Technical Report No. 24

Expanded Program on Immunization in Bangladesh: Cost, Cost-Effectiveness, and Financing Estimates

September 1998

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Recommended Citation

Khan, M. Mahmud and Yoder, Richard A. September 1998. *Expanded Program on Immunization in Bangladesh: Cost, Cost-Effectiveness, and Financing Estimates.* Technical Report No. 24. Bethesda, MD: Partnerships for Health Reform Project, Abt Associates Inc.

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Contract No.:	HRN-C-00-95-00024
Project No.:	936-5974.13
Submitted to:	USAID/Dhaka
and:	Robert Emrey, COTR Health Policy and Sector Reform Division Office of Health and Nutrition Center for Population, Health and Nutrition Bureau for Global Programs, Field Support and Research United States Agency for International Development

Abstract

The Bangladesh Expanded Program of Immunization (EPI) began in 1979 as a means of reducing vaccine preventable morbidity and mortality. Widely recognized as having achieved significant gains since its beginning, some concerns have been expressed recently over the financial sustainability of the EPI, diminishing donor support, competition for scarce resources within the government budget, as well as plateauing immunization coverage rates. Partly in response to such concerns, a comprehensive EPI review was conducted that includes, among other things, this assessment of costs, cost-effectiveness and financing issues.

The assessment found that the total cost of the EPI for the current year will approximate $18.3 million while fully immunizing approximately 1.56 million infants under one year of age, resulting in a cost per fully immunized child of $11.76. The immunizations are estimated to prevent 134,000 deaths during the current year, at a cost of $136 per death prevented. As a broad picture, it is estimated that some 1.15 million deaths have been averted since 1987 due to immunization activities.

At the current level of costs, the gap between total resources needed ($18.3 million) and the resources provided through government funding ($8.3 million) approximates $10 million. This gap must be closed through generating additional resources, through cost containment, or both. As an indicator of the Government of Bangladesh's ability to finance EPI activities, current EPI costs represent approximately 0.06 percent of GDP, 0.5 percent of GOB revenue, and 4.95 percent of the budget of the Ministry of Health and Family Welfare.

In general, the EPI program was found to be relatively cost-effective, particularly when compared to similar countries and to the opportunity cost of treating the sick child. Thus, one of the best ways to generate savings in the entire health sector is to reduce the needs in the highly visible curative sector by reducing its demand—precisely what a strong immunization program does.

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Acronyms

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BCG	Bacillus Calmet-Guerin Vaccine (against tuberculosis)
BRAC	Bangladesh Rural Advancement Committee
CBR	Crude Birth Rate
CDR	Crude Death Rate
CES	Coverage Evaluation Survey
CFIC	Crude Fully Immunized Children (rate)
DALYs	Disability-Adjusted Life Years
DPT	Diphtheria-Pertussis-Tetanus Vaccine
EPI	Expanded Program of Immunization
ESP	Essential Service Package
FIC	Fully Immunized Child
FWA	Family Welfare Assistant
GDP	Gross Domestic Product
GNP	Gross National Product
GOB	Government of Bangladesh
HAPP-5	Fifth Health and Population Program
HeaLYs	Healthy Life Years Saved
HES	Health Expenditure Survey
HPSP	Health and Population Sector Program
IDA	International Development Association
IMR	Infant Mortality Rate
MOH&FW	Ministry of Health and Family Welfare
NID	National Immunization Day
NGO	Non-Governmental Organization
NCHS	National Center for Health Statistics
OPV	Oral Polio Vaccine
PHR	Partnerships for Health Reform Project
THC	Thana Health Complex

TT	Tetanus Toxoid
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
VII	Vaccine Independence Initiative
WHO	World Health Organization

Acknowledgments

The authors of this study acknowledge and thank the various individuals who contributed to the completion of this study. While they are too numerous to mention by name all of them, we want to give special thanks to the many EPI officials and those from government and non-governmental organizations who gave time from their schedules to be interviewed and provide information. We also want to give particular thanks to the Health Economics Program of International Center for Diarrheal Disease Research, Bangladesh who made available their equipment and facilities as well as three staff members who provided substantial assistance in data collection and analysis: Dr. Disha Ali (Medical Officer), Mr. Abdullah Al-Mamun (Statistician), and Ms. Zohra Ferdousi (Economist). In addition, we want to thank Ms. Denise DeRoeck and Dr. Ann Levin for their thoughtful critique and careful editing of the study.

Executive Summary

Background

This study is one component of a comprehensive review of the Bangladesh Expanded Program of Immunization (EPI) conducted from April 26–May 14, 1998. Spearheaded by the Government of Bangladesh (GOB) along with the World Health Organization (WHO), the review had financial support from the U.S. Agency for International Development (USAID), the British Department for International Development, and the Swedish International Development Agency. As developed by WHO, EPI reviews are to be conducted every three to five years and involve a systematic assessment of key elements of EPI.

The purpose of the EPI review was to recognize and affirm the continuing achievements of the program, identify and resolve barriers that limit achievement of the program's targets, and reassess the role of EPI within the changing development and infrastructure realities.

Because of the bulk of a costing and financing study, this report is prepared as a document separate from the EPI Review report; however, key findings and recommendations from this study are included in the main report. Some of the data between the two reports are different because adjustments have been made to this report to include the costs of the urban immunization program, which was not part of the main EPI Review report.

