Sudan National Micronutrient Survey Indicators Definition

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Contents

1 Background

To aid the analysis of the Sudan National Micronutrient Survey 2017-2018 data, appropriate indicators needed to be defined. The only documentation of indicators to be assessed from the survey was the last version of the S3M-II indicators list dated 16 November 2018. However, this document does not clearly define the indicators with no cut-off values provided. As such, indicator definitions were made based on a rapid literature review including micronutrient survey reports done elsewhere and reflected upon based actual available data from the survey itself to update the indicator definitions. This document presents these definitions.

2 Haemoglobin

In the main S3M-II survey, we defined multiple indicators based on Hb data. These indicators represented the different severities of anaemia by different respondent groupings. Classification into these severity categories was based on Hb level cut-offs defined by WHO [World Health Organization and Centers for Disease Control and Prevention, 2007, World Health Organization, 2011b] as follows:

Table 1: Hb levels to diagnose anaemia at sea level in grams per litre (g/L)

Population	**Mild**	**Moderate**	**Severe**
Children 6-59 months of age	100 - 109	70 - 99	< 70
Children 5-11 years of age	110 - 114	80 - 109	< 80
Children 12-14 years of age	110 - 119	80 - 109	< 80
Non-pregnant women (15 years and above)	110 - 119	80 - 109	< 80
Pregnant women	100 - 109	70 - 99	< 70
Men (15 years and above)	110 - 129	80 - 109	< 80

For the Sudan S3M-II main survey, no data was collected for children 5-17 years of age and for adult men 15 years of age and above so the indicator for this age group was not calculated and reported. When categorising respondents based on the above cut-offs in the main S3M-II survey, no adjustments to Hb were done based on altitude and for smoking history as recommended by WHO [World Health Organization and Centers for Disease Control and Prevention, 2007, World Health Organization, 2011b].

We propose to analyse the Sudan National Micronutrient Survey data using the same indicator definitions used in the Sudan S3M-II main survey. We also propose to adjust Hb based on altitude of the PSU from where the data was collected. Altitude data will be gathered from publicly available elevation model data (such as the Shuttle Radar Topography Mission or SRTM data that is available freely through various outlets for Sudan) if no altitude data can be provided by UNICEF. Map below shows elevation for Sudan based on publicly available SRTM data [for Spatial Information].

