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SUPPLEMENT ARTICLE

Evaluation of the Impact of Meningococcal Serogroup A Conjugate Vaccine Introduction on Second-Year-of-Life Vaccination Coverage in Burkina Faso

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Background. After successful meningococcal serogroup A conjugate vaccine (MACV) campaigns since 2010, Burkina Faso introduced MACV in March 2017 into the routine Expanded Programme for Immunization schedule at age 15–18 months, concomitantly with second-dose measles-containing vaccine (MCV2). We examined MCV2 coverage in pre- and post-MACV introduction cohorts to describe observed changes regionally and nationally.

Methods. A nationwide household cluster survey of children 18–41 months of age was conducted 1 year after MACV introduction. Coverage was assessed by verification of vaccination cards or recall. Two age groups were included to compare MCV2 coverage pre-MACV introduction (30–41 months) versus post-MACV introduction (18–26 months).

Results. In total, 15 925 households were surveyed; 7796 children were enrolled, including 3684 30–41 months of age and 3091 18–26 months of age. Vaccination documentation was observed for 86% of children. The MACV routine coverage was 58% (95% confidence interval [CI], 56%–61%) with variation by region (41%–76%). The MCV2 coverage was 62% (95% CI, 59%–65%) pre-MACV introduction and 67% (95% CI, 64%–69%) post-MACV introduction, an increase of 4.5% (95% CI, 1.3%–7.7%). Among children who received routine MACV and MCV2, 93% (95% CI, 91%–94%) received both at the same visit. Lack of caregiver awareness about the 15- to 18-month visit and vaccine unavailability were common reported barriers to vaccination.

Conclusions. A small yet significant increase in national MCV2 coverage was observed 1 year post-MACV introduction. The MACV/MCV2 coadministration was common. Findings will help inform strategies to strengthen second-year-of-life immunization coverage, including to address the communication and vaccine availability barriers identified.

Keywords. Burkina Faso; immunization schedule; measles vaccine; meningococcal conjugate vaccine; serogroup A meningococcal meningitis.

Meningococcal serogroup A conjugate vaccine ([MACV] MenAfriVac) was first used in Burkina Faso, Mali, and Niger in December 2010, and subsequently in other African countries where meningococcal serogroup A disease was highly endemic, via mass vaccination campaigns targeting those between the ages of 1 and 29 years. The high coverage achieved by these campaigns resulted in a substantial decrease in the incidence of *Neisseria meningitidis* serogroup A disease [1, 2]. To ensure long-term suppression of disease, the World Health Organization (WHO) recommended that the 26 countries with epidemic meningitis, in a region of sub-Saharan Africa known as the "meningitis belt," introduce 1 dose of MACV into the routine childhood Expanded Programme for Immunization (EPI) schedule at 9–18 months of age within 1–5 years after mass campaign completion [3]. In March 2017, Burkina Faso introduced MACV as part of the routine EPI schedule at 15–18 months of age, at the same immunization visit with a second dose of measles-containing vaccine (MCV2); both vaccines are supplied in 10-dose vials. Before routine MACV introduction, a catch-up campaign took place in November 2016 for children 1–6 years of age who were born after the 2010 mass vaccination campaign but before the age range eligible for the anticipated routine MACV introduction. Administrative campaign coverage in 2016 exceeded 100% nationally and in all regions [4].

Given the observed high community acceptance of MACV during campaigns in Burkina Faso [5], we hypothesized that introduction of this vaccine into the routine EPI schedule would

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encourage caregivers to bring their children for vaccination and, in turn, improve uptake of MCV2 among children receiving the 2 vaccines at the same healthcare visit. The MCV2 was introduced in Burkina Faso in October 2013, and WHO-United Nations Children's Fund (WUENIC) coverage estimates reached 17% in 2014 and remained at 50% in 2015, 2016, and 2017 [6]. Similar to that in other developing countries, MCV2 coverage is lower than that of the first dose of MCV (MCV1) and other vaccines scheduled during the first year of life because of high dropout rates (ie, the proportion of children who received MCV1 but not MCV2); this is also observed with other vaccines given in the second year of life [7].

Few prior studies have assessed the impact of new vaccine introduction in the routine EPI schedule in low-income countries, and those studies have not shown significant positive impact in terms of increased overall vaccination coverage or increased coverage for coadministered vaccines [8, 9]. To describe observed changes in MCV2 coverage after MACV introduction in Burkina Faso, we compared national and regional MCV2 coverage in cohorts of children who were age-eligible to receive MACV as part of the routine EPI schedule versus those who reached age 18 months before routine MACV rollout. We also sought to estimate both MACV and MCV2 coverage at the regional level, dropout rates between MCV2 and MCV1, and variables associated with MACV coverage. This study focuses on the quantitative aspect of the evaluation. A concurrent qualitative evaluation assessed knowledge and attitudes of healthcare providers and caregivers regarding disease awareness and vaccine acceptability [10].