Objectives

The Scope of Work for this study addresses five objectives:

- *to determine the total cost of the EPI from 1985 to 1997 (excluding polio National Immunization Days) from available data;*
- *to conduct cost projections of the EPI from 1998 to 2003;*
- *to analyze the current and anticipated financing of Bangladesh's EPI against projected costs in order to determine gaps in financing and their implications for the program;*
- *to develop approximations of the cost-effectiveness of the EPI, as time and availability of data permit; and*
- *to review the Government of Bangladesh/World Bank Fifth Health and Population project proposal, and contribute to the comments and recommendations of the team for strengthening EPI's role in light of donor interests and plans for supporting EPI.*

Methods

This study was carried out from the perspective of the providers and thus excludes costs incurred by households and communities in obtaining immunizations. As a means of estimating total costs of an immunization program, as opposed to total expenditures, a survey is typically conducted of a sample of facilities and sites to generate parameters of resource utilization (e.g., personnel). Because of limited time and other resources, such a survey was not possible. Consequently, recurrent and capital *expenditure* data were used and obtained from the EPI Unit accounts office and supplemented with *cost* data obtained from the Directorate of Health, EPI officials, and other individuals knowledgeable about EPI activities and the program's pattern of resource use.

Findings

Program Expenditures

The expenditure level of the EPI program increased from US $ 406,000 in 1985/86 to $16.3 million in 1993/94. After 1993/94, the annual expenditure averaged approximately $15 million, except for 1995/96, when the expenditure level dipped to just over $8 million.

The contribution of the government to EPI expenditure through the EPI program increased from zero during the years 1985–87 to approximately 45 percent in 1994/95. In recent years, the government's role as a funding source appears to have declined. In the current fiscal year, the direct government contribution to the program as part of project funding is estimated at about 14 percent of total expenditures. However, if expenditures through the GOB revenue budget—which covers much of the health sector personnel, infrastructure and other costs—are included, the government's contribution increases to 45 percent of the total.

Current Program Costs

The total cost of EPI will differ significantly from the actual annual expenditure. Expenditures track the flow of money through the system for goods or services paid, often, by government or donors. Costs, on the other hand, measure the full value to society of all resources used in producing a good or service, regardless of its source. Thus, a proper costing of an EPI should include items such as household and community costs, volunteer time, costs which are shared with non-immunization programs (such as control of diarrheal disease, acute respiratory infection, family planning), as well as depreciation costs on buildings, equipment or vehicles. In this study household and community costs are not included.

The total cost of EPI in the current year is expected to be approximately $18.3 million. Excluded from the cost estimates are the costs of National Immunization Days (NIDs), although since NID coverage effects have also been excluded, the cost-effectiveness ratios will be the same.

The full costs of the urban immunization program have also been excluded from the cost estimates. The cost of vaccine ($7.7 million) accounts for approximately 42 percent of the total, while personnel costs account for another 41 percent ($7.58 million) of total cost. Approximately 38 percent of total EPI costs was paid by the GOB directly through its general revenue budget.

Projected Program Costs: 1998/99 to 2002/03

Projected costs over the next five years will vary depending on the assumptions that are used regarding immunization coverage rates and the number of delivery points and sessions held. The data below show an estimate of projected five-year costs as well as annual costs under different assumptions.

1998/99 to 2002/03 EPI costs with current crude coverage rate (70%):

with 110,000 sessions a month:	$119 million ($23.8 million/year)
with 55,000 sessions a month:	$117 million ($23.4 million/year)
with 22,000 sessions a month:	$107 million ($21.4 million/year)

1998/99 to 2002/03 EPI costs with 90-percent crude coverage rate:

110,000 sessions a month:	$139 million ($27.8 million/year)
55,000 sessions a month:	$147 million ($29.4 million/year)
22,000 sessions a month:	$156 million ($31.2 million/year)

Effectiveness Measures

As a broad picture of the achievements of EPI activities over the last decade, estimates of the number of deaths averted since 1987 due to EPI activities range from 1.25 million (internal EPI estimates) to 1.15 million (authors' estimates). Regardless of which estimate is most accurate, it is clear that EPI activities have had a substantial impact on reducing mortality.

The number of vaccine doses administered by the program, as reported by EPI's routine reporting system, during the current fiscal year should be approximately 37 million. About 1.56 million children will be fully immunized within 12 months of birth during 1997/98. The immunizations administered or to be administered during the current year are likely to prevent 134,000 deaths.

The number of deaths prevented during 1997/98 translates to about 2.66 million discounted life years saved (using 5% as the discount rate). If morbidity and disability are considered, immunizations carried out this year will save an estimated 2.8 million healthy life years (HeaLYs). More than two-thirds of total healthy life years saved is due to the prevention of tetanus (through both tetanus toxoid and diphtheria-pertussis-tetanus vaccine).

Cost-Effectiveness Ratios for 1997/98

From estimates of costs and measures of effectiveness, six cost-effectiveness ratios are shown below. The cost-effectiveness ratios are based on the assumption that community-level personnel costs for the delivery of immunization services in urban areas are about 20 percent of rural personnel costs. The percentage of infants born in urban Bangladesh is about 17 percent of those born in rural areas, and therefore, the estimate of urban personnel costs being 20 percent of rural personnel costs is a reasonable assumption to make in the absence of more information on this cost category. A sensitivity analysis in which urban personnel costs are assumed to be 14 percent, and rural personnel costs to be 25 percent was also carried out. The results of this analysis are shown in parentheses.

