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Coverage and quality of seasonal malaria chemoprevention supported by Malaria Consortium in 2021:

Results from Burkina Faso, Chad, Mozambique, Nigeria, Togo, and Uganda

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Established in 2003, Malaria Consortium is one of the world's leading non-profit organisations specialising in the prevention, control and treatment of malaria and other communicable diseases among vulnerable populations. Our mission is to improve lives in Africa and Asia through sustainable, evidence-based programmes that combat targeted diseases and promote child and maternal health.

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Acronyms and abbreviations

95% CI	95 percent confidence intervals
ACCESS-SMC	Achieving Catalytic Expansion of Seasonal Malaria Chemoprevention in the Sahel
AQ	amodiaquine
COVID-19	Coronavirus disease (2019)
CI	confidence interval
CISM	Centro de Investigação em Saúde de Manhiça
DHS	Demographic and Health Surveys
DOT	directly observed therapy
EoC	end-of-cycle
EoR	end-of-round
GF	Global Fund to Fight AIDS, Tuberculosis and Malaria
IPC	infection prevention and control
INSTech	Institut de Sciences & Techniques
KOICA	Korea International Cooperation Agency
LGA	local government area
LQAS	lot quality assurance sampling
M&E	monitoring and evaluation
PMI	President's Malaria Initiative
SA	supervision area
SP	sulfadoxine-pyrimethamine
SPAQ	sulfadoxine-pyrimethamine and amodiaquine
SMC	seasonal malaria chemoprevention
WHO	World Health Organization
UNICEF	United Nations International Children's Emergency Fund

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 against malaria to at-risk populations during this period of high transmission. The World Health Organization currently recommends a single dose of sulfadoxine-pyrimethamine (SP) in combination with three daily doses amodiaquine (AQ) to children over 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 SMC to be safe, feasible, effective, and cost-effective in children under five.

SMC is typically delivered door-to-door over a period of four days by trained community distributors during each month for four monthly SMC cycles during the rainy season (and, in some cases, five cycles). The first dose of SP and AQ ('day 1 SPAQ') is given under the supervision of the community distributors, 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 reactions to SPAQ. 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 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 as follows:

- To outline methods employed by Malaria Consortium for monitoring coverage of its SMC program and quality of SMC delivery in 2021
- To provide a summary of program coverage and degree of adherence to the program's protocols in 2021
- To provide recommendations on potential adaptations to approaches for SMC coverage surveys and monitoring and evaluation activities for the 2022 campaign.

A note about this report

SMC was introduced in Nampula province in Mozambique in November 2020. This 2021 quantitative report on Malaria Consortium's SMC program covers the period from November 2020 to October 2021, inclusive.

Malaria Consortium's SMC program in 2020/21

In 2021, Malaria Consortium supported SMC in Burkina Faso, Chad, Mozambique, Nigeria, Togo, and Uganda, covering a target population of 12,191,005 children 3–59 months. In Mozambique and Uganda, SMC was introduced in 2020/21 as part of studies to assess the acceptability, feasibility, and effectiveness of SMC in areas with elevated prevalence of markers of resistance among circulating *Plasmodium falciparum* parasites.

Methods

In addition to estimating administrative coverage in Burkina Faso, Chad, and Nigeria based on routine monitoring forms — referred to as SMC tally sheets — and SPAQ stock reconciliation data, program coverage in all four 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, 2, and 3 (where possible) to enable implementing teams to identify areas of low coverage and other issues in SMC delivery, and to rapidly take corrective actions to improve SMC delivery in subsequent cycles. Surveys were completed within two weeks of the completion of the SMC cycle.
- Comprehensive end-of-round (EoR) surveys (which took place within eight weeks of completion of cycle 4) to assess SMC performance across all monthly cycles in which SMC was delivered.

In some regions of Burkina Faso, in the Nigerian states of Kogi, Nasarawa, and Plateau, and in the Karamoja region of Uganda, five cycles of SMC were delivered during 2020.

EoC surveys were carried out after cycles 1 (in states with five cycles), 2, 3, and 4 in Nigeria; cycles 1, 2, 3, and 4 in Burkina Faso (with a cycle 1 survey in areas with five cycles); cycles 2 and 3 in Chad; and in cycle 2, in both Mozambique and Uganda in areas where SMC was introduced. In Togo, EoC surveys were conducted in Mô district in the Centrale region in cycles 1–3, and in the district of Kozah, in cycle 3. A nationally representative EoR survey in areas where SMC was delivered in 2020/21 was also conducted in the last cycle in all five countries; in Burkina Faso, however, the survey was not nationally representative as it was conducted in the commune of Ipelcé in the region of Centre-Sud only. 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 who received SMC per cycle, and eligible children who received SPAQ in all four cycles. We also investigated the proportions of children who received SMC and 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 proportion of ineligible children aged five to ten years who had received SMC, and the proportion who received day 1 SPAQ by sources other than home visits by community distributors.

Results

Administrative coverage

Administrative coverage was consistently high across all five countries in 2021, and comparable with that in previous years spanning 2018–2020. Administrative coverage was estimated based on SMC

tally sheets in Nigeria, Burkina Faso, and Togo, and based on stock reconciliation data in Chad, Mozambique, and Uganda where tally sheet data were not available for 2021.

Data on doses of SPAQ administered by community distributors show that an average of 12,059,501 doses were provided in each cycle across Burkina Faso, Chad, Nigeria, Togo, and Uganda based on combined results from SMC tally sheets and stock reconciliation data.

End-of-cycle and end-of-round surveys

The results of our analyses based on coverage survey data showed that the program achieved high coverage across all cycles and countries — despite adaptations to SPAQ delivery made in response to COVID-19 infection prevention procedures — of over 90 percent, 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

- Coverage of eligible children was high, with between 98.9 percent and 99.1 percent of eligible children 3–59 months receiving day 1 SPAQ from community distributors during home visits based on EoC surveys of all districts targeted in cycles 2, 3, and 4 (which included all districts reached by Malaria Consortium in Burkina Faso).
- Among those children who received day 1 SPAQ, 96.8 percent, 96.5 percent, and 96.3 percent received both day 2 and day 3 AQ from caregivers during cycles 2, 3, and 4, respectively.
- Community distributors observed DOT for over 93 percent of all SPAQ doses administered across all surveys of the 2021 SMC round.
- The results of the EoR survey, which was representative of the commune of Ipelcé (in the region of Centre-Sud) only, show that 93.8 percent of eligible children received day 1 SPAQ during each of the four monthly cycles.

Chad

- Coverage in terms of provision of day 1 SPAQ by a community distributor was 93.2 percent in cycle 2, 94.7 percent in cycle 3, and 95.1 percent in cycle 4; of these children, over 96 percent received both day 2 and day 3 AQ in all cycles.
- Adherence to DOT was observed for 82 percent of all children who received day 1 SPAQ in cycle 4 based on the EoR survey; this proportion was over 90.3 percent in both cycles 2 and 3 according to EoC surveys.
- The EoR survey showed that that 83.5 percent of eligible children received SPAQ in all four cycles during 2021.

Mozambique

- SMC was delivered in two districts in Nampula province (Malema and Mecubúri) between November 2020 and February 2021 as part of a study on introduction of SMC to Mozambique.
- In cycles 2 and 4, 85.2 percent and 85.8 percent of eligible children received day 1 SPAQ.
- In cycles 2 and 4, 93.7 percent and 98.3 percent of children who received day 1 SPAQ received both day 2 and day 3 AQ.

- Community distributors observed DOT for 83.4 percent of SPAQ doses administered in cycle 4.
- The results show that 77.0 percent of eligible children received day 1 SPAQ during each of the four monthly cycles.

Nigeria

- Five SMC cycles were delivered in Kogi, Nasarawa, and Plateau states, while four were delivered in Bauchi, Borno, Kebbi, and Sokoto.
- Results of EoR surveys show that across the seven states where SMC was supported by Malaria Consortium, 96.4 percent of eligible children received day 1 SPAQ from a community distributor in the final cycle (cycle 5). Coverage varied between states, ranging from 95.4 percent in Borno (where SMC was newly introduced in 2021) to 99.2 percent in Kebbi.
- Among those children who received day 1 SPAQ, the proportion who received both day 2 and day 3 AQ exceeded 95percent across all states in the EoR and all EoC surveys.
- The EoR survey results showed that, in cycle 5, adherence to DOT among community distributors was 90.6 percent across all seven states.
- The population-weighted proportion of eligible children receiving day 1 SPAQ during each of the cycles delivered was 65.8 percent across the three states with five cycles, and 77.8 percent across the four states with four cycles.

Togo

- During cycle 4, 95.4 percent of eligible children received day 1 SPAQ from a community distributor.
- Among those children who received day 1 SPAQ, 98.1 percent received both day 2 and day 3 AQ in cycle 4.
- Community distributors observed DOT for 83.4 percent of SPAQ doses administered in cycle 4.
- The results show that 70.2 percent of eligible children received day 1 SPAQ during each of the four monthly cycles.

Uganda

- SMC was delivered in the districts of Kotido and Moroto in the Karamoja region as part of a study.
- In cycles 2 and 4, 98.7 percent and 99.4 percent of children who received day 1 SPAQ received both day 2 and day 3 AQ.
- In cycles 2 and 4, 96.1 percent and 95.9 percent of eligible children received day 1 SPAQ.
- Community distributors observed DOT for 97.0 percent of SPAQ doses administered in cycle 4.
- Among eligible children, 82.2 percent received day 1 SPAQ during each of the four monthly cycles.

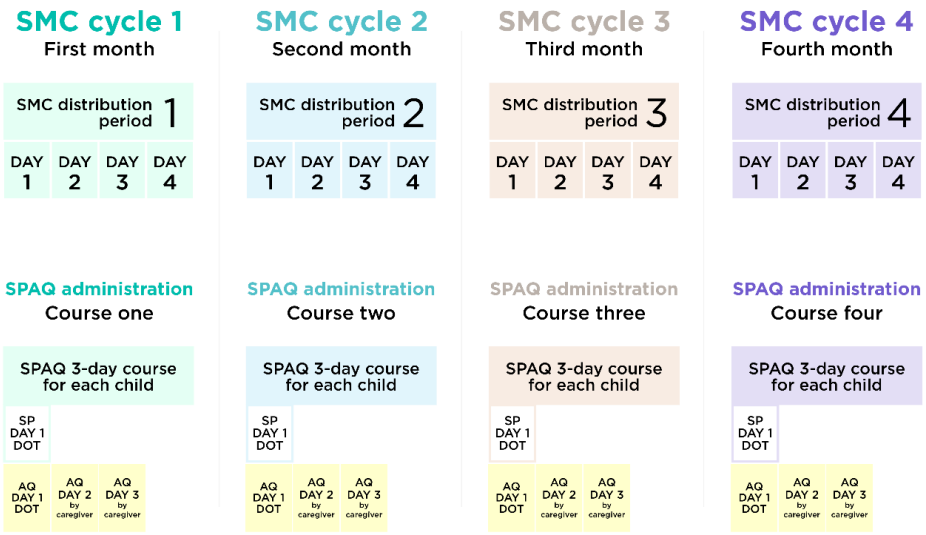
1. Introduction

Across the Sahel regions of sub-Saharan Africa, most malaria cases and deaths occur during a three- to five-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 3–59 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'.[1,2]

WHO classifies areas eligible for SMC as those in which over 60 percent 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 protective efficacy remains above 90 percent.[1,3]

SMC is typically delivered in yearly rounds of four cycles during the peak of the rainy season, approximately July to October in the Sahel, with distribution periods approximately 28 days apart (timing of SMC delivery in other locations, such as in the Southern Hemisphere, should reflect differences in timing of the rainy season). In some areas, SMC is now delivered in an additional cycle. Burkina Faso, Nigeria, and Uganda, for example, have five cycles. SPAQ is distributed through door-to-door campaigns by volunteer community distributors, who in most settings receive a stipend, during a SPAQ distribution 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 comprise a pair of community 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 in areas with four cycles



Each monthly SPAQ course consists of one single dispersible tablet of SP and three daily dispersible tablets of AQ. There are two doses of SPAQ: a lower dose for children three to <12 months, and a higher dose for children 12–59 months.

A dose of SP and the first dose of AQ ('day 1 SPAQ') is 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 all of the dispersed tablets without spitting them out or vomiting. This is referred to as directly observed therapy (DOT). Children who vomit or spit out most of the medicine within 30 minutes should be given one replacement dose of SP and AQ by distributors. The remaining two doses of AQ are administered by the caregiver once per day (every 24 hours) over the following two days ('day 2 AQ' and 'day 3 AQ'). Community 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 or contact the community distributor by mobile phone to receive a replacement dose.

According to WHO guidelines,[1,2] SPAQ should not be administered to children with an acute febrile illness who: test positive for malaria; are severely ill; are unable to take oral medication; are receiving co-trimoxazole prophylaxis; have taken a single dose of either SP or AQ, or any sulfamide-containing medicine during the past four weeks; or have a known allergy to either SP or AQ, or a known allergy to sulfamide-containing medicines such as co-trimoxazole. SMC with SPAQ should not be administered to children outside the eligible age range of 3–59 months. For older children, the formulations specified above are unlikely to provide sufficient antimalarial drug concentrations in the blood to provide protection throughout the 28-day period of each cycle 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 SPAQ 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. Community distributors are given training on methods to determine a child's age; however, administration of SPAQ to children outside the eligible age range is still reported to be common. Furthermore, community distributors may come under pressure from caregivers to administer SPAQ to older children because SMC is seen as an effective protection from malaria.[4]

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. If the test result is positive, they should be treated for malaria as per national treatment guidelines.

