.1 (1.2)	109/93.6 (1.2)	1.02
42 to 53	12	38/48.8 (0.8)	38/43.4 (0.9)	76/92.1 (0.8)	1.00
54 to 59	6	15/24.1 (0.6)	14/21.5 (0.7)	29/45.6 (0.6)	1.07
6 to 59	54	226/213.5 (1.1)	201/213.5 (0.9)		1.12

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.226 (boys and girls equally represented)
Overall age distribution: p-value = 0.002 (significant difference)
Overall age distribution for boys: p-value = 0.041 (significant difference)
Overall age distribution for girls: p-value = 0.081 (as expected)
Overall sex/age distribution: p-value = 0.001 (significant difference)

Digit preference Weight:

Digit .0 : ##
Digit .1 : ##
Digit .2 : ##
Digit .3 : ##
Digit .4 : ##
Digit .5 : ###################################
Digit .6 : ##
Digit .7 : ##############################
Digit .8 : ##
Digit .9 : ##

Digit preference score: **5** (0-7 excellent, 8-12 good, 13-20 acceptable and > 20 problematic)
p-value for chi2: 0.476

Digit preference Height:

Digit .0 : ##########################
Digit .1 : ##############################
Digit .2 : ###################################
Digit .3 : ########################
Digit .4 : ###################
Digit .5 : ########################
Digit .6 : ######################
Digit .7 : ##############
Digit .8 : ##########

Digit .9 : ##########

Digit preference score: **11** (0-7 excellent, 8-12 good, 13-20 acceptable and > 20 problematic)
p-value for chi2: 0.000 (significant difference)

Digit preference MUAC:

Digit .0 : ##
Digit .1 : ##
Digit .2 : ##
Digit .3 : ##
Digit .4 : ##
Digit .5 : ##
Digit .6 : ##
Digit .7 : ####################################
Digit .8 : ####################################
Digit .9 : ##################################

Digit preference score: **6** (0-7 excellent, 8-12 good, 13-20 acceptable and > 20 problematic)
p-value for chi2: 0.131

Evaluation of Standard deviation, Normal distribution, Skewness and Kurtosis using the 3 exclusion (Flag) procedures

.	no exclusion	exclusion from reference mean (WHO flags)	exclusion from observed mean (SMART flags)
WHZ			
Standard Deviation SD:	1.08	1.06	1.05
(The SD should be between 0.8 and 1.2)			
Prevalence (< -2)			
observed:	20.3%	20.1%	20.2%
calculated with current SD:	19.4%	18.6%	18.6%
calculated with a SD of 1:	17.6%	17.3%	17.5%
HAZ			
Standard Deviation SD:	1.78	1.73	1.25
(The SD should be between 0.8 and 1.2)			
Prevalence (< -2)			
observed:	23.4%	23.4%	22.1%
calculated with current SD:	26.5%	26.3%	21.7%
calculated with a SD of 1:	13.1%	13.6%	16.4%
WAZ			
Standard Deviation SD:	1.22	1.22	1.11
(The SD should be between 0.8 and 1.2)			
Prevalence (< -2)			
observed:	25.2%	25.2%	25.1%
calculated with current SD:	26.9%	26.9%	25.9%
calculated with a SD of 1:	22.6%	22.6%	23.7%

Results for Shapiro-Wilk test for normally (Gaussian) distributed data:

WHZ	p= 0.048	p= 0.112	p= 0.170
HAZ	p= 0.000	p= 0.000	p= 0.007
WAZ	p= 0.022	p= 0.022	p= 0.100

(If p < 0.05 then the data are not normally distributed. If p > 0.05 you can consider the data normally distributed)

Skewness

WHZ	-0.06	0.11	0.07
HAZ	0.65	0.48	-0.06
WAZ	0.17	0.17	-0.08

If the value is:
-below minus 0.4 there is a relative excess of wasted/stunted/underweight subjects in the sample
-between minus 0.4 and minus 0.2, there may be a relative excess of wasted/stunted/underweight subjects in the sample.
-between minus 0.2 and plus 0.2, the distribution can be considered as symmetrical.
-between 0.2 and 0.4, there may be an excess of obese/tall/overweight subjects in the sample.
-above 0.4, there is an excess of obese/tall/overweight subjects in the sample

Kurtosis

WHZ	0.48	-0.09	-0.14
HAZ	2.15	1.45	-0.53
WAZ	0.54	0.54	-0.22

Kurtosis characterizes the relative size of the body versus the tails of the distribution. Positive kurtosis indicates relatively large tails and small body. Negative kurtosis indicates relatively large body and small tails.
If the absolute value is:
-above 0.4 it indicates a problem. There might have been a problem with data collection or sampling.
-between 0.2 and 0.4, the data may be affected with a problem.
-less than an absolute value of 0.2 the distribution can be considered as normal.

