2019 coverage report: seasonal malaria chemoprevention in Burkina Faso, Chad and Nigeria

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Acronyms and abbreviations

ACCESS-SMC	Achieving Catalytic Expansion of Seasonal Malaria Chemoprevention in the Sahel
AQ	amodiaquine
CI	confidence interval
DOT	directly observed therapy
EoC	end-of-cycle
EoR	end-of-round
INSTech	Institut de Sciences & Techniques
LGA	local government area
LQAS	lot quality assurance sampling
RDT	rapid diagnostic test
SA	supervision area
SP	sulfadoxine-pyrimethamine
SPAQ	sulfadoxine-pyrimethamine and amodiaquine
SMC	seasonal malaria chemoprevention
WHO	World Health Organization

EXECUTIVE SUMMARY

Background

Most malaria illness and deaths in the Sahel and sub-Sahel regions of sub-Saharan Africa occur during the rainy season. Seasonal malaria chemoprevention (SMC) is an intervention intended to provide prophylactic protection to children aged three to 59 months against malaria during this period. The World Health Organization currently recommends a single dose of sulfadoxine-pyrimethamine (SP) in combination with three daily doses amodiaquine (AQ) over four consecutive monthly cycles. The objective of SMC is to maintain therapeutic antimalarial drug concentrations in the blood throughout the period of greatest risk. Evidence from randomized control trials and accumulated evidence from SMC implementation in the field at scale has shown it to be safe, feasible, effective and cost-effective in children under five.

SMC is typically delivered household-to-household over a period of four days by trained community distributors each month for four monthly SMC cycles during the rainy season. The first dose of SP and AQ ("Day 1 SPAQ") is given under the supervision of the community distributors —this is referred to as directly observed therapy (DOT). The community distributors give the remaining two tablets of AQ in the blister pack to the child's caregivers to administer daily over the following two days ("Day 2 AQ" and "Day 3 AQ") and provide information on AQ administration and how to respond in the event of adverse drug reactions. To be fully effective at providing sufficient protection from malaria infection, children should receive the full three-day course of SPAQ during each of the four monthly SMC cycles. It is therefore not only important to demonstrate program coverage to evaluate performance against coverage targets, but also essential to determine the proportion of children who have received a full course of SPAQ each monthly cycle to assess the degree to which target populations are protected against malaria transmission.

The primary objectives of this report are first to provide a summary of program coverage, and degree of adherence to the program's protocols; and second, to identify lessons learned, and provide recommendations for improvements to SMC administration and program monitoring and evaluation. The report presents coverage results across Malaria Consortium's 2019 SMC program, regardless of funding source.

Malaria Consortium's SMC program in 2019

In 2019, Malaria Consortium implemented SMC in three countries, covering a target population of 6,178,750 children aged three to 59 months, in Burkina Faso (1,323,841 children in 23 health districts), Chad (982,616 children in 20 health districts), and northern Nigeria (3,872,293 children across 72 local government areas in the States of Jigawa, Katsina, Sokoto, Yobe and Zamfara). The 2019 total represents an increase of 57.0% compared to the target population of 3,936,723 children in 2018. This year-on-year change is a result of program expansion, including five additional health districts in Burkina Faso, four districts in Chad (in addition to one district newly created from the division of an existing district), and 26 local government areas (LGAs) in Nigeria, including four LGAs in Yobe state which received Malaria Consortium-supported SMC for the first time in 2019.

Methods

In addition to estimating administrative coverage[i], program coverage in all three countries was also assessed using two types of household coverage surveys:

- End-of-cycle (EoC) surveys employing the lot quality assurance sampling methodology following cycles 1 to 3 to enable implementing teams to identify areas of low coverage and rapidly take corrective actions to improve SMC delivery in subsequent cycles.
- Comprehensive end-of-round (EoR) surveys following the completion of the SMC round (that is, after cycle 4) to assess SMC performance across all four monthly cycles.

These surveys assessed coverage of Malaria Consortium's SMC program in terms of proportions of households with eligible children visited by a community distributor, eligible children treated per cycle, and eligible children who received SPAQ in all four cycles. We also investigated the proportions of treated children for whom DOT was observed, and who received two doses of AQ from caregivers over the two days following visits by community distributors. The analyses also considered the proportions of ineligible children aged five to ten years who had received SMC.

Results

Administrative coverage was consistently high across all three countries in 2019. Data on doses of SPAQ administered by community distributors shows that an average of 6,541,040 doses were provided in each cycle across all three countries; this corresponds to an administrative coverage of 106.9%.

The results of our analyses based on coverage survey data showed that the program achieved a high coverage across all cycles and countries, typically over 90%, both in terms of eligible children receiving SPAQ from a community distributor, as well as the proportion of those receiving doses of AQ from their caregivers in the days following visits by distributors. A summary of coverage survey results by country can be found below:

Burkina Faso

- During each of the four SMC cycles, between 93.0% and 96.9% of eligible children received Day 1 SPAQ from a community distributor.
- Among those children who received Day 1 SPAQ, coverage in terms of Day 2 and 3 AQ was over 98% in all EoC and EoR surveys.
- Community distributors observed DOT in over 95% of all SPAQ doses administered.
- Over 80% of eligible children received Day 1 SPAQ during each of the four monthly cycles. Only 7.3% of children did not receive any SPAQ.

Chad

- Coverage in terms of administration of Day 1 SPAQ by a community distributor exceeded 90% across the two SMC cycles for which EoC surveys were conducted.
- Among those children who received Day 1 SPAQ, coverage in terms of Day 2 and 3 AQ was 98.7% in cycle 1 and 97.8% in cycle 4.

[i] Administrative coverage is defined as the total number of SPAQ administered in a given cycle divided by the target population (children aged three to 59 months).

- Adherence to DOT was observed for over 80% of all SPAQ doses administered by community distributors.
- While 47.2% of eligible children received SPAQ in all four cycles during 2019, 1.5% of children did not receive any SPAQ.

Nigeria

- Results of EoC surveys show that over 90% of eligible children received Day 1 SPAQ from a community distributor in each SMC cycle.
- Across Nigeria, a weighted average of 85.1% of eligible children received at least one dose of SPAQ.
- The EoR survey conducted in Nigeria showed a lower coverage cycle-by-cycle in most states than the EoCs.
- Among those children who received Day 1 SPAQ, coverage of Day 2 and Day 3 AQ exceeded 95% across all states.
- In cycles 1 to 3, adherence to DOT among community distributors was generally high, exceeding 80% in all states except Zamfara and exceeding 95% in Sokoto and Yobe.
- EoR data show, however, that both coverage of Day 1 SPAQ (76.8% in any cycle; 58.2% in cycle 4) and adherence to DOT (59.6%) was lowest in Sokoto. Anecdotal reports by caregivers suggest that community distributors did not systematically visit compounds door-to-door in some areas in this state.
- Between 23.5% (Yobe) and 45.3% (Jigawa) of eligible children received SPAQ during all four SMC cycles. The proportion of children who did not receive any SPAQ during 2019 was highest in Sokoto (18.7%).

BACKGROUND

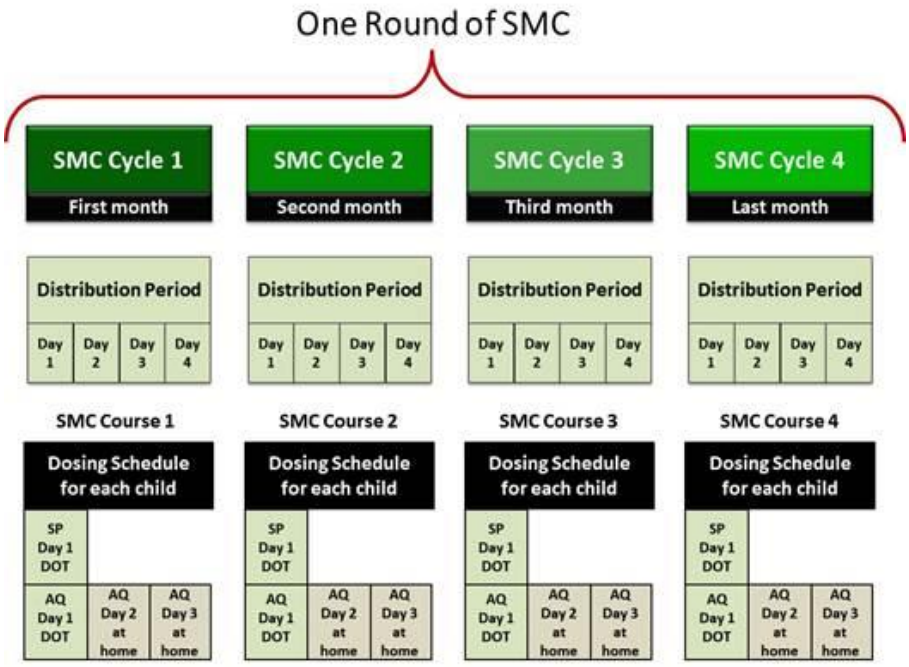
Across the Sahel and sub-Sahel regions of sub-Saharan Africa, the majority of malaria cases and deaths attributable to malaria occur during a four-month window corresponding to the rainy season. Seasonal malaria chemoprevention (SMC) is an intervention recommended by the World Health Organization (WHO) to provide prophylactic protection to children aged three to 59 months against *Plasmodium falciparum* malaria during the period of highest-risk of malaria transmission through intermittent administration of monthly courses of sulfadoxine-pyrimethamine (SP) and amodiaquine (AQ), or "SPAQ". SMC has been shown to be safe, feasible, effective and cost-effective for the prevention of malaria cases in targeted populations **[1]**.

Guidance provided by WHO classifies areas eligible for SMC as those in which over 60% of clinical malaria cases occur within a four-month period, the clinical attack rate of malaria is greater than 0.1 attack per transmission season in the target age group, and resistance to SPAQ has not developed such that its efficacy remains above 90% **[2]**. According to the 2019 World Malaria Report **[3]**, data from 2018 show that 31 million children aged under five years were living in areas eligible for administration of SMC. Of these, 19 million children in 12 African countries (62%) were reached by SMC programs. The number of eligible children yet to be served by SMC programs has fallen from 13.6 million in 2017 to 12 million in 2018.

SMC administration

SMC activities take place in yearly rounds of four months during the peak of the rainy season, approximately July to October, with distribution periods approximately 28 days apart from each other. SPAQ is typically distributed through door-to-door campaigns by volunteer community distributors during a period of three to four days per cycle (**Figure 1**). The volunteers are coordinated and supervised by salaried, facility-based health workers. Distribution teams typically take the form of a pair of distributors, who are each assigned a supervisor whose role is to ensure that activities are carried out in compliance with agreed procedures.

Figure 1. Illustration of schedule for an annual round of SMC.



Each monthly SMC course consists of one dispersible tablet of SP and three daily dispersible tablets of AQ. There are two doses of SPAQ: a lower dose for children aged three to <12 months, and a higher dose for children aged 12 to 59 months. For children aged 12 to 59 months, the dosage comprises a single dose of a full tablet of 500/25mg SP and three daily doses of a full tablet of 153mg AQ. Those aged three to <12 months are administered half the dose given to those aged 12 to 59 months, given as full dispersible tablets.

A dose of SP and the first dose of AQ ("Day 1 SPAQ") are administered by or under the supervision of community distributors to ensure that the tablets are correctly dispersed in water and that the child fully ingests the drugs without spitting them out or vomiting. This is referred to as directly observed treatment (DOT). Children who vomit or spit out the drug within 30 minutes should be given one replacement dose by distributors. The remaining two doses of AQ are administered by the caregiver once per day over the following two days ("Day 2 AQ" and "Day 3 AQ"). Distributors leave a blister pack with the two remaining tablets with caregivers and provide instructions on how to administer and record the dose on the *SMC Child Record Card*. If a child vomits or spits out the second or third dose of AQ, caregivers are encouraged to visit the nearest health facility to receive a replacement dose.