1.1. Malaria Consortium's SMC program in 2020/21

Malaria Consortium has been involved in implementation of 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.

The total target population covered by SMC programs supported by Malaria Consortium in 2021 was 12,191,005 in areas in Burkina Faso, Chad, Mozambique, Nigeria, Togo, and Uganda. These were funded or co-funded using philanthropic donations. This is comparable with 2020.[5] In Mozambique in 2020/21, and Uganda in 2021, SMC was delivered as part of a study on acceptability, feasibility, and effectiveness of SMC in limited areas of one province or region, respectively.

Five SMC cycles were delivered during the 2021 SMC round in some areas of these countries with longer high-transmission seasons. For the purposes of this report, in countries with five cycles, this additional is referred to as 'cycle 1,' while the final cycle in areas with five cycles is referred to as 'cycle 5'; in areas in Burkina Faso and Nigeria with four cycles, the first cycle of the SMC round is referred to as 'cycle 2'.In Burkina Faso, an additional cycle was delivered in 2021 in the Cascades and Hauts Bassins regions (except the district of Dande); and in Pô district, Centre-Sud region. The situation in 2021 contrasts with 2020 when five cycles were delivered Mangodara district in the Cascades region only.[6] In Nigeria, the states of Kogi, Nasarawa, and Plateau received five cycles and the states of Bauchi, Borno, Kebbo, and Sokoto received four. In Uganda, all SMC was delivered in five cycles in all areas receiving SMC (Kotido and Moroto districts). SMC was delivered in four cycles in Chad, Togo, and Mozambique. Countries and regions covered by Malaria Consortium's SMC program in 2020/21, dates of SMC rounds, and estimated target populations are shown in **Table 1**, alongside primary funders of SMC delivery in each Nigerian state.

Table 1: Malaria Consortium's SMC program in 2021 by number of children targeted for SMC delivery and funder

Country	Areas covered and funder	Number of children targeted (mean per cycle)
Burkina Faso (June–October 2021)	29 health districts in nine regions: Cascades,[PF] Centre,[PF] Hauts Bassins,[PF] Nord,[PF] Centre Nord,[UNICEF/PF] Centre Ouest,[PF] Centre Sud,[PF] Centre Est,[PMI] and Plateau Central[PF]	2,021,753 (cycles 2–5), of which 104,139 jointly supported by UNICEF
Chad (July–October 2021)	26 health districts in six regions: Barh el Gazel,[PF] Batha,[PF] Chari Baguirmi,[PF] Hadjer Lamis,[PF] Mayo Kebbi Est,[PF] N'Djamena[PF]	1,080,566
Mozambique (November 2020 – February 2021)[1]	Two districts (Malema and Mecubúri) in one region: Nampula[PF]	114,276
Nigeria (June–October 2021)	129 local government areas (LGAs) in seven states: Kogi,[PF] Nasarawa,[PF] Plateau,[PF] Bauchi,[KOICA/PF] Borno,[PF] Kebbi,[PF] Sokoto[PF]	8,399,151 (cycles 2–5), of which around 260,000 supported by KOICA in two LGAs
Togo (July–October 2021)	19 health districts in one of the country's three SMC-eligible regions: Savanes,[UNICEF/PF] Kara,[GF/PF] Centrale[GF/PF]	489,389
Uganda (May–September 2021)	Two districts (Kotido and Moroto) in one region: Karamoja[PF]	85,870
Program (total)		**12,191,005**

GF: Global Fund to Fight AIDS, Tuberculosis and Malaria; PF: philanthropic funding; PMI: President's Malaria Initiative; KOICA: Korea International Cooperation Agency; UNICEF: United Nations International Children's Emergency Fund.
[1]SMC was introduced in Nampula province in Mozambique in November 2020 (to February 2021); the results shown in this table are, therefore, representative of the period from November 2020 to October 2021, inclusive, overall.

Of the 12,191,005 mean children targeted per cycle for SMC delivery with support from philanthropic funding, a population of 300,258 children in Savanes region in Togo was targeted for SMC delivery with co-funding from the Global Fund, and a population of 292,270 in Burkina Faso and

Togo was targeted with co-funding from the United Nations International Children's Emergency Fund (UNICEF). In Bauchi, SMC delivery to a target population of 264,883 children was supported by the Korea International Cooperation Agency (KOICA). Each of these three populations of children accounted for around one percent of the total.

The total number of children targeted for SMC delivery in 2021 was comparable with that in 2020 (12,568,449).

1.1.1 SMC and COVID-19

Malaria Consortium developed operational guidance in 2020 for adapted SMC implementation to minimize potential for transmission of COVID-19.[7] The program continued to adhere to this guidance in 2021.

1.2. Objectives of this report

This report summarizes data on coverage and quality of SMC implementation in areas supported by Malaria Consortium's SMC program in 2021, including administrative data, stock reconciliation data, end-of-cycle (EoC) surveys, and end-of-round (EoR) surveys. Its objectives are to:

- outline methods employed by Malaria Consortium for monitoring coverage of its SMC program and quality of SMC delivery in 2021
- provide a summary of program coverage and degree of adherence to the program's protocols in 2021
- provide recommendations on potential adaptations to approaches for SMC coverage surveys and monitoring and evaluation activities for the 2022 campaign.

Coverage results are presented from all areas where Malaria Consortium implemented SMC in 2021 with full or partial philanthropic funding through GiveWell.

2. Methods

For maximum protective effect, children should receive a full three-day course of SPAQ during all 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 were reached by the SMC campaign in each monthly cycle during the transmission season. Coverage can be measured using program data and representative surveys specifically designed for this purpose.

SPAQ coverage, meanwhile, can be defined in different ways. Given that 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 consider adherence to all relevant components of SPAQ administration, including proportions of households visited by distributors, administration of day 2 and day 3 AQ by caregivers, and whether children received SPAQ in all monthly cycles. We also considered, where possible, the proportion of ineligible children (60 –119 months) who received day 1 SPAQ by monthly cycle and investigated the proportion of eligible children who received SPAQ by means other than its distribution by SMC community distributors during home visits (including both potentially legitimate sources of SPAQ, such as distribution at health facilities and distribution at makeshift fixed distribution points, and illegitimate sources of SPAQ, such as through private purchase). All the above indicators were measured using data from multiple sources — during 2021, these included administrative program data, stock reconciliation data, and data provided by independent coverage surveys commissioned by Malaria Consortium. Surveys also considered quality of SMC delivery in terms of receipt of SPAQ by eligible children outside of home visits by community distributors.

Surveys took the form of EoC surveys following cycles 1–4 (where possible, and depending on the number of cycles delivered), and commissioned EoR surveys after the final cycle (following cycle 4 or 5, depending on number delivered in a given area). All surveys were administered using data forms in SurveyCTO (version 2.70), an electronic data collection platform for smartphones, and data were uploaded to a remote server after each day of data collection. Generic questionnaires for both types of survey were initially developed in English for Nigeria and translated into French for use in Burkina Faso, Chad, and Togo.

Survey forms were based on those used in 2020 in all cases. In Mozambique and Uganda, where EoR surveys were implemented for the first time, surveys were based on the Nigerian questionnaire, but with two key differences: first, surveys were designed to obtain a representative sample of older ineligible children 60–119 months; and, second, they contained additional questions including on gender roles within the household and on household members primarily responsible for decision-making in children's receipt of SMC and curative malaria treatment.

In all countries, questionnaires were given minor adaptations 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, local usage of French, or program terminology. Informed consent was sought from all survey participants in accordance with Malaria Consortium's policy on

ethical research, and caregivers and heads of household were read a description of the survey, its purpose, and the types of questions it contained.

2.1. Administrative and stock reconciliation data

Administrative coverage was estimated using two methods, as described below. Preference was given for the tally sheet method when relevant data were available from tally sheets completed by SMC community distributors, and the stock reconciliation method was employed where data from SMC tally sheets were not available. In Nigeria, Burkina Faso, and Togo the tally sheet method was employed, while the stock reconciliation method was used in Chad, Mozambique, and Uganda (compilation of tally sheet data was not fully completed as of April 2022).

SMC tally sheets

Administrative data were obtained through routine monitoring forms, referred to as SMC tally sheets, which are used by community distributors to record numbers of SPAQ doses administered each day, the number of children re-dosed with SPAQ because of vomiting, and the number of blister packets wasted due to spills or contamination. Supervisors and facility in-charges then compiled information on a daily basis from all the collected SMC tally sheets onto daily summary forms, and then for all the daily summary forms onto SMC EoC reports. Information was then aggregated by dedicated monitoring and evaluation staff at district and/or LGA level, to allow calculations of the number of children who received SMC in each country (and by state in the case of Nigeria) by cycle. Tally sheet data were used to give estimates of SMC program coverage in each country and Nigerian state, defined as the proportion of eligible children 3–59 months who had received day 1 SPAQ by community distributors. To calculate administrative coverage, the total number of SPAQ courses administered in a given cycle (including both doses given during home visits by distributors and those given after referral of eligible children to health facilities) was divided by the estimated target population of children 3–<12 months, 12–59 months, and 3–59 months (i.e. for each formulation of SPAQ, and overall) in the relevant implementation area. Administrative coverage was expressed as a percentage of the estimated target population, both overall and disaggregated by age group.

Stock reconciliation data

Numbers of SPAQ blister packs used over all four monthly cycles by country were also calculated using stock reconciliation data, by subtracting SPAQ blisters returned and doses wasted or lost from doses distributed to the health district level in advance of SMC campaigns. 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. 3–<12 months and 12–59 months).

SMC child record cards

Although 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, their retention by caregivers has been consistently low across most areas where SMC is delivered. Moreover, information recorded by caregivers on day 2 and day 3 AQ doses administered to children at home after distributor visits may be inconsistent. As in 2020, SMC child record cards were not employed to measure coverage for the purposes of this report.

2.2. End-of-cycle surveys

EoC surveys are routinely conducted after all but the last annual SMC cycle, so that data from each can be collected and processed before the next cycle to identify issues within smaller discrete local areas, and to suggest changes or improvements to SMC delivery.

In Burkina Faso and Nigeria, surveys took place following every cycle of SMC (i.e. three EoC surveys following cycles 2, 3, and 4 in areas with four cycles and cycles 1, 2, 3, and 4 in areas with five cycles) except for in the state of Borno where no survey was conducted following cycle 1. In Togo, EoC surveys took place after cycles 1, 2, and 3 in the district of Mô in the Centrale region; a survey was also conducted after cycle 3 the district of Kozah in the Centrale region (for which results are not shown in this report). EoC surveys were conducted after cycles 2 and 3 in Chad, and after cycle 2 only in both Mozambique and Uganda.

All EoC surveys were conducted by independent parties. In Burkina Faso and Nigeria, the EoC surveys were performed by various independent consultants, while in Chad and Mozambique, EoC surveys were carried out by the consultancy Cible RH and research institution Centro de Investigação em Saúde de Manhiça (CISM), respectively.

Infection prevention and control (IPC) procedures were applied to data collectors based on the IPC adaptations for SMC delivery.[7] These adaptations included use of face masks or coverings by data collectors and supervisors while at work, regular temperature checks for fever, instructions not to enter compounds or come into close physical contact with their residents and to maintain physical distancing, protocols for safe disposal of masks, and hand washing using soap or an alcohol-based hand sanitizer. Surveys were also adapted to collect data on COVID-19-specific indicators (described later in this report).

2.2.1. Rationale and design

EoC surveys employed the cluster lot quality assurance sampling (LQAS) method, which has been recommended by the malaria community for monitoring health interventions as it provides a simple, rapid method to assess performance at the sub-project level.[8] In the context of public health programs such as SMC, LQAS subdivides program implementation areas into smaller functional areas (e.g. wards or health facility catchment areas) referred to as ‘supervision areas’ (SAs). The LQAS method requires a relatively small sample per SA to allow for a hypothesis test of whether a predetermined standard for a particular indicator (e.g. percentage coverage) has been met in a given SA. 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 (i.e. between monthly SMC cycles).[9]

We defined decision criteria and targets for 16 indicators, based on a consultative process involving Malaria Consortium staff at headquarters and country offices (**Table 2**). Decision criteria are defined as a proportion of units (i.e. compounds) per SA below which action is considered necessary to improve program delivery. Targets, meanwhile, are defined as the proportion of units per SA in which a standard is met such that no further improvement is considered necessary.

Based on results from previous surveys, program requirements, and maximum alpha and beta errors of 10 percent, a ‘lot size’ of 25 compounds per SA was found to be the minimum such that the

sample was sufficient to run hypothesis tests for each of the indicators to determine whether required standards had been met. Finally, decision rules were calculated based on the lot size, decision criteria, and targets. These decision rules defined a threshold number of compounds out of 25, which were required to have met a standard for each SA; if the compounds meeting a standard fell below the decision rule, this indicated that actions were necessary before the next SMC cycle to address issues related to that standard. For example, if fewer than 22 caregivers in an SA reported administering day 2 and day 3 AQ to their eligible children, this issue was reported to distributors' supervisors and further actions were considered to increase caregiver adherence, such as improved distributor training or community sensitization campaigns before the next SMC cycle.