METHODS

Survey Design

A nationwide vaccination coverage survey was conducted in Burkina Faso between February 12 and March 7, 2018, using 2-stage stratified cluster sampling to assess routine EPI coverage of MACV, MCV1, and MCV2. Cluster survey methods followed revised 2015 WHO guidelines [11]. The sampling frame was derived from the 2010 update to the 2006 national census [12]. In each of the 13 administrative regions, 35 enumeration areas were selected using probability proportional to size (455 total enumeration areas). In lieu of conducting a pre-MACV introduction survey, we assessed coverage for MCV2 by age group retroactively during the 2018 survey. To estimate regional MCV2 coverage for children eligible for MCV2 before MACV routine introduction (pre-MACV age group, 30–41 months) and for those eligible for MCV2 after MACV introduction (post-MACV age group, 18–26 months), we estimated a target sample size of 1167 households per stratum, 205 households of which were expected to consent and have age-eligible children. The calculated sample size allowed for regional MCV2 coverage estimates with ±10% precision, assuming 50% MCV2 coverage, a 90% probability of achieving the desired precision, an intracluster correlation of 0.2 and an average of 6 children enrolled per cluster (design effect of 2), and a 5% nonresponse rate. This calculated sample size was also expected to allow for a calculation of the difference in coverage at the national level between the 2 age groups of interest.

In each of the 455 enumeration areas, field teams demarcated the boundaries of the enumeration area, enumerated all households, and systematically selected 35 households per enumeration area by calculating a sampling interval. All children between 18 and 41 months of age at the time of the survey were eligible for inclusion; if a household had multiple children within this age group, all eligible children were included. Among eligible children, those aged 18–26 months and 30–41 months served as the post-MACV introduction and pre-MACV introduction populations, respectively, for estimation and comparison in the analysis. Children aged 27–29 months were eligible for both the MACV catch-up campaign and MACV via the routine EPI and were therefore not included in coverage comparisons but were included in other analyses for this study.

Before survey implementation, we conducted a formal training of the 39 field teams (3 teams per region), followed by a pilot study. Each field team consisted of 2 interviewers and a supervisor who were under the direction of a regional supervisor, for a total of 124 investigators deployed to the field for the survey.

Data Collection

In each selected household, a questionnaire was administered in the respective local language (*mooré*, *dioula*, *foufouldé*, *gourmatché*, *dagari/lobiri*, or *bobo/dioula*) to the head of household or other parent or guardian to collect household-level demographic and socioeconomic data. For each eligible child, vaccination status, dates of vaccination, channels of communication about immunization, and reasons for nonvaccination were recorded on electronic tablets. Vaccination status was assessed based on verification of vaccination cards, other written documentation, or by recall in the absence of written documentation. For this analysis, children with evidence of vaccination via either documentation or recall were defined as vaccinated.

Statistical Analysis

Descriptions of sample demographics are presented as unweighted. Estimates of coverage, difference in coverage, and the associated 95% (logit) confidence intervals (CIs) were calculated accounting for stratification, first stage clusters, and individual sampling weights using Stata 14 and SAS 9.4. Sampling weights accounted for the primary sampling unit and household selection probabilities. A post hoc analysis among those children with vaccination documentation available graphed reverse Kaplan-Meier survival curves to visually compare the time to MCV2 vaccination among children in pre- versus post-MACV routine EPI introduction groups.

We also conducted multivariable analyses for factors associated with MACV vaccination to obtain adjusted odd ratios (aORs) and 95% CIs. This model focused mainly on household-level factors; therefore, to avoid the correlation between household members, 1 randomly selected child between the ages of 18 and 26 months per household was included. Included variables were determined *a priori* as factors logically potentially associated with vaccination regardless of univariate significance: region, household setting (urban/rural), maternal age group, maternal education level, and vaccination information source.

Ethical Considerations

The protocol was approved by the Ethics Committee for Health Research in Burkina Faso. It was reviewed in accordance with the US Centers for Disease Control and Prevention human research protection procedures and was determined to be nonresearch, public health program evaluation. Informed consent was obtained for participation from mothers and caregivers before enrollment.

RESULTS

Sample Characteristics

In Burkina Faso, 15 925 households were surveyed from 455 enumeration areas in all 13 regions of the country (Figure 1). Among these households, 290 (2%) had no adult family member present to interview, 8739 (55%) had no eligible children, and 1 household refused to participate, leaving 6895 participating households (43%) with 7796 eligible children.

