Costing of immunization service provision in Kalutara district, Sri Lanka: a cross-sectional study

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ABSTRACT

Background: Immunization is regarded as the single most cost-effective way to prevent vaccine-preventable diseases. With the rising cost of the National Immunization Programme (NIP) in Sri Lanka, immunization costing studies could help programme managers to ensure sustainable immunization financing in the country.

Methods: Four medical officer of health (MOH) divisions in Kalutara district were included, to estimate the cost incurred for the NIP programme. Fifteen immunization clinics from urban and rural settings were selected from the selected MOH divisions, by a simple random sampling method. Data were collected for a period of 3 months, using pretested check-lists. In addition, related data at national and district levels were also collected. Cost estimates were made for direct capital and recurrent costs.

Results: The cost of vaccines under the national immunization schedule for infants was 1361.84 SL Rs (US$ 10.32). For children under 5 years of age, it was 1535.64 SL Rs (US$ 11.63). The majority of these costs were direct recurrent costs (93.4%). Vaccines (84.3%) and staff salaries (6.4%) were the main components of direct recurrent costs, while cold-chain equipment (5.3%) was the main contributor to direct capital cost.

Conclusion: The cost of vaccine is the highest proportion among all other cost components in the NIP in Sri Lanka, and this is largely attributable to new costly vaccines. Staff payments are not significant, as they are a shared cost of public health service providers. Studies exploring the costing of the NIP in the country would be beneficial, to ensure sustainable immunization financing.

Key words: cost, immunization, immunization costing, Sri Lanka, vaccines

BACKGROUND

The history of immunization in Sri Lanka goes back to the 19th century. The law relating to compulsory vaccination against smallpox is referred to in the Vaccination Ordinance of 1886. Bacille Calmette–Guérin (BCG) vaccination was introduced in Sri Lanka in 1949. The Expanded Programme on Immunization (EPI) was introduced in Sri Lanka in 1978 and has continued to make excellent progress since then. In 1978, all EPI vaccines were donated by the United Nations Children’s Fund (UNICEF) but in 1990, the Government of Sri Lanka began financing for selected vaccines and by 1995 all EPI vaccines were fully funded by the government.¹ In 2007, a separate budget line within the allocation for drugs and medical supplies was identified for vaccines. This ensures that the government is committed to providing the necessary funds for the National Immunization Programme (NIP). However, the high cost of new vaccines will be a challenge to balancing the sustainability of the programme and its expansion.²

The Global Alliance for Vaccine and Immunization (GAVI) funded the introduction of hepatitis B vaccine in 2004 and pentavalent vaccine (diphtheria, tetanus pertussis, Haemophilus influenzae type B, hepatitis B) in 2008. The total cost for hepatitis B (Hep B) vaccine was provided as a donation and pentavalent vaccine was provided under a co-financing strategy. Since the gross national income per capita of Sri Lanka has now exceeded the eligibility threshold of GAVI’s graduation policy, all funding was taken over by the government by 2015.³ Notably, the contribution of the private sector to immunization services...
in the country is not significant, except in Colombo. Health care, including immunization, in Sri Lanka is free of charge; therefore, virtually all the financial burden of immunization service in the country is borne by the public sector.

It is accepted that vaccines are the single most cost-effective, long-lasting method to eliminate vaccine-preventable diseases in all age groups. However, financing the NIP is challenged by many factors, including increased vaccine costs, high demand for new vaccines and competing priorities in the health sector. The strategies required to make immunization financing sustainable include: ensuring continued government commitment to the NIP, increasing budgetary allocation, reducing costs, monitoring and supervision of the programme, raising awareness of all stakeholders, and guaranteeing donor support. Limited data are available on the financing of vaccine and immunization services in Sri Lanka. This creates a challenge for programme managers in their decision-making. Thus, this study was carried out with the aim of estimating the cost incurred by the NIP of immunizing children aged less than 5 years in the district of Kalutara.