Cost per dose of vaccine given (crude coverage rate)	$ 0.70 ($0.69 to 0.71)
Cost per fully immunized child (FIC)	$ 11.76 ($11.58 to 11.96)
Cost per crude number of immunized children (CFIC)	$ 9.08 ($8.94 to 9.23)
Cost per death prevented	$ 136 ($135 to 138)
Cost per life year saved	$ 6.89 ($6.79 to 7.01)
Cost per healthy life year saved	$ 6.56 (6.46 to 6.67)

While not strictly comparable, some examples of other cost-effectiveness ratios from other low-income countries are of interest. The World Bank and others estimate that the cost per FIC ranges from $15–$17 and the cost per healthy life-year saved to be $12–$17. Further, the alternative to not immunizing a child is to treat the sick child which bears a substantially greater cost. The World Bank estimates that the cost of managing a sick child is $30–$50 per disability-adjusted life year saved. Consequently, one of the best ways to generate savings in the entire health sector is to reduce the need in the highly visible curative sector by reducing its demand— precisely what a strong immunization program does.

Financial Sustainability

At the current level of cost, the gap between total resources needed ($18.3 million) and the resources provided through public sector funding ($8.3 million) is about $10 million. This gap must be closed either by generating additional resources or through cost containment or both. As an indicator of ability to finance EPI activities, current EPI costs represent approximately 0.06 percent of gross domestic product (GDP), 0.5 percent of total GOB revenue, and 4.95 percent of the budget of the Ministry of Health and Family Welfare (MOH&FW).

Recommendations

1. Develop a long-term plan for financing EPI activities, in particular for self-financing of the vaccine budget. Currently, there is a shortfall of approximately $10 million in the EPI budget, of which vaccines account for nearly $7.7 million. In order to achieve the targeted immunization coverage rate of 90 percent, the additional resources needed over the next five years (mainly for increased social mobilization efforts) will be between $35 million and $47 million, depending on the number of immunization sessions organized. All else

being equal, the shortfall will increase over the next five years. Thus far, the shortfall has been met by contributions from external partners and international loans. This situation makes the program vulnerable to the vagaries of external funding sources.

2. Develop ways to expand the Vaccine Independence Initiative (VII) as a means of ensuring the needed supply of vaccines and to save scarce foreign exchange.

3. Improve the immunization completion rates for infants. The cost per administered dose of vaccine in Bangladesh is $0.70. Bearing in mind, however, that the EPI actually uses more than 67 million doses of vaccines to administer 38 million doses, eight doses per birth plus two lifetime doses per woman of child bearing age should cost not much more than $7.00 per FIC. This compares with the current estimated cost per FIC of $11.76. With better completion rates (fewer drop-outs) for infants, the cost per FIC can, in theory, be reduced by some 40 percent without increasing the supply of vaccines or health personnel.

4. Since historical patterns of EPI expenditure show significant year-to-year variability, examine the causes of this variability to identify the expenditure items most susceptible to high variation and find ways to even out expenditure patterns. In addition, in searching for ways to reduce costs, attention should be focused on the big ticket cost items, such as vaccines and personnel.

5. Identify methods for reducing the resource gap in the longer run by conducting the following kinds of studies:

   - *operations research activities to identify more cost-effective methods of delivering EPI services to the target population (Possible examples of such research activities are: finding ways to reduce the size of the EPI administration, achieving greater efficiency in the distribution of vaccines, using equipment more efficiently, ensuring higher attendance at fewer sites, and involving NGOs or the private sector to a greater extent in EPI activities);*

   - *research into cost-saving strategies for the delivery of EPI services that are quality-neutral or that improve quality (Examples include: an open vial policy on diphtheria-pertussis-tetanus vaccine (DPT) and tetanus toxoid (TT), sterilization of syringes at a central level instead of at the point of delivery, primary school vaccination with tetanus-diphtheria, and the development of policy guidelines on handling open vials for outreach teams);*

   - *studies on methods for generating more effective use of vaccine doses to reduce the total amount of vaccines needed in the country; and*

   - *research into methods to strengthen communication in order to improve the demand for vaccinations and reduce the cost of seeking out infants for immunization.*

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1. Introduction

1.1 Purpose and Background

This study is one component of a comprehensive review of the Bangladesh Expanded Program of Immunization (EPI) conducted from April 26–May 14, 1998. Spearheaded by the Government of Bangladesh (GOB) along with the World Health Organization (WHO), the review received financial support from the U.S. Agency for International Development (USAID), the British Department for International Development, and the Swedish International Development Agency. As developed by WHO, EPI reviews are to be conducted every three to five years and involve a systematic assessment of key elements of EPI.

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1.2 Bangladesh EPI Program Summary[1]

The principal objective of the Expanded Program on Immunization (EPI) is to reduce mortality, morbidity and disability associated with tuberculosis, tetanus, diphtheria, measles, pertussis and poliomyelitis. The program also has the explicit objective of promoting the country's self-reliance in the delivery of immunization services through the gradual incorporation of EPI activities into the comprehensive health care delivery system of the country, especially at the community level.

The full course of child immunizations in Bangladesh consists of three shots of DPT, three doses of oral polio vaccine (OPV), one shot of Bacillus Calmet-Guerion Vaccine against tuberculosis (BCG), and one of measles. A fully immunized child therefore receives the six standard EPI antigens through eight vaccinations (shots). Pregnant women are also given two doses of tetanus toxoid (TT) through the EPI.

