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Costs of Vaccinating a Child

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Introduction

Costs of vaccinating a child is a summary paper developed in response to a need expressed by advocacy and resource mobilization stakeholders to be able to better communicate the costs involved in vaccinating a child residing in low and middle income countries (LMICs). Using an assumed, standard vaccination schedule for 2020, the paper provides benchmark values that can be helpful for advocacy and fundraising purposes.

The costs of vaccinating a child differ between countries due to variations in vaccine products, vaccine prices negotiated with manufacturers and differences in vaccine delivery costs. UNICEF price data for vaccines and injection supplies are publicly available, but data on delivery costs have until recently been less accessible. A large, systematic literature review has now made delivery cost data available for dozens of LMICs[1] .

In this summary paper, delivery costs were combined with costs of vaccine commodities to derive an estimate for total costs of delivering a 'standard' childhood immunization schedule in LMICs. In 2020, the average costs of fully vaccinating a child under the age of 24 months against eleven different

[1] Vaughan K, Ozaltin A, Mallow M, Moi F, Wilkason C, Stone J, Brenzel L. The costs of delivering vaccines in low- and middle-income countries: Findings from a systematic review. *Vaccine* X. 2019 Jul 15;2

diseases is estimated at US$58 for LMICs that procure vaccines through UNICEF. The range in costs across countries is between US$37 and US$101 per fully vaccinated child less than 24 months, reflecting the difference in delivery costs between settings.

Section A: Assumptions

Vaccines

The assumed 'standard' immunization schedule encompasses the vaccines most frequently used by countries that procure through UNICEF. Assumptions on number of doses per child, vaccine wastage rates and vaccine prices per dose of this schedule are seen in Table 1. Approximately 70 countries obtain vaccines at prices established in consultation with Gavi, the Vaccine Alliance. These prices were used for the relevant vaccines[2]. For vaccines without a Gavi price, the average price across the different products procured by UNICEF was used[3].

[2] Gavi prices are available for the following vaccines: DTP-HepB-Hib, HPV, IPV, meningococcal A, oral cholera vaccine, PCV, rotavirus, yellow fever, measles, measles-rubella, Japanese encephalitis and typhoid conjugate vaccines (https://www.unicef.org/supply/media/2471/file/Gavi-product-menu-April2020.pdf)

[3] https://www.unicef.org/supply/pricing-data

Table 2 shows assumptions for vaccines recommended for certain geographic or high-risk areas and for Human Papilloma Virus (HPV) vaccine. HPV vaccine was assumed to be delivered to adolescent girls only[4].

UNICEF handling fee is 3.5 per cent of the price for pentavalent, pneumococcal conjugate, injectable polio, rotavirus, typhoid and Human Pappiloma Virus (HPV) vaccines. The handling fee is 4.5 per cent of the price for Bacille Calmette Guerin (BCG), Hepaitis B, Oral Polio, Measles-Rubella, Diphteria-Tetatus-Pertussis (DTP), Japanese Encephalitis and Meningococcal A vaccines[5][6].

Freight charge was assumed as 5 per cent of the price for all vaccines.

[4] While some high-income countries also offer the HPV vaccine to boys, this has not yet been implemented in any low- or middle-income country

[5] https://www.unicef.org/supply/procurement-services

[6] https://www.unicef.org/supply/handling-fees

Table 1. Assumed 'standard' immunization schedule for children less than 24 months

Antigen	Number of doses in schedule	Injection syringe*	Recon-stitution syringe	Doses per vial	Vaccine wastage**	2020 price per dose (US$)
First year of life						
Bacille Calmette Guerin (BCG)	1	X	X	20	50%	0.16
Hepatitis B (HepB) birth dose	1	X		10	25%	0.25
Oral polio (OPV)	3			10	25%	0.10
Pentavalent (DPT-HepB-Hib)	3	X		10	25%	0.70
Pneumococcal conjugate (PCV13)	3	X		1	5%	3.30
Injectable polio (IPV)	1	X		10	25%	1.96
Rotavirus***	2			1	5%	2.29
Measles-rubella (MR)	1	X	X	10	25%	0.66
Second year of life						
Measles-rubella (MR)	1	X	X	10	25%	0.66
Diphtheria-Tetanus-Pertussis (DTP)	1	X		10	25%	0.18

Hib: *Haemophilus influenzae* type b, PCV13: 13 valent pneumococcal conjugate vaccine

*BCG injection syringe is 0.05 ml. Injection syringes for all other vaccines are 0.5 ml.