Demographic, socioeconomic, and vaccination characteristics for eligible children and mothers/caregivers are shown in Table 1. Of the 7796 eligible children, 3648 were 30–41 months of age (47%), 1057 were 27–29 months of age (14%), and 3091 were 18–26 months of age (40%) (Figure 1). The sex distribution of eligible children was approximately equal (48% female), and the majority of children lived in rural areas (77%). The age of mothers/caregivers ranged from 14 to 87 years (median 28, interquartile range 9). The majority of mothers/caregivers (84%) had no formal education; this proportion was higher in rural (88%) than in urban (71%) areas. The majority of caregivers reported their occupation as homemaker (71%), followed by agricultural worker or animal husbandry (18%). A smaller number of caregivers were self-employed (8%), students or unemployed (2%), or had salaried positions (1%). Unless otherwise stated, demographic characteristics of children and caregivers were similar in urban and rural areas.

Nationally, 86% (95% CI, 86%–87%) of children had a vaccination card or other form of written documentation available for the interviewer to observe. Observed card retention was slightly higher among children in the post-MACV introduction group than among the children in the pre-MACV group (89% vs 84%, respectively [$P < .0001$]). Overall, 94% (95% CI, 93%–94%) of caregivers reported having a vaccination card, whether observed by the interviewer or declared by the mother/caregiver. At the regional level, reported card retention ranged from 88% to 98%, but card retention was similar in urban (94%) and rural (93%) areas. A small proportion (1%) of mothers/caregivers presented vaccination documentation that was written on a document other than the official vaccination card; this documentation was included in coverage estimates.

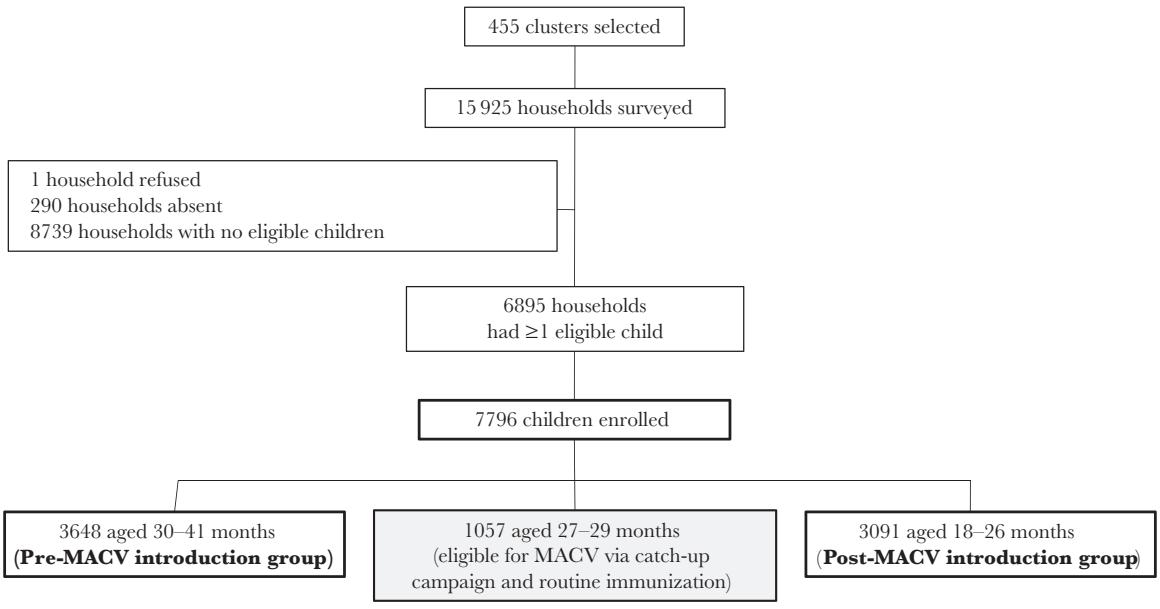

Figure 1. Household coverage survey population and eligible children. The 18- to 26-month and 30- to 41-month age groups were included in coverage analyses. MACV, meningococcal serogroup A conjugate vaccine.