According to WHO guidelines **[2]**, SMC should not be administered to children with an acute febrile illness or to severely ill children unable to take oral medication; HIV-positive children receiving co-trimoxazole prophylaxis; children who have taken a single dose of either SP or AQ during the past four weeks; children with a known allergy to either SP or AQ, or a known allergy to sulfa drugs such as co-trimoxazole. SMC with SPAQ should not be administered to children outside the eligible age range of three to 59 months. For older children, the formulations specified above are unlikely to provide sufficient antimalarial drug concentrations in the blood to provide protection throughout the period of greatest risk of malaria transmission, and are therefore likely to contribute to the development of drug-resistant *Plasmodium falciparum* malaria. In addition, use of doses by children outside the targeted age range poses challenges for quantification of drug needs for campaigns and procurement. However, caregivers do not always know their children's ages, civil registration and identification systems are underdeveloped, and the high prevalence of widespread malnutrition and stunting in areas with high malaria attack rate often complicate accurate determination of children's ages. Consequently, while community distributors are taught to estimate age by observing children's physical development stage[ii], they are often unable to reliably determine children's ages and, as a result, administration of SPAQ to children outside the eligible age range is reported to be common. Furthermore, anecdotal reports by supervisors of community distributors in Nigeria suggest that distributors may come under pressure from caregivers to administer SPAQ to older children because SMC is seen as an effective protection from malaria.

Community distributors are instructed to refer children with fever to the nearest health facility, where they should be tested for malaria using a rapid diagnostic test (RDT). If the test result is negative, children should be given SP and the first dose of AQ by the health facility worker, giving the remaining two doses of AQ to the caregiver for administration over the following two days. **Table 1** summarizes the procedural guidelines for SMC administration.

[ii] For example, children who cannot reach their arm over their head to touch the opposite ear are assumed to be under 5 years of age and therefore eligible for SMC. Infants who are not able to sit up on their own are considered to be under three months.

Table 1. Procedural guidelines for administering SMC.

SMC component	SMC procedures
Eligibility	Malaria Consortium's SMC program targets children aged three to 59 months. Children aged three to 59 months who have malaria, are too sick to swallow the drugs, have received SP or AQ during the last 28 days, are taking certain types of medication containing sulfa, or have known allergies to SPAQ or sulfa-containing medications should not receive SPAQ.
Referral	Children who have a fever should be referred to a health facility where they should be tested for malaria using an RDT. Children who are very sick or have a suspected allergy to SPAQ should be referred to a health facility to be evaluated by a trained health provider.
Administration	The correct dose should be administered according to the child's age (three to <12 months and 12 to 59 months). Day 1 SPAQ should be administered by or under the supervision of the community distributor as DOT. If the child vomits or spits out all the drugs within 30 minutes, the child should be re-dosed once with SP and AQ. Children who have a fever but test negative for malaria should receive Day 1 SPAQ from a health worker. Day 2 and Day 3 AQ should be administered by the caregiver. If the child vomits or spits out all of the Day 2 AQ within 30 minutes, the caregiver should re-dose the child with the tablet intended for Day 3 AQ, and go to a health facility to get another tablet for Day 3 AQ. If the child vomits or spits out all of the Day 3 AQ, the caregiver should go to a health facility to get another tablet of AQ to re-dose the child for Day 3.

SMC component	SMC procedures
Communication	Community distributors should explain the purpose and benefits of SMC to caregivers. Community distributors should explain correct administration of AQ. Caregivers should be instructed how to administer one dose of AQ on each of the following two days. Caregivers should be instructed how to complete and retain the *SMC Child Record Card* after each dose of AQ is given. Caregivers should be instructed to retain the empty blister pack as proof of administration of Day 2 and 3 AQ. Caregivers should be instructed to visit a health facility for another dose of AQ if the child vomits or spits out Day 2 or Day 3 AQ. Caregivers should be instructed to visit a health facility if the child experiences severe adverse reactions after swallowing the drugs. Caregivers should be reminded of the importance to sleep under a mosquito net and seek prompt treatment when a child falls sick. Caregivers should be reminded of the importance to seek care within 24 hours if a child develops a fever so they can be tested for malaria with an RDT.
Recording	Administration of Day 1 SPAQ and any re-dosing should be recorded on the SMC *Tally Sheet.* Any blister packs or tablets which are wasted by dropping or contamination should also be recorded on the SMC *Tally Sheet.* Administration of all doses of SP and AQ should be recorded on an *SMC Child Record Card*, which should be kept by the caregiver. Each compound or household visited should be marked by indicating the year, cycle, team code, house number, number of children eligible/ number of children given SPAQ, and whether the visit was completed, needs to be revisited, excluded, or completed after a revisit. Severe adverse reactions should be recorded by health workers in the *End-of-cycle Report* and on the *National Pharmacovigilance Form*.

Malaria Consortium's SMC program in 2019

Malaria Consortium has been implementing SMC in Sahelian countries since 2013, with a major scale-up from 2015 through the Unitaid-funded "Achieving Catalytic Expansion of Seasonal Malaria Chemoprevention in the Sahel" (ACCESS-SMC) project. Since 2018, Malaria Consortium's SMC program has relied primarily on philanthropic funding to implement SMC in three countries: Burkina Faso, Chad and Nigeria. In 2019, additional funding or in-kind contributions were received from the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund), President's Malaria Initiative (PMI) and the United Kingdom's Department for International Development (DfID).

The total target population covered by Malaria Consortium's SMC program in 2018 was 3,936,723 in 2018 compared with 6,178,750 in 2019**,** representing an increase of 57.0%. This was due to both expansion of the program and population growth in areas already covered in 2018. Countries and regions covered by Malaria Consortium's SMC program in 2019 and estimated target populations are shown in **Table 2**, alongside primary funders of SMC administration in each Nigerian state.

Table 2. Malaria Consortium's SMC program in 2019.

Country	Areas covered	Number of children targeted in 2019 (mean per cycle)
Burkina Faso	23 health districts in nine regions: Cascades, Centre, Hauts Bassins, Nord, Centre Nord, Centre Ouest. Centre Sud Centre Est, and Plateau Central	1,323,841
Chad	20 health districts in four regions: Chari Baguirmi, Hadjer Lamis, Mayo Kebbi Est, and N'Djamena	982,616
Nigeria	72 LGAs in five states: 27 LGAs in Jigawa[PF/DfID], 8 LGAs in Katsina[GF/PF], 23 LGAs in Sokoto[PF], 4 LGAs in Yobe[GF], and 14 LGAs in ZamfaraPMI[PF/PMI]	3,872,293
Program (total)		**6,178,750**

GF: Global Fund to Fight AIDS, Tuberculosis and Malaria; PF: philanthropic funding; DfID: Department for International Development, United Kingdom; PMI: President's Malaria Initiative.

Compared with 2018, geographic coverage was expanded in all countries: from 18 to 23 health districts in Burkina Faso, from 15 to 20 health districts in Chad (including one district newly created from the division of an existing district since 2018), and from 46 to 72 LGAs in Nigeria. The additional LGAs covered in Nigeria include four LGAs in Yobe State, where SMC was administered for the first time. The largest increase, both in absolute and relative terms, was in Nigeria, where the estimated target population of eligible children increased by 68.2% from 2,302,463 in 2018 to 3,872,293 in 2019.

In addition to geographic expansion of the SMC program and as part of an implementation research study, Malaria Consortium has extended SMC provision in one health district in Burkina Faso, Mangodara, to five cycles, from June 2019 to October. The rationale for this study is the observation that, in areas of Burkina Faso (and other sub-Sahelian countries) where the high-transmission rainy season is longer than four months and starts earlier, malaria incidence in the targeted age group is already high before the beginning of SMC implementation in July.

Objectives of this report

This report summarizes coverage data from Malaria Consortium's 2019 SMC campaign from administrative data, end-of-cycle (EoC) surveys and end-of-round (EoR) surveys. Its objectives are to:

- Outline methods currently employed by Malaria Consortium for monitoring of its SMC program
- Provide a summary of program coverage, and degree of adherence to the program's protocols
- Where appropriate, draw comparisons with findings from 2018

- Describe lessons learned and provide recommendations for improvements to SMC administration and monitoring and evaluation
- Give an overview of next steps, in terms of changes expected to be implemented in 2020.

Coverage results are presented from all areas where Malaria Consortium implemented SMC in 2019, regardless of funding source.

METHODS

Definitions of coverage and data sources

For maximum protection, children should receive a full three-day course of SPAQ during all four monthly cycles in a seasonal round of SMC. At the population level, SMC should provide maximum coverage to extend protection as widely as possible among the eligible population in targeted areas.

In general, coverage can be defined as the number of people reached by services offered by a program as a proportion of the eligible target population. In the context of SMC, coverage can therefore be defined as the proportion of children who received SMC in each monthly cycle during the transmission season. It should be noted, however, that in a given population, SMC coverage can be defined in different ways. As receiving the first dose of SP and AQ alone is insufficient to provide full protection for the full duration of the high transmission season, coverage indicators should take into account adherence to all relevant components of SMC administration, including proportions of households visited by distributors, administration of Day 2 and 3 AQ by caregivers, and whether children received SMC in all monthly cycles. In this report, the following coverage indicators will be presented:

1) Compounds/households with eligible children visited by a community distributor
2) Day 1 SPAQ administered by community distributors to eligible children aged three to 59 months
3) Children who received a full three-day course of SPAQ (*among children who had received Day 1 SPAQ*)
4) Day 1 SPAQ administered by community distributors observing DOT (*among children who had received Day 1 SPAQ*)
5) Number of Day 1 SPAQ doses received per child over the course of the SMC round
6) Children who received Day 1 SPAQ during all four monthly SMC cycle.

We also considered, where possible, the proportion of ineligible children who received Day 1 SPAQ by monthly cycle.

All the above indicators were measured using data from multiple sources, which during 2019 included administrative program data, and data provided by independent coverage surveys commissioned by Malaria Consortium. Information recorded on *SMC Child Record Cards* kept by caregivers was also reported and compared with coverage indicator outcomes based on self-reports by caregivers in coverage surveys where applicable.

Administrative coverage

Administrative data was obtained in two ways. First, data were collected on routine monitoring forms, referred to as *Tally Sheets* (see **Appendix 1**), which are used by community distributors to record numbers of SPAQ doses administered each day. Supervisors and facility in-charges then compiled information from the *Tally Sheets* into *Daily Summary Forms* and *SMC End-of-cycle Reports*[iii]. Information was then aggregated by dedicated monitoring and evaluation staff at district and/or LGA

[iii] Note that in Burkina Faso, administrative data from Tally Sheets was not reported by health workers due to a strike. This data is therefore not available for 2019.

level, to allow calculations of the number of children treated in each country (and by state in the case of Nigeria) by cycle. Second, numbers of doses administered over all four monthly cycles by country were calculated using stock reconciliation data, by subtracting doses returned and doses wasted from doses distributed to the health district level in advance of SMC campaigns[iv]. Numbers of doses per country and state were then divided by four to give per cycle means. Both methods disaggregated calculations of doses administered by age range (i.e. three to <12 months and 12 to 59 months).

To calculate administrative coverage, the total number of doses administered in a given cycle was divided by the estimated target population of children aged three to <12 months, 12 to 59 months and three to 59 months (i.e. for each formulation of SPAQ, and overall) in the relevant implementation area based on data provided by national or state authorities. The same denominators of target population were used for calculations of administrative coverage using both methods[v]. Administrative coverage was expressed as a percentage of the estimated target population, both overall and disaggregated by age group.

