Report on Coverage Assessment of Direct Nutrition Interventions in Liberia

Valid International

08 November 2019

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Acknowledgements

We are indebted to all the data collection teams who made this assessment possible, including data collectors, supervisors, and management teams from Ministry of Health, Liberia Institute of Statistics and Geo-Information Services and UNICEF Liberia. We are thankful for all the study participants - the mothers and children - who participated in the survey for their time and patience in providing information needed for this study. Without them, this study would not have been possible.

Acronyms and abbreviations

Acronyms/Abbreviations	Definition
ANC	Antenatal care
CMAM	Community-based management of acute malnutrition
DHS	Demographic and health surveys
GAM	Global acute malnutrition
IDW	Inverse distance weighting
IFA	Iron-folic acid
IU	International units
IYCF	Infant and young child feeding
MAM	Moderate acute malnutrition
MICS	Multiple indicator cluster survey
MNP	Micronutrient powder
MUAC	Middle upper arm circumference
ODK	Open data kit
PoN	Power of Nutrition
PSU	Primary sampling unit
SAM	Severe acute malnutrition
SMART	Standardized Monitoring and Assessment of Relief and Transitions
UNICEF	United Nations Children's Fund

Executive Summary

A three-year nutrition programme has been implemented in Liberia by UNICEF aimed at tackling child undernutrition in the country. Funded by Power of Nutrition and UNICEF UK, the programme has been implemented across 15 counties in Liberia starting from January 2017 up to December 2019. The overall aim of the programme is to improve the coverage of direct nutrition interventions or what is commonly termed nutrition-specific interventions, i.e. interventions or programmes that address the immediate determinants of foetal and child nutrition and development — adequate food and nutrient intake, feeding, caregiving and parenting practices, and low burden of infectious diseases [Bhutta et al., 2013, Ruel et al., 2013]. The current programme supports the following specific key interventions: 1) *treatment of severe acute malnutrition (SAM) for children 6-59 months*; 2) *vitamin A supplementation for children 6-59 months*; 3) *promotion of appropriate infant and young child feeding (IYCF) practices among pregnant or lactating women*; 4) *multiple micronutrient powder (MNP) supplementation for children 6-23 months*; and, 5) *iron and folic acid (IFA) supplementation for pregnant women*.

The coverage assessment was implemented as a two-stage spatial sample survey with $m = 30$ primary sampling units per programme area. A complete enumeration of children 6-59 months old from $m = 30$ PSUs per programme area was performed in order to find all children who are SAM using mid-upper arm circumference (MUAC) and bipedal oedema for the CMAM programme coverage assessment Within this cohort of children 6-59 months, a systematic sample of children and their mothers were selected for the coverage assessment of the other four nutrition-specific interventions. A total of $n = 192$ children 6-23 months old for the MNP supplementation coverage, children 6-59 months for vitamin A supplementation coverage and mothers of children 6-59 months for the IYCF counselling coverage and IFA coverage were systematically selected. A set of hierarchical coverage indicators was used to assess coverage of each of the five nutrition-specific programmes. Data was collected using a specifically-designed Open Data Kit data collection system. Data was analysed using R language for statistical computing. A blocked-weighted bootstrapping approach was used to estimate the various coverage indicators and to report the corresponding 95% confidence interval. Indicators were also mapped using spatial interpolation using inverse distance weighting.

The results of the coverage assessment of direct nutrition interventions in Liberia specifically in Greater Monrovia and Grand Bassa indicate various levels of disparity in coverage both between the programme areas assessed and within the programme areas assessed. Long-standing programmes such as IFA, IYCF counselling and vitamin A supplementation have performed fairly well in terms of coverage. The majority of women and children targeted by these programmes are knowledgeable of the programme and are beneficiaries of the programme. Years of implementation complemented by the level of support and investment by the government and its partners seem to have paid dividends in allowing for these programmes to reach almost all of their targeted beneficiaries. However, there is still much room for improvement and the current coverage levels can still be improved and increased.

Programmes such as MNP and CMAM, on the other hand, show how new and recently scaled-up programmes are still in the process of achieving the highest levels of coverage possible. MNP supplementation which is the newest programme of those assessed is understandably still struggling with coverage even at endline. Knowledge of the programme is the key falter point which is typical of a programme at this stage of its evolution. The programme is mainly anchored to the health centre and therefore knowledge and access to it is primarily influenced by mothers' behaviours and attitudes towards seeking care and treatment at the health facility. Given that MNP is aimed at children who are otherwise healthy (not acute malnourished), the current MNP coverage estimates indicate that health-seeking behaviour leading to a visit to a health facility is mainly influenced by whether their children are sick rather than as a way to seek information or participate in promotive and preventive services such as MNP supplementation. Other factors include physical access to health centres. A more community-based approach to MNP supplementation that is integrated with other community-based programmes such as vaccinations and CMAM should be considered as a potential delivery mechanism.

Finally, for CMAM which is not entirely new but still in its early stages of scale-up, the coverage estimates at baseline and endline indicate 1) disparity between Greater Monrovia and Grand Bassa in terms of the level and intensity of the community aspects of the programme; 2) signficant drop in coverage of CMAM in Greater Monrovia given that at baseline its coverage was exemplary for an urban CMAM programme; and, 3) significant increase in coverage of CMAM in Grand Bassa though the increase is still at a level that is unacceptable for coverage. At baseline, screening and case-finding in Greater Monrovia is better than in Grand Bassa and this can partly explain the difference in treatment coverage between the two areas at baseline. At endline, no improvement in screening has happened and the levels of coverage for CMAM has signficantly plummetted. Based on feedback by stakeholders, this has been attributed to government being the main service provider for CMAM in the past year as usual stakeholders that supported government were not engaged due to several programmatic issues. This points to the need for ensuring increased and continued capacity building of government in CMAM and other related interventions so that they can be truly in a position that they can implement and maintain these programmes with or without external support.

Lessons learned from the years of implementation of the IFA and vitamin A programmes can be useful in improving coverage of MNP and CMAM particularly with potential integration of these services into a unified and coherent child health and nutrition programme in Liberia.

1 Introduction

A three-year nutrition programme has been implemented in Liberia by UNICEF aimed at tackling child undernutrition in the country. Funded by Power of Nutrition and UNICEF UK, the programme has been implemented across 15 counties in Liberia starting from January 2017 up to December 2019. The overall aim of the programme is to improve the coverage of direct nutrition interventions or what is commonly termed nutrition-specific interventions, i.e. interventions or programmes that address the immediate determinants of foetal and child nutrition and development — adequate food and nutrient intake, feeding, caregiving and parenting practices, and low burden of infectious diseases [Bhutta et al., 2013, Ruel et al., 2013]. The current programme supports the following specific key interventions: 1) *treatment of severe acute malnutrition (SAM) for children 6-59 months*; 2) *vitamin A supplementation for children 6-59 months*; 3) *promotion of appropriate infant and young child feeding (IYCF) practices among pregnant or lactating women*; 4) *multiple micronutrient powder (MNP) supplementation for children 6-23 months*; and, 5) *iron and folic acid (IFA) supplementation for pregnant women*.

To assess the programme's progress towards its overall aim, two coverage assessments have been implemented - the first at the halfway point of the programme and the second at the end. Only two programme areas were selected for the assessments: *Urban Montserrado (Greater Monrovia)* district and *Grand Bassa* county. This report presents the results of these assessments.

2 Methods

2.1 Survey and sampling design

The coverage assessment was designed to be spatially representative of each of the two programme areas using a two-stage spatial sampling survey approach. An even spatial distribution of primary sampling units (PSUs) (i.e., villages/city blocks) was selected from across each enumeration area. This approach was used in order to assess coverage and its spatial distribution in order to detect and map heterogeneity of coverage [Elliott and Wartenberg, 2004, Diggle [2014]]. PSUs were selected based on their proximity to centroids of a hexagonal grid laid over the two selected programme areas resulting in a triangular irregular network [Isaaks and Srivastava, 1989, Elliot et al., 2000]. A complete enumeration of children 6-59 months old from $m = 30$ PSUs per programme area was performed in order to find all children who are SAM based on specified case definitions[1] for the CMAM programme coverage assessment. Within this cohort of children 6-59 months, a systematic sample of children and their mothers were selected for the coverage assessment of the other four nutrition-specific interventions. A total of $n = 192$ children 6-23 months old for the MNP supplementation coverage, children 6-59 months for vitamin A supplementation coverage and mothers of children 6-59 months for the IYCF counselling coverage and IFA coverage were systematically selected. A detailed description of the sampling design can be found here.

[1] Initial design used both weight-for-height z-score (WHZ) and MUAC and oedema criteria for SAM. However, for the first round of coverage assessments in 2018, the survey technical team decided to use MUAC and oedema only for SAM case-finding during the survey given the length of time it took to perform complete enumeration using WHZ. For the second round of coverage assessments in 2019, WHZ, MUAC and oedema case definitions for SAM were used.

2.2 Indicators

The coverage assessment evaluated the following indicators.

2.2.1 CMAM coverage

CMAM coverage usually pertains to coverage of SAM treatment. Historically, there have been two coverage estimators in common use: **point** and **period** coverage.

Point coverage is the number of current SAM cases in a treatment programme divided by the total number of current SAM cases.

Point coverage uses data for current cases only. It is calculated using the following formula:

$nbsp;

$$\text{Point coverage} = \frac{C_{in}}{C_{in} + C_{out}}$$

$$where:$$

$$\begin{aligned} C_{in} &= \text{current SAM cases in the programme} \\ C_{out} &= \text{current SAM cases out of the programme} \end{aligned}$$

Point coverage provides a snapshot of programme performance, putting a strong emphasis on the effectiveness and timeliness of case-finding and recruitment [Myatt et al., 2012].

Period coverage, on the other hand, uses data for both current and recovering cases. It is calculated using the following formula:

$$\text{Period coverage} = \frac{C_{in} + R_{in}}{C_{in} + C_{out} + R_{in}}$$

$$where:$$

$$R_{in} = \text{recovering SAM cases in the programme}$$

Period coverage is the number of current and recovering cases in a treatment programme divided by all current SAM cases and recovering cases. It approximates treatment coverage much better (albeit with limitations) as it accounts for children who are no longer cases but are in the programme.

However, given the known limitations of point and period coverage [Myatt et al., 2012], the single coverage estimator proposed and recommended by Balegamire et al. [2015] was used as the CMAM programme coverage estimators. Also, given the single coverage estimator, we adopted a shift in terminology that is more descriptive and specific with regard to what the estimator is actually measuring, allowing both measures to be reported together without confusion. **Point coverage** was termed *case-finding effectiveness* to more precisely reflect it as a measure of the programme's ability to find and recruit current cases. This indicator assesses how good the treatment programme is in finding cases of SAM and then getting them to treatment. **Period coverage** that has been improved into the single coverage metric was named *treatment coverage* as this is the estimator that approximates this coverage indicator the closest.

2.2.2 Vitamin A supplementation

The standard estimator for vitamin A supplementation is the proportion of children aged 6-59 months who received two age-appropriate doses of vitamin A in the past 12 months.

In standard surveys such as the Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS), this indicator is adjusted to a recall of 6 months for a single age-appropriate dose of vitamin A. This was the indicator used for this assessment.

Age appropriate vitamin A supplementation was assessed mainly through mother's recall of which gel capsule the child received recently. The blue vitamin A gel capsule containing 100,000 IU of vitamin A is given to children 6-11 months. The red vitamin A gel capsule containing 200,000 IU of vitamin A is given to children 12 - 59 months. A photo of the blue and the red gel capsule was used to aid the mother/caregiver in answering this question.

2.2.3 Iron-folic acid (IFA) supplementation for pregnant women

Population-based surveys typically report the percentage of women with a live birth in the two to five years before the survey who received and took IFA supplementation during their most recent pregnancy. Because antenatal care (ANC) is the main platform for IFA supplement distribution for pregnant women, survey questions on antenatal care attendance was used to provide information on the use of this platform to deliver IFA supplementation. Sununtnasuk et al. [2015] proposed a falter point framework[2] that utilises four indicators that proxy the five critical points at which the ANC approach to IFA distribution might falter in IFA supplementation coverage to pregnant women. These indicators are:

1. At least one ANC visit during most recent pregnancy
2. Knowledge of IFA tablet/s
3. Receipt or purchase of IFA tablet/s
4. IFA consumption
5. Adherence to at least 90 days of supplementation

[2] Similar to a bottleneck framework and consistent with Tanahashi [1978] hierarchical model of coverage.

2.2.4 Micronutrient powder supplementation

The indicator for coverage of micronutrient powder supplementation is the proportion of children aged 6-23 months who consume micronutrient powder supplements. An indicator set on MNP supplementation was devised similar to the IFA supplementation falter point or bottleneck framework that first assessed knowledge and awareness of MNP supplementation, then the receipt/purchase of MNP and finally consumption of MNP.

2.2.5 IYCF counselling

There are no standard indicators for IYCF counselling hence indicators were devised based on how this intervention was being delivered to pregnant or lactating women. In terms of mechanism, these sessions are delivered via the health clinic/health post and that the target beneficiaries are pregnant or lactating women. Given this, similar approach to the IFA supplementation coverage of falter points/bottle necks was used with the following indicators:

1. At least one ANC visit during most recent pregnancy
2. Awareness of IYCF counselling
3. Attendance at IYCF counselling

2.3 Survey instrument

The following are sample/template questionnaires used for the two types of surveys that will be implemented.

2.3.1 CMAM coverage survey instruments

The CMAM coverage surveys primarily used two forms. The first form was used to collect coverage data from SAM children found during the survey. Given that this survey used house-to-house/door-to-door sampling for stage 2, then it was necessary to record all data from all children that were measured with MUAC and oedema. The following tabular form was used for this purpose:

SAM Coverage Data Collection Form

PSU ID	County	Village Name
|__|__|	|__| 1 = Grand Bassa **2 = Rural Montserrado**	|______________________________|

ID	AGE	SEX	MUAC	WEIGHT	HEIGHT	OEDEMA	PROGRAMME	SCREENING
	months	1 = M 2 = F	mm	kg	cm	1 = YES 2 = NO	1 = OTP 2 = TSFP 3 = NONE	1 = YES 2 = NO

Figure 1: SAM coverage survey sample/template form

The data collected using the tabular forms allows for estimation of coverage. They do not, however, allow one to know the reasons for coverage failure. To collect this data we applied a “barriers” questionnaire to the mothers/carers of uncovered SAM cases. Here is an example of a barriers questionnaire:

SAM Coverage Barriers Data Collection Form

PSU ID	ID
|__|__|	|__|__|

B1: Do you know that your child is malnourished or thinner than he/she should be?

|__| YES |__| NO

B2: Do you know that there is a programme that can treat malnourished children?

|__| YES |__| NO

If ***NO***, thank mother/carer and terminate interview.

B3: What do you call this programme? ____

B4: Where is this programme? ____

B5: Why is this child not attending this programme?

Do not prompt. Probe "Any other reasons?"

|__| Programme site is too far away
|__| No time/too busy to attend the programme
|__| Carer/mother cannot travel with more than one child
|__| Woman cannot travel alone
|__| Carer is ashamed to attend programme
|__| Difficulty with childcare
|__| Child has been rejected by the programme

Record all other reasons given:
____

____

____

____

B6: Has this child ever been to the program site or examined by program staff?

|__| YES |__| NO

If ***NO***, thank mother/carer and terminate interview.

B7: Why is this child not in the programme now?

|__| Previously rejected
|__| Defaulted
|__| Discharged as cured
|__| Discharged as not cured

Thank mother/carer. Issue a referral slip. Inform mother/carer of site and date to attend.

Figure 2: SAM coverage barriers survey sample/template form

2.3.2 Survey for children 6-59 months and their mothers

For the survey for children 6-59 months, following is a sample/template questionnaire used.

Children 6-59 months Data Collection Form

PSU ID	County	Village Name
|__|__|	|__| 1 = Grand Bassa 2 = Rural Montserrado	|____________________________|

Administrative Data		
ad1	Date of data collection	|__|__|/|__|__|/|__|__|
ad2	Team number	|__|__|
ad3	Name of enumerator	|______________________________|
ad4	Consent?	1 = YES 2 = NO

If consent is not given then stop the interview and move to next respondent.

