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Cost of human papillomavirus vaccine delivery in a single-age cohort, routine-based vaccination program in Senegal☆

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Abstract

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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.

7. Disclaimers

The findings represent the personal views of the authors and not the official position of the U.S. Centers for Disease Control and Prevention.

8. Human subjects

The evaluation protocol was determined to be not human subjects research and therefore exempt from institutional review board (IRB) review by the CDC Center for Global Health Associate Director for Science.

Credit authorship contribution statement

Timothy Brennan: Conceptualization, Methodology, Software, Validation, Formal analysis, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision. **Anna Hidle**: Conceptualization, Methodology, Software, Validation, Formal analysis, Resources, Data curation, Writing – original draft, Writing – review & editing. **Reena H. Doshi**: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Qian An:** Conceptualization, Methodology, Validation, Formal analysis, Writing – original draft, Writing – review & editing. **Anagha Loharikar:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Funding acquisition. **Rebecca Casey:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Ousseynou Badiane:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Alassane Ndiaye:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Aliou Diallo:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Jerlie Loko Roka:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Nelly Mejia:** Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Taiwo Abimbola:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing, Supervision, Project administration.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2021.11.057.

Introduction: In 2018, Senegal introduced human papillomavirus (HPV) vaccine into its routine immunization program for all nine-year-old girls nationwide. We evaluated the costs of Senegal's introduction of HPV vaccine via this delivery approach.

Methods: We conducted a retrospective, incremental, ingredients-based cost evaluation from the provider perspective. The study timeframe included Senegal's first planning meeting in 2018 through data collection in early 2020. We collected costs from all involved units at the national and regional levels. A multi-stage cluster sampling approach was used to obtain a nationally representative sample of districts and health facilities. Weights were applied to costs from sampled units to estimate costs across all units. The cost evaluation was based on four dimensions: program activity, resource input, payer, and administrative level. Total costs were divided by the number of HPV doses administered to determine cost per dose and per dimension.

Results: Excluding vaccine program activity costs, the total financial and economic delivery costs of Senegal's HPV vaccination program were US$ 1,152,351 and US$ 2,838,466, respectively (US$ 3.07 and US$ 7.56 per dose, respectively). A total of 375,608 HPV vaccine doses were administered during the cost evaluation. Training and per diem represented the largest shares of financial costs. Service delivery and personnel time accounted for the largest shares of economic costs. By administrative level, district and health facility levels had the largest shares of financial and economic costs, respectively. Senegal's Ministry of Health accounted for the largest share of financial and economic costs. Including vaccine program activity costs (US$ 4.68/per dose), the total financial cost was US$ 2,911,343 (US$ 7.75 per dose).

Conclusion: This cost evaluation can support Senegal's future vaccine introductions and inform other countries planning to introduce HPV vaccine nationwide. These findings support previous costing studies which anticipated potential economies of scale during the transition from HPV vaccine pilot demonstration projects to national introduction.

Keywords

Vaccine introduction; Human papillomavirus vaccine; Cost; Senegal

1. Background

The World Health Organization (WHO) recommends all countries to proceed with nationwide human papillomavirus (HPV) vaccine introduction, irrespective of the status of the country's cervical cancer screening and treatment programs [1]. Countries are responsible for determining the most feasible HPV vaccine delivery strategies to optimize coverage. As of 2020, more than 100 countries globally have introduced the HPV vaccine into their national immunization program (NIP) [2].

With a population of just under 16 million in 2018, an estimated 4.43 million women are at risk of developing cervical cancer in Senegal [3–5]. Cervical cancer is the most frequent cancer among women in Senegal and is the leading cause of morbidity from all cancers, with 1,876 new cases and 1,367 deaths in 2018 [3,4].

Following WHO recommendations, Gavi, the Vaccine Alliance (Gavi), financed pilot demonstration programs of HPV vaccine introduction for eligible low-income countries

since 2013, aiming to understand the best strategies for delivering HPV vaccines and to apply lessons learned towards national introductions of the HPV vaccine.