LQAS can also provide a representative 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. This report shows the EoC results aggregated across SAs to give country-level (or state-level, in the case of Nigeria) summaries of key indicators not limited to coverage of eligible children.

Together, modifications to the LQAS methodology and implementation in EoC surveys in 2020 and 2021 have improved the surveys in three major aspects since 2019. First, surveys were adapted to assess multiple indicators and to identify specific issues using hypothesis tests. These issues can be acted upon to drive improvements in SMC delivery at the local level. Second, lot sizes were adapted to facilitate hypothesis tests based on realistic targets and decision criteria informed by consensus from Malaria Consortium's country teams and surveys in previous years.[5] Third, EoC surveys, where conducted, were completed within two weeks of the preceding cycle in nearly all cases. This gave an additional two weeks before the succeeding cycle to process data, perform hypothesis tests, identify and prioritize issues at the SA level, communicate results to stakeholders at the local level, and engage with them to take actions to improve SMC delivery before the start of the succeeding cycle.

2.2.2. Aims, objectives, and indicators

EoC surveys had two aims. The first was to determine whether SAs had met each of the 16 targets below, including achieving acceptable SMC coverage, achieving high use of SMC record cards, disseminating information to ensure caregivers have knowledge of SMC, and ensuring that protocols for minimization of risk of COVID-19 transmission are followed by community distributors (see **Table 2**).

The second aim was to provide country- and state-level summaries of key indicators. EoCs were intended to meet the following objectives in support of this aim:

- To assess program coverage in terms of compounds/households visited
- To assess coverage of eligible children in terms of day 1 SPAQ administered, and full three-day course of SPAQ received during cycle 4
- To assess adherence to the SMC protocol, including adaptations in response to COVID-19
- To provide timely insights on implementation issues requiring adaptations in subsequent cycles.
- To assess coverage of ineligible children 60–119 months.

The key summary indicators assessed for the purposes of this report were:

- compounds/households with eligible children visited by a community distributor
- day 1 SPAQ provided to eligible children by a community distributor*
- children who received a full three-day course of SPAQ (including both day 2 and day 3 AQ) (among eligible children who received day 1 SPAQ)
- SPAQ administered with community distributors observing DOT (among eligible children who received day 1 SPAQ).

*For the purposes of measuring coverage of children with SPAQ on day one, children who had fever at the time of the distributor's visit, had an allergy to SMC medicines (as reported by caregivers), or who were not eligible for any other reason (including, but not limited to, age; currently being treated for malaria; or taking other medicines containing SP or AQ), were excluded from the analytic sample.

Table 2: List of key indicators assessed by EoC surveys, by unit of analysis, denominator, and LQAS specifications including decision criteria for action, targets, errors, and decision rules for action

Indicator with targets	Unit of analysis	Denominator	Decision criterion	Target	α error	β error	Selected lot size	Decision rule (below is failure)
Households with eligible children visited	Household	Households with eligible children	80%	100%	<0.0001	0.0982	25	23
SPAQ administered to eligible child (day 1)	Child	Households with eligible children	80%	100%	<0.0001	0.0982	25	23
Eligible child received three-day complete course of SPAQ (inc. day 2 and day 3 AQ)	Child	Eligible children provided SPAQ (day 1)	75%	95%	0.0341	0.0962	25	22
SPAQ administration observed by a community distributor (day 1)	Child	Eligible children provided SPAQ (day 1)	75%	95%	0.0341	0.0962	25	22
SMC child record card retention	Child	Eligible children provided SPAQ (day 1)	80%	100%	<0.0001	0.0982	25	23
All SPAQ doses received marked on card	Child	Eligible children provided SPAQ (day 1)	80%	100%	<0.0001	0.0982	25	23
Caregiver accepted SMC administration (not refused)	Child	Compounds reached	90%	100%	<0.0001	0.0718	25	25
SMC awareness (heard of SMC)	Caregiver	Households with eligible children	80%	100%	<0.0001	0.0982	25	23
SMC knowledge (purpose of SMC)	Caregiver	Households with eligible children	80%	100%	<0.0001	0.0982	25	23
SMC knowledge (age eligibility for SMC)	Caregiver	Households with eligible children	70%	90%	0.098	0.0905	25	21
SMC knowledge (importance of age eligibility for SMC)	Caregiver	Households with eligible children	70%	90%	0.098	0.0905	25	21
SMC knowledge (importance of administering AQ on day two and day three)	Caregiver	Households with eligible children	70%	90%	0.098	0.0905	25	21
SMC knowledge (what to do in case of an adverse event)	Caregiver	Households with eligible children	70%	90%	0.098	0.0905	25	21
Confidence in SPAQ efficacy	Caregiver	Households with eligible children	75%	95%	0.0341	0.0962	25	22
Caregiver reported distributor wore mask	Caregiver	Compounds reached	80%	100%	<0.0001	0.0982	25	23
Information on COVID-19 prevention received	Caregiver	Compounds reached	80%	100%	<0.0001	0.0982	25	23

2.2.3. Sampling methods

Selection of SAs was based on health facility catchment areas and is described below in greater detail for each country, with the exception of Borno state in Nigeria, where wards were used instead. With the exception of Mozambique, within each SA a lot of 25 compounds (with at least one child 3–59 months) was randomly selected, preferably from a household list, where available. In Mozambique, 40 were selected per SA. It should be noted that lists were updated at the start of the SMC season, or just before the survey, to reflect changes in the villages' populations. Where it was not possible to use a household list, the traditional 'spin the pen' method was used.

Compounds in which residents refused or were unable to participate, or without a child aged under five years, were resampled. Interviews were conducted in local languages using questionnaires provided by Malaria Consortium, with data collectors translating from the English, French, or Portuguese questionnaire on the spot to caregivers and assigning responses to predefined answer categories in SurveyCTO.

In each compound, after obtaining consent from residents for participation in the survey, a roster of all children 3–119 months was made in SurveyCTO, and their first name, age, and sex were recorded. One child 3–59 months was automatically selected at random from the roster by SurveyCTO. All questions relating to coverage related to that child, and all other questions to that child's primary caregiver. An additional child 60–119 months was also randomly selected, if present, to allow for estimation of summary statistics for the proportion of overage non-eligible children who received day 1 SPAQ in each country and Nigerian state.

Burkina Faso

In Burkina Faso, 85 SAs were sampled with 25 households interviewed in each, giving a total sample size of 2,125. These were chosen through simple random selection from among the health facilities where SMC was delivered in that cycle. Three settlements were randomly selected from the catchment area of each of these three health facilities, and eight or nine compounds were sampled from each to give a total of 25 compounds sampled per health facility catchment area

In cycle 1, SAs were selected only from among the 296 health facilities in areas with the additional cycle of SMC delivery (namely the Cascades and Hauts Bassins regions — except Dandé district — and Pô district in the Centre-Sud region). In subsequent cycles, health facilities were selected from a list of 859. For this reason, coverage estimates from the cycle 1 EoC survey were not comparable with those from other cycles.

Chad (cycles 2 and 3)

In Chad, EoC surveys were carried out after cycles 2 and 3. Methods were the same as in 2020 with the addition of new health districts.

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. Enumeration of SAs was generally performed by local health districts in Chad, but this was checked by Malaria Consortium's data manager. Within each SA, nine

settlements (e.g. villages or urban wards in the case of N'Djamena) were randomly selected, from which three to four compounds were randomly sampled (by enumerating all compounds per cluster, assigning them numbers, and then randomly selecting a number) to give a total number of compounds sampled per SA of 25 (**Table 3**). This process covered the catchment areas of all health facilities in which SMC was delivered during 2021 and resulted in a target sample size of 3,800 compounds across 436 health facility catchments.

Table 3: Sampling frame for 2021 end-of-cycle surveys, Chad

Region	Health district	Number of health facilities	Number of supervision areas	Target number of compounds surveyed
Bahr-el-Gazal	Chaddra	16	6	150
	Michemire	12	5	125
	Moussoro	22	12	300
	Salal	13	6	150
Batha	Yao	54	7	175
Chari Baguirmi	Ba-Illi	9	3	75
	Bousso	11	4	100
	Dourbali	16	5	125
	Kouno	4	1	25
	Mandelia	20	7	175
	Massenya	16	5	125
Hadjer Lamis	Bokoro	24	8	200
	Gama	9	3	75
	Karal	10	3	75
	Mani	13	4	100
	Massaguet	21	7	175
	Massakory	17	6	150
Mayo Kebbi Est	Bongor	34	11	275
	Gam	18	4	100
	Guelendeng	11	4	100
	Moulkou	10	3	75
N'Djamena	N'Djamena Est	20	7	175
	N'Djamena Centre	17	6	150
	N'Djamena Nord	16	5	125
	N'Djamena Sud	25	8	200
	Toukra	14	5	125
Chad (total)	**n=26**	**436**	**139**	**3,800**

Mozambique (cycle 2)

The two districts surveyed contain 23 health facility catchment areas, including 13 in Mecubúri and 10 in Malema, all of which were surveyed. A larger lot size of 40 was used due to the small total number of SAs in the two districts, allowing for a total sample size of 920 to estimates of SMC coverage with an error of less than 10 percent at the 95 percent confidence level. Decision rules were adjusted to the larger lot size. Within each SA, five communities were selected at random and eight households were surveyed in each.

Nigeria (cycles 1, 2, 3, and 4)

In Nigeria, between 10 and 20 health facilities were randomly selected from each LGA in proportion to the LGA's population size. The catchment areas of these facilities were considered SAs for the purposes of the EoC surveys. Three settlements were randomly selected from the catchment area of each of these three health facilities, and eight or nine compounds were sampled from each to give a total of 25 compounds sampled per health facility catchment area (**Table 4**). It could also be considered a representative sample that was approximately self-weighted, on the assumption that health facility catchment areas were of similar population size.

Table 4: Sampling frame for 2021 end-of-cycle surveys, Nigeria (cycle 1 example)

Region	Number of health facility catchment areas/wards (Borno) sampled	Number of households surveyed per cycle
Kogi	70	1,750
Nasarawa	121	3,025
Plateau	200	5,000
Bauchi	285	7,125
Borno	70	1,750
Kebbi	175	4,375
Sokoto	155	3,875
Nigeria (total)	1,076	26,900

Compared with 2020, a number of improvements were made to collector training and supervision, and the data collection forms and their use, as described in the discussion section of this report.

Togo (Mô district, cycles 1, 2, and 3)

As 2021 was the first year that EoC LQAS surveys were introduced, EoC surveys were conducted in a limited area ahead of anticipated scale-up to all regions with SMC delivery in 2022. SAs comprised each of the six health facilities of Mô district in the Centrale region (Agbamassomou, Boulohou, Djarkpanga Kagnigbara, Saïboude, and Tindjassi). At the request of the National Malaria Control Program, an additional four health facilities were sampled in the health district of Kozah in and around the district capital of Kara. Results from these health facilities are not included in the results of this report. Three villages were randomly selected from the catchment area of each of these three

health facilities, and eight or nine compounds were sampled from each to give a total of 25 compounds sampled per health facility catchment area.

Uganda (cycle 2)

SAs were defined at the level of wards. Each of the 32 wards in Kotido and Moroto districts were sampled, with three villages randomly selected from each, and eight or nine compounds sampled from each to give a total of 25 compounds sampled per SA. This gave a total target sample size across the three districts of 800 households.

2.3. End-of-round surveys

EoR surveys were conducted following cycle 4 in all countries where Malaria Consortium supported SMC implementation during 2021, including in Mozambique and Uganda.

End-of-round coverage surveys were mostly conducted independently by local research firms selected by Malaria Consortium through a competitive bidding process. In Burkina Faso, the survey was conducted by Malaria Consortium due to a contracting issue with the selected consultancy. In Uganda, meanwhile, the survey was conducted in-house due to considerations of cost and capacity of local consultancies.

- Chad: Cible RH
- Nigeria: Stradel CSH
- Mozambique: CISM
- Burkina Faso and Uganda: Malaria Consortium

Only households with at least one child 3–59 months were eligible for inclusion in EoR surveys. Relevant questions for coverage indicators related to one randomly selected eligible child 3–59 months per household, and one randomly selected child 60–119 months (when present) to ascertain coverage among ineligible children. Villages that were inaccessible or compounds in which residents refused or were unable to participate, or without a child aged under five years, were resampled. 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 predefined answer categories in SurveyCTO. Conduct of surveys was adapted to minimize risk of COVID-19 transmission in the same manner as EoC surveys.

IPC procedures to minimize potential transmission of COVID-19 were applied to data collectors based on the IPC adaptations for SMC delivery.[7]

2.3.1. Aims, objectives, and indicators

The EoR surveys aimed to assess SPAQ coverage defined as the proportion of eligible children that received SPAQ during the four monthly cycles of the 2021 SMC campaign.