Identifying Data		
psu	PSU (cluster) number	|__|__|
hh	Household identifier	|__|__|

Mother Information		
m1	Mother's identifier	|__|__|
m2	Mother's age (in full years)	|__|__|
m3	How many children 6-59 months do you have?	|__|__|

Iron-Folic Acid (IFA) Supplementation			
ifa1	During your pregnancy for your youngest child, did you see anyone for antenatal care?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
ifa2	During your pregnancy for your youngest child, did you receive any information about taking iron-folic acid tablets (show sample/photo)?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
ifa3	During your pregnancy for your youngest child, did you receive and/or purchase iron-folic acid tablets (show sample/photo)?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
	*If **NO**, go to **ifa3a**; If **DON'T KNOW/NOT SURE**, skip to **icf1**; If **YES**, go to **ifa4***		
ifa3a	Why did you not receive or purchase iron-folic acid tablets? *Do not prompt. Probe "Any other reasons?"*	|__| Health centre ran out |__| Took to long to get tablets |__| Too expensive Other reasons: ________________________________ ________________________________	

Figure 3: Children 6-59 months old and their mothers survey sample/template form

		________________________________	
ifa4	During your pregnancy for your youngest child, did you take iron-folic acid tablets (show sample/photo)?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
	*If **NO**, go to **ifa4a**; If **DON'T KNOW/NOT SURE**, skip to **icf1**; If **YES**, go to **ifa5***		
ifa4a	Why did you not take iron-folic acid tablets? *Do not prompt. Probe "Any other reasons?"*	|__| Concerns about side effects |__| Don't need it |__| I was told not to take it |__| I don't think it helps Other reasons: ________________________________ ________________________________ ________________________________	
ifa5	During the whole duration of your pregnancy for your youngest child, how many days did you take the iron-folic acid tablets (show sample/photo)?	|__|__|__|	

IYCF Counselling			
icf1	During your pregnancy for your youngest child, did you receive any information or hear about any service that provided counselling for pregnant women on infant and young child feeding?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
icf2	During your pregnancy for your youngest child, did you attend any counselling session for pregnant women on infant and young child feeding?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
	If NO, go to icf2a; If DON'T KNOW/NOT SURE, skip to ; If YES, go to icf3.		
icf2a	Why did you not attend the counselling sessions? *Do not prompt. Probe "Any other reasons?"*	|__| Timing was not convenient |__| Not interested |__| Do not trust counsellor |__| Don't think I need it Other reasons: ________________________________ ________________________________ ________________________________	
icf3	How many counselling sessions did you attend?	|__|__|	

Figure 4: Children 6-59 months old and their mothers survey sample/template form

<table>
<tr><th colspan="3">Child Information</th></tr>
<tr><td></td><td colspan="2">If m3 > 1, randomly select one child from the mother's children.</td></tr>
<tr><td>c1</td><td>Age in months of respondent child</td><td>|__|__|</td></tr>
<tr><td></td><td>If c1 ≥ 23, go to mnp1; If c2 > 23, got to vit1</td><td></td></tr>
</table>

<table>
<tr><th colspan="4">Micronutrient Powder (MNP) Supplementation</th></tr>
<tr><td>mnp1</td><td>Have you heard about [LOCAL NAME OF MNP] or seen [show sample/photo of MNP]?</td><td>1 = YES
2 = NO
99 = Don't know/not sure</td><td>|__|__|</td></tr>
<tr><td>mnp2</td><td>Have you received or bought [LOCAL NAME of MNP] (show sample/photo of MNP) for your child aged 6-23 months?</td><td>1 = YES
2 = NO
99 = Don't know/not sure</td><td>|__|__|</td></tr>
<tr><td></td><td colspan="3">If NO, go to mnp2a; If DON'T KNOW/NOT SURE, go to vit1; IF YES, go to mnp3</td></tr>
<tr><td>mnp2a</td><td>Why did you not receive/buy [LOCAL NAME of MNP] (show sample/photo of MNP) for your child aged 6-23 months?

Do not prompt. Probe "Any other reasons?"</td><td colspan="2">|__| Health centre ran out
|__| Took to long to get MNP
|__| Too expensive
|__| Child doesn't need it
|__| Heard it doesn't work/help

Other reasons:
____
____
________________________________</td></tr>
<tr><td>mnp3</td><td>Did you give your child aged 6-23 months the [LOCAL NAME OF MNP] to eat?</td><td>1 = YES
2 = NO
99 = Don't know/not sure</td><td>|__|__|</td></tr>
<tr><td></td><td colspan="3">If NO, go to mnp3a; If DON'T KNOW/NOT SURE, go to vit1; IF YES, go to mnp4</td></tr>
<tr><td>mnp3a</td><td>Why did you not give the [LOCAL NAME OF MNP] to your child aged 6-23 months to eat?

Do not prompt. Probe "Any other reasons?"</td><td colspan="2">|__| Too expensive
|__| Not available in the market
|__| Do not need MNP
|__| Heard other's bad experience
|__| Advised not to use it
|__| Not seen other mothers use it
|__| Don't trust the product
|__| Using another product
|__| Haven't seen it

Other reasons:
____
____
________________________________</td></tr>
<tr><td>mnp4</td><td>In the last week, how many times did your child aged 6-23 months old eat [LOCAL NAME OF MNP]?</td><td colspan="2">|__|__|</td></tr>
</table>

Figure 5: Children 6-59 months old and their mothers survey sample/template form

Vitamin A Supplementation			
vit1	In the past 6 months, has your child received drops from a capsule like this one (show vitamin A sample or photo)?	1 = YES 2 = NO 99 = Don't know/not sure	|__|__|
	*If **NO**, go to **vit1a**; If **DON'T KNOW/NOT SURE**, thank mother and end interview; If **YES**, go to **vit2**.*		
vit1a	Why did your child not receive (show vitamin A capsule sample or photo)? *Do not prompt. Probe "Any other reasons?"*	|__| Health centre ran out |__| Took to long to get drops |__| Child doesn't need it |__| Heard it doesn't work/help Other reasons: ____________________ ____________________ ____________________	
vit2	What type of capsule (show sample or photo of blue and red capsule) did your child get drops from?	1 = blue capsule 2 = red capsule 99 = Don't know/not sure	|__|__|
vit3	How many months ago did your child receive drops from (show vitamin A sample or photo)?		|__|

Figure 6: Children 6-59 months old and their mothers survey sample/template form

2.3.3 Using Open Data Kit

Based on the template forms described above, a digital data collection system using Open Data Kit (ODK) was developed. These forms are available as a Github repository. The system is composed of two forms.

2.3.3.1 Village form

This form (`liberiaCoverageVillageForm.xlsx` and `liberiaCoverageVillageForm.xml`) collected information on the villages or primary sampling units (PSU) selected for the Liberia Coverage Survey. This information includes:

1. County name (and identifier)
2. Village name (and identifier)
3. Village population size
4. Village geocoordinates

2.3.3.2 Coverage form

This form (`liberiaCoverage.xlsx` and `liberiaCoverage.xml`) collected information on the various coverage indicators assessed in the Liberia Coverage Survey:

1. CMAM coverage

2. Iron-folic acid supplementation coverage

3. IYCF counselling coverage

4. Micronutrient powder supplementation coverage

5. Vitamin A supplementation coverage

The coverage form was developed in such a way that it implements the survey as per survey design such that the modules for IFA coverage, IYCF counselling coverage, MNP supplementation coverage and vitamin A supplementation coverage are only shown based on the sampling interval for a particular primary sampling unit (PSU) and based on the different eligibility requirements for each coverage survey module.

2.4 Data analyses

Data analysis was performed using R language for statistical computing [R Core Team, 2019]. An R package called `liberiaData` containing specific functions for data processing and analysis of the Liberia coverage survey was produced to ensure open availability of data and reproducibility of analysis[3]. An auxiliary R package called `liberia` containing additional secondary data including maps used for the sampling and survey process was also produced[4].

2.4.1 Analytical approach for estimating coverage indicators

Data analysis procedures accounted for the sample design.

- This survey is a two-stage sample. Subjects are sampled from a small number of PSUs.
- This survey is **not** prior weighted. This means that per-PSU sampling weights will be needed. These are usually the populations of the PSU.

For this survey, the *blocked weighted bootstrap* estimation approach was used:

- **Blocked** : The block corresponds to the PSU or cluster.
- **Weighted** : The sampling procedure for this survey does not use population proportional sampling (PPS) to weight the sample prior to data collection as is done with SMART type surveys. This means that a posterior weighting procedure is required. The "roulette wheel" algorithm to weight (i.e. by population) the selection probability of PSUs in bootstrap replicates will be utilised.

[3]See package site at https://validmeasures.org/liberiaData/ for more information and for instructions on installation and usage

[4]See package site at https://validmeasures.org/liberia/ for more information and for instructions on installation and usage

A total of `m` PSUs are sampled *with-replacement* from the survey dataset where `m` is the number of PSUs in the survey sample. Individual records within each PSU are then sampled *with-replacement*. A total of n' records are sampled *with-replacement* from each of the selected PSUs where `n` is the number of individual records in a selected PSU. The resulting collection of records replicates the original survey in terms of both sample design and sample size. A large number of replicate surveys are taken (minimum of $r = 399$ replicate surveys but this can be changed). The required statistic (e.g. the mean of an indicator value) is applied to each replicate survey. The reported estimate consists of the 50th (point estimate), 2.5th (lower 95% confidence limit), and the 97.5th (upper 95% confidence limit) percentiles of the distribution of the statistic observed across all replicate surveys. The blocked weighted bootstrap procedure is outlined in Figure 7.

The principal advantages of using a bootstrap estimator are:

- Bootstrap estimators work well with small sample sizes.
- The method is *non-parametric* and uses empirical rather than theoretical distributions. There are no assumptions of things like normality to worry about.
- The method allows estimation of the sampling distribution of almost any statistic using only simple computational methods.

2.4.2 Analytical approach for mapping coverage indicators

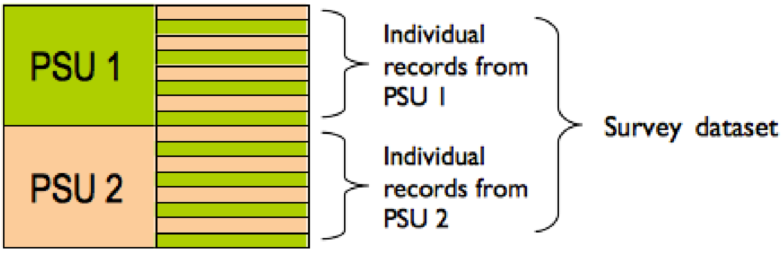
The indicator mapping approach for this survey created a surface map of indicator values using spatial interpolation. There are various approaches and methods of spatial interpolation, the main differences are determined by the weights applied to the point dataset to estimate values at each of the unknown points of the surface map. For the Liberia coverage survey, spatial interpolation was performed using the inverse distance weighting (IDW) method. As the name implies, the IDW method uses weights that are inversely proportional to the distance of a point being estimated from the sampling point locations [Isaaks and Srivastava, 1989, Diggle and Ribeiro, 2007, Diggle, 2013]. This can be mathematically demonstrated as follows:

$$\hat{v} = \frac{\sum\limits_{i=1}^{n} \frac{1}{d_i^p} v_i}{\sum\limits_{i=1}^{n} \frac{1}{d_i^p}}$$

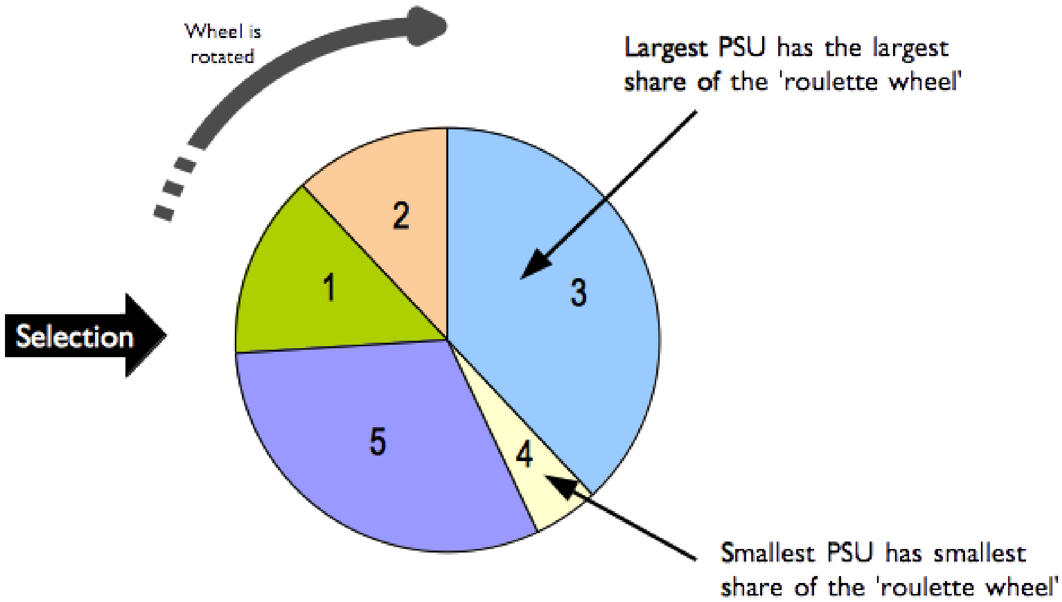
$$where:$$

$$\begin{aligned} d_1 \ldots d_n &= \text{distances from each } n \text{ sampling points to estimation point} \\ p &= \text{power of the distance} \\ v_1 \ldots v_n &= \text{sample values} \end{aligned}$$

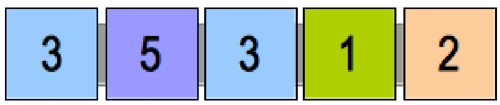
Data are collected using a two-stage cluster design:



PSUs are selected from the survey dataset *with-replacement* and with probability proportional to population size (PPS) using a *roulette wheel* algorithm :



PSUs are selected *with-replacement* and proportional to population size (PPS) :



Individual records are selected *with-replacement* from within each PSU to create a *replicate* survey. The estimator is applied to the replicate survey and the result recorded. This process is repeated many times. The estimate of the indicator value is made from the distribution of the results from each replicate survey which is the *empirical sampling distribution* of the indicator :

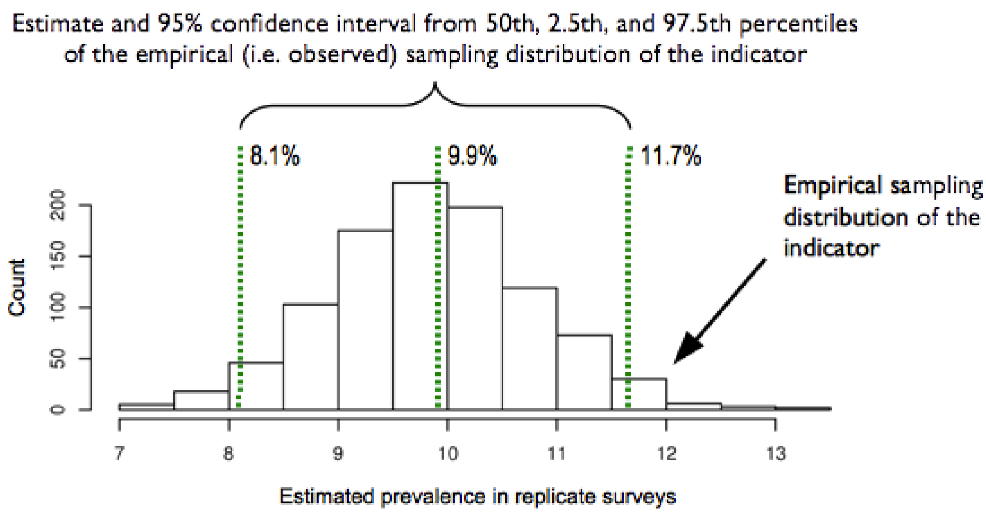


Figure 7: The blocked weighted bootstrap

The power of the distance p is an important aspect of the IDW method for point estimation. The influence of p to the weights applied to the point estimation is such that as p approaches 0, the weights become more similar, thereby giving more weight to the nearest sample values. As p approaches ∞, the weights become more different from each other, thereby giving more weight to the closest sample. The power of the distance p has been traditionally set at 2 for convenience and ease of calculations. For the Liberia Coverage Survey, p was initially set at 2 and then cross-validation (see below) was applied to optimise p to a value that minimises the estimation errors at each of the sampling point locations.

Cross-validation is a technique applied to validate predictive models. It assesses how accurately the predictive model performs in practice. IDW is one of the simplest model-based interpolation methods available, but ideally would still require a form of cross-validation to determine the optimal value of the distance power p (described above).

A two-fold cross validation [Bivand et al., 2013] was applied to the Liberia coverage data wherein data points were randomly split into two sets of equal size, with one set assigned as the validation data for testing the model, and the other set as the training data. The validation data was then interpolated using the IDW method with an initial p of 2 and the resulting predictions were compared with the training data. Comparison was made using the sum of the squared residuals between the predicted values and the observed values to report errors. Optimisation was then performed by replicating the two-fold cross validation process 100 times using randomly generated values for p. Out of these replicates, the value of p that provided prediction results with the minimum errors was selected as the distance power for the eventual interpolation performed.