Table 1. Characteristics of Eligible Children and Caregivers, Household Survey, Burkina Faso, 2018

Individual Characteristics	n	%
Characteristics of the child (N = 7796)		
Age category, months		
18–26	3091	40
27–29	1057	14
30–41	3648	47
Age, months (mean, SD)	29	7
Female	3737	48
Household setting		
Rural	5979	77
Urban	1817	23
Characteristics of the mother/caregiver (N = 7796[a])		
Age, years (mean, range)	29	14–87
Age category, years		
14–19	309	4
20–44	7283	93
≥45	204	3
Education level		
None	6548	84
Primary	799	10
Secondary	416	5
University	32	0.4
Occupation		
Homemaker	5592	71
Agriculture/animal husbandry	1369	18
Self-employed	591	8
Student/unemployed	151	2
Salaried	93	1
Child vaccination characteristics		
Vaccination card availability (N = 7796)		
Card observed	6646	85
Card reported available, not observed	631	8
Other written documentation observed	81	1
No card	438	6
Vaccination location for routine EPI MACV (N = 1776)		
Hospital or health center	1569	88
Community outreach	164	9
Other location	43	2
Vaccination location for routine EPI MCV2 (N = 4922)		
Hospital or health center	4437	90
Community outreach	406	8
Other location	79	2
Main source of information on immunization services (N = 7796)		
Community health workers	4949	64
Health center staff	382	5
Radio/television	136	2
Family/neighbors	106	1
Community leaders	23	0.3
None	2200	28

Abbreviations: EPI, Expanded Programme on Immunization; MACV, meningococcal serogroup A conjugate vaccine; MCV2, second-dose measles-containing vaccine; SD, standard deviation.

[a]The denominator for mothers/caregivers is equal to the number of eligible children because some households had more than 1 mother/caregiver (ie, polygamous households). Characteristics of an individual mother/caregiver would be counted more than once if the household had multiple children with the same caregiver.

Health facilities were where most children received vaccinations for both MACV (88%) and MCV2 (90%). Fewer than 10% of respondents cited vaccination via community outreach. Community-based health workers (64%) and other health staff members (5%) were the primary sources of information on childhood vaccination. Reports of receiving immunization information via media such as radio and television were rare (2%). It is notable that a significant proportion of mothers

(28%) reported having no source of information regarding immunization; lack of an information source was reported more frequently in urban (34%) than in rural (27%, $P < .0001$) areas.

Vaccination Coverage Estimates

Among children 18 to 26 months of age, MACV vaccination coverage in the routine EPI was 58% (95% CI, 56%–61%) nationally, with considerable variability by region (range, 41% to 76%) (Table 2). The MACV coverage was similar in rural (58%) and urban (59%) areas. Among children eligible for the 2016 MACV catch-up campaign (ages 27–41 months), 52% (95% CI, 49%–55%) received MACV during the campaign; coverage was 53% (95% CI, 50%–56%) in rural areas and 48% (95% CI, 44%–53%) in urban settings.

Nationally, MCV2 coverage was 62% (95% CI, 59%–65%) pre-MACV introduction and 67% (95% CI, 64%–69%) post-MACV introduction, with regional variation postintroduction (range, 48% to 82%) (Table 3). Comparison of pre- and post-MACV introduction groups showed an MCV2 coverage increase of 4.5% nationally (95% CI, 1.3%–7.7%). Significant increases in MCV2 coverage were observed in 2 regions and in urban (9.7%; 95% CI, 3.7–15.8) areas. A post hoc time to vaccination analysis included 3051 (84%) of the enrolled children in the pre-MACV group and 2745 (89%) in the post-MACV group. A small percentage of children in the pre-MACV group (2.1%) received MCV2 late (ie, beyond the age range of the post-MACV age group or >26 months of age). Reverse Kaplan-Meier curves comparing time to MCV2 vaccination showed vaccination to be more timely in the post-MACV introduction group (Supplemental Figure 1). Among children 18–26 months of age at the time of the survey vaccinated with MCV2 and with documentation available, 73% received MCV2 between 15 and 18 months of age, whereas 65% of children 30–41 months of age with vaccination documentation available received MCV2 according to the recommended schedule.

National MCV1 vaccination coverage did not significantly change pre- and post-MACV introduction (88% [95% CI, 87%–90%]) vs 89% [95% CI, 87%–90%], respectively) (Supplemental Table 1). The national MCV2 dropout rate, or the proportion of children who received MCV1 but not MCV2, decreased from 26% before MACV introduction to 23% post-MACV introduction ($P = .004$). A significant decrease in dropout rates was observed in urban areas (33% vs 25%, $P < .001$) but not in rural areas (24% vs 22%, $P = .09$).

