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Serogroup A meningococcal conjugate (PsA-TT) vaccine coverage and measles vaccine coverage in Burkina Faso—Implications for introduction of PsA-TT into the Expanded Programme on Immunization

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Abstract

Background—A new serogroup A meningococcal conjugate vaccine (PsA-TT, MenAfriVac™) has been developed to combat devastating serogroup A *Neisseria meningitis* (MenA) epidemics in Africa. A mass immunization campaign targeting 1–29 year olds was conducted in Burkina Faso in December 2010. Protection of subsequent infant cohorts will be necessary through either introduction of PsA-TT into the routine Expanded Programme on Immunization (EPI) or periodic repeat mass vaccination campaigns.

Objectives—To inform future immunization policy for PsA-TT vaccination of infants through a comparison of PsA-TT campaign vaccination coverage and routine measles-containing vaccine (MCV) coverage in Burkina Faso.

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Conflict of interest statement

No authors have any relevant conflicts of interest to disclose.

Methods—A national survey was conducted in Burkina Faso during December 17–27, 2011 using stratified cluster sampling to assess PsA-TT vaccine coverage achieved by the 2010 nationwide immunization campaign among 2–30 year olds and routine MCV coverage among 12–23 month olds. Coverage estimates and 95% Confidence Intervals (CI) were calculated, reasons for non-vaccination and methods of campaign communication were described, and a multivariable analysis for factors associated with vaccination was conducted.

Results—National overall PsA-TT campaign coverage was 95.9% (95% CI: 95.0–96.7) with coverage greater than 90% all 13 regions of Burkina Faso. National overall routine MCV coverage was 92.5% (95% CI: 90.5–94.1), but ranged from 75.3% to 95.3% by region. The primary predictor for PsA-TT vaccination among all age groups was a head of household informed of the campaign. PsA-TT vaccination was more likely in residents of rural settings, whereas MCV vaccination was more likely in residents of urban settings.

Conclusion—Overall national vaccination rates in Burkina Faso were similar for PsA-TT and MCV vaccine. The regions with MCV coverage below targets may be at risk for sub-optimal vaccination coverage if PsA-TT is introduced in EPI. These results highlight the need for assessments of routine vaccination coverage to guide PsA-TT immunization policy in meningitis belt countries.

Keywords

Serogroup A meningococcal meningitis; Conjugate meningococcal vaccine; PsA-TT; Measles; Measles vaccine; Burkina Faso

1. Background

In December 2010, Burkina Faso became the first country to introduce PsA-TT (MenAfriVac™), a novel meningococcal serogroup A polysaccharide conjugate vaccine. PsA-TT was developed to eliminate epidemic meningitis as a public health problem in the ‘meningitis belt’ of Sub-Saharan Africa, a region stretching from Senegal to Ethiopia and home to 430 million people. The country vaccinated over 11 million persons, or approximately 70% of the country’s population, via a 10-day nationwide mass immunization campaign, achieving vaccination coverage of 95.9% in the target group of 1–29 year-olds [1].

The strategy for PsA-TT vaccine introduction in 26 African countries from 2010 to 2016 consists of two phases [2]. In the first phase, one-time mass immunization campaigns targeting 1–29 year olds are conducted to rapidly interrupt disease transmission and eliminate carriage. In the second phase, new birth cohorts will be protected through either introduction of the vaccine into the Expanded Programme on Immunization (EPI) schedule as a 1 or 2 dose series with likely measles-containing vaccine (MCV) coadministration, and/or via periodic repeat mass vaccination campaigns targeting children aged 1–4 years [3]. Pending the results of infant clinical trials [4], the vaccine has not yet been licensed for use in infants and no countries have introduced the vaccine through routine EPI. The future vaccination strategy for the protection of infants will depend in part on routine EPI coverage in implementing countries [2].

To guide future PsA-TT vaccine policy in infants, we assessed routine MCV coverage among 12–23 month old residents of households included in a nationwide survey of PsA-TT vaccine coverage following the mass immunization campaign in Burkina Faso [1], compared PsA-TT campaign coverage with routine MCV coverage estimates within households and among regions, and identified predictors for vaccination and reasons for non-vaccination with PsA-TT and MCV vaccines.

