



Community-based household assessment of human papillomavirus (HPV) vaccination coverage and acceptability – HPV vaccine demonstration program, Cambodia – 2017



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ABSTRACT

Background: In 2017, the Cambodia Ministry of Health introduced human papillomavirus (HPV) vaccine through primarily school-based vaccination targeting 9-year-old girls. Vaccination with a two-dose series of HPV vaccine took place in six districts in two provinces as a demonstration program, to better understand HPV vaccine delivery in Cambodia.

Methods: We conducted a community-based coverage survey using a one-stage sampling design to evaluate dose-specific vaccination coverage among eligible girls (those born in 2007 and residents in the areas targeted by the campaign). The household-level survey also assessed factors associated with vaccine acceptability and communication strategies. Trained data collectors interviewed caregivers and girls using a standard questionnaire; vaccination cards and health facility records were reviewed.

Results: Of the 7594 households visited in the two provinces, 315 girls were enrolled in the survey (188 in Siem Reap; 127 in Svay Rieng). Documented two-dose HPV vaccination coverage was 84% (95% confidence interval [CI]: 78–88%) overall [85% (95% CI: 78–90%) in Siem Reap; 82% (95% CI: 73–88%) in Svay Rieng.] Almost all girls (>99%) were reported to be enrolled in school and over 90% of respondents reported receipt of vaccine in school. Knowledge of HPV infection and associated diseases was poor among caregivers and girls; however, 58% of caregivers reported “protection from cervical cancer” as the primary reason for the girl receiving vaccine. No serious adverse events after immunization were reported.

Conclusions: The HPV vaccine demonstration program in Cambodia achieved high two-dose coverage among eligible girls in both provinces targeted for vaccination in 2017, through primarily school-based vaccination. High school enrollment and strong microplanning and coordination were seen throughout the campaign. Cambodia will use lessons learned from this demonstration program to prepare for national introduction of HPV vaccine.

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1. Background

Cervical cancer is the fourth most common cancer among women worldwide resulting in an estimated 569,847 new cases and 311,365 deaths, per 2018 estimates [1]. Over 85% of deaths occur in low- and middle-income countries, because access to cervical cancer screening and treatment services is often lacking or non-existent [2,3]. Almost all cervical cancers are caused by persis-

tent infection with sexually-transmitted human papillomavirus (HPV), with HPV types 16 and 18 being responsible for approximately 70% of cancerous lesions [4,5].

Three vaccines against HPV are prequalified by the World Health Organization (WHO) – a bivalent vaccine against HPV types 16 and 18, a quadrivalent vaccine against HPV types 6, 11, 16 and 18, and a 9-valent vaccine against additional types 31, 33, 45, 52, and 58. All vaccines are recommended by WHO as a two-dose series administered to girls age 9–14 years, separated by a minimum 6-month interval, for primary prevention of HPV infection [6]. All vaccines have been shown to be safe, efficacious and effective in

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clinical trials and field evaluations [7]. As of October 4, 2018, 91 (47%) of 194 WHO member states had fully or partially introduced HPV vaccine into their national schedules; however, the majority of low- and middle-income countries, where the burden of cervical cancer is the highest, have yet to introduce HPV vaccine [8]. Gavi, the Vaccine Alliance (Gavi), began providing support for HPV vaccine introduction to Gavi eligible countries in 2012. To learn how to best reach this target age group that does not routinely access immunizations or other health services in many countries, Gavi initially supported subnational demonstration programs to provide countries an opportunity to gain the experience needed for successful future national introduction. Gavi provided financial support for 2-year demonstration programs in countries targeting approximately 15,000 girls in two geographic areas.

In Cambodia, cervical cancer is the most common cause of female cancer with an estimated 993 new cases and 708 deaths annually [2]; the estimated age-standardized incidence rate is 13.5 cases per 100,000 women per year [2]. In 2016, Cambodia received Gavi support to conduct an HPV vaccine demonstration program [9], to administer two doses of bivalent HPV vaccine to all 9-year-old girls (in-school and out-of-school) residing in all four operational districts (ODs) in Svay Rieng province (hereafter called Svay Rieng) and two of four ODs in Siem Reap province (hereafter called Siem Reap), during January and July of 2017. Cambodia's Ministry of Health – National Immunization Program (MOH-NIP) purposefully selected these two provinces for having extensive rural areas, representation of high-risk communities (e.g. migrant populations), and being accessible for national level staff. The objective of the program was to demonstrate ability to achieve high vaccination coverage among this new target population and to understand the successes and challenges of HPV vaccine delivery; lessons learned could further inform the country for national scale-up. Schools served as fixed vaccination sites, and out-of-school girls were identified by community health volunteers and invited to come to schools for vaccination during the specified vaccination dates. Prior to the vaccination campaign, a list of eligible girls for each school was generated by teachers and school staff, with the assistance of community health workers who identified out-of-school girls living in the area. HPV vaccine was also available at health centers for one month after the campaign ended for any eligible girls (in-school or out-of-school) who missed school vaccination days.