Meningococcal Serogroup A Conjugate Vaccine and MCV2 Coadministration and Reasons for Nonvaccination

In the current survey, among eligible children between the ages of 18 and 26 months who received both vaccines in the routine EPI schedule, 93% (95% CI, 91%–94%) received both at the same time. Findings were similar in both urban and rural settings and across regions (Table 4). The main reasons for nonvaccination of children with MACV (n = 1277) were lack of awareness about the 15- to 18-month vaccination visit (39%), lack of availability of the vaccine (13%), mother/caregiver/family being too busy or traveling (9%), mother/caregiver rescheduling the visit (8%) or having to travel a long distance from the vaccination site (6%), and having too few children to open the vaccine vial (5%) (Table 5). Mothers/caregivers were asked separately about reasons for nonvaccination with MCV2;

Table 2. MACV Coverage After Routine EPI Introduction Among Children 18–26 Months[a], Household Survey, Burkina Faso, 2018

Survey Location	n	N	MACV Coverage % (95% CI)
Region			
Boucle du Mouhoun	169	226	76 (68–83)
Cascades	135	195	68 (58–77)
Centre Est	133	204	66 (58–73)
Nord	187	281	66 (55–75)
Centre Sud	181	292	64 (52–74)
Centre Nord	155	245	63 (52–73)
Plateau Central	154	243	63 (54–70)
Hauts Bassins	147	237	62 (50–72)
Centre Ouest	121	206	56 (45–67)
Sahel	171	349	49 (42–56)
Sud Ouest	71	151	48 (37–58)
Centre	60	143	43 (33–53)
Est	130	319	41 (32–50)
Setting			
Urban	495	821	59 (55–64)
Rural	1319	2270	58 (55–61)
National	1814	3091	58 (56–61)

Abbreviations: CI, confidence interval; EPI, Expanded Programme on Immunization; MACV, meningococcal serogroup A conjugate vaccine; N, unweighted denominator; n, unweighted numerator.

[a]Weighted coverage estimates are shown with unweighted numerators and denominators.

Table 3. MCV2 Coverage Before and After MACV EPI Introduction[a], Household Survey, Burkina Faso, 2018

	Children Who Received MCV2 Before EPI MACV Introduction (30–41 Months of Age)			Children Who Received MCV2 After EPI MACV Introduction (18–26 Months of Age)			Change in MCV2 Coverage[b]
Survey Location	n	N	% (95% CI)	n	N	% (95% CI)	% (95% CI)
Region							
Boucle du Mouhoun	218	311	70 (59–79)	183	226	82 (75–87)	**11.8 (2.7–20.9)**
Centre Nord	207	327	64 (55–72)	184	245	75 (66–82)	**10.7 (1.4–20.0)**
Hauts Bassins	160	273	60 (48–71)	167	237	69 (58–79)	9.1 (–5.7–23.9)
Sahel	196	343	57 (49–65)	222	349	64 (55–72)	7.0 (–1.2–15.2)
Centre	79	185	42 (34–51)	67	143	48 (38–58)	5.7 (–7.6–19.1)
Cascades	170	242	70 (62–77)	147	195	74 (66–81)	4.4 (–2.9–11.8)
Centre Ouest	169	259	63 (53–72)	144	206	66 (53–78)	2.9 (–11.7–17.6)
Centre Est	171	249	70 (61–77)	143	204	71 (63–77)	1.3 (–6.3–8.8)
Nord	204	299	68 (58–77)	193	281	69 (60–76)	0.4 (–9.9–10.7)
Centre Sud	250	350	75 (65–83)	209	292	75 (65–83)	0.3 (–6.9–7.5)
Plateau Central	199	273	74 (64–82)	176	243	73 (66–79)	–0.6 (–9.3–8.0)
Est	181	368	49 (40–58)	154	319	48 (39–57)	–1.2 (–11.4–9.0)
Sud Ouest	94	169	56 (48–65)	77	151	52 (41–62)	–4.9 (–16.1–6.3)
Setting							
Urban	427	727	56 (51–61)	545	821	66 (61–70)	**9.7 (3.7–15.8)**
Rural	1871	2921	64 (61–67)	1521	2270	67 (64–70)	3.0 (–0.7–6.6)
National	2298	3648	62 (59–65)	2066	3091	67 (64–69)	**4.5 (1.3–7.7)**

Abbreviations: CI, confidence interval; EPI, Expanded Programme on Immunization; MACV, meningococcal serogroup A conjugate vaccine; MCV2, second-dose measles-containing vaccine; N, unweighted denominator; n, unweighted numerator.

[a]Weighted estimates are shown with unweighted numerators and denominators.

[b]Bolded confidence intervals represent statistically significant results for change in coverage.

the most common reasons were similar in frequency to those cited for MACV (data not presented). Among 156 mothers/caregivers whose children received both MACV and MCV2 in the routine EPI schedule but did not receive them at the same 15- to 18-month visit, the most common reasons were lack of availability of MACV (62%), lack of availability of MCV2 (12%), and having too few children to open the MACV or MCV2 vaccine vial (6%) (Table 5).