The surveys were designed to meet the following objectives:

- To assess program coverage in terms of compounds/households visited
- To assess coverage of eligible children in terms of day 1 SPAQ administered, and full three-day course of SPAQ received during cycle 4
- To assess adherence to program protocols, in terms of the proportion of day 1 SPAQ dose administered by community distributors adhering to DOT
- To assess SPAQ coverage in terms of children who received day 1 SPAQ during all four monthly cycles.

The key summary 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 3–59 months†
3) Children who received a full three-day course of SPAQ (including both day 2 and day 3 AQ, among children who had received day 1 SPAQ)
4) Day 1 SPAQ administered with 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) Coverage of ineligible children 60–119 months (as day 1 SPAQ administered by community distributors).

Several other indicators relating to the full ingestion of dispersed SPAQ, general malaria prevention, and caregivers' knowledge of SMC were investigated. 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.

In 2020, variables were also included in the EoR surveys to facilitate further analyses to better understand how Malaria Consortium's SMC program works (see the 2020 coverage report for information on specific variables[5]). In 2021, new variables were added to some surveys to answer specific research questions or obtain additional contextual information on SMC campaigns.

†For the purposes of measuring coverage of children with SPAQ on day one, children who had fever at the time of the distributor's visit, had an allergy to SMC medicines (as reported by caregivers), or who were not eligible for any other reason (including, but not limited to, age; currently being treated for malaria; or taking other medicines containing SP or AQ), were excluded from the analytic sample. The same exclusion criteria were applied in analyses of 2020 data.

These new variables added in 2021 included:

- receipt of doses of AQ by ineligible older children 60–119 months
- receipt of doses of AQ on day two and day three by eligible children who had received day 1 SPAQ from sources other than SMC community distributors
- receipt of indoor residual spray within the last 12 months (Nigeria, Mozambique, and Uganda)
- receipt of doses of AQ by ineligible older children aged 60–119 months
- receipt of doses of AQ by ineligible older children 60–119 months from sources other than SMC community distributors
- sources from which day 1 SPAQ is available other than from SMC community distributors
- caregiver opinions on, and engagement with, SMC community distributors during household visits (Nigeria and Burkina Faso)
- research questions relating to caregiver opinions on, and engagement with, the 'lead mothers' intervention (Nigeria) and the 'role model approach' (Burkina Faso)[10] during household visits
- children's consumption of food at the time of, and before and after, day 1 SPAQ and days 2 and 3 AQ administration (Burkina Faso)
- children's consumption of drinks at the time of, and before and after, day 1 SPAQ and days 2 and 3 AQ administration (Burkina Faso).

2.3.2. Sampling methods and survey implementation

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 six EoR surveys, only one child was sampled for questions related to both 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. Sample sizes were intended to allow indicators to be estimated to a high degree of accuracy (designed to be a maximum of five percentfor most indicators across individual Nigerian states, and a maximum of three percent by country).

All EoR surveys were conducted around late November to early December 2021 in Chad, Nigeria, Togo, and Uganda. In Burkina Faso, the EoR survey was delayed due to contractual issues with the selected consultancy firm and took place in January 2022. The Mozambique EoR survey was administered in March 2021.

Burkina Faso

Due to contractual issues with the selected consultancy firm, the nationally representative EoR survey for 2021 in Burkina Faso was cancelled. A survey was designed to obtain data for a study of the role model approach,[10] which had been introduced in the commune of Ipelcé in Saponé district, located in the Centre-Sud region, in addition to providing representative estimates of SMC coverage

among eligible children and other key indicators for that area. A total of 25 households selected at random from household lists were surveyed in each of the 19 communities of the commune (including the four in which the role model approach was implemented). A total of 475 households were surveyed and, given the estimated population of children of around 3,500 eligible children in the commune, after finite population correction, this sample size was considered to be sufficient to estimate coverage with a margin of error of five percent at the 95 percent confidence level. Data analysis for key indicators involved calculation and application of post hoc survey weights when estimating SMC coverage and other indicators

Chad

In Chad, each district was classified as either urban or rural and sampling was carried out independently within those two strata as in 2019. 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 facility 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 nine randomly selected compounds per ward in N'Djamena (urban) and four in villages outside the capital (rural) based on numbering of each compound and random number selection. The target sample size was 2,450 compounds (**Table 5**). Villages or wards were resampled if they were determined to be inaccessible. The survey took place in mid-November 2020 and achieved a sample of 2,458 compounds.

Table 5: Sampling frame for 2021 end-of-round surveys, Chad

Region	Health district	Number of health facilities covered	Number of clusters (settlements) sampled	Target number of compounds surveyed
Bahr-el-Gazal	Chaddra	6	30	120
	Michemire	4	20	80
	Moussoro	10	50	200
	Salal	5	25	100
Batha	Yao	6	30	120
Chari Baguirmi	Ba-Illi	3	15	60
	Bousso	8	40	160
	Dourbali	9	45	180
	Mandelia	5	25	100
	Massenya	3	15	60
	Kouno	2	10	40
Hadjer Lamis	Bokoro	3	15	60
	Gama	3	15	60
	Karal	2	10	40
	Mani	6	30	120
	Massaguet	4	20	80
	Massakory	4	20	80
Mayo Kebbi Est	Bongor	4	20	80
	Gam	4	20	80
	Guelendeng	5	25	100
	Moulkou	3	15	60
N'Djamena	N'Djamena Est	5	25	225
	N'Djamena Centre	6	30	270
	N'Djamena Nord	5	25	225
	N'Djamena Sud	7	35	315
	Toukra	3	15	135
Chad (total)	**n=20**	**90**	**450**	**2,450**

Nigeria

In Nigeria, target sample sizes were specified in advance for each state, with 1,320 compounds from 66 clusters (20 compounds per cluster) considered appropriate for estimating coverage at state level to within an accuracy of five percent (**Table 6**). At the state level, single-stage sampling was used to select 66 villages in each state, with probability proportional to population size. At the second stage, 20 eligible households were be selected from each selected cluster using a simple random sampling method. This was preceded by preparation of a household listing to generate a household sampling frame. Where applicable, a mapping update of the clusters was also conducted to ensure that new changes to the existing map were reflected since the last population census was held.

These sampling methods are explained in greater detail by the national protocol (based on the 2020 protocol) produced by Malaria Consortium in partnership with the Nigerian National Malaria Elimination Programme,[11] and surveys were designed to be representative within states.

Table 6: Sampling frame for 2021 end-of-round surveys, Nigeria

Region	Number of clusters sampled	Target number of compounds surveyed
Kogi	66	1,320
Nasarawa	66	1,320
Plateau	66	1,320
Bauchi	66	1,320
Borno	66	1,320
Kebbi	66	1,320
Sokoto	66	1,320
Nigeria (total)	**462**	**9,240**

Togo

The sampling strategy employed was the same as in 2020. In brief, a simple random sample of clusters (comprising both villages and urban districts, referred to as 'localities') was performed in the three northernmost regions of the country where SMC was delivered in 2021 (Centrale, Kara, and Savanes). A randomizer was designed by Malaria Consortium, and data on localities and their populations (provided by the country's National Malaria Control Program) were entered into the randomizer, which selected 201 new localities for 2021 with probability proportional to their population size (**Table 7**). A total of 10 compounds was randomly sampled in each locality.

Table 7: Sampling frame for 2021 end-of-round surveys, Togo

Region	Health district	Number of clusters (localities) sampled	Target number of compounds surveyed
Centrale	Blitta	11	110
	Mô	3	30
	Sotouboua	10	100
	Tchamba	13	130
	Tchaoudjo	17	170
Kara	Assoli	5	50
	Bassar	10	100
	Binah	6	60
	Dankpen	10	100
	Doufelgou	9	90
	Keran	12	120
	Kozah	19	190
Savanes	Cinkasse	6	60
	Kpendjal	7	70
	Kpendjal-Ouest	9	90
	Oti	8	80
	Oti-Sud	10	100
	Tandjoare	10	100
	Tone	26	260
Togo (total)	**n=19**	**201**	**2,010**

Mozambique and Uganda

A similar design was employed for EoR surveys in Mozambique and Togo in 2021; in both countries, surveys were designed to give a representative of older ineligible children 60–119 months. Communities in areas with SMC delivery during 2020/21 were selected at random using a single-stage procedure. In Mozambique, these were selected using a simple random procedure; while, in Uganda, they were selected with probability proportional to sample size (post hoc survey weights were, therefore, needed for analysis of Mozambique data as the survey was not considered self-weighting).

In Mozambique, 90 clusters were selected, from which 10 households were selected at random from each for a total sample of 900. In Uganda, 120 clusters were selected with 15 households sampled at random and surveyed per cluster; this was intended to yield a total sample of 1,800 households and was considered sufficient to provide estimates of coverage for children 3–59 months, 60–119 months, and 3–119 months with margins of error of 5.0 percent, 5.4 percent, and 3.5 percent, respectively.

In each household, one child aged between three and 119 months was selected at random, and all questions related to that child and their caregiver. The survey was representative of older ineligible children 60–119 months, as all children in this age group were eligible for inclusion in the survey, not just those residing in households with at least once child 3–59 months, as in EoR surveys in other countries during 2021.

Survey implementation

In all countries, individuals involved in SMC delivery were considered ineligible to work as data collectors.

In Chad, Mozambique, Nigeria, and Togo, data collectors were generally selected through an open process managed by the external contractor and overseen by Malaria Consortium. Contractors conducted interviews with the data collectors and, during these interviews, in addition to ascertaining whether they met other key criteria such as being able to speak the local language, the contractor also verified whether the data collectors were involved in SMC delivery in any capacity.

In Burkina Faso and Uganda, data collectors were employed directly by Malaria Consortium as independent contractors using the same criteria, and typically drawn from lists of data collectors previously contracted by Malaria Consortium.

2.4. Data analysis

Data from both EoC and EoR surveys were processed and analyzed by Malaria Consortium staff using STATA version 16. Coverage and related indicators were calculated using the proportion command, with 95 percent confidence intervals (95% CI) calculated using a logit transform.

All indicators were expressed as percentages at the country level, in addition to the state level in the case of Nigeria. Population size weights were applied using the svy: command as appropriate (i.e. when clusters were not selected with probability proportional to population size and surveys could not be considered self-weighting); these were used for analysis for cycle 5 EoR data from Burkina Faso; cycle 1, 2, and 3 data from Togo; and cycle 5 EoR data from Mozambique to ensure representativeness of the results for the areas surveyed.

For cycle 5 EoR data from Nigeria, results for key indicators were shown at the state level, and also at the country level as an average of the seven states surveyed, weighted by their target population size. Aggregated results for key indicators for Nigeria based on EoC surveys were not generated for cycles 1–4, as not all states had available data in each cycle.

No weightings were used for Burkina Faso, Chad, or Togo, or within Nigerian states, as samples were designed to be self-weighting.

3. Results

3.1. Administrative coverage and stock reconciliation data

Malaria Consortium's 2021 SMC campaign aimed to reach 12,191,005 children per monthly cycle across Burkina Faso, Chad, Mozambique, Nigeria, Togo, and Uganda.

Estimates of administrative coverage by cycle using data from SMC tally sheets, and mean coverage across all cycles delivered by age group based on data from SMC tally sheets are shown for Nigeria, and Burkina Faso and Togo, in **Table 8** and **Table 9,** respectively. Results based on stock reconciliation data for Chad, Mozambique, and Uganda — where data from SMC tally sheets were not available — are shown in **Table 10**.

Based on data from SMC tally sheets, the mean number of day 1 doses provided by community distributors to children 3–59 months across the seven Nigerian states included in the analysis was 8,249,952, representing an average of 102.6 percent of the target population. While mean administrative coverage in individual states, excluding Nasarawa, ranged from 100.5 percent (Borno) to 105.2 percent (Plateau), mean administrative coverage for Nasarawa over cycles 1–5 was 76.5 percent based on the original overestimated target population, and 107.7 percent based on the revised target population.

In Burkina Faso and Togo, a mean of 2,125,057 and 477,801 eligible children received day 1 SPAQ per cycle, representing 105.1 percent and 97.6 percent of the target population, respectively.

In Chad, Mozambique, and Uganda, a mean of 1,125,153, 74,960, and 81,538 doses of SPAQ were used based on stock reconciliation data, representing administrative coverage of 104.1 percent, 85.6 percent, and 95.0 percent, respectively, after dividing by the target population.

The results show that, in Mozambique and Uganda, where SMC was first introduced in 2020/21, coverage based on stock reconciliation data increased between cycles (for example, from 74.0 percent in cycle 1 to 95.6 percent in cycle 4 in Mozambique).