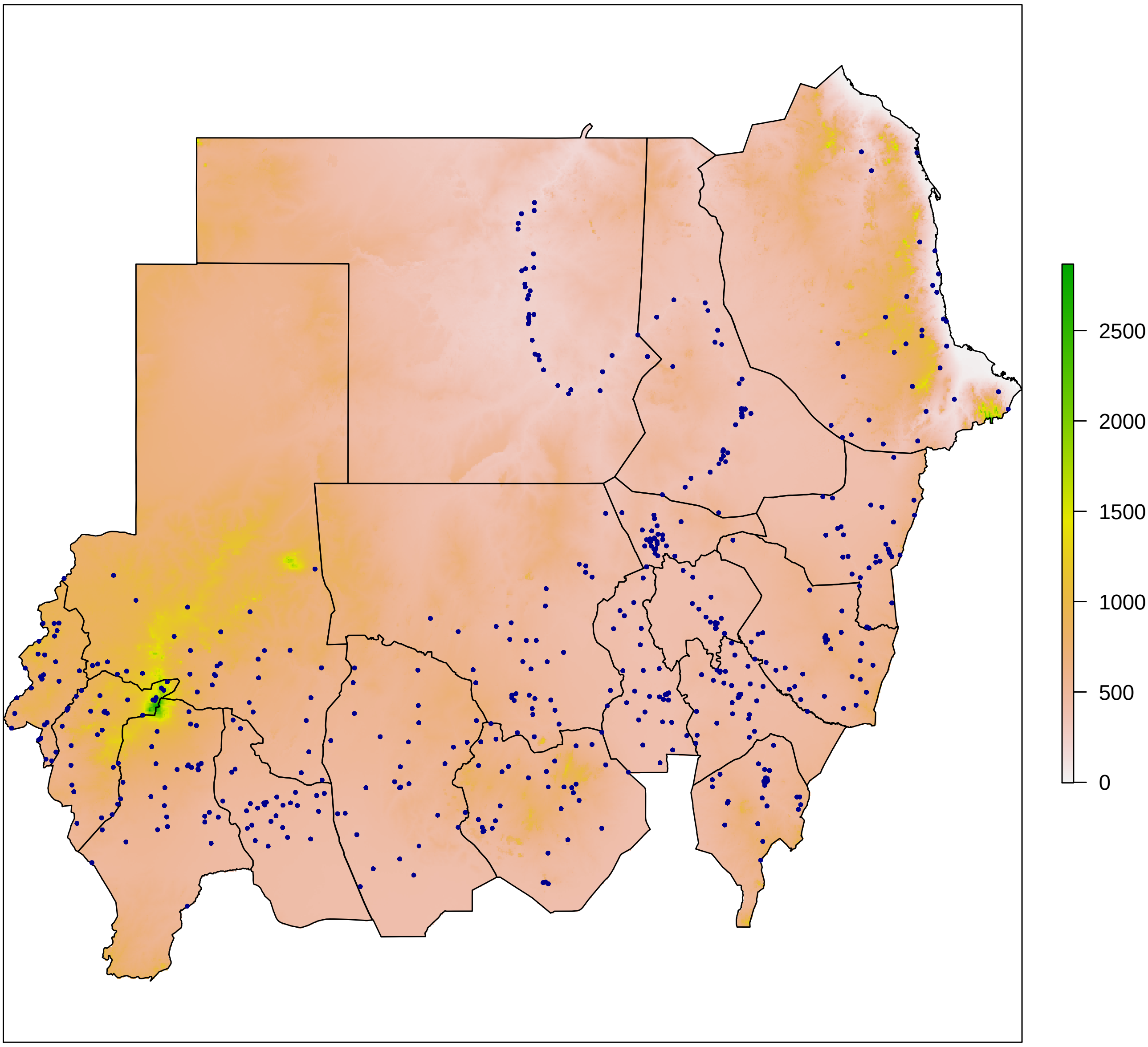

Figure 1: Shuttle Radar Topography Mission (SRTM) 90m Digital Elevation Model (DEM) for Sudan overlaid with the Sudan National Micronutrient survey primary sampling unit locations

With this data, we are able to extract elevation data for each of the PSUs in the Sudan Micronutrient Survey dataset.

Table 2: Sudan National Micronutrient Survey dataset with altitude extracted from SRTM 90m DEM

psu	state	locality	sex	hb	altitude
45	16	164	2	11.6	978
45	16	164	2	13.9	978
45	16	164	2	12.4	978
45	16	164	2	13.1	978
45	16	164	2	13.2	978
45	16	164	2	10.3	978
45	16	164	2	12.4	978
45	16	164	1	8.8000000000000007	978
45	16	164	2	11.8	978
45	16	164	1	8.1	978
45	16	164	2	12.4	978
45	16	164	2	9.1	978
45	16	164	2	13.3	978
45	16	164	1	9.8000000000000007	978
45	16	164	2	10.4	978
45	16	164	2	13	978
45	16	164	2	11.8	978
45	16	164	2	13	978
45	16	164	2	8.5	978
45	16	164	2	8.6	978
45	16	164	2	11.4	978
45	16	164	2	12.6	978
45	16	164	2	8.9	978
45	16	164	2	14.2	978
45	16	164	1	10.5	978
45	16	164	2	11.9	978
45	16	164	2	11.6	978
45	16	164	2	10.7	978
45	16	164	2	10.8	978
53	16	164	1	10.6	874
53	16	164	2	10	874
53	16	164	NA	NA	874
53	16	164	1	11.8	874
53	16	164	2	NA	874
53	16	164	2	12.4	874
53	16	164	1	7.9	874
53	16	164	1	8.4	874
53	16	164	2	11.7	874
53	16	164	2	10.6	874
53	16	164	2	12.5	874

Adjustments to measured Hb based on altitude will be done based on the following [World Health Organization, 2011b]:

Table 3: Altitude adjustments to measured haemoglobin concentrations

Altitude (metres above sea level)	**Measured haemoglobin adjustment (g/L)**
< 1000	0
1000	-2
1500	-5
2000	-8
2500	-13
3000	-19
3500	-27
4000	-35
4500	-45

3 Serum ferritin

Normal serum ferritin levels range from 12 µg/L to 150 µg/L. Following are the cut-offs for serum ferritin concentration that indicate either iron depletion or iron overload [World Health Organization and Centers for Disease Control and Prevention, 2007, Gorstein et al., 2007, Wegmüller et al., 2020, World Health Organization, 2011a].

Table 4: Relative extent of iron stores on the basis of serum ferritin concentration (µg/L)

	Serum ferritin (µg/L)			
	Less than 5 years		**5 years or older**	
	Male	**Female**	**Male**	**Female**
Depleted iron stores	< 12	< 12	< 15	< 15
Depleted iron stores in the presence of infection	< 30	< 30	-	-
Severe risk of iron overload (adults)	-	-	> 200	> 150

Serum ferritin will be used to assess iron deficiency for children less than 5 and for any other individual above 5 years old. For children less than 5 years old, a cut-off for serum ferritin value of $< 12\ \mu/L$ indicates iron deficiency while for those older than 5 years old, a cut-off of $< 15\ \mu/L$ is used.