3 Results and Discussion

3.1 Iron-Folic Acid Supplementation Coverage

Figure 8 and Table 2 presents a summary of the IFA supplementation coverage indicators for Greater Monrovia and Grand Bassa at baseline and endline. The majority of mothers surveyed at baseline and endline from Greater Monrovia and Grand Bassa have attended ANC during their last pregnancy, are aware of IFA tablets, have received IFA tablets and have consumed IFA tablets. Knowledge, receipt and consumption of IFA have all increased at endline compared to baseline with the increase being statistically significant.

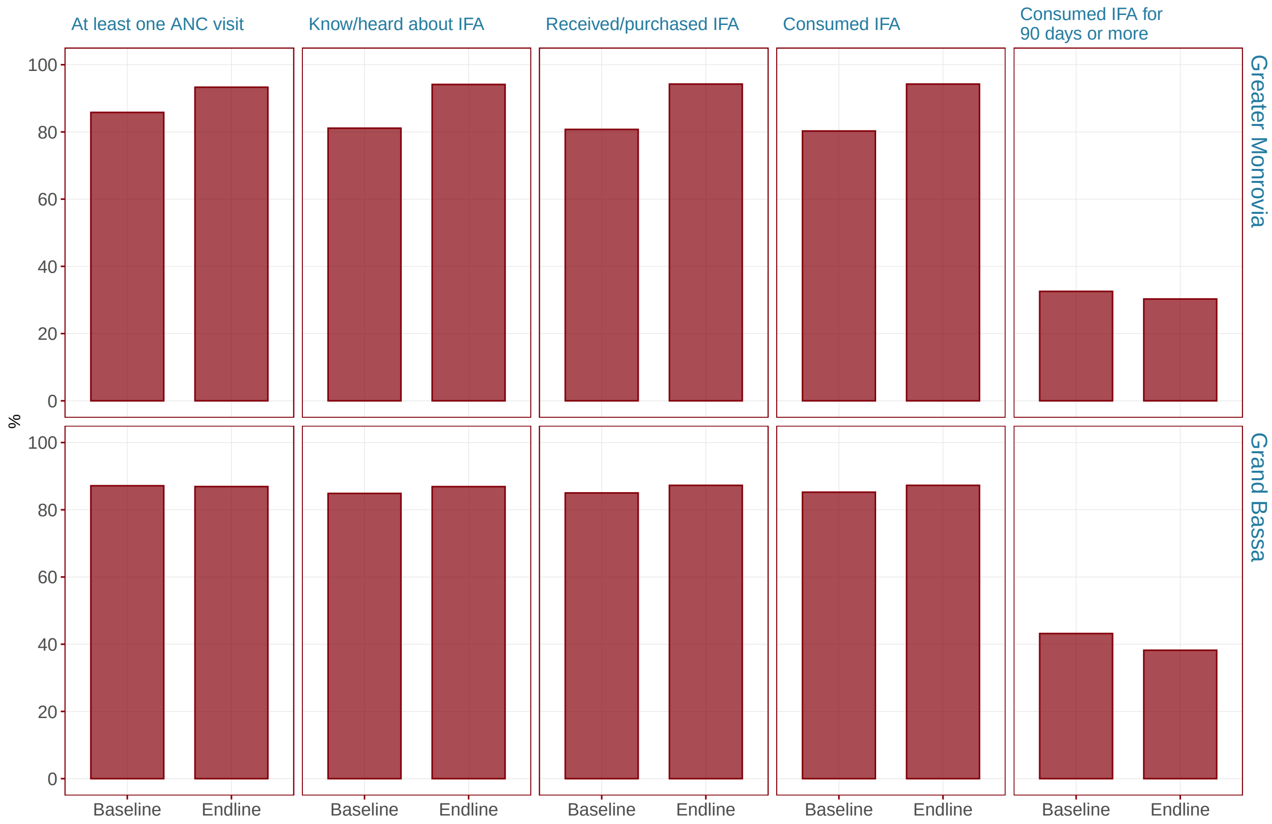


Figure 8: IFA supplementation coverage

Table 2: Iron-folic acid supplementation coverage

	Greater Monrovia						Grand Bassa					
	Baseline			Endline			Baseline			Endline		
Indicator	**Est (%)**	**95% LCL**	**95% UCL**	**Est (%)**	**95% LCL**	**95% UCL**	**Est (%)**	**95% LCL**	**95% UCL**	**Est (%)**	**95% LCL**	**95% UCL**
At least one ANC visit	85.8	79.7	91.4	93.3	90.3	96.5	87.1	82.7	91.2	86.9	80.6	92.3
Know/heard about IFA	81.1	73.2	87.0	94.1	91.0	97.1	84.9	80.0	89.0	86.9	81.3	91.8
Received/purchased IFA	80.7	73.7	86.8	94.2	91.1	97.1	85.0	79.4	89.4	87.3	81.4	92.6
Consumed IFA	80.3	73.1	87.1	94.2	91.1	97.1	85.2	79.1	89.5	87.3	81.4	92.6
Consumed IFA for 90 days or more	32.6	20.8	43.0	30.3	24.1	36.8	43.2	33.6	52.0	38.2	27.5	50.0

However, coverage of IFA faltered significantly in both areas when length (in days) of IFA tablet consumption was assessed with no improvement at endline compared to baseline (see Figure 9).

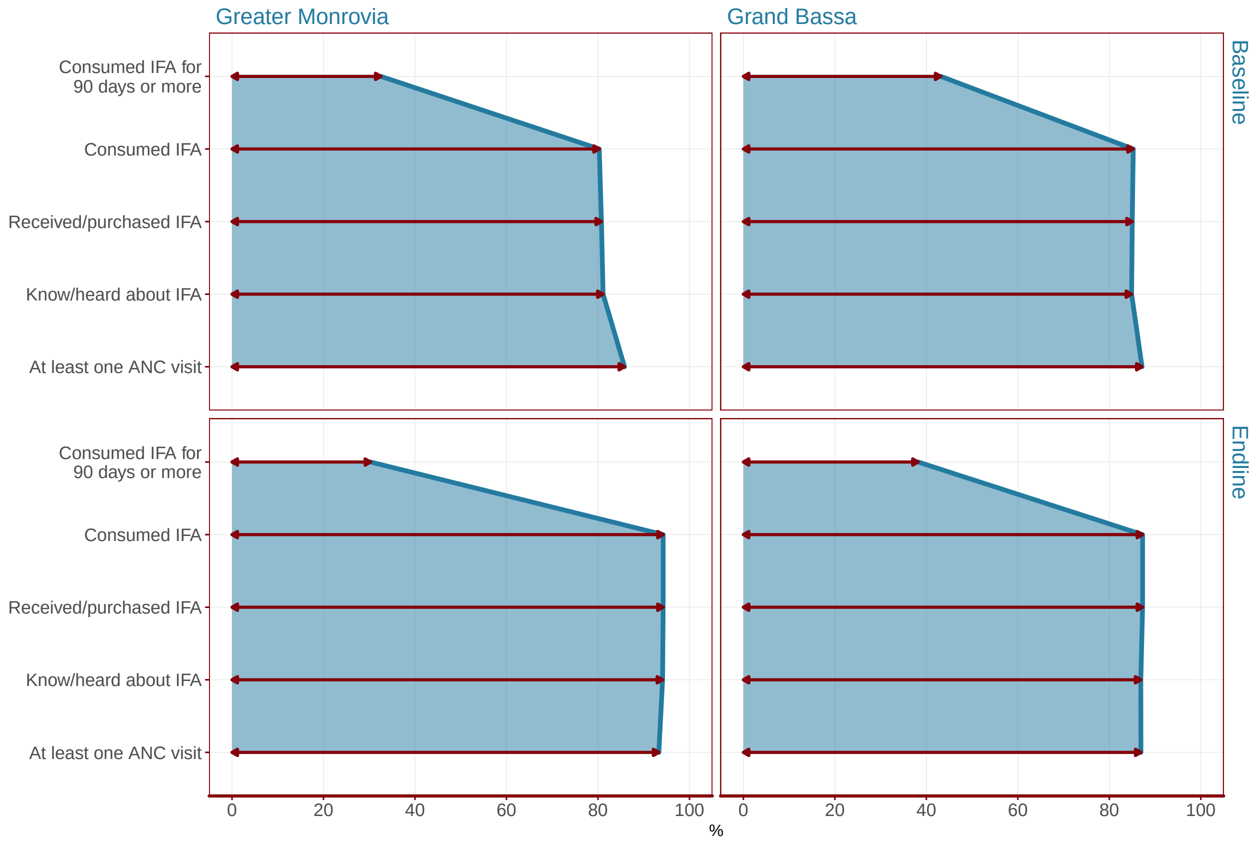


Figure 9: Tanahashi plot for IFA supplementation coverage

Of the few who have not received IFA tablets in Greater Monrovia and Grand Bassa despite attending ANC during their last pregnancy, the main reasons for not getting IFA tablets are shown in Figure 10. At baseline, information regarding the IFA tablets was the main reason for non-coverage in both areas. At endline, easy access and availability of IFA tablets at the clinics or hospital were the main reasons for non-coverage. This may mean that previous issue of lack of information was addressed over the past year but those who have learned about IFA tablets have struggled to gain access to it.

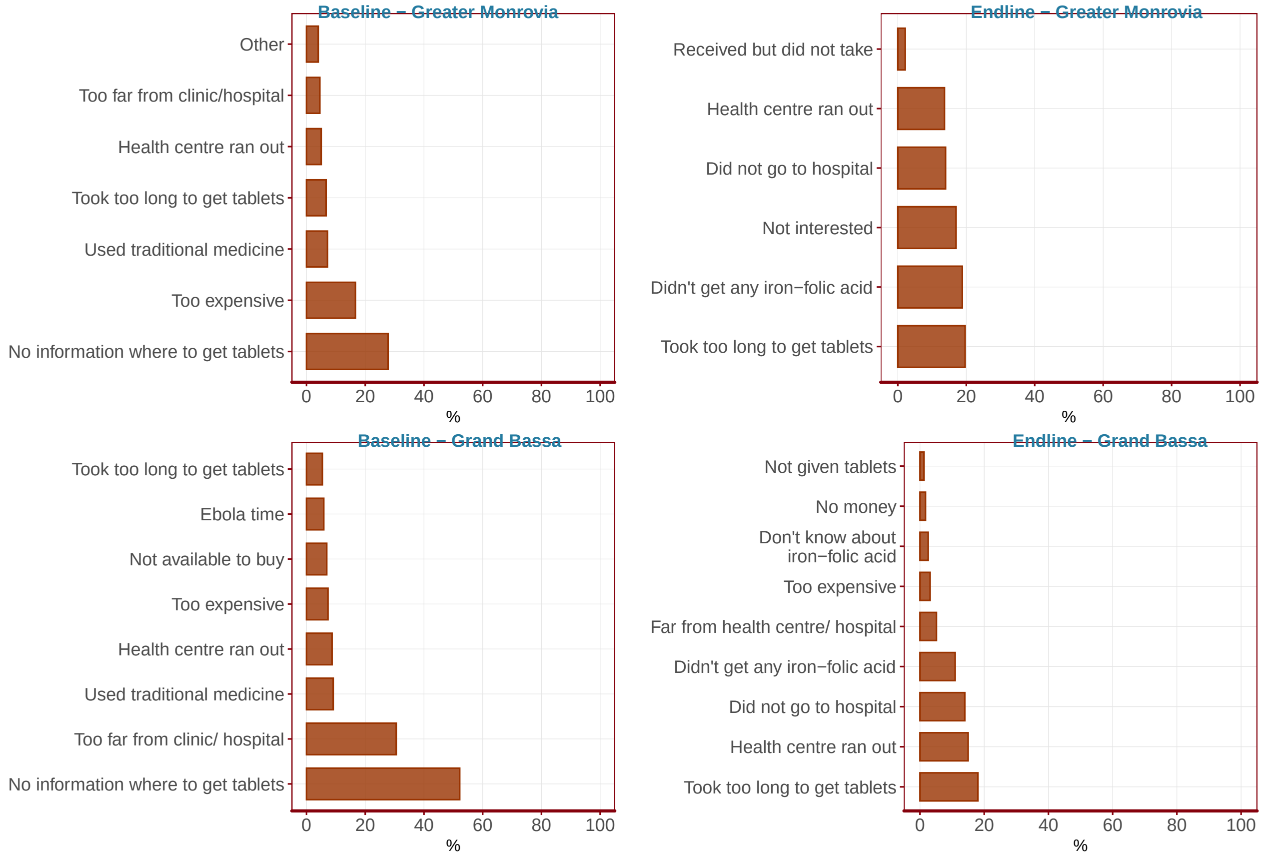


Figure 10: Reasons for not receiving/purchasing IFA supplementation

The spatial distribution of IFA supplementation coverage in Greater Monrovia and Grand Bassa is shown in Figure 11 and 12. At baseline, IFA supplementation coverage was lowest in the eastern section of Monrovia. At endline, these areas have increased coverage. For Grand Bassa, IFA supplementation coverage was lowest in the southern and eastern parts of the county. At endline, these areas have increased coverage but with new but much smaller hot spots of low coverage in different parts of the county. The maps for both Greater Monrovia and Grand Bassa show the significant faltering in IFA coverage once adequate consumption of IFA is considered consistent with the aggregated point estimates presented above.

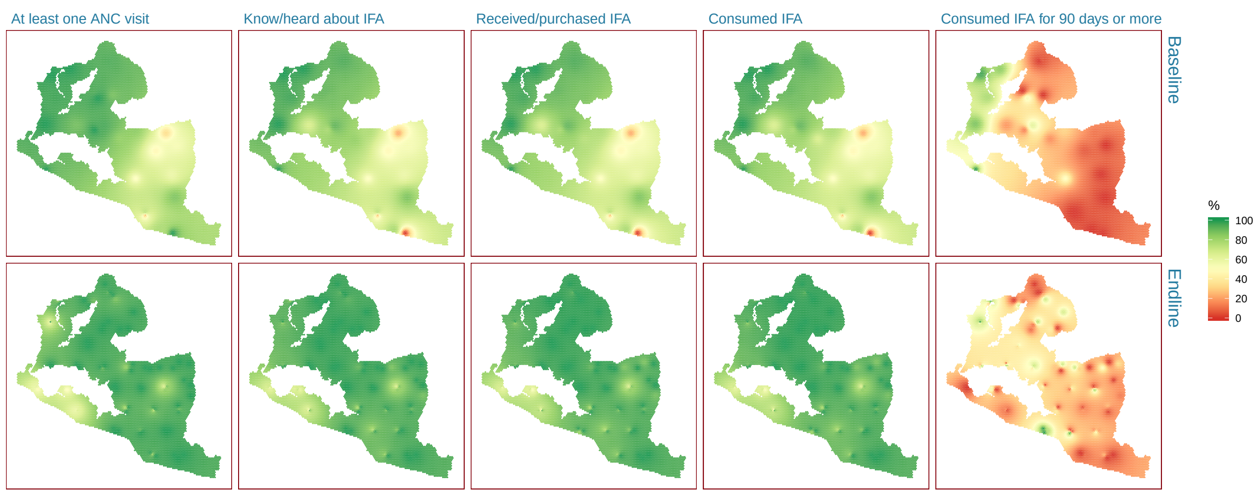


Figure 11: Spatial distribution of IFA supplementation coverage in Greater Monrovia

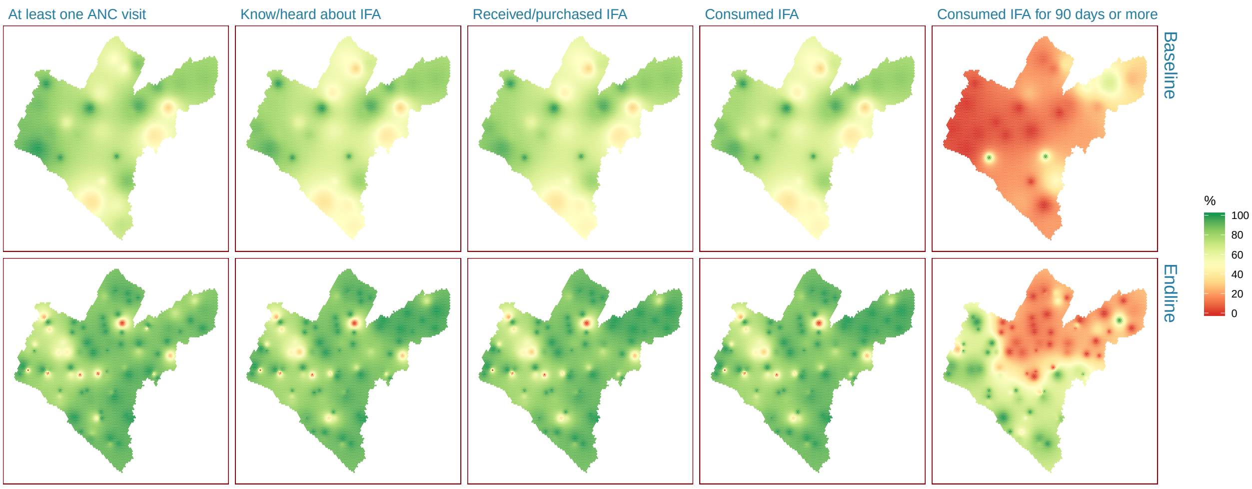


Figure 12: Spatial distribution of IFA supplementation coverage in Grand Bassa

3.2 IYCF Counselling Coverage

Knowledge of and attendance to IYCF counselling is both close to 80% in Greater Monrovia and Grand Bassa at baseline. At endline, these indicators increase to close to 90% for Greater Monrovia and close to 85% in Grand Bassa (see Figure 13 and Table 3). No faltering between knowledge of and attendance to IYCF counselling is noted in either areas.