**METHODS**

**Study design and setting**

The setting for this descriptive cross-sectional study, which was done in 2013, was Kalutara district. Kalutara is one of 25 districts in Sri Lanka, which are organized into nine provinces. This district is situated in the Western Province of Sri Lanka, on the southern coastal belt. It has an estimated population of 1.1 million, with a total area 1606.4 km². The infant population in 2012 was approximately 20 427.

**Sample size**

There are 13 medical officer of health (MOH) divisions in the district, with 136 immunization clinics. Four MOH divisions, representing both urban and rural divisions, were purposely selected to estimate the cost incurred for the NIP in the district. Out of 31 immunization clinics in these four MOH divisions, 15 were selected, using a simple random technique, to provide a sample for estimations of immunization costs.

**Data collection**

Data, including immunization performance (immunization coverage, vaccine use and wastage, use and wastage of injection-safety supplies), salaries and payments to staff, and the costs of cold-chain equipment, buildings, vehicles, maintenance and utilities (electricity, water), were collected over 3 months. Both national and district levels are actively involved in vaccine logistics, hence the costs incurred at these levels for NIP service were also included in the study, and related data were collected.

Pretested check-lists were used to collect data and the first author, with two trained medical pre-interns, carried out the data collection. Information was abstracted from immunization clinic and MOH office registers, returns, records, invoices, diaries and other relevant documents. Financial records of the costs of vaccine and cold-chain equipment were collected from the central Epidemiology Unit, Ministry of Health. Information was collected on both input (capital and recurrent costs) and output (number immunized) components of the NIP programme. In the study period, this was as follows: all children during their first year of life should be immunized with BCG, oral polio vaccine (OPV), diphtheria–tetanus–pertussis (DTP), Hep B, *Haemophilus influenzae* type B (Hib), Japanese encephalitis (JE) and measles–mumps–rubella (MMR), to complete the primary series of vaccination before reaching the age of one year. DTP (booster) and OPV (booster) should be administered at 18 months. At 3 years, the MMR (booster) should be given. At school entry aged 5 years, the fifth OPV dose should be given, as well as one dose of DT for those children who have completed the primary course of DTP.

Most of the information on capital costs of MOH divisions was collected from the office of the regional director of health services in Kalutara, as this is the district administrative centre.

**Data analysis**

Data were coded and entered into Statistical Package for Social Sciences (SPSS) version 17.0. Data were collected on, and categorized as: (i) direct capital costs; (ii) direct recurrent costs; and (iii) costs of vaccines and injection-safety items.

Direct capital costs include costs for cold-chain equipment, buildings and vehicles. Items of cold-chain equipment are mainly procured at national level. However, cost estimates for cold-chain items at all levels were separately calculated. Since the values of buildings and equipment depreciate over time, it was assumed that over a given lifespan for each item, equal usage would correlate linearly with the depreciations in values.

Direct recurrent costs include staff salaries, based on the proportion of time spent on NIP activities, administrative costs, utilities (water and electricity payments) and consumables. Maintenance costs include the costs for cold-chain equipment, buildings, vehicles and waste disposal. Training costs allocated by national and provincial government, and costs incurred for adverse events following immunization, were not included. These activities are a part of the country’s overall training and disease-surveillance activities and thus the costs are non-specific. The study population was around 5% of the country’s population of children aged under 5 years and therefore inclusion of estimates for these non-specific costs would be unlikely to influence the study findings.

Vaccines and injection-safety items (auto-disable and reconstitution syringes and safety boxes) are procured at national level. Data on vaccine usage for a 3-month period in the study areas were collected for estimation of vaccine costs. Vaccine wastage was also considered separately for each antigen in these estimates.

First the cost per each input item was estimated – for capital (cold-chain equipment, buildings, vehicles) and recurrent
items (salaries, utilities, maintenance and administrative costs). The costs of vaccines and injection-safety items were also estimated separately. This was followed by estimation of the output items, i.e. number of immunized children aged under 5 years, for the given time period. Finally, the mean cost incurred by each item per immunized child aged under 5 years was estimated, using following formula:

\[
\text{cost per child aged under 5 years for a given item} = \frac{\text{cost of the given input item for the 3-month study period}}{\text{total number of children aged under 5 years immunized for the 3-month study period}}
\]

**Ethical clearance**

Ethical clearance was received from the ethical review committee of the Faculty of Medicine, University of Kelaniya. Written informed consent was obtained from each study participant.

