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Oral cholera vaccination coverage after the first global stockpile deployment in Haiti, 2014

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ABSTRACT

Introduction: In 2014, an oral cholera vaccine (OCV) campaign targeting 185,314 persons aged ≥1 years was conducted in 3 departments via fixed post and door-to-door strategies. This was the first use of the global OCV stockpile in Haiti.
Methods: We conducted a multi-stage cluster survey to assess departmental OCV coverage. Target population estimates were projected from the 2003 Haiti population census with adjustments for population growth and estimated proportion of pregnant women. In the three departments, we sampled 30/106 enumeration areas (EAs) in Artibonite, 30/244 EAs in Centre, and 20/29 EAs in Ouest; 20 households were systematically sampled in each EA. Household and individual interviews using a standard questionnaire were conducted in each selected household; data on OCV receipt were obtained from vaccination card or verbal report. We calculated OCV campaign coverage estimates and 95% confidence intervals (CIs) accounting for survey design.
Results: Overall two-dose OCV coverage was 70% (95% CI: 60, 79), 63% (95% CI: 55, 71), and 44% (95% CI: 35, 53) in Artibonite, Centre, and Ouest, respectively. Two-dose coverage was higher in the 1–4 years age group than among those ≥ 15 years in Artibonite (difference: 11%; 95% CI: 5%, 17%) and Ouest (difference: 12%; 95% CI: 3, 20). A higher percentage of children aged 5–14 years received both recommended doses than did those ≥ 15 years (Artibonite: 14% (95% CI: 8%, 19%) difference; Centre: 11% difference (95% CI: 5%, 17%); Ouest: 10% difference (95% CI: 2%, 17%). The most common reason for not receiving any OCV dose was being absent during the campaign or not having heard about vaccination activities.
Conclusions: While coverage estimates in Artibonite and Centre were comparable with other OCV campaigns in Haiti and elsewhere, inadequate social mobilization and outdated population estimates might have contributed to lower coverage in Ouest.

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1. Introduction

On October 22nd, 2010 the first case of cholera was reported in Haiti; subsequently, over 815,000 suspected cholera cases and 9,700 deaths were reported as of December 2, 2017 [1]. In 2013, the Haitian Ministry of Health and Population (French acronym: MSPP) developed a 10-year cholera elimination plan, which called for long-term improvements to water, sanitation, and waste management, in response to sustained cholera transmission [1,2]. As an interim measure, in 2012 MSPP proposed offering oral cholera vaccine (OCV) to approximately 600,000 persons living in areas with high cholera attack rates and poor access to healthcare, clean water, and basic sanitation [2].

Three OCVs -- Dukoral, Shanchol and Euvichol-- have been licensed and prequalified by the World Health Organization (WHO) and are available for global use [3,4]. Shanchol was first

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licensed in India in 2009 and is recommended for persons ≥ 1 year old as a two-dose series separated by at least 14 days [5]. Studies have demonstrated an overall protective efficacy of 65% at 5 years post-vaccination, and a previous study in Haiti estimated Shanchol's effectiveness to be 58% against any cholera up to 2 years after vaccination, similar to those in other settings [5–10]. In 2013, a global OCV stockpile was established with initial funding from multiple donors, for use in outbreak and humanitarian emergency settings and managed by the International Coordinating Group [11]. Subsequently, Gavi, the Vaccine Alliance (Gavi), approved support for the stockpile, and its use has since expanded to include additional preemptive vaccination in endemic settings under the guidance of the OCV Working Group of the Global Taskforce for Cholera Control (GTFCC). [3].

OCV was first used in Haiti in 2012 during a pilot study targeting almost 120,000 persons conducted by two non-governmental organizations in collaboration with MSPP [12,13]. Reported two-dose coverage was 77% in Bocozel and 62% in Grande Saline, both rural communities, and 69% in five urban slums in Port-au-Prince [12,13]. In 2013, the first MSPP-led OCV campaign was implemented in 2 departments targeting 107,906 persons [14]. Two-dose coverage based on coverage survey was estimated to be 63% in Petite Anse, an urban community in the North Department and 77% in Cerca Carvajal, a rural community in Centre department [14].

In 2014, the first global OCV stockpile deployment for Haiti was approved, and a vaccination campaign was planned and implemented by MSPP. An estimated 185,314 individuals aged ≥ 1 years were targeted in 7 communes and 3 communal sections across 3 departments: Gonaives and Ennery in Artibonite; Lascahobas, Saut d' eau, Savanette, and Mirebalais in Centre; and Arcahaie in Ouest [Fig. 1]. Two campaign rounds were conducted using fixed post and door-to-door strategies in August 2014, during the school summer holiday, and September 2014, after the start of the school year. Target population estimates were projected from the 2003 Haiti population census with adjustments for population growth and an assumption that pregnant women composed 3.2% of the population [Table 1].