2. Methods

Burkina Faso is a hyperendemic country for meningococcal meningitis in West Africa with a 2010 population of 15.7 million persons [5]. The nationwide PsA-TT immunization campaign targeting 1–29 year olds, or approximately 11 million persons, was conducted from December 6 to 15, 2010. A vaccination card designed specifically for the campaign was distributed to each vaccinated person. At the time of the survey in Burkina Faso, MCV was delivered through routine EPI as a single dose between the ages of 9 and 11 months and through periodic supplemental immunization activities (SIAs). Receipt of measles vaccination delivered through EPI is documented by a vaccination book used to record routine immunizations.

A national survey was conducted in Burkina Faso during December 17–27, 2011, using stratified cluster sampling to assess PsA-TT vaccine coverage achieved by the nationwide immunization campaign among 2–30 year olds (those aged 1–29 years during the December 2010 campaign) and routine MCV coverage among 12–23 month olds. The sampling frame was derived from 2011 population estimates projected from the 2006 national census [6]. Strata were defined by the 13 administrative regions. Twenty-five enumeration areas were selected from each stratum in the first stage using probability proportional to size. In each enumeration area, field teams demarcated the boundaries of the enumeration area, enumerated all the households, and systematically selected 20 households by calculation of a sampling interval. All persons aged 1–30 years residing in selected households were included. Based on demographic indictors of household size and age distribution in Burkina Faso, a sample size of 500 households per stratum was calculated to provide regional estimates for PsA-TT vaccination for three age groups (2–5 years, 6–15 years, and 16–30 years) and national MCV coverage estimate in 12–23 month olds with ±8% precision, assuming 80% coverage, a 95% probability of achieving the desired precision, a design effect of two, and a 5% nonresponse rate.

A questionnaire was administered to heads of household to collect household demographic and socioeconomic information. For PsA-TT campaign-eligible subjects, vaccination status, modes of communication regarding the PsA-TT campaign, and reasons for non-vaccination were recorded by interviewing eligible household members, or the head of household or other parent for children too young to respond. Vaccination status was determined by review of a PsA-TT campaign vaccination card or by recall. Persons with documentation of receipt of PsA-TT by vaccination card or who stated that they had received the vaccine without documentation by vaccination card were defined as vaccinated. Additionally, presence in Burkina Faso during the PsA-TT campaign was recorded to obtain campaign coverage estimates and 2011 population coverage estimates, accounting for migration.

For MCV-eligible subjects aged 12–23 months, vaccination status, date of vaccination, and reasons for non-vaccination were recorded by interview with parent or guardian of the child. Vaccination status was determined by review of the child's vaccination book or by parental recall. Children with documentation of MCV receipt by vaccination book or a parent that stated the child had received the vaccine without documentation by vaccination book were defined as vaccinated. Of note, a nationwide measles SIA targeting children 9–59 months of age was conducted in April 2011 following WHO recommendations for measles elimination by providing high vaccination coverage with two doses of MCV [7]. Thus, survey participants aged 17–23 months were eligible for vaccination through both routine EPI and the SIA. Receipt of vaccination through this SIA was not documented in the routine EPI vaccination book. For children with report of MCV receipt but without documentation in the routine immunization book, interviewers were instructed to elicit information surrounding the administration of the vaccine and confirm that it was received through routine health services and not during this SIA.

Before survey implementation, a pilot study and formal training of the 65 field teams were conducted. Each field team consisted of two interviewers and a supervisor who were under the direction of a regional supervisor, for a total of 208 investigators deployed to the field for the survey.

Estimates of coverage and (Wilson) 95% confidence intervals (CIs) accounted for the stratified cluster design using SAS 9.3 (SAS Institute). For the national coverage estimates, stratum-specific weights were included. Multivariable analysis for factors associated with vaccination was conducted using SAS-callable SUDAAN v10 to obtain adjusted relative risks (aRR) and 95% CIs. For this analysis, the factors of interest were household-level; therefore, to avoid the correlation among household members, one randomly selected person per age group per household was included for the PsA-TT analysis and one child per household for the MCV analysis. All variables determined *a priori* as potential factors associated with vaccination were included in the model, regardless of univariate significance. The design effects (DE) were estimated on the sample with one person per HH using survey procedures accounting for the cluster sampling only. The intraclass correlations (ICC) were estimated by (DE − 1)/(mean number observations per cluster − 1).