Test if cases are randomly distributed or aggregated over the clusters by calculation of the Index of Dispersion (ID) and comparison with the Poisson distribution for:

WHZ < -2: ID=0.60 (p=0.969)
WHZ < -3: ID=1.03 (p=0.422)
GAM: ID=0.60 (p=0.969)
SAM: ID=1.03 (p=0.422)
HAZ < -2: ID=1.25 (p=0.147)
HAZ < -3: ID=1.11 (p=0.295)
WAZ < -2: ID=1.16 (p=0.233)
WAZ < -3: ID=0.85 (p=0.717)

Subjects with SMART flags are excluded from this analysis.

The Index of Dispersion (ID) indicates the degree to which the cases are aggregated into certain clusters (the degree to which there are "pockets"). If the ID is less than 1 and p > 0.95 it indicates that the cases are UNIFORMLY distributed among the clusters. If the p value is between 0.05 and 0.95 the cases appear to be randomly distributed among the clusters, if ID is higher than 1 and p is less than 0.05 the cases are aggregated into certain cluster (there appear to be pockets of cases). If this is the case for Oedema but not for WHZ then aggregation of GAM and SAM cases is likely due to inclusion of oedematous cases in GAM and SAM estimates.

Are the data of the same quality at the beginning and the end of the clusters?

Evaluation of the SD for WHZ depending upon the order the cases are measured within each cluster (if one cluster per day is measured then this will be related to the time of the day the measurement is made).

Time point	SD for WHZ 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
01: 1.08 (n=36, f=0)	############
02: 1.12 (n=36, f=0)	##############

```
03: 1.27 (n=36, f=1)  ####################
04: 1.07 (n=36, f=0)  ###########
05: 1.02 (n=34, f=0)  #########
06: 1.27 (n=33, f=0)  ####################
07: 0.98 (n=31, f=0)  #######
08: 0.92 (n=29, f=0)  #####
09: 1.08 (n=29, f=0)  ############
10: 1.17 (n=27, f=0)  ################
11: 0.97 (n=25, f=1)  #######
12: 0.84 (n=19, f=0)  ##
13: 1.01 (n=15, f=0)  #########
14: 0.90 (n=11, f=0)  OOOO
15: 1.38 (n=06, f=0)  ~~~~~~~~~~~~~~~~~~~~~~~~~
16: 1.40 (n=05, f=0)  ~~~~~~~~~~~~~~~~~~~~~~~~~
17: 0.76 (n=04, f=0)
18: 1.10 (n=03, f=0)  ~~~~~~~~~~~~~~
19: 1.11 (n=03, f=0)  ~~~~~~~~~~~~~~
20: 0.37 (n=02, f=0)
21: 0.72 (n=02, f=0)
22: 0.44 (n=02, f=0)

(when n is much less than the average number of subjects per cluster different symbols are
used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART
flags found in the different time points)
```

Analysis by Team

Team	**1**	**2**	**3**	**4**	**5**	**6**
n =	72	64	74	45	86	87
Percentage of values flagged with SMART flags:						
WHZ:	0.0	0.0	1.4	0.0	1.2	0.0
HAZ:	6.9	6.3	12.2	17.8	3.5	11.5
WAZ:	1.4	4.7	1.4	2.2	0.0	4.6
Age ratio of 6-29 months to 30-59 months:						
	1.00	1.13	1.47	1.14	0.70	0.85
Sex ratio (male/female):						
	1.67	0.94	0.85	1.65	1.05	1.07
Digit preference Weight (%):						
.0 :	15	5	7	18	9	10
.1 :	10	17	11	9	14	9
.2 :	10	11	8	18	13	11
.3 :	4	8	15	4	10	10
.4 :	15	11	12	9	8	6
.5 :	10	6	12	9	3	9
.6 :	11	16	4	13	12	11
.7 :	7	8	7	2	8	8
.8 :	8	9	7	7	16	15
.9 :	10	9	18	11	6	9
DPS:	11	12	13	16	12	8

Digit preference score (0-7 excellent, 8-12 good, 13-20 acceptable and > 20 problematic)

Digit preference Height (%):						
.0 :	14	11	11	18	7	15
.1 :	13	9	16	13	13	13
.2 :	10	25	18	13	15	15
.3 :	13	13	12	4	12	14
.4 :	4	8	8	11	9	14