Monitoring and evaluation of the global OCV stockpile vaccine deployments is important to better understand and target OCV use, and apply lessons learned to other settings. We conducted a survey to evaluate coverage, adverse events and reasons for non-vaccination for the 2014 OCV campaign in Haiti.

2. Methods

2.1. Study design

A multi-stage cluster survey was designed to obtain representative samples at the departmental level from the communes or commune sections targeted for vaccination during the 2014 campaign. Targeted areas are referred to by the department names, Artibonite, Centre, and Ouest. Estimated sample size was calculated at the household level and assumed 75% 2-dose coverage, 0.15 intra-class correlation, and 5% non-response, based on the findings of the previous coverage survey from 2013 [14]. To achieve 8% precision in Artibonite and Centre and 10% precision in Ouest, we estimated that a total of 1,600 households were needed for a sample size of 560 children ages 1–4 years. We

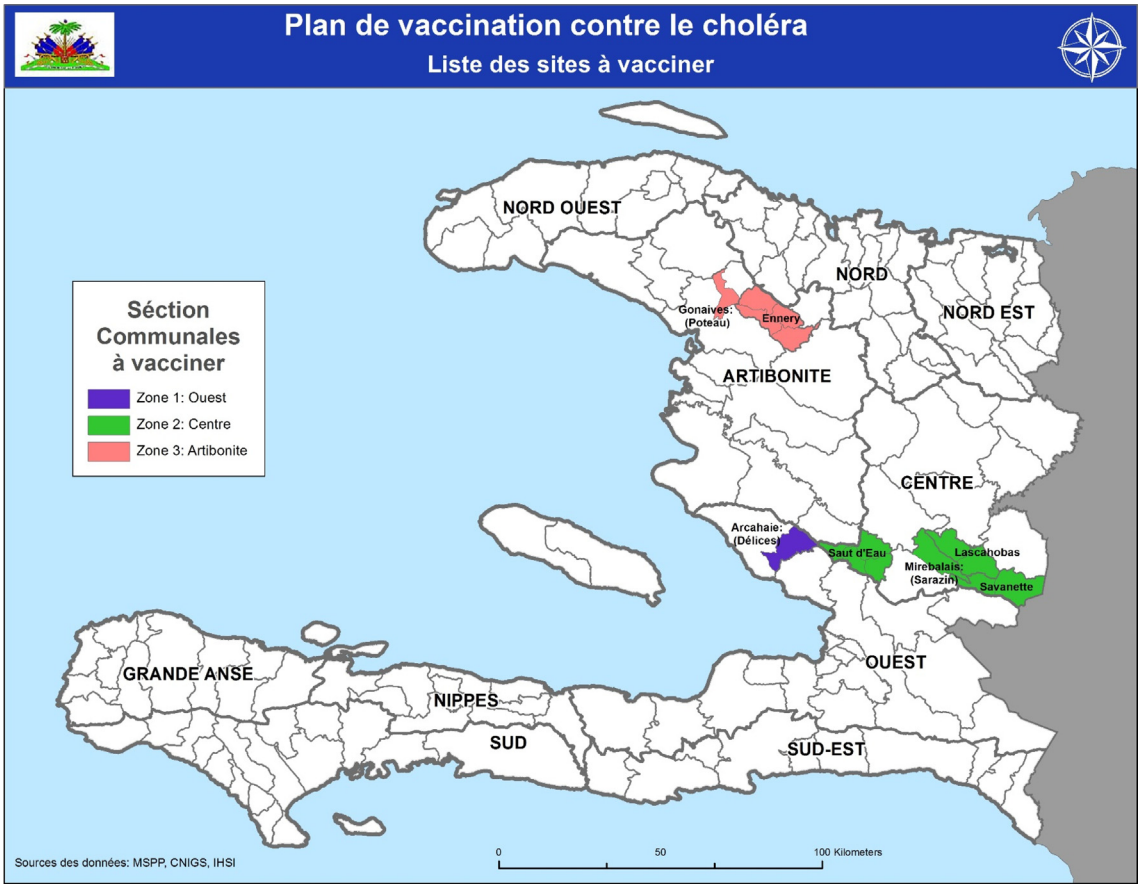

Fig. 1. Areas targeted for the oral cholera vaccination campaign. Haiti, 2014.