The accuracy of coverage figures obtained using administrative data is dependent on the accuracy of both the numerator and the denominator. Accuracy of the denominator can be compromised because population estimates are often based on outdated census data. On the denominator side, while most community distributors across the three countries are literate and have received a basic education, some may still encounter difficulties completing the forms. Reliability of data on drugs administered by formulation is also dependent on distributors' ability to assess children's eligibility, in particular their age. Distributors may be under significant time pressure to deliver SMC in low-resource environments with underdeveloped infrastructure, and supervisors are not able to supervise all instances of drug administration or check the validity of all information recorded.

SMC Child Record Card

Coverage can also be calculated on the basis of *SMC Child Record Cards*, which are given to caregivers by community distributors the first time they administer SPAQ to a child each season. Caregivers are then asked to record administration of AQ doses 2 and 3 and to retain the card. Caregivers should produce the card during subsequent cycle visits and information on the card is updated. In previous years, it has been observed that *SMC Child Record Cards* have represented an unreliable data source, as their retention by caregivers can be low in some areas, and information recorded by caregivers on doses administered to children at home after distributor visits may be inconsistent.

Data on coverage of SPAQ doses from *SMC Child Record Cards* were obtained during EoR surveys. The proportion of eligible children for whom caregivers had a *SMC Child Record Card*, and the proportion of these cards on which the date of the last SMC cycle had been marked, were calculated for each of the three countries. While this report gives consideration to data from *SMC Child Record Cards* as a method for estimating coverage, this will be presented as a secondary coverage indicator.

Coverage surveys

In 2019, coverage surveys were implemented across all areas of Burkina Faso, Chad and Nigeria where SMC was implemented with the support of Malaria Consortium. The objective of these surveys is to

[iv] At the time of writing this report, stock reconciliation data from Katsina and Yobe states were not available.
[v] In Burkina Faso, where an additional cycle was administered as part of an implementation research study in the health district of Mangodara (with a target population of 41,195 children aged three to 59 months, of which 7,255 and 37,940 were aged three to <12 months and 12 to 59 months) in June 2019 ("cycle 0"), the mean target population was adjusted upwards to account for the additional demand for SPAQ.

retrospectively determine coverage by surveying caregivers of eligible children and asking them if their children received SPAQ during the previous monthly cycle or over the course of that year's SMC round. Before 2018, Malaria Consortium only commissioned end-of-round (EoR) coverage surveys for each country after the final monthly SMC cycle based on a multi-stage sampling protocol. These surveys were intended to administer a comprehensive questionnaire covering multiple aspects of SMC delivery not restricted to coverage, and their sampling methods were designed to return results that are representative of areas targeted for SMC. However, in order to draw rapid inferences as to the performance of the program, Malaria Consortium has, since then, added end-of-cycle (EoC) coverage surveys following cycles 1 to 3 in each of the three implementation countries.

Generic questionnaires for both types of survey were initially developed in English and translated into French for use in Burkina Faso and Chad. Questionnaires were further adapted by Malaria Consortium staff in each country according to the specific context, for example by changing terminology used to reflect differences in local administrative units or program terminology. Informed consent was sought from all survey participants in accordance with Malaria Consortium's policy on ethical research. All surveys were administered using Magpi, an electronic data collection platform for smartphones, and data were uploaded to a remote server after each day of data collection[vi]. **Figure 2** illustrates the sequence of coverage surveys conducted over the course of the SMC season.

Figure 2. Sequence of coverage surveys conducted over the course of the SMC season.

July					August					September					October				
cycle 1				EoC coverage survey	cycle 2				EoC coverage survey	cycle 3				EoC coverage survey	cycle 4				EoR coverage survey
1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4	

All coverage surveys were conducted independently by local research firms selected by Malaria Consortium through a competitive bidding process:

- Burkina Faso: Institut de Sciences & Techniques (INSTech)
- Chad: CSKG (cycle 1 EoC), Cible RH (cycle 3 EoC) and Institut de Sciences & Techniques (INSTech) (EoR)
- Nigeria: various independent consultants at the state level.

Lead researchers from those firms were trained by Malaria Consortium staff. The research firms subsequently recruited and trained data collectors, oversaw data collection and analysis, and submitted a final report to Malaria Consortium. An example of an EoR questionnaire can be found in **Appendix 3.** Final reports with detailed description of the methods used can be found attached to this report (**Appendices 4–6**). Brief summaries are presented below.

Only households with at least one child up to the age of 10 were eligible for inclusion in EoC and EoR surveys. Relevant questions for coverage indicators related to one randomly-selected eligible child aged three to 59 months per household, with the exception of certain LQAS surveys in Burkina Faso and Chad, in which data was also collected on non-eligible children aged five to ten years. Villages that were inaccessible or compounds in which residents refused or were unable to participate, or without a child aged under ten years, were resampled.

[vi] https://home.magpi.com/solutions/field-surveys/

All data collectors had completed at least a tertiary education and were fluent in at least one local language. Interviews were conducted in local languages using questionnaires provided by Malaria Consortium, with data collectors translating from the French or English questionnaire on the spot and assigning responses to pre-defined answer categories in Magpi.

End-of-cycle surveys

EoC coverage surveys were conducted following cycles 1 to 3 using lot quality assurance sampling (LQAS), a method for assessing programs by analyzing the data produced in a comparatively small sample. The LQAS method was developed in the 1920s for industrial quality control and has been recommended by WHO as a practical method for monitoring health interventions as it provides a rapid, simple, and statistically sound method for in-process coverage assessment. It is employed in situations where the performance of indicators at the sub-project level, not just at the level of the project as a whole, is of interest **[4]**.

In the context of public health programs, LQAS subdivides program implementation areas into smaller functional areas (e.g. wards or health facility catchment areas), which are referred to as "Supervision Areas" (SAs), with the aim of classifying whether SAs have or have not reached a predetermined coverage standard. The LQAS method results in the need for a relatively small sample per SA as it does not attempt to construct a precise estimate of population parameters (e.g. standard errors). Although this limits interpretation of findings at the SA level, the smaller sample size allows for surveys to be rapidly completed to inform actions for program improvements (for example, between monthly cycles in the case of SMC) **[5]**.

Typically, 80% coverage is used as the coverage standard for mass drug distribution campaigns such as SMC. LQAS also assumes a lower threshold of 50% below which SAs are classified as having failed the coverage target. The lower threshold of 50% is the commonly accepted standard in health intervention assessments and derives from the original industrial framework for which LQAS was developed. The decision rule determines how many units or respondents must meet a certain condition (or respond affirmatively to a given question) within each SA for it to be classified as having reached the coverage target. In the case of an 80% coverage target with a 50% lower threshold, and alpha and beta errors of 10%[vii], the decision rule is 13 out of a required sample of n=19[viii]. A sample size of 19 per SA is the standard generally recommended for LQAS surveys, and this was employed for all EoC surveys carried out by Malaria Consortium during 2019 **[6]**.

For the purposes of this report, LQAS can provide a summary of coverage at the state or national level, and interpretation of these findings is similar to that of conventional cluster surveys on the assumption that SAs are selected through random sampling, and that they are of approximately equal population size to ensure a representative sample. As a general rule, an LQAS survey of five SAs (with a combined sample size of 95) is considered the minimum useful size for assessing program performance indicators as this provides a degree of accuracy of ±10% **[6]**. As the purpose of this report is to provide an overview of coverage at the national and state levels, results on attainment of coverage thresholds by SA are not shown.

[vii] 'Alpha error' refers to the probability of classifying a SA as not having reached the coverage target when in fact, it did (i.e. false positives). 'Beta error' is the probability of classifying a SA as having achieved the coverage target, when in actual fact it didn't (i.e. false negatives).

[viii] See, for example, http://lqas.spectraanalytics.com/ for a tool that can be used to calculate sample size per SA based on the LQAS methodology.

Aims, objectives and indicators

The aim of the EoC surveys was to determine whether SAs had reached acceptable coverage, defined as the proportion of households with eligible children (aged zero to ten years) visited by a community distributor during the preceding monthly cycle as part of the SMC campaign. The surveys were designed to meet the following objectives:

- To assess coverage in terms of compounds/households visited, Day 1 SPAQ administered and full three-day course of SPAQ received
- To assess adherence to SMC guidelines
- To provide timely insights on implementation issues requiring adaptations in subsequent cycles.

The key indicators assessed were:

1) Compounds/households with eligible children visited by a community distributor
2) Day 1 SPAQ administered by community distributors to eligible children aged three to 59 months
3) Children who received a full three-day course of SPAQ (including Day 2 and Day 3 AQ) (*among eligible children who received Day 1 SPAQ*)
4) SPAQ administered by community distributors observing DOT (*among eligible children who received Day 1 SPAQ*).

Sampling

In Burkina Faso, for each monthly cycle, EoC surveys targeted a selection of 89 health facility catchment areas as SAs in the 23 health districts where Malaria Consortium implemented SMC in 2019 (**Table 3**). Health facilities were selected using random sampling, and the probability of selection was proportional to the population of each health district. In each health facility's catchment area, villages were assigned to three categories according to their distance from the health facility. A total of 19 households per health center catchment areas were then randomly selected from each of the three strata.

Table 3. Sampling frame end-of-cycle surveys, Burkina Faso.

Region	Health district	Number of health facilities	Number of compounds surveyed
Cascades	Mangodara	13	247
Centre	Baskuy	2	38
	Bogodogo	4	76
	Boulmiougou	4	76
	Nongremassom	1	19
	Signonguin	3	57
Hauts Bassins	Dafra	2	38
	Lena	2	38
Nord	Gourcy	4	76
	Seguenega	3	57

Region	Health district	Number of health facilities	Number of compounds surveyed
	Yako	6	114
Centre Nord	Kaya	4	76
	Kongoussi	4	76
Centre Ouest	Koudougou	6	114
	Leo	4	76
	Nanoro	3	57
	Reo	2	38
	Sapouy	3	57
Centre Sud	Manga	4	76
	Pô	3	57
Centre Est	Tenkodogo	3	57
Plateau central	Bousse	3	57
	Ziniaré	6	114
Burkina Faso (total)	**n=23**	**89**	**1,691**

In Chad, EoC surveys were carried out after cycles 1 and 3 only. It was not possible to conduct a survey after cycle 2 because a suitable contractor could not be engaged. All health districts across the four regions in which Malaria Consortium supports SMC delivery were divided into SAs of approximately equal population size, each covering the catchment areas of an average of three health centers. Within each SA, nine villages were randomly selected, from which a total of 19 compounds were randomly sampled (**Table 4**).

Table 3. Sampling frame end-of-cycle survey, Chad.

Region	Health district	Number of health facilities	Number of supervision areas	Number of compounds surveyed
Chari Baguirmi	Ba-Illi	9	3	57
	Bousso	11	4	76
	Dourbali	15	5	95
	Kouno	20	1	19
	Mandelia	16	6	114
	Massenya	4	5	95
Hadjer Lamis	Bokoro	21	6	114
	Gama	5	2	38
	Karal	10	3	57
	Mani	11	4	76
	Massaguet	16	5	95
	Massakory	17	6	114
Mayo Kebbi Est	Bongor	30	10	190
	Guelendeng	10	3	57
	Moulkou	10	3	57

Region	Health district	Number of health facilities	Number of supervision areas	Number of compounds surveyed
N'Djamena	N'Djamena Est	19	6	114
	N'Djamena Centre	17	6	114
	N'Djamena Nord	15	5	95
	N'Djamena Sud	20	7	133
	Toukra	11	4	76
Chad (total)	**n=20**	**233**	**94**	**1,786**

In Nigeria, each LGA was subdivided into wards, which were sampled as the SAs for the EoC surveys. The LQAS survey sampled 19 compounds across 528 wards in the five states where SMC was implemented. One household was surveyed per compound. This could be considered a representative sample that was approximately self-weighted, on the assumption that wards were of similar population size. This approach resulted in a target sample size of 10,032 households per cycle across the five states (Error! Reference source not found.).