With Gavi support, Senegal conducted an HPV vaccine pilot demonstration project in 2014–2016 through a school-based campaign. Across the two pilot districts, a 90% administrative coverage rate was achieved in both cohorts of nine-year-old girls vaccinated, with 11,232 HPV vaccine doses administered [6]. A cost evaluation conducted in conjunction with the pilot demonstration project estimated the total financial cost as US$ 77,639 (adjusted to 2020 United States Dollars–USD) for the two pilot districts, including the cost of vaccine (vial) [7]. The financial cost per dose was US $ 7.37 including the cost of vaccine (vial) and US$ 6.85 excluding the cost of the vaccine (vial) [7].

Supplemental cost analysis following the pilot demonstration project further informed Senegal's decision to introduce HPV vaccine nationwide either via a campaign or via routine immunization services [7,15]. Among other factors, Senegal concluded that HPV vaccine introduction via routine immunization services was less expensive and ultimately opted to use routine immunization services for the introduction of the HPV vaccine nationwide.

Following the pilot demonstration project, Senegal's Ministry of Health and Social Action (MSAS in French) applied and successfully received support from Gavi for national HPV vaccination introduction. Senegal's national HPV vaccination program was launched in late 2018, targeting all nine-year-old girls and offering a two-dose series throughout the year, with a 6–12-month interval between the two doses.

As part of Senegal's routine NIP delivery platform, immunization services are offered at health facilities, schools, and community outreach sites. Senegal utilizes four different service delivery strategies as part of its routine immunization services:

1. **Fixed Site** – service delivery conducted at the health facility
2. **Outreach**– service delivery conducted at an outreach site within 5 km of the health facility
3. **Expanded Outreach** – service delivery conducted at an outreach site between 5 and 15 km from the health facility
4. **Mobile** – service delivery conducted by a district team at an outreach site than 15 km

Senegal deployed a cascade training system by administrative level as part of its national HPV vaccination introduction. Districts were tasked with the majority of the trainings and organized three separate HPV vaccine-focused trainings for the healthcare providers working at the health facilities, teachers, and community health workers.

Previous studies have documented the cost of adding HPV vaccination to an existing immunization program through Gavi pilot demonstration projects; however, there is a knowledge gap regarding the cost of nationwide HPV vaccine delivery [8–14]. Although the HPV pilot demonstration projects provide important information, they are not designed to demonstrate whether a country can implement HPV vaccination sustainably and at national

scale. Further, previous studies have indicated that the costs involved can be a deterrent for countries considering HPV vaccine introduction into their respective NIPs because the HPV vaccine is considerably more expensive than traditional vaccines [12]. The previous studies concluded that HPV demonstration projects were perceived to be expensive but that costs would decrease as countries introduce the HPV vaccine nationally and start reaping the benefits from economies of scale [12].

Senegal conducted this Gavi-supported cost evaluation in conjunction with its national HPV introduction to better understand the required financial and economic resources [16]. The goal was to determine the cost of national HPV vaccination introduction in Senegal's routine immunization program for a single-age cohort of nine-year-old girls. Cost outputs included the total incremental cost of adding HPV vaccination to the Senegal's immunization program, as well as a cost per dose estimate. This cost evaluation aimed to provide Senegal's decision-makers with evidence on the overall resource needs.

2. Methods

A retrospective, incremental, ingredients-based, financial, and economic program cost evaluation was conducted from the provider perspective [17]. The cost evaluation calculated the financial and economic costs of HPV vaccine introduction activities. Financial costs were defined as the actual expenditures of a program from the perspective adopted. Economic costs were defined as financial costs plus opportunity costs, with opportunity cost as the value of time or other input in its alternative use (i.e., how the specific resource could be used if not employed during the program) [18,19]. Further details regarding the design of this evaluation can be found in the Appendix.

The evaluation focused on the identification of HPV-vaccination related costs by four dimensions: program activity, resource input, administrative level, and payer (Fig. 1). These four dimensions were not mutually exclusive. Each cost was understood in terms of the four dimensions associated with its use.

Cost components were broadly delineated by HPV vaccination program activities, which were organized into the following categories: service delivery, planning, training, social mobilization, supervision and monitoring, cold chain, vaccine, and other. Resource inputs were grouped into the following categories: personnel time, per diem, vaccine and vaccination supplies, equipment, transportation, venue, and non-vaccination supplies and materials. Administrative level refers to the administrative level at which the cost occurred and corresponds to the administrative level of the health system: national, regional, district, or health facility. Payer was defined as the disbursing agent or custodian of funds that expends the monetary payment directly for the good or service. The funding source was not assessed in this evaluation. In terms of economic costs, such as personnel time, the payer was defined as the organization responsible for paying salaries. In the case of non-paid personnel costs, such as community health workers, we estimated the value of labor time using the salary of the lowest known paid personnel. In the case of existing capital goods, we considered the payer to be the resource owner.