**RESULTS**

The study estimated the cost of immunization service at three levels: divisional (immunization clinic and MOH office), district and national levels. Most of the data derived from divisional level, as it is the primary level of immunization service delivery in the country. The immunization data for this study were based on 16,946 children aged less than 5 years and registered in four selected MOH areas, during the study period of 3 months. With the exception of vaccines and injection-safety supplies, the capital and recurrent costs were based on costs incurred at 15 immunization clinics, 4 MOH offices and the district cold stores in Kalutara district.

The cost estimates were made separately for direct capital costs and direct recurrent costs. All these costs were estimated for children aged under 5 years and are presented in both Sri Lankan rupees (SL Rs) and United States dollars (US$).

The cost of vaccines under the national immunization schedule for infants was 1361.84 SL Rs (US$ 10.32). For children under 5 years of age, the total vaccine cost was 1535.64 SL Rs (US$ 11.63) (see Table 1). When the costs of injection-safety supplies and the direct capital and recurrent costs at the national, district and divisional level were added, the total cost of a fully vaccinated child under 5 years of age was 1821.62 SL Rs (US$ 13.80) (see Table 2). The highest proportion of the cost is therefore borne at the national level, for the supply of vaccines and injection-safety items. Costs borne at the district level are largely for administration, and for the district medical-supply division, where vaccines are stored. At divisional level, costs for immunization service delivery include both capital (cold-chain equipment, buildings, vehicles) and recurrent (largely salary, maintenance, utility) costs.

The capital cost was only 6.6%, of which cold-chain equipment (5.3%) was the main costing component. The capital cost for buildings and vehicles was only 1.3%, as these costs are shared with other public health-care services. Vaccines (84.3%) and staff salaries (6.4%) were the main components of recurrent costs (see Fig. 1).

**Table 1. Vaccine costs\(^a\) by antigens per fully immunized infant and per child under 5 years of age, according to the schedule of the National Immunization Programme, Sri Lanka**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Cost per infant</th>
<th>Cost per child under 5 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SL Rs</td>
<td>US$(^b)</td>
</tr>
<tr>
<td>BCG</td>
<td>6.84</td>
<td>0.05</td>
</tr>
<tr>
<td>OPV 1st, 2nd, 3rd doses</td>
<td>60.00</td>
<td>0.45</td>
</tr>
<tr>
<td>OPV boosters 4th, 5th doses</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Pentavalent vaccine,(^c) 1st, 2nd, 3rd doses</td>
<td>1095.00</td>
<td>8.30</td>
</tr>
<tr>
<td>JE</td>
<td>100.00</td>
<td>0.76</td>
</tr>
<tr>
<td>MMR 1st dose</td>
<td>100.00</td>
<td>0.76</td>
</tr>
<tr>
<td>MMR booster – 2nd dose</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>DTP booster</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>DT</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Total</td>
<td>1361.84</td>
<td>10.32</td>
</tr>
</tbody>
</table>


\(^a\)Vaccine costs include two components – absolute cost per dose (from national procurement invoices) and vaccine wastage (calculated based on usage rate for each vaccine separately). While the vaccine cost per dose is actual, wastage is an estimated mean.

\(^b\)1 US$ = 132 SL Rs (in 2012).

\(^c\)Pentavalent vaccine: diphtheria, tetanus, pertussis, *Haemophilus influenzae* type B, hepatitis B.
This study estimated that the cost for full vaccination of a child by the age of 5 years was 1821.62 SL Rs (US$ 13.8). Previously, only one study was available in Sri Lanka for the cost of the NIP for infant immunization; this was carried out in Badulla district. According to this study, the cost for full immunization of an infant for six antigens (BCG, DTP, OPV and measles vaccines) ranged from 61.47 SL Rs to 369.15 SL Rs (US$ 1.48 to US$ 8.89). However, this study was done nearly 25 years ago, hence cost comparison needs to be done with caution.