Multivariable analysis revealed that the primary predictor for MACV nonvaccination among eligible children 18 to 26 months of age (n = 3091) was the region of residence; children in *Boucle du Mouhoun* were more likely to be vaccinated than those from any other region, and children in the *Est* region were less likely to be vaccinated (Table 6). In addition, children whose caregivers indicated they had no source of information on immunization services were more likely to be unvaccinated (aOR = 1.7; 95% CI, 1.3–2.2). Children whose caregivers were educated at the secondary or university level were less likely to be unvaccinated than children with uneducated caregivers (aOR = 0.6; 95% CI, 0.4–0.9). There was no significant association between MACV nonvaccination and setting (urban/rural) or maternal age group.

DISCUSSION

Consistent with the evaluation hypothesis, MCV2 coverage 1 year after introduction of MACV in the routine EPI schedule in Burkina Faso was higher at both the national level and in some regions compared with pre-MACV introduction coverage. However, the 4.5% increase in MCV2 coverage cannot be directly attributed to the introduction of MACV into the routine EPI schedule because it cannot be separated from the expected increase in MCV2 coverage over time. A post hoc descriptive analysis showed that, among children in the post-MACV cohort with vaccination documentation available, a higher percentage received a timely dose of MCV2 than those in the pre-MACV cohort. The difference in MCV2 vaccination coverage by 26-months between the pre- and post-MACV cohorts could have been greater than the estimated difference we report here because the post-MACV cohort had a longer opportunity to be vaccinated. Post-MACV introduction coverage was relatively low for both MACV and MCV2 (<60%); opportunities for catch-up vaccination of children after the recommended age range could increase coverage in the future. In contrast to MCV2, MCV1 coverage was not observed to increase significantly during the same pre- to post-MACV introduction period nationally or in any region.

By 1-year postintroduction, the coverage estimate for MACV exceeded 60% in 8 of the 13 regions; only the highest performing region, Boucle du Mouhoun, achieved the national target of greater than 70% [13]. After the mass vaccination campaign in 2010, MACV coverage in the target age group of 1–29 years was estimated as 95.6% nationally and exceeded 90% in all regions and all eligible age groups [14]. Despite high coverage, acceptability, and desirability of the vaccine in

Table 4. Children Aged 18–26 Months Who Received Both MACV and MCV2 at the Same Time at EPI Visits[a], Household Survey, Burkina Faso, 2018

Survey Location	n	N	MACV and MCV2 Coadministration % (95% CI)
Region			
Boucle du Mouhoun	159	167	95 (90–98)
Centre	57	60	95 (85–99)
Centre Nord	141	149	95 (88–98)
Centre Sud	171	179	95 (90–98)
Hauts Bassins	136	145	93 (88–96)
Sahel	156	167	93 (87–97)
Cascades	123	134	92 (85–96)
Centre Est	120	132	91 (85–95)
Centre Ouest	108	119	91 (82–96)
Plateau Central	134	149	91 (84–95)
Sud Ouest	61	66	91 (78–97)
Est	109	123	89 (78–95)
Nord	151	170	89 (80–95)
Setting			
Urban	443	474	93 (90–95)
Rural	1183	1286	93 (91–94)
National	1626	1760	93 (91–94)

Abbreviations: CI, confidence interval; EPI, Expanded Programme on Immunization; MACV, meningococcal serogroup A conjugate vaccine; MCV2, second-dose measles-containing vaccine; N, unweighted denominator; n, unweighted numerator.

[a]Weighted coverage estimates are shown with unweighted numerators and denominators, among children 18–26 months who received both MACV and MCV2 via EPI, N = 1760.

communities during the mass campaign in 2010 [5], this evaluation showed routine MACV coverage 1 year after introduction in the routine EPI schedule to be substantially lower in comparison. An analysis of global trends in routine vaccination coverage since the start of EPI programs in 1980 revealed that achieving high coverage for individual vaccines given during the first year of life takes multiple years and varies greatly by antigen, country, and region [15]. Data on trends in coverage over time are very limited when considering newer second-year-of-life vaccination schedules. This evaluation provides an early assessment at 12 months after introduction, and further increases in both MCV2 and MACV coverage are anticipated. Nonetheless, the estimates for both routine MACV coverage (58%) and the 2016 catch-up campaign coverage among eligible children (52% among children 17–41 months of age) were both relatively low and were lower than campaign administrative coverage estimates (>100%) [4]. Burkina Faso, Ghana, and the Gambia have introduced MACV into the routine childhood EPI schedule in the second year of life, whereas 6 other countries have introduced MACV at 9–11 months of age in conjunction with MCV1. As of May 2019, 17 of the 26 meningitis belt countries had not yet introduced MACV into the childhood EPI schedule. The modest coverage achieved in Burkina Faso in the first year after routine introduction and lack of negative effect on concurrent MCV2 coverage have the potential to inform schedule selection in the countries that will introduce MACV in the future. If high MACV coverage is not achieved during the initial routine postintroduction year or years, strengthening of routine EPI services as well as conducting additional catch-up campaigns may be needed to ensure adequate population immunity against *N meningitidis* serogroup A.