Table 1
Communes and commune sections targeted for oral cholera vaccination by department. Haiti, 2014.

Department	Commune (commune section)	Estimated population (2012)	Estimated number of households (2012)
Artibonite	Gonaives (Poteaux)	16,739	3756
	Ennery	48,880	11,583
Centre	Lascahobas	43,776	9422
	Saut d'eau	37,284	8611
	Savanette	34,546	7942
	Mirebalais (6ème Sarazin)	13,630	3242
Ouest	Arcahaie (5ème Delice)	9441	2421

sampled 30 enumeration areas (EAs) of 106 in Artibonite, 30 of 244 in Centre, and 20 of 29 in Ouest using systematic random sampling without replacement (implicitly stratified by commune) due to the finite number of EAs available in each area. To be eligible for selection, EAs had to be primarily geographically located in the OCV campaign targeted commune or commune section [15,16]. During data collection, progress and adherence to the EA boundaries was monitored with Garmin model 60stc GPS devices.

In each EA, 20 households were systematically sampled using a predetermined skip pattern based on official household estimates [15]. Survey teams started in the corner of each EA and systematically selected households following the EA's predetermined skip pattern. When an EA had fewer or more households than expected, the planned skip pattern was followed until 20 households were selected, or until there were no additional households in the EA; irregularities in the expected number of households were documented. The exception was one EA in Centre; over 100 households were identified though only 14 households were expected based on the population estimates used; hence, all households were enumerated and a skip pattern was developed to select 20 households. A household was defined as a group of people who slept under the same roof and ate together. Household members who were residents of the targeted areas during the campaign, and eligible for vaccination, were eligible to participate in the survey. Household members meeting these criteria were enumerated and categorized by age group (1–4 years, 5–14 years, and 15 years and older). In households with more than one person in an age group, one individual was randomly selected from each age group using a random numbers table.

Verbal informed consent was obtained using a standard consent script, and structured household level surveys were administered to the female heads of household when available, or an alternative available adult household member. For individual surveys, verbal informed consent using a standard consent script, was obtained from the selected individual or their parent or guardian for children <18 years old; verbal assent was obtained from children 8–17 years old. Structured individual surveys were administered to adults and assenting children or a child's parent or guardian. The survey questionnaire included household questions about water and sanitation, access to health facilities, and awareness of the OCV campaign, as well as questions for individuals about their cholera vaccination status, knowledge of cholera prevention, and adverse events. Data were digitally collected using ODK on smartphones by a team of trained survey personnel. Vaccination information was recorded from vaccination cards, or verbal report when documentation was unavailable at the participant's home. The survey was conducted from October 26 to November 11, 2014.

This survey was reviewed and approved as a program evaluation activity by the National Bioethics Committee in Haiti and the US Centers for Disease Control and Prevention.

2.2. Analytic methods

Unweighted descriptive statistics, including median and interquartile range (IQR), are provided to describe the selected sample. Individual and household level weights were calculated based on the estimated probability of selection at each stage of sampling. Stata v.13 was used for statistical analysis and accounted for the cluster design, survey weights, and finite population correction of selected EAs and selected households. We calculated OCV coverage estimates and 95% confidence intervals (CI) for 2 doses and one dose by department. We also calculated the difference in coverage estimates with 95% CIs by age group (1–4 years, 5–14 years and $\geq$ 15 years) and sex (male, female). Organ pipe plots [17] are presented to visualize variability in coverage by plotting the percent of selected individuals in each EA that had received both OCV doses during the campaign, arranged by percent and stratified by age group. Included are the estimated design effect due to clustering only, and the estimated intra-class correlation (ICC) using the formula: ICC = (design effect – 1)/(average cluster size – 1).

3. Results

Overall, 1489 households and 3201 individuals participated in the survey. There were fewer inhabited households in 16 of 80 EAs than in the official estimates used for our cluster sampling methods. In Artibonite, 533 (89%) of 600 planned households existed for selection, and of these, 527 (99%) participated. In Centre, 591 (99%) of 600 planned households existed for selection, of which 99.5% (588 households) participated, and in Ouest, 376 (94%) of 400 planned households existed of which 99.7% (374 households) participated. No household refused to participate. The response rate among selected individuals was 99.5%.