Costs were also organized into investment and recurrent costs. Investment costs are costs that are expected to last longer than one year and include costs from the following program activities: planning, training, social mobilization, cold chain (supplement), and other (investment) [18,19]. Recurrent costs are expected to be repetitive in nature and include costs from the following program activities: service delivery, supervision and monitoring, cold chain (recurrent), and other (recurrent) [18–19]. Categorization of investment and recurrent costs followed the Cervical Cancer Control and Costing (C4P) Tool [18] and EPIC costing guidance [19], with adaption for this cost evaluation. Further information on investment and recurrent costs is provided in the Appendix.

The study timeframe was from Senegal's first planning activity for nationwide HPV vaccine introduction in May 2018 through the end of data collection in March 2020. The analytic horizon was concurrent with the study timeframe.

2.1. Sampling

We collected cost data at the national, regional, district, and health facility levels. Data were collected on all costs incurred at national and regional levels, with all regions in Senegal included and no sampling performed at these administrative levels. For the districts and health facility levels, we used a multi-stage cluster sampling approach (Fig. 2) based on immunization delivery costing guidance [19]. Districts were stratified as rural, urban, or mixed based on the rural/urban status of their health facilities. We selected the districts using probability proportional to size (PPS) sampling, with the volume of measles-containing vaccine first dose (MCV1) administered as the size variable because the number of HPV doses administered were not reliable at the time of sampling, which happened early in the program when many centers were not yet vaccinating. The number of rural, urban, and mixed districts were selected in proportion to the corresponding district types in Senegal. We sampled a total of 31 districts (4 urban, 13 rural, and 14 mixed) out of 77 districts and selected two health facilities from each sampled district through simple random sampling. Seventy-seven health facilities (59 rural and 18 urban) were selected out of 1,518 health facilities. The sample size for districts and health facilities was based on cost data distributions from previous cost studies in other countries [20] and an assumed normal distribution of costs.

2.2. Data collection

The primary sources of data were the cost data related to delivering the HPV vaccination program at the administrative levels involved and the administrative estimate of the number of HPV vaccine doses administered during the study period. Trained data collectors used standardized questionnaires developed specifically for this cost evaluation to collect cost data from the program staff who were directly involved in the HPV vaccination introduction and delivery activities and also from individuals with information regarding the program (e.g., human resources, logistics, volunteers). We also used other data sources, such as meeting notes, program budgets, personnel salary information, participant attendance lists, invoices, receipts, and other planning documents to complement the data collected.

At the national level, U.S. Centers for Disease Control and Prevention (CDC) and CDC Foundation staff conducted interviews in June 2019 and March 2020. Regional-level questionnaires were sent via email to the regional medical doctor of each region between August 2019 and March 2020. At the district and health facility levels, local data collectors collected data in February–March 2020.

2.3. Analysis

We analyzed the data by four dimensions (i.e., program activity, resource input, administrative level, and payer). We multiplied the costs from sampled districts by district sample weights; the costs from the sampled health facilities were multiplied by both their respective district and health facility sample weights. Using sample weights allowed for inference to all similar units (i.e., district and health facility sampling frames) and for calculation of the total weighted cost per administrative level.

The costs at the district and health facility levels were collected entirely as local currency (Franc Communauté Financière d'Afrique – FCFA). We then converted these costs from the local currency to USD, using a two-step process [21]. We first adjusted all local costs from nominal year to 2020 FCFA, using Senegal's Consumer Price Index [22]; we then converted the costs to 2020 USD using the average exchange rate for May 2020 [23].

Capital goods procured and used for the national HPV vaccination were annuitized and discounted at a default discount rate of 5 percent. We estimated the Useful Life Years (ULYs) using WHO-CHOICE [24] and the costs for cold chain capital goods using the UNICEF supply catalog [25]. The purchase price of vehicles, ULYs, and resale values for similar vehicles were estimated from a list of vehicles purchased by MSAS.