Administrative coverage for the first dose of HPV vaccine was 98% in Svay Rieng and 91% in Siem Reap, as reported by the Cambodia MOH-NIP. Coverage based on administrative data is subject to denominator bias (i.e., underestimation or overestimation of the target population) and is often inaccurate [10]. Therefore, a community-based household-level coverage survey was conducted to more accurately estimate HPV vaccination coverage. Additionally, the survey examined factors associated with vaccine acceptability, vaccine hesitancy, and community understanding of HPV infection and associated conditions. Findings from this evaluation will be used to assist key stakeholders in understanding the uptake of vaccination and acceptability of the demonstration program, related communications and delivery strategies, and community knowledge and attitudes towards HPV and HPV vaccination, to assist in planning for national HPV vaccine introduction in the future.

2. Methods

2.1. Survey design

In September 2017, two months after delivery of the second dose of HPV vaccine, a community-based household-level coverage

survey with stratified cluster survey design was conducted in the six ODs in the two provinces (Svay Rieng and Siem Reap) targeted during the vaccination campaign. The survey consisted of house-to-house visits with interviews of caregivers and girls using a structured questionnaire. Caregivers included adult respondents who were either primary caregivers (e.g., mother, father), guardians (e.g., grandparents, older siblings), or other family members in the household knowledgeable of girls' vaccination status. Dose-specific HPV vaccination coverage was assessed through two separate means: respondent report and documented report. Documented report consisted of review of home-based vaccination cards; if cards were not available in the household, health facility records were reviewed. An eligible girl was defined as a 9-year-old girl (either in-school or out-of-school) who was a resident of one of the selected ODs in the two provinces targeted for vaccination, at the time that the first round of the vaccination campaign was initiated in January 2017. Age was assessed through respondent report.

2.2. Sampling method

The effective sample size in the combined Svay Rieng and Siem Reap area was estimated to be 196 girls assuming 2-dose vaccine coverage = 85%, desired precision = $\pm 5\%$ (simple asymptotic formula) and $\alpha = 0.05$. To account for intra-class correlation (ICC) = 0.1 and an expected average number of four enrolled girls per cluster, the effective sample size was adjusted to 255 girls. To have an 80% probability of achieving the target sample size, assuming approximately 4.4% of households (HHs) would have a girl 9 years old, and 15% non-response rate, we planned to survey 64 clusters of 115 HHs in the target area. The sampling frame consisted of a list of all villages within the six ODs targeted during the HPV vaccine demonstration program, with an estimated number of families residing in each village from the 2014 Cambodia Bureau of Statistics commune database. Thirty-two clusters (villages) were selected from each province via systematic probability proportional to estimated size (PPES), using the number of families as the size measure, and allowing for implicit stratification by district. A household was defined as all persons sharing food from the same cooking pot and sleeping under the same roof. All HHs were surveyed in clusters with ≤ 115 HHs. For clusters containing more than 115 HHs, approximately 115 HHs were surveyed by combining smaller geographical subunits within the cluster.

2.3. Data collection

All girls meeting eligibility criteria were enrolled in the survey and available primary caregivers, girls or both were interviewed using a standard paper-based questionnaire. If primary caregivers were absent, other adult guardians (grandparents, family members or other guardians) were interviewed. A section of the questionnaire was targeted to girls specifically and they were also interviewed, if available, though their participation was not required. If a household contained an eligible girl but the primary caregiver was absent, the girl could be interviewed independently, with permission from an adult residing in the household. An adult was defined as being aged 15 years or older. Oral consent to participate in the household survey was obtained from caregivers and assent was obtained from all eligible girls. The questionnaire included demographic characteristics, status of HPV immunization, reasons for vaccine acceptance or non-acceptance, exposure to communication materials and knowledge about HPV and HPV vaccine. Interviews were conducted in the local language and verbal reports on vaccination status were verified by vaccination cards, where available, or health facility registers of HPV vaccination.