Household and individual characteristics of survey participants are listed in Table 2. In regards to age group, 270/1144 (24%) individual respondents in Artibonite, 251/1253 (20%) respondents in Centre, and 183/804 (23%) respondents in Ouest were 1-4 years old. Approximately half of individual respondents were female in all three departments (Artibonite, 54%; Centre, 53%; Ouest, 51%). Overall, 355/527 (67%) households in Artibonite, 229/588 (70%) in Centre, and 315/374 (84%) in Ouest reported using an unimproved water source (unprotected spring, unprotected well, tanker truck, surface water, or bottled water); 127 (24%), 229 (39%), and 131 (35%) households reported not treating their drinking water in Artibonite, Centre, and Ouest, respectively. The proportion of households with unimproved sanitation (pit latrine without a slab, bucket, hanging toilet, bush or field), was 73% in Artibonite, 71% in Centre, and 82% in Ouest. In Ouest, 322 (88%) households reported being at least an hour away from the nearest health facility, compared with 230 (45%) in Artibonite and 312 (54%) in Centre. Overall, 38% of households in Ouest and 41% of households in Artibonite and Centre each reported at least one household member having received care at a cholera treatment center. At least one cholera death among household members was reported by 9 (2%) households in Ouest, 14 (3%) in Artibonite and 22 (4%) in Centre.

Self-reported two-dose OCV coverage was 70% (95% CI: 60%, 79%) among the 1144 individual respondents in Artibonite, 63% (95% CI: 55%, 71%) among 1253 respondents in Centre, and 44% (95% CI: 35%, 53%) among 804 respondents in Ouest [Fig. 2]. Among those individuals who reported receiving 2 OCV doses, 629 (77%) of 817 in Artibonite, 595 (72%) of 826 in Centre, and 262 (70%) of 374 in Ouest had available OCV campaign vaccination cards; card-documented coverage for 2 OCV doses among all individual respondents was 45% (95% CI: 37%, 52%) in Artibonite, 38% (95% CI: 32%, 44%) in Centre, and 26% (95% CI: 20%, 33%), in Ouest.

Table 2
Household and individual characteristics of survey respondents among areas targeted for oral cholera vaccination, by department, Haiti, 2014.

	Artibonite		Centre		Ouest	
Households	(n = 527)		(n = 588)		(n = 374)	
Number of residents per household (median, IQR)	5	3–7	5	3–6	4	3–6
Unimproved water source[1] (n, %)	355	67	414	70	315	84
Does not treat water (n, %)	127	24	229	39	131	35
Unimproved sanitation[2] (n, %)	384	73	432	74	307	82
One hour or more to nearest health facility (n, %)	230	45	312	54	322	88
Individuals	(n = 1,144)		(n = 1,253)		(n = 804)	
Female (n, %)	619	54	664	53	410	51
1–4 years old (n, %)	270	24	251	20	183	23
5–14 years old (n, %)	349	31	418	33	251	31
≥15 years old (n, %)	525	46	584	47	370	46

IQR = interquartile range.
[1] Unprotected spring, unprotected well, tanker truck, surface water, bottled water.
[2] Pit latrine without slab, bucket, hanging toilet, no facilities or bush or field.