Table 8: Administrative coverage by Nigerian state, cycle and age group (tally sheet method)

Country and state		Age group*	Target population	Tally sheet method											
				cycle 1		cycle 2		cycle 3		cycle 4		cycle 5		Mean	
				Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage
Nigeria	Kogi	3–<12 months	72,787	73,536	101.0%	77,134	106.0%	87,693	120.5%	87,632	120.4%	87,677	120.5%	**82,734**	**113.7%**
		12–59 months	311,368	296,844	95.3%	308,214	99.0%	327,945	105.3%	310,210	99.6%	310,539	99.7%	**310,750**	**99.8%**
		3–59 months	384,155	370,380	96.4%	385,348	100.3%	415,638	108.2%	397,842	103.6%	398,216	103.7%	**393,485**	**102.4%**
	Nasar-awa[1]	3–<12 months	180,470	119,416	66.2%	138,371	76.7%	151,446	83.9%	151,694	84.1%	152,106	84.3%	**142,607**	**79.0%**
		12–59 months	772,010	487,240	63.1%	572,213	74.1%	622,804	80.7%	623,244	80.7%	626,507	81.2%	**586,402**	**76.0%**
		3–59 months	952,480	606,656	63.7%	710,584	74.6%	774,250	81.3%	774,938	81.4%	778,613	81.7%	**729,008**	**76.5%**
	Nasar-awa[2]	3–<12 months	115,589	119,416	103.3%	119,416	103.3%	119,416	103.3%	119,416	103.3%	152,106	131.6%	**125,954**	**109.0%**
		12–59 months	479,544	487,240	101.6%	487,240	101.6%	487,240	101.6%	487,240	101.6%	626,507	130.6%	**515,093**	**107.4%**
		3–59 months	595,133	606,656	101.9%	606,656	101.9%	606,656	101.9%	606,656	101.9%	778,613	130.8%	**641,047**	**107.7%**
	Plateau	3–<12 months	149,268	146,836	98.4%	154,323	103.4%	157,743	105.7%	160,422	107.5%	160,684	107.6%	**156,002**	**104.5%**
		12–59 months	638,535	622,825	97.5%	660,747	103.5%	677,935	106.2%	697,648	109.3%	705,263	110.5%	**672,884**	**105.4%**
		3–59 months	787,803	769,661	97.7%	815,070	103.5%	835,678	106.1%	858,070	108.9%	865,947	109.9%	**828,885**	**105.2%**
	Bauchi	3–<12 months	340,063			367,722	108.1%	374,753	110.2%	377,655	111.1%	374,345	110.1%	**373,619**	**109.9%**
		12–59 months	1,454,715			1,485,184	102.1%	1,455,652	100.1%	1,509,362	103.8%	1,491,255	102.5%	**1,485,363**	**102.1%**
		3–59 months	1,794,778			1,852,906	103.2%	1,830,405	102.0%	1,887,017	105.1%	1,865,600	103.9%	**1,858,982**	**103.6%**
	Borno	3–<12 months	388,756			394,469	101.5%	395,393	101.7%	390,692	100.5%	389,238	100.1%	**392,448**	**100.9%**
		12–59 months	1,663,014			1,679,616	101.0%	1,677,293	100.9%	1,662,170	99.9%	1,660,021	99.8%	**1,669,775**	**100.4%**
		3–59 months	2,051,770			2,074,085	101.1%	2,072,686	101.0%	2,052,862	100.1%	2,049,259	99.9%	**2,062,223**	**100.5%**
	Kebbi	3–<12 months	233,114			254,743	109.3%	254,423	109.1%	254,100	109.0%	254,000	109.0%	**254,317**	**109.1%**
		12–59 months	997,212			1,020,495	102.3%	1,020,423	102.3%	1,020,295	102.3%	1,020,156	102.3%	**1,020,342**	**102.3%**
		3–59 months	1,230,326			1,275,238	103.7%	1,274,846	103.6%	1,274,395	103.6%	1,274,156	103.6%	**1,274,659**	**103.6%**
	Sokoto	3–<12 months	226,959			242,480	106.8%	243,475	107.3%	243,488	107.3%	242,699	106.9%	**243,036**	**107.1%**
		12–59 months	970,880			991,762	102.2%	993,318	102.3%	993,933	102.4%	990,886	102.1%	**992,475**	**102.2%**
		3–59 months	1,197,839			1,234,242	103.0%	1,236,793	103.3%	1,237,421	103.3%	1,233,585	103.0%	**1,235,510**	**103.1%**
	Total	3–<12 months	1,526,537	1,599,202	104.8%	1,618,917	106.1%	1,630,787	106.8%	1,627,752	106.6%	400,467	108.6%	**1,619,165**	**106.1%**
		12–59 months	6,515,268	6,583,966	101.1%	6,602,887	101.3%	6,678,880	102.5%	6,657,416	102.2%	1,642,309	105.1%	**6,630,787**	**101.8%**
		3–59 months	8,041,805	8,183,168	101.8%	8,221,804	102.2%	8,309,667	103.3%	8,285,168	103.0%	2,042,776	105.7%	**8,249,952**	**102.6%**

*The dose for children 3–<12 months is SP 250 mg/12.5 mg and AQ 76.5 mg. For children 12–59 months, the dosage is SP 500/25mg and AQ 153mg. [1]The target population for Nasarawa was overestimated in 2021. The target population for Nasarawa was revised downwards after cycle 2 and administrative coverage re-estimated.

Table 9: Administrative coverage by country, cycle and age group (tally sheet method)

Country		Age group*	Target population	Tally sheet method											
				cycle 1		cycle 2		cycle 3		cycle 4		cycle 5		Mean	
				Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage
Burkina Faso	Districts with five cycles	3–<12 months	127,231	94,391	74.2%										
		12–59 months	546,128	522,264	95.6%										
		3–59 months	673,359	616,655	91.6%										
	All districts	3–<12 months	385,535			316,901	82.2%	330,786	85.8%	347,400	90.1%	357,692	92.8%	**338,195**	**87.7%**
		12–59 months	1,636,218			1,717,919	105.0%	1,780,460	108.8%	1,814,974	110.9%	1,834,096	112.1%	**1,786,862**	**109.2%**
		3–59 months	2,021,753			2,034,820	100.6%	2,111,246	104.4%	2,162,374	107.0%	2,191,788	108.4%	**2,125,057**	**105.1%**
Togo		3–<12 months	76,154	67,502	88.6%	70,028	92.0%	74,451	97.8%	72,863	95.7%			**71,211**	**93.5%**
		12–59 months	413,234	384,267	93.0%	396,171	95.9%	418,416	101.3%	427,505	103.5%			**406,590**	**98.4%**
		3–59 months	489,389	451,769	92.3%	466,199	95.3%	492,867	100.7%	500,368	102.2%			**477,801**	**97.6%**

*The dose for children 3–<12 months is SP 250 mg/12.5 mg and AQ 76.5 mg. For children 12–59 months, the dosage is SP 500/25mg and AQ 153mg.

Table 10: Administrative coverage by country, cycle and age group (stock reconciliation method)

Country	Age group*	Target population	Stock reconciliation method											
			cycle 1		cycle 2		cycle 3		cycle 4		cycle 5		Mean	
			Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage	Doses	Coverage
Chad	3–<12 months	239,541	227,849	95.1%	233,085	97.3%	233,414	97.4%	234,215	97.8%			**232,141**	**96.9%**
	12–59 months	841,025	888,754	105.7%	885,787	105.3%	901,429	107.2%	896,077	106.5%			**893,012**	**106.2%**
	3–59 months	1,080,566	1,116,603	103.3%	1,118,872	103.5%	1,134,843	105.0%	1,130,292	104.6%			**1,125,153**	**104.1%**
Mozambique	3–<12 months	15,803	10,510	66.5%	12,815	81.1%	13,811	87.4%	14,765	93.4%			12,975	82.1%
	12–59 months	71,748	54,293	75.7%	59,445	82.9%	65,307	91.0%	68,892	96.0%			61,984	86.4%
	3–59 months	87,551	64,803	74.0%	72,260	82.5%	79,118	90.4%	83,657	95.6%			74,960	85.6%
Uganda	3–<12 months	22,047	19,947	90.5%	22,620	102.6%	22,702	103.0%	21,525	97.6%	22,916	103.9%	**21,699**	**98.4%**
	12–59 months	63,823	53,500	83.8%	62,308	97.6%	62,118	97.3%	61,432	96.3%	65,543	102.7%	**59,840**	**93.8%**
	3–59 months	85,870	73,447	85.5%	84,928	98.9%	84,820	98.8%	82,957	96.6%	88,459	103.0%	**81,538**	**95.0%**

*The dose for children 3–<12 months is SP 250 mg/12.5 mg and AQ 76.5 mg. For children 12–59 months, the dosage is SP 500/25mg and AQ 153mg.

3.2. Coverage surveys

This section presents results of EoC and EoR surveys in Burkina Faso, Chad, Mozambique, Nigeria, Togo, and Uganda.

3.2.1. Households with eligible children visited by a community distributor

Table 11 shows proportions of households visited by a community distributor in each cycle for which a survey was conducted, with 95% CI and sample sizes.

According to EoC and EoR survey results, the percentage of compounds or households visited by community distributors during each cycle was over 95 percent in Burkina Faso, Nigeria, and Togo, and over 90 percent in Chad (**Table 11**). In Mozambique, household coverage was 80.8 percent and 89.3 percent in cycles 2 and 4, respectively. Proportions varied across individual Nigerian states and by survey (**Table 12** and **Table 13**); the proportion of households with eligible children ranged from 94.5 percent in Kogi to 99.1 percent in Kebbi. With the exception of Togo, the results show a gradual increase in the proportion of households visited by community distributors between cycles in all countries and Nigerian states; this increase was not statistically significant for the majority of countries surveyed, however.

Table 11: Proportions of households with eligible children visited by a community distributor by country and survey

Data source	Number of households sampled	Proportion of households covered	95% CI
Burkina Faso (areas with five cycles: Cascades and Hauts Bassins regions; Pô district, Centre-Sud region)			
EoC: cycle 1	2,131	97.6	96.8–98.1
Burkina Faso			
EoC: cycle 2	2,212	96.8	96.0–97.4
EoC: cycle 3	2,131	97.6	96.8–98.1
EoC: cycle 4	2,249	98.0	97.3–98.5
Burkina Faso (Ipelcé commune only, Saponé district)			
EoR: cycle 5	745	99.6	98.3–99.9
Chad			
EoC: cycle 2	3,688	92.3	91.4–93.1
EoC: cycle 3	3,526	94.6	93.8–95.3
EoR: cycle 4	3,227	95.1	94.3–95.8
Mozambique (Malema and Mecubúri districts, Nampula region)			
EoC: cycle 2	938	80.8	78.2–83.2
EoR: cycle 4	1,175	89.3	85.8–92.0
Nigeria (all states; total, weighted proportion)			
EoR: cycle 5	10,833	96.3	95.9–96.7
Togo (Mô district only)			
EoC: cycle 1	150	99.9	99.3–100.0
EoC: cycle 2	150	99.7	98.2–99.9
EoC: cycle 3	150	95.0	92.3–98.7
Togo			
EoR: cycle 4	2,016	96.8	96.0–97.5
Uganda (Kotido and Moroto districts, Karamoja region)			
EoR: cycle 5	1,869	95.9	94.9–96.7

Table 12: Proportions of households with eligible children visited by a community distributor by Nigerian state and survey (states with five cycles)

Data source	Number of households sampled	Proportion of households covered	95% CI
Kogi			
EoC: cycle 1	1,769	79.8	77.9–81.6
EoC: cycle 2	1,733	96.6	95.6–97.3
EoC: cycle 3	2,023	96.1	95.2–96.9
EoC: cycle 4	2,283	94.0	92.9–94.9
EoR: cycle 5	1,341	94.5	93.1–95.6
Nasarawa			
EoC: cycle 1	2,763	86.8	85.4–88.0
EoC: cycle 2	3,027	89.5	88.3–90.5
EoC: cycle 3	3,186	90.0	88.9–91.0
EoC: cycle 4	3,224	91.8	90.8–92.7
EoR: cycle 5	1,328	96.4	95.2–97.3
Plateau			
EoC: cycle 1	2,928	84.6	83.3–85.9
EoC: cycle 2	5,016	82.6	81.5–83.6
EoC: cycle 3	4,910	89.3	88.5–90.2
EoC: cycle 4	5,075	89.8	90.8–92.7
EoR: cycle 5	1,337	95.7	94.5–96.7

Table 13: Proportions of households with eligible children visited by a community distributor by Nigerian state and survey (states with four cycles)

Data source	Number of households sampled	Proportion of households covered	95% CI
Bauchi			
EoC: cycle 2	7,472	91.6	90.9–92.1
EoC: cycle 3	7,168	92.3	91.6–92.9
EoC: cycle 4	7,292	92.1	91.5–92.8
EoC: cycle 5	1,374	95.9	94.7–96.9
Borno			
EoC: cycle 3	1,915	93.3	92.1–94.4
EoC: cycle 4	1,198	93.2	91.7–94.5
EoC: cycle 5	1,371	96.2	95.1–97.2
Kebbi			
EoC: cycle 2	4,314	88.8	87.9–89.7
EoC: cycle 3	4,298	90.0	89.1–90.9
EoC: cycle 4	4,360	93.6	92.9–94.3
EoC: cycle 5	1,355	99.1	98.5–99.5
Sokoto			
EoC: cycle 2	4,172	94.8	94.1–95.5
EoC: cycle 3	3,968	97.2	96.7–97.7
EoC: cycle 4	1,700	98.2	97.5–90.2
EoC: cycle 5	1,401	98.3	97.5–98.8

3.2.2. Day 1 SPAQ provided to eligible children aged three to 59 months

EoC and EoR surveys showed high coverage in terms of day 1 SPAQ provided by community distributors across all surveys in Burkina Faso, Chad, and Togo, with coverage exceeding 95 percent in all EoR surveys in these countries (**Table 14**). Weighted average coverage across the seven Nigerian states included in the EoR survey was 85.4 percent (95% CI: 84.4–86.3). The results of the analysis of EoR survey data show that coverage in individual Nigerian states varied from 95.4 percent in Borno to 99.2 percent in Kebbi (**Table 15** and **Table 16**).