2.4. Data entry and analysis

Data were entered into a CSPro electronic database and analyzed using SAS version 9.4 (Cary, North Carolina, USA). Descriptive analysis was used to evaluate sociodemographic characteristics, reasons for vaccination and non-vaccination, and knowledge and attitudes regarding HPV and HPV vaccine. Sampling weights were calculated to account for selection of clusters, and any segmentation that took place. Coverage estimates and 95% (Wilson-Score) confidence intervals were calculated using Taylor series method accounting for stratification, clustering, and sampling weights for the survey overall and for each province. Vaccination coverage was estimated by verbal report and documented record (vaccination card or health facility register).

2.5. Ethical considerations

The survey was designated as a public health program evaluation by the Cambodia Ministry of Health National Ethics Committee for Health Research. This project was reviewed in accordance with the Centers for Disease Control and Prevention human research protection procedures and was determined to be a non-research, program evaluation activity.

3. Results

All 64 sampled clusters were visited (32 in each province). Among the 7594 households visited (3784 in Siem Reap; 3810 in Svay Rieng), 6391 (84%) had persons at home and willing to participate, 1176 (15%) had no persons at home and 27 (0.4%) had persons at home, but not willing to participate. Of those visited, at home and willing to participate, 313 (5%) households had at least one eligible girl and completed the survey (187 HH in Siem Reap, 126 HH in Svay Rieng); two households had two eligible girls each. Three girls in each province were interviewed independently, with permission from an adult residing in the household. In total, 315 eligible girls (188 in Siem Reap; 127 in Svay Rieng) were enrolled in the survey, with interviews completed by either a caregiver, the girl, or both. The median numbers of girls enrolled per cluster were 6 (range 2, 12) and 4 (range 1, 8) in Siem Reap and Svay Rieng, respectively.

3.1. Demographics and school enrollment

Of the 309 adult respondents, 228 were parents (79% in Siem Reap; 66% in Svay Rieng) and 81 (21% in Siem Reap; 34% in Svay Rieng) were grandparents or other adults in the household. Most (87% in each province) adult respondents were female; the median age was 38 years old in Siem Reap (range 15–68 years) and 44 years old in Svay Rieng (range 15–77 years). Approximately half (48% in Siem Reap, 51% in Svay Rieng) of adult respondents had completed primary school education (Table 1).

Almost all (99.7%) adult respondents in both provinces reported girls being enrolled in school at the time of the vaccination campaign. Almost half (48%) of girls enrolled in the survey were reported to be in grade 4, 23% in grade 3, 20% in grade 5 and 4% in grade 2. Three percent of respondents reported the girl to be enrolled in school but did not specify a grade.

3.2. HPV knowledge

Among adult respondents, 127 (69%) in Siem Reap and 103 (83%) in Svay Rieng did not know what diseases and complications HPV infection can cause. Similarly, most girls did not know what HPV causes (107 (61%) in Siem Reap; 82 (72%) in Svay Rieng). Only

Table 1

Sociodemographic characteristics of all adult respondents in a community-based evaluation of HPV vaccination coverage; Siem Reap and Svay Rieng provinces, Cambodia – 2017.

	Siem Reap province	Svay Rieng province
Characteristics of all adult respondents ^a	N = 185 n (%) ^b	N = 124 n (%) ^b
<i>Primary survey respondent</i>		
- Parent	146 (79)	82 (66)
- Grandparent	20 (11)	34 (27)
- Other	19 (10)	8 (6)
<i>Respondent ethnicity</i>		
- Khmer	185 (100)	123 (99)
- Vietnamese	0 (0)	1 (1)
Respondent sex (female)	161 (87)	108 (87)
Respondent age in years, median (range)	38 (15–68)	44 (15–77)
<i>Respondent educational status</i>		
- Never attended school	64 (35)	23 (19)
- Nursery school	2 (1)	4 (3)
- Primary school	89 (48)	63 (51)
- Secondary school	27 (15)	24 (19)
- Higher education	2 (1)	9 (7)
- Other	0 (0)	1 (1)

^a Interviews were completed for a total of 315 girls (188 in Siem Reap and 127 in Svay Rieng). Three girls in each province completed the survey independently and there are no adult respondents for these households included in the table.