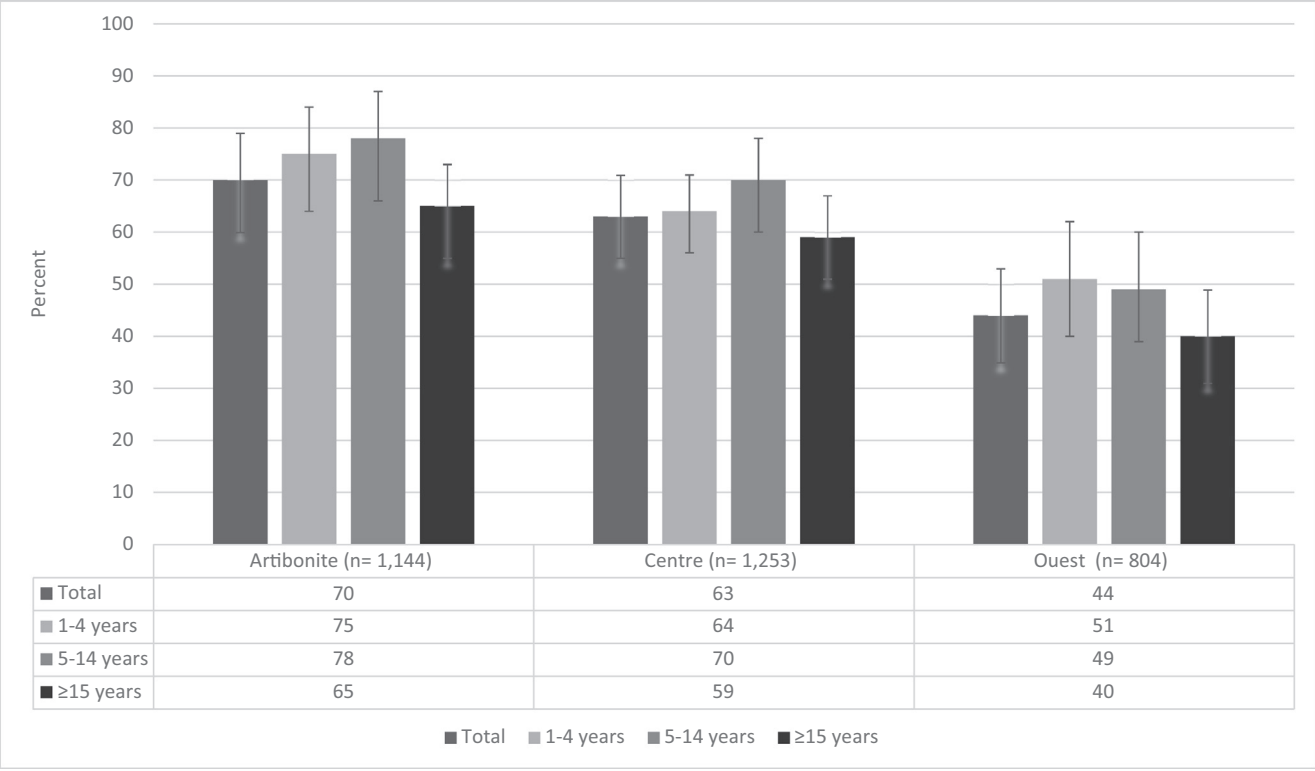

Fig. 2. Two dose coverage, with confidence intervals, of oral cholera vaccine by age group and department, oral cholera vaccination campaign, Haiti, 2014.

Two-dose coverage among children 1–4 years old compared with persons ≥ 15 years old was significantly higher in Artibonite and Ouest, with differences of 11% (95% CI: 5%, 16%) and 12% (95% CI: 3, 20), respectively [Table 3]. A higher percentage of children 5–14 years old received both recommended doses compared with those ≥ 15 years old in all three departments (Aribonite: 14% (95% CI: 8%, 19%); Centre: 11% (95% CI: 5%, 17%); Ouest: 10% (95% CI: 2%, 17%)). Two-dose coverage was significantly higher among females ≥15 years old than among males ≥ 15 years old in Artibonite (female = 69%; male = 58%; p = 0.034) and Centre (female = 65%; male = 51%; p = 0.011), but not in Ouest (female = 39%; male = 40%; p = 0.880). The number of individuals who reportedly received the first dose but not the second dose ranged from 2 (1%) among children 1–4 years old in Ouest to 48 (10%) among those ≥15 years old in Artibonite.

Fig. 3 shows organ pipe plots for the percentage of persons who received both OCV doses in each EA, by department and age group. In 2 EAs, one each in Artibonite and Ouest, none of the 45 and 34

Table 3
Percent difference between groups in 2-dose coverage by department. Haiti, 2014.

	Artibonite		Centre		Ouest	
	%	95% CI	%	95% CI	%	95% CI
Female minus male	5	0, 11	7	1, 14	1	−7, 9
1–4 years minus 15 + years	11	5, 17	5	−3, 13	12	3, 20
5–14 years minus 15 + years	14	8, 19	11	5, 17	10	2, 17

respective selected individuals reported having received 2 OCV doses during the campaign, though one respondent in Artibonite reported having received the first dose. Respondents reported receiving only the first dose in 2 additional EAs, one each in Artibonite (10/49) and Center (12/41).

In Centre and Artibonite the most common reason for non-vaccination with OCV was being absent during the campaign, reported by 105 (33%) of the 319 unvaccinated respondents in Centre and 65 (27%) of the 244 unvaccinated respondents in Artibonite [Table 4]. Not hearing about vaccination activities was the most common reason for non-vaccination with OCV in Ouest, reported by 120 (30%) of 404 unvaccinated respondents, and the second most common reason in Artibonite, reported by 49 (15%) of 244 unvaccinated respondents. Among the respondents who received only one dose in Artibonite (n = 83), Centre (n = 108), and Ouest (n = 26), respectively, the most common reason for receiving only one dose was being absent during the second round of the campaign (Artibonite: n = 42 (51%); Centre: n = 55 (52%); Ouest: n = 11 (42%)). In all, 387 (73%) of 527 household respondents in Artibonite, 442 (75%) of 588 household respondents in Centre, and 229 (61%) of 374 household respondents in Ouest reported knowing about the OCV campaign in advance of vaccination activities, most frequently through megaphone messages. Households that reported having heard about the campaign in advance were more likely to have at least one vaccinated member: 347(90%) of 387 households compared with 104 (74%) of 140 households in Artibonite ($p < 0.01$), 375 (85%) of 442 households compared with 104 (71%) of 146 households in Centre ($p < 0.01$), and 156 (68%) of 229 households compared with 59 (41%) of 145 households in Ouest ($p < 0.01$).