During its lifetime the EPI has experienced four phases of development. The first phase was initiated in 1979, with financial assistance primarily from UNICEF. During this phase, EPI

[1] Much of the material from this section is taken from EPI Unit documents, the EPI Project Proforma 1995/96 to 1999/2000, ICDDR'B documents, and The Center for Policy Dialogue, *The Quality of Public Investment in Bangladesh*, University Press Ltd, 1997, pp. 61–78.

services were delivered through fixed centers only, limiting the coverage of immunization. The amount of funding was low—approximately US $1.5 million. Around 8 percent of the total financial resources were provided by the GOB. The program remained narrow in scope, and had insufficient supplies of vaccine. By the end of the first phase in 1985, 2 percent of infants were fully immunized by the EPI activities (see Project Proforma 1995/96 to 1999/2000) (GOB, 1996). Statistics indicated that during the mid-1980s the six vaccine preventable diseases accounted for one-third of all child deaths.

The second phase of the EPI (1985/86–1992/93) was initiated with the objective of attaining universal child immunization by the year 1989/90. EPI activities were intensified with the objective of geographically covering all of the country's *thanas* and unions.[2] This phase also had limited funding—approximately US $17 million over the five-year period. Although the political commitment for the program was strong, the coverage by 1987 remained below 10 percent, due in part to weak management and lack of resources. It was felt that in order to improve the coverage rate, EPI services needed to be delivered at the community level with many outreach sessions. The logistics of community-based EPI services required a well-functioning cold chain, transportation facilities, vaccination equipment and the timely availability of vaccines. Consequently, the second phase was revised to include a community-based delivery system with an additional US $58 million provided.

Under Phase Two, immunization services in the rural areas were provided from eight outreach sites in every ward (approximately one third of a union), with about 108,000 immunization sessions held every month. In the urban areas, the program delivered EPI services through 2,243 immunization centers. By the end of this phase, immunization coverage increased to around 50 percent. Integrating EPI services within the primary health care delivery system is thought to be an important reason for the increase in immunization coverage observed since 1987.

The third phase of the EPI program covered the years 1993 to 1995. The goal of this phase was to increase the coverage rate to 85 percent and to strengthen the delivery structure developed during the earlier phases. This phase also identified major needs of the program: encouraging participation of local leadership in EPI activities, training of health workers, involvement of NGOs, and proper integration of immunization services with primary care and family planning activities. For this two-year period, the allocation was increased to approximately $38 million, or $19 million per year.

The fourth phase of the program covers the period 1995 to 2000 and has the objective of achieving 90-percent coverage by the year 2000. Like the two previous phases, this phase is designed to improve the integration of EPI services with other primary health care services and to encourage local communities to deliver EPI services. This includes the strengthening of local and international training, mass communication, intensification of immunization services in urban areas, and involvement of *thana* and union *parishad* leaders in identifying problems and in planning EPI services.

The current immunization strategy is based on a model of eight outreach sites per ward, with two immunization sessions held each week. Immunizations are delivered by 9,000 Health

[2] Bangladesh is divided administratively into 10 divisions (analogous to states or provinces), districts, *thanas*, unions, and wards. A ward is the smallest unit, consisting of several villages, and a union comprises, on average, three wards. A thana consists of between four and 16 unions, and there are several thanas in each district.

Assistants and 4,500 Family Welfare Visitors (FWAs) who are appointed by the Ministry of Health and Family Welfare (MOH&FW) at the village level. Health Assistants are supposed to carry out all types of basic health activities at the local level, while the FWAs deliver family planning services. However, FWAs, along with the Health Assistants, conduct social mobilization activities one day prior to the outreach sessions in the locality. And, although it is the Health Assistants who are supposed to administer the vaccinations, in many cases, FWAs also help deliver EPI services.

Supplementing the routine immunization services are National Immunization Days (NIDs), four of which have been conducted thus far, with the fifth NID being planned for November 1998. Building on lessons learned and new technologies, significant improvements in coverage have been achieved. According to the 1998 Coverage Evaluation Survey (CES), coverage for BCG is 91.1 percent, 85.5 percent for DPT1, 78 percent for DPT2, 67.7 percent for DPT3, 85.2 percent for OPV1, 77.8 percent for OPV2, 68.1 percent for OPV3, and 61.5 percent for measles. Overall, 54 percent of children under age one are fully immunized.[3]

As part of the World Bank/GOB Fifth Health and Population Sector Program (HAPP-5), there are plans to integrate the health and population divisions of the Ministry of Health and Family Welfare. In conjunction with this, plans are underway to shift EPI activities from the ward and outreach site model to a fixed site/population-based model centered at the union level (there are three wards per union). Two immunization sessions per week will be conducted in each union, which covers a population of approximately 6,000 people. In addition, there will be some outreach—currently projected at four sites per month. From the perspective of the MOH&FW, EPI activities will be part of an Essential Service Package (ESP) available at the union level.[4]

With the strong historical commitment and support from both the GOB and external sources, the EPI as a single project has been one of the largest recipient of funds among development projects in the health sector since 1990/91. The GOB share of total EPI spending has increased from less than 2 percent in the mid-1980s to 45 percent in 1994/95, and has averaged 35 percent over the last three years. As will be shown in subsequent sections, the evidence indicates that this has been an investment providing high returns.

Recently, concerns have been expressed over the financial sustainability of the immunization program and the fact that coverage rates have plateaued during the last three years. Donor priorities change over time and competition for scarce resources is increasing in Bangladesh. In response to these concerns, the EPI review was conducted along with this assessment of cost, financing, and sustainability issues.

