

Research Article

Cost analysis of pilot school-based HPV vaccination program in two provinces of Lao PDR

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KEYWORDS:

Cost analysis; Immunization programs; Human papillomavirus vaccine; Lao PDR

ABSTRACT

Cancers including cervical cancer are leading causes of mortality in Lao PDR. Human papillomavirus (HPV) vaccination has been introduced as a pilot project. As a part of the evaluation, program cost of the school-based vaccination was estimated. We employed an ingredient-based/ bottom-up costing study of incremental vaccine delivery cost using the WHO Cervical Cancer Prevention and Control Costing Tool (C4P). Both financial and economic costs are measured from the Ministry of Health perspective covering central supply unit to service provider levels. Costs are composed of labor cost and material cost but costs of building, vehicle and cold chain equipment are not included, except for extra cold chain equipment. Costs are presented in nominal value for the year 2013 (USD 1=7,855 LAK) in terms of total cost, cost component and unit cost. Scenarios for both 3- and 2-dose vaccination were explored. In two pilot provinces, there are 22 districts, 107 health centers, 917 schools and 13,558 target girls. We found that, with 100% coverage, the total costs of the 3-dose program were USD 106,677 and USD 135,479 for financial and economic cost, respectively. In terms of cost proportion by type of activities, service delivery comprised the highest percentage of economic cost (41.7%). For financial cost, supervision/AEFI comprised 42.5% and was the largest component. Costs per vaccination dose were USD 2.62 and USD 3.33 for financial and economic perspectives, respectively. Costs per fully immunized girl (FIG) for financial and economic perspective were USD 7.87 and USD 9.99, respectively. For a 2-dose vaccination scenario, costs per FIG were USD 5.7 and USD 7.9 for financial and economic cost, respectively. In conclusion, the overall cost of HPV vaccination program of Lao PDR was found to be in range of other countries, particularly those with similar features. Using a 2-dose vaccination schedule instead of a 3-dose schedule could save approximately one-third of the recurrent cost.

1. INTRODUCTION

Lao People's Democratic Republic (Lao PDR) is a landlocked country in Southeast Asia with an estimated population of 6,695,166 (in July 2013). The country's total area is 236,800 square kilometers, comprising the capital city of Vientiane Capital and 17 provinces. In 2012, the estimated real GDP per capita