Day 1 SPAQ coverage among eligible children in the 2022 EoR survey was similar to that in 2021, when coverage in Chad, Nigeria, and Togo was 96.9 percent (95% CI: 96.4–97.4), 97.1 percent (95% CI: 96.3–97.7), 85.4 percent (95% CI: 84.4–86.3), and 96.9 percent (95.5–98.4), respectively.

Table 14: Proportions of eligible children (3–59 months) who received day 1 SPAQ by country and survey

Data source	Number of children sampled	Proportion of children covered	95% CI
Burkina Faso (areas with five cycles: Cascades and Hauts Bassins regions; Pô district, Centre-Sud region)			
EoC: cycle 1	2,108	98.9	98.3–99.2
Burkina Faso			
EoC: cycle 2	2,202	99.0	98.5–99.3
EoC: cycle 3	2,108	98.9	98.3–99.2
EoC: cycle 4	2,228	99.1	98.6–99.4
Burkina Faso (Ipelcé commune only, Saponé district, weighted proportion)			
EoR: cycle 5	475	98.4	96.8–99.2
Chad			
EoC: cycle 2	3,666	93.2	92.3–94.0
EoC: cycle 3	3,489	94.7	93.9–95.4
EoR: cycle 4	3,206	95.1	94.2–95.8
Mozambique (Malema and Mecubúri districts, Nampula region)			
EoC: cycle 2	925	85.2	82.7–87.3
EoR: cycle 4	1,165	85.8	82.1–88.9
Nigeria (total, weighted proportion)			
EoR: cycle 5	10,796	96.4	96.1–96.8
Togo (Mô district only)			
EoC: cycle 1	150	90.1	83.1–94.4
EoC: cycle 2	150	98.2	88.8–99.7
EoC: cycle 3	150	85.0	69.3–93.4
Togo			
EoR: cycle 4	2,006	95.4	94.4–96.2
Uganda (Kotido and Moroto districts, Karamoja region)			
EoC: cycle 2	820	96.1	94.5–97.2
EoR: cycle 5	1,422	95.9	94.7–96.8

Table 15: Proportions of eligible who received day 1 SPAQ, by Nigerian state and survey (states with four cycles)

Data source	Number of households sampled	Proportion of children covered	95% CI
Kogi			
EoC: cycle 1	1,753	81.2	79.3–82.9
EoC: cycle 2	1,731	96.5	95.5–97.2
EoC: cycle 3	2,019	95.6	94.6–96.4
EoC: cycle 4	2,279	95.7	94.8–96.5
EoR: cycle 5	1,321	95.9	94.7–96.9
Nasarawa			
EoC: cycle 1	2,727	89.3	88.1–90.4
EoC: cycle 2	3,010	90.1	88.9–91.1
EoC: cycle 3	3,169	91.0	90.0–92.0
EoC: cycle 4	3,222	92.2	91.2–93.1
EoR: cycle 5	1,323	97.0	95.9–97.8
Plateau			
EoC: cycle 1	2,895	88.8	87.6–89.9
EoC: cycle 2	4,975	85.1	84.1–86.1
EoC: cycle 3	4,865	89.9	89.1–90.8
EoC: cycle 4	5,024	90.4	89.5–91.2
EoR: cycle 5	1,332	95.8	95.6–96.8

Table 16: Proportions of eligible who received day 1 SPAQ, by Nigerian state and survey (states with five cycles)

Data source	Number of households sampled	Proportion of children covered	95% CI
Bauchi			
EoC: cycle 2	7,365	91.4	90.8–92.1
EoC: cycle 3	7,120	91.4	90.8–92.1
EoC: cycle 4	7,245	92.1	91.5–92.7
EoR: cycle 5	1,360	95.6	94.4–96.4
Borno			
EoC: cycle 3	1,908	95.8	94.8–96.6
EoC: cycle 4	1,196	94.0	92.5–95.2
EoR: cycle 5	1,370	95.4	94.2–96.4
Kebbi			
EoC: cycle 2	4,272	88.6	87.6–89.5
EoC: cycle 3	4,245	89.7	88.8–90.6
EoC: cycle 4	4,332	93.7	93.0–94.4
EoR: cycle 5	1,352	99.2	98.5–99.5
Sokoto			
EoC: cycle 2	4,144	94.8	94.1–95.5
EoC: cycle 3	3,945	97.2	96.6–97.6
EoC: cycle 4	1,690	97.9	97.1–98.5
EoR: cycle 5	1,398	97.9	97.0–98.6

Table 17 shows day 1 SPAQ coverage of eligible children by cycle based on retrospective reporting by caregivers during EoR surveys following the last cycle of SMC delivery, in each country where the survey was representative at a national level (Chad, Nigeria, and Togo)

The results for all three countries show lower coverage in earlier cycles, and lower coverage of eligible children in earlier cycles compared with EoR surveys in the same countries. For example, coverage based on data from the cycle 2 EoC survey in Chad was estimated at 93.2 percent (95% CI: 92.3–94.0); this is significantly lower than the estimate obtained from the cycle 2 EoR survey (90.3 percent, 95% CI: 89.2–91.3).

Table 17: Proportions of eligible children (3–59 months) who received day 1 SPAQ by country, EoR survey

Number of cycles	Number of children sampled	Proportion of children covered	95% CI
Chad			
EoR: cycle 1	3,094	88.6	87.4–89.7
EoR: cycle 2		90.3	89.2–91.3
EoR: cycle 3		90.0	88.9–91.0
EoR: cycle 4		95.2	94.4–95.9
Nigeria (areas with five cycles, Kogi, Nasarawa and Plateau states only; total, weighted proportion)			
EoR: cycle 1	3,918	83.7	82.4–84.8
Nigeria (all states; total, weighted proportion)			
EoR: cycle 2	9,373	80.3	79.4–81.2
EoR: cycle 3		81.0	80.1–81.9
EoR: cycle 4		86.8	86.1–87.5
EoR: cycle 5		96.4	96.1–96.8
Togo			
EoR: cycle 1	1,990	80.9	79.1–82.5
EoR: cycle 2		85.7	84.1–87.2
EoR: cycle 3		87.4	85.9–88.8
EoR: cycle 4		95.4	94.4–96.2

3.2.3 Proportion of eligible children who received a full three-day course of SPAQ

Both types of surveys found that very high proportions of children received AQ doses on both day two and day three from their caregivers (**Table 18**, **Table 19**, and **Table 20**). Adherence across all countries and Nigerian states surveyed was over 95 percent in each monthly SMC cycle based on estimates from EoC and EoR surveys, with the exception of Uganda in cycle 2.

Table 18: Proportions of eligible children (3–59 months) who received a full three-day course of SPAQ among those who received day 1 SPAQ, by country and survey

Data source	Number of children sampled	Proportion of children received full course	95% CI
Burkina Faso (areas with five cycles: Cascades and Hauts Bassins regions; Pô district, Centre-Sud region)			
EoC: cycle 1	2,084	97.6	96.9–98.2
Burkina Faso			
EoC: cycle 2	2,180	98.4	97.8–98.8
EoC: cycle 3	2,084	97.6	96.9–98.2
EoC: cycle 4	2,208	98.1	97.5–98.6
Burkina Faso (Ipelcé commune only, Saponé district, weighted proportion)			
EoR: cycle 5	467	99.4	98.1–99.8
Chad			
EoC: cycle 2	3,417	96.8	96.1–97.3
EoC: cycle 3	3,306	96.5	95.8–97.0
EoR: cycle 4	2,988	96.3	95.7–97.0
Mozambique (Malema and Mecubúri districts, Nampula region)			
EoC: cycle 2	789	93.7	91.9–95.3
EoR: cycle 4	972	98.3	98.5–99.7
Nigeria (total, weighted proportion)			
EoR: cycle 5	10,411	98.6	98.4–98.9
Togo (Mô district only)			
EoC: cycle 1	143	98.3	82.8–99.9
EoC: cycle 2	145	99.1	93.8–99.9
EoC: cycle 3	140	99.9	98.8–100.0
Togo			
EoR: cycle 4	1,889	98.1	97.4–98.7
Uganda (Kotido and Moroto districts, Karamoja region)			
EoC: cycle 2	788	98.7	97.7–99.3
EoR: cycle 5	1,344	99.4	98.8–99.7

Table 19: Proportions of eligible children (3–59 months) who received a full three-day course of SPAQ among those who received day 1 SPAQ, by Nigerian state and survey (states with four cycles)

Data source	Number of households sampled	Proportion of children received full course	95% CI
Kogi			
EoC: cycle 1	1,379	98.0	97.7–98.3
EoC: cycle 2	1,670	98.1	97.3–98.6
EoC: cycle 3	1,930	97.7	96.9–98.3
EoC: cycle 4	2,182	98.7	98.1–99.1
EoR: cycle 5	1,267	98.9	98.1–99.3
Nasarawa			
EoC: cycle 1	2,416	97.8	97.1–98.3
EoC: cycle 2	2,711	97.1	96.4–97.7
EoC: cycle 3	2,884	97.2	96.5–97.7
EoC: cycle 4	2,972	96.8	96.1–97.4
EoR: cycle 5	1,283	97.4	96.4–98.2
Plateau			
EoC: cycle 1	2,514	96.3	95.5–97.0
EoC: cycle 2	4,235	98.0	97.5–98.4
EoC: cycle 3	4,367	98.4	98.0–98.7
EoC: cycle 4	4,541	96.9	96.3–97.3
EoR: cycle 5	1,276	97.7	96.7–98.4

Table 20: Proportions of eligible children (3–59 months) who received a full three-day course of SPAQ among those who received day 1 SPAQ, by Nigerian state and survey (states with five cycles)

Data source	Number of households sampled	Proportion of children received full course	95% CI
Bauchi			
EoC: cycle 2	6,684	98.0	97.7–98.3
EoC: cycle 3	6,511	97.7	97.3–98.0
EoC: cycle 4	6,674	98.4	98.1–98.7
EoC: cycle 5	1,300	99.1	98.4–99.5
Borno			
EoC: cycle 3	1,828	98.2	97.5–98.8
EoC: cycle 4	1,124	98.3	97.3–98.9
EoC: cycle 5	1,306	99.1	98.4–99.5
Kebbi			
EoC: cycle 2	3,746	96.0	95.3–96.6
EoC: cycle 3	3,810	95.2	94.4–95.8
EoC: cycle 4	4,060	97.5	97.0–97.9
EoC: cycle 5	1,341	98.9	98.2–99.3
Sokoto			
EoC: cycle 2	3,918	97.0	96.4–97.5
EoC: cycle 3	3,833	97.2	96.7–97.7
EoC: cycle 4	1,655	96.9	96.0–97.7
EoC: cycle 5	1,369	98.9	98.2–99.3

3.2.4 SPAQ administration directly supervised by community distributors adhering to DOT

The EoC survey consistently showed high levels of adherence to DOT by community distributors who administered day 1 SPAQ to eligible children. Adherence to DOT by community distributors in exceeded 90 percent in all countries overall except in Togo (83.4 percent) (**Table 21**).

Adherence to DOT varied widely between Nigerian states (**Table 22** and **Table 23**) and between cycles within states; results based on EoR survey data show that this was lowest in Plateau (80.2 percent) and highest in Borno (95.8 percent).