[3] EPI's routine reporting system consistently shows higher coverage rates: for example, 97-percent coverage for measles and 98 percent for OPV3.

[4] Section 4 provides a more detailed comment on the possible affects of HAPP-5 on EPI activities.

1.3 Health Status Indicators

Three widely used health status indicators are presented to provide some indication of the health status of the population in Bangladesh. The first set of indicators is based on mortality rates. The other two indicators are based on morbidity and malnutrition data.

Table 1 shows data from the Bangladesh Bureau of Statistics (BBS) on life expectancy and infant mortality rates from 1981 to 1995. As seen in the table, life expectancy at birth has increased from about 54.5 years in 1982 to over 58 years in 1994. Ten percent of the increase can be explained by the increasing share of the urban population, and 89 percent of the change is due to the increase in life expectancy in rural areas. In urban areas, life expectancy at birth has remained virtually static at about 60 years since 1981/82.

Table 1 also shows that infant mortality rates (IMRs) have declined consistently over the last 15 years. At the national level, infant mortality declined from more than 110 per thousand live births in 1982 to less than 80 in 1994. In urban areas, the IMR shows a decline from approximately 100 in 1982 to around 60 in 1994. Child and maternal mortality rates also show significant improvements since 1987. Infectious and easily preventable diseases account for more than one-third of total infant deaths in the country.

A number of small-scale surveys in urban slum areas have reported the IMR at more than 100 per thousand live births, even as recently as 1993–95. It is not clear whether the BBS could adequately take into account the differential mortality rates between the slum and non-slum population. Out of the total BBS urban sample, less than 8 percent were drawn from slum areas in 1992. This appears to be much lower than the actual proportion of the slum population in the urban areas. Therefore, the BBS's infant mortality rate estimates and other health indicators in the urban areas may be biased downwards and the error may have increased in recent years due to rapid urbanization and rapid growth of urban slums.

The Child Nutrition Surveys of the BBS indicate that the nutritional status of children measured by stunting (NCHS standard of less than -2SD (standard deviations) height for age) may have declined slightly since 1985, but even in 1995–96 more than 50 percent of all children were stunted. In general, children in urban areas appear to be slightly better off than their rural counterparts. However, data disaggregated by slum and non-slum areas show that the prevalence of stunting among slum children was found to be almost twice that of rural children (80% compared to 43%). The BBS surveys showed that, overall, around one-half of all urban children were stunted. If we assume that the slum population makes up 25 percent of the total urban population, giving a 25-percent weight to the slum statistics, the urban stunting rate increases to about 58 percent. Similarly, 73 percent of children in urban slum areas were found to be severely wasted (less than -2 SDs weight for height), compared to 55 percent of children in non-slum areas. Since 1985/86, the percentage of children severely stunted shows no systematic decline in urban areas, while the prevalence of wasting shows an increasing trend in the cities.

Table 1: Three-Year Moving Average of Life Expectancy at Birth and Infant Mortality Rate in Rural and Urban Areas

Year	Life Expectancy at Birth			Infant Mortality Rate (per 1,000 Live Births)		
	Urban	Rural	National	Urban	Rural	National
1981–83	60.3	53.8	54.4	100.4	118.8	116
1982–84	59.9	53.8	54.6	107.3	122.0	120
1983–85	59.7	54.1	55.0	105.9	118.6	117
1984–86	59.2	54.6	55.6	106.7	117.7	114
1985–87	59.6	55.2	55.9	98.3	115.3	113
1986–88	59.9	55.4	56.1	95.7	115.0	107
1987–89	60.3	55.5	56.0	90.0	110.7	101
1988–90	60.4	55.3	56.0	82.0	104.7	95
1989–91	60.2	55.5	56.1	74.7	98.7	91
1990–92	60.3	55.8	56.8	68.3	94.0	88
1991–93	60.4	56.6	57.4	65.0	91.0	83
1992–94	60.4	57.1	58.2	61.0	86.0	78
1993–95	60.5	57.8	58.5	57.3	80.7	75

Source: Bangladesh Bureau of Statistics

Although infant mortality rates and some nutritional status indicators appear to be showing some improvements over the years, a reversal in the trend may occur in urban areas during the next few years. A recent report estimates that more than 50 percent of the urban population in Bangladesh will live in slum areas by the year 2010. Even if the indicators continue to improve for both slum and non-slum areas, the increasing weight of the slum population may cause the overall indicators to worsen. The lack of safe water supply, unsanitary disposal of wastes, poor quality of residential structures, extremely high population density, and environmental pollution may trigger a health crisis in the slum areas. In this environment, EPI activities become a crucial factor in averting declining health status.

The morbidity rate in Bangladesh is also very high, about 172 cases per thousand population as measured over a two-week period for acute conditions and over a three-month period for chronic conditions, according to the BBS morbidity and disability survey of 1994 (BBS, 1994). The prevalence of morbidity was found to be higher for females than males (181.3 compared to 162.8 per 1,000 population). As expected, the morbidity rate increases with age (from five years). In rural areas, the morbidity rate for 1994 was found to be 168 per thousand, while the urban rate was reported to be 150 per thousand. However, if the urban population had the same age distribution as the rural population, the morbidity in urban areas would be approximately 161 per thousand population. Therefore, rural-urban differences in morbidity are rather small and urban amenities cannot effectively reduce the prevalence of morbidity. Moreover, as mentioned above, the urban rates may be biased downward due to the lower weight assigned to slum dwellers in the BBS survey.

