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Current costs & projected financial needs of India's Universal Immunization Programme

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***Background & objectives*: India's Universal Immunization Programme (UIP) is one of the largest programmes in the world in terms of quantities of vaccines administered, number of beneficiaries, number of immunization sessions, and geographical extent and diversity of areas covered. Strategic planning for the Programme requires credible information on the cost of achieving the objectives and the financial resources needed at national, State, and district levels. We present here expenditures on immunization services in India in 2012 (baseline) and projected costs for five years (2013-2017).**

***Methods*: Data were collected from the Immunization Division of the Ministry of Health and Family Welfare, Government of India, and immunization partners, such as the World Health Organization and UNICEF. The cost components were immunization personnel, vaccines and injection supplies, transportation, trainings, social mobilization, advocacy and communication activities, disease surveillance, Programme management, maintenance of cold chain and other equipment, and capital costs.**

***Results*: Total baseline expenditure was ₹ 3,446 crore [1 crore = 10 million] (US$718 million), including shared personnel costs. In 2012, the government paid for 90 per cent of the Programme. Total resource requirements for 2013-2017 are ₹ 34,336 crore (US$ 5, 282 million). Allocations for vaccines increase from ₹ 511 crore in 2013 to ₹ 3,587 crore in 2017 as new vaccines are assumed to be introduced in the Programme.**

***Interpretation & conclusions*: The projections show that the government immunization budget will be double in 2017 as compared to 2013. It will increase from ₹ 4,570 crore in 2013 to ₹ 9,451 crore in 2017.**

Key words Cold chain cost - cost drivers - immunization - personnel cost - supplemental immunization activities - UIP - vaccines

Immunization is a critical component of the Government of India's child survival strategy and achieving sustainable development goal of ending preventable deaths of newborn and under-five children by 2030[1]. The success of smallpox eradication in the mid - 1970s drew attention to India's immunization programme[2], since at the time of independence, India had the highest number of smallpox cases in the world[3]. Another success of India's programme is eradication of poliomyelitis. In 2014, India (and the 10

other countries of Southeast Asia) were certified polio free[4].

Introduced in 1978, India's Expanded Programme on Immunization (EPI) supplied vaccines to children to protect against diphtheria, pertussis, and tetanus (DPT), poliomyelitis (OPV), tuberculosis [Bacillus Calmette Guerin (BCG)] and typhoid-paratyphoid[2]. Typhoid-paratyphoid vaccine was dropped from EPI in 1981, due to higher reactogenecity and low efficacy of the vaccines and also due to perceived reduced burden of typhoid disease in the country. The programme was renamed as the Universal Immunization Programme (UIP) in the mid-1980s and was expanded to include the tetanus vaccine for pregnant mothers in 1983 and measles in 1985[2]. The vaccines currently covered under the Programme are BCG, hepatitis B, OPV (oral polio vaccine), DPT, measles, Hib-containing pentavalent (DPT+Hep B+Hib), Japanese encephalitis (JE), inactivated polio vaccine (IPV) and tetanus toxoid (TT). However, JE vaccines are administered only in endemic districts[3]. The government recently introduced rotavirus vaccine in four States - Andhra Pradesh, Haryana, Himachal Pradesh and Odisha[5]. Routine immunization in India aims to administer all primary vaccines to 26 million newborns each year[6]. To vaccinate this cohort, approximately nine million immunization sessions are conducted[6].

The World Health Organization (WHO) provides a framework and guidelines for developing a comprehensive multi-year plan (cMYP) for activities to achieve immunization objectives[7]. Strategic planning for immunization requires credible information about costs, available funding, and allocation of funds within the Programme to avoid funding shortfalls and ensure sustainable financial resources at national, State, and district levels. Analysis of the costs and funding is the first step in the planning process: how much it will cost to reach Programme objectives, what are the potential funding sources, and how should activities be prioritized. An understanding of the funding gaps can focus discussion with policymakers and donors on how to mobilize the required resources.

A few studies have provided analysis of costing of immunization programmes and cMYPs of GAVI (Global Alliance for Vaccine Initiative) eligible countries[8,9]. This study is an attempt to provide information on cMYP costing and to present expenditure on immunization services in India in 2012 and projected costs for five years (2013-2017).