.5 :	13	11	12	11	13	7
.6 :	8	9	8	16	12	11
.7 :	8	6	3	4	12	5
.8 :	8	3	5	7	3	3
.9 :	10	5	7	2	5	3
DPS:	9	19	15	17	12	15

Digit preference score (0-7 excellent, 8-12 good, 13-20 acceptable and > 20 problematic)

Digit preference MUAC (%):

.0 :	8	11	15	13	9	9
.1 :	13	9	12	16	14	10
.2 :	6	8	11	16	12	13
.3 :	6	6	12	4	15	8
.4 :	14	11	15	16	9	13
.5 :	10	17	11	16	10	11
.6 :	13	13	8	9	5	7
.7 :	17	8	5	4	8	7
.8 :	10	9	5	4	8	11
.9 :	6	8	5	2	9	10
DPS:	12	10	12	18	10	7

Digit preference score (0-7 excellent, 8-12 good, 13-20 acceptable and > 20 problematic)

Standard deviation of WHZ:

SD	1.11	1.06	1.18	1.10	1.09	0.93

Prevalence (< -2) observed:

%	20.8	21.9	24.3	31.1	18.6

Prevalence (< -2) calculated with current SD:

%	20.0	23.0	25.2	24.1	17.4

Prevalence (< -2) calculated with a SD of 1:

%	17.5	21.7	21.5	22.0	15.4

Standard deviation of HAZ:

SD	1.59	1.88	1.87	2.02	1.36	1.94

observed:

%	25.0	43.8	16.2	15.6	17.4	23.0

calculated with current SD:

%	25.3	38.5	22.7	22.7	22.0	26.4

calculated with a SD of 1:

%	14.6	29.1	8.1	6.5	14.7	11.1

Statistical evaluation of sex and age ratios (using Chi squared statistic) for:

Team 1:

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	9/10.4 (0.9)	5/6.3 (0.8)	14/16.7 (0.8)	1.80
18 to 29	12	15/10.2 (1.5)	7/6.1 (1.1)	22/16.3 (1.4)	2.14
30 to 41	12	10/9.9 (1.0)	9/5.9 (1.5)	19/15.8 (1.2)	1.11
42 to 53	12	8/9.7 (0.8)	4/5.8 (0.7)	12/15.5 (0.8)	2.00
54 to 59	6	3/4.8 (0.6)	2/2.9 (0.7)	5/7.7 (0.7)	1.50
6 to 59	54	45/36.0 (1.3)	27/36.0 (0.8)		1.67

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.034 (significant excess of boys)
Overall age distribution: p-value = 0.304 (as expected)
Overall age distribution for boys: p-value = 0.484 (as expected)
Overall age distribution for girls: p-value = 0.587 (as expected)
Overall sex/age distribution: p-value = 0.027 (significant difference)

Team 2:

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	10/7.2 (1.4)	11/7.7 (1.4)	21/14.8 (1.4)	0.91
18 to 29	12	5/7.0 (0.7)	8/7.5 (1.1)	13/14.5 (0.9)	0.63
30 to 41	12	11/6.8 (1.6)	7/7.2 (1.0)	18/14.0 (1.3)	1.57
42 to 53	12	5/6.7 (0.7)	6/7.1 (0.8)	11/13.8 (0.8)	0.83
54 to 59	6	0/3.3 (0.0)	1/3.5 (0.3)	1/6.8 (0.1)	0.00
6 to 59	54	31/32.0 (1.0)	33/32.0 (1.0)		0.94

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.803 (boys and girls equally represented)
Overall age distribution: p-value = 0.053 (as expected)
Overall age distribution for boys: p-value = 0.091 (as expected)
Overall age distribution for girls: p-value = 0.480 (as expected)
Overall sex/age distribution: p-value = 0.022 (significant difference)

Team 3:

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	14/7.9 (1.8)	12/9.3 (1.3)	26/17.2 (1.5)	1.17
18 to 29	12	8/7.7 (1.0)	10/9.0 (1.1)	18/16.7 (1.1)	0.80
30 to 41	12	8/7.5 (1.1)	8/8.8 (0.9)	16/16.2 (1.0)	1.00
42 to 53	12	3/7.3 (0.4)	6/8.6 (0.7)	9/16.0 (0.6)	0.50
54 to 59	6	1/3.6 (0.3)	4/4.3 (0.9)	5/7.9 (0.6)	0.25
6 to 59	54	34/37.0 (0.9)	40/37.0 (1.1)		0.85

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.486 (boys and girls equally represented)
Overall age distribution: p-value = 0.068 (as expected)
Overall age distribution for boys: p-value = 0.055 (as expected)
Overall age distribution for girls: p-value = 0.776 (as expected)
Overall sex/age distribution: p-value = 0.027 (significant difference)

Team 4:

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	13/6.5 (2.0)	5/3.9 (1.3)	18/10.4 (1.7)	2.60
18 to 29	12	4/6.3 (0.6)	2/3.8 (0.5)	6/10.2 (0.6)	2.00
30 to 41	12	8/6.1 (1.3)	6/3.7 (1.6)	14/9.9 (1.4)	1.33
42 to 53	12	2/6.0 (0.3)	3/3.7 (0.8)	5/9.7 (0.5)	0.67
54 to 59	6	1/3.0 (0.3)	1/1.8 (0.6)	2/4.8 (0.4)	1.00
6 to 59	54	28/22.5 (1.2)	17/22.5 (0.8)		1.65

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.101 (boys and girls equally represented)
Overall age distribution: p-value = 0.012 (significant difference)
Overall age distribution for boys: p-value = 0.018 (significant difference)
Overall age distribution for girls: p-value = 0.551 (as expected)
Overall sex/age distribution: p-value = 0.001 (significant difference)

Team 5:

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	10/10.0 (1.0)	13/9.7 (1.3)	23/19.7 (1.2)	0.77
18 to 29	12	7/9.7 (0.7)	5/9.5 (0.5)	12/19.2 (0.6)	1.40
30 to 41	12	10/9.4 (1.1)	10/9.2 (1.1)	20/18.6 (1.1)	1.00
42 to 53	12	12/9.3 (1.3)	9/9.1 (1.0)	21/18.3 (1.1)	1.33
54 to 59	6	4/4.6 (0.9)	5/4.5 (1.1)	9/9.1 (1.0)	0.80
6 to 59	54	43/42.5 (1.0)	42/42.5 (1.0)		1.02

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.914 (boys and girls equally represented)
Overall age distribution: p-value = 0.441 (as expected)
Overall age distribution for boys: p-value = 0.796 (as expected)
Overall age distribution for girls: p-value = 0.501 (as expected)
Overall sex/age distribution: p-value = 0.286 (as expected)

Team 6:

Age cat.	mo.	boys	girls	total	ratio boys/girls
6 to 17	12	10/10.4 (1.0)	10/9.7 (1.0)	20/20.2 (1.0)	1.00
18 to 29	12	13/10.2 (1.3)	7/9.5 (0.7)	20/19.7 (1.0)	1.86
30 to 41	12	8/9.9 (0.8)	14/9.2 (1.5)	22/19.1 (1.2)	0.57
42 to 53	12	8/9.7 (0.8)	10/9.1 (1.1)	18/18.8 (1.0)	0.80
54 to 59	6	6/4.8 (1.2)	1/4.5 (0.2)	7/9.3 (0.8)	6.00
6 to 59	54	45/43.5 (1.0)	42/43.5 (1.0)		1.07

The data are expressed as observed number/expected number (ratio of obs/expect)

Overall sex ratio: p-value = 0.748 (boys and girls equally represented)
Overall age distribution: p-value = 0.902 (as expected)
Overall age distribution for boys: p-value = 0.781 (as expected)
Overall age distribution for girls: p-value = 0.202 (as expected)
Overall sex/age distribution: p-value = 0.104 (as expected)

Evaluation of the SD for WHZ depending upon the order the cases are measured within each cluster (if one cluster per day is measured then this will be related to the time of the day the measurement is made).

Team: 1

Time point	SD for WHZ															
	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3

```
01: 0.73 (n=06, f=0)
02: 1.44 (n=06, f=0)  ############################
03: 0.88 (n=06, f=0)  ###
04: 1.20 (n=06, f=0)  ##################
05: 0.89 (n=06, f=0)  ####
06: 1.40 (n=06, f=0)  ########################
07: 0.81 (n=05, f=0)  #
08: 1.35 (n=05, f=0)  ######################
09: 0.88 (n=05, f=0)  ###
10: 1.35 (n=05, f=0)  ######################
11: 0.49 (n=04, f=0)
12: 0.86 (n=04, f=0)  ##
13: 0.57 (n=03, f=0)
14: 1.70 (n=02, f=0)  OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
15: 1.08 (n=02, f=0)  OOOOOOOOOOOO
```

(when n is much less than the average number of subjects per cluster different symbols are used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART flags found in the different time points)

Team: 2

```
Time                                          SD for WHZ
point               0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
01: 1.03 (n=06, f=0)  ##########
02: 1.05 (n=06, f=0)  ###########
03: 0.23 (n=06, f=0)
04: 0.89 (n=06, f=0)  ####
05: 0.82 (n=06, f=0)  #
06: 1.68 (n=06, f=0)  ######################################
07: 1.05 (n=06, f=0)  ###########
08: 1.18 (n=05, f=0)  ################
09: 1.61 (n=05, f=0)  ##################################
10: 1.32 (n=05, f=0)  ######################
11: 0.45 (n=04, f=0)
12: 0.85 (n=02, f=0)  OO
```