According to the survey, the major causes of morbidity were fever, fever with chills, cold/cough, diarrhea, acidity and heartburn, skin diseases, headache and dizziness, blood pressure, and typhoid. This pattern of disease indicates that the health policy for Bangladesh must combine preventive services with effective basic curative services. The threat of high infant mortality remains a significant health concern along with a number of adult health problems, more than half of which can be considered longer term, life style- or accident-related.

1.4 Socioeconomic Indicators

The socioeconomic environment is an important determinant of childhood illnesses and the effect of EPI activities on child survival depends significantly on the economic and social environment in which children are being raised.

The gross national product (GNP) per capita of Bangladesh has shown some progress in recent years. From 1985 to 1995, the annual rate of growth of GNP per capita was about 2.1 percent, even though the population continued to grow at more than 2 percent per year during this period. If the country maintains the current rate of GNP growth, the rate of increase in the GNP per capita should be higher than 2.1 percentage in the future, due to declines in population growth. The Asian Development Bank estimated GDP growth to be 5.9 percent during 1996/1997.[5] In 1995, the GNP per capita was estimated at about US $240 and, given the rate of growth experienced during the last decade, the GNP per capita should be around $260 in 1997/98.

Despite the growth of the economy, poverty in Bangladesh remains high. The Household Expenditure Survey 1991/92 (HES) found that more than 12 percent of the population earned less than US $90 per capita per year. If poverty is defined by a consumption of less than the calorie requirement of 2,122 kilo-calories per person per day, approximately 50 percent of the population consumed less than this level in 1991/92. More than a quarter of the population can be categorized as extremely poor even if a lower calorie consumption of 1,800 per capita per day is used. The poverty situation has improved slightly since 1985/86, but most of the improvements have occurred in urban areas, keeping rural poverty almost unchanged.

The Bangladesh economy also experienced significant structural changes over the last decade. The proportion of GDP derived from agriculture declined from about 40 percent in 1985/86 to less than a third in 1995/96. The contribution of the industrial sector, especially large-scale industries, has increased over the years and now accounts for more than 10 percent of GDP. Considerable regional differences in income also exist in Bangladesh. For example, per capita GDP of Pabna in 1995/96 was less than half of the GDP per capita of Chittagong (excluding Chittagong Hill Tracks).

[5] *Bangladesh Observer*, 24 April 1998.

1.5 Objectives of the Study

The Scope of Work for this study, which is included as Annex A, addresses five objectives:

1. to determine the total cost of the EPI from 1985 to 1997 (excluding polio NIDS) from available data;

2. to conduct cost projections of the EPI from 1998 to 2003;

3. to analyze the current and anticipated financing of Bangladesh's EPI against projected costs in order to determine gaps in financing and their implications for the program;

4. to develop approximations of the cost-effectiveness of the EPI, as time and availability of data permit; and

5. to review the Government of Bangladesh/World Bank Fifth Health and Population project proposal, and contribute to the comments and recommendations of the team for strengthening EPI's role in light of donor interests and plans for supporting the EPI.

2. Methods

2.1 Study Design

This costing exercise was carried out from the perspective of the providers, that is, the EPI program, the MOH&FW, and agencies collaborating in the delivery of EPI services. Therefore, costs incurred by households and communities to receive the immunizations or to organize the community-level sessions are not included in the costing. As a consequence, costing of the EPI from this narrower provider perspective makes it more difficult to compare the costs incurred over the years. This is because, during the first phase of the program, community participation was relatively low and it was realized that the success of the program depended on the active participation of households and the communities. Gradually, the EPI program encouraged the involvement of community members and local leaders in the delivery of immunization services. For example, to conduct the outreach sessions in local areas, community leaders provide the space and carry out social mobilization prior to each session. In the absence of community involvement, the EPI program or its partners must supply these resources. If the program goes back to a system of delivery based on fixed sites, some of these community-level costs will be transferred back to the EPI program and its partners. Since the method of delivering EPI services has changed over the years and will also change in the future—affecting cost-sharing between the providers of EPI services and the community—the cost per immunization should be adjusted to reflect the changing cost burden before any analysis comparing costs over time can be made.

As a means of estimating total costs of an immunization program, as opposed to total expenditures, a survey typically is conducted of a sample of facilities and sites to generate parameters for resource utilization (e.g., personnel). Because of time limitations, such a survey was not possible. Consequently, recurrent and capital expenditure data were used and obtained from the EPI Unit accounts office and supplemented with cost data obtained from the Directorate of Health, EPI officials, and other individuals knowledgeable about EPI activities and the program's pattern of resource use.

The distinction between expenditures and costs is important to highlight. Expenditures simply measure the flow of money through the system—goods and services paid for by government or donors. Costs, on the other hand, measure the value of all the resources used up in the process of delivering the services, regardless of who pays for them. Thus, a proper costing exercise should include all resources used, such as donated items, volunteer time, resources provided through non-immunization programs (such as acute respiratory infection or control of diarrheal disease, space provided by communities for outreach sessions, as well as depreciation costs of capital equipment.

Because of the methods used to estimate program costs for this study— in particular the absence of survey-based data—caution needs to be exercised in interpreting the data and the findings emanating from the data.