^b Missing values excluded and percentages rounded to the nearest whole number.

33% of girls in Siem Reap and 20% of girls in Svay Rieng stated that HPV infection can cause cervical cancer (Table 2).

3.3. Vaccination coverage

By respondent report (caregivers and girls), two-dose coverage overall was 84% (95% CI: 78–88%); 84% (95% CI: 77–89%) in Siem Reap and 83% (95% CI: 74–90%) in Svay Rieng (Table 3). By documented report (vaccination card or health facility register), two-dose HPV vaccination coverage overall was 84% (95% CI: 78–88%), 85% (95% CI: 78–90%) in Siem Reap and 82% (95% CI: 73–88%) in Svay Rieng (Table 3).

Most respondents who reported that the girl was vaccinated also reported having received an HPV vaccination card (91% overall; 87% in Siem Reap, 97% in Svay Rieng). Among those who received a card, 85% of cards were seen by data collectors in Siem Reap and 83% were seen in Svay Rieng. Over 90% of respondents in both provinces whose girls had received at least one dose of HPV vaccine reported school as the venue for vaccination. Among 18 respondents who reported girls receiving HPV vaccine somewhere other than a school, 72% reported receiving the vaccine in a health center.

Less than 30% of adult respondents (29% in Siem Reap, 12% in Svay Rieng) reported any type of adverse event experienced by the girl after receiving HPV vaccine. Among these, swelling or soreness at the injection site (72% in Siem Reap, 46% in Svay Rieng) and fever (39% in Siem Reap, 46% in Svay Rieng) were the most common (Table 4). No severe adverse events (i.e. death, hospitalization, life-threatening illness or disability) after vaccination were reported by caregivers.

3.4. Vaccine acceptability

Among girls who received at least one HPV vaccine dose by documented report, 32% and 25% of their caregivers in Siem Reap and Svay Rieng respectively had discussed HPV vaccination with someone, mostly family members, before the girl received HPV vaccine

Table 2

Knowledge about causes of HPV infection among adult respondents and girls in a community-based assessment of HPV vaccination coverage; Siem Reap and Svay Rieng provinces, Cambodia – 2017.

	Siem Reap province		Svay Rieng province	
	Adult Respondents ^a N = 185 n (%) ^c	Girl Respondents ^b N = 174 n (%) ^c	Adult Respondents N = 124 n (%) ^c	Girl Respondents N = 114 n (%) ^c
Reported that HPV infection causes cervical cancer	52 (28)	58 (33)	14 (11)	23 (20)
Reported that HPV infection causes cancer (type not specified)	2 (1)	0 (0)	7 (6)	5 (4)
Other	5 (3)	10 (6)	1 (1)	5 (4)
Did not know what HPV infection causes	127 (69)	107 (61)	103 (83)	82 (72)

^a Interviews were completed for a total of 315 girls (188 in Siem Reap and 127 in Svay Rieng). Three girls in each province completed the survey independently and there are no adult respondents for these households included in the table.

^b A total of 288 girls (174 in Siem Reap and 114 in Svay Rieng) completed the girl portion of the interview.

^c Missing values excluded and percentages rounded to the nearest whole number.

Table 3

Vaccination coverage by respondent report and documentation in community-based assessment of HPV vaccination coverage; Siem Reap and Svay Rieng provinces, Cambodia – 2017.

		Siem Reap province		Svay Rieng province		Overall	
		N = 188 n	% [95% CI] ^d	N = 127 n	% [95% CI]	N = 315 n	% [95% CI]
Coverage by respondent report ^b	2 doses ^a	153	84 [77–89]	104	83 [74–90]	257	84 [78–88]
	1 dose	7	3 [2–7]	9	7 [3–14]	16	5 [3–8]
	0 dose	26	13 [8–19]	12	9 [5–18]	38	11 [8–16]
Coverage by documented report ^c	2 doses	156	85 [78–90]	104	82 [73–88]	260	84 [78–88]
	1 dose	4	2 [1–5]	7	5 [3–11]	11	3 [2–6]
	0 dose	28	13 [9–20]	16	13 [8–20]	44	13 [10–18]

^a The estimated ICC = 0.12, based on a design effect due to clustering = 1.48 and the average cluster size = 4.92.