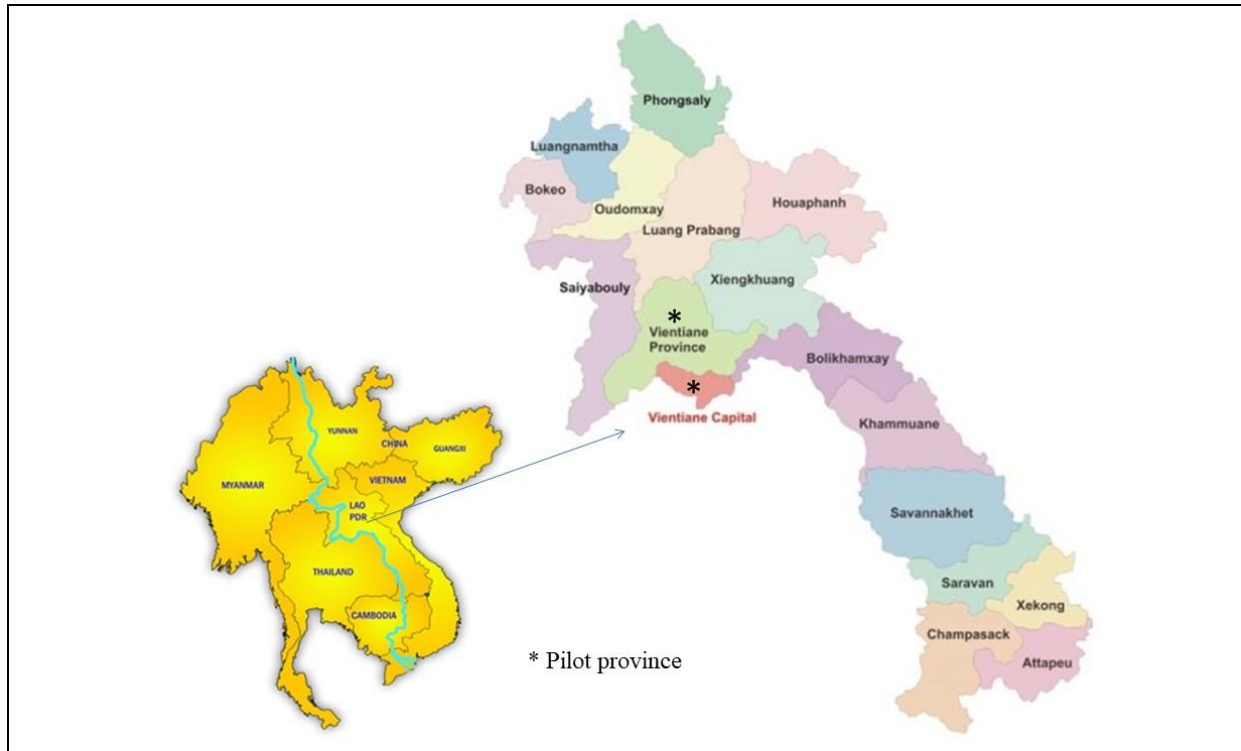


Figure 1. Pilot provinces; Vientiane Capital and Vientiane Province
(Source: <https://sites.google.com/site/sc2evers/laos/unit-1>
<http://www.getdomainvids.com/keyword/vietnam%20and%20laos/>)

(purchasing power parity, PPP) was USD 3,100. The GDP growth rate was 8.3% and the inflation rate in consumer prices was 4.3%¹.

Regarding disease burden, noncommunicable diseases caused 48% of total deaths in Lao PDR in 2014. Eleven percent of the total deaths were caused by cancers². Age-standardized death rate caused by cervical cancer per 100,000 population was 7.81, making cervical cancer the 25th most common cause of deaths³. The rate was increased from 7.4 in 2012⁴. In 2014, a public national cervical cancer screening program including cytology, visual inspection with acetic acid (VIA), and human papillomavirus (HPV) screening is in place. However, due to limited numbers of skilled practitioners and required co-payment for these services, the coverage was less than 5%⁴. Gavi, the Vaccine Alliance, has supported demonstration projects that are intended to last two years and allow countries to assess the feasibility of their vaccination strategy before scaling-up to a national level (HPV vaccine support for national introduction guidelines (see: www.gavi.org/support/apply/)). As part of these Gavi demonstration projects, Lao PDR received financial and technical support from Gavi and the World Health Organization (WHO) to implement HPV vaccination in two

pilot provinces for two cohorts starting in 2013. In this regard, other than post introduction evaluation (PIE), the cost incurred in implementation of vaccination program is required to be reported to the vaccine donor for a scale-up planning.

This study applied the WHO Cervical Cancer Prevention and Control Costing Tool (C4P)⁵⁻⁷, which is a Microsoft Excel-based costing and planning template, for the analysis. The study aimed to estimate the cost of implementation of school-based HPV vaccination program in two pilot provinces of Lao PDR as part of the Gavi demonstration projects.

2. METHOD

2.1. Study sites and program activities

The study was conducted through the National Immunization Program (NIP), Ministry of Health in two pilot provinces; Vientiane capital urban setting (VTC) and Vientiane Province rural setting (VTP) (Figure 1). Provincial organizations involved included the provincial health office, the district health office, and health centers. The study covered all organizations and activities of

Table 1. Activities and responsible service levels

Activities	National Immunization Program	Provincial Health Office	District Health Office	Health Center
1. Micro-planning	yes	Yes	yes	no
2. Training	yes	Yes	yes	no
3. Social mobilization, IEC	yes	Yes	no	no
4. Procurement	yes	No	no	no
5. Logistics/transport	yes	Yes	no	no
6. Vaccine delivery	no	No	no	yes
7. Supervision/ monitor/ evaluation	yes	Yes	no	no
8. Waste Management	no	Yes	no	no

Remark: 1. Responsible service levels represents organizations that are responsible for activity and budget management.
2. IEC = Information, education and communication

immunization program ranging from planning to waste management (Table 1).

2.2. Study design

This study was a cost analysis of a healthcare program from a Ministry of Health perspective. This study is an ingredient-based/ bottom-up costing study of incremental cost of the HPV vaccination program, meaning additional costs for new resources that are not already being utilized in the health system in place. Furthermore, both investment costs, such as for extra cold chain and introduction activities, and recurrent costs, such as the running program costs, were considered. Financial costs, or the actual expenditures of the government, are a subset of the economic costs, which also include resources used for service delivery that have opportunity costs. These economic costs include resources already paid for or owned by the government, such as salaries of health personnel, partner-donated items like vaccines, and volunteer time⁸.