Table 21: Proportions of eligible children (3–59 months) who received day 1 SPAQ by community distributors adhering to DOT among those who received day 1 SPAQ by community distributors during home visits, by country and survey

Data source	Number of children sampled	Proportion administered SMC by DOT	95% CI
Burkina Faso (areas with five cycles: Cascades and Hauts Bassins regions; Pô district, Centre-Sud region)			
EoC: cycle 1	2,084	93.2	92.1–94.2
Burkina Faso			
EoC: cycle 2	2,180	95.6	94.6–96.4
EoC: cycle 3	2,084	93.2	92.1–94.2
EoC: cycle 4	2,208	93.2	92.0–94.1
Burkina Faso (Ipelcé commune only, Saponé district, weighted proportion)			
EoR: cycle 5	467	95.6	93.6–97.0
Chad			
EoC: cycle 2	3,333	90.3	89.3–91.3
EoC: cycle 3	3,253	90.3	89.3–91.3
EoR: cycle 4	2,988	82.4	81.0–83.8
Mozambique (Malema and Mecubúri districts, Nampula region)			
EoC: cycle 2	788	94.0	92.1–95.5
EoR: cycle 4	972	96.1	93.7–97.6
Nigeria (total, weighted proportion)			
EoR: cycle 5	10,272	90.6	90.0–91.1
Togo (Mô district only)			
EoC: cycle 1	143	93.4	78.2–98.2
EoC: cycle 2	145	99.1	97.6–99.7
EoC: cycle 3	140	93.6	76.5–98.5
Togo			
EoR: cycle 4	1,889	83.4	81.6–85.0
Uganda (Kotido and Moroto districts, Karamoja region)			
EoC: cycle 2	788	97.4	96.6–98.7
EoR: cycle 5	1,344	97.0	96.0–97.8

Table 22: Proportions of eligible children (3–59 months) who received a full three-day course of SPAQ among those who received day 1 SPAQ, by Nigerian state and survey (states with five cycles)

Data source	Number of households sampled	Proportion administered SMC by DOT	95% CI
Kogi			
EoC: cycle 1	1,367	91.4	89.8–92.7
EoC: cycle 2	1,661	97.4	96.5–98.1
EoC: cycle 3	1,929	95.8	94.8–96.6
EoC: cycle 4	2,179	96.2	95.3–96.9
EoR: cycle 5	1,233	91.4	89.7–92.8
Nasarawa			
EoC: cycle 1	2,407	94.0	93.0–94.9
EoC: cycle 2	2,706	89.1	87.8–90.2
EoC: cycle 3	2,850	90.2	89.0–91.2
EoC: cycle 4	2,960	88.5	87.2–89.5
EoR: cycle 5	1,260	92.5	90.9–93.8
Plateau			
EoC: cycle 1	2,501	92.6	91.6–93.6
EoC: cycle 2	4,181	89.8	88.9–90.7
EoC: cycle 3	4,344	89.7	88.8–90.6
EoC: cycle 4	4,498	86.7	85.7–87.6
EoR: cycle 5	1,245	80.2	77.9–82.3

Table 23: Proportions of eligible children (3–59 months) who received a full three-day course of SPAQ among those who received day 1 SPAQ, by Nigerian state and survey (states with four cycles)

Data source	Number of households sampled	Proportion administered SMC by DOT	95% CI
Bauchi			
EoC: cycle 2	6,672	81.4	80.4–82.3
EoC: cycle 3	6,502	82.6	81.7–83.5
EoC: cycle 4	6,662	84.1	83.2–85.0
EoC: cycle 5	1,281	84.9	82.8–86.7
Borno			
EoC: cycle 3	1,812	92.3	91.0–93.5
EoC: cycle 4	1,123	92.1	90.4–93.6
EoC: cycle 5	1,300	95.8	94.6–96.8
Kebbi			
EoC: cycle 2	3,741	86.2	85.0–87.2
EoC: cycle 3	3,807	88.1	87.0–89.1
EoC: cycle 4	4,055	90.5	89.5–91.3
EoC: cycle 5	1,333	91.7	90.1–93.1
Sokoto			
EoC: cycle 2	3,915	87.9	86.8–88.9
EoC: cycle 3	3,832	88.9	87.9–89.9
EoC: cycle 4	1,655	93.8	92.5–94.8
EoC: cycle 5	1,366	91.9	90.4–93.3

3.2.5 Receipt of SPAQ by eligible children outside of home visits by community distributors

Results based on EoR survey data show that less than 1.5 percent of caregivers reported receipt of day 1 SPAQ by eligible children outside home visits by community distributors during EoR surveys in all countries except Mozambique (**Table 24**). No cases of receipt of SPAQ outside of distributor visits was reported in Ipelcé, Burkina Faso. In Nigeria, the proportion was significantly lower than in 2020 (5.1 percent, 95% CI: 4.5–5.6); this may, however, be attributable to the difference in the states included in the EoR survey between years.

As in 2020, the majority of instances of receipt of SPAQ outside home visits were via personnel at local health facilities and from community distributors handing out SPAQ at makeshift fixed distribution points; these sources may be considered legitimate sources of SPAQ.

Table 24: Receipt of SPAQ by eligible children outside of home visits by community distributors by country

Data source	Number of eligible children sampled	Proportion of eligible children covered	95% CI
Burkina Faso (Ipelcé commune only, Saponé district, weighted proportion)			
EoR: cycle 5	475	0.0	N/A
Chad			
EoR: cycle 4	3,206	1.5	1.1–2.0
Mozambique (Malema and Mecubúri districts, Nampula region)			
EoR: cycle 4	1,175	2.4	1.5–3.8
Nigeria (total, weighted proportion)			
EoR: cycle 5	10,796	1.3	1.1–1.5
Togo			
EoR: cycle 4	2,006	1.2	0.8–1.8
Uganda (Kotido and Moroto districts, Karamoja region)			
EoR: cycle 5	1,422	1.3	0.9–2.1

3.2.6 Day 1 SPAQ received per child over the course of the SMC round and children who received day 1 SPAQ during all monthly SMC cycles

The number of cycles in which sampled children received day 1 SPAQ during the 2021 round was assessed only through the EoR surveys at the end of the cycle, as this was not possible using EoC surveys.

Table 25, **Table 26**, and **Table 27** show the proportions of eligible children by country and state by number of day 1 SPAQ received during the 2021 SMC round. Nationally, 83.5 percent of eligible children in Chad and 70.2 percent in Togo received SMC in each of the four SMC cycles delivered. In the study areas in Mozambique and Uganda, 77.0 percent and 82.2 percent of eligible children received four and five cycles of SMC, respectively. In Ipelcé commune in Burkina Faso, 93.8 percent of eligible children received all four cycles.

Table 25: Proportions of eligible children (3–59 months) who received day 1 SPAQ by community distributors by number of cycles during 2021 (EoR survey), by country

Number of cycles	Number of children sampled	Proportion of eligible children covered	95% CI
Burkina Faso (Ipelcé commune only, Saponé district, weighted proportion)			
None	475	0.2	0.0–1.6
One		0.7	0.3–2.0
Two		2.3	1.3–4.0
Three		3.0	1.7–5.0
Four		93.8	91.3–95.6
Chad			
None	3,094	3.5	2.9–4.2
One		2.3	1.8–2.9
Two		4.5	3.8–5.3
Three		6.3	5.5–7.2
Four		83.5	82.2–84.8
Nigeria (areas with five cycles, Kogi, Nasarawa and Plateau states only; total, weighted proportion)			
None	3,918	2.8	2.3–3.3
One		1.6	1.2–2.0
Two		11.0	10.1–12.0
Three		8.1	7.3–9.0
Four		10.7	9.8–11.7
Five		65.8	64.3–67.3
Nigeria (areas with four cycles, Bauchi, Borno, Kebbi and Sokoto states; total, weighted proportion)			
None	6,792	1.3	1.1–1.6
One		2.4	2.0–2.8
Two		12.0	11.2–12.7
Three		6.6	6.0–7.2
Four		77.8	76.8–78.8
Mozambique			
None	908	4.9	2.9–8.1
Four		77.0	69.7–82.9
Togo			
None	1,990	2.1	1.6–2.8
One		3.2	2.6–4.1
Two		7.7	6.6–8.9
Three		16.7	15.2–18.4
Four		70.2	68.2–72.2
Uganda			
None	1,136	2.3	1.6–3.3
Five		82.2	79.9–84.3

In Nigeria, the population-weighted proportion of eligible children receiving day 1 SPAQ during each of the cycles delivered was 65.8 percent across the three states with five cycles (**Table 26**) and 77.8 percent across the four states with four cycles (**Table 27**). The proportion of eligible children receiving day 1 SPAQ in all cycles delivered was lowest in Borno (55.1 percent), where cycles 1 and 2 faced disruption in some areas of the state due to insecurity, and highest in Sokoto (89.4 percent).

In no country or Nigerian state, with the exception of Kebbi, was the proportion of eligible children receiving no cycles greater than five percent.

Table 26: Proportions of eligible children (3–59 months) who received day 1 SPAQ by community distributors by number of cycles during 2021 (EoR survey), by Nigerian state (states with five cycles)

Number of cycles	Number of children sampled	Proportion of eligible children covered	95% CI
Kogi			
None	1,297	3.9	3.0–5.1
One		2.0	1.4–2.9
Two		6.1	4.9–7.5
Three		6.7	5.5–8.2
Four		9.9	8.4–11.6
Five		71.4	68.9–73.8
Nasarawa			
None	1,303	3.2	2.4–4.3
One		0.4	0.2–0.9
Two		20.4	18.3–22.7
Three		9.4	7.9–11.1
Four		8.1	6.7–9.7
Five		58.6	55.9–61.2
Plateau			
None	1,318	1.1	0.7–1.9
One		2.4	1.7–3.3
Two		6.6	5.4–8.1
Three		8.3	6.9–9.9
Four		14.2	12.4–16.2
Five		67.5	64.9–69.9

Table 27: Proportions of eligible children (3–59 months) who received day 1 SPAQ by community distributors by number of cycles during 2021 (EoR survey), by Nigerian state (states with four cycles)

Number of cycles	Number of children sampled	Proportion of eligible children covered	95% CI
Bauchi			
None	1,358	1.5	1.0–2.4
One		2.8	2.0–3.8
Two		4.8	3.8–6.1
Three		7.6	6.4–9.2
Four		83.2	81.1–85.1
Borno			
None	1,351	3.1	2.3–4.2
One		4.2	3.3–5.4
Two		32.5	29.6–34.6
Three		5.5	4.4–6.8
Four		55.1	52.5–57.8
Kebbi			
None	1,350	0.6	0.3–1.1
One		2.3	1.6–3.2
Two		12.2	10.6–14.1
Three		4.8	3.8–6.1
Four		80.1	77.9–82.1
Sokoto			
None	1,396	1.0	0.6–1.7
One		1.4	0.9–2.2
Two		2.4	1.7–3.3
Three		5.8	4.7–7.2
Four		89.4	87.7–90.9

3.2.7 SPAQ provided to ineligible children aged five years and above

Table 28 shows the proportions of ineligible children 60–119 months who received SPAQ, based on data from EoR surveys: these were 28.2 percent in Burkina Faso, 17.5 percent in Chad, a weighted average of 31.9 percent (33.3–36.1) across the seven states in Nigeria surveyed, and 9.7 percent in Togo. Administration of SPAQ to overage ineligible children varied markedly between Nigerian states, according to cycle 5 EoR data (**Table 29**).

In these four countries, the proportion of ineligible children who received SMC in the last cycles of the 2021 SMC round was lower than in 2020, when this was 34.9 percent (31.0–39.0) in Burkina Faso, 44.4 percent (41.7–47.0) in Chad, 35.0 percent (33.3–36.1) in Nigeria, and 32.7 percent (30.4–35.1) in Togo.

It should be noted, however, that surveys in these four countries were not designed to provide a representative sample of children 60–119 months; estimates of the proportion of this group receiving day 1 SPAQ are likely to represent an overestimate as only children in this group residing in households with eligible children 3–59 months were included in the sample.

In Mozambique and Uganda, where surveys were designed to be representative of this group, the results of the EoR surveys indicated that 15.3 percent and 62.5 percent of older ineligible children received day 1 SPAQ, respectively.

Table 28: Proportions of ineligible children (60 –119 months) who received day 1 SPAQ (EoR survey) by country

Data source	Number of ineligible children sampled	Proportion of eligible children covered	95% CI
Burkina Faso (Ipelcé commune only, Saponé district)[1]			
EoR: cycle 5	248	28.2	23.2–33.9
Chad[1]			
EoR: cycle 4	862	17.5	15.1–20.2
Mozambique (Malema and Mecubúri districts, Nampula region)			
EoR: cycle 4	525	15.3	11.5–20.1
Nigeria (total, weighted proportion)[1]			
EoR: cycle 5	3,530	31.9	30.4–33.5
Togo[1]			
EoR: cycle 4	1,296	9.7	8.2–11.5
Uganda (Kotido and Moroto districts, Karamoja region)			
EoR: cycle 5	403	62.5	57.7–67.1

[1]Survey not representative of ineligible children 5–9 years; sample comprised children 5–9 years living in households with eligible children 3–59 months. Estimates of coverage of ineligible children in these areas are likely to represent an overestimate. Surveys in Mozambique and Uganda did obtain a representative sample of this group.

Table 29: Proportions of ineligible children (60 –119 months) who received day 1 SPAQ (EoR survey), by Nigerian state

Data source	Number of ineligible children sampled	Proportion of eligible children covered	95% CI
Bauchi			
EoR: cycle 5	697	25.9	22.8–29.4
Borno			
EoR: cycle 5	149	73.8	66.1–80.2
Kebbi			
EoR: cycle 5	336	36.3	31.3–41.6
Kogi			
EoR: cycle 5	553	16.6	13.6–41.6
Nasarawa			
EoR: cycle 5	438	29.0	24.9–33.4
Plateau			
EoR: cycle 5	474	51.7	47.2–56.2
Sokoto			
EoR: cycle 5	464	22.4	18.8–26.4

4. Discussion

Administrative program data show very high coverage of SMC across all areas where Malaria Consortium implemented SMC in 2021. The proportion of eligible children receiving day 1 SPAQ from a community distributor was found to exceed 90 percent in Burkina Faso, Chad, and Nigeria based on analysis of data from SMC tally sheets and stock reconciliation data. In some instances, administrative coverage estimated using either method exceeded 100 percent; this is likely a reflection of provision of SMC to ineligible children or inaccuracy in target population estimates. This was illustrated in the case of Nasarawa, where population estimates were revised during the 2021 SMC round and administrative coverage re-estimated using the new denominator.