2.2 Data Collection Process

The raw data for this study were obtained from the annual expenditure statements provided by the accounts section of the EPI Unit for the years 1995 to 1998. From this a three-year average of annual expenditures was calculated in 1997 prices. The office also provided aggregate expenditure data for earlier phases. The EPI's accounting system has twenty separate line items or categories of expenditures. These were reclassified into standard categories typically used in immunization costing studies. When EPI line item expenditures were shared among several of the standard categories used in this study, they were apportioned among these categories using the approximate percentage share of each reported by the accounts officer and other EPI officials. Although this system of apportioning cost items into standard categories is a possible source of error for each of the new line items, it would have no effect on total spending. Details of the reclassification system are shown in Annex B.

Current prices of vaccines were obtained from UNICEF. Unit costs for capital equipment, vehicles and buildings were taken from the project proforma and additional unit cost data were collected from knowledgeable sources.

To estimate the target population, the demographic data and parameters were obtained from the BBS reports and yearbooks. More details about infant and child mortality patterns, pregnancy to birth ratios, and so forth were obtained from the ICDDR'B's Matlab reports.

Although the majority of spending on immunizations is channeled through the EPI Unit, there is some that is not. A portion of spending on urban immunizations by NGOs is not included, nor is spending by private practitioners. Because data on the urban EPI were not available, an indirect method of estimating costs, described in Section 3.1.2.1, was used to incorporate these into the cost estimates. Also excluded from the cost estimates are the costs associated with the NIDs. However, since immunization coverage surveys distinguish routine immunizations from immunizations through NIDs, the effects of the NIDs can also be excluded from the effectiveness measures so that they will not distort the cost-effectiveness ratios of the routine immunization activities. This report specifically examines the cost-effectiveness ratios of the routine immunization program.

2.3 Description of Variables

This section describes the three sets of variables used in this study. These are: recurrent costs, capital costs, and effectiveness indicators.

2.3.1 Recurrent Costs

Recurrent costs include personnel, vaccines, supplies, transport, maintenance and operations, and training. Each is summarized below.

- *Personnel: includes salary and benefits of both full-time and part-time (shared costs) personnel involved with the organization and delivery of EPI activities. Personnel costs at the central, division, district, thana, municipality, union and ward levels are included, irrespective of the source of funding. Individuals involved with EPI activities, either full or part-time, but who are not paid through the EPI project, were identified by interviewing the EPI Medical Officers and costed accordingly.*

- *Vaccines: includes expenditures on all vaccines, local or imported, as reported in the EPI financial statements. Total expenditures on vaccines are used as a measure of vaccine cost. The cost of the vaccines includes the international market value of vaccines procured by UNICEF, as well as transport and handling costs.*

- *Supplies: includes items such as needles, syringes, stationary, electrical goods as well as items related to the cold chain (e.g., ice packs). These items are not considered durable goods and have a value less than US$ 100.*

- *Transport: includes costs related to operation and maintenance of vehicles as well as "landing and transportation" costs related to imported goods.*

- *Maintenance and Operations: includes social mobilization; planning, monitoring and evaluation; operations research; equipment repairs; and repair of other capital items.*

- *Training (in-service): short-term, in-service training such as workshops, seminars and study tours that occur on a regular basis.*

2.3.2 Capital Costs

Capital costs include buildings, equipment, vehicles and long-term training, as described below.

- *Buildings: includes the cost of constructing cold rooms, offices, residential housing and warehouses as well as pre-construction phase expenses on land acquisition and development.*

- *Equipment: includes all expenses for durable machines and equipment with a replacement value of US$ 100 or more, such as refrigerators, cold boxes, vaccine carriers, and related equipment whether procured locally or imported. Ice packs are not included.*

- *Vehicles: includes trucks, refrigerated vehicles, pick-ups, cars, jeeps and bicycles.*

- *Training: long-term and degree-oriented training organized or provided by the program. This type of training is not of a recurrent nature.*

2.3.3 Effectiveness Indicators

Seven indicators are used to measure the effectiveness of EPI activities. These are summarized below.

- *Number of Immunizations administered: three measures of the number of immunizations administered are used:*
  - number of children fully immunized as reported by EPI's routine reporting system
  - number of children fully immunized within the first twelve months of life as reported by the Coverage Evaluation Survey
  - number of immunizations given at any time before the survey, regardless of age, as reported by the Coverage Evaluation Survey (crude number of immunizations)
- *Fully Immunized Children: the number or percentage of children receiving valid doses of all eight vaccinations (3 DPT shots, 3 OPV, 1 BCG and 1 measles) before 12 months of age.*
- *Crude Fully Immunized Children: the number or percentage of children fully immunized irrespective of the validity of the immunization or age at administration. Therefore, any child, regardless of age, receiving all eight doses any time before the survey will be counted as CFIC.*[6]
- *Deaths averted: the number of deaths from EPI-related diseases prevented by EPI activities. This involves estimating the number of deaths averted due to the prevention of tetanus, pertussis, measles, and polio, and includes indicators of cumulative number of deaths averted as well as deaths averted by 1997/98 activities (see Section 3.2.3).*
- *Life Years Saved: using the number of deaths prevented, the number of life years saved for the society as a whole are estimated. Since EPI activities usually save a life in early childhood, the years of life saved should be highly correlated with the number of lives saved.*
- *Healthy Life Years Saved: a measure similar to Disability-Adjusted Life Years (DALYs), HeaLYs are a simpler and more flexible composite measure that combines the amount of healthy life lost due to morbidity, including disability, with that attributable to premature mortality.*[7]

[6] All FICs receiving vaccinations before 12 months of age are also in the CFIC category, but not all CFIC cases belong to FICs.