2.3. Study program

Gavi supported three-dose HPV vaccination for two pilot provinces of Lao PDR for two years starting in 2013. The program incorporated a school-based approach targeting girls in grade five. Out-of-school girls aged 10 years and absent students are appointed to receive

the vaccine at health facilities. This study aims to determine HPV vaccine delivery costs of the first pilot year. The vaccination period was between October 2013 and April 2014.

2.4. Cost component

Based on the WHO guidelines and the WHO Cervical Cancer Prevention and Control Costing (C4P) Tool⁵⁻⁷, an overview of the concept of cost analysis of vaccination programs can be deduced. There are two types of costs involved in analysis; economic and financial cost.

From either the economic or the financial perspective, costs are composed of labor cost and material cost. Costs of facilities, vehicle and cold chain equipment already in use are not included except for extra cold chain equipment. Both economic and financial costs are detailed in Table 2. The cost components included in this study are labor cost, including basic salary, daily subsistence allowance (DSA) and accommodation of health and education personnel, and material cost, including meeting/ training materials like halls for rent, stationery, documents and meals. Other costs include cost of mass media campaigns, costs incurred in custom process during vaccine importation, and transportation cost including fuel cost. This study does not include cost of vaccine, syringes and safety boxes, the costs to individual households, or other private sector costs.

Table 2. Classification of costs

Resources	Economic cost	Financial cost
Salary	yes	no
Daily Subsistence Allowance (DSA) or per diem	yes	yes
Material costs, i.e., document, hall renting fee, meal, fuel	yes	yes
Transportation cost (recurrent)	yes	yes
Micro-planning, training and social mobilization (annualized)	yes	yes

Table 3. Unit cost of resources used

Payment	USD 2013	Unit
Average salary; NIP	240.54	per month
Average salary; PHO	236.64	per month
Average salary; DHO	174.25	per month
Average salary; HC	163.15	per month
Average salary; NIP	11.10	per day
Average salary; PHO	10.92	per day
Average salary; DHO	8.04	per day
Average salary; HC	7.53	per day
DSA; same province, same day	4.46	per day
DSA; different province, same day	8.91	per day
DSA; different province, stay over night	24.19	per day
Supervision DSA; NIP to PHO	24.19	per day
Supervision DSA; PHO to DHO	24.19	per day
Supervision DSA; DHO to HC	14.00	per day
Compensation for vaccinators	0.64	per dose
Travelling; car	0.16	per km
Travelling; motorcycle	0.15	per km
Travelling for vaccinating	3.82	per school

Note: NIP = National Immunization Program, PHO = provincial health office, DHO = district health office, HC = health center, DSA = daily subsistence allowance

2.5. Data collection and data management

Data collection in this study was composed of measuring the quantity of resources used and the outputs. Resources used per activity were measured including number of each activity for the whole program. Data were collected by extracting from the activity and financial reports from the NIP under the Ministry of Health. Self-administered questionnaires were developed as a primary data collection tool, which was administered at all units involved in the vaccination pilot program. Outputs were the number of vaccine doses injected and the number of girls who received the full three doses of the vaccine. Data extracted from the forms and financial reports were entered into MS Excel for checking, cleaning and managing. Afterwards they were entered into the WHO C4P tool for further cost estimation.

2.6. Valuation of resources used

Actual expenses were directly included as the costs. For resources used, to calculate the cost, the quantity of resources used was multiplied by their unit costs resulting in the monetary value of the resources. Based on the time used for each activity in the financial report or survey, the salary was adjusted to calculate labor cost from salary. After data collection from each level, salary was found to be average for each month. Monthly salary was adjusted to annual salary, which was then divided by 52

weeks and 5 working days per week resulting in salary per day. Unit costs included average salary, daily subsistence allowance (DSA) and travelling cost (Table 34). Initially, introduction activities like micro-planning, training and social mobilization were implemented once for more than one year of effect similar to capital assets. Therefore, they were classified as capital (investment) cost and then annualized with 5 useful years. Costs of introduction activities as capital cost in economic perspective is calculated using 3% discount for a period of 5 useful life years. Capital cost in financial perspective is calculated without any discount.