We used the weighted total cost to calculate a unit cost per HPV vaccine dose administered, with and without the cost of vaccine program activity. In addition to the price of the vaccine product (Gardasil [quadrivalent]) itself, the cost of the "vaccine" program activity included costs for syringes, safety boxes, wastage- and procurement-related costs, and freight (see Appendix). For per dose calculations, we used the total number of doses administered between October 2018 and March 2020 as the denominator.

We analyzed the total weighted costs in terms of the four dimensions (i.e., program activity, resource input, administrative level, and payer).

We also organized the total unweighted financial costs by sampled units into histograms and box plots of unweighted financial costs from sampled units by total cost, by program activity, and by resource input to describe the distribution of costs.

3. Results

The total financial and economic costs of nationwide HPV vaccine introduction and delivery in Senegal were US$ 1,152,351 and US$ 2,838,466, respectively, excluding the cost of vaccine program activity. During the study timeframe, which includes the time of Senegal's introduction of the HPV vaccination in late 2018 through the end of the data collection period in early 2020, a total of 375,608 HPV vaccine doses were administered to girls aged

nine years. The total financial and economic cost per dose was US$ 3.07 and US$ 7.56, respectively, excluding the cost of vaccine program activity (Fig. 3).

With the cost of vaccine program included, the total financial and economic costs were US$ 2,911,343 and US$ 4,597,458, respectively. With these costs included, the financial cost per dose was US$ 7.75 and the economic cost per dose was US$ 12.24. Unit costs per dose for the vaccine, syringes, and safety boxes were US$ 4.50, US$ 0.041, and US$ 0.005, respectively.

The results we present below do not include the cost of vaccine program activity.

The weighted financial costs by administrative level as a percentage of the total were 11% at the national level, 1% at the regional level, 54% at the district level, and 34% at the health facility level (Table 1). The weighted economic costs at the national, regional, district, and health facility levels were 5%, <1%, 25%, and 70%, respectively, as a percentage of the total.

The program activities of training and service delivery accounted for the largest proportions of the total weighted financial costs at 42% and 30%, respectively (Table 2), or US$ 1.29 and US$ 0.91 per dose, respectively. Service delivery accounted for the largest share of the total weighted economic costs (57% or US $ 4.28 per dose), followed by training (18% or US$ 1.36 per dose).

In terms of investment and recurrent costs, we estimated an investment cost per dose of $1.85 and a financial recurrent cost per dose of $1.22 (Table 3). Investment costs represented 60% of the total weighted financial costs and 34% of the total weighted economic costs. Whereas, recurrent costs represented 40% of the total weighted financial costs and 66% of the total weighted economic costs.

We collected the share of the costs attributed to the HPV vaccination program for all resource inputs. Per diem accounted for the largest share of weighted financial costs by resource input at 47% (Table 4). Personnel time accounted for the largest share of total weighted economic costs by resource input at 47%.

By payer, Senegal’s Ministry of Health accounted for the largest share of costs, with 61% of the total weighted financial costs and 56% of the total weighted economic costs, which includes funding received from external partners, such as Gavi (Table 5). The health facility-level Comités de Développement Sanitaire (Committee of Health Development in English -- CDS) accounted for 21% of the total weighted financial costs and 17% of total weighted economic costs. Senegal’s Ministry of Education accounted for less than 1% of total weighted financial costs, but 12% of total weighted economic costs. Other payers included other government agencies, UNICEF, WHO, and others, all of which accounted for roughly 18% of the total weighted financial costs.

We also described the distribution of financial costs (not including vaccine program activity) for sampled districts and health facilities. At the district level, the mean total unweighted financial cost per district was US$ 4,557 (standard deviation [SD], US$ 2,290) and the

median was U$ 4,121 (interquartile range [IQR], US$ 3,221–US$ 5,623) (Appendix Fig. 1). At the health facility level, the mean total unweighted financial cost was US$ 179 (SD, US$ 223), and the median was US$ 102 (IQR, US$ 22–US$ 263) (Appendix Fig. 2).

4. Discussion

With a total of 375,608 doses to girls aged nine years administered via Senegal's nationwide HPV vaccination program during this project timeframe, the total weighted financial cost was US$ 3.07 per dose, excluding the cost of vaccine program activity. As a reference point, for Senegal's pilot demonstration project the financial cost per dose excluding the cost of vaccine (the cost of the vials, not the entire vaccine program activity) was US$ 6.85, suggesting that some benefits from economies of scale may have been realized as anticipated by previous cost studies. Importantly, this is not a direct comparison because Senegal's pilot demonstration project utilized a school-based campaign approach, while routine immunization services were used for the national introduction.