This evaluation was approved by the human subjects advisor at CDC as public health practice and exempted from full review by the CDC Institutional Review Board and the Burkina Faso Ministry of Health ethics committee. Informed consent for participation was obtained prior to enrollment.

3. Results

A total of 6455 households were surveyed from 325 enumeration areas. The sampled enumeration areas were geographically diverse, covering 57 of 63 health districts, and all 13 regions. Among these households, 6434 (99.7%) consented to survey participation and 25,627 persons were enrolled: 23,957 PsA-TT-eligible persons from 6102 households and 1670 MCV-eligible children from 1340 households. The majority (97.5%) of households with a 12–23 month old also had at least one member eligible for PsA-TT vaccination

during the campaign. Among enrolled persons, 219 (0.9%) were excluded from the analysis due to unknown or ineligible age: 67 (0.3%) PsA-TT-eligible persons and 152 (9.1%) MCV-eligible children.

Among the 23,769 persons aged 2–30 years surveyed, 23,577 (99.2%) reported presence in Burkina Faso during the 2010 vaccination campaign. Vaccination coverage among persons residing in Burkina Faso during the campaign vs. coverage among all surveyed persons, regarding of presence during the campaign, did not differ substantially: 95.9% (95% CI: 95.0–96.7) vs. 95.1% (95% CI: 94.2–95.9), respectively, and thus only those results among persons present in Burkina Faso during the campaign are reported.

National campaign PsA-TT vaccine coverage was 95.9%: 74.3% by vaccine card and 21.6% by recall (Table 1). Vaccination coverage was high in all 13 regions (Table 1a), in all age groups (Table 2), and did not differ significantly among females and males (96.1% vs. 95.8%, $p = 0.49$). Coverage was higher in rural settings compared to urban settings (96.7% vs. 92.7%, $p = <0.01$).

National routine MCV coverage among 12–23 month olds was 92.5%, with 53.6% by vaccination book and 38.9% by recall only. Overall coverage by region ranged from 75.3% to 96.3%, with coverage by vaccination book ranging widely from 17.3% to 76.3% (Tables 1 and 2). There was no difference in vaccination status among females and males (92.4% vs. 92.5%, $p = 0.97$). Reported routine EPI coverage among 17–23 month olds ($n = 681$) who were eligible for both routine EPI and SIA-administered MCV during the study period was 93.3%, similar to the coverage among the 12–16 month olds who were only MCV-eligible through routine EPI ($p = 0.51$). In addition, the proportion of 17–23 month olds with report of MCV vaccination by recall only was 35.4% compared to 42.2% among 12–16 month olds ($p = 0.05$). MCV vaccination was higher among infants in urban vs. rural settings (97.9% vs. 91.8%, $p = 0.04$). Among the 593 children with known date of birth and known date of MCV vaccination, the median age of vaccination was 9 months (range 6–22 months).

Among the 5025 households participating in the PsA-TT survey with more than 1 enrolled person in the household and where vaccination status of household members was known, high concordance of vaccination status within the household was observed: all members of the household received PsA-TT in 4565 (90.9%) of households, and in 121 (2.4%) households, no persons received PsA-TT. Among the 119 households participating in the MCV survey with more than 1 enrolled child in the household and where the vaccination status was known, high concordance was observed for MCV vaccination: all children in the household received MCV in 111 (93.3%) of household and in 5 households (4.2%) none of the children received MCV vaccine.

Among the 1242 households that had at least one PsA-TT and MCV eligible participant and known vaccination status of all household members, 1059 (85.2%) households were fully vaccinated for both PsA-TT and MCV. In 104 households (8.4%), at least one eligible household member received PsA-TT vaccine but no eligible household members received MCV vaccine. In contrast, only 10 households (0.01%) had at least one child vaccinated for

MCV but no household members vaccinated for PsA-TT. In only six households (<0.01%), no eligible household members received PsA-TT or MCV vaccine.