2.7. Analysis and presentation

The demo version 2.2 of the WHO Cervical Cancer Prevention and Control Costing (C4P) Tool was modified and used for cost analysis. All costs are presented in USD 2013 values (USD 1=7,855 LAK) as follows:

1. Total cost of the program
2. Total cost classified by types of activities
3. Cost per dose of vaccination
4. Cost per fully immunized girl (FIG)

Due to two-dose vaccination was proposed but not yet officially recommended by WHO. Therefore, sensitivity analysis was conducted for a scenario with a two-dose HPV vaccination schedule. It is a multi-way or multivariate sensitivity analysis. Costs of the services of all levels were estimated for two-dose vaccination.

Table 4. Average workload of vaccination at health center per round (dose) of vaccination

	unit	dose 1	dose 2	dose 3
School preparation/ coordination	days	2.83	1.20	0.84
Vaccine preparation	hours	1.6	2.16	1.44
Vaccine delivery	days	3.09	3.08	2.45
Number of vaccinators	persons	2.08	2.28	2.11
Total person-days	days	9.44	8.48	6.17

Note: 1 day = 8 working hours

3. RESULTS

3.1. Coverage results and resources used

In two pilot provinces, there were in total 22 districts, 107 health centers, 917 schools and 13,558 target girls. All target girls received the vaccine, hence, 100% coverage for all three doses was achieved. Unit costs of resources used are presented in Table 3. Average monthly salary of staff at NIP, PHO, DHO and HC were USD 241, USD 237, USD 174 and USD 163, respectively. Daily subsistence allowances (DSA), or per diem, was varied from a same province-same day scenario (USD 4.46/day) to a different province-staying overnight scenario (USD 24.19). The average workload of school-based vaccination per health center was 9.44, 8.48 and 6.17 person-days for dose 1, dose 2 and dose 3 vaccinations, respectively. The time used included school coordination, vaccine preparation and vaccine delivery (Table 4). Average labor time used for vaccination by health center was highest for dose 1 and lowest for dose 3 (Table 4).

3.2. HPV Vaccination program costs

Total annualized financial costs and unit costs classified by program activities for three-

dose and two-dose vaccination of the first vaccination batch are presented in Table 5 and 6.

3.3. Cost of 3-dose vaccination

Comparing the proportion of cost by type of activities, service delivery comprised the highest percentage of economic cost (42%). For financial cost, supervision/adverse events following immunization (AEFI) comprised the largest component at 42%. In Table 6, the cost of micro planning, training and social mobilization and information, education, communication (IEC) were combined as program introduction costs. The rest was recurrent costs comprised of procurement, logistics/transportation, service delivery, supervision and waste management. Introduction costs of three-dose and two-dose vaccination were assumed to be the same. Recurrent costs of two-dose vaccination were approximately two-thirds of that of three-dose vaccination, which was to be expected. Introduction costs were 13% and 19% of the total cost of three-dose and two-dose vaccination, respectively.

For three-dose vaccination, financial and economic costs per fully immunized girl (FIG) were USD 7.87 and USD 9.99, respectively. Financial and economic costs per vaccination dose were USD 2.62 and USD 3.33, respectively.

Table 5. Total annualized financial and economic costs of the HPV vaccination program (USD 2013)

Activity	Three-dose HPV vaccination program				Two-dose HPV vaccination program (theoretical)			
	Financial cost		Economic cost		Financial cost		Economic cost	
	USD	%	USD	%	USD	%	USD	%
1. Micro-planning	1,010	0.9	1,754	1.3	1,010	1.3	1,754	1.6
2. Training	3,030	2.8	108	0.1	3,030	3.9	108	0.1
3. Social mobilization, IEC	10,298	9.7	11,628	8.6	10,298	13.3	11,628	10.8
4. Procurement*	5,850	5.5	6,002	4.4	3,402	4.4	3,745	3.5
5. Logistics/ transport	108	0.1	5,263	3.9	108	0.1	5,263	4.9
6. Service delivery	38,889	36.5	57,571	42.5	25,866	33.5	39,761	37.0
7. Supervision/ AEFI	44,504	41.7	48,790	36.0	31,577	40.8	42,162	39.3
8. Waste Management	2,988	2.8	4,362	3.2	2,034	2.6	2,943	2.7
Total	106,677	100.0	135,479	100.0	77,326	100.0	107,365	100.0

Note: AEFI = adverse event following immunization, IEC = information, education, communication

Table 6. Unit cost of the HPV vaccination (USD 2013)