The financial cost estimate of US$ 3.07 per dose included an investment cost of US$ 1.85 and a recurrent cost of US$ 1.22. Because Senegal's HPV vaccination program is ongoing, the investment cost per dose will decrease as more girls are vaccinated over time. Previous cost studies have suggested that the costs associated with national introduction may decrease by a factor of two within the first few years following HPV vaccine introduction, as investment activities are no longer needed [12].

These cost estimates per dose fall near those reported by HPV vaccination cost evaluations conducted in other low- and lower-middle-income countries. In a 2014 study, Levin examined the costs of HPV vaccine pilot demonstration projects and the nationwide scale-up across several low- and lower-middle-income countries (Tanzania, Uganda, India, Peru, and Vietnam) [26]. The study found that estimates for recurrent cost per dose for the HPV nationwide scale-up ranged from US$ 1.26 to US$ 1.71 (adjusted to 2020 USD), varying by delivery strategy and country [26], as compared to our estimated recurrent cost per dose of US$ 1.22 in Senegal.

A separate costing study from 2013 estimated the costs related to service delivery for HPV pilot projects in Peru, Uganda, and Vietnam [9]. The study estimated that the average financial service delivery cost per dose ranged from US$ 1.33 to US$ 2.52, excluding the cost of vaccine and varying according to country and service delivery strategy [9]. This compares to our estimated financial cost per dose of US$ 0.91 for service delivery-related costs from the national introduction in Senegal. Although not a direct comparison with the 2013 study of pilot projects, the lower estimate from Senegal's national introduction may suggest reduced costs from integration of HPV vaccine into routine immunization services, as well as lessons learned and scale-up efficiencies from its pilot project.

An important contextual consideration is that the number of HPV vaccine doses administered throughout the project period (375,608 doses) may have been impacted by a health worker strike that occurred in Senegal in late 2018 through early 2019. This strike

may have resulted in a lower number of HPV doses administered than anticipated during this period, which would subsequently lead to a higher cost per dose.

In terms of cost drivers for Senegal's HPV vaccine introduction, the program activity of training accounted for the largest proportion of total weighted financial costs (42%). Importantly, training is considered an investment cost rather than a recurrent cost. While refresher trainings may be necessary in the future, the costs from these initial trainings are considered an investment cost with benefits lasting longer than one year. In addition to being investment costs, trainings could be considered as an opportunity for program integration and potential cost-savings. During the study timeframe, each of the three district-led HPV trainings was solely dedicated to HPV. In the future, while Senegal seeks to ensure the sustainability of its HPV program, HPV training sessions could be combined with trainings for other vaccination or cervical cancer prevention programs, which could contribute to future cost-savings.

By payer, Senegal's health facility-level CDS accounted for the second largest share of financial costs. A 2018 decree introduced the CDS as a local-level actor in the Senegalese health system, replacing what was perceived as an out-of-date Comité de Gestion. The creation of the CDS, an individual unit in association with a local health facility, was viewed as an improvement to local health service delivery and knowledge transfer in a decentralized format. The importance of the CDS, viewed in this evaluation as a collection of decentralized units, was substantiated by its contribution to total financial costs (21%) and economic costs (17%), predominantly for service delivery-related costs.

Two other important attributes of Senegal's introduction of the HPV vaccine at national scale was its prior pilot experience with HPV vaccination and its multi-sectoral approach to the national introduction. Senegal's prior experience with the HPV vaccination demonstration project and other new vaccine introductions informed and improved its division of responsibilities by administrative level, institutional knowledge, and cooperation across sectors. Further, additional investment in areas such as vaccination recording and reporting or cold chain systems for HPV vaccine was limited because Senegal was largely able to rely upon its existing processes and infrastructure. Continued high-level institutional capacity and reliance upon existing infrastructure will be critical as Senegal seeks to continue HPV vaccination and introduce other new vaccines into its routine immunization program.