(when n is much less than the average number of subjects per cluster different symbols are used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART flags found in the different time points)

Team: 3

```
Time                                          SD for WHZ
point               0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
01: 1.11 (n=06, f=0)  #############
02: 0.96 (n=06, f=0)  #######
03: 1.75 (n=06, f=1)  ########################################
04: 0.89 (n=06, f=0)  ####
05: 1.37 (n=05, f=0)  ########################
06: 2.05 (n=05, f=0)  ####################################################
07: 0.53 (n=05, f=0)
08: 0.83 (n=05, f=0)  #
09: 1.00 (n=05, f=0)  #########
10: 1.37 (n=05, f=0)  ########################
11: 1.13 (n=05, f=0)  ###############
12: 0.57 (n=03, f=0)
13: 1.51 (n=02, f=0)  OOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
14: 0.39 (n=02, f=0)
```

(when n is much less than the average number of subjects per cluster different symbols are used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART flags found in the different time points)

Team: 4

```
Time                                          SD for WHZ
point               0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
01: 0.99 (n=06, f=0)  ########
02: 1.35 (n=06, f=0)  ######################
03: 1.42 (n=06, f=0)  ############################
04: 1.03 (n=06, f=0)  #########
05: 0.55 (n=05, f=0)
```

```
06: 1.20 (n=04, f=0)  ################
07: 0.68 (n=03, f=0)
08: 0.91 (n=02, f=0)  OOOOO
09: 0.39 (n=02, f=0)

(when n is much less than the average number of subjects per cluster different symbols are
used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART
flags found in the different time points)
```

Team: 5

```
Time                                          SD for WHZ
point                 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
01: 1.11 (n=06, f=0)  #############
02: 0.59 (n=06, f=0)
03: 1.17 (n=06, f=0)  ###############
04: 1.40 (n=06, f=0)  ########################
05: 1.50 (n=06, f=0)  ############################
06: 0.70 (n=06, f=0)
07: 1.16 (n=06, f=0)  ###############
08: 0.47 (n=06, f=0)
09: 0.66 (n=06, f=0)
10: 1.37 (n=06, f=0)  ########################
11: 1.13 (n=06, f=0)  ###############
12: 1.05 (n=05, f=0)  ###########
13: 0.41 (n=04, f=0)
14: 0.72 (n=03, f=0)
15: 1.66 (n=02, f=0)  OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
16: 2.36 (n=02, f=0)  OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
17: 0.47 (n=02, f=0)

(when n is much less than the average number of subjects per cluster different symbols are
used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART
flags found in the different time points)
```

Team: 6

```
Time                                          SD for WHZ
point                 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
01: 1.26 (n=06, f=0)  ##################
02: 0.94 (n=06, f=0)  ######
03: 1.32 (n=06, f=0)  ######################
04: 1.06 (n=06, f=0)  ###########
05: 0.50 (n=06, f=0)
06: 0.56 (n=06, f=0)
07: 0.50 (n=06, f=0)
08: 0.79 (n=06, f=0)
09: 1.03 (n=06, f=0)  ##########
10: 0.28 (n=05, f=0)
11: 1.15 (n=05, f=0)  ###############
12: 0.36 (n=04, f=0)
13: 1.77 (n=04, f=0)  ########################################
14: 1.27 (n=03, f=0)  ###################

(when n is much less than the average number of subjects per cluster different symbols are
used: 0 for n < 80% and ~ for n < 40%; The numbers marked "f" are the numbers of SMART
flags found in the different time points)
```

(for better comparison it can be helpful to copy/paste part of this report into Excel)

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Annex 3: Age assessment critical events and seasonal calendar

Season		2010		2011		2012		2013		2014		2015		2016	
Taking of cattle to cattle camps	**Jan**	New Year's day	83	New Year's day	71	New Year's day ***CPA signing day***	***59***	New Year's day	***47***	Start of UNMISS Bentiu Base	***35***	New Year's day	***23***	New Year's day	***11***
Movement to cattle Camps/Grass cutting	**Feb**	People moving to cattle camps in big numbers	82	People moving to cattle camps in big numbers	70	oil shutdown	***58***	People moving to cattle camps in big numbers	***46***		***34***		***22***		***10***
Clearing bushes	**Mar**	Cattle in camps	81	Cattle in camps	69	Cattle in camps	***57***	Cattle in camps	***45***	Cattle in camps	***33***	Cattle in camps	***21***	Air drops in Nhiadiu	***9***
Clearing bushes	**April**	Land preparation	80	Land preparation	68	Fighting between North &South Sudan	***56***	Land preparation	***44***	Land preparation	***32***	Resurgence of violence in Bentiu	***20***	Land preparation	***8***