Table 4. Sampling frame end-of-cycle surveys, Nigeria.

Region	Number of LGAs implementing SMC	Number of wards	Number of households surveyed per cycle
Jigawa	27	54	1,026
Katsina	4	43	817
Sokoto	23	254	4,826
Yobe	4	40	760
Zamfara	14	137	2,603
Nigeria (total)	**n=72**	**528**	**10,032**

The same sample frames were employed across cycles 1 to 3 in all three countries. There was some minor variation in the actual numbers of children sampled between surveys.

End-of-round surveys

Aims, objectives and indicators

The EoR surveys aimed to assess coverage defined as the proportion of eligible children that received SPAQ during each of the four monthly cycles of the 2019 SMC campaign. The surveys were designed to meet the following objectives:

- To assess coverage in terms of compounds/households visited, Day 1 SPAQ administered and full three-day course of SPAQ received during cycle 4
- To assess coverage in terms of children who received Day 1 SPAQ during all four monthly cycles
- To assess coverage in terms of number of Day 1 SPAQ received per child

- To assess adherence to SMC guidelines
- To assess program performance across the four monthly SMC cycles.

The key indicators assessed were:

1) Compounds/households with eligible children visited by a community distributor
2) Day 1 SPAQ administered by community distributors to eligible children (in terms of children who received Day 1 SPAQ at least once during 2019, and by monthly cycle)
3) Children who received a full three-day course of SPAQ (including Day 2 and Day 3 AQ) (*among eligible children who received Day 1 SPAQ*)
4) SPAQ administered by community distributors observing DOT (*among eligible children who received Day 1 SPAQ*)
5) Day 1 SPAQ received per child over the course of the SMC round (including proportion of children who received Day 1 SPAQ during all four SMC cycles).

Several other indicators relating to the full ingestion of drugs, general malaria prevention, and caregivers' knowledge of SMC were investigated. Full results can be found in detailed EoR survey reports summarizing findings from each country, which have been provided in **Appendices 4–6**. Only key coverage indicators are presented for the purposes of this report. Unless otherwise specified, estimates of coverage indicators were based on self-reported information provided by caregivers.

Sampling

EoR surveys employed multi-stage random samples of households in areas covered by Malaria Consortium's SMC program, and they were intended to achieve a representative sample of the target population at the state or country level, as appropriate to the country setting. Sampling protocols aimed to achieve a self-weighted sample with sampling units selected with probability proportional to size. Only at the last stage of sampling (i.e. at the compound level) was a constant number of eligible children (one child per household) selected. In all three EoR surveys, only one child was sampled for both questions related to coverage and adherence to the SMC guidelines. This method was statistically efficient, due to the likely high within-household correlation of coverage status among eligible children. In Chad and Burkina Faso, sample sizes were intended to give estimates of country-level coverage indicators accurate to ±3%. Sampling protocols differed by country due to country-specific reporting requirements, differences in administrative areas, and logistics.

In Burkina Faso, the health district of Mangodara, where an implementation research study was conducted, and the remaining 22 districts were sampled separately. Households in Mangodara were purposively oversampled, to give coverage estimates with a ±5% degree of accuracy. For the remaining 22 health districts, a two-stage sampling design was employed. Health supervision areas were chosen from among the 22 health districts proportional to the population size of each district. SAs were divided into areas of approximately equal size. Two clusters per SA, comprising 15 compounds, were randomly selected from among these subdivisions. Compounds in each cluster were sampled after selection of a random direction from the center of the cluster. One eligible child was sampled per compound, under the assumption that compounds contained similar numbers of eligible children. A total of 4,999 compounds were surveyed (**Table 6**).

Table 6. Sampling frame for end-of-round survey, Burkina Faso.

Region	Health district	Target number of compounds surveyed
Cascades	Mangodara	1,068
Centre	Baskuy	144
	Bogodogo	193
	Boulmiougou	209
	Nongremassom	170
	Signonguin	105
Hauts Bassins	Dafra	190
	Lena	170
Nord	Gourcy	175
	Seguenega	170
	Yako	194
Centre Nord	Kaya	169
	Kongoussi	166
Centre Ouest	Koudougou	198
	Leo	194
	Nanoro	182
	Reo	188
	Sapouy	180
Centre Sud	Manga	211
	Pô	210
Centre Est	Tenkodogo	176
Plateau central	Bousse	167
	Ziniaré	170
Burkina Faso (total)	**n=23**	**4,999**

In Chad, each district was classified as either urban or rural and sampling was carried out independently within those two strata. Initially, 72 health facility catchment areas were randomly selected from a total of 233 across the four regions where SMC implementation was supported by Malaria Consortium, with probability of selection proportional to the size of the catchment area populations. Next, five villages (or wards in urban areas) within health catchment areas were randomly selected with the aid of comprehensive village lists. Due to differences in the numbers of health facilities per district and their population size between urban and rural areas, the team aimed to survey ten compounds per ward in N'Djamena (urban) and three in villages outside the capital (rural). The target sample size was 2,500 compounds (**Table 7)**.

Table 7. Sampling frame for end-of-round survey, Chad.

Region	Health district	Number of health facilities	Number of supervision areas sampled	Number of compounds surveyed
Chari Baguirmi	Ba-Illi	9	3	65
	Bousso	11	4	65
	Dourbali	15	5	109
	Mandelia	20	6	130
	Massenya	16	5	109
	Kouno	4	1	22
Hadjer Lamis	Bokoro	21	6	131
	Gama	5	2	44
	Karal	10	3	65
	Mani	11	3	65
	Massaguet	16	5	109
	Massakory	17	5	109
Mayo Kebbi Est	Bongor	30	9	196
	Guelendeng	10	3	65
	Moulkou	10	3	65
N'Djamena	N'Djamena Est	19	6	230
	N'Djamena Centre	17	5	276
	N'Djamena Nord	15	5	230
	N'Djamena Sud	20	6	276
	Toukra	11	3	138
Chad (total)	**n=20**	**233**	**78**	**2,500**

In Nigeria, target sample sizes were specified in advance for each state, with 840 considered appropriate for estimating coverage at state level. Where two funding sources were used for SMC implementation in a given state, the target sample size was doubled (**Table 8**). The LGAs were randomly selected from amongst the LGAs currently covered by the program in each state, except for Katsina and Yobe states where all SMC implementing LGAs were selected to achieve the targeted sample size (due to the small number of LGAs covered by SMC administration in these states). Within LGAs, health facilities were then sampled at random. Communities were then randomly sampled from each health facility catchment area, and clusters of seven households were randomly selected from each community.

Table 8. Sampling frame for end-of-cycle surveys, Nigeria.

Region	Number of LGAs implementing SMC	Number of LGAs selected	Number of health facilities	Number of communities	Number of households surveyed
Jigawa[PF/DfID]	23	9	48	240	1,680
Katsina[GF/PF]	8	8	42	240	1,680
Sokoto[PF]	27	6	30	120	840
Yobe[GF]	4	4	24	120	840
Zamfara[PF/PMI]	14	6	30	120	840
Nigeria (total)	**76**	**33**	**174**	**840**	**5,880**

Funders: GF: Global Fund to Fight AIDS, Tuberculosis and Malaria; PF: philanthropic funding; DfID: Department for International Development, United Kingdom; PMI: President's Malaria Initiative.

Analyses of data from the EoR survey in Nigeria employed population size weights to account for the unequal probability of selection of households between states and LGAs **[7]**. While LGAs in each state differed significantly with respect to population size, each LGA had an equal probability of selection in the States of Jigawa, Sokoto and Zamfara. For example, in Sokoto, target populations of the 23 LGAs where SMC was administered in 2019 ranged from 18,985 (Binji) to 68,937 (Yabo). Sample sizes by state were not proportional to their target populations of eligible children. While Katsina is estimated to have had 394,397 eligible children, the survey sample size was double that of Sokoto, with 1,026,555 eligible children in LGAs targeted for SMC. To allow coverage indicators to be estimated for the SMC program in Nigeria as a whole, analyses employed population size weights by state, such that smaller states with larger relative sample sizes were not overrepresented.

Data analysis

Data from both EoC and EoR surveys were processed and analyzed by Malaria Consortium staff using STATA 16. Coverage was calculated using the proportion command, with 95% confidence intervals calculated using a logit transform. Population size weights were applied using the svy: command as appropriate for estimates of coverage indicators for Burkina Faso and Nigeria.

RESULTS

Administrative coverage

Malaria Consortium's 2019 SMC campaign aimed to reach 6,178,750 children per monthly cycle across the three implementation countries. Estimates of administrative coverage by cycle using the tally sheet method, and mean coverage over all cycles using both the tally sheet and stock reconciliation method for all eligible children (and those aged three to <12 months and 12 to 59 months), are shown in **Table 9**. The average number of SPAQ doses administered per cycle is also shown.

Using the tally sheet method, the number of doses administered by community distributors was 6,541,040 per cycle on average across all four cycles, corresponding to administrative coverage of 106.9%. Total numbers of doses administered and corresponding administrative coverage estimates were 1,442,127 (108.9%) for Burkina Faso; 1,053,146 (107.2%) for Chad; and 4,045,768 (104.5%) for Nigeria in the states where SMC administration took place with support from Malaria Consortium. Average administrative coverage was above 100% in all three countries. There was a general trend of increasing coverage cycle-by-cycle. Across all areas for which full data from Tally Sheets and on stock reconciliation were available, administrative coverage estimates based on stock reconciliation were marginally higher than those obtained from *Tally Sheet* data. This small discrepancy between the two types of estimate may be related to errors and inconsistencies in reporting of doses administered using *Tally Sheets*, or indicate that not all doses of SPAQ were delivered to health districts.

Mean administrative coverage estimates in 2019 for each country based on the tally sheet method was comparable with those found in 2018, when administrative coverage was estimated at 106.5% for Burkina Faso, 108.4% for Chad and 102.7% for Nigeria.