Among respondents $\geq$ 15 years old, 351/525 (67%) in Artibonite, 415/584 (71%) in Centre, and 204/370 (55%) in Ouest reported having heard cholera prevention messages during the campaign; of those who reported hearing prevention messages, 341 (97%) in Artibonite, 408 (98%) in Centre and 198 (97%) in Ouest reported hearing hand washing messages, and 235 (67%) in Artibonite, 250 (60%) in Centre and 136 (67%) in Ouest reported hearing messages about using treated water. Of individual respondents $\geq$ 15 years old who were vaccinated during the campaign, 222 (56%) of 394 in Artibonite, 247 (60%) of 413 in Centre, and 65 (41%) of 157 in Ouest reported not knowing how long OCV protects against cholera disease. In all departments, cholera prevention messages were most frequently heard from healthcare workers and community health workers (Artibonite: n = 255 (49%); Centre: n = 290 (50%); Ouest: n = 136 (37%)).

Among respondents who had received at least one dose of OCV, side effects within 14 days of receiving either the first or second dose of OCV were reported by 109/900 (12%) in Artibonite, 104/934 (11%) in Centre, and 52/400 (13%) in Ouest. Most commonly, minor events were reported, primarily dizziness, nausea, fatigue and stomachache. Seven individuals reported rash, and eight reported difficulty breathing following vaccination. One individual $\geq$15 years old reported seizures (no further details regarding the event were available); no other severe side effects were reported.

4. Discussion

We report 2-dose OCV coverage from the first deployment of the global OCV stockpile in Haiti. We found that 2-dose OCV coverage following the 2014 campaign in the targeted communes and commune sections of Artibonite and Centre was 70% and 63%, respectively, which is comparable to that achieved by previous OCV campaigns in Haiti [12–14] and many other settings globally where OCV has been used [18–22]. Similar to the 2013 OCV campaign in Haiti [14] also led by MSPP, persons $\geq$15 years old were less likely to be vaccinated than younger age groups. However, coverage was markedly lower in Ouest, and our findings suggest that inadequate social mobilization might have played a role.

Estimating vaccination coverage based on administrative data is known to have limitations [23–25]. In this campaign, 2-dose administrative coverage was estimated to be 99.6% across the three departments, a difference of almost 30% from the survey estimate in Artibonite, 37% in Centre, and 45% in Ouest. Card documented