Program and cost category	Financial cost (USD)				Economic cost (USD)			
	Total	Per eligible girl	Per dose	Per FIG	Total	Per eligible girl	Per dose	Per FIG
Three-dose vaccination								
Introduction costs	14,338	1.06	0.35	1.06	13,490	1.00	0.33	1.00
Recurrent costs	92,339	6.81	2.27	6.81	121,989	9.00	3.00	9.00
Total cost	106,677	7.87	2.62	7.87	135,479	9.99	3.33	9.99
Two-dose vaccination								
Introduction costs	14,338	1.06	0.53	1.06	13,490	1.00	0.50	1.00
Recurrent costs	62,988	4.65	2.32	4.65	93,875	6.92	3.46	6.92
Total cost	77,326	5.70	2.85	5.70	107,365	7.92	3.95	7.92

Note: 1. Number of girls in target group and number of fully immunized girls (FIGs) of both 3- and 2- dose vaccination were 13,558.
2. Number of doses used for 3- and 2- dose vaccination were 40,725 and 27,170 doses, respectively.

3.4. Cost of 2-dose vaccination schedule

Costs for a two-dose vaccination schedule were also explored. The delivery cost for each dose of vaccination was assumed to be the same as those of the three-dose vaccination schedule. Considering activities of the vaccination program, supervision/AEFI comprised the highest percentage of resources (41% and 39% for financial and economic costs, respectively) (Table 5).

The Cost per fully immunized girl (FIG) was USD 5.70 and USD 7.92 for financial and economic values, respectively. Cost per vaccination dose was USD 2.85 and USD 3.95 for financial and economic values, respectively.

4. DISCUSSION AND CONCLUSION

The study calculated cost per FIG and per dose vaccinated of the pilot HPV vaccination program in Vientiane Capital and Vientiane Province of the Lao People's Democratic Republic. For the base case study of 3-dose vaccination, financial cost per FIG was USD 7.87. A scenario of 2-dose vaccination was explored and the financial cost per FIG was found to be USD 5.70.

However, the study has some limitations. Data collection through self-administered questionnaires may result in limited understanding of the questions. Due to limited resources, the meeting for the process of data collection was held only for provincial health officers. Then provincial officers explained the process to lower level staff. As a result, district health officers and health center staff might have limited understanding of the data collection forms. Another limitation of the study is that the WHO C4P Tool estimates the cost from a public

health care provider perspective, which means that the individual costs to households and other private sector costs are not included. Finally, we did not include the cost incurred by the education sector when vaccinating girls in schools. School-based vaccination depends on existing school health programs, such as the involvement of school health teacher and education administrators in planning vaccine delivery and provision of education and information.

The role of educators may affect vaccination coverage. For instance, in Kenya, Malaysia and Uganda, teachers were included in a feasibility study¹⁰⁻¹². In Australia, there is an ongoing study comparing an adolescent intervention comprising education taught through the school in an interactive lesson, an HPV vaccination decisional support tool for adolescents and parents, and logistical strategies including methods for increasing consent form return¹³. Regarding the importance of the teacher's role, in terms of economic burden, there are costs incurred in the education sector. From the public provider perspective, these costs have to be included.

Comparing with other studies, there are cost analyses of HPV vaccine introduction programs in Bhutan, India, Peru, Rwanda, Tanzania, Uganda and Vietnam^{8, 14-17}. In the comparison, original costs were adjusted by inflation to be values in 2013 as those of this study. Country-specific consumer price index (CPI) were taken from the World Bank reference data¹⁸. These studies look at retrospective costs of EPI, costs of pilot studies, and forecasted scale-up costs. Focusing on the pilot projects in India, Vietnam, Tanzania, Uganda and Peru, Levin *et al*¹⁵ reviewed results and found that financial introduction cost per eligible girl ranged from USD 2.20 (2013 value in India) to USD

28.45 (2013 value in Vietnam). Financial recurrent cost per FIG ranged from USD 1.48 (2013 value in India) to USD 19.59 (2013 value in Tanzania). The reviewers proposed that considerable variation was due to differences in scope and scale (number of girls in the target population and population density), vaccination strategies (outreach/clinic-based, school-based), country and health system characteristics (national income, infrastructure, health care cost, personnel cost) and public health policy and management. Another study that was conducted in Rwanda indicates that service delivery strategies have an important influence on costs of introducing new vaccines and costs per girl reached with HPV vaccine are higher than the other vaccines such as rotavirus and pneumococcal conjugate vaccines because of its delivery strategy¹⁴.