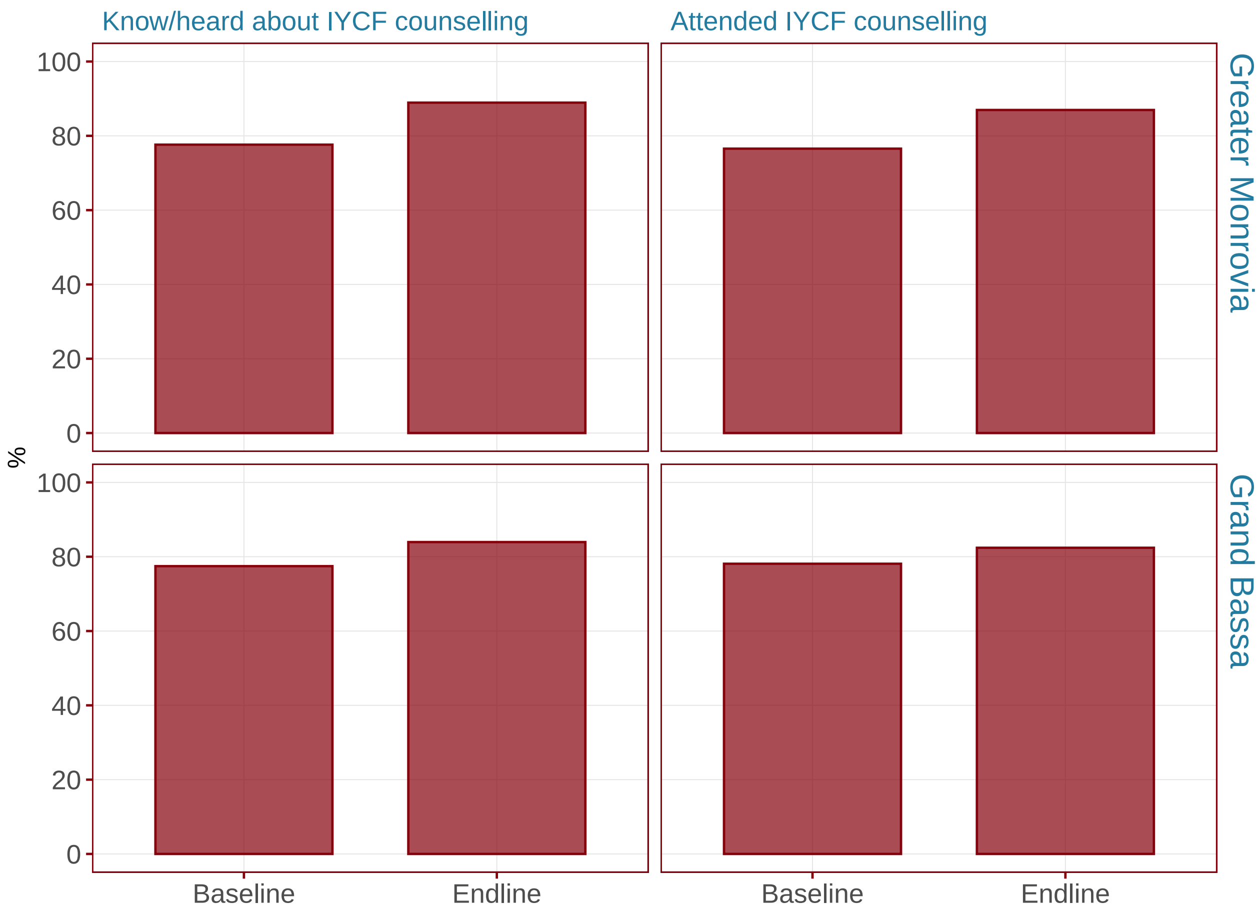


Figure 13: IYCF counselling coverage in Greater Monrovia

Table 3: IYCF counselling coverage

	Greater Monrovia						Grand Bassa					
	Baseline			Endline			Baseline			Endline		
Indicator	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL
Know/heard about IYCF counselling	77.6	69.2	85.4	88.9	84.7	92.5	77.5	72.1	83.7	83.9	76.4	89.2
Attended IYCF counselling	76.5	66.3	83.4	87.0	81.5	91.4	78.1	71.3	83.3	82.4	74.9	87.9

Of the few who did not attend IYCF counselling in Greater Monrovia, their main reasons for not attending are presented in 14. At baseline, mothers not covered by IYCF counselling reported being too busy and timing of IYCF counselling as the main reasons for non-coverage. At endline, timing of IYCF counselling was still an issue but interest in IYCF counselling was reported the most.

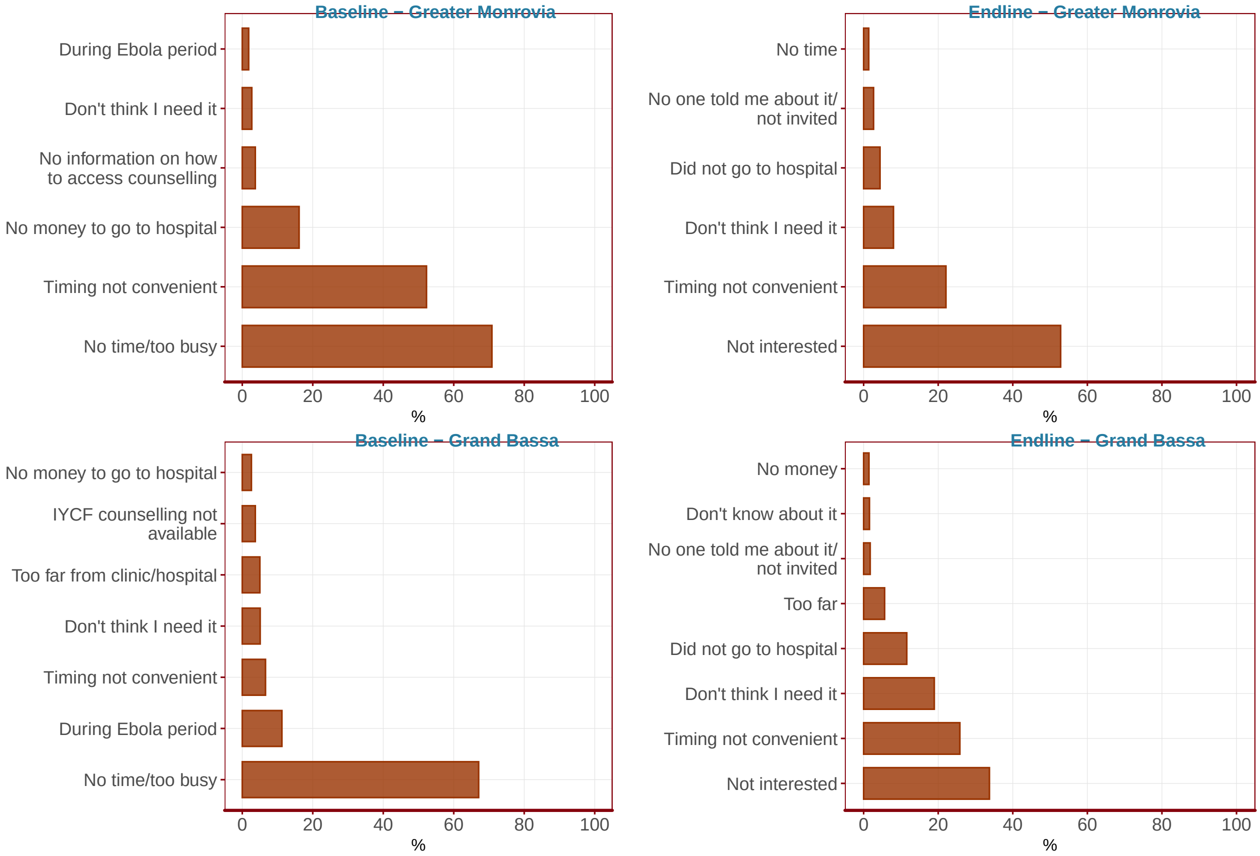


Figure 14: Reasons for not attending IYCF counselling in Greater Monrovia

Spatial distribution of IYCF counselling coverage in Greater Monrovia is shown in Figure 15. IYCF counselling coverage was at its lowest in eastern sections of Greater Monrovia at baseline. These areas have improved coverage at endline.

Spatial distribution of IYCF counselling coverage in Grand Bassa is shown in Figure 16. IYCF counselling coverage was at its lowest in southern sections of Grand Bassa at baseline. These areas have improved coverage at endline but with newer focused areas of low coverage spread throughout the county.

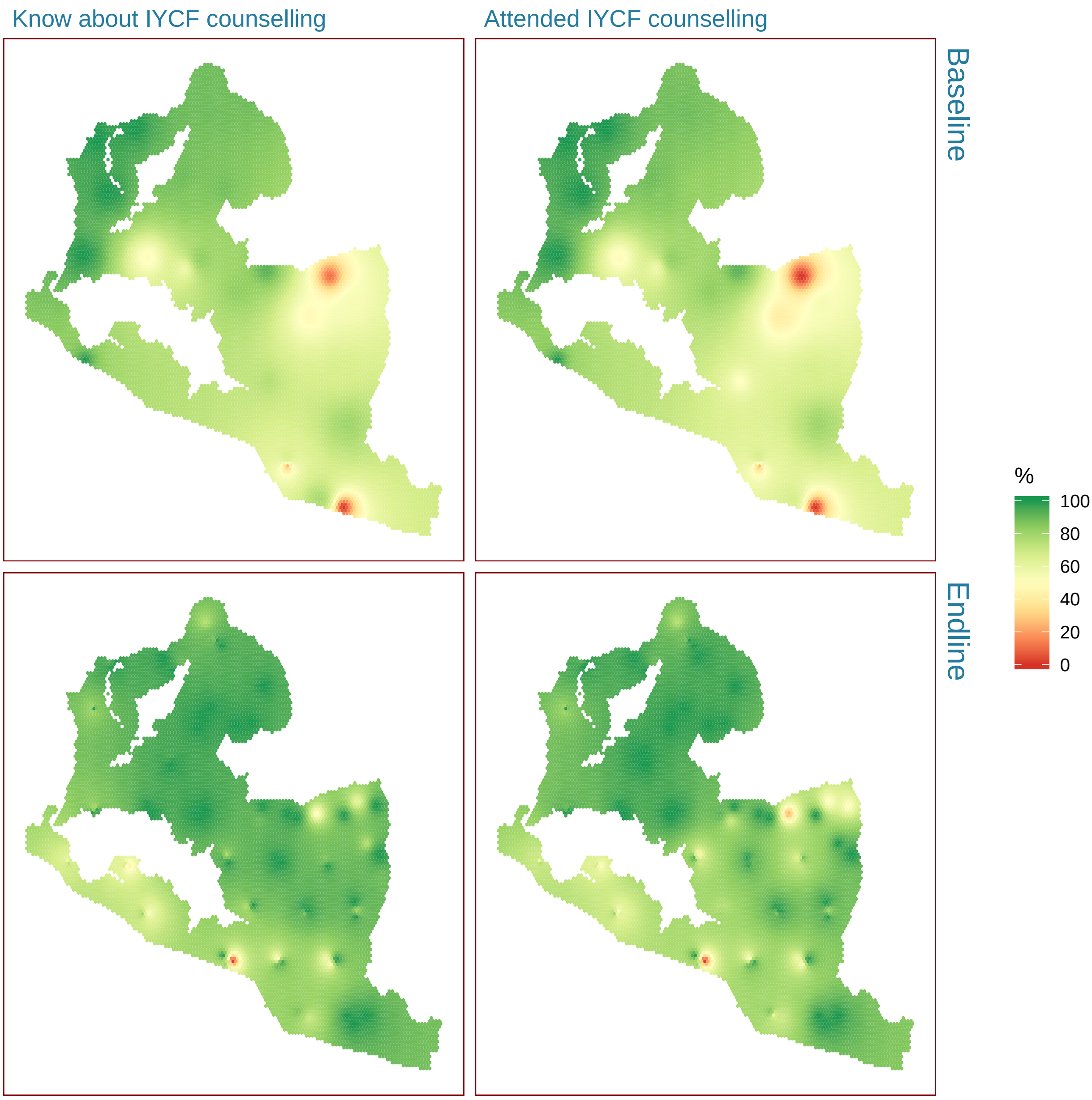


Figure 15: Spatial distribution of IYCF counselling coverage in Greater Monrovia

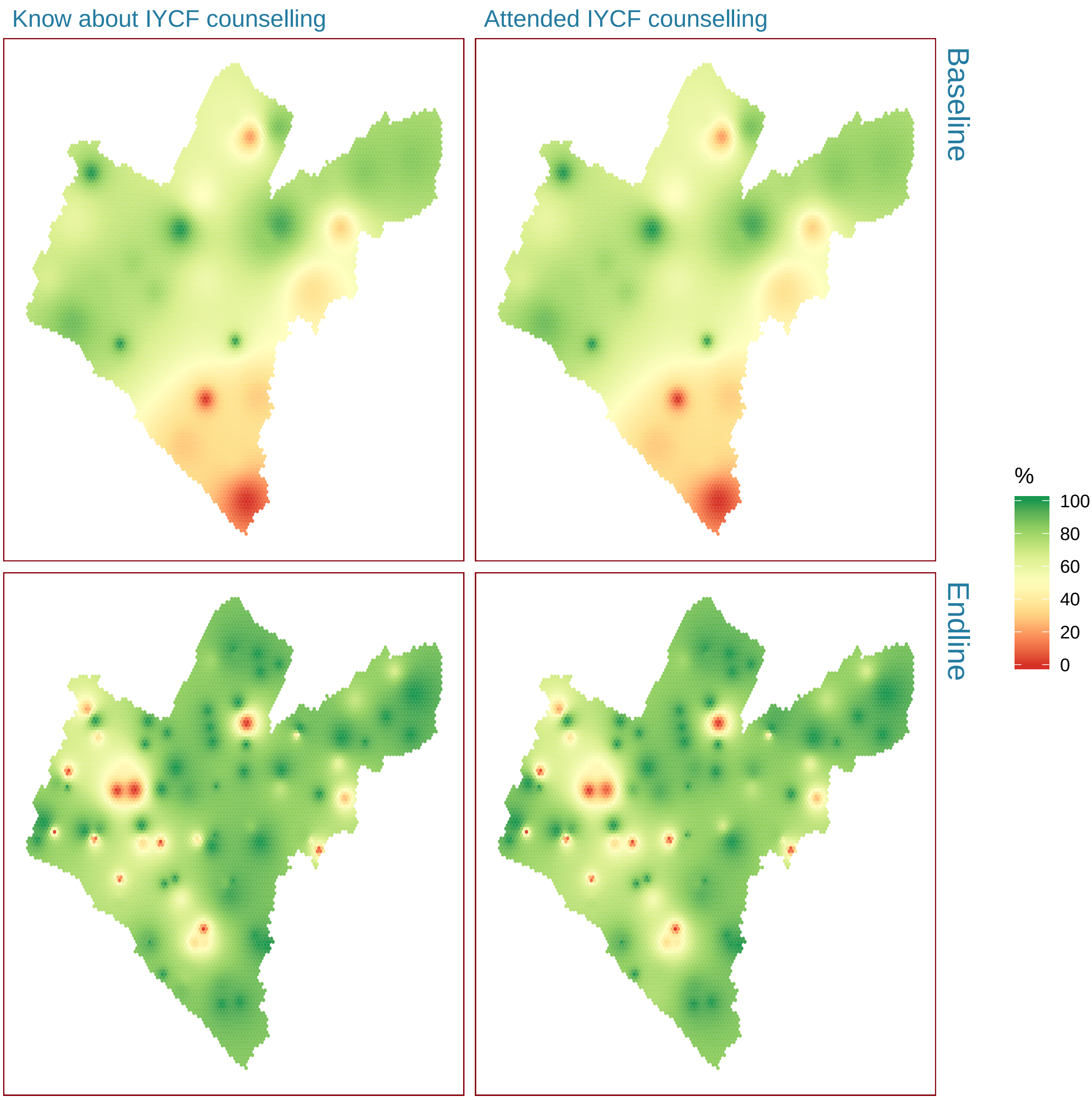


Figure 16: Spatial distribution of IYCF counselling coverage in Grand Bassa

3.3 Micronutrient powder supplementation coverage

Figure 17 and Table 4 summarises the hierarchical MNP supplementation coverage indicators in Greater Monrovia and Grand Bassa. MNP supplementation coverage was extremely low at baseline in each area. This was expected given that programme was at its early implementation phase. At endline, the MNP supplementation coverage indicators have increased significantly compared to baseline with estimates approaching 50% in both areas. However, it should be noted that these MNP coverage results are still considerably low. From a hierarchical coverage perspective, these results still indicate that knowledge and information about MNP is the key faltering point of the programme.