Rain starts	**May**	Start of the long rainy season	79	Start of the long rainy season	67	Start of the long rainy season	***55***	Start of the long rainy season	***43***	Start of the long rainy season	***31***	Mass cattle raiding in Rubkona county	***19***	Start of the long rainy season	***7***
Planting of crops; maize, sorghum	**June**		78	Opening of Lich University College in Bentiu	66		***54***		***42***		***30***	Start of the long rainy season	***18***		***6***
Weeding	**July**		77	Martyr day	65	Independence day Martyr day	***53***	Independence day Martyr day	***41***	Independence day Martyr day	***29***	Independence day Martyr day	***17***	Independence day Martyr day	5
Weeding	**Aug**		76		64		***52***		***40***		***28***		***16***		4
Maize harvesting	**Sept**		75		63		***51***		***39***		***27***		***15***		3
Sorghum harvesting	**Oct**		74		62		***50***		***38***		***26***		***14***		2
	Nov		73		61		***49***		***37***		***25***		***13***		1
Christmas	**Dec**	Dry season	72	Dry season	60	Dry season	***48***	Fighting erupt	***36***	Dry season	***24***	Dry season	***12***	Dry season	0

		begins		begins		begins		in Juba		begins		begins		begins		

TEM (Technical Error of Measurement)/precision and accuracy using the new standardization report

Standardisation test results					Precision				Accuracy		OUTCOME		
Weight		subjects	mean	SD	max	Technical error	TEM/mean	Coef of reliability	Bias from superv	Bias from median	result		
		#	kg	kg	kg	TEM (kg)	TEM (%)	R (%)	Bias (kg)	Bias (kg)			
	Supervisor	10	10.2	3.4	0.6	0.14	1.4	99.8	-	0.31	TEM poor	R value good	Bias reject
	Enumerator 1	10	10.3	3.4	0.4	0.09	0.9	99.9	0.04	0.35	TEM acceptable	R value good	Bias reject
	Enumerator 2	10	10	3.1	4.8	1.08	10.8	87.8	-0.18	0.13	TEM reject	R value reject	Bias poor
	Enumerator 3	10	13.9	21.4	93.2	20.85	150.5	5	3.65	3.96	TEM reject	R value reject	Bias reject
	Enumerator 4	10	9.1	2.7	1.7	0.39	4.3	97.9	-1.11	-0.8	TEM reject	R value acceptable	Bias good
	Enumerator 5	10	10.2	3.3	2.4	0.6	5.9	96.6	-0.01	0.3	TEM reject	R value acceptable	Bias reject
	Enumerator 6	10	10.6	3.1	3.5	0.9	8.6	91.6	0.35	0.66	TEM reject	R value poor	Bias reject
	Enumerator 7	10	10.3	3.3	3.2	1.07	10.4	89.7	0.06	0.37	TEM reject	R value reject	Bias reject
	Enumerator 8	10	10.3	3.3	2.8	0.78	7.6	94.2	0.12	0.43	TEM reject	R value poor	Bias reject
0.09	0.4	TEM poor	R value good	Bias reject									
	Enumerator 10	10	10.3	3.4	0.5	0.17	1.7	99.7	3.41	3.73	TEM reject	R value reject	Bias reject
	Enumerator	10	13.6	15	67.5	15.09	110.8	-1.3	-0.85	-0.54	TEM reject	R value reject	Bias good