5. Limitations

Senegal introduced the HPV vaccine nationally in October 2018, while data collection occurred in 2019 and 2020. This time-lag translates into the potential for recall bias, with respondents being more familiar with events that had occurred in closer time-proximity to data collection; however, the direction of this bias in over- or underestimating costs is unclear. Furthermore, volume weighting was not used to estimate unit costs; the simple mean approach used here may lead to an upward bias in unit costs [19].

Staff turnover, particularly at the health facility level, was a challenge during data collection; therefore, the respondent's answers were limited to any available documentation or information from other staff who were more familiar with the HPV vaccination activities conducted by the health facility. Imputations from similar health facilities and districts were used to impute missing data; how these imputations may bias our results is unknown.

Some data elements (e.g., ULYs of equipment and annual vehicle maintenance costs) were not collected in the field to reduce respondent burden and because standard values were available from other sources that could be imputed for analytical purposes. The direction of any potential bias is unknown but expected to be small because these equipment costs were not major cost drivers.

As part of the questionnaire, we asked respondents to estimate the percentage allocation of a resource input or activity to HPV vaccination; however, as Senegal introduced the HPV vaccine through its routine immunization program, many activities were not dedicated solely to HPV vaccination. The inherent difficulties in retrospectively estimating percent allocations of resource use for shared resources [19] and Senegal's strategy of integrating the HPV vaccination into its routine immunization program make it challenging to directly compare budgeted HPV vaccination funds received from external donors (e.g., Gavi) and the financial costs from all funding sources captured in this evaluation.

6. Conclusion

This cost evaluation represents an important step in addressing knowledge gaps related to the nationwide introduction of HPV vaccine. These results support previous costing studies in anticipating potential economies of scale in the transition from pilot demonstrations to national introduction. This is one of the first costing studies of national HPV vaccine introduction using routine immunization delivery strategies in a low- or-middle-income, Gavieligible country. This study also represents the first HPV vaccination costing study that is nationally representative at all levels, including the district and health facility administrative levels. The results are intended to support Senegal with budgeting and planning for future vaccine introductions and inform other countries planning to introduce the HPV vaccine and other new vaccines at national scale.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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10. Data statement

- Authors do not have permission to share
  - The data from the Senegal HPC vaccination cost evaluation belongs to Senegal MOH. Permission has not been requested and/or granted from Senegal MOH to make this data publicly available.

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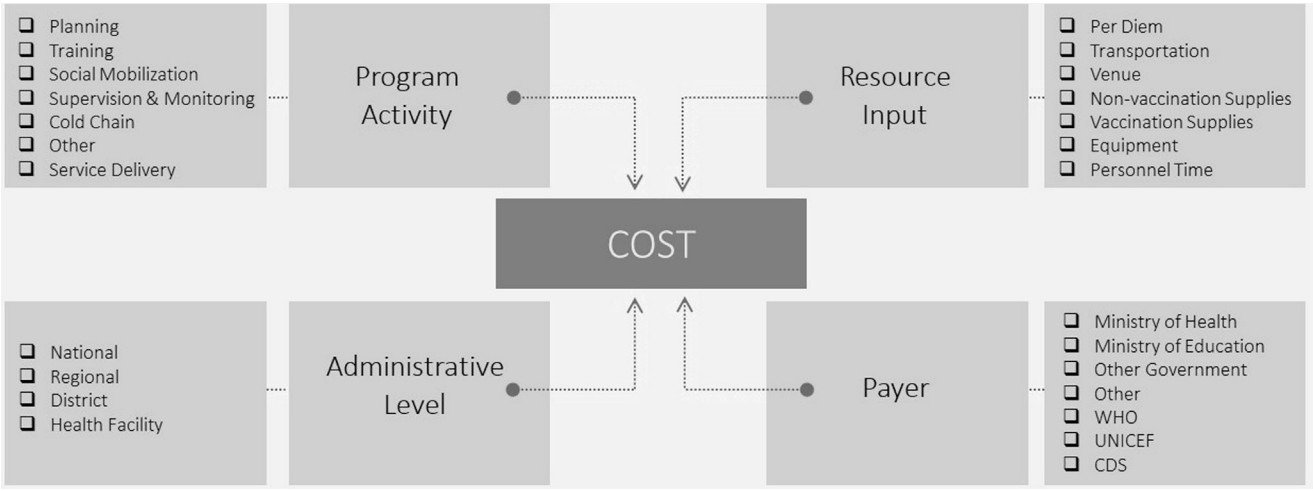

Fig. 1.