Among the 775 persons unvaccinated during the PsA-TT campaign and the 115 children unvaccinated for routine MCV with a known reason for non-vaccination, the most commonly cited reasons for both vaccines were ‘not informed’ and ‘absence’ (Table 3). The most commonly reported modes of PsA-TT campaign communication were criers (social mobilizers) (36.8%), and community health workers (24.0%) (Fig. 1).

The primary predictor for PsA-TT vaccination in all age groups was having a head of household informed of the PsA-TT campaign: aRR of 1.35 in 2–5 year olds (95% CI 1.17–1.56), aRR of 1.35 in 6–15 year olds (95% 1.18–1.56), and aRR of 1.47 in 16–30 year olds (95% 1.28–1.70). Factors significantly associated with receipt of campaign communication were head of household employed as a salaried worker (aRR 1.04, 95% CI 1.01–1.07) and rural setting (aRR 1.04, 95% CI 1.01–1.03). There was no association between vaccination and sex, employment status of head of household, and household size (Table 4).

Receipt of MCV was less likely in rural settings (aRR 0.94, 95% CI 0.90–0.97), and less likely with a head of household with any employment (aRR 0.94, 95% CI 0.91–0.98), defined as any wage or goods-receiving employment, including agriculture (Table 4). Vaccination was not associated with sex, education status of head of household, presence of other age groups in the house outside of infant age group, or household size.

4. Discussion

The results of this survey demonstrate that Burkina Faso successfully achieved the first phase of PsA-TT vaccine introduction through high mass vaccination campaign coverage in the target group aged 1–29 years. However, with the accumulation of susceptible birth cohorts since the 2010 campaign, implementation of a strategy for protection of infants is critical. As introduction of PsA-TT into EPI through co-administration with MCV at age 9 months is likely, routine MCV vaccination coverage estimates may be an indicator for future PsA-TT coverage. Our concurrent evaluation of routine MCV coverage among 12–23 month olds enrolled from the same households as PsA-TT eligible persons demonstrated that overall estimated routine MCV coverage was high, although certain regions of Burkina Faso may be at risk for sub-optimal PsA-TT vaccination if introduced into EPI.

While we found similar overall rates of PsA-TT campaign (95.9%) and routine MCV (92.5%) vaccination coverage, vaccination by card or vaccine book differed substantially: 74.3% for PsA-TT and 53.6% for MCV, with an even greater disparity by region. The high percentage of recall-only MCV vaccination substantially limits the interpretation of routine MCV coverage as a proxy for future PsA-TT vaccine coverage if delivered through routine EPI. It is likely that some of the 17–23 month old children who reported MCV receipt without documentation in the vaccine book received MCV through the SIA, and not through routine services as reported. However, the 2010 Burkina Faso Demographic Health Survey–Multiple Indicator Cluster Survey 4 (DHS–MICS4) found a slightly lower overall MCV coverage of 87.3%, but much higher coverage documented by card at 75.8%, and only

11.5% by recall. The reasons for this substantial disparity among the two surveys, which both enrolled large sample sizes and utilized similar sampling strategies, are unclear. Despite this uncertainty, the regions with the lowest MCV vaccination documented by card in our survey corresponded to those with the lowest overall coverage in the DHS–MICS4 survey [8]. Regardless, the overall MCV coverage estimates for Sahel and Sud-Ouest region were below international measles elimination targets for coverage of the first routine MCV dose [7]. Thus, these regions in Burkina Faso may benefit from either repeat PsA-TT mass immunization campaigns alone or as a supplement to routine immunization services similar to the “Catch-Up, Keep-Up, Follow-up” measles elimination strategy [9,10], as opposed to introduction of PsA-TT into routine EPI alone for protection of infant cohorts. Sahel and Sud-Ouest, despite low overall MCV vaccination of 75.3% and 82.6% (17.3% and 35.7% by vaccine book), respectively, both attained very high PsA-TT campaign coverage of 94.5% and 95.9% (76.3% and 76.8% by vaccination card). Furthermore, achievement of high PsA-TT coverage in Sahel and Est, regions with low population density and large nomadic populations, demonstrates that the communication and operational strategies employed to reach these populations during the PsA-TT campaign were successful. As opposed to the higher routine MCV coverage in urban settings, campaign PsA-TT coverage was higher in rural settings, which comprise nearly 80% of the country [11], suggesting that future national PsA-TT coverage rates may be higher with a campaign approach as long as vaccine demand remains high and campaigns remain well-managed.