Table 9. Administrative coverage by cycle, by round, and age group (tally sheet and stock reconciliation methods)

Country and state		Age group	Target population	Tally sheet										Stock reconciliation	
				cycle 1		cycle 2		cycle 3		cycle 4		Mean		Mean	
				Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage
Burkina Faso		3– <12 months	**238,400**	N/A		N/A		N/A		N/A		**260,558**	**109.3%**	**238,400**	**100.5%**
		12–59 months	**1,085,441**									**1,181,569**	**108.9%**	**1,085,441**	**109.9%**
		3–59 months	**1,323,841**									**1,442,127**	**108.9%**	**1,323,841**	**108.2%**
Chad		3– <12 months	**172,819**	176,114	101.9%	178,224	103.1%	175,183	101.4%	178,498	103.3%	**177,005**	**102.4%**	**182,654**	**105.7%**
		12–59 months	**809,796**	833,025	102.9%	876,283	108.2%	906,957	112.0%	888,298	109.7%	**876,141**	**108.2%**	**883,455**	**109.1%**
		3–59 months	**982,616**	1,009,139	102.7%	1,054,507	107.3%	1,082,140	110.1%	1,066,796	108.6%	**1,053,146**	**107.2%**	**1,066,109**	**108.5%**
Nigeria	Jigawa	3– <12 months	**236,465**	242,834	102.7%	260,980	110.4%	265,270	112.2%	267,342	113.1%	**259,107**	**109.6%**	**264,694**	**111.9%**
		12–59 months	**1,011,546**	973,479	96.2%	1,037,905	102.6%	1,051,601	104.0%	1,048,514	103.7%	**1,027,875**	**101.6%**	**1,035,928**	**102.4%**
		3–59 months	**1,248,011**	1,216,313	97.5%	1,298,885	104.1%	1,316,871	105.5%	1,315,856	105.4%	**1,286,981**	**103.1%**	**1,300,622**	**104.2%**
	Katsina	3– <12 months	**70,576**	81,194	115.0%	82,319	116.6%	84,688	120.0%	86,193	122.1%	**83,599**	**118.5%**	**N/A**	
		12–59 months	**323,821**	337,107	104.1%	337,352	104.2%	342,415	105.7%	347,038	107.2%	**340,978**	**105.3%**		
		3–59 months	**394,397**	418,301	106.1%	419,671	106.4%	427,103	108.3%	433,231	109.8%	**424,577**	**107.7%**		
	Sokoto	3– <12 months	**183,699**	215,264	117.2%	241,620	131.5%	241,353	131.4%	240,696	131.0%	**234,733**	**127.8%**	**237,612**	**129.3%**
		12–59 months	**842,856**	874,981	103.8%	911,514	108.1%	911,538	108.1%	908,653	107.8%	**901,672**	**107.0%**	**906,203**	**107.5%**
		3–59 months	**1,026,555**	1,090,245	106.2%	1,153,134	112.3%	1,152,891	112.3%	1,149,349	112.0%	**1,136,405**	**110.7%**	**1,143,814**	**111.4%**
	Yobe	3– <12 months	**24,340**	25,155	103.4%	26,428	108.6%	26,465	108.7%	27,216	111.8%	**26,316**	**108.1%**	**N/A**	
		12–59 months	**111,675**	102,179	91.5%	108,781	97.4%	111,572	99.9%	113,611	101.7%	**109,036**	**97.6%**		
		3–59 months	**136,015**	127,334	93.6%	135,209	99.4%	138,037	101.5%	140,827	103.5%	**135,352**	**99.5%**		
	Zamfara	3–<12 months	**190,993**	192,357	100.7%	210,538	110.2%	214,415	112.3%	209,788	109.8%	**206,775**	**108.3%**	**210,257**	**110.1%**
		12–59 months	**876,322**	823,817	94.0%	856,120	97.7%	870,021	99.3%	872,758	99.6%	**855,679**	**97.6%**	**858,254**	**97.9%**
		3–59 months	**1,067,315**	1,016,174	95.2%	1,066,658	99.9%	1,084,436	101.6%	1,082,546	101.4%	**1,062,454**	**99.5%**	**1,068,511**	**100.1%**
	Total	3– <12 months	**692,937**	756,804	109.2%	821,885	118.6%	832,191	120.1%	831,235	120.0%	**810,529**	**117.0%**	**N/A**	
		12–59 months	**3,179,356**	3,111,563	97.9%	3,251,672	102.3%	3,287,147	103.4%	3,290,574	103.5%	**3,235,239**	**101.8%**		
		3–59 months	**3,872,293**	3,868,367	99.9%	4,073,557	105.2%	4,119,338	106.4%	4,121,809	106.4%	**4,045,768**	**104.5%**		
Total		3–59 months	**6,178,750**	**N/A**		**N/A**		**N/A**		**N/A**		**6,541,040**	**106.90%**	**N/A**	

Coverage surveys

1. Compounds/households with eligible children visited by a community distributor

According to EoC survey results, the percentage of compounds or households visited by community distributors during the first three monthly cycles was over 90% in all countries and states (**Table 10**). Proportions are shown with 95% confidence intervals (95% CI), and sample sizes.

Table 10. Compounds/households with eligible children visited by a community distributor.

Data source	Number of compounds surveyed	Number of compounds visited	Coverage (95% CI)
Burkina Faso (*23 health districts / **22 health districts exc. Mangodara)			
EoC: cycle 1*	2,070	2,038	98.5 (97.8–98.9)
EoC: cycle 2*	2,245	2,227	99.2 (98.7–99.5)
EoC: cycle 3*	2,357	2,350	99.7 (99.4–99.9)
EoR: At least 1 visit**	3,923	3,916	99.8 (99.7–99.9)
Burkina Faso (Mangodara health district only)			
EoR: At least 1 visit	1,063	1,662	100.0 (99.4–100.0)
Chad			
EoC: cycle 1	2,132	2,120	99.4 (99.0–99.7)
EoC: cycle 2	N/A	N/A	N/A
EoC: cycle 3	1,869	1,763	94.3 (93.1–95.3)
EoR: At least 1 visit	2,696	2,694	99.9 (99.7–100.0)
Jigawa			
EoC: cycle 1	5,214	5,085	97.5 (97.1–97.9)
EoC: cycle 2	4,590	4,537	98.8 (98.5–99.1)
EoC: cycle 3	5,521	5,497	99.6 (99.4–99.7)
EoR: At least 1 visit	1,633	1,518	93.3 (89.2–95.9)
Katsina			
EoC: cycle 1	1,653	1,637	99.0 (98.4–99.4)
EoC: cycle 2	1,626	1,605	98.7 (98.0–99.2)
EoC: cycle 3	1,650	1,627	98.6 (97.9–99.1)
EoR: At least 1 visit	1,690	1,633	96.9 (93.2–98.6)
Sokoto			
EoC: cycle 1	3,851	3,799	98.6 (98.2–99.0)
EoC: cycle 2	3,487	3,486	100.0 (99.8–100.0)
EoC: cycle 3	4,086	4,079	99.8 (99.6–99.9)
EoR: At least 1 visit	859	758	88.1 (86.5–89.5)
Yobe			
EoC: cycle 1	732	730	99.7 (98.9–99.9)
EoC: cycle 2	691	684	99.0 (97.9–99.5)
EoC: cycle 3	732	729	99.6 (98.7–99.9)
EoR: At least 1 visit	798	760	95.2 (90.0–97.8)

Data source	Number of compounds surveyed	Number of compounds visited	Coverage (95% CI)
Zamfara			
EoC: cycle 1	2,627	2,434	92.7 (91.6–93.6)
EoC: cycle 2	1,991	1,932	97.0 (96.2–97.7)
EoC: cycle 3	2,455	2,405	98.0 (97.3–98.5)
EoR: At least 1 visit	835	744	86.7 (70.8–94.6)
Nigeria (total, weighted proportion)			
EoR: At least 1 visit	5,815	5,413	89.4 (83.4–93.4)

In Burkina Faso, estimates of the proportion of households visited by a community distributor based on LQAS in 2018 were 96.9%, 97.9% and 99.2% over cycles 1 to 3 respectively (no EoR survey was available 2018). These proportions are comparable with findings from equivalent EoC surveys in 2019, which show that 98.5% to 99.7% of compounds received at least one visit in 2019. In Chad, meanwhile, the findings from EoR surveys show that this proportion increased from 96.4% in 2018 to 99.9% in 2019. The proportion of households visited at least once in 2019 was higher in all Nigerian states compared with 2018, with the exception of Jigawa, where there was a non-significant decline from 94.7% in 2018 to 93.3% in 2019.

In Nigeria, the lower coverage figures found by the EoR survey in Sokoto and Zamfara may reflect the logistical challenges of implementing campaigns in these states with larger distances between villages and compounds, as well as poor accessibility of remote areas especially during the rainy season. Estimates of proportions of households visited using data from EoR surveys were lower, which may be attributed to recall bias. The differences between the EoC and EoR results may also have been a result of questionnaire desig[ix]. In general, EoC and EoR results should be compared with caution due to differences in the sampling frames employed.

2. Day 1 SPAQ administered by community distributors to eligible children aged three to 59 months

EoC surveys showed high coverage in terms of Day 1 SPAQ administered by community distributors in cycles 1 to 3, with coverage rates consistently above 90% in Burkina Faso and Chad. Proportions of eligible children receiving SPAQ based on findings of EoR surveys were lower than 90% in the states of Sokoto and Zamfara in Nigeria (**Table 11**). This difference in findings between the EoC and EoR surveys may be a result of recall bias, selection bias introduced by data collectors, or differences in questionnaire design and sampling protocols. The finding of low coverage of Day 1 SPAQ administration in the states of Sokoto and Zamfara based on EoR coverage survey data are reflective of low coverage within specific LGAs: While Bodinga and Gada LGAs in Sokoto had coverage of less than 80%, Bugundu LGA in Zamfara had a coverage of 67.4% (95% CI: 59.1–74.7) compared with over 85% in all other sampled LGAs in that state. Overall, coverage of SPAQ administered by community distributors across the program in 2019 was comparable with that in 2018, if not marginally higher.

[ix] For example, EoC survey questions pertain to visits by community distributors during the previous week, whereas the EoR survey question wording does not contain a specific time reference.

Table 11. Day 1 SPAQ administered by community distributors to eligible children

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso (*23 health districts / **22 health districts exc. Mangodara)			
EoC: cycle 1*	2,070	1,925	93.0 (91.8–94.0)
EoC: cycle 2*	2,245	2,110	94.0 (92.9–94.9)
EoC: cycle 3*	2,357	2,233	94.7 (93.8–95.6)
EoR: At least 1 dose**	3,923	3,803	96.9 (96.4–97.4)
Burkina Faso (Mangodara health district only)			
EoR: At least 1 dose	1,063	1,029	96.8 (95.6–97.7)
Chad			
EoC: cycle 1	1,740	1,643	94.4 (93.2–95.4)
EoC: cycle 2	N/A	N/A	N/A
EoC: cycle 3	1,801	1,771	98.3 (97.6–98.8)
EoR: At least 1 dose	2,620	2,581	98.5 (98.0–98.9)
Jigawa			
EoC: cycle 1	5,214	5,029	96.5 (95.9–96.9)
EoC: cycle 2	4,590	4,528	98.6 (98.3–98.9)
EoC: cycle 3	5,521	5,450	98.7 (98.4–99.0)
EoR: At least 1 dose	1,633	1,463	89.8 (84.7–93.3)
Katsina			
EoC: cycle 1	1,653	1,627	98.4 (97.7–98.9)
EoC: cycle 2	1,626	1,601	98.5 (97.7–99.0)
EoC: cycle 3	1,650	1,597	96.8 (95.8–97.5)
EoR: At least 1 dose	1,690	1,576	93.8 (88.3–96.8)
Sokoto			
EoC: cycle 1	3,851	3,761	97.7 (97.1–98.1)
EoC: cycle 2	3,487	3,474	99.6 (99.4–99.8)
EoC: cycle 3	4,086	4,063	99.4 (99.1–99.6)
EoR: At least 1 dose	859	669	76.8 (76.8–76.8)
Yobe			
EoC: cycle 1	732	722	98.6 (97.5–99.3)
EoC: cycle 2	691	672	97.3 (95.7–98.2)
EoC: cycle 3	732	719	98.2 (97.0–99.0)
EoR: At least 1 dose	797	723	91.2 (83.9–95.4)
Zamfara			
EoC: cycle 1	2,627	2,400	91.4 (90.2–92.4)
EoC: cycle 2	1,991	1,905	95.7 (94.7–96.5)
EoC: cycle 3	2,455	2,363	96.3 (95.4–96.9)
EoR: At least 1 dose	835	719	84.1 (72.0–91.5)
Nigeria (total, weighted proportion)			
EoR: At least 1 dose	5,814	5,177	85.1 (78.6–89.9)

Tables 12 and 13 shows the coverage of Day 1 SPAQ per cycle in each country (and Nigerian state) based on data from EoR coverage survey only. The results for Burkina Faso show weighted proportions and confidence intervals to adjust for the purposive oversampling of eligible children in the health district of Mangodara.