	11												
	Enumerator 12	10	9.4	2.5	5	1.12	11.9	80.7	-0.35	-0.04	TEM reject	R value reject	Bias good
	Enumerator 13	10	9.9	2.9	5	1.12	11.3	85.2	-0.24	0.07	TEM reject	R value good	Bias acceptable
	Enumerator 14	10	10	3.4	0.9	0.25	2.5	99.4	-0.26	0.05	TEM reject	R value poor	Bias acceptable
	Enumerator 15	10	9.9	3.1	2.2	0.76	7.6	94.2	0.32	0.63	TEM reject	R value reject	Bias reject
	Enumerator 16	10	10.5	2.8	4.3	1.5	14.3	70.4	1.64	1.95	TEM reject	R value reject	Bias reject
	Enumerator 17	10	11.9	5.6	25.8	5.81	49	-7.7	9.5	9.81	TEM reject	R value reject	Bias reject
	Enumerator 18	10	19.7	33.3	94.6	21.16	107.4	59.5	3.79	4.1	TEM reject	R value reject	Bias reject
	Enumerator 19	10	14	15.8	64.6	14.48	103.5	15.7	3.45	3.76	TEM reject	R value reject	Bias reject
	Enumerator 20	10	13.7	16.9	68.85	15.42	113	16.5					
	enum inter 1st	19x10	11.6	13.6	-	13.22	113.5	5.6	-	-	TEM reject	R value reject	
	enum inter 2nd	19x10	11.2	8.8	-	7.29	64.9	30.6	-	-	TEM reject	R value reject	
	inter enum + sup	20x10	11.4	11.2	-	10.01	87	22	-	-	TEM reject	R value reject	
	TOTAL intra+inter	19x10	-	-	-	14.08	123.1	-51.8	1.23	1.48	TEM reject	R value reject	Bias reject
	TOTAL + sup	20x10	-	-	-	13.73	120.6	-51.2	-	-	TEM reject	R value reject	
Height		subjects	mean	SD	max	Technical error	TEM/ mean	Coef of reliability	Bias from superv	Bias from median	result		

		#	cm	cm	cm	TEM (cm)	TEM (%)	R (%)	Bias (cm)	Bias (cm)			
	Supervisor	10	86.1	14.4	0.1	0.04	0	100	-	3.69	TEM good	R value good	
	Enumerator 1	10	86.2	14.3	0.5	0.17	0.2	100	0.13	3.83	TEM good	R value good	Bias good
	Enumerator 2	10	85.1	13.6	22	5.23	6.2	85.1	-1.04	2.65	TEM reject	R value reject	Bias good
	Enumerator 3	10	81	12.2	15	3.47	4.3	91.9	-5.09	-1.39	TEM reject	R value poor	Bias good
	Enumerator 4	10	81.5	11.8	22.4	5.02	6.2	82	-4.63	-0.94	TEM reject	R value reject	Bias good
	Enumerator 5	10	83.8	13.5	22.4	5.02	6	86.1	-2.28	1.41	TEM reject	R value reject	Bias good
	Enumerator 6	10	85.1	14.9	0	0	0	100	-1.04	2.66	TEM good	R value good	Bias good
	Enumerator 7	10	79.2	21.4	27.1	7.26	9.2	88.5	-6.93	-3.24	TEM reject	R value reject	Bias good
	Enumerator 8	10	78.7	21.5	95.2	24.84	31.6	-33.5	-7.43	-3.74	TEM reject	R value reject	Bias good
-6.97	-3.28	TEM reject	R value reject	Bias good									
	Enumerator 10	10	79.1	28.1	77.9	22.98	29	33	-6.29	-2.6	TEM good	R value good	Bias good
	Enumerator 11	10	79.8	28.5	0	0	0	100	-1.03	2.67	TEM reject	R value reject	Bias good
	Enumerator 12	10	85.1	16	22.7	5.23	6.1	89.3	-0.24	3.46	TEM good	R value good	Bias good
	Enumerator 13	10	85.9	14.4	0.7	0.27	0.3	100	-1.13	2.57	TEM acceptable	R value good	Bias good
	Enumerator	10	85	14.7	1.5	0.6	0.7	99.8	-1.5	2.19	TEM good	R value good	Bias good

	14												
	Enumerator 15	10	84.6	14.8	0	0	0	100	-1.33	2.36	TEM reject	R value reject	Bias good
	Enumerator 16	10	84.8	14.9	38.3	11.87	14	36.1	-1.22	2.48	TEM reject	R value poor	Bias good
	Enumerator 17	10	84.9	13.7	12.8	3.96	4.7	91.7	-1.18	2.52	TEM reject	R value poor	Bias good
	Enumerator 18	10	84.9	13.8	10.6	4.01	4.7	91.6	-3.27	0.43	TEM reject	R value reject	Bias good
	Enumerator 19	10	82.8	13.8	31.4	10.44	12.6	42.6	-0.63	3.06	TEM reject	R value acceptable	Bias good
	Enumerator 20	10	85.5	15.1	7.4	1.69	2	98.7					
	enum inter 1st	19x10	83.4	17.6	-	13.33	16	42.6	-	-	TEM reject	R value reject	
	enum inter 2nd	19x10	83.2	16	-	10.02	12	61	-	-	TEM reject	R value reject	
	inter enum + sup	20x10	83.4	16.7	-	11.42	13.7	53.9	-	-	TEM reject	R value reject	
	TOTAL intra+inter	19x10	-	-	-	14.94	17.9	21	-2.79	1.04	TEM reject	R value reject	Bias good
	TOTAL + sup	20x10	-	-	-	14.59	17.5	23.6	-	-	TEM reject	R value reject	
MUAC		subjects	mean	SD	max	Technical error	TEM/mean	Coef of reliability	Bias from superv	Bias from median	result		
		#	mm	mm	mm	TEM (mm)	TEM (%)	R (%)	Bias (mm)	Bias (mm)			
	Supervisor	10	12.7	0.9	0.3	0.12	0.9	98.1	-	-0.06	TEM good	R value acceptable	Bias good
	Enumerator 1	10	12.8	0.9	0.3	0.12	0.9	98	0.09	0.03	TEM good	R value acceptable	Bias good