Material & Methods

Data collection: Fiscal year 2012 (April 2012 to March 2013) was the baseline for the cost and financing projections. Actual expenses of the government and immunization partners - the WHO - India country office and the United Nations Children's Fund (UNICEF) - were included for the baseline cost calculation. Data were collected from the Immunization Division of the Ministry of Health and Family Welfare, India, and from the immunization partners. The demographic data were collected from the 2011 census of India[10].

Cost components: The cost components were categorized into the following line items: immunization-specific personnel; traditional, new, and limited used vaccines; injection supplies; transportation for fixed sites and outreach activities; trainings; social mobilization, advocacy and communication activities; disease surveillance; programme management; operational costs, including cold chain maintenance and maintenance of other equipment; other routine recurrent cost which included service provision in underserved and hard-to-reach areas, incentives given to accredited social health activists (ASHAs), intensification of routine immunization services, research studies on immunization, *etc*.; cold chain equipment; and vehicles and construction of buildings. We considered pentavalent, IPV, measles-rubella (MR), rotavirus, and pneumococcal conjugate vaccine (PCV) as new vaccines and JE as a limited used vaccines. JE is being used only in some States and in a few districts within the States. The assumptions regarding vaccine prices, expected start date, and implementation strategies are presented in Table I, and the details of all cost components are presented in Table II. Data were also gathered on the costs of campaigns and shared costs. For calculating projected cost of campaigns, the Immunization Division of the Ministry of Health was consulted to know the number of campaigns they are planning during 2013-2017 and the assumptions related to these campaigns. Shared costs included the value of inputs that were not specific to immunization and were used by different programmes or activities in the health sector. Their utilization for immunization was less than 100 per cent.

Cost calculations: The projected costs of vaccines were based on number of target children, number of doses, price of the vaccines, wastage factor, and buffer stock. The calculation of the birth cohort and other target groups was based on Indian government estimates and on the latest census of India[10]. The population growth

Table I. Vial size, price per dose, expected start year, and implementation strategy for routine immunization

Vaccine	Doses per vial	Price per dose (US$)	Expected start year	Implementation strategy	Sources of financing
Bacillus Calmette-Gueirin (BCG)	10	0.05	NA	Routine	Government
Hepatitis B (birth dose)	10	0.05	NA	Routine	Government
Oral polio vaccine (OPV)	20	0.06	NA	Routine	Government
Measles	5	0.16	NA	Routine	Government
Diphtheria, pertussis, tetanus (DTP)	10	0.04	NA	Routine	Government
Tetanus toxoid (TT)	10	0.02	NA	Routine	Government
Japanese encephalitis (JE)	5	0.18	NA	Campaign	Government
DTP-HepB- *Haemophilus influenzae* type B (Hib) (pentavalent)	10	2.11	2014-2015	Roll out to all States: 2014, 11 States; 2015, 16 States	GAVI, through 2015
Inactivated polio vaccine (IPV)	10	1.00	2015-2016	Pan India	Government
Measles rubella (MR)	5	0.50	2014-2015	Introduction announced; 2014, 1-15 years; 2015, routine at 9 months or 1.5 years	Government
Rotavirus	10	1.00	2016-2017	Introduction announced	Government
Pneumococcal conjugate vaccine (PCV)	1	3.30	2017	Pending NTAGI endorsement	Government

Source: Refs 11, 12
1 US$ = ₹ 65; All other informaiton comes from personal communication with the Immunization Division of Ministry of Health and Family Welfare, India; NTAGI, National Technical Advisory Group on Immunization; NA, not applicable

rate was assumed one per cent and the infant mortality rate was assumed to decrease from 44 per 1,000 in 2012 to 25 per 1,000 in 2017 (personal communication with WHO and Immunization Division of the Ministry of Health and Family Welfare, Government of India). Coverages of all vaccines at baseline were taken from a survey by UNICEF[13]. Projected coverages of both current and new vaccines for 2013-2017 were estimated based on discussions with the Immunization Division of the Ministry of Health and Family Welfare. Assumptions on wastage rate and coverage of each antigen are presented in Table III. The costs for injection supplies took into account number of syringes required, price per unit, wastage factor, and buffer stock. Two types of auto-disable (AD) syringes and one type of reconstitution syringe are used - AD syringe 0.5 ml (unit price of ₹ 1.95); AD syringe 0.1 ml (unit price of ₹ 2.60) and reconstitution syringe 5 ml (unit price ₹ 1.95). A buffer stock of 25 per cent was assumed for all vaccines and injection supplies at the baseline or at the implementation year. Wastage rate for injection supplies was assumed 10 per cent (Immunization Division, Ministry of Health and Family Welfare, Government of India, personal communication).