^b Respondent report information missing for 2 girls in each province.

^c Weighted percent.

^d CI, confidence interval.

^e Vaccination status confirmed by vaccination card or health facility record.

Table 4

Adverse events following HPV vaccination among girls who received at least one vaccine dose, by documented report in a community-based assessment of HPV vaccination coverage; Siem Reap and Svay Rieng provinces, Cambodia – 2017.

	Siem Reap province	Svay Rieng province
Girls who received at least 1 vaccine dose ^{a,b}	N = 161 n (%) ^c	N = 111 n (%) ^c
Respondent reported that girl experienced adverse event after receiving HPV vaccine	46 (29)	13 (12)
Among those who reported an adverse event, the following events were specified ^d		
- Swelling or soreness at injection site	33 (72)	6 (46)
- Fever	18 (39)	6 (46)
- Headache	5 (11)	1 (8)
- Nausea or vomiting	0 (0)	3 (23)
- Fainting or dizziness	0 (0)	0 (0)
- Other	2 (4)	1 (8)

^a Interviews were completed for a total of 315 girls (188 in Siem Reap and 127 in Svay Rieng).

^b By documented record (vaccination card or health facility record).

^c Unweighted percent, missing values excluded and percentages rounded to the nearest whole number.

^d Multiple responses were allowed.

(Table 5). The main reason cited by adult respondents for the girl receiving the vaccine was “protection from cervical cancer” (57% in Siem Reap; 61% in Svay Rieng). For girls who did not receive any HPV vaccine by documented report, “not being aware of the campaign” was cited by adult respondents as the primary reason (39% in Siem Reap and 25% in Svay Rieng). Other reasons included not normally attending school (5%) and concerns about vaccine safety (5%).

3.5. Social mobilization

Among adult respondents who had heard about the HPV vaccination campaign from someone verbally before it happened, most heard about it from the girl (87% in Siem Reap, 61% in Svay Rieng). Teachers (14% in Siem Reap, 17% in Svay Rieng) and health workers or community health volunteers (13% in Siem Reap, 9% in Svay Rieng) were identified as primary sources of information. Nearly a quarter of adult respondents (24% in Siem Reap, 23% in Svay Rieng) in both provinces had observed or received written materials about the campaign, mostly brochures or pamphlets (84% in Siem Reap, 93% in Svay Rieng) (Table 6). Of adult respondents who received either verbal or written messages prior to the campaign (66% in Siem Reap and 56% in Svay Rieng), “vaccine prevents cervical cancer” (64% in Siem Reap, 44% in Svay Rieng), “vaccine is free” (25% in Siem Reap, 28% in Svay Rieng), and “vaccine is provided at school” (28% in Siem Reap, 13% in Svay Rieng) were the messages cited most frequently. Some respondents in Siem Reap (23%) and Svay Rieng (33%) reported not having received any messages (Table 6).

4. Discussion

This community-based household-level coverage survey indicated that the HPV demonstration program in Cambodia achieved high (>80%) two-dose coverage among 9-year-old girls in the six ODs targeted for vaccination in 2017, through a primarily school-based delivery strategy. Coverage survey estimates were slightly (4–10%) lower than reported administrative coverage for the first dose of HPV vaccine. Our survey found very high self-reported

Table 5

Primary influencers and reasons for accepting HPV vaccine among adult respondents where girls were recipients of at least one vaccine dose in community-based assessment of HPV vaccination coverage; Siem Reap and Svay Rieng provinces, Cambodia – 2017.

	Siem Reap province	Svay Rieng province
Girls who received at least 1 vaccine dose ^{a,b}	N = 161 n (%) ^c	N = 111 n (%) ^c
Discussed HPV vaccine with someone before making the decision to receive vaccine	52 (32)	28 (25)
<i>Person respondent discussed HPV vaccine with prior to the campaign</i>		
- Family member	28 (54)	18 (64)
- Health worker	0 (0)	2 (7)
- Teacher	4 (8)	0 (0)
- Community health volunteer	1 (2)	0 (0)
- Other	4 (8)	2 (7)
<i>Main reason for the girl receiving vaccine^d</i>		
- Protection from cervical cancer	91 (57)	68 (61)
- Vaccines thought to be good for health or wanted girl to be healthy	30 (19)	5 (5)
- Protection from cancer (no type specified)	13 (8)	12 (11)
- Prevents her from getting sick (no illness specified)	10 (6)	4 (4)
- School was providing it to the girls	5 (3)	10 (9)
- Vaccine is free	1 (1)	3 (3)
- Followed advice of someone who said to receive it	1 (1)	2 (2)
- Other	5 (3)	1 (1)

^a Interviews were completed for a total of 315 girls (188 in Siem Reap and 127 in Svay Rieng).