Table 12. Day 1 SPAQ administered by community distributors to eligible children by cycle, end-of-round survey

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso (23 health districts, weighted proportion)			
EoR: cycle 1	4,986	4,375	87.2 (83.4–90.3)
EoR: cycle 2		4,469	88.7 (85.1–91.4)
EoR: cycle 3		4,488	90.0 (84.9–91.5)
EoR: cycle 4		4,453	89.3 (85.7–93.0)
Burkina Faso (Mangodara health district only)			
EoR: cycle 0	1,063	932	87.7 (85.6–89.5)
Chad			
EoR: cycle 1	2,696	1,686	62.5 (60.7–64.3)
EoR: cycle 2		1,850	68.6 (66.8–70.3)
EoR: cycle 3		1,945	72.1 (70.4–73.8)
EoR: cycle 4		1,914	71.0 (69.3–72.7)

Table 13. Day 1 SPAQ administered by community distributors to eligible children aged three to 59 months per cycle, end-of-round survey (Nigeria)

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Jigawa			
EoR: cycle 1	1,208	888	73.1 (68.1–77.6)
EoR: cycle 2		948	78.6 (73.1–83.2)
EoR: cycle 3		880	72.4 (63.6–79.8)
EoR: cycle 4		981	81.5 (73.7–87.4)
Katsina			
EoR: cycle 1	1,274	1,043	81.9 (74.6–87.4)
EoR: cycle 2		1,050	82.6 (75.1–88.3)
EoR: cycle 3		956	75.3 (68.4–81.1)
EoR: cycle 4		734	57.6 (48.9–65.9)
Sokoto			
EoR: cycle 1	657	353	56.9 (48.7–64.8)
EoR: cycle 2		422	63.0 (57.9–67.9)
EoR: cycle 3		395	58.6 (51.7–65.1)
EoR: cycle 4		379	58.2 (49.4–66.4)
Yobe			
EoR: cycle 1	473	353	75.4 (62.7–84.7)
EoR: cycle 2		370	78.4 (71.9–83.8)

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
EoR: cycle 3		352	74.8 (71.4–77.9)
EoR: cycle 4		294	62.1 (56.6–67.2)
Zamfara			
EoR: cycle 1	682	507	72.9 (62.7–81.1)
EoR: cycle 2		535	76.2 (63.1–85.8)
EoR: cycle 3		483	68.6 (54.6–79.9)
EoR: cycle 4		389	56.6 (44.2–68.2)
Nigeria (total, weighted proportion)			
EoR: cycle 1	4,934	3,169	69.4 (56.6–79.8)
EoR: cycle 2		3,325	73.7 (62.6–82.5)
EoR: cycle 3		3,066	67.3 (58.7–74.9)
EoR: cycle 4		2,777	62.5 (46.4–76.3)

According to data obtained by EoR data collectors from *SMC Child Record Cards*, in Burkina Faso 3,251 of 4,896 children sampled, or 67.9% (95% CI: 61.2–74.0; weighted data from 23 health districts) had record cards, of which 1,901 of 3,251, or 60.5% (95% CI: 51.5–68.8) contained a record of SMC administration in cycle 4. In Chad, *SMC Child Record Cards* were found for 1,634 of 2,620 children, or 62.4% (95% CI: 60.5–64.2) of the sample with available data. Of these 1,485 of 1,634 cards (90.9%; 95% CI: 89.3–92.2) indicated that these children had received SPAQ in cycle 4. In Nigeria, the weighted proportions of children with *SMC Child Record Cards* ranged from 67.8% (95% CI: 64.7–70.8) in Sokoto to 90.0% (95% CI: 82.4–96.7) in Yobe. Of those children with cards, the proportions whose cards indicated they had received SPAQ in cycle 4 ranged from 73.2% (95% CI: 66.3–79.1) in Sokoto to 85.4% (95% CI: 76.8–91.2) in Yobe. The proportions of children having received SPAQ based on information obtained from *SMC Child Record Cards* differed from those based on self-reporting, and, in the case of Sokoto and Yobe, was notably higher. The sample of respondents with record cards may not have been representative of all caregivers.

3. Children who received a full three-day course of SPAQ

Both types of surveys found that very few children did not receive the AQ doses on Day 2 and 3 from their caregivers, with little difference between Day 2 (**Table 14**) and Day 3 (**Table 15**). Coverage of Day 2 and 3 doses among children who had received Day 1 SPAQ in Burkina Faso and Chad across all surveys was universally over 95%. This was also the case for Nigeria, with the exception of Yobe State, where coverage was based on data from the cycle 1 EoC survey was 88.0% (95% CI: 85.4–90.1).

Table 14. Children who received Day 2 AQ from their caregiver.

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso (*23 health districts / **22 health districts exc. Mangodara)			
EoC: cycle 1*	1,978	1,955	98.8 (98.3–99.2)
EoC: cycle 2*	2,192	2,155	98.3 (97.7–98.8)
EoC: cycle 3*	2,293	2,258	98.5 (97.9–98.9)
EoR: cycle 4**	3,923	3,803	99.6 (99.3–99.8)

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso (Mangodara health district only)			
EoR: cycle 4	1,029	1,029	100
Chad			
EoC: cycle 1	1,570	1,550	98.7 (98.0–99.2)
EoC: cycle 2	N/A	N/A	N/A
EoC: cycle 3	1,771	1,735	98.0 (97.2–98.5)
EoR: cycle 4	2,581	2,524	97.8 (97.1–98.3)
Jigawa			
EoC: cycle 1	5,029	4,960	98.6 (98.3–98.9)
EoC: cycle 2	4,528	4,507	99.5 (99.3–99.7)
EoC: cycle 3	5,450	5,419	99.4 (99.2–99.6)
EoR: cycle 4	1,463	1,420	97.1 (95.4–98.2)
Katsina			
EoC: cycle 1	1,627	1,615	99.3 (98.7–99.6)
EoC: cycle 2	1,601	1,589	99.3 (98.7–99.6)
EoC: cycle 3	1,597	1,586	99.3 (98.8–99.6)
EoR: cycle 4	1,576	1,551	98.4 (97.1–99.2)
Sokoto			
EoC: cycle 1	3,761	3,721	98.9 (98.6–99.2)
EoC: cycle 2	3,474	3,466	99.8 (99.5–99.9)
EoC: cycle 3	4,063	4,054	99.8 (99.6–99.9)
EoR: cycle 4	696	664	95.1 (92.8–96.7)
Yobe			
EoC: cycle 1	722	635	88.0 (85.4–90.1)
EoC: cycle 2	672	665	99.0 (97.8–99.5)
EoC: cycle 3	719	713	99.2 (98.2–99.6)
EoR: cycle 4	723	718	99.1 (95.7–99.8)
Zamfara			
EoC: cycle 1	2,400	2,364	98.5 (97.9–98.9)
EoC: cycle 2	1,905	1,881	98.7 (98.1–99.2)
EoC: cycle 3	2,363	2,336	98.9 (98.3–99.2)
EoR: cycle 4	719	688	95.9 (93.7–97.3)
Nigeria (total, weighted proportion)			
EoR: cycle 4	5,177	5,041	96.2 (94.7–97.3)

Table 15. Children who received Day 3 AQ from their caregiver.

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso (*23 health districts / **22 health districts exc. Mangodara)			
EoC: cycle 1	1,978	1,934	97.8 (97.0–98.3)
EoC: cycle 2	2,192	2,137	97.5 (96.7–98.1)

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
EoC: cycle 3	2,293	2,251	98.2 (97.5–98.6)
EoR: cycle 4	3,802	3,786	99.6 (99.4–99.7)
Burkina Faso (Mangodara health district only)			
EoR: cycle 4	1,027	1,026	99.9 (99.3–100.0)
Chad			
EoC: cycle 1	1,563	1,514	96.9 (95.9–97.6)
EoC: cycle 2	N/A	N/A	N/A
EoC: cycle 3	1,771	1,711	96.6 (95.7–97.4)
EoR: cycle 4	2,581	2,487	96.4 (95.6–97.0)
Jigawa			
EoC: cycle 1	5,029	4,962	98.7 (98.3–99.0)
EoC: cycle 2	4,528	4,508	99.6 (99.3–99.7)
EoC: cycle 3	5,450	5,431	99.7 (99.5–99.8)
EoR: cycle 4	1,463	1,398	95.7 (93.6–97.1)
Katsina			
EoC: cycle 1	1,627	1,614	99.2 (98.6–99.5)
EoC: cycle 2	1,601	1,588	99.2 (98.6–99.5)
EoC: cycle 3	1,597	1,578	98.8 (98.1–99.2)
EoR: cycle 4	1,576	1,507	95.4 (88.0–98.3)
Sokoto			
EoC: cycle 1	3,761	3,694	98.2 (97.7–98.6)
EoC: cycle 2	3,474	3,453	99.4 (99.1–99.6)
EoC: cycle 3	4,063	4,045	99.6 (99.3–99.7)
EoR: cycle 4	696	655	93.7 (90.1–96.0)
Yobe			
EoC: cycle 1	722	636	88.1 (85.5–90.3)
EoC: cycle 2	672	663	98.7 (97.4–99.3)
EoC: cycle 3	719	716	99.6 (98.7–99.9)
EoR: cycle 4	723	704	97.0 (91.1–99.0)
Zamfara			
EoC: cycle 1	2,400	2,355	98.1 (97.5–98.6)
EoC: cycle 2	1,905	1,881	98.7 (98.1–99.2)
EoC: cycle 3	2,363	2,322	98.3 (97.7–98.7)
EoR: cycle 4	719	671	93.7 (91.2–95.6)
Nigeria (total, weighted proportion)			
EoR: cycle 4	5,177	4,935	94.4 (92.8–95.6)

Adherence to the third dose of AQ was marginally lower than that for the second dose. With the exception of the states of Yobe and Zamfara in Nigeria, adherence was above 95% in each monthly SMC cycle based on estimates from EoC and EoR surveys. In Yobe, the proportions of children who received second and third doses of AQ from caregivers were below 90% in cycle 1, but reached 99.6% by cycle 3. This may be explained by the fact that 2019 was the first year that Malaria Consortium had

supported SMC campaigns in the state, and increased over the course of the season, which may be indicative of greater sensitization of caregivers over time as they received further visits from community distributors. In all countries and states, administration of both Day 2 and Day 3 AQ was higher in 2019 than in 2018. However, these differences were not statistically significant.

According to data obtained from the EoR survey conducted in Nigeria, the main reasons given for not administering Day 2 AQ (based on the weighted average across all states surveyed) included "*the caregiver did not know or think it was necessary to administer AQ on Day 2 and 3*" (36.3%), "*the caregiver forgot about giving the Day 2 and 3 doses*" (34.1%), "*the child refused to take the same drug again*" (15.9%), and "*the child was sick following administration on Day 1*" (6.5%).

While these responses were given by relatively few caregivers, they suggest that communication on the necessity of follow-up doses on Day 2 and 3 to ensure the maintenance of prophylactic protection against malaria may still require improvement to ensure full adherence.

4. SPAQ administered by community distributors observing DOT

The EoC survey consistently showed high levels of adherence to DOT, as a proportion of children who had received Day 1 SPAQ. However, the EoR survey found significantly lower adherence rates. This was particularly noticeable in Sokoto, where 59.6% of doses were administered as DOT (**Table 16**). This represents an improvement compared with 2018, however, when less than one third of doses were administered as DOT.

Table 16. SPAQ administered by community distributors observing DOT.