The decision to introduce PsA-TT into EPI or via follow-up immunization campaigns will involve other factors in addition to routine vaccine coverage estimates, including safety and immunogenicity of coadministration with other vaccines, duration of protection, and cost. Results from a clinical trial demonstrate that concomitant administration of PsA-TT with local EPI vaccines is safe and immunogenic [12]; an evaluation to determine the optimal schedule and formulation of PsA-TT for routine vaccination in co-administration with measles vaccine is ongoing [4]. A mathematical model developed to identify optimal long-term PsA-TT vaccination strategies using surveillance and carriage data from Burkina Faso demonstrated that either strategy, introduction into EPI or repeat mass campaigns, would be effective in substantially reducing MenA incidence over a 40 year period following the initial mass immunization campaign. The most effective modelled strategy is mass immunization campaigns in 1–5 year olds every 5 years, with introduction of PsA-TT into the routine EPI program resulting in higher predicted MenA incidence than periodic immunization campaigns [13]. However, there is limited data on the duration of protection following PsA-TT vaccination, and thus forecasts of vaccine program impact may vary depending on assumptions made about duration of protection. A cost savings analysis conducted using data from neighboring Niger found that all evaluated vaccination strategies, including a single dose of PsA-TT at 9 months or at 12–18 months, a two-dose series at 14 weeks and 9 months, or follow-up campaigns in 1–4 year olds, are projected to result in considerable savings to the health systems of affected countries. However, introduction of PsA-TT into EPI as a single dose at age 9 months was expected to have the greatest cost savings [14]. Given the higher predicted disease reductions through a periodic campaign approach yet lower projected costs through introduction into EPI, a long-term and

sustainable plan to eliminate MenA meningitis epidemics will need to carefully weigh the cost versus effectiveness of the different strategies under consideration.

Whether the recommended strategy for protection of infant cohorts involves repeat mass campaigns, introduction of PsA-TT into EPI, or both, achieving and sustaining high PsA-TT coverage in 'meningitis belt' countries could prove challenging. Meningitis belt countries are among the least developed in the world, constituting 9 of the 10 lowest-ranking countries on the United Nations Human Development Index [15]. Weak and fragile public health infrastructures may limit the delivery of routine immunization services in meningitis belt countries, which represent 5 of the 10 countries in the world with the lowest routine MCV coverage [16]. Even with Burkina Faso's high-performing immunization program, which achieved a remarkable increase in reported routine MCV coverage from 48% in 2000 to 92% in 2010 and multiple years with SIA coverage >95% [17], the country experienced its largest ever recorded measles epidemic in 2009 with over 54,000 cases. Non-vaccination, likely longstanding as evidenced by the high disease rates in adolescents and adults, was identified as the greatest risk factor [18]. These challenges highlight the need for support for immunization programs with careful monitoring of vaccine introduction and strong surveillance systems to ensure sustained high coverage and rapid identification of gaps in population immunity.

The first phase of PsA-TT vaccine introduction in Burkina Faso and elsewhere in the meningitis belt has been a remarkable public health success. By the end of 2013, over 150 million persons in 12 countries received PsA-TT vaccine via mass immunization campaigns, with national and subnational administrative vaccine coverage estimates at >90% in most countries. Substantial impact of the vaccine has already been observed on MenA incidence and carriage in countries that have introduced the vaccine [19–21], and overall, the number of suspected meningitis cases in the Meningitis Belt reached a 10-year low in 2013 [22]. With over 160 million more persons in 14 countries targeted to receive the vaccine by the end of 2016 through mass campaigns, PsA-TT holds great promise for further reductions in MenA disease. To sustain these gains over the long term, protection of infant cohorts is a critical next step. As vaccine policy around this next phase evolves, an assessment of each country's routine vaccination coverage and immunization program will be important to guide decision-making.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.vaccine.2015.01.043.