^b By documented record (vaccination card or health facility record).

^c Missing values excluded and percentages rounded to the nearest whole number.

^d Questions were free response and grouped into pre-defined categories by data collectors.

school enrollment in these areas (100% in Svay Rieng and 99% in Siem Reap), and the majority of girls in the survey who received at least one dose of HPV vaccine reported receiving it in school. This was a likely a contributor to the high vaccination coverage observed and supports the use of school-based vaccine delivery in this setting. The proportion of girls enrolled in school is somewhat higher than what was found in the 2014 Cambodia Demographic and Health Survey which estimated a net attendance ratio for primary school (age 6–12 years) to be 83.4% for females (82.7% in Siem Reap and 88.5% in Svay Rieng) [11]. School-based vaccine delivery has been shown to attain higher coverage than health facility only-based strategies, but can be resource intensive, (though there are very few data on health facility-only based strategies) [12–14]. A list of girls developed for each school, supplemented with information from community health volunteers, facilitated comprehensive enumeration of the target population both in and out of school and helped ensure that a high number of eligible girls received HPV vaccine.

Overall, vaccine acceptability was high. Most caregivers discussed HPV vaccination with other adult family members prior to the campaign. Although knowledge of HPV infection and associated diseases was poor among caregivers and girls, protection from cervical cancer was cited as the most common reason for accepting the vaccine. Studies in other low-income countries in the Western Pacific region have reported similar findings, including high willingness among caregivers to accept a vaccine to prevent cervical cancer, despite low knowledge of cervical cancer and its causes [15,16]. Similarly, other HPV demonstration programs have shown strong trust in HPV vaccination among caregivers and found that parents are often motivated by a general understanding of the health benefits of vaccines [17–19]. Because there is no specific translation for the term “HPV” in the Cambodian language, written

Table 6

Sources of messaging received by adult respondents prior to the HPV vaccination campaign; Siem Reap and Svay Rieng provinces, Cambodia – 2017.

	Siem Reap province	Svay Rieng province
Adult respondents ^a	N = 185 n (%) ^b	N = 124 n (%) ^b
Received verbal messages prior to the campaign:	119 (64)	66 (53)
<i>Source of verbal message^c</i>		
- Girl	103 (87)	40 (61)
- Teacher	17 (14)	11 (17)
- Health worker or community health volunteer	16 (13)	6 (9)
- Community leader	1 (1)	7 (11)
- Other	4 (3)	5 (8)
Received written messages prior to the campaign	44 (24)	29 (23)
<i>Source of written messages^c:</i>		
- Brochure/pamphlet	37 (84)	27 (93)
- Poster	8 (18)	4 (14)
- Banner	4 (9)	2 (7)
<i>Main messages reported received (from any source)^c</i>		
- Vaccine prevents cervical cancer	119 (64)	55 (44)
- Vaccine is free	46 (25)	35 (28)
- Vaccine is provided at school	51 (28)	16 (13)
- Girl must receive 2 doses	27 (15)	6 (5)
- Girls who are 9 years old will receive vaccine	27 (15)	6 (5)
- Vaccine prevents cancer	15 (8)	14 (11)
- Vaccine is safe	15 (8)	13 (10)
- Girls in school will receive vaccine	3 (2)	6 (5)
- Vaccine is provided at health center	5 (3)	0 (0)
- Girl may experience side effects or problems	2 (1)	0 (0)
- Other	1 (1)	4 (3)
- Did not receive any messages	42 (23)	41 (33)

^a Interviews were completed for a total of 315 girls (188 in Siem Reap and 127 in Svay Rieng). Three girls in each province completed the survey independently and there are no adult respondents for these households included in the table.

^b Missing values excluded and percentages rounded to the nearest whole number.