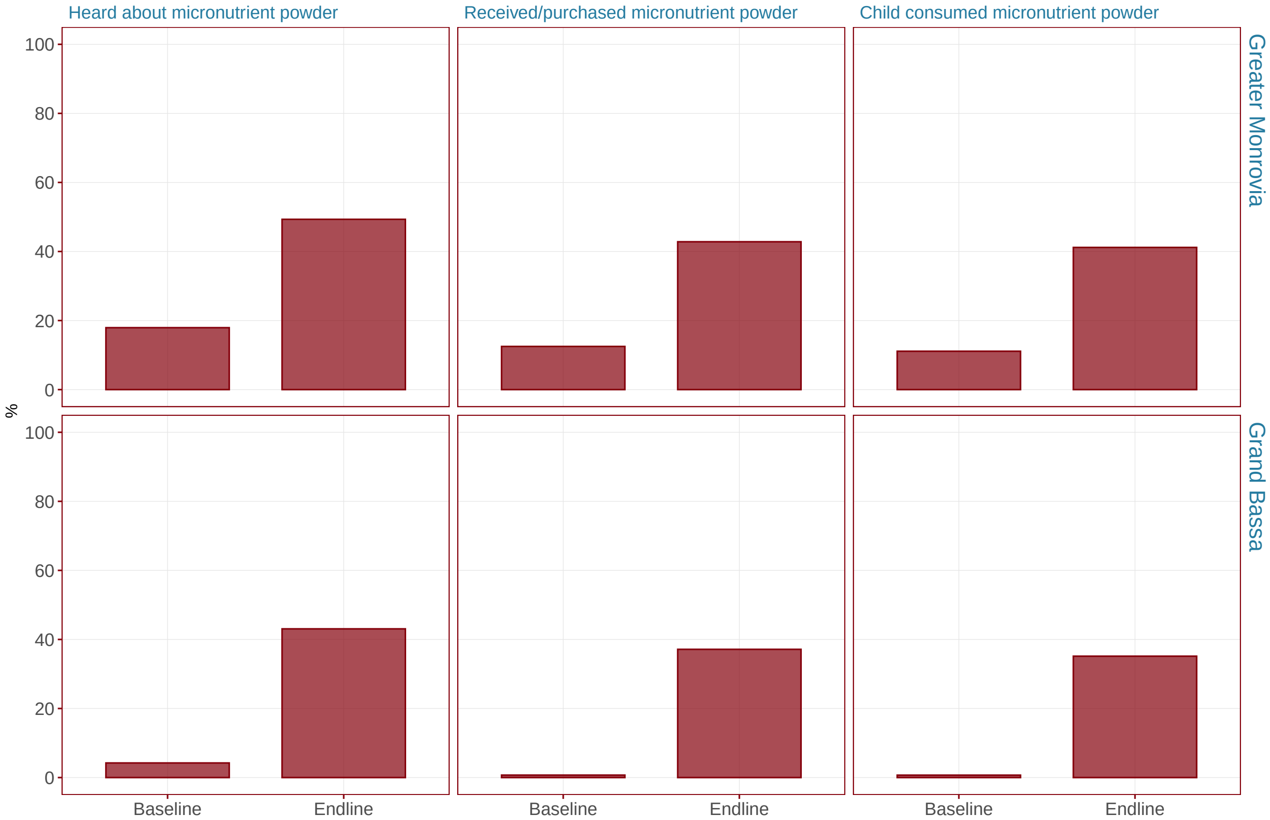


Figure 17: Micronutrient powder supplementation coverage

Table 4: MNP supplementation coverage

Indicator	Greater Monrovia						Grand Bassa					
	Baseline			Endline			Baseline			Endline		
	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL
Heard about micronutrient powder	17.9	10.5	26.5	49.3	38.4	59.9	4.2	0.8	9.0	43.1	29.8	55.0
Received/purchased micronutrient powder	12.5	5.7	20.8	42.8	31.1	54.2	0.7	0.0	3.4	37.1	25.9	48.4
Child consumed micronutrient powder	11.1	3.9	19.4	41.2	29.4	52.4	0.7	0.0	3.0	35.2	24.9	47.2

The main reasons for not receiving MNP supplements are presented in Figure 18. At baseline, availability of MNP was the main reason for non-coverage. At endline, reasons have shifted more to personal preferences by parents not to have children take the MNP supplement mainly because they think their child doesn't need the supplement. It should be noted, however, that given the coverage results, knowledge, awareness and information about MNP supplementation is the main falter point for coverage and this is reflected in the various reasons conveyed by those not covered.

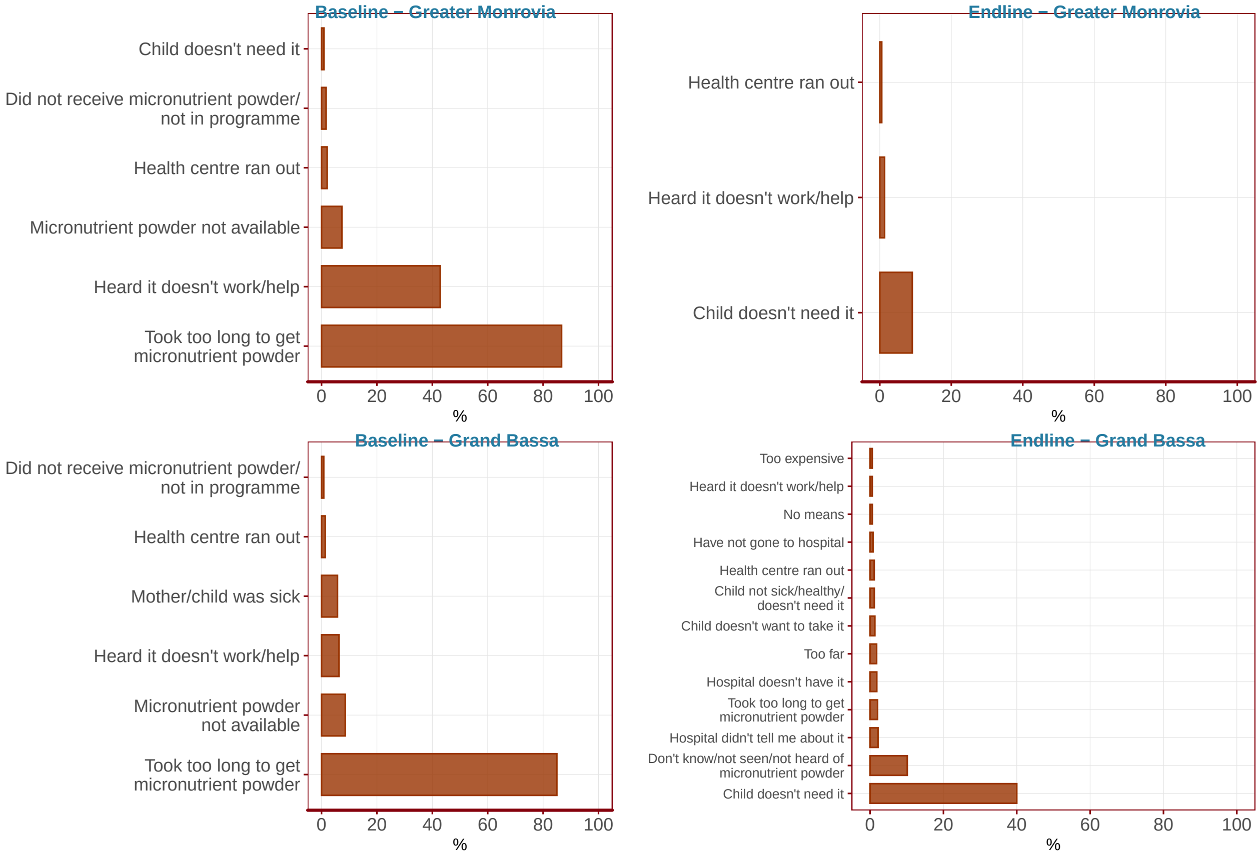


Figure 18: Reasons for not receiving micronutrient powder in Greater Monrovia

Spatial distribution of MNP supplementation coverage was across the board low in Greater Monrovia and Grand Bassa at baseline. By endline, improved coverage was concentrated in the north and central areas of Greater Monrovia (see Figure 19) and at north and central areas of Grand Bassa (see Figure 20). The spatial distribution of coverage for both areas emphasise the point that despite increased aggregated coverage shown above, a still greater number of children and areas are uncovered by the MNP supplementation programme.

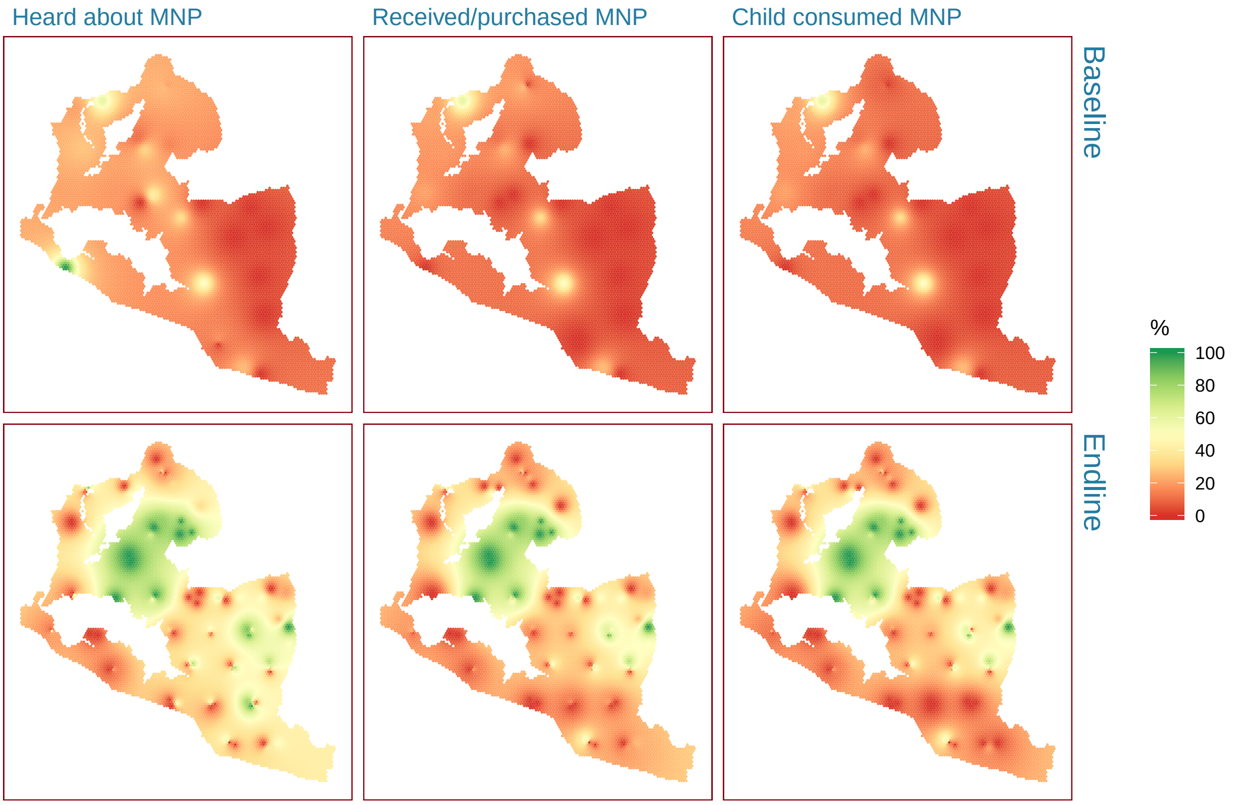


Figure 19: Spatial distribution of MNP supplementation coverage in Greater Monrovia

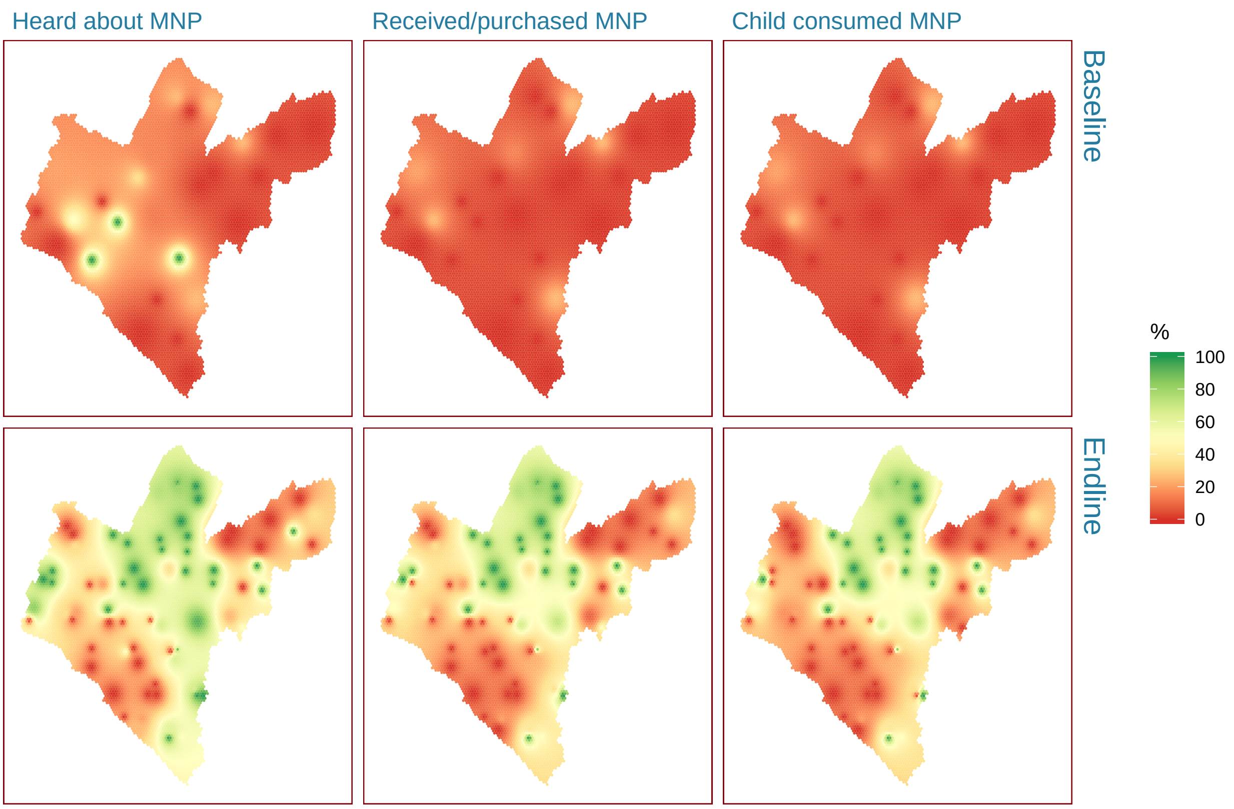


Figure 20: Spatial distribution of MNP supplementation coverage in Grand Bassa

3.4 Vitamin A Supplementation Coverage

Vitamin A supplementation coverage in Greater Monrovia and Grand Bassa is shown in Figure 21. There were 82% of children 6-59 months in Greater Monrovia who received vitamin A supplementation in the past 6 months at baseline. This rate dropped slightly at endline to 78% though this difference is not statistically significant. In Grand Bassa, about 84% of children 6-59 months received vitamin A supplementation in the past 6 months at baseline. This dropped slightly to about 82% at endline though the difference is not statistically significant.