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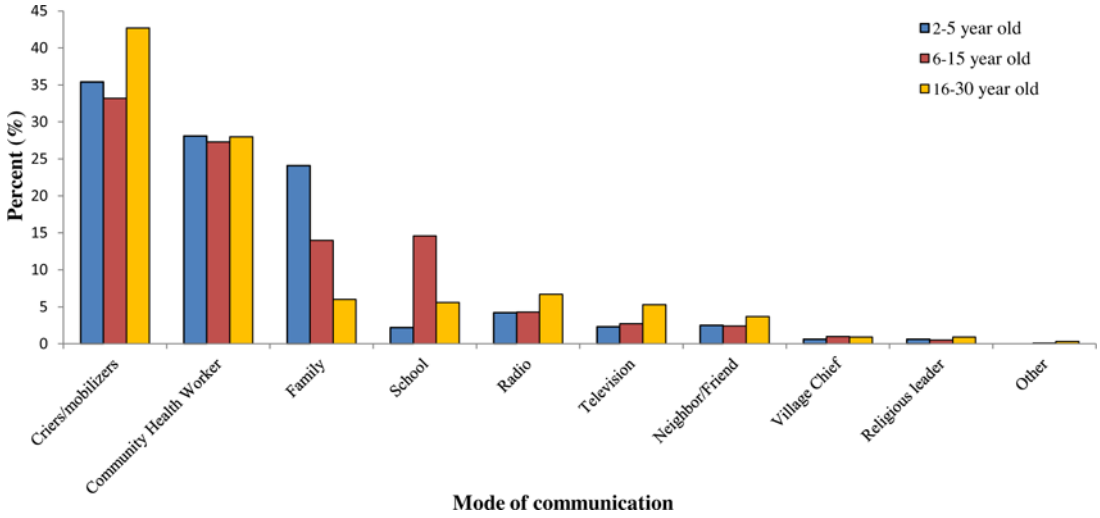

Fig. 1.
Mode of PsA-TT campaign communication by age group.

Table 1

Serogroup A meningococcal (PsA-TT) conjugate vaccine and measles-containing vaccine (MCV) administrative and survey coverage by region.

Region	**PsA-TT (aged 2–30 years)**					
	Sample size (*n*)	**Administrative coverage (%)**	**Survey coverage**			
			Total coverage (card + recall)		**Card only**	
			%	**95% CI**	**%**	**95% CI**
Boucle du Mouhoun	1998	103.1	96.0	92.6–97.9	72.4	62.3–82.5
Cascades	1655	105.3	98.1	96.2–99.1	68.1	58.4–77.8
Centre	1508	100.2	90.8	85.3–94.4	59.2	47.8–70.6
Centre-Est	1676	95.8	98.2	96.7–99.0	85.9	81.1–89.7
Centre-Nord	1892	103.9	96.9	94.8–98.2	82.3	75.0–87.8
Centre-Ouest	2134	108.6	98.3	96.9–99.0	68.8	57.6–80.0
Centre-Sud	1585	103.4	98.2	96.2–99.2	82.0	72.5–88.8
Est	1949	98.8	94.8	89.2–97.5	81.8	70.0–89.6
Hauts-Bassins	1938	100.4	96.7	93.3–98.4	76.7	66.4–87.1
Nord	1918	107.4	97.3	95.5–98.4	72.6	65.2–80.0
Plateau Central	2098	106.1	96.6	94.9–97.8	72.8	64.0–81.6
Sahel	1526	104.4	94.5	91.3–96.6	76.3	68.4–84.1
Sud-Ouest	1700	103.9	95.9	91.0–98.1	76.8	67.6–86.0
Burkina Faso	23,577	102.6	95.9	95.0–96.7	74.3	71.6–77.1
Region	MCV (aged 12–23 months)					
	Sample size (*n*)	Administrative coverage (%)	Survey coverage			
			Total coverage (card + recall)		Card only	
			%	95% CI	%	95% CI
Boucle du Mouhoun	105	100.7	94.9	88.6–97.8	49.0	31.5–66.4
Cascades	111	105.5	95.4	88.7–98.2	55.0	36.4–73.7
Centre	66	100.8	93.3	83.0–97.6	73.3	60.1–86.6
Centre-Est	114	93.7	95.6	90.1–98.1	76.3	65.5–87.2
Centre-Nord	104	94.7	92.8	85.8–96.5	37.1	23.5–50.7
Centre-Ouest	99	93.0	94.9	88.1–97.9	60.2	47.9–72.5
Centre-Sud	96	88.2	95.7	87.0–98.7	54.3	29.6–79.0