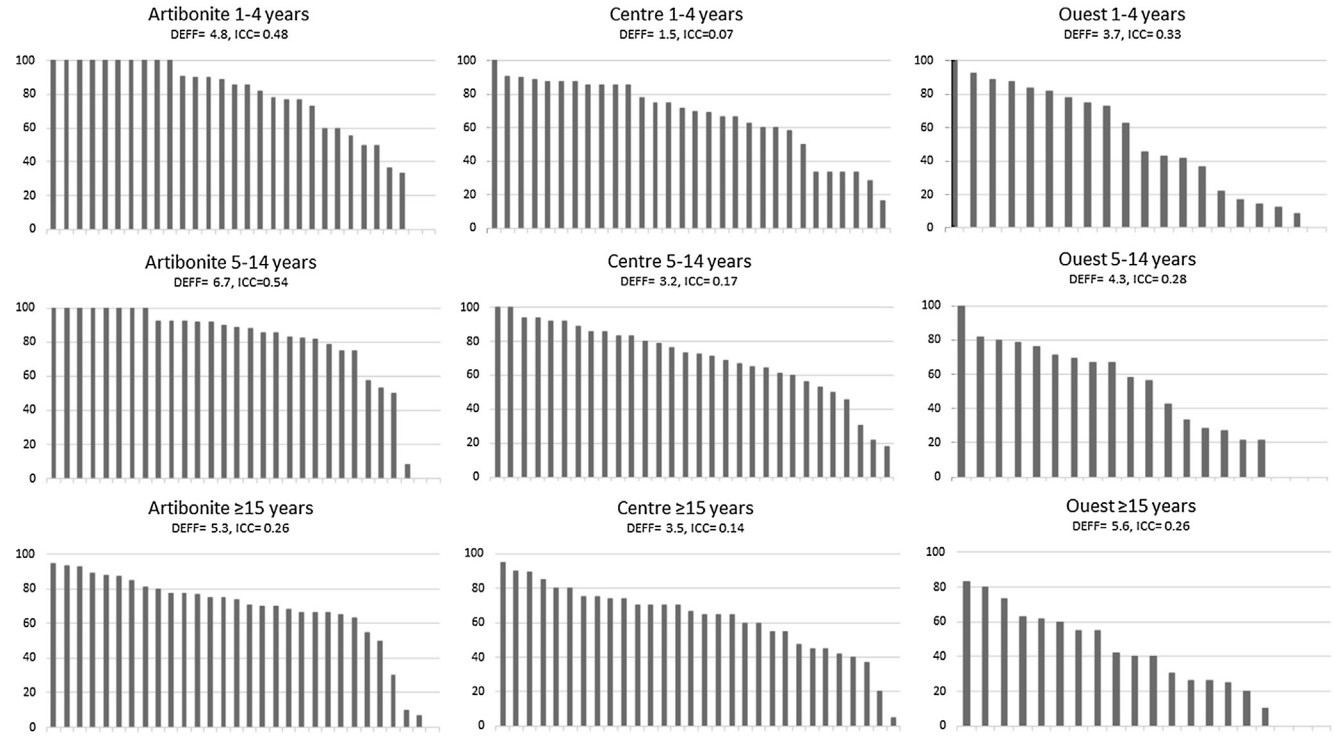

Fig. 3. Percent of individual respondents reporting vaccination with 2 doses of oral cholera vaccine in each enumeration area, by age group and department. Haiti, 2014.

Table 4
Reasons for not receiving oral cholera vaccine. Haiti, 2014.

	Artibonite (n = 244)		Centre (n = 319)		Ouest (n = 404)	
	n	%	n	%	n	%
Persons who had received zero doses						
Didn't know about campaign	63	26	49	15	120	30
Absent during campaign	47	19	95	30	61	15
OCV[1] was not available	24	10	24	8	58	14
Didn't know where to go	3	1	25	8	10	2
Didn't think OCV[1] was necessary/important	15	6	23	7	21	5
Persons who had received one dose	Artibonite (n = 83)		Centre (n = 108)		Ouest (n = 26)	
Absent during second round	42	51	5	5	11	42
Didn't know where to go	9	11	10	9	1	4
Didn't know second dose was needed	8	10	5	5	2	8

[1] OCV = Oral cholera vaccine.

coverage was substantially lower, partially because campaign vaccination cards were reportedly not available everywhere during the campaign. This may partly explain the high variability within EAs, shown in the high design effect. Other factors include differences in campaign implementation and vaccine stock across communities, differences in caregivers' ability to access the campaign, and differences in attitudes towards the importance of receiving the vaccine. Allocation of vaccine doses, and evaluation of performance via administrative coverage, requires microplans based on accurate population estimates. From administrative records, more doses were administered in Ouest than expected based on population projections while in Artibonite far fewer doses than projected were administered [26], despite a substantial percentage of survey respondents reporting the vaccine was not available; this survey was unable to determine the reasons for this discrepancy. As the school year began between the first and second rounds of the campaign, it is unclear what role migration for the school year may have played in the accuracy of population estimates. These findings are similar to those of the 2013 campaign, where the 2-dose administrative coverage was estimated to be 88% in Petite-Anse and 100% in Cerca Carvajal, and the subsequent coverage survey estimated two-dose coverage to be 63% and 77%, respectively, a difference of about 25% [14]. An evaluation of previous deployment of the global OCV stockpile in South Sudan also found issues with availability of accurate population estimates as a barrier to effective monitoring and evaluation [27]. Use of inaccurate population estimates has broad implications for implementation of routine vaccination activities and campaigns globally [23–25].

There are several possible reasons for the lower coverage in Ouest. Access to health facilities where OCV was delivered during the campaign varied considerably among EAs in Ouest [26]; the observed proportion of fully-vaccinated respondents also varied considerably among EAs in the same department, especially in Ouest. Other reasons for the lower OCV coverage in Ouest may include inaccurate and outdated population estimates, and confusion regarding geographic boundaries and jurisdictions. During data collection, we identified discrepancies in the understanding of geographic boundaries at national and local levels. For example, it was unclear if an area of 5ème Delice in Ouest was targeted for the campaign. In the 2 EAs where almost all survey respondents reported not having received OCV, local health workers stated that those EAs were not targeted, contrary to the list obtained from the national level. Overall, 9% of individuals surveyed in Ouest reported their area was not targeted during the campaign. We were unable to determine the cause or implications of these apparent discrepancies in this survey.