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso (*23 health districts / **22 health districts exc. Mangodara)			
EoC: cycle 1	1,966	1,865	94.9 (93.8–95.8)
EoC: cycle 2	2,169	2,146	98.9 (98.4–99.5)
EoC: cycle 3	2,269	2,206	97.2 (96.5–97.8)
EoR: cycle 4	3,803	3,750	98.6 (98.2–98.9)
Burkina Faso (Mangodara health district only)			
EoR: cycle 4	1,029	1,023	99.4 (98.7–99.7)
Chad			
EoC: cycle 1	1,663	1,362	81.9 (80.0–83.7)
EoC: cycle 2	N/A	N/A	N/A
EoC: cycle 3	1,771	1,456	82.2 (80.4–83.9)
EoR: cycle 4	2,620	2,170	82.8 (81.3–84.2)
Jigawa			
EoC: cycle 1	5,029	4,323	86.0 (85.0–86.9)
EoC: cycle 2	4,528	3,989	88.1 (87.1–89.0)
EoC: cycle 3	5,450	4,562	83.7 (82.7–84.7)
EoR: cycle 4	1,463	874	56.5 (37.7–73.6)
Katsina			
EoC: cycle 1	1,627	1,409	86.6 (84.9–88.2)
EoC: cycle 2	1,601	1,387	86.6 (84.9–88.2)
EoC: cycle 3	1,597	1,389	87.0 (85.2–88.5)

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
EoR: cycle 4	1,576	1,186	74.6 (60.3–85.0)
Sokoto			
EoC: cycle 1	3,761	3,575	95.1 (94.3–95.7)
EoC: cycle 2	3,474	3,383	97.4 (96.8–97.9)
EoC: cycle 3	4,063	4,019	98.9 (98.5–99.2)
EoR: cycle 4	696	412	59.6 (54.1–64.9)
Yobe			
EoC: cycle 1	722	697	96.5 (94.9–97.6)
EoC: cycle 2	672	669	99.6 (98.6–99.9)
EoC: cycle 3	719	716	99.6 (98.7–99.9)
EoR: cycle 4	723	642	89.2 (81.8–93.9)
Zamfara			
EoC: cycle 1	2,400	2,064	86.0 (84.6–87.3)
EoC: cycle 2	1,905	1,626	85.4 (83.7–86.9)
EoC: cycle 3	2,363	1,833	77.6 (75.8–79.2)
EoR: cycle 4	719	513	70.5 (55.7–82.0)
Nigeria (total, weighted proportion)			
EoR: cycle 4	5,177	3,627	65.2 (53.9–75.0)

Adherence in Burkina Faso was particularly high (over 95%), and the proportion of SPAQ administered observing DOT in 2019 is similar to that reported in 2018. Adherence in Chad was over 80% in all monthly cycles. However, it varied widely between states in Nigeria. Reasons for non-adherence to DOT may include time pressure on community distributors, or cultural norms which may have prevented all-male distributor teams from entering households. Malaria Consortium recommends that at least 50% of community distributors be female, and that distributor pairs should be of mixed gender wherever possible.

5. Day 1 SPAQ received per child over the course of the SMC round and children who received Day 1 SPAQ during all four monthly SMC cycles

Day 1 SPAQ received per child and number of children who received Day 1 SPAQ during all four cycles could only be assessed through the EoR surveys. This does not take into account Day 2 and Day 3 AQ, so full protection cannot be presumed. **Tables 17 and 18** show the proportions of eligible children by country and state by number of Day 1 SPAQ doses received, in addition to the cumulative proportions of children who received SPAQ at least during a given number of cycles (fourth column). For example, in Chad, 98.5% of eligible children received Day 1 SPAQ during at least one monthly cycle, 78.5% received a dose of SPAQ in at least two cycles, and 47.2% received SPAQ in all monthly SMC cycles. The proportion of children who received all four monthly Day 1 SPAQ doses over the course of the SMC rounds ranged from 23.5% in Sokoto State to 83.5% in Burkina Faso.

Table 17. Proportions of eligible children aged three to 59 months by number of Day 1 SPAQ administered by community distributors during 2019, end-of-round survey (Burkina Faso and Chad)

Data source	Number of children surveyed	Number of children covered (by number of cycles)	Cumulative proportion (by number of cycles)	Percent (%) coverage (95% CI)
Burkina Faso (22 health districts exc. Mangodara)				
None	3,923	286	100	7.3 (6.5–8.1)
One		21	92.7	0.5 (0.3–0.8)
Two		80	92.2	2.0 (1.6–2.5)
Three		259	90.2	6.6 (5.9–7.4)
Four		3,277	83.5	83.5 (82.3–84.7)
Burkina Faso (Mangodara health district only)				
None	1,063	29	100	2.7 (1.9–3.9)
One		7	97.3	0.7 (0.3–1.4)
Two		28	96.6	2.6 (1.8–3.8)
Three		62	94.0	5.8 (4.6–7.4)
Four		66	88.2	6.2 (4.9–7.8)
Five		871	81.9	81.9 (79.5–84.1)
Chad				
None	2,619	39	100	1.5 (1.1–2.0)
One		523	98.5	20.0 (18.5–21.5)
Two		283	78.5	10.8 (9.7–12.1)
Three		538	67.7	20.5 (19.0–22.1)
Four		1,236	47.2	47.2 (45.3–49.1)

Table 18. Proportions of eligible children aged three to 59 months by number of Day 1 SPAQ administered by community distributors during 2019, end-of-round survey (Nigeria).

Data source	Number of children surveyed	Number of children treated (by number of cycles)	Cumulative proportion (by number of cycles)	Percent (%) coverage (95% CI)
Jigawa				
None	1,632	169	100.0	10.2 (6.1–16.5)
One		425	89.6	25.0 (14.4–39.8)
Two		84	63.6	5.0 (2.9–8.4)
Three		214	58.5	13.3 (8.3–20.6)
Four		740	45.3	46.6 (33.0–60.7)
Katsina				
None	1,690	113	100.0	6.1 (2.7–13.3)
One		416	93.3	25.3 (12.4–44.7)
Two		275	68.7	16.5 (9.7–26.6)
Three		315	52.4	18.7 (12.3–27.3)
Four		571	33.8	33.4 (22.1–46.9)

Sokoto				
None	856	160	100.0	19.4 (16.5–22.6)
One		202	81.3	24.1 (16.2–34.2)
Two		145	57.7	16.1 (12.9–20.0)
Three		148	40.8	16.5 (12.7–21.1)
Four		201	23.5	24.0 (17.2–32.4)
Yobe				
None	796	73	100.0	8.6 (2.5–25.6)
One		324	90.8	45.3 (8.8–87.7)
Two		73	50.1	7.4 (1.5–29.9)
Three		75	41.0	9.4 (6.9–12.8)
Four		251	31.5	29.3 (6.7–70.4)
Zamfara				
None	835	116	100.0	15.9 (6.7–33.5)
One		153	86.1	18.8 (12.1–27.9)
Two		116	67.8	12.6 (6.9–22.2)
Three		108	53.9	11.9 (6.2–21.7)
Four		342	41.0	40.7 (27.6–55.4)
Nigeria (total, weighted proportion)				
None	5,809	631	100.0	14.7 (10.0–21.1)
One		1,520	89.1	22.5 (17.4–28.5)
Two		693	63.0	12.1 (7.2–19.4)
Three		860	51.0	13.8 (10.6–17.8)
Four		2,105	36.2	36.9 (24.6–51.1)

6. SPAQ administered to ineligible children aged 5 and above

Table 19 shows the proportions of ineligible children aged five to ten years who received SPAQ, based on data from EoC surveys in Burkina Faso and Chad, where children in this age range were sampled. Sample sizes per survey are small, and it is not possible to draw any robust comparisons between cycles or between 2019 and 2018. The results for these two countries indicate that around 40% of ineligible children received SPAQ 2019.

Table 19. SPAQ administered to ineligible children aged five and above.

Data source	Number of children surveyed	Number of children covered	Percent (%) coverage (95% CI)
Burkina Faso			
EoC: cycle 1	338	125	37.0 (32.0–42.3)
EoC: cycle 2	320	148	46.3 (40.8–51.8)
EoC: cycle 3	257	114	56.0 (49.9–62.0)
Chad			
EoC: cycle 3	684	268	39.2 (35.6–42.9)

In Nigeria, children aged five to ten years were sampled by the EoR coverage survey in Jigawa state only, where it was found that 11.9% (95% CI: 8.9–15.7) of children in this age group had received SPAQ at least once in 2019.

The issue of determining age eligibility has been highlighted as a major area for improvement during training of supervisors, and they in turn have emphasized the importance of adhering to the SMC guidelines in interactions with community distributors. In addition to the general challenges in determining age as outlined above, the inability for all-male teams of community distributors to enter compounds in some areas may have also contributed to children over five being treated, as they may have been unable to determine age themselves. At the same time, distributors may have been influenced by caregivers to administer doses to ineligible children and may have been reliant on caregivers' self-reports of children's ages.

DISCUSSION, RECOMMENDATIONS & CONCLUSIONS

Discussion

Administrative program data shows very high coverage of SMC across all areas where Malaria Consortium implemented SMC in 2019. Coverage surveys also confirmed generally high coverage, with the proportion of eligible children receiving Day 1 SPAQ from a community distributor exceeding 80% in all countries and Nigerian states (except Sokoto, where coverage based on EoR survey data was 76.8%). Per cycle coverage exceeded 90% across all EoC surveys following cycles 1, 2 and 3. In Burkina Faso, it is very encouraging that, as in 2018, over 80% of children surveyed received Day 1 SPAQ during all four monthly SMC cycles.

Among those children who received Day 1 SPAQ, the proportion of those receiving Day 2 and Day 3 AQ from their caregivers was consistently over 90% across all monthly SMC cycles and countries. Adherence to DOT was also high, exceeding 90% for all surveys in Burkina Faso and 80% for all surveys in Chad. However, adherence varied markedly across Nigerian states.

Together, these outcomes suggest that the program successfully reached and large proportion of its target population of eligible children and was broadly successful in providing protection against malaria during the high transmission season.

It should be noted, however, that administration of SMC to children above the eligible age range continues to occur, especially in Chad and Burkina Faso where the proportion of older children receiving Day 1 SPAQ was around 40%, and that doses given to ineligible children were included in counts of total doses administered. Provision of SPAQ to children above the eligible age range not only diverts limited supplies of SPAQ from eligible children, it is unlikely to provide older children sufficient protection against malaria while at the same time may promote the development of anti-malarial drug resistance.

Coverage of Day 1 SPAQ and adherence to DOT were not uniformly high across all countries and states surveyed and were lowest in Sokoto. While self-reports by caregivers in the EoR survey indicated that 76.8% (95% CI: 76.8–76.8) of eligible children received Day 1 SPAQ at least once, the same survey found that 58.2% (95% CI: 49.4–66.4) were treated in cycle 4. Adherence to DOT, meanwhile, was 59.6% (95% CI: 54.1–64.9). One explanation for these findings, based on anecdotal reports by children's caregivers, was that in some areas community distributors administered Day 1 SPAQ from a fixed point (without a systematic method of informing caregivers) without direct observation of administration. To prevent such occurrences in future SMC rounds, training of community distributors should stress the need to visit each compound to ascertain the presence of eligible children, to re-visit each compound where families were found to be absent at an appropriate time of day, and the importance of DOT. Mechanisms for monitoring distributors should also be strengthened with more frequent supervision.

Use of *SMC Child Record Cards* for ascertaining the number of doses administered for each child has the potential to provide a more objective indicator of whether a given child has received SPAQ in each monthly cycle, when compared with self-reporting. Although retention of *SMC Child Record Cards* was relatively low in Burkina Faso (67.9%), Chad (62.4%) and most Nigerian states surveyed, the 90.0% retention of *SMC Child Record Cards* in Yobe State highlights the possibility of achieving widespread card retention and their potential utility for monitoring coverage indicators.

Recommendations relating to collection and use of administrative data, coverage surveys, program management and research are summarized in **Table 20** below.

Table 20. Recommendations resulting from 2019 SMC coverage report.