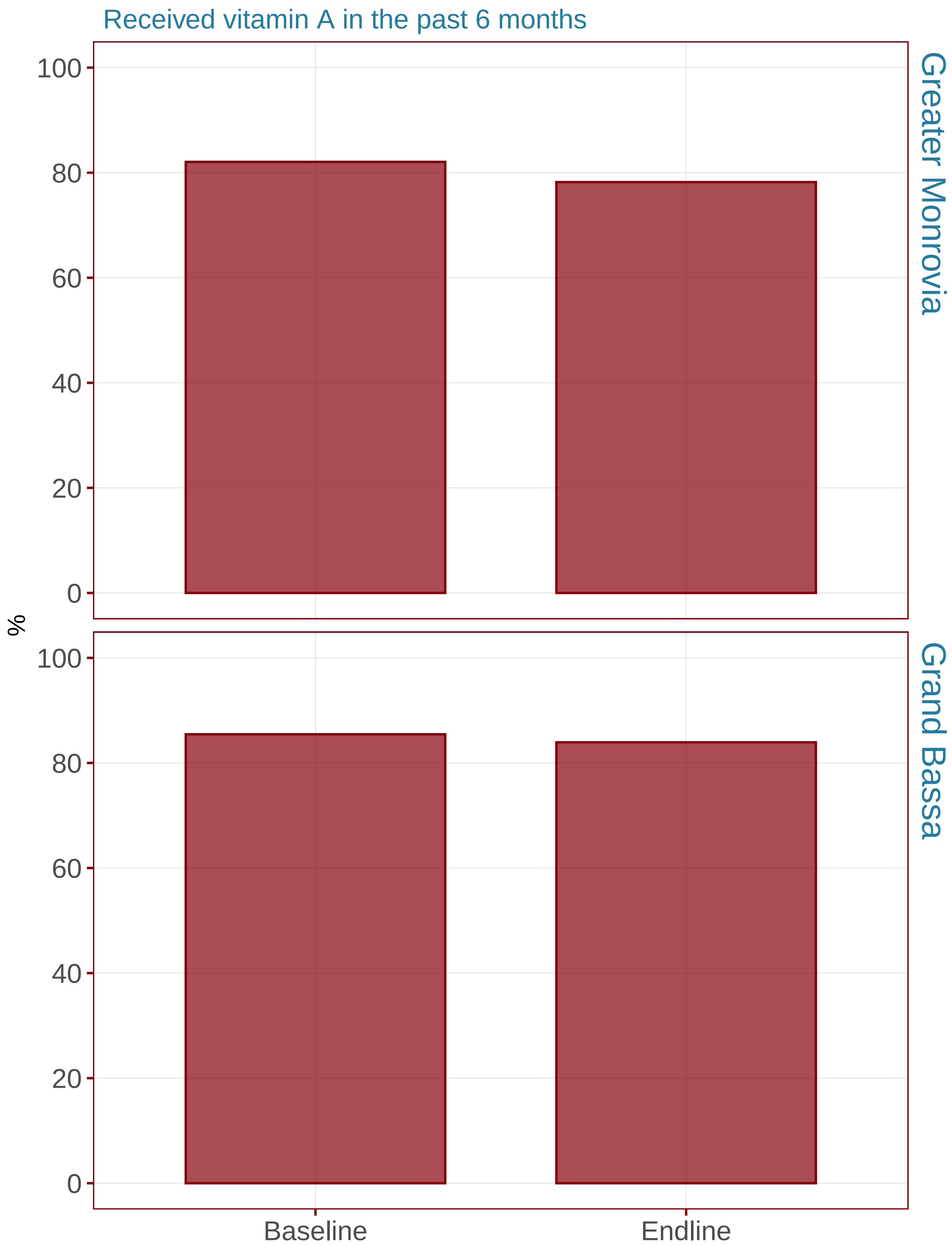


Figure 21: Vitamin A supplementation coverage in Greater Monrovia

Spatial distribution of vitamin A supplementation in Greater Monrovia is shown in Figure 22. The south and eastern areas of Greater Monrovia have the lowest vitamin A supplementation coverage which have shown improvement at endline though other areas in the northeast and southwest of Greater Monrovia have decreased vitamin A supplementation. Spatial distribution of vitamin A supplementation in Grand Bassa is shown in Figure 23. The south, central and northern areas of Grand Bassa have the lowest vitamin A supplementation coverage which have shown improvement at endline though other areas in the southeast and northeast of Grand Bassa have decreased vitamin A supplementation.

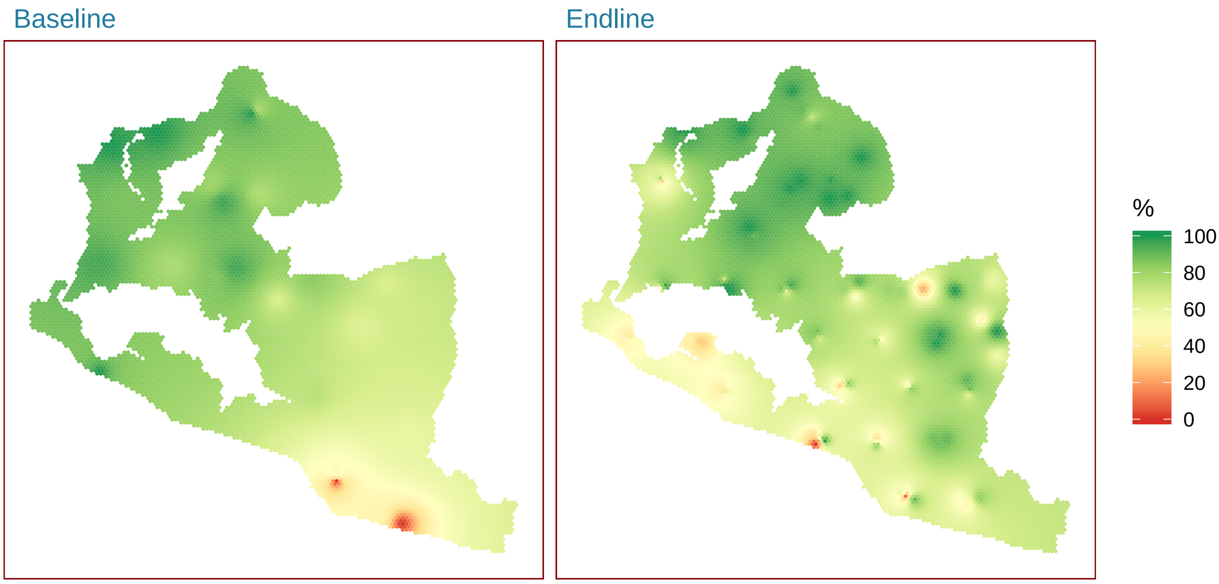


Figure 22: Spatial distribution of vitamin A coverage in Greater Monrovia

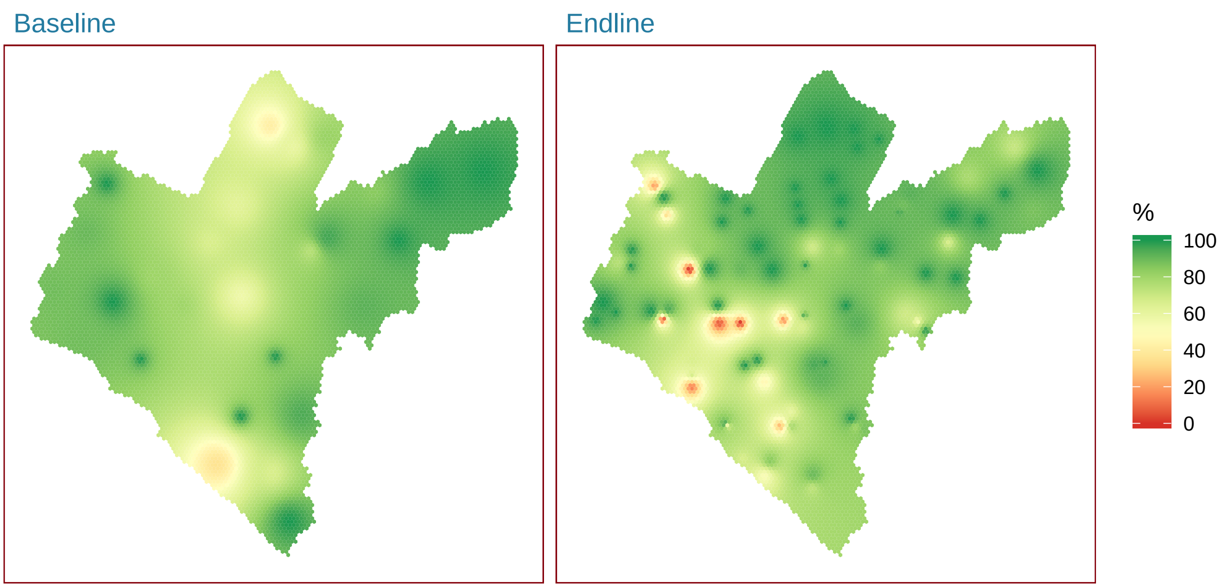


Figure 23: Spatial distribution of vitamin A coverage in Grand Bassa

The main reasons for not receiving vitamin A are presented in Figure 24. At baseline, the main reasons for non-coverage was access and availability of the supplement. At endline, these reasons are still the most common in Grand Bassa but for Greater Monrovia, there is a factor of mothers choosing not to have their children receive the supplement as they perceive their child not needing it.

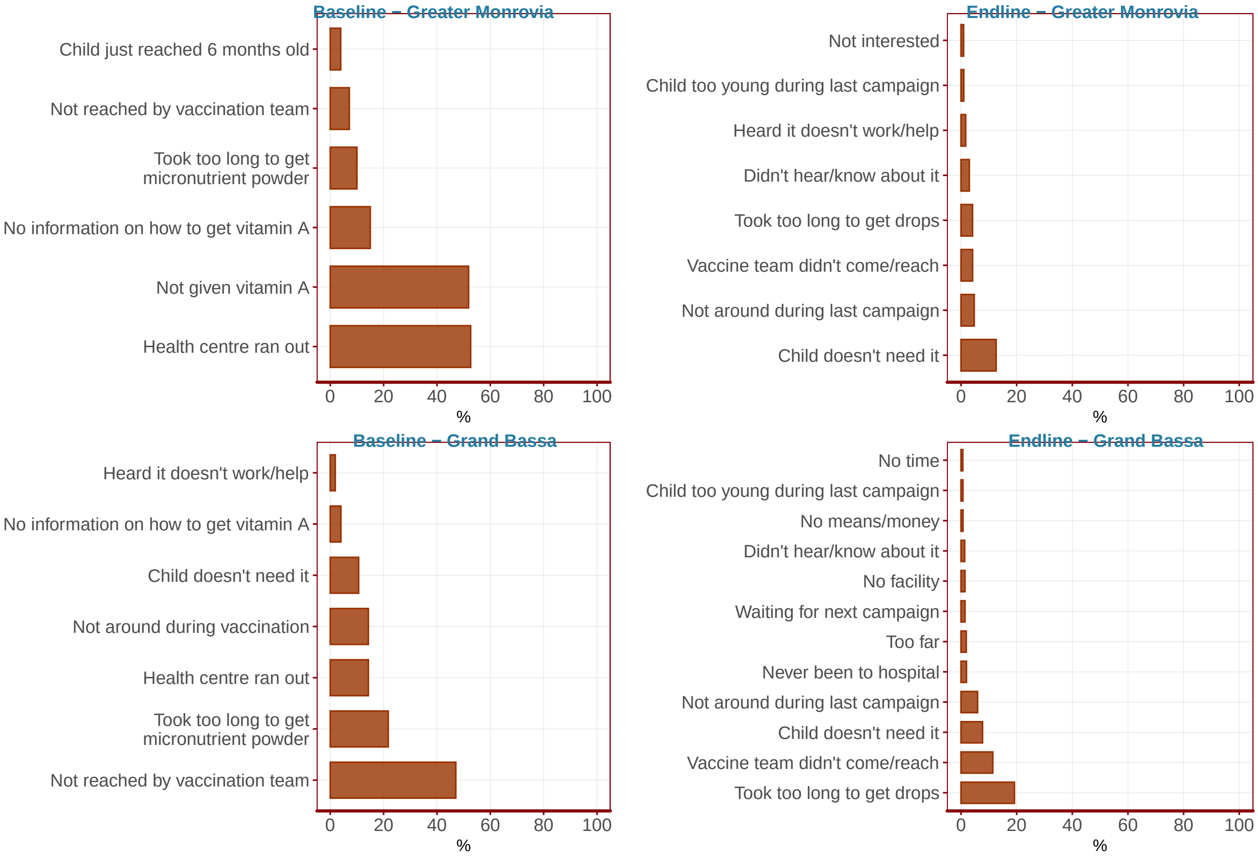


Figure 24: Reasons for not receiving vitamin A

3.5 Acute undernutrition prevalence by MUAC

Prevalence of acute undernutrition is presented in Figure 25 and Table 5. Acute undernutrition rates were highest in Grand Bassa reaching up to 4% GAM and close to 2% GAM in Greater Monrovia at baseline. These estimates are relatively low but are the generally expected values for these areas in Liberia. At endline, the rates for Greater Monrovia increased slightly while for Grand Bassa they decreased slightly. These changes are not statistically significant.

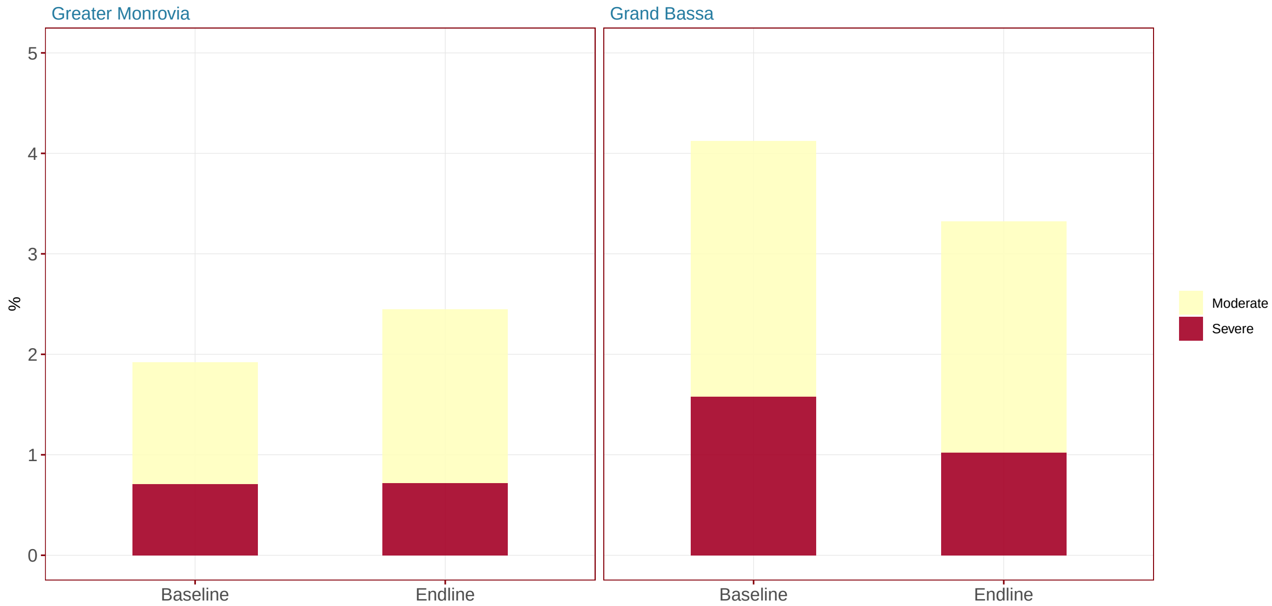


Figure 25: Acute undernutrition prevalence in Greater Monrovia

Table 5: Acute undernutrition by MUAC prevalence

	Greater Monrovia						Grand Bassa					
	Baseline			**Endline**			**Baseline**			**Endline**		
Indicator	**Est (%)**	**95% LCL**	**95% UCL**	**Est (%)**	**95% LCL**	**95% UCL**	**Est (%)**	**95% LCL**	**95% UCL**	**Est (%)**	**95% LCL**	**95% UCL**
Global acute malnutrition	1.91	1.29	2.73	2.5	1.8	3.3	4.19	3.45	5.04	3.4	2.4	4.4
Moderate acute malnutrition	1.21	0.78	1.72	1.7	1.1	2.5	2.54	2.02	3.22	2.3	1.5	3.1
Severe acute malnutrition	0.71	0.32	1.14	0.7	0.4	1.1	1.58	1.07	2.14	1.0	0.6	1.7

3.6 Acute undernutrition screening coverage

Screening coverage is very low for both Greater Monrovia and Grand Bassa as shown in Figure 26 and Table 6 and spatial distribution is low across both programme areas as shown in the maps in Figure 27 and Figure 28.