Region	PsA-TT (aged 2–30 years)					
	Sample size (*n*)	Administrative coverage (%)	Survey coverage			
			Total coverage (card + recall)		Card only	
			%	95% CI	%	95% CI
Est	159	108.0	92.1	85.6–95.7	33.8	21.8–45.7
Hauts-Bassins	112	111.8	96.3	90.4–98.7	68.8	46.7–90.9
Nord	117	99.2	95.2	88.0–98.2	61.5	48.5–74.6
Plateau Central	129	94.2	92.9	86.4–96.4	65.4	53.9–76.9
Sahel	165	107.2	75.3	58.8–91.8	17.3	9.6–29.1
Sud-Ouest	141	95.6	82.6	69.9–90.7	35.7	19.0–52.3
Burkina Faso	1518	100.0	92.5	90.5–94.1	53.6	49.0–58.2

Design effects and intraclass correlation coefficients for the national and regional estimates for MCV and for each age group for PsA-TT are shown in Table 1 of supplementary materials.

Table 2

Serogroup A meningococcal (PsA-TT) conjugate vaccine and measles-containing vaccine (MCV) vaccination coverage rates by region and age group.

Region	PsA-TT						MCV	
	2–5 years		6–15 years		16–30 years		12–23 months	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Boucle du Mouhoun	96.4	92.5–98.3	97.7	94.1–99.1	93.3	87.1–96.7	94.9	88.6–97.8
Cascades	97.8	93.9–99.2	98.5	96.6–99.4	97.8	95.2–99.0	95.4	88.7–98.2
Centre	93.5	88.0–96.6	93.9	88.6–96.9	87.1	80.2–91.9	93.3	83.0–97.6
Centre-Est	99.2	97.8–99.7	98.9	96.7–99.7	96.4	94.2–97.8	95.6	90.1–98.1
Centre-Nord	98.1	95.9–99.1	98.9	96.8–99.6	93.3	89.9–95.6	92.8	85.8–96.5
Centre-Ouest	98.6	96.0–99.5	99.0	97.8–99.6	96.7	94.6–98.1	94.9	88.1–97.9
Centre-Sud	99.1	97.3–99.7	99.0	97.0–99.7	96.1	92.5–98.1	95.7	87.0–98.7
Est	96.2	91.0–98.4	95.4	89.5–98.1	92.8	85.3–96.7	92.1	85.6–95.7
Hauts-Bassins	97.0	90.5–99.1	98.4	94.8–99.5	94.6	91.0–96.9	96.3	90.4–98.7
Nord	98.0	96.2–99.0	97.9	95.9–99.0	95.8	92.8–97.6	95.2	88.0–98.2
Plateau Central	97.1	94.7–98.5	97.9	96.2–98.9	93.9	90.5–96.2	92.9	86.4–96.4
Sahel	95.6	91.1–97.9	95.6	92.0–97.6	93.0	89.0–95.6	75.3	58.8–91.8
Sud-Ouest	96.7	91.7–98.8	96.3	91.6–98.4	94.8	87.3–97.9	82.6	69.9–90.7
Burkina Faso	97.0	96.1–97.8	97.4	96.6–98.0	93.4	91.9–94.6	92.5	90.5–94.1

Table 3

Reason for non-vaccination for serogroup A meningococcal (PsA-TT) conjugate vaccine and measles-containing vaccine (MCV) by age group.