The results of the EoC and EoR surveys across the four countries suggest that SMC programs supported by Malaria Consortium were generally effective in ensuring high program coverage and adherence to the SMC protocols. Except for some Nigerian states, coverage in terms of receipt of day 1 SPAQ by eligible children 3–59 months exceeded 90 percent across all countries. We noted a pattern of increase between cycles, although in the majority of cases this cannot be considered to be statistically significant.

The proportion of children receiving the full three-day course of SMC (among those who had received day 1 SPAQ) exceeded 95 percent in all countries across all cycles, with the exception of Mozambique in cycle 2. These results, taken as a whole, suggest that the SMC program was successful in promoting adherence to day 2 and day 3 AQ among caregivers, and they imply a large proportion of eligible children were provided effective protection against malaria during the high transmission season in all areas surveyed.

A high proportion of children received all SMC cycles delivered; however, there was variation between countries and Nigerian states. This proportion was lowest in the Nigerian state of Borno (55.1 percent) where cycles earlier in the 2021 SMC round, particularly cycles 1 and 2, were disrupted due to the complex operational environment and the security situation.

The proportion of eligible children receiving day 1 SPAQ outside of home visits by SMC community distributors across all countries can be considered negligible (<2.5 percent).

Significant areas for improvement in SMC delivery remain, however. First, in Kogi, the proportions of households visited and eligible children receiving day 1 SPAQ were low in cycle 1 (79.8 percent and 81.2 percent). The proportion of visits by SMC community distributors adhering to DOT was relatively low in some areas. In Togo, based on cycle 4 EoR data, this proportion was 83.4 percent (95% CI: 81.6–85.0); the proportion was higher in EoC surveys, which were only representative of the district of Mô. The proportion of visits with adherence to DOT by distributors in the Nigerian states of Bauchi and Plateau in cycles 4 and 5 was also relatively low (<85 percent).

Treatment of ineligible children aged five years and above

Treatment of children 60–119 months is likely primarily a reflection of the challenges related to determination of children's ages. Estimates of SMC coverage in this group may also be affected by over-reporting among caregivers due to social desirability bias.

According to the results of the EoR surveys, the proportion of ineligible older children receiving day 1 SPAQ varied widely between countries. Estimates of SMC coverage among ineligible children in Burkina Faso, Chad, Nigeria, and Togo may not have been representative, as children from this age group were only sampled from households with eligible children. Results for coverage in this age group may represent an overestimate as overage children in households without eligible children, who were less likely to be administered day 1 SPAQ, were absent from the analytic sample.

Surveys in Mozambique and Uganda were designed to provide a representative sample and are more likely to provide accurate estimates of coverage in this group. Despite this, the results of the EoR surveys indicated showed widely varying results by country, with 15.3 percent and 62.5 percent of older ineligible children receiving day 1 SPAQ in Mozambique and Uganda, respectively. While results from Mozambique and Uganda are more likely to be accurate representations of coverage among ineligible older children, further efforts will be made to improve our estimates in the coming years. In particular, the estimate of coverage of ineligible older children in Uganda (62.5 percent is unlikely to be reliable, given that insufficient SPAQ blisters were available to cover both 95.9 percent of eligible children and nearly two-thirds of older children. The potential reasons for this overestimation of coverage in older children in Uganda will be investigated, including issues in random selection of households with children 3–119 months and identification of children's age group during surveys.

Comparability of results between years and surveys

It should be noted that results of certain surveys within countries between different cycles in 2021, and within countries between years, may not be comparable due to differences in areas represented in each individual survey. For example, in Nigeria, between 2020 and 2021, there were changes in the states included in the EoR survey, with Borno, Kogi, and Plateau featuring in 2021 but not 2020.

Comparisons are also complicated by the introduction of a fifth cycle of SMC in specific areas during the 2021 SMC round. For example, results for the cycle 1 EoC survey in Burkina Faso are representative of the regions of Cascades and Hauts Bassins regions, and Pô district in the Centre-Sud region, and not of all areas where SMC is delivered with support from Malaria Consortium as in other surveys. In addition, comparisons of the proportions of children receiving day 1 SPAQ in all cycles of the 2021 round may not be made between areas where four and five cycles were delivered. In areas with five cycles, the proportions of children receiving day 1 SPAQ in no cycle, and of children receiving day 1 SPAQ in all cycles, are likely lower (due to the opportunity to receive an additional cycle of SMC, but also the increased probability of missing at least one cycle). The addition of a fifth cycle, therefore, has implications for the harmonization of this indicator between areas with four and five cycles within countries, and between countries.

Time between delivery of day 1 SPAQ and coverage surveys may have influenced our results through recall bias and may explain differences in coverage estimates between EoC and EoR surveys; this is particularly the case when comparing EoC results from earlier cycles and results based on retrospective self-reports by caregivers for the same cycles (i.e. when comparing results shown in **Table 14** and **Table 17**).

It should also be noted that in Nigeria and Chad in particular, EoR surveys commenced in a timelier fashion following the completion of cycle 5 than in 2020. This is likely to have reduced the potential

for recall bias, which is likely to have been a contributor to the differences in coverage estimates based on EoC and EoR surveys in some Nigerian states in 2020.[5]

Improvements to survey implementation and data analysis since 2020

In Nigeria, actions were taken to improve the representativeness and quality of data obtained from surveys. These included random audio checks of one in 10 interviews to ensure good interview practice was being followed and to allow feedback to be provided to specific data collectors. In addition, hidden variables were introduced to check time taken for segments of the interview to ensure sufficient time was taken to explain the consent statement to participants and to read interview questions in full, and GPS coordinates were taken at the beginning and end of each interview to ensure the correct households were sampled and that interviews started and ended in the same location. Similar improvements were made to the Mozambique, Nigeria, and Uganda EoR surveys. An error reporting form was also developed in Excel for Nigeria to show all errors in the dataset in real time, with particular attention to numbers of interviews for each data collector by supervision area and per day.

LQAS and improving delivery of SMC

In 2021 LQAS data have been increasingly used at the SA level to identify issues in SMC delivery based on the 16 indicators assessed, and on associated hypothesis tests.

In nearly all cases, it was possible to obtain LQAS hypothesis test results before the start of the next cycle. These results and recommendations for actions in each SA were shared with national and state ministries of health, and malaria control programs, as a starting point for engagement to implement improvements in SMC delivery.

Several successes were reported in use of EoC data to drive improvements in SMC delivery:

- In Burkina Faso, Malaria Consortium shared tailored reports on health facilities with the National Malaria Control Program and district-level managers before the start of each cycle. One key recommendation in several areas related to the need to re-map health facility catchment areas, as it was found that some households were not included in household lists held at health facilities and were not visited by SMC community distributors.

- In Chad, in the districts of Mani, Toukra, and Yao, it was noted that there were discrepancies between proportions of households visited and children who received day 1 SPAQ; it was suggested that it should be investigated whether SPAQ was distributed outside of home visits (e.g. through fixed distribution points or through blisters left in a marketplace). In most supervision areas in the district of Yao, there was a high rate of refusal of day 1 SPAQ, despite high awareness of SMC; in some areas of the capital N'Djamena, it was reported that there was a relatively low proportion of caregivers reporting confidence in the effectiveness of SMC. As a result, it was advised that content of information disseminated before SMC distribution should be revised to reflect caregivers' specific needs and concerns. In the district of Toukra, where SMC was introduced in 2021, day 1 SPAQ coverage and caregiver knowledge of several aspects of SMC was low; in response, it was suggested that additional support should be given to distributor training.

- In Malema and Mecubúri districts in Mozambique, the results indicated that knowledge on multiple aspects of SMC among caregivers was low; it was subsequently determined that sensitization efforts before the start of the 2020/21 SMC round were over-reliant on radio broadcasts, despite the low household penetration of radio receivers. As a result, sensitization activities subsequently prioritized information dissemination through other media and town criers.

- In Nigeria, given the large number of SAs surveyed in each EoC survey, an LQAS feedback tool was developed to improve efficiency in reporting issues identified and to track sharing of recommendations and actions taken at the SA level.

- In the district of Mô in Togo, the results indicated that there was a need for distributors to communicate with caregivers about age eligibility for SMC and actions to take in the case of an adverse reaction to SPAQ. Training on supervision of administration of SMC was also reinforced.

- In Kotido and Moroto districts in Uganda, wards with low day 1 SPAQ coverage were identified and the supervisors were reallocated to these areas.

Finally, it is expected that the progress made as a result of expansion and adaptation of the LQAS methodology to Malaria Consortium's SMC program will be reported in a peer-reviewed publication, which is expected to be published within the next year.

4.1. Strengths and limitations

Key strengths of our analysis include use of independent coverage surveys in the majority of countries 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 serve to reduce bias, it also allowed for external resources to be utilized to ensure that surveys were implemented in a timely manner. Self-weighting sampling designs were employed in all EoR surveys — with the exception of Mozambique — with the number of clusters sampled by district proportional to the size of the target population. This ensured that estimates of program coverage were representative of the populations targeted for SMC administration. Post-hoc weights were applied when analyzing Mozambique EoR data.

The proportion of missing responses for key indicators in our datasets was low (<2 percent for EoR surveys across all countries for day 1 SPAQ coverage among eligible children).

Several limitations may be noted, however. 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. Estimates of population sizes may not adequately reflect population movements due to migration or internal displacement.

The primary limitation of coverage surveys is that they rely on self-reporting, and findings based on survey responses may be subject to recall and social desirability bias. Recall bias is likely to increase along with time between the completion of cycle 4 SMC distribution and the beginning of EoR surveys. It should be noted, however, that time between the end of cycle 4 and the EoR surveys was typically shorter in 2021 than in 2020 and 2019.

Language and translation present further opportunities for introducing bias, especially as questionnaires were only provided in English and French and relied on data collectors to translate questions when interviewing caregivers. While survey questions used consistent wording and answer choices across all cycles and countries as far as possible, caution should be exercised when making comparisons between results from EoC and EoR surveys within the same country due to difference in sampling methods.

Finally, we did not consider use of SMC child record cards for estimation of coverage, as they may not represent a reliable source of coverage data where retention and completion are poor due to potential for bias in estimates of SMC coverage.

4.2. Recommendations, conclusions, and next steps

Although LQAS surveys have been improved since 2019 and have been better adapted for identifying specific issues in SMC delivery at the health facility level, further consideration will be given during 2021 as to how survey findings can be used to engage with local stakeholders to identify issues, plan actions for improvement with stakeholders, make timely adaptations to program delivery, and follow up to verify whether improvements have been realized. EoC surveys will also be implemented for the first time in Togo in 2021 and used to inform improvements to SMC delivery.

Discussions at the country level will also focus on how reports drafted by contractors may be used more effectively to engage with country- and state-level authorities.

Attempts will be made to improve analysis of data from EoC surveys through use of sampling weights to overcome potential under-sampling of larger communities within SAs. In addition to existing data on community-level populations available for Burkina Faso, Togo, Uganda, and Mozambique, data have recently been obtained on populations by village for Kebbi, Bauchi, and Sokoto (the latter two having the widest discrepancies between EoC and EoR results); in 2022 these will be cleaned and merged with future datasets from EoC surveys to refine estimates for day 1 SPAQ coverage and other key indicators.

The M&E framework, meanwhile, which is described in greater detail in the 2021 Philanthropy Report,[12] specifies a range of indicators relating to program inputs, outputs, outcomes, and impacts, which will align with key program quality standards that are currently in development. The M&E framework objectives and features are described in a recent Malaria Consortium technical brief[13]; the full framework is expected to be published as an article in a peer-reviewed academic journal by 2022/23. Issues identified in EoC surveys at the SA level, actions taken in response to these issues between cycles, and summaries of follow-up reports will be systematically recorded as part of the M&E framework. EoC and EoR data will also increasingly drive quality improvement initiatives between annual SMC rounds.

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 update contingency plans and protocols for SMC and monitoring and evaluation activities to both prevent disruptions and reduce the risk of COVID-19 transmission.

One area for further enquiry in 2022 will be the reasons for the high reported coverage of older ineligible children 60–119 months in Uganda, and EoC surveys may be modified for this purpose.

Data from EoR surveys, which typically occur one to two months after the completion of cycle 4 and now include a range of contextual variables, may be used to complement Malaria Consortium's work on evaluating the impact of SMC, which is described in more detail in the 2021 Philanthropy Report.[12] For example, survey data could be used to analyze the association between SMC status, and fever and confirmed malaria (based on caregiver reports) in the month after cycle 4 to evaluate the efficacy of SPAQ in reducing malaria incidence in eligible children. They may also be used to study the associations between socioeconomic variables and other household characteristics on the one hand, and caregiver refusal of SMC, adherence to day 2 and day 3 AQ administration, and SMC provision to ineligible children on the other hand. Although the variables included in questionnaires are more limited in scope, EoC LQAS surveys also provide a readily available source of data to answer research questions through secondary analyses.

In 2022, Malaria Consortium will continue to conduct EoC and EoR surveys in Burkina Faso, Chad, Nigeria, and Togo, as well as in our SMC pilot projects in Mozambique and Uganda. Further expansion of SMC to new countries will also be accompanied by implementation of coverage surveys.

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