Personnel costs included salary and benefits of all workers fully or partially involved in immunization activities. Personnel in the Immunization Division at the Ministry of Health and Family Welfare, State and district immunization officers, cold chain handlers, and vaccine logistics managers were assumed to spend full time on immunization. At the block level, auxiliary nurse midwives (ANM), multipurpose workers, and lady health volunteers (LHV) were assumed to spend 33 per cent of their time on immunization activities; medical officers at the block and primary health centre level, 10 per cent; and data entry operators, five per cent. We assumed a five per cent increase in salaries and a two per cent increase in staff at the block level. All assumptions related to personnel were taken into account after discussing with the Immunization Division of the Ministry. The recommendations of the Human Resources Needs Assessment study for projecting personnel requirements for UIP at the national and State levels were also considered[14].

The costs of transporting vaccines were based on the useful life of the vehicles, average kilometres travelled per year, fuel price, and fuel and vehicle price inflation rate.

Table II. Cost components, by category

Social mobilization, advocacy, and communication activities
ASHA incentives for social mobilizations
Printed materials (banners, posters, IEC materials) BCC tool
Advocacy and communication (UNICEF)
SMNet (UNICEF)
Programme management
Evaluations, programme reviews, assessment meetings
Office supplies, consumables
Micro planning
Immunization Technical Support Unit
Operational cost of poliomyelitis and other VPDs (UNICEF)
Operational cost of poliomyelitis and other VPDs (WHO)
Other routine immunization activities
Service provision in underserved and hard-to-reach areas (including slums)
ASHA incentives
Planning, supportive supervision, monitoring
Intensification of routine immunization (WHO)
Research studies (Government + WHO)
Measles, JE control programme (UNICEF)
Other State-specific activities

ASHA, accredited social health activist; BCC, behaviour change communication; IEC, information, education and communication; VPD, vaccine-preventable disease; SMNet, social mobilization network

The cold chain cost projections were based on current assessments of the cold chain situation in India conducted by National Institute of Health and Family Welfare (NIHFW) and UNICFF (*http://unicef.in/Uploads/Publications/Resources/pub_doc109.pdf*) and future needs. Future needs were determined from national cold chain evaluation meetings, cold chain officers' meeting minutes, the national cold chain management information system, and discussions with the Immunization Division of the Ministry of Health and Family Welfare and with UNICEF.

For waste management it was assumed that hub cutters would be used in all immunization sessions, and plastic bags and safety pits for disposal.

The exchange rate at the base year was 1 US$ = ₹48 (the average exchange rate during 2012). For projections, we assumed 1 US$ = ₹ 65, based on the trend in the exchange rate in 2013.

Results

The detailed baseline expenditures are presented in Table IV. Total baseline expenditure was ₹ 3,446.54 crore [1 crore = 10 million (10,000,000)] ($718 million at 2012 prices), including shared personnel costs (for those who spent less than 100 per cent of their time on immunization), and ₹ 2,131.61 crore ($444 million) without shared costs. Expenditure on routine immunization was ₹ 1,253 crore ($261 million); for the

Table III. Wastage rates and coverage of different antigens in 2012 and 2017

	Coverage (%)		Wastage rate (%)	
Antigens	2012 or at implementation year	2017	2012 or at implementation year	2017
BCG	87	95	50	50
Hep B	72	-	25	-
OPV	70	90	25	10
DPT	72	-	25	-
Measles	74	95	25	25
JE	80	80	25	25
TT	80	85	25	10
Pentavalent Hib	5	90	25	10
IPV	80	85	30	30
MR	70	80	25	25
Rotavirus	60	80	10	10
PCV	-	80	25	5

Abbreviations as given in Table I
Source: Ref. 13

supplemental immunization activities (SIAs), it was ₹ 878 crore ($183 million) (both excluding shared costs). Shared personnel costs were the biggest category of expenditure: 38 per cent of the total (Table IV). Recurrent costs (vaccines and injection supplies) for routine immunizations accounted for 36 per cent, and for SIAs, 25 per cent.