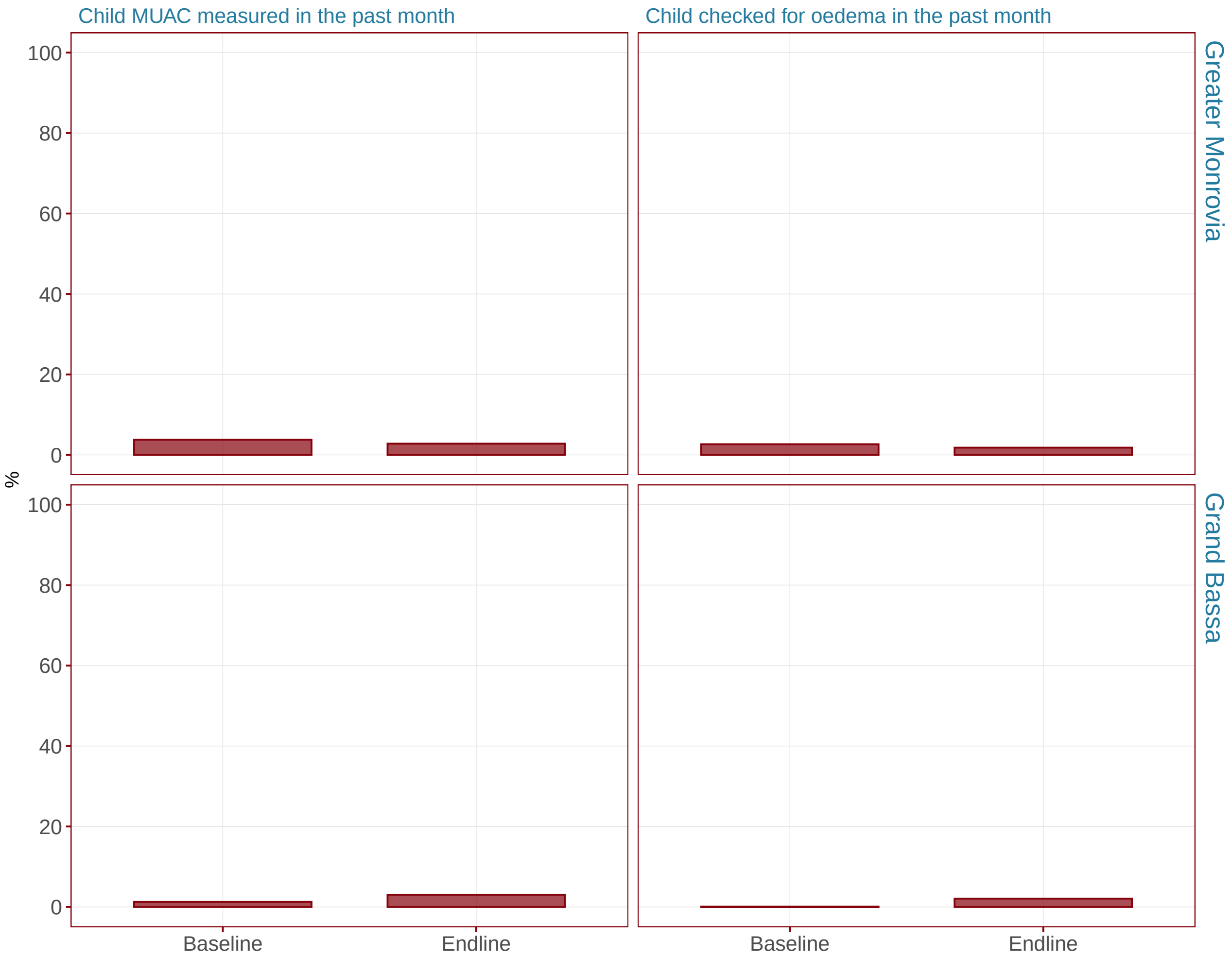


Figure 26: Acute undernutrition screening coverage

Table 6: Acute undernutrition screening coverage

	Greater Monrovia						Grand Bassa					
	Baseline			Endline			Baseline			Endline		
Indicator	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL
Child MUAC measured in the past month	3.79	1.37	7.73	2.8	1.90	3.83	1.26	0.81	1.92	3.03	1.34	5.45
Child checked for oedema in the past month	2.65	0.52	6.63	1.8	1.07	2.54	0.07	0.00	0.21	2.08	0.89	4.10

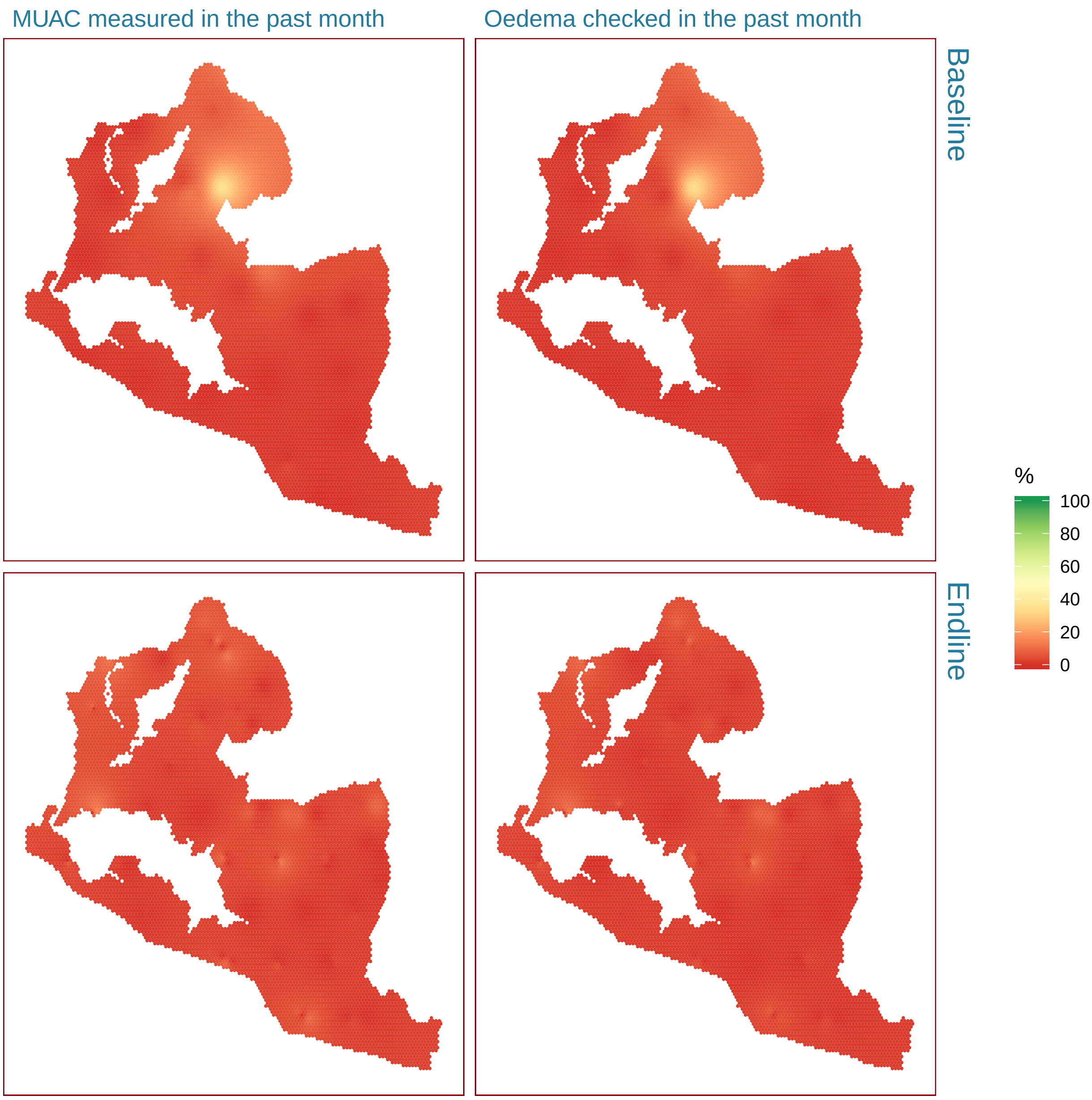


Figure 27: Spatial distribution of acute undernutrition screening coverage in Greater Monrovia

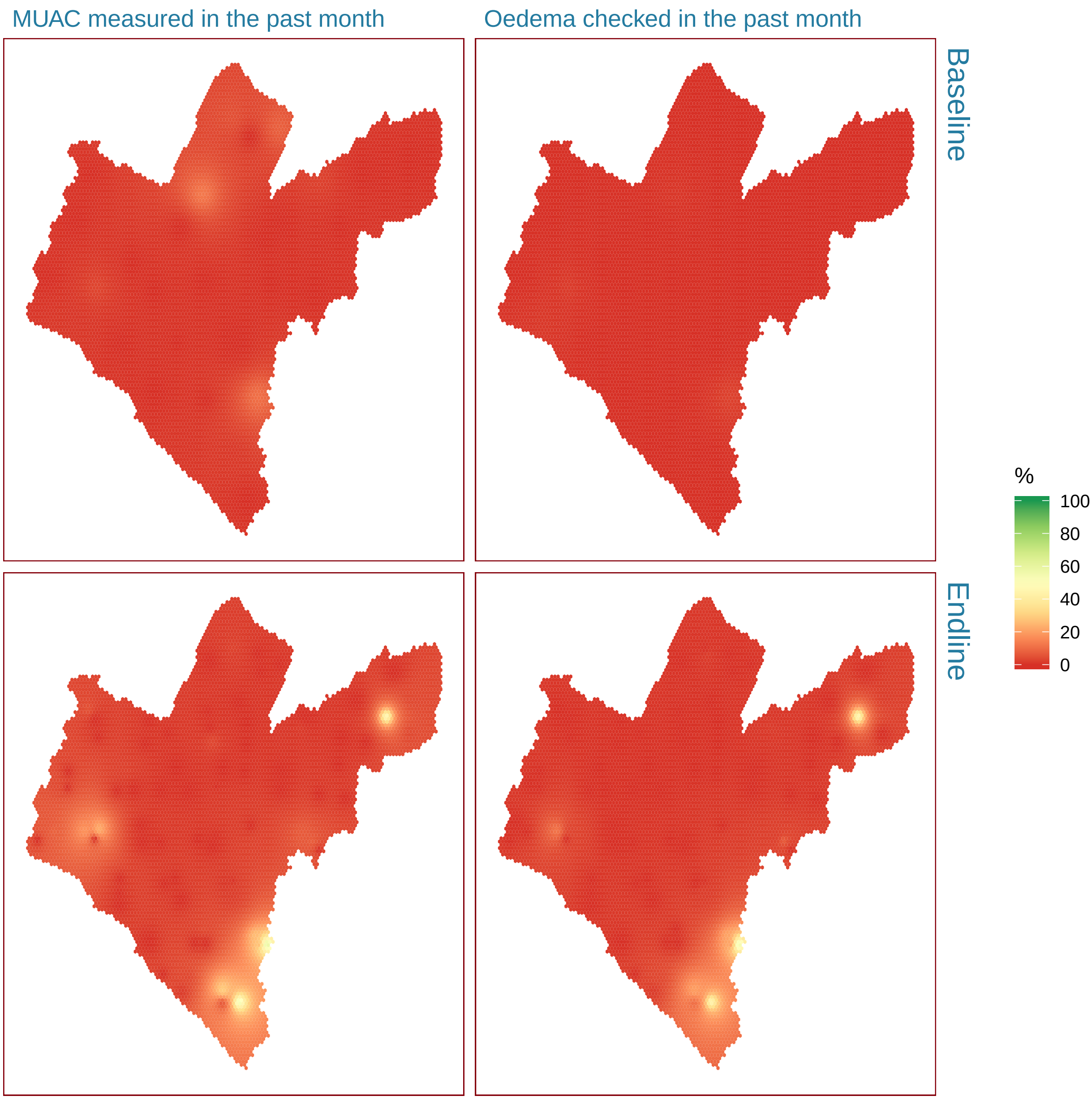


Figure 28: Spatial distribution of acute undernutrition screening coverage in Grand Bassa

3.7 CMAM Coverage

Case-finding effectiveness in both Greater Monrovia and Grand Bassa are low at baseline (see Figure 29 and Table 7) with Greater Monrovia having a higher rate at about 31% compared to 6% in Grand Bassa. At endline, Greater Monrovia's case-finding effectiveness dropped significantly to just about 15% while Grand Bassa's case-finding effectiveness increased to about 18%.

Treatment coverage is at 55% in Greater Monrovia at baseline which is an improvement from previous coverage estimates for the area but Grand Bassa only managed to get 18% treatment coverage. At endline, treatment coverage in Greater Monrovia dropped to less than 30% while treatment coverage in Grand Bassa increased to about 16%. The drop in coverage of CMAM for Greater Monrovia is statistically signficant and the increase in coverage of CMAM in Grand Bassa is statistially significant.

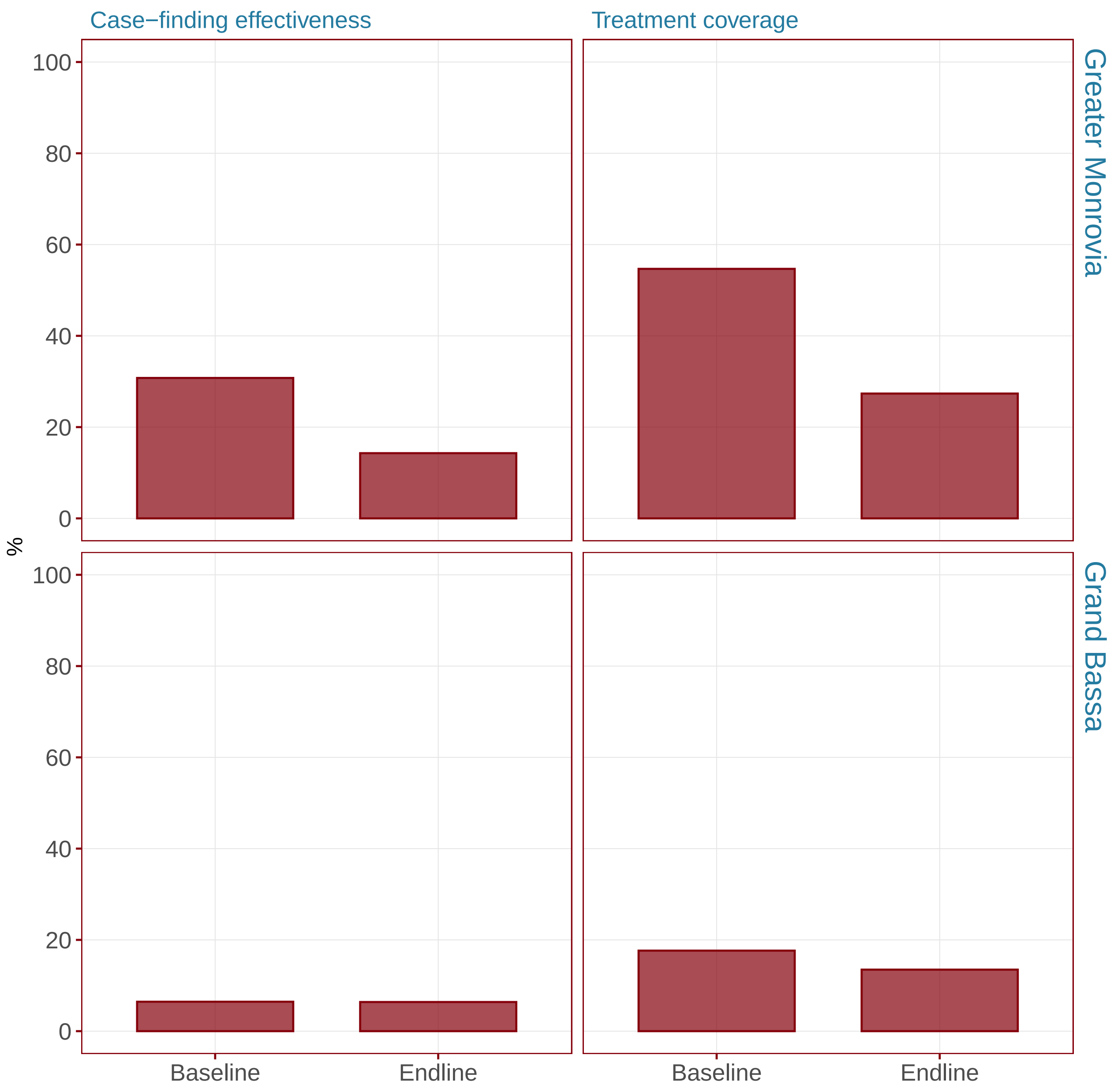


Figure 29: CMAM coverage

Table 7: CMAM coverage

Indicator	Monrovia						Grand Bassa					
	Baseline			Endline			Baseline			Endline		
	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL	Est (%)	95% LCL	95% UCL
Case-finding effectiveness	30.77	27.29	34.25	14.29	12.89	15.69	6.45	4.90	8.00	6.38	5.36	7.40
Treatment coverage	54.68	53.97	55.38	27.35	26.60	28.10	17.65	16.77	18.53	13.48	12.73	14.24

The spatial distribution of CMAM coverage in Greater Monrovia is shown in Figure 30. It shows high levels of coverage at baseline throughout most of Greater Monrovia but with significant areas of low coverage in the western and southeastern sections. At endline, case-finding effectiveness and treatment coverage is low throughout the whole of Greater Monrovia with very little spatial variation.