Our survey had several limitations. We opted for equal probability of selection of EAs instead of probability proportion to estimated size (PPES) due to the finite number of EAs targeted for the campaign in each department and the out-of-date population estimates that were available. In addition, the lack of resources to enumerate selected EAs led to a non-probability sample design with estimated sampling weights that may not produce the unbiased estimates that are desired. The combination of a constant sampling probability in the first stage selection, and the variable sampling probability of HHs and persons led to variable weights and loss of precision. A fixed sampling interval for the selection of households in each department instead of a fixed number of households in EA, as well as including all eligible persons in a household would have yielded less variable weights and therefore better precision. Having variable size clusters means varying workloads for each team that can be difficult to implement. Additionally, this survey was limited to residents of the targeted areas who were available at the time of data collection; individuals living in adjacent non-targeted areas were not assessed, though they may have accessed vaccination during the campaign, which may explain some discrepancies in the administrative versus coverage survey data. Although low drop-out was observed in all three departments, drop-out might be underestimated if there were significant migration out of targeted areas between the first and second rounds of the campaign due to the school year; administratively, 6758, fewer doses were given in the second round than the first [26]. We estimated coverage based on recall, except when card documentation was available. Recall is less reliable than written documentation; however, several factors may have mitigated the impact of recall bias. For example, the survey was done shortly after the campaign, the vaccination campaign targeted older age groups, and the vaccine was oral and easily recognizable. Finally, reported adverse events are not comparable to an adverse event following immunization (AEFI) surveillance system as this assessment was not designed or powered to detect rare adverse events.

Our recommendations following this evaluation were similar to recommendations made following the 2013 OCV campaign in Haiti [14]. Future campaigns should be scheduled in coordination with other important events to avoid people being absent during either round of the campaign. Social mobilization activities should be implemented in a timely manner. We found megaphones were a common source of campaign awareness in the vaccinated population; however, alternate delivery strategies should be considered to reach groups with low coverage, for example adult men. It remains important to improve estimates of the target population and clearly define geographic boundaries for target areas to improve implementation of the campaign and subsequent estimation of coverage. Improved estimates of the target population, combined with enhanced surveillance, will better allow for

identification of cholera hotspots for targeted use of OCV. Given the mobility of the population, political events and natural disasters since the last census in 2003, future coverage surveys in Haiti should plan for probability sampling when designing surveys, as recommended by the 2015 WHO cluster survey guidelines.

There has been increasing attention and momentum on cholera prevention and control [28]. In April 2017, the Strategic Advisory Group of Experts on Immunization (SAGE) reviewed the existing evidence on OCVs which led to revision of the WHO position paper providing specific recommendations for OCV use in different settings (endemic, outbreak and humanitarian emergencies) [3,29]. In October 2017, all GTFCC partners launched an intensified effort for cholera prevention and control – 'Ending Cholera – A Global Roadmap to 2030′ focusing on a multisectoral strategy in 47 cholera endemic countries aiming to reduce cholera deaths by 90% and targeting cholera elimination in up to 20 countries, including Haiti [30]. In June 2019, the Gavi board approved the decision to support OCV use for preventive campaigns in endemic settings – a key strategy to meet the roadmap objectives [31]. With the global cholera situation worsening, particularly in conflict-ridden areas [30,32], OCV provides a useful short- to medium-term intervention in areas where it may be challenging to implement permanent improvements in water, sanitation, and hygiene infrastructure. However, given the high proportion of respondents in this survey who used an unimproved water source and unimproved sanitation, it remains important to improve the integration of WASH interventions during OCV campaigns [33]. With increasing use of the vaccine in multiple settings and emphasis on preventive OCV use, there is a real opportunity to use OCVs as part of a multisectoral National Cholera Control Plans (NCP). Haiti has already made great strides towards creation of an NCP, with its national cholera elimination goals, aligning with the global roadmap. With Haiti's NCP looking at cholera elimination, lessons learned from OCV use remains relevant for future OCV campaigns in Haiti and in other countries implementing the global roadmap at the national level.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Disclosures

The authors have no financial relationships relevant to this article to disclose.

Disclaimer

The findings and conclusions of this report are those of the authors and do not necessarily represent the views of the US Centers for Disease Control and Prevention.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2019.09.018.

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