	Enumerator 2	10	13	0.9	0.5	0.21	1.6	94.8	0.22	0.16	TEM good	R value poor	Bias good
	Enumerator 3	10	12.5	0.8	0.4	0.11	0.9	98.4	-0.23	-0.29	TEM good	R value acceptable	Bias good
	Enumerator 4	10	12.5	0.8	0	0	0	100	-0.27	-0.33	TEM good	R value good	Bias good
	Enumerator 5	10	12.8	0.9	1	0.29	2.2	89.7	0.01	-0.05	TEM good	R value reject	Bias good
	Enumerator 6	10	12.8	0.9	0.4	0.13	1	97.9	0.05	-0.01	TEM good	R value acceptable	Bias good
	Enumerator 7	10	12.8	0.9	0.4	0.13	1	98.1	0.05	-0.01	TEM good	R value acceptable	Bias good
	Enumerator 8	10	12.8	0.9	0.8	0.25	2	92.1	0.05	-0.01	TEM good	R value poor	Bias good
0.05	-0.01	TEM good	R value reject	Bias good									
	Enumerator 10	10	12.8	0.9	1.8	0.42	3.3	78.7	0.17	0.11	TEM good	R value reject	Bias good
	Enumerator 11	10	12.9	1	0.9	0.33	2.6	89.3	0.53	0.47	TEM good	R value good	Bias good
	Enumerator 12	10	13.3	1.1	0	0	0	100	0.4	0.34	TEM good	R value reject	Bias good
	Enumerator 13	10	13.1	1	0.6	0.31	2.4	89.9	0.16	0.1	TEM good	R value acceptable	Bias good
	Enumerator 14	10	12.9	0.8	0.3	0.1	0.8	98.4	0.17	0.11	TEM good	R value reject	Bias good
	Enumerator 15	10	12.9	0.7	0.9	0.29	2.2	84.2	0.24	0.18	TEM good	R value acceptable	Bias good
	Enumerator 16	10	13	0.8	0.3	0.1	0.8	98.4	0.24	0.18	TEM good	R value reject	Bias good
	Enum	10	13	0.7	0.9	0.29	2.2	84.4	0.19	0.13	TEM	R value	Bias

	erator 17										good	reject	good
	Enum erator 18	10	12.9	0.9	2.1	0.67	5.2	39.8	0.23	0.17	TEM good	R value reject	Bias good
	Enum erator 19	10	13	0.8	1.1	0.4	3.1	77.8	0.07	0.01	TEM good	R value accept able	Bias good
	Enum erator 20	10	12.8	0.9	0.8	0.19	1.5	95.2					
	enum inter 1st	19x 10	12.9	0.9	-	0.58	4.5	60.2	-	-	TEM good	R value reject	
	enum inter 2nd	19x 10	12.9	0.8	-	0.48	3.8	66.2	-	-	TEM good	R value reject	
	inter enum + sup	20x 10	12.9	0.9	-	0.53	4.1	64.1	-	-	TEM good	R value reject	
	TOTAL intra+i nter	19x 10	-	-	-	0.6	4.7	52.8	0.13	0.06	TEM good	R value reject	Bias good
	TOTAL + sup	20x 10	-	-	-	0.6	4.6	54	-	-	TEM good	R value reject	
Suggested cut-off points for acceptability of measurements													
Parameter		MU AC m m	Wei ght Kg	Height cm									
individ ual	good	<2. 0	<0.0 4	<0. 4									
TEM	accept able	<2. 7	<0.1 0	<0. 6									
(intra)	poor	<3. 3	<0.2 1	<1. 0									
	reject	>3. 3	>0.2 1	>1. 0									
Team TEM	good	<2. 0	<0.1 0	<0. 5									
(intra+i nter)	accept able	<2. 7	<0.2 1	<1. 0									
and Total	poor	<3. 3	<0.2 4	<1. 5									
	reject	>3. 3	>0.2 4	>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									
From sup if good	acceptable	<2	<0.10	<0.6									
outcome, otherwise	poor	<3	<0.21	<1.4									
from median	reject	>3	>0.21	>1.4									