For the baseline year, the government paid 90 per cent of the programme expenditure. Other sources of financing were WHO (4 per cent), UNICEF (3 per cent), and GAVI (3 per cent) (not reported in the Table).

Total resource requirements for UIP for 2013-2017 were ₹ 34,336 crore ($5,282 million) (Table V). Resource requirements for vaccines increased from ₹ 511 crore ($79 million) in 2013 to ₹ 3,587 crore ($ 552 million) in 2017 as new vaccines were assumed to be introduced in the Programme. The requirement will double from 2014 to 2015 if pentavalent vaccination is rolled out in all States and if IPV and MR vaccines are added. It will increase significantly again in 2017 if PCV is added. Fig. 1 shows the changes in resource requirements for routine immunization vaccines only, from 2013 to 2017. Introduction of rotavirus vaccine in the programme will increase the vaccines cost from ₹ 1,455 crore ($224 million) in 2015 to ₹ 1,770 crore ($ 272 million) in 2016 while the amount will be more than doubled when PCV will be introduced in the Programme in 2017. The vaccines cost will increase to ₹ 3,587 crore ($552 million) in 2017 (Table V).

It was assumed that poliomyelitis SIAs would take place every year while measles campaign would end in 2013. However, starting in 2015, as part of the commitment to reach the target of eliminating measles in the region by 2020[15], UIP will phase in MR vaccine through SIAs between 2015 and 2016. This was reflected in the SIA resource requirement, which increased from ₹ 741 crore ($ 114 million) in 2014 to ₹ 1,521 crore ($ 234 million) in 2015 (Table V).

Discussion

In this paper, we report current expenditures and project the financial requirements of India's national immunization programme. We chose fiscal year 2012, the most recent for which complete information was available, as the base year. The baseline cost per capita and cost per DPT 3 child (a proxy for cost per fully immunized child) were ₹19.2 ($0.40) and 1,440 ($30), respectively, including shared costs. The average per capita cost as reported in the historical analysis of immunization plans in GAVI - eligible countries for the baseline period was $0.61, and the cost per DPT 3 child was $ 28 including shared cost[8]. The relatively lower per capita cost in India's programme is probably because most of the existing vaccines are manufactured locally and in large quantity, given the number of target children. The historical analysis also found that the per capita cost was lowest in the Southeast Asia - Western Pacific regions ($0.35)[8], likely because of the large population.

While looking at the cost drivers, it was found that shared personnel costs were the major component in all projection years except for the last year, 2017, when vaccines were the major cost. This was because we assumed that PCV would be added to UIP in 2017. The finding was in contrast with that of the historical analysis of immunization programmes, for which the vaccines were the major cost in the baseline as well as in projection years, followed by immunization-specific personnel[7].

Shared personnel cost was the major cost driver in most of the projected years. As India has shortage of health workforce, depending heavily on shared personnel may affect the efficient implementation of the Programme. As recommended[14], the immunization specific positions should be filled up soon to increase immunization coverage in the country.

As we had made a few assumptions while calculating the shared personnel cost, for example, we assumed five per cent increase in salary for the staff, we did a sensitivity analysis by using 10 per cent increase in salary and found that it would increase total personnel cost from approximately five per cent in 2013 to 26 per cent in 2017. As we did not have data on actual salary of the ANMs and other staff, we assumed average salary range paid to staff employed through National Rural Health Mission (NRHM) programme. We did a re-calculation assuming ANM's monthly average salary of ₹ 20,000 against our original assumption of ₹ 10,000 to 15,000 and for LHVs average monthly salary of ₹ 30,000. This increases the personnel cost by approximately 53 per cent in all projected years.

We did another sensitivity analysis using the wastage rates found in UNICEF wastage assessment study in India[16]. Vaccine costs increased by approximately seven per cent in 2013 and 2014, approximately three per cent in 2015 and 2016 and 1.36 per cent in 2017. In our original estimate we assumed five per cent wastage rate of PCV vaccine which was optimistic, and did a recalculation using 10 per cent wastage rate of PCV and that increased the vaccine cost by four per cent in 2017.