The survey results highlight imbalances in vaccination coverage across regions in Burkina Faso, particularly for MCV2 and MACV vaccination in the second year of life, where there was approximately a 35% coverage difference between high- and low-performing regions. These results will allow the EPI to gather lessons learned from high-performing regions and to focus strategies for coverage improvement in lower-performing regions. Although challenges have been reported in achieving high coverage in densely populated urban areas compared with rural areas in Burkina Faso [16, 17], rural and urban coverages in this survey were similar; the only exception was that MCV1/MCV2 dropout rates were higher in urban settings. Although vaccine access is challenging in some rural and remote settings, the lack of information sources about vaccination was reported more frequently in urban than in rural areas in this survey (34% versus 27%, respectively), possibly because urban mothers/caregivers spend more time out of the home and have fewer opportunities for interaction with community health workers.

The most common reason for nonvaccination identified during this survey was a lack of awareness of the 15- to 18-month vaccination visit, followed by lack of availability of the vaccine, competing priorities of the family, having too few children present at the vaccination site to open the vaccine vial, and having to travel a long distance to the vaccination site. Caregivers and healthcare providers who participated in a simultaneous qualitative evaluation echoed these reasons for nonvaccination [10], many of which have been reported

Table 5. Reasons for Nonvaccination, Household Survey, Burkina Faso, 2018

Reasons for MACV Nonvaccination as Part of the EPI, Among Children Aged 18–26 Months (N = 1277/3091)	n	%
Lack of awareness of 15th month visit (need, place, time)	501	39.2
Vaccine not available	168	13.2
Mother/family too busy or traveling	117	9.2
Mother/caregiver rescheduled vaccination date	102	8.0
Place of vaccination too far	72	5.6
Too few children to open vial	63	4.9
Vaccinated during the 2016 catch-up campaign	52	4.1
Family problem: illness or death	39	3.1
Sick child not brought for vaccination or not vaccinated due to illness	29	2.3
Vaccinator absent	27	2.1
Inconvenient hours of vaccination	13	1.0
Long waiting times	9	0.7
Family problem: separation of parents	8	0.6
Fear of side effects	4	0.3
Lost vaccination card	4	0.3
Family problem: religion	3	0.2
Lack of confidence in the vaccine/vaccination	2	0.2
Poor reception by vaccination staff	1	0.1
Cost of vaccination or syringe	0	0.0
Other reasons	63	4.9
Total	1277	100
Reasons for nonvaccination of MACV and MCV2 at the same time during the 15- to 18-month visit, among children aged 18–29 months who received both vaccines (N = 156/2080)	n	%
MACV not available	96	61.5
MCV2 not available	18	11.5
Too few children to open MACV vial	10	6.4
Received MACV during the 2016 catch-up campaign	5	3.2
Too few children to open MCV2 vial	2	1.3
Fear of side effects	3	1.9
Long waiting times	1	0.6
Lack of confidence in the vaccine/vaccination	1	0.6
Other reasons	20	12.8
Total	156	100

Abbreviations: EPI, Expanded Programme on Immunization; MACV, meningococcal serogroup A conjugate vaccine; MCV2, second-dose measles-containing vaccine.