Introduction Cost of Human Papillomavirus Vaccine Delivery, Senegal; Four Cost Dimensions. Abbreviations: WHO: World Health Organization; UNICEF: United Nations International Children's Emergency Fund; CDS: Comité de Développement Sanitaire.

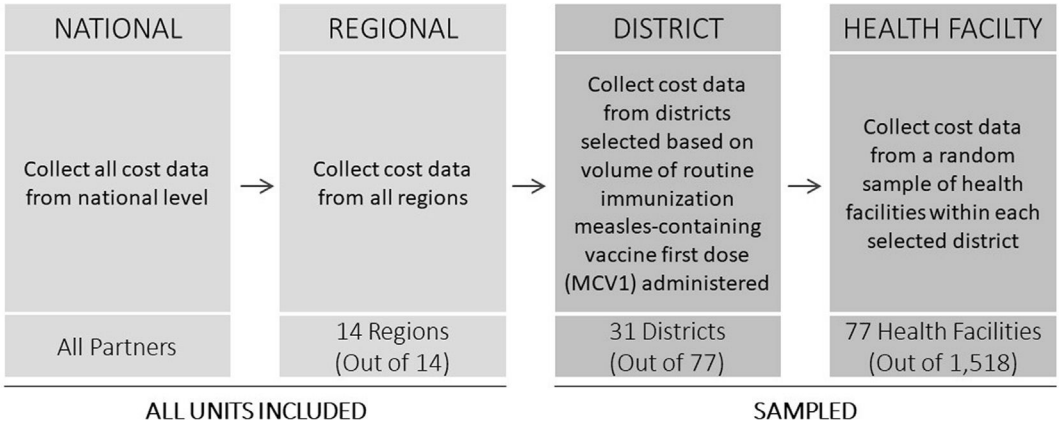

Fig. 2.

Introduction Cost of Human Papillomavirus Vaccine Delivery, Senegal; Sampling Strategy by Administrative Level.

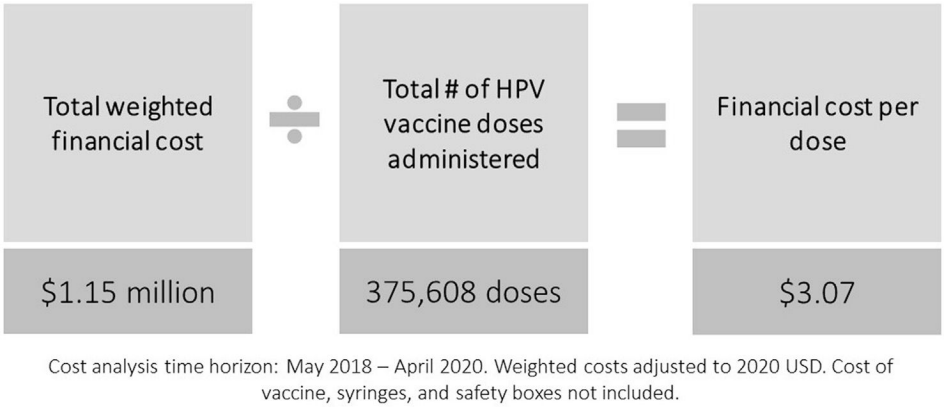

Fig. 3.

Introduction Cost of Human Papillomavirus Vaccine Delivery, Senegal; Summary of Weighted Financial Costs.

Table 1

Cost of Human Papillomavirus Vaccine Delivery in a Single-Age Cohort, Routine-Based Vaccination Program in Senegal; Cost by Administrative Level (Excluding the Cost of Vaccine Program Activity), May 2018–March 2020

	FINANCIAL		ECONOMIC	
	Total Weighted Financial Costs (US$)	**% of Total**	**Total Weighted Economic Costs (US$)**	**% of Total**
National	$125,070	11%	$127,869	5%
Regional	$16,577	1%	$17,245	<1%
District	$622,633	54%	$704,061	25%
Health Facility	$388,070	34%	$1,989,291	70%
TOTAL	$1,152,351	100%	$2,838,466	100%

Note: Data are presented in 2020 US dollars.