Table IV. Baseline expenditure for India's National Immunization Programme, 2012

Routine recurrent costs	2012 (US$ millions)	2012 (₹ crore)	Percentage of total expenditure
Vaccines	59.92	287.60	8.3
Injection supplies	16.46	79.00	2.3
Personnel	11.40	54.72	1.6
Transport	27.09	130.02	3.8
Cold chain maintenance	9.24	44.34	1.3
Training	5.94	28.53	0.8
Social mobilization, advocacy, communication activities	50.23	241.10	7.0
Disease surveillance	18.97	91.04	2.6
Programme management	9.67	46.40	1.3
Other routine recurrent costs*	37.91	181.96	5.3
Subtotal	246.81	1,184.71	34.4
Capital costs			
Cold chain equipment	14.28	68.52	2.0
Subtotal	14.28	68.52	2.0
Total costs (excluding shared costs)	261.09	1,253.23	36.4
Supplemental immunization activities (SIAs)			
Poliomyelitis			
Vaccines and injection supplies	95.22	457.04	13.2
Operational costs	53.00	254.37	7.4
Total	148.21	711.41	20.6
Measles			
Vaccines and injection supplies	15.14	72.69	2.1
Operational costs	13.11	62.91	1.8
Total	28.25	135.59	3.9
JE			
Vaccines and injection supplies	4.85	23.30	0.7
Operational costs	1.68	8.08	0.2
Total	6.54	31.38	0.9
Subtotal SIAs	183.00	878.38	25.5
Total routine and SIAs costs (excluding shared costs)	444.09	2,131.61	61.9
Shared personnel costs	273.94	1,314.93	38.1
Grand Total	718.03	3,446.54	100.0

1 US$ = ₹ 48 (exchange rate for 2012); * service provision in underserved and hard-to-reach areas, incentives given to accredited social health activists (ASHAs), intensification of routine immunization services, research studies on immunization, *etc*.
1 crore = 10 million (10,000,000)

UIP is financed largely by the Government of India. Fig. 2 identifies the future secure financing and shortfalls for 2013-2017. The gap increases from ₹ 56 crore in 2013 to ₹ 3,537 crore in 2017. The funding gap arises because of several reasons - costs of personnel are borne by the government and with the increased number of personnel and salary increase, the amount required for personnel will increase. Further, India is going to introduce several new vaccines in the Programme and the additional spending on new vaccines will create funding gap. For example, introducing rotavirus vaccine in the Programme will require additional ₹ 300 crore in 2016. If the government introduces PCV in 2017, that will require double the amount required for vaccines in 2016. All these create funding gap based on the base year financing of the government and other immunization partners.

The study had several limitations. First, the shared personnel costs - which we found to be the biggest component in India's immunization programme - were

Table V. Resource requirements (₹ in crores) for India's National Immunization Programme, 2013-2017

Cost Category	2013	2014	2015	2016	2017	Total
Vaccines (routine vaccines only)	510.6	632.8	1,455.1	1,769.9	3,587.1	7,955.5
Injection supplies	71.8	72.3	89.7	84.7	102.9	421.4
Personnel	78.7	84.7	89.9	95.5	101.4	450.2
Transportation	203.4	234.9	271.3	313.3	361.9	1,384.8
Cold chain and other capital equipment maintenance	116.3	149.4	175.9	207.0	220.9	869.4
Training	30.8	36.5	41.5	47.4	54.1	210.3
Social mobilization/advocacy/communication activities	284.1	373.8	421.3	467.9	483.1	2,030.3
Disease surveillance	132.9	161.4	186.4	215.3	248.7	944.7
Programme management	94.1	225.5	215.4	231.7	248.5	1,015.2
Other routine recurrent costs	219.3	248.4	266.3	282.0	300.2	1,316.3
Cold chain equipment	131.4	198.2	269.2	343.6	419.7	1,362.1
Supplemental immunization activities	789.6	740.6	1,520.7	1,522.6	813.5	5,386.9
Shared personnel costs	1,907.1	2,042.5	2,187.5	2,342.8	2,509.1	10,989.0
Total	4,570.0	5,201.0	7,190.2	7,923.9	9,451.0	34,336.1