Studies done in many other low- and middle-income countries have reported a wide range of costs for full immunization of a child, from the lowest of US$ 4.81 in Viet Nam, to the highest of US$ 332.3 in Moldava. Bangladesh has also reported a low average cost per fully vaccinated child, at US$ 6.91. The costs of full immunization of a child reported for Cameroon (US$ 12.73) and Peru (US$ 17.42) are closer to the estimates of the present study. The cost of fully immunizing a child also varies within a region; for example, in Africa, the cost in Ghana has been estimated as US$ 60.30, which is almost five times higher than that for Cameroon. Studies in Ghana and Moldova showed a cost for fully vaccinating a child in a middle-income country that was much higher than for many other middle-income countries. However, these estimates should be compared with caution, as the cost can vary according to the number and type of vaccines in a country’s EPI schedule, and also depends on the timing of the study performed, and its assumptions and methodology. The majority of these studies were focused on children in the first year of life; therefore, the

**Table 2. Cost per fully vaccinated child under 5 years of age, by National Immunization Programme costing levels**

<table>
<thead>
<tr>
<th>National Immunization Programme costing levels</th>
<th>Cost per child under 5 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>National level</td>
<td></td>
</tr>
<tr>
<td>Vaccines</td>
<td>1535.64</td>
</tr>
<tr>
<td>Injection-safety supplies</td>
<td>42.88</td>
</tr>
<tr>
<td>Direct (capital and recurrent)</td>
<td>17.40</td>
</tr>
<tr>
<td>District level</td>
<td></td>
</tr>
<tr>
<td>Direct (capital and recurrent)</td>
<td>73.29</td>
</tr>
<tr>
<td>Divisional (MOH) level</td>
<td></td>
</tr>
<tr>
<td>Direct (capital and recurrent)</td>
<td>152.41</td>
</tr>
<tr>
<td>Total cost</td>
<td>1821.62</td>
</tr>
</tbody>
</table>

MOH: medical officer of health; SL Rs: Sri Lankan rupees; US$: United States dollars.

*All values presented are means except absolute dose/unit costs of vaccines and injection-safety costs incurred by the National Immunization Programme. Cold-chain costs, building costs and salaries were calculated at national, district and divisional levels and then extrapolated as a mean value to the target population of immunized children in the four MOH areas. Since these are pooled costs of absolute values and estimated means, standard errors are not presented.

1 US$ = 132 SL Rs (in 2012).

Auto-disable and reconstitution syringes, safety boxes.

Capital costs include cold-chain equipment, vehicles, buildings; recurrent costs include salaries, maintenance, administration and utility costs, such as electricity and water.

**DISCUSSION**

This study estimated that the cost for full vaccination of a child by the age of 5 years was 1821.62 SL Rs (US$ 13.8). Previously, only one study was available in Sri Lanka for the cost of the NIP for infant immunization; this was carried out in Badulla district. According to this study, the cost for full immunization of an infant for six antigens (BCG, DTP, OPV and measles vaccines) ranged from 61.47 SL Rs to 369.15 SL Rs (US$ 1.48 to US$ 8.89). However, this study was done nearly 25 years ago, hence cost comparison needs to be done with caution. Studies done in many other low- and middle-income countries have reported a wide range of costs for full immunization of a child, from the lowest of US$ 4.81 in Viet Nam, to the highest of US$ 332.3 in Moldava. Bangladesh has also reported a low average cost per fully vaccinated child, at US$ 6.91. The costs of full immunization of a child reported for Cameroon (US$ 12.73) and Peru (US$ 17.42) are closer to the estimates of the present study. The cost of fully immunizing a child also varies within a region; for example, in Africa, the cost in Ghana has been estimated as US$ 60.30, which is almost five times higher than that for Cameroon. Studies in Ghana and Moldova showed a cost for fully vaccinating a child in a middle-income country that was much higher than for many other middle-income countries. However, these estimates should be compared with caution, as the cost can vary according to the number and type of vaccines in a country’s EPI schedule, and also depends on the timing of the study performed, and its assumptions and methodology. The majority of these studies were focused on children in the first year of life; therefore, the
term “fully immunized child” refers to infants. However, since most vaccines are given in the first 12 months, the costs of fully immunized infants and fully immunized children at 5 years can validly be compared. Furthermore, the determinants of routine immunization costing vary by country. For example, the total number of doses administered in routine immunization was accounted as the main cost component in both Ghana and Benin. In Ghana, the time spent on immunization, the cost for cold-chain items and staff costs were positively associated with total costs. In a pooled sample, facilities in capital cities had higher costs.