In our study, we found that financial introduction cost per eligible girl and financial recurrent cost per FIG were USD 1.06 and USD 7.87 (2013 value in Lao PDR), respectively. The introduction cost in Lao PDR is a little lower than the range in the reviewed pilot country study⁸, while the recurrent cost is within the range in the reviewed countries. The number of girls in the target population in Lao PDR (13,558) was most similar to that in India (14,533). For the periodic school-based program in India, financial introduction cost per eligible girl and financial recurrent cost per FIG were USD 2.20 and USD 1.48 (2013 value), respectively. In another study in Peru with the same strategy but fewer target girls (8,092), financial introduction cost per eligible girl and financial recurrent cost per FIG were USD 12.81 and USD 2.13 (2013 value), respectively. Cost of program introduction is fixed. Therefore, the unit cost is varied due to number of target girls. In comparative analysis, efficiency cannot directly be measured due to difference in context.

Another characteristic to be compared is population density. This affects transportation cost including labor time and the cost for travelling to deliver the vaccine at schools. Lao PDR has a relatively low-density population (27 people per km² in 2009) similar to Tanzania (46 people per km² in 2009) and Uganda (136 people per km² in 2009)¹⁹. Financial recurrent cost per FIG of Lao PDR is in range of these two countries (USD 7.84 vs USD 3.97 and USD 13.08).

It is worth exploring why recurrent cost per FIG in this study (USD 7.87) was higher than that of the India (USD 1.00) and Peru (USD 1.90)

studies, but within the range of recurrent costs for Uganda (USD 3.97) and Tanzania (USD 13.08). The India and Peru projects had a scale similar to that of Lao PDR, but India is very densely populated and Peru is a middle-income country with better existing infrastructure. The Uganda and Tanzania projects were set in less densely populated countries, similar to Lao PDR. Recurrent cost is the running cost of the program such as transport, allowances, monitoring and evaluation, and supervision. The review by Levin *et al.* mentions that pilot projects do not include monitoring and evaluation, while these are included in this study. Therefore, they are not directly comparable. In addition, refresher training as a recurrent cost was not designed in this study. This might be required in the following years, resulting in higher recurrent cost. When comparing the same activity, recurrent cost is calculated from the amount of resource used and its unit price or cost. Both variables are to be compared to consider how to increase level of efficiency.

In the exploration of a two-dose vaccination schedule, cost per FIG is decreased due to lower total costs (numerator) but a constant number of FIGs (denominator) because coverage of three-dose vaccination is already 100%. In case coverage of three-dose vaccination is less than 100%, coverage of two-dose vaccination has the potential to increase because the drop-out rate of lower-dose vaccination is normally less than that of more dose vaccination. In contrast, the cost per vaccinating dose has increased although both total cost and number of vaccinating doses have decreased. This is because initial investment cost is fixed. Then, initial investment cost per unit of vaccinating dose is increased while operating cost per unit is constant, assuming that operating costs across the doses (round of vaccinating) are the same. Based on these assumptions, using a two-dose vaccination schedule could save approximately one-third of the recurrent cost (USD 7.87 per FIG), while the introduction cost (USD 1.09 per eligible girl) remains the same.

In conclusion, the overall cost of the HPV vaccination program in Lao PDR was in the range of other countries, particularly those with characteristics similar to Lao PDR. Compared to countries with a similar scale of program, introduction costs in Lao PDR were slightly lower and recurrent costs were higher. Compared to countries with low population density, introduction costs in Lao PDR were

lower and recurrent costs were within the same range. The potential for reduction of recurrent cost could be explored by examining the quantity (number of activities and number of resource used in each activity) and price or cost of recurrent resources. In addition, using a two-dose vaccination schedule could save approximately one-third of the recurrent cost of using a three-dose schedule. The results from this study will be used for projections of national scale-up in the future including as inputs for cost-effectiveness analysis of the vaccination program to assist the Lao government with future planning of their HPV vaccination program.

5. ACKNOWLEDGEMENTS

This work was financially supported by World Health Organization. RH and KF are staff members of the World Health Organization. The views expressed are those of the authors and do not necessarily represent the views of the World Health Organization. We thank Taylor Holroyd for editing the manuscript.

Conflict of interest

None to declare

Funding

World Health Organization

Ethical approval

None to declare

Article info:

Received October 5, 2017

Received in revised form April 11, 2018

Accepted April 15, 2018

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