Program component	Recommendation
Administrative data	While *SMC Child Record Cards* may not themselves a reliable source of coverage data where retention and completion are poor, their use should be continued to support tracking of number of doses received per child. Although practicing the use of *Tally Sheets* is a key component of community distributors' and supervisors' training curriculum, it is likely that this is not always followed; there is therefore a need to reinforce the monitoring and evaluation of training. In Nigeria, Tally Sheets to be used in 2020 have been simplified for easier recording of doses provided. The importance of collecting administrative data should be emphasized to everyone involved in delivering the program. Alternative methods of enumerating households and estimating target populations should be explored in the absence of up-to-date official census data, for example the use of geospatial intelligence.
Coverage surveys	Improve the reliability of data by implementing automatic data validation during surveys through use of question restrictions. Translate questionnaires into local languages and ensure they are administered identically by all data collectors. Build a pool of reliable and experienced local research firms and consultants, in order to ensure timely data collection and strong adherence to sampling and data collection protocols. Improve enumeration of households to inform survey planning and reduce potential bias introduced by survey researchers during randomization of compounds. Implement forms for randomization of children within compounds as part of the mobile survey application to reduce selection bias. Strengthen training of data collectors in general, and with regard to determining children's age in particular. Refine and harmonize the terminology, sampling protocols, data collection methods and analyses across Malaria Consortium's SMC program, while allowing some flexibility for country-specific contexts. Encourage better use of LQAS to identify issues at the SA level, to facilitate timely decision making, and to inform content of training sessions for community distributors. Indicators measured by EoC surveys may be adapted to monitor a wider range of aspects of program delivery (beyond SMC coverage). Their findings may be employed to identify barriers to increasing coverage or adherence to SMC guidelines.
Program management	Strengthen communication provided to caregivers regarding the administration of Day 2 and Day 3 AQ.

Program component	Recommendation
	Strengthen communication provided to caregivers regarding the need to retain the *SMC Child Record Card*. Tailor training to respond to specific local challenges (e.g. by State, LGA, health district or SA) identified by surveys. Emphasize the importance of DOT to community distributors during training and supervision, particularly in areas where adherence was low. Mechanisms for monitoring distributors should be strengthened. Emphasize the importance of adhering to age eligibility criteria to community distributors during training and supervision. Perform regular evaluations of the performance of external contractors. Monitor and evaluate contextual factors such as local security, climatic events such as flooding, and health worker strikes, to contextualize findings from coverage surveys (for example, where coverage in a given area is low).
Research	Investigate determinants of caregivers' knowledge and acceptance of SMC, and adherence to administration of Day 2 and 3 AQ to eligible children.

Strengths and limitations

The use of independent coverage surveys allowed for evaluation of the program's performance and coverage of its target population by data collectors who had no involvement in program implementation. Not only did this reduce bias, it also allowed for external resources to be utilized to ensure that surveys were implemented in a timely manner. Strengths of our investigations of SMC program coverage include the relatively large sample sizes by country (or state in the case of Nigeria), which allowed coverage indicators to be estimated to a high degree of accuracy (of <5% for most indicators). Meanwhile, the self-weighting sampling design in Burkina Faso and Chad, with the number of clusters sampled by district proportional to the size of the target population, ensured that estimates of program coverage were representative of the populations targeted for SMC administration. In the case of Nigeria, where this was not possible, however, this issue was remedied with the use of population size weights in the analytical phase. This has allowed for coverage of Malaria Consortium's SMC program in Nigeria to be estimated as a whole.

Several limitations should be noted. First, target populations used for calculation of administrative coverage were estimated on the basis of official population figures, which were often based on outdated national census data and adjusted for projected population growth. For example, the last national censuses in both Burkina Faso and Nigeria took place in 2006. At the same time, while the population growth factors employed may have been inaccurate, estimates of population sizes could not adequately reflect population movements, for example due to migration or internal displacement. Administration of SPAQ to ineligible children above the targeted age range is also likely to have led to an overestimation of the proportion of children within the eligible age range who received SPAQ. As a result of the numerous limitations of using administrative data to measure coverage, it is possible

(and not uncommon) to achieve coverage of well over 100%. At the same time, population size weights used in analyses of EoR data from Burkina Faso and Chad relied on the same estimates of target populations.

One reported criticism of the data collection platform by data collectors was that there is no in-built function for randomization to select children within households. As a result, data collectors may not have applied a systematic randomization method across all households, and selection bias may have been introduced. At the village level, randomization involving random selection of a direction from a central point and sampling of compounds along a straight line may also introduce selection bias. Although convenient, "traditional" randomization procedures for surveying compounds within village clusters, based on selecting a random direction from the center of the cluster, and counting out compounds in that that direction to the boundary of the cluster, may introduce selection bias in terms of variation in the method's implementation between teams of data collectors and disproportionate probability of selection for households near the center of a cluster **[8]**. Alternative randomization methods could be explored, depending on the availability of accurate and up-to-date area mapping.

The primary limitation of coverage surveys is that they rely on self-reporting, and findings based on survey responses could be subject to recall and social desirability bias. Time elapsed from data of SMC administration to the date of the survey. This was particularly relevant for respondents in Mangodara, where the EoR survey occurred over six months following cycle 0, the additional fifth monthly SMC cycle implemented as part of an implementation research study in June. It was also problematic in Chad, where the EoR survey was only conducted in January due to challenges in engaging a suitable supplier. Length of time between administration of SMC and coverage surveys may influence the severity of recall bias.

Neither EoC or EoR questionnaires could identify instances where children received SPAQ, but were ineligible for SMC for reasons other than age, for example because of illness at the time or known history of allergies. In addition, questionnaires were unable to verify children's' eligibility independently of caregivers' self-reports and estimates of coverage indicators were intended to pertain eligible children only. Both these issues may have led to incorrect specification of the analytic sample. Questionnaires also did not attempt to measure provision of SMC through health workers for children who were referred with fever to a health facility and tested negative for malaria. The data collection platform's in-built data validation was limited, and appropriate question restrictions were not always automatically applied. Although likely to have occurred infrequently, this may have allowed data collections to enter impossible combinations of responses. Language and translation present further opportunities for introducing bias, especially as questionnaires were only provided in English and French. Interpretations and understanding of questions, and their translations of questions into local languages such as Hausa and Arabic, may have differed between data collectors, thereby introducing bias.

Implementing coverage surveys with close involvement and quality control by Malaria Consortium staff might address quality issues. However, this would also introduce reporting bias in favor of higher coverage. We therefore decided to rely on independent surveys conducted by third parties. However, it should be noted that this may pose different challenges. This was particularly the case in Chad, where capacity of local research firms to execute large-scale surveys is relatively low. Due to inability to engage a suitable contractor no cycle 2 EoC survey was carried out. The EoR survey was also delayed as it was necessary to contract the same research firm from Burkina Faso which also conducted that country's EoR survey. Reports submitted by external research firms were of variable quality, gave disproportionate attention to descriptions of operational challenges for SMC administration, and

often omitted key information relating to sampling procedure and data analysis methods; particularly relating to how analytic samples were defined for each outcome investigated.

Challenges were also reported in the use of mobile devices while administering surveys. These primarily related to poor internet connection, upload speed, operating system instability and crashes, and ease-of-use of the data collection application.

Improvements are also needed in terms of harmonized analysis and presentation of data. In 2019, each Malaria Consortium country team and each external research firm analyzed and reported results independently. Methods of analysis used in reports provided by external research firms may have differed, and their results may not be directly comparable. To address this, data were re-analyzed, and the descriptive analyses presented in this coverage report were performed using consistent methods for defining the analytic samples for each indicator. We have strengthened capacity for measuring capacity at the programme level and aim to have a more harmonized approach across countries in 2020.

It should also be noted that the two types of surveys (employing LQAS and multi-stage cluster sampling in EoC and EoR surveys respectively) served different purposes, used different methods and operationalized coverage differently. It is uncertain whether results based on these two different sampling methods may be directly compared.

Next steps

From 2020 onwards, following the signing of a memorandum of understanding (MOU) with the country's malaria programme, Malaria Consortium is planning to provide support to the ongoing SMC program in Togo, which was initiated in 2013 and has to date received funding from UNICEF and Global Fund. The 2020 campaign is expected to comprise four monthly SMC cycles covering a projected target population of 476,357 children aged three to 59 months in the three northernmost regions of Centrale, Kara and Savanes. Malaria Consortium's support will include strengthening monitoring and evaluation of the SMC program, including independent coverage surveys.

As part of our strategic focus on evidence, Malaria Consortium is currently developing a monitoring and evaluation framework for its SMC program, which is expected to be implemented in 2020. The framework will specify a range of indicators relating to program inputs, outputs, outcomes, and impacts, which will align with key program quality standards, which are also currently in development. It will be employed not only to evaluate the effectiveness of a range of program elements, but also to inform future improvements in program delivery. Related to this is the use of survey data; where further consideration will be given as to how survey findings can be used to identify issues and make timely adaptations to program delivery.

Malaria Consortium has recently started preparatory work for testing a satellite-based spatial intelligence tool called Reveal, for use in its SMC program. Possible applications include improving enumeration of target populations **[9]**, randomization of areas for sampling, identification of unserved areas or populations, and tracking of eligible children over time.

To better meet needs for future surveys, Malaria Consortium is evaluating data collection platforms currently available on the market on the dimensions of reliability, upload speed, cost, user-friendliness, user-support, and other features including options for data validation and randomization of children within households.

Studies of the impact of SMC in Burkina Faso, Chad and Nigeria, including primary analyses based on collection of data on suspected and confirmed malaria cases and secondary analyses employing routine data available through Health Management Information Systems (HMIS), are ongoing.

Finally, Malaria Consortium will continue to monitor the status of the global COVID-19 pandemic and evolving security situation across countries and regions reached by its SMC program, and will draw up necessary contingency plans and make relevant adjustments to, program delivery, monitoring and evaluation, and research activities.

REFERENCES

1. World Health Organization. WHO policy recommendation: seasonal malaria chemoprevention (SMC) for Plasmodium falciparum malaria control in highly seasonal transmission areas of the Sahel sub-region in Africa. Geneva, Switzerland; 2012.

2. World Health Organization. Seasonal Malaria Chemoprevention with Sulfadoxine–Pyrimethamine Plus Amodiaquine in children: A field guide. Geneva: World Health Organization, 2013.

3. World Health Organization. World malaria report 2018. Geneva, Switzerland; 2018.

4. MEASURE Evaluation, Macro International Inc., John Snow Research and Training Institute, Tulane University. Report of a technical meeting on the use of Lot Quality Assurance Sampling (LQAS) in polio eradication programs. Chapel Hill, NC; 1998.

5. UNICEF, Liverpool School of Tropical Medicine. LQAS detailed implementation plan v1.0 Jun 2012. Liverpool, UK: LSTM; 2012.

6. CORE Group. LQAS frequently asked questions. Washington, D.C.: CORE Group Inc.; 2008.

7. European Social Survey. Weighting European Social Survey data. London, United Kingdom: European Social Survey; 2014.

8. Grais RF, Rose AM, Guthmann JP. Don't spin the pen: two alternative methods for second-stage sampling in urban cluster surveys. Emerging Themes in Epidemiology 2007; 4: 8.

9. Bridges DJ, Pollard D, Winters AM, Winters B, Sikaala C et al. Accuracy and impact of spatial aids based upon satellite enumeration to improve indoor residual spraying spatial coverage. Malaria Journal 2018; 17(1): 93.

APPENDICES

Appendix 1: SMC Tally Sheet

Appendix 2: End-of-cycle survey questionnaire

Appendix 3: End-of-round survey questionnaire

Appendix 4: End-of-round survey report, Burkina Faso

Appendix 5: End-of-round survey report, Chad

Appendix 6 End-of-round survey report, Nigeria