Table 2

Cost of Human Papillomavirus Vaccine Delivery in a Single-Age Cohort, Routine-Based Vaccination Program in Senegal; Cost by Program Activity (Excluding the Cost of Vaccine Program Activity), May 2018–March 2020

	FINANCIAL			ECONOMIC		
	Total Weighted Financial Costs (US$)	**% of Total**	**Financial Cost per Dose (US$)**	**Total Weighted Economic Costs (US$)**	**% of Total**	**Economic Cost per Dose (US$)**
Planning	$45,665	4%	$0.12	$140,442	5%	$0.37
Training	$482,693	42%	$1.29	$511,161	18%	$1.36
Social Mobilization	$165,298	14%	$0.44	$301,498	11%	$0.80
Supervision & Monitoring	$98,056	9%	$0.26	$255,299	9%	$0.68
Cold Chain	$15,759	1%	$0.04	$20,156	1%	$0.05
Other	$3,149	<1%	$0.01	$3,242	<1%	$0.01
Service Delivery	$341,729	30%	$0.91	$1,606,665	57%	$4.28
TOTAL	$1,152,351	100%	$3.07	$2,838,466	100%	$7.56

Note: Data are presented in 2020 US dollars.

Table 3

Cost of Human Papillomavirus Vaccine Delivery in a Single-Age Cohort, Routine-Based Vaccination Program in Senegal; Investment vs. Recurrent Costs (Excluding the Cost of Vaccine Program Activity), May 2018–March 2020

	FINANCIAL			ECONOMIC		
	Total Weighted Financial Costs (US$)	**% of Total**	**Financial Cost per Dose (US$)**	**Total Weighted Economic Costs (US$)**	**% of Total**	**Economic Cost per Dose (US$)**
Investment *	$693,657	60%	$1.85	$953,102	34%	$2.54
Recurrent **	$458,694	40%	$1.22	$1,885,364	66%	$5.02
TOTAL	$1,152,351	100%	$3.07	$2,838,466	100%	$7.56

Note: Data are presented in 2020 US dollars.

* Investment costs are expected to last longer than one year.

** Recurrent costs are expected to last less than one year.

Table 4

Cost of Human Papillomavirus Vaccine Delivery in a Single-Age Cohort, Routine-Based Vaccination Program in Senegal; Cost by Resource Input (Excluding the Cost of Vaccine Program Activity), May 2018 – March 2020

	FINANCIAL		ECONOMIC	
	Total Weighted Financial Costs (US$)	**% of Total**	**Total Weighted Economic Costs (US$)**	**% of Total**
Personnel Time	$0	0%	$1,336,598	47%
Per Diem	$545,455	47%	$545,455	19%
Vaccination Supplies *	$34,150	3%	$102,751	4%
Transportation	$321,328	28%	$515,340	18%
Venue	$29,619	3%	$113,499	4%
Non-vaccination Supplies and Materials	$221,795	19%	$224,751	8%
Equipment	$0.88	<1%	$70	<1%
TOTAL	$1,152,351	100%	$2,838,466	100%

Note: Data are presented in 2020 US dollars.

* Does not include the cost of vaccine, syringes, or safety boxes. Vaccination supplies refers to other supplies, such as cotton, that were used as part of vaccination.

Table 5

Cost of Human Papillomavirus Vaccine Delivery in a Single-Age Cohort, Routine-Based Vaccination Program in Senegal; Cost by Payer (Excluding the Cost of Vaccine Program Activity), May 2018–March 2020

	FINANCIAL		ECONOMIC	
	Total Weighted Financial Costs (US$)	**% of Total**	**Total Weighted Economic Costs (US$)**	**% of Total**
Ministry of Health	$702,853	61%	$1,598,929	56%
CDS	$239,485	21%	$482,119	17%
Ministry of Education	$5,684	<1%	$334,705	12%
WHO	$53,375	5%	$52,639	2%
Other Government	$3,350	<1%	$8,067	<1%
UNICEF	$45,994	4%	$46,063	2%
Other	$20,195	2%	$166,022	6%
Unknown *	$81,412	7%	$139,170	5%
TOTAL	$1,152,351	100%	$2,838,466	100%

Note: Data are presented in 2020 US dollars.

* Unknown indicates that payer information was not collected or not asked. **Abbreviations: WHO: World Health Organization; UNICEF: United Nations International Children's Emergency Fund; CDS: Comité de Développement Sanitaire.**