^c Multiple responses were allowed.

materials included English terminology (i.e. HPV) to describe the virus. Prior to the campaign, verbal communication activities described HPV vaccine as the “vaccine to prevent cervical cancer” [20]. Anecdotal feedback on written communication materials from parents after the campaign recommended defining the term “HPV” in the local language to aid in understanding, as well as inclusion of images to aid with community understanding [21]. It is possible that the way these questions were worded on the questionnaire or how the data collectors conducted the interview may have impacted these findings. Consistency in terminology during both campaign communication activities and coverage survey interviews would facilitate a more accurate measure of full understanding around HPV infection and HPV vaccine. As with other self- and caregiver-reported surveys, the potential for social desirability bias remains a possibility.

Girls were identified as a primary source of information about the HPV vaccination campaign for caregivers. Teacher training with strong messaging to girls in schools was utilized to transmit messages to parents and caregivers prior to the HPV vaccination campaign. In other HPV vaccine demonstration programs, collaboration with teachers and community health volunteer networks contributed to effective and efficient service delivery [12,22]. In future HPV vaccination activities, girls should be considered a key target audience for communication activities [16]. Among the few surveyed girls who received zero doses of HPV vaccine, not being aware of the campaign was the primary reason cited for not receiving

ing the vaccine. Fear of injections and concerns about safety were infrequently identified as reasons for not receiving the vaccine; no widespread instances of vaccine refusal, hesitancy or rumors were found. As the country considers national introduction, equipping healthcare workers, teachers and community volunteers with standard information about HPV vaccine including eligibility, benefits and safety could ensure preparedness to address rumors that could potentially arise and reinforce key knowledge among the community.

Findings from the coverage survey may not be generalizable to other countries, and it is possible that the areas selected for the demonstration program differed from other provinces in Cambodia. Household non-response was 16%. If the same proportion of non-responding HHs had eligible girls as did responding HHs (4.9%), then we estimate that 59 eligible girls were in the non-responding HHs. If eligible non-responders were more likely not to receive vaccination, this could bias coverage estimates toward the high side. In addition, very few out-of-school girls were identified during the survey; it is unclear whether this was a result of a true absence of out-of-school girls in the community or whether the survey methodology was ineffective for identifying this sub-population. It is also possible that the sample frame used to select clusters, though based upon the most recent census, may not have included some marginalized populations such as migrants or other groups potentially containing out-of-school girls.

More research is needed to evaluate the effectiveness of strategies to identify and enumerate out-of-school girls [23]. If the target population for the HPV demonstration program is truly higher than initially estimated, due to poor enumeration of out-of-school girls, estimated coverage may be falsely elevated. Other countries have reported similar challenges in quantifying out-of-school girls [12]. Aside from conducting a complete census, school headcounts have proved to be a reliable means for calculating target population, though unverified estimates of out-of-school girls are an ongoing challenge [24]. As more low- and middle-income countries begin to introduce HPV vaccine nationally, it will be important to identify ways to enumerate and reach out-of-school girls, as well as populations that may be vulnerable due to geographic or socioeconomic isolation, cultural or language barriers or migrant status. Some of these populations may be at higher risk for sexually-transmitted infections including HPV and most may have limited access to cervical cancer screening and treatment [23].

In 2017, WHO recommended that all countries proceed with national introduction of HPV vaccine, irrespective of availability of cancer screening or treatment, in a way that is affordable, cost-effective, sustainable, compatible with health infrastructure, and capable of achieving the highest possible coverage [6]. Overall, findings from the Cambodia coverage survey reflect that the country was successful in delivering HPV vaccination to the target population of girls during the HPV demonstration program. This evidence greatly contributed to the country's decision to scale-up vaccination and introduce HPV vaccine into the national immunization program. However, national introduction should involve thoughtful consideration of key implementation factors including target age group, vaccine delivery strategy, dosing schedule and respective training and social mobilization approaches. WHO now recommends vaccinating multiple age cohorts (e.g., 9–14 year olds) in the first year of vaccine introduction, if feasible [6]. Though a school-based vaccination strategy was successful in Cambodia's demonstration program targeting 9-year-old girls, national introduction to older age groups may pose different challenges. School enrollment is high in primary school but drops significantly in secondary school. While 9-year-old girls may be easily reached through school-based vaccination in primary schools, older girls (age 13 and 14) may be missed through a similar strategy in sec-

ondary schools. As Cambodia plans for national introduction, recommendations from this survey, along with deliberations around new challenges that may arise with scale-up, should be thoroughly considered.

Declaration of interests

The authors declare no conflict of interest.

Disclaimer

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

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