In this study, the cost of vaccines overwhelmingly accounted for the highest proportion of the total cost (84.3%), at 1535.64 SL Rs (US$ 11.63) for full immunization of one child. Of this vaccine cost, the highest amount of 1095.00 SL Rs (US$ 8.29) was spent on three doses of pentavalent vaccine, followed by MMR vaccine, at 200 SL Rs (US$ 1.52) for two doses. This highlights that the newly introduced vaccines are costly and one of the main contributing factors for the increased cost of immunization in Sri Lanka. A study done in Ethiopia following introduction of pentavalent vaccine revealed that a cost estimation for the country of including this vaccine increased the total cost by US$ 2.5 million annually.

Many studies have shown that a high proportion of immunization cost is contributed by the labour or salary components. In 1991, salary was the leading cost component in the Sri Lanka EPI (46%) and vaccines accounted for only 21.9% of total costs. Similar findings were reported from Moldova (labour cost 65%, vaccines 9%), Ghana (salary 61%, vaccines 17%), Honduras (labour cost 54%, vaccines 23%) and Uganda (salaries 38%, vaccines 7%). In the present study, the findings were different; vaccines were the lead component, largely due to the cost of newer vaccines. The salary component accounted for the second highest proportion of total costs in the present study, but it was low at only 6.4%. Provision of an immunization service is one part of the responsibilities of public health service providers. Hence, their salary and time spent on EPI was hypothetically assumed. This may also partially explain the differences of EPI costings by components in the different studies.


The estimated total price tag for immunization activities in 2006–2015 in the 72 poorest countries is US$ 35 billion. One third of this amount will be spent on vaccines, rising from about US$ 350 million in 2005 to nearly US$ 1.5 billion per year by 2015, as vaccination coverage is expanded with underused vaccines, and new vaccines are introduced. Two thirds will be spent on immunization delivery systems, including shared costs for the strengthening of overall health systems, a key factor in increasing immunization coverage. US$ 2.2 billion will go towards immunization campaigns, such as those for measles, tetanus, yellow fever, and polio. Direct capital and direct recurrent costs are the major components for estimating the cost of a programme to provide services. The present study revealed that direct recurrent cost was the major contributor to the cost of the NIP programme in Kalutara district, at 93.4%. The capital cost for cold-chain equipment, buildings and vehicles was only 6.6%. Of note, the assumptions on depreciations in the values of both buildings and equipment were also based on the subjective opinions of respondents. Nevertheless, similar findings were reported in the study from a rural setting in northern Viet Nam, where the capital cost constituted 6.6% and recurrent cost made up 93.4% of the total immunization cost in 2005. Out of the recurrent costs in Viet Nam, vaccines and supplies were the largest category (33% of the total), followed by staffing costs at 30.2%. In the United States of America, the 2009 birth cohort was analysed to estimate the direct and societal cost for infant immunization; the ratio for the two was reported to be 3:10.1

This study highlights the financial burden of the introduction of costly new vaccines into the country’s NIP. Similar trends have also been observed in other countries. Since the incidence of vaccine-preventable disease is becoming low and less visible, there could be challenges in obtaining the necessary funds and logistics in the future, as many donors are interested in other competing priorities, such as noncommunicable disease, vector-borne disease and public health issues associated with climate change. All these competing priorities have created challenges to health authorities’ planning and allocation of the limited financial resources available.

Despite the above-mentioned limitations, this study has highlighted the basic cost components of the NIP in a selected district in Sri Lanka. In the authors’ opinion, a more robust nationwide study on immunization costing and financing of the NIP in the country is a timely need, and national immunization programmes in other low- and middle-income countries would also benefit from such studies.

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REFERENCES