Reason for non-vaccination	PsA-TT						MCV	
	2–5 years		6–15 years		16–30 years		12–23 months	
	n	%	*n*	%	*n*	%	*n*	%
Not informed	67	49.3	94	43.3	174	41.2	42	36.5
Subject or guardian absent	22	16.2	51	23.5	73	17.3	15	13.0
No vaccine available	12	8.8	25	11.5	26	6.2	3	2.6
Vaccination site unknown	2	1.5	10	4.6	24	5.7	3	2.6
Vaccinator absent	6	4.4	14	6.5	5	1.2	2	1.7
Vaccination hours inconvenient	2	1.3	4	1.8	23	5.5	4	3.5
Pregnant at time of vaccination campaign (PsA-TT only)	–	–	0	0	31	7.3	–	–
Fear of injections	2	1.5	2	0.9	13	3.1	1	0.9
Ill at time of vaccination	5	3.7	5	2.3	11	2.6	4	3.5
Wait too long at vaccination site	3	2.2	4	1.8	12	2.8	3	2.6
Vaccination site too far away	1	0.7	0	0	4	1.5	9	7.8
Was told that child was too young to receive vaccine	9	6.6	0	0	0	0	9	7.8
Confused with other vaccines (believed to already have been vaccinated)	1	0.7	1	0.2	3	0.6	8	7.0
Fear of side effects	0	0	0	0	4	0.7	1	0.9
Other[a]	3	2.2	7	3.2	19	4.5	11	9.6
Total	136	100.0	217	100.0	422	100.0	115	100.0

[a]Other includes: lack of confidence in the vaccine, religious beliefs, not authorized by head of household, and unspecified ‘other’.

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Table 4

Predictors of serogroup A conjugate meningococcal (PsA-TT) and measles-containing vaccine (MCV) vaccination by age group.

Predictor	PsA-TT Survey						MCV Survey	
	2–5 years (*n* = 3421)		6–15 years (*n* = 4192)		16–30 years (*n* = 4226)		12–23 month (*n* = 1222)	
	aRR	95% CI	aRR	95% CI	aRR	95% CI	aRR	95% CI
Male sex[a]	0.99	0.97–1.0	1.01	0.997–1.02	1.01	0.98–1.03	0.99	0.96–1.02
Rural household setting[b]	1.04	1.004–1.07	1.00	0.99–1.02	1.05	1.005–1.1	0.94	0.91–0.98
Household size >6 persons[c]	0.99	0.98–1.01	1.00	0.99–1.01	0.99	0.97–1.02	1.03	0.99–1.07
Head of household with any education[d,e]	1.02	1.003–1.03	1.00	0.99–1.01	0.99	0.97–1.02	1.0	0.95–1.05
Head of household with any employment[f,g]	1.02	0.99–1.04	1.01	0.99–1.02	1.00	0.99–1.04	0.94	0.91–0.98
Head of household informed of the PsA-TT vaccination campaign[h]	1.35	1.17–1.56	1.35	1.18–1.56	1.47	1.28–1.70	1.16	0.99–1.36
Presence of household members of other age groups (by age group during campaign)[i]:								
Infant <12 months	1.01	1.001–1.02	0.99	0.98–1.01	1.02	0.99–1.04	–	–
1–4 year old	–	–	0.99	0.98–1.0	1.03	1.0–1.05	0.98	0.95–1.01
5–14 year old	1.01	0.99–1.03	–	–	1.03	1.01–1.06	0.98	0.94–1.02
15–29 year old	1.01	0.996–1.02	1.01	0.996–1.02	–	–	1.01	0.97–1.06

Reference groups:

[a] Females,

[b] Urban household setting,

[c] household with ≤6 persons,

[d] head of household with no education,

[f] head of household without any employment,

[h] head of household not informed of the PsA-TT campaign,

[i] no other household members in respective age groups.

[e] Any education defined as completion of primary, secondary, or university education.

[g] Any employment defined as any wage or goods-earning employment (including agriculture). Excludes those self-reported as unemployed, retired, homemaker, or student.