However, it has been recommended that serum ferritin values be adjusted based on inflammation status ideally using both of the acute phase proteins - C-reactive protein (CRP) and α_1-acid glycoprotein (AGP) to yield the most unbiased estimates of iron deficiency. However, the Sudan

Micronutrient Survey only assessed CRP in the samples. The recommended adjustments when only one of the active phase proteins is available is to use an appropriate multiplier to the serum ferritin value depending on inflammation status of the respondent as described below:

Table 5: Cut-offs to determine inflammation

Active Phase Protein	**Cut-off**
CRP	>5 mg/L
AGP	>1 g/L

If a respondent is classified as being in an active inflammation process, then serum ferritin is adjusted accordingly. If inflammation is assessed using CRP only, the serum ferritin is adjusted by 0.65 [Thurnham et al., 2010].

4 Calcium

The range of normal values for serum calcium is age-dependent as shown below [Lietman et al., 2010]:

Table 6: Representative normal values for age for concentration of serum total calcium

Target Group	**Age**	**Serum total calcium (mg/dL)**
Infants	0-3 months	8.8 - 11.3
	1-5 years	9.4 - 10.8
Children	6-12 years	9.4 - 10.3
Men	20 years	9.1 - 10.2
	50 years	8.9 - 10.0
	70 years	8.8 - 9.9
Women	20 years	8.8 - 10.0
	50 years	8.8 - 10.0
	70 years	8.8 - 10.0

We propose to use these normal ranges by age to determine whether a specific respondent group is hypocalcemic or below the normal range for their age or hypercalcemic or above the normal range for their age.

5 Iodine

Currently, cut-offs for urinary iodine are available for school-age children and older (6 years and older), pregnant women, and for lactating women and children aged less than 2 years.

Following are the various criteria for assessing iodine status in school-age children and older [World Health Organization, 2013]:

Table 7: Epidemiologic criteria for assessing iodine nutrition based on median urinary iodine concentration in school-age children and older

Median urinary iodine (µg/L)	Iodine intake	Iodine status
< 20	Insufficient	Severe iodine deficiency
20 - 49	Insufficient	Moderate iodine deficiency
50 - 99	Insufficient	Mild iodine deficiency
100 - 199	Adequate	Adequate iodine nutrition
200 - 299	Above requirements	May pose a slight risk of more than adequate iodine intake in these populations
300	Excessive	Risk of adverse health consequences (iodine-induced hyperthyroidism, autoimmune thyroid disease)

Following are the various criteria for assessing iodine status in pregnant women, lactating women and children aged less than 2 years [World Health Organization, 2013]:

Table 8: Epidemiologic criteria for assessing iodine nutrition based on median urinary iodine concentration in pregnant women, lactating women, and children aged less than 2 years

Median urinary iodine (g/L)	Iodine intake
Pregnant women	
< 150	Insufficient
150 - 249	Adequate
250 - 499	Above requirements
500 or more	Excessive
Lactating women and children aged less than 2 years	
< 100	Insufficient
100 or more	Adequate

6 Summary

Given these indicator definition, we propose the following list of indicators to be analysed and reported for the Sudan Micronutrient Survey.

Table 9: List of proposed indicators for Sudan National Micronutrient Survey

Category	**Indicators**	**Type**
Anaemia	Mild anaemia in children 6-59 months old	Proportion
	Moderate anaemia in children 6-59 months old	Proportion
	Severe anaemia in children 6-59 months old	Proportion
	Mild anaemia in non-pregnant carers	Proportion
	Moderate anaemia in non-pregnant carers	Proportion
	Severe anaemia in non-pregnant carers	Proportion
	Mild anaemia in pregnant carers	Proportion
	Moderate anaemia in pregnant carers	Proportion
	Severe anaemia in pregnant carers	Proportion
Iron deficiency	Iron deficiency in children 6-59 months old	Proportion
	Iron deficiency in non-pregnant carers	Proportion
	Iron deficiency in pregnant carers	Proportion
Iron overload	Iron overload in children 6-59 months old	Proportion
	Iron overload in non-pregnant carers	Proportion
	Iron overload in pregnant carers	Proportion
Inflammation	Active inflammation in children 6-59 months old	Proportion
	Active inflammation in non-pregnant carers	Proportion
	Active inflammation in pregnant carers	Proportion
Calcium deficiency	Hypocalcemia in children 12-59 months old	Proportion
	Hypocalcemia in non-pregnant women carers	Proportion
	Hypocalcemia in pregnant carers	Proportion
Calcium overload	Hypercalcemia in children 12-59 months old	Proportion
	Hypercalcemia in non-pregnant women carers	Proportion
	Hypercalcemia in pregnant carers	Proportion
Iodine deficiency	Mild iodine deficiency in non-pregnant carers	Proportion
	Moderate iodine deficiency in non-pregnant carers	Proportion
	Severe iodine deficiency in non-pregnant carers	Proportion
	Iodine deficiency in pregnant carers	Proportion
	Iodine deficiency in lactating carers	Proportion
Iodine excess	Excessive iodine in non-pregnant carers	Proportion
	Excessive iodine in pregnant carers	Proportion