** WHO, Revising global indicative wastage rates: a WHO initiative for better planning and forecasting of vaccine supply needs, Concept note, 8 April 2019

*** Rotarix at €1.88 per dose. The price in US dollars reflects conversion at exchange rate of 1.218 USD/EUR, which is an average across a 5-year period (Bloomberg projected foreign exchange rates)

Table 2. Vaccines used in certain geographic areas and Human Papilloma Virus vaccine for girls

Antigen	Number of doses in schedule	Injection syringe	Reconstitution syringe	Doses per vial	Vaccine wastage	2020 price per dose (US$)
Vaccines used in certain geographic areas						
Yellow fever	1	X	X	10	25%	1.17
Japanese Encephalitis	1	X	X	5	10%	0.45
Meningococcal A	1	X	X	10	25%	0.54
Typhoid	1	X		10	25%	1.50
Adolescent girls						
Human Papilloma Virus (HPV)	2	X		1	5%	4.60

Injection devices

Assumptions on parameter values for injection devices are seen in Table 3.

Table 3: Assumed injection device parameter values

Parameter	Value
Injection syringes	
Unit price of BCG injection syringe (2020 US$)	0.036
Unit price of 0.5 ml injection syringe (2020 US$)	0.037
Injection syringe wastage	5%
Reconstitution syringes	
Unit price of reconstitution syringe (2020 US$)	0.042
Reconstitution syringe wastage	5%
Safety boxes	
Unit price of safety box (5 liters)	0.557
Capacity of safety box (no. of syringes)	100
Freight and handling fees	
Injection device freight charge	30%
Injection device UNICEF handling fee	8%

Delivery costs

Delivery costs, also referred to as operational costs, are defined as costs associated with delivering vaccines exclusive of vaccine costs (Box 1). Studies from a large systematic review of over 15,000 published and unpublished resources on vaccine delivery costs from LMICs (2005 to 2019)[7] have been stored in a user-friendly, online database[8]. Portnoy and colleagues extrapolated data from the database and estimated average delivery cost as **US$1.87 per dose** across all LMICs, with a 95 per cent

Box 1: Definition of vaccine delivery costs

Delivery costs may include any of the following recurrent and capital cost items:

1. Human resources
2. Per diem and travel allowances
3. Cold chain equipment
4. Vehicles, transport and fuel
5. Program management
6. Training and capacity building
7. Social mobilization and advocacy
8. Waste management
9. Buildings, utilities, and other shared costs
10. Vaccine preventable disease surveillance
11. Monitoring of adverse events following immunization

[7] Vaughan K, Ozaltin A, Mallow M, Moi F, Wilkason C, Stone J, Brenzel L. The costs of delivering vaccines in low- and middle-income countries: Findings from a systematic review. Vaccine X. 2019 Jul 15;2.

[8] Immunization Delivery Cost Catalogue: http://immunizationeconomics.org/ican-idcc

uncertainty interval of US$0.64 – US$4.38.[9]

HPV vaccine has only recently started to be introduced in routine schedules in LMICs. Countries are using different strategies for delivery of HPV vaccine, including through schools, health facilities, outreach services and during child health days. Costs differ according to the strategy used; school delivery is expected to be more expensive than delivery at health facilities because of the involvement of teachers and the need for health staff to travel to schools. Since there are not yet any detailed studies available on the costs of routine HPV vaccine delivery, it was assumed that the costs per dose delivered are equivalent to that for children less than 24 months.