1 US$ = ₹ 65, 1 crore = 10 million

based on experts' assumptions about what percentage of time shared staff spent on immunization. The cost estimates might be different if we knew the exact percentages. Second, when calculating transportation costs, only those vehicles were considered which were used exclusively for immunization and did not include vehicles shared with other programmes because of non-availability of data. Even though this cost (unlike costs of shared personnel) contributed a small fraction of total immunization programme cost, it led to an underestimation of total cost. A similar caveat relates to building costs. Third, the vaccine requirements for 2016 and 2017 were overestimated because we assumed that rotavirus and PCV would be introduced simultaneously throughout the country rather than phased in (which is more likely). Fourth, we could not make projections for JE because the campaign would depend on the epidemiological situation, and thus the total resource requirement was underestimated. Fifth, coverage data for all vaccines at baseline were taken from coverage evaluation survey (CES) 2009[13] as no recent data were available. The assumptions of projected coverage were based on discussions with the Immunization Division, not on the rate of increase of coverage from previously available data. Finally, paracetamol syrup/tablets are routinely given with DPT/pentavalent immunization and vitamin A is given with measles doses, the costs of which are not included in this calculation. Hence, the total estimate was underestimated.

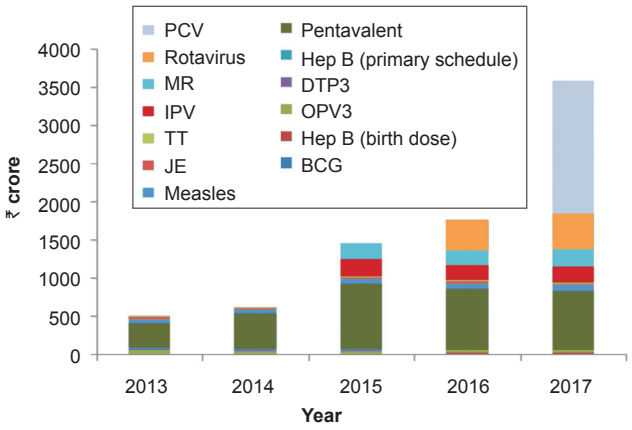

Fig. 1. Resource requirements for vaccines, routine immunization, 2013-2017 (₹ in crore). PCV, pneumococcal conjugate vaccine; MR, measles rubella; IPV, inactivated polio vaccine; TT, tetanus toxoid; JE, Japanese encephalitis; pentavalent, (DPT, Hep B and Hib - *Haemophilus influenzae* type B); Hep B, Hepatitis B; DPT, diphtheria, pertussis, and tetanus; OPV, oral polio vaccine; BCG, bacillus Calmette Guerin.

The government of India spent ₹ 3,466 crore in 2012 to deliver immunization services. The total projected resource requirement for 2013-2017 is ₹ 34,336 crore. The resource requirement will increase from ₹ 4,570 crore in 2013 to ₹ 9,451 crore in 2017 due to the introduction of new vaccines and improvement

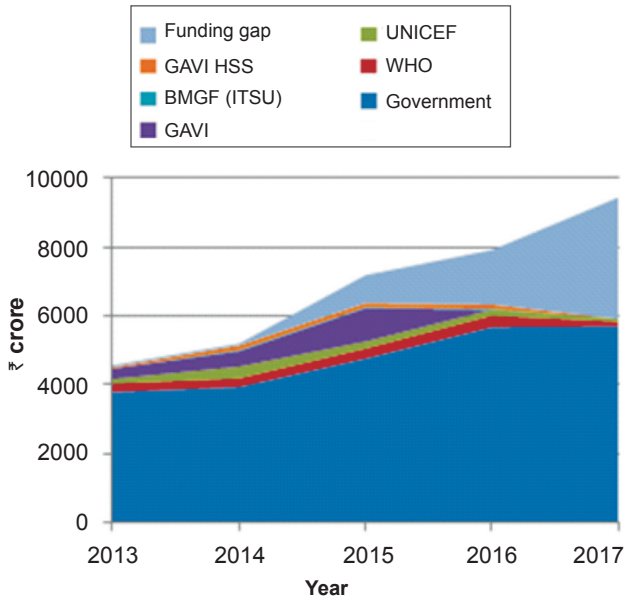

Fig. 2. Future secure financing and funding gaps, 2013-2017, (₹ in crore). GAVI HSS, The Global Alliance for Vaccines and Immunization - Health system strengthening support; BMGF (ITSU), - Bill & Melinda Gates Foundation (Immunization Technical Support Unit); UNICEF, United Nations Children's fund; WHO, World Health Organization.

in other programmes. As the total resource requirement increases steadily, the government health budget on immunization needs to be increased in the coming years to fill the funding gap.

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***Conflicts of Interest*:** None.

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