previously in Burkina Faso and other low-income countries [16, 18–21]. Strategies are needed to overcome challenges to achieving high coverage for vaccines given in the second year of life, both in terms of improving vaccine demand and having an adequate supply and provision of services. Before the introduction of MACV into the routine EPI schedule, the Burkina Faso Ministry of Health provided training sessions for healthcare workers on technical and programmatic characteristics of MACV and launched a national communications campaign to inform specific groups and communities about the availability of the new vaccine and vaccination in general. Communications strategies intended to increase awareness of the new immunization visits and encourage adoption of new behaviors by parents might increase coverage. To foster greater commitment to immunization, the communications strategy focused on political, social, and religious authorities, organized community groups, media outlets (print, radio, television), and health workers in addition to the primary target group (parents) [13]. Despite preparation for introduction, approximately 30% of the surveyed population noted that they did not have any source of information on the availability of immunization services, suggesting that strengthening of social mobilization and more consistent rollout of preparatory activities in both rural and urban settings could increase uptake of future vaccines. Strengthening of healthcare staff messaging about the availability of second-year-of life vaccines at prenatal visits, childhood vaccination visits, as well as at trainings for local community health workers could improve community awareness and improve coverage of new vaccines during the first year of introduction and beyond. The concomitant qualitative results from this evaluation provide additional information on caregiver and community knowledge about vaccine-preventable diseases, vaccines available in the second year of life, and barriers to vaccination, including gaps in communication [10]. These results will be used to inform strategies to improve vaccination coverage during the second year of life.

Table 6. Predictors of MACV Nonvaccination Among EPI-Eligible Children 18–26 Months of Age (N = 3091) From Multivariable Analysis, Household Survey, Burkina Faso, 2018

Predictor	aOR[b]	95% CI
Region		
Boucle du Mouhoun[a]	—	—
Cascades	**2.2**	**1.2–3.9**
Centre	**5.8**	**3.3–10.2**
Centre Est	**2.4**	**1.4–4.0**
Centre Nord	**2.8**	**1.5–5.1**
Centre oust	**3.2**	**1.8–5.7**
Centre Sud	**2.3**	**1.2–4.3**
Est	**6.4**	**3.6–11.2**
Hauts Bassins	**2.4**	**1.3–4.5**
Nord	**2.6**	**1.5–4.8**
Plateau Central	**2.5**	**1.5–4.2**
Sahel	**4.7**	**2.8–7.8**
Sud Ouest	**5.0**	**2.9–8.6**
Setting		
Urban	0.8	0.6–1.0
Rural[a]	—	—
Mother/caregiver age group (years)		
14–19	1.1	0.8–1.6
20–44[a]	—	—
≥45	1.5	0.9–2.4
Mother/caregiver education level		
None[a]	—	—
Primary	0.9	0.6–1.1
Secondary or university	**0.6**	**0.4–0.9**
Reported primary source of information on immunization services		
Radio/television	1.9	0.7–4.9
Healthcare staff	0.9	0.6–1.3
Community health workers[a]	—	—
Community members (leaders, neighbors, family)	1.7	0.8–3.5
None	**1.7**	**1.3–2.2**

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; EPI, Expanded Programme on Immunization; MACV, meningococcal serogroup A conjugate vaccine.

[a]Reference groups.

[b]Bolded confidence intervals represent statistically significant results.

The lack of availability of MACV reported by 13% of participants at the scheduled 15- to 18-month visit accounts for missed opportunities for vaccination. Further evaluation could elucidate whether this is related to issues with microplanning and distribution to individual vaccination facilities or to refusal to vaccinate children based on restrictive vial-opening policies for multiple-dose vials [16, 20]. Both MACV and MCV2 vials contain 10 doses each. Given competing priorities in the lives of mothers/caregivers, maintaining flexibility in the vaccination schedule during the second year of life is likely to provide valuable additional opportunities for vaccination to protect against meningitis and measles.

This evaluation had several limitations. One year post-MACV introduction is a relatively short time frame in which to assess achievement of coverage. New vaccine coverage will be expected to increase over time as the EPI addresses challenges to delivery of the new vaccine and as the community becomes more aware of the availability of vaccine. Another limitation to our objective to assess the impact of MACV on MCV2 coverage is the design relying on a comparison of older and younger pre- and post-MACV introduction age groups, respectively. Without a true control group, we cannot know what the average change in MCV2 coverage would have been in absence of MACV introduction; therefore, we cannot attribute the observed change to any specific cause. We estimated coverage using reported vaccination data from observed vaccination cards and from caregiver recall in the absence of a card. Recall bias may have occurred for caregivers of children in the older pre-MACV age group, although card retention (where a vaccination document was available for review) was high, over 84% in both age groups.

CONCLUSIONS

Documentation of trends in routine MACV coverage in Burkina Faso and the continued obstacles to achieving high coverage of both MACV and MCV2 have the potential to inform future introduction strategies for MACV and other

priority vaccines scheduled during the second year of life. Few reports documenting increasing trends in new vaccination coverage during the second year of life exist in the literature. A repeat evaluation in Burkina Faso allowing more time for strengthening of coverage may be useful for tracking trends and identifying successful strategies to increase vaccination coverage and to thereby increase population immunity to control epidemic meningitis.

SUPPLEMENTARY DATA

Supplementary materials are available at *The Journal of Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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