The spatial distribution of CMAM coverage in Grand Bassa is shown in Figure 31. Coverage at baseline in Grand Bassa is low throughout but with pockets of high coverage in the western area of the county. At endline, the case-finding effectiveness and treatment coverage of CMAM in Grand Bassa is still generally low but with lighter hotspots than baseline. Areas of high coverage in the west of the county has increased.

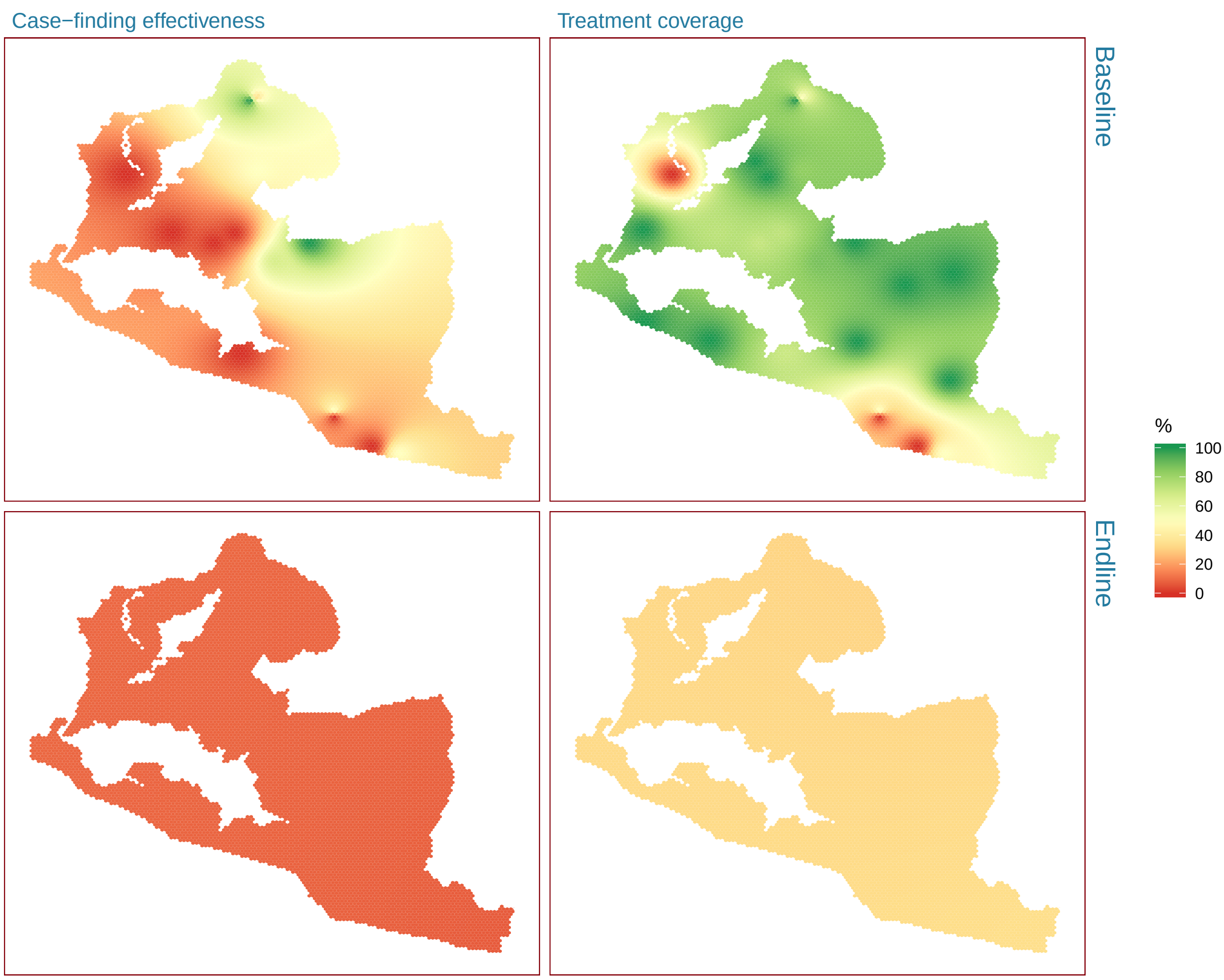


Figure 30: Spatial distribution of CMAM coverage in Greater Monrovia

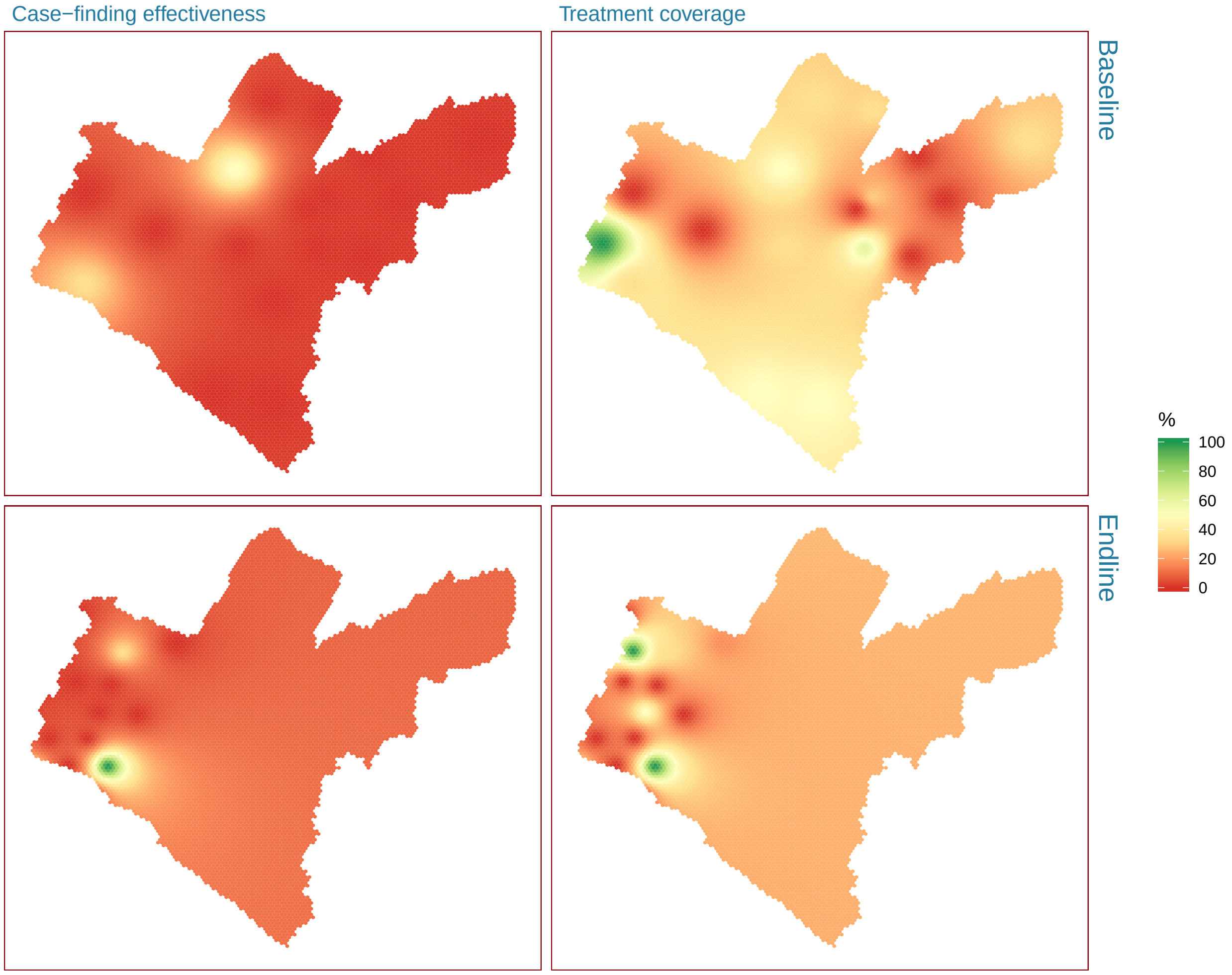


Figure 31: Spatial distribution of CMAM coverage in Grand Bassa

For SAM cases not covered by the programme, Figure 32 summarises the reasons for non-coverage. No knowledge of the treatment modality for acute undernutrition was consistently the reason reported by non-covered cases at baseline and endline in both areas.

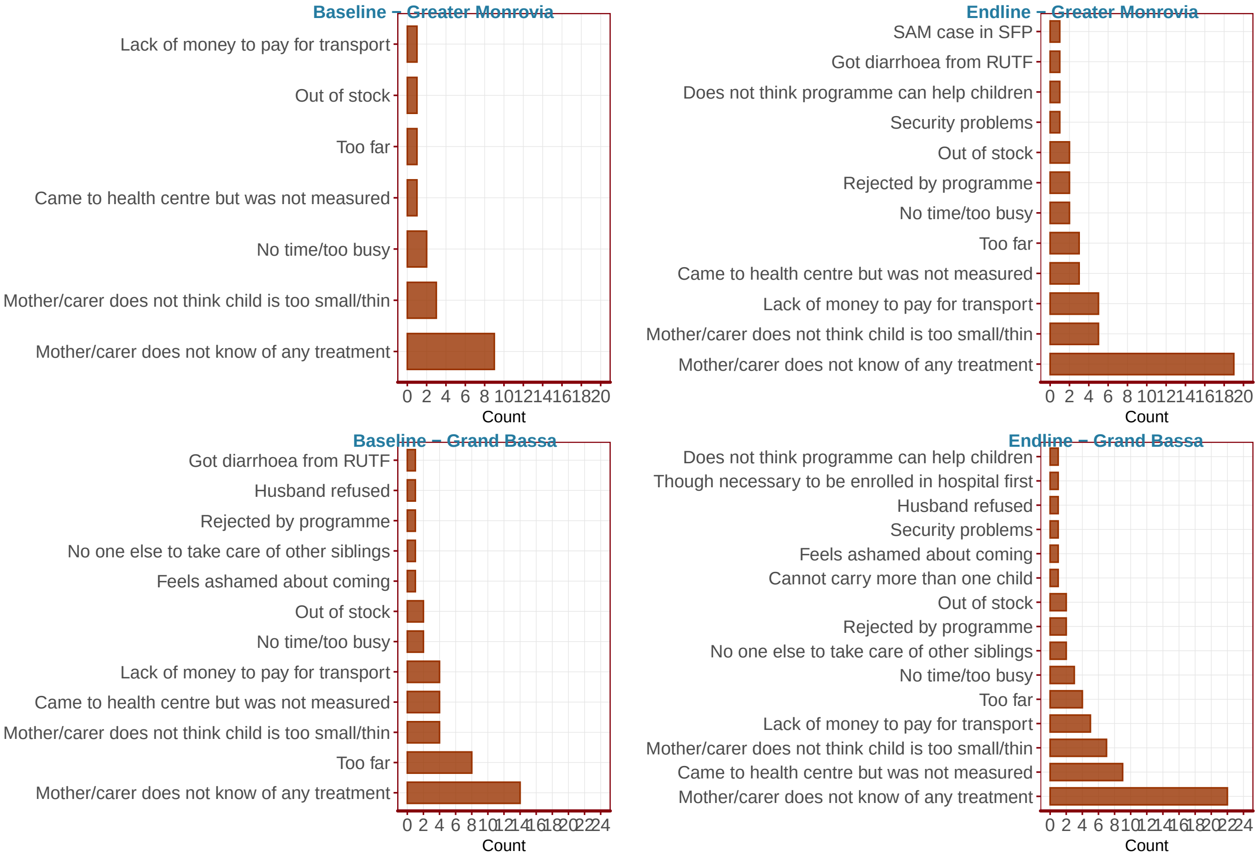


Figure 32: Reasons for not being in CMAM programme

4 Discussion

The results of the coverage assessment of direct nutrition interventions in Liberia specifically in Greater Monrovia and Grand Bassa indicate various levels of disparity in coverage both between the programme areas assessed and within the programme areas assessed.

Long-standing programmes such as IFA, IYCF counselling and vitamin A supplementation have performed fairly well in terms of coverage. The majority of women and children targeted by these programmes are knowledgeable of the programme and are beneficiaries of the programme. Years of implementation complemented by the level of support and investment by the government and its partners seem to have paid dividends in allowing for these programmes to reach almost all of their targeted beneficiaries. However, there is still much room for improvement and the current coverage levels can still be improved and increased.

For IFA supplementation, the programme has been able to reach most mothers and has been successful in getting them to take IFA supplements. However, the key challenge for the programme now is to keep mothers taking the tablets for the recommended period of time (at least 90 days). Whilst the survey did not collect data on mother's reasons for stopping IFA tablet consumption, the most common reason for not continuing at this early stage is because of side effects caused by the IFA tablets. Given that contact with health care services during pregnancy is high, it would be good to review existing guidance provided through ANC regarding the intake of IFA and to see whether relevant and appropriate information on correct usage of IFA and its known side effects and ways by which to minimise them are included and/or emphasised.

For IYCF counselling, the survey only assessed knowledge and attendance of IYCF counselling. The natural next level in the coverage hierarchy is whether mothers practice what they have been taught. The most straightforward way of doing so would be assessing IYCF practices as these are the key behaviours that are targeted by the counselling. If this was to be considered, however, UNICEF and its partners would have to take into account the fact that current standard IYCF indicators can only be assessed through big sample surveys such as DHS and MICS. Yet these surveys would most likely not provide the same level of detail and information as current assessment. However, there are small sample alternatives to the standard IYCF indicators such as the Infant and Child Feeding Index (ICFI) indicator set [Guevarra et al., 2016].

For vitamin A supplementation, the current figures are relatively lower than the expected indirect coverage estimates produced by government. It would be important to see what the potential reasons for this disparity are and to ensure that vaccination campaigns, to which vitamin A supplementation is generally attached, does not neglect vitamin A supplementation as it seems access to vaccination is the key reason for non-coverage.

Programmes such as MNP and CMAM, on the other hand, show how new and recently scaled-up programmes are still in the process of achieving the highest levels of coverage possible. MNP supplementation which is the newest programme of those assessed is understandably still struggling with coverage even at endline. Knowledge of the programme is the key falter point which is typical of a programme at this stage of its evolution. The programme is mainly anchored to the health centre and therefore knowledge and access to it is primarily influenced by mothers' behaviours and attitudes towards seeking care and treatment at the health facility. Given that MNP is aimed at children who are otherwise healthy (not acute malnourished), the current MNP coverage estimates indicate that health-seeking behaviour leading to a visit to a health facility is mainly influenced by whether their children are sick rather than as a way to seek information or participate in promotive and preventive services such as MNP supplementation. Other factors include physical access to health centres. A more community-based approach to MNP supplementation that is integrated with other community-based programmes such as vaccinations and CMAM should be considered as a potential delivery mechanism.

Finally, for CMAM which is not entirely new but still in its early stages of scale-up, the coverage estimates at baseline and endline indicate 1) disparity between Greater Monrovia and Grand Bassa in terms of the level and intensity of the community aspects of the programme; 2) signficant drop in coverage of CMAM in Greater Monrovia given that at baseline its coverage was exemplary for an urban CMAM programme; and, 3) significant increase in coverage of CMAM in Grand Bassa though the increase is still at a level that is unacceptable for coverage. At baseline, screening and case-finding in Greater Monrovia is better than in Grand Bassa and this can partly explain the difference in treatment coverage between the two areas at baseline. At endline, no improvement in screening has happened and the levels of coverage for CMAM has signficantly plummetted. Based on feedback by stakeholders, this has been attributed to government being the main service provider for CMAM in the past year as usual stakeholders that supported government were not engaged due to several programmatic issues. This points to the need for ensuring increased and continued capacity building of government in CMAM and other related interventions so that they can be truly in a position that they can implement and maintain these programmes with or without external support.

Lessons learned from the years of implementation of the IFA and vitamin A programmes can be useful in improving coverage of MNP and CMAM particularly with potential integration of these services into a unified and coherent child health and nutrition programme in Liberia.

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