6.1 Results presentation

Estimates with corresponding confidence intervals for these indicators will be presented in tables. Estimates for these indicators will also be presented as choropleth maps at the state level for which estimates will be representative of.

In addition, we will summarise the biomarker values using the usual 6 figure summary (minimum value, first quantile, median, mean, third quartile and maximum value) and then present the distribution of the biomarker values as a violin plot with the range of normal values shown. An example violin plot for Hb is shown below.

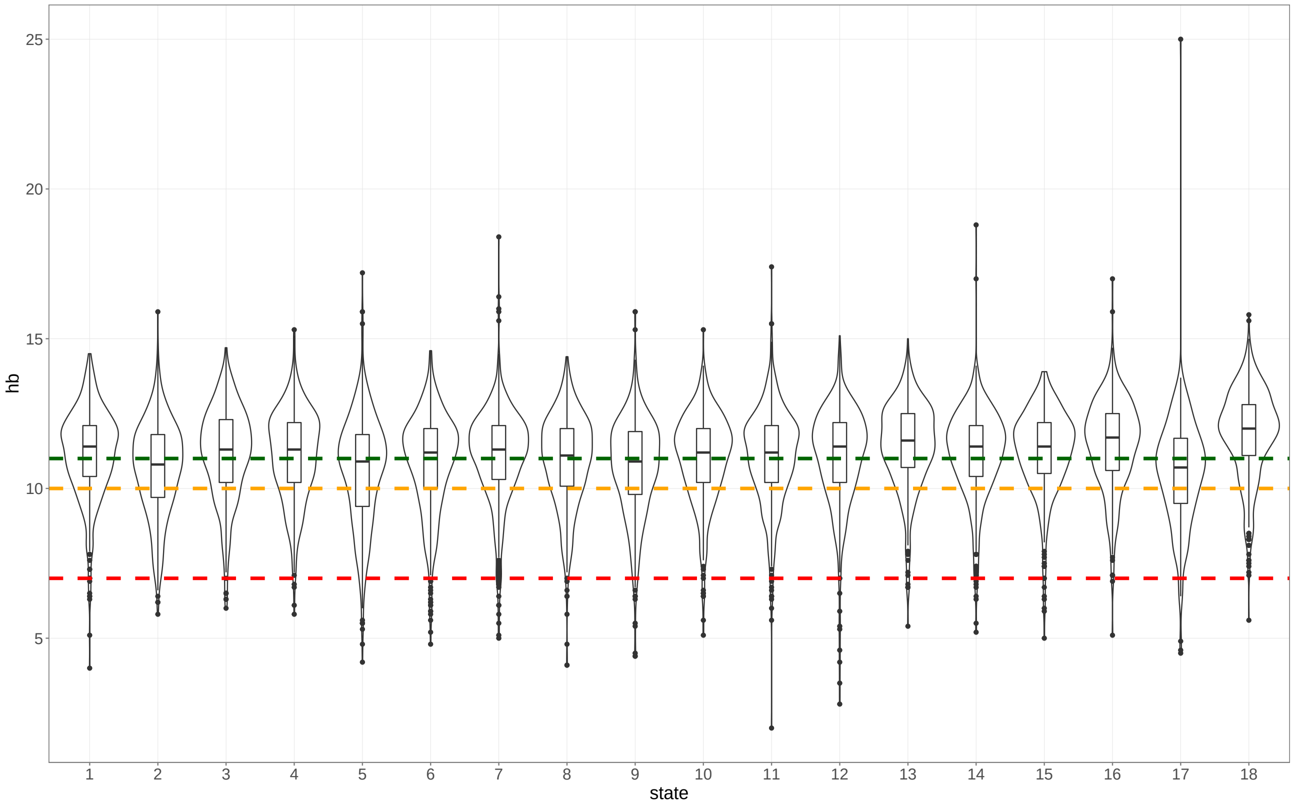

Figure 2: Example violin plot for Hb in children 6-59 months sample by state

References

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