[9] Bayesian meta-regression modelling techniques were used to extrapolate cost data to LMICs with no studies available. Only studies of routine vaccine delivery of children less than 5 years of age that specified cost categories included in the estimate were used for the modelling. Data from 29 studies from 24 different countries, which generated 52 cost per dose estimates, were used. Reference: Portnoy A, Vaughan K, Clarke-Deelder E, *et al.* Producing Standardized Country-Level Immunization Delivery Unit Cost Estimates, *Pharmacoeconomics*. 2020;10.

Section B: Costs per Child

Costs of fully vaccinating a child according to the 'standard' schedule is seen in Table 4. Costs of vaccine and injection supplies for a child less than 12 months amounts to US$25. When adding delivery costs, total costs are US$53 per child (range US$35 – US$91). When including costs of MR and DTP in the second year of life, total costs per child are US$58 (range US$37 – US$101).

The costs of geographically specific vaccines and HPV are seen in Table 5. As an example, for a country using yellow fever, meningococcal A and HPV vaccines, the costs of fully vaccinating a boy total US$64 (range US$41 – US$112), and the costs of fully vaccinating a girl total US$79 (range US$53 – US$131).

Table 4: Costs per fully vaccinated child with standard schedule for children < 24 months (2020 US$)

Antigen	Vaccine costs	Injection supply costs	Total vaccine and injection supply costs	Average delivery costs	Total
First year of life					
Bacille Calmette Guerin (BCG)	0.33	0.07	0.40	1.87	2.27
Hepatitis B (HepB) birth dose	0.35	0.05	0.41	1.87	2.28
Oral polio (OPV)	0.42	-	0.42	5.61	6.03
Pentavalent (DPT-HepB-Hib)	2.98	0.16	3.16	5.61	8.77
Pneumococcal conjugate (PCV13)	11.26	0.16	11.44	5.61	17.05
Injectable polio (IPV)	2.78	0.05	2.84	1.87	4.71
Rotavirus	5.21	-	5.21	3.74	8.95
Measles-rubella (MR)	0.94	0.07	1.02	1.87	2.89
Subtotal: First year of life	***24.26***	***0.57***	***24.90***	***28.05***	***52.95***
Second year of life					
Measles-rubella (MR)	0.94	0.07	1.02	1.87	2.89
Diphtheria-Tetanus-Pertussis (DTP)	0.25	0.05	0.31	1.87	2.18
Subtotal: Second year of life	***1.19***	***0.13***	***1.33***	***3.74***	***5.07***
TOTAL	**25.45**	**0.70**	**26.23**	**31.79**	**58.02**

Table 5: Costs per child vaccinated with geographically specific vaccines and HPV (2020 US$)

Antigen	Vaccine costs	Injection supply costs	Total vaccine and injection supply costs	Average delivery costs	Total
Yellow fever	1.66	0.07	1.80	1.87	**3.61**
Japanese Encephalitis	0.54	0.08	0.65	1.87	**2.50**
Meningococcal A	0.77	0.07	0.88	1.87	**2.72**
Typhoid	2.13	0.05	2.26	1.87	**4.06**
Adolescent girls					
Human Papilloma Virus	10.47	0.11	11.05	3.74	**14.33**

Conclusion

Based on the best available data, this document provides benchmark values for the costs of vaccine delivery in LMICs in 2020. Since costs differ between settings, the benchmark values cannot be used for planning and budgeting in any particular country. The values are instead intended to give a rough indication of the resources needed for fully vaccinating a child, when taking both vaccine commodities and delivery activities into consideration. The ranges provided are relatively wide, reflecting the variation in delivery costs between settings.

UNICEF promotes integration of immunization services with other primary health care interventions. Nutrition interventions are especially suitable for delivery alongside vaccination, such as growth monitoring, infant and young child feeding counseling, vitamin A supplementation and de-worming. For malaria prevention, insecticide treated bed-nets can be distributed during vaccination visits. Birth registration at the same time as the first vaccine delivery can result in substantial broader benefits. Delivery costs would only marginally increase when adding extra interventions to a visit. Hence, costs of commodities will be the most important factor. Integrated service delivery has been shown in several studies to be cost-effective compared to delivering interventions separately.

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