[7] For a more detailed presentation of HeaLYs, see Hyder et. al., "Measuring the Burden of Disease: Health Life Years." American Journal of Public Health, Volume 88, No. 2, February 1998, pp 196–202.

3. Findings

This section presents the major findings of the study. Section 3.1 examines expenditures and costs while Section 3.2 presents the effectiveness estimates and method of calculating these estimates. Cost-effectiveness ratios are presented in Section 3.3 and estimates of future costs are discussed in Section 3.4. Finally, a discussion of options to improve the financing and sustainability of the EPI in Bangladesh is presented in Section 3.5.

3.1 Total Expenditures and Total Costs

As described in Section 2.1, expenditures show the financial outlay of the EPI program in a particular year. To provide an indication of historical expenditure patterns of EPI, expenditures since 1980 are presented.

3.1.1 Historical Patterns of Expenditure: 1980 to 1998

Expenditures on EPI activities started from a very modest level in 1979 and gradually increased to become a major program of the Government of Bangladesh. The data in Table 2 reports the expenditure levels paid through the EPI program by year since 1979/80. (These data do not include government spending for EPI paid through the general revenue budget, which funds regular health activities, including many personnel costs, as discussed below.) The expenditure level of the EPI increased from US $406,000 in 1985/86 to $16.3 million in 1993/94. After 1993/94, the annual expenditure remained around $13 to 14 million, except for 1995/96, when the expenditure level dipped to about $8 million. This dip in expenditures may be due to the fact that the latest phase of the program was not formally approved by the government until November 1996.

From these data, several observations can be highlighted. First, expenditure levels show considerable fluctuation from one year to the next, although the overall trend is in a upwards direction. In 1993/94, expenditures allocated through the EPI program reached their highest level of $16 million. The year-to-year variability could be due to capital expenditures, the irregular procurement of supplies, delays in the disbursement of funds, and so on. Since EPI is a regular time-dependent activity, irregular patterns of expenditure not explained by capital expenses can have a detrimental effect on the program's efficiency and effectiveness.

Table 2: Total Expenditures Paid through the EPI Program in Bangladesh: 1979 to 1997/98

Year	Expenditures		Expenditures (in Lakh Taka) by:		
	in Lakh Taka**	'000 US$***	GOB	Donors	% of Total from GOB
1979 to 85	419.20	1,497.00		Not available	Not available
1985/86	121.20	406.00	0.00	121.20	0.00
1986/87	658.88	2,151.00	0.00	658.88	0.00
1987/88	945.16	3,025.00	15.00	930.16	1.59
1988/89	702.15	2,185.00	64.83	637.32	9.23
1989/90	1,081.52	3,285.00	198.77	882.75	18.38
1990/91	3,359.17	9,404.00	28.48	3,330.69	0.85
1991/92	3,957.13	10,375.00	24.68	3,932.45	0.62
1992/93	3,525.92	9,008.00	28.92	3,497.00	0.82
1993/94	6,511.44	16,279.00	2,559.86	3,951.58	39.31
1994/95	6,185.43	15,463.00	2,756.14	3,429.29	44.56
1995/96	3,373.31	8,261.00	1,377.58	1,995.73	40.84
1996/97	6,790.65	15,433.00	2,490.65	4,300.00	36.68
1997/98*	6,241.33	13,568.00	901.00	5,340.33	14.44
Budgeted 1997/98	6,550.00	14,239.00	1,800.00	4,750.00	27.48

* Annualized on the basis of nine month expenditure data.
** Lakh = 100,000
*** Taka/$ exchange rate used: 1985/86: 29.88; 1986/87: 30.63; 1987/88: 31.24; 1988/89: 32.14; 1989/90: 32.92; 1990/91: 35.72; 1991/92: 38.14; 1992/93: 39.14; 1993/94: 40.00; 1994/95: 40.00; 1995/96: 40.83; 1996/97: 44.00; 1997/98: 46.00 (Source BBS 1996 and recent issues of newspapers).
Source: EPI Office

Second, the GOB contribution to EPI expenditures fluctuates widely from year to year. Initially, the program was almost totally funded by donors. By 1989/90, the GOB share of the total EPI budget increased to 18 percent from zero in 1985–87. During the period 1990 to 1993, the GOB substantially reduced its contribution through the program. In recent years as well, the government's share of funding shows a significant decline (from 45% in 1994/95 to 14% in 1997/98), if one looks only at expenditures allocated directly to the EPI. However, as will be shown in subsequent sections, approximately 38 percent of total EPI costs in 1997/98 was paid by the GOB directly through the government's revenue budget, which funds health personnel, maintenance and construction of fixed health centers, outreach activities and other regular government health activities. If the revenue budget expenditures used for EPI are included, the GOB contribution to the annual costs of EPI activities in 1997/98 increases from 14 percent to approximately 45 percent. This compares to a five-country average (Burkina Faso, Tanzania,

Mauritania, Philippines, and Turkey) of 56.7-percent government share of total EPI costs (Brenzel and Claquin, 1994).[8]

Third, as shown in the above paragraph, contributions of donors and the GOB to total EPI expenditures over the years cannot be compared without carefully examining the proportion they spent through the EPI program. Neither the donors nor the GOB contribute all the EPI-related funding through the program. This is especially true for the GOB as payment of many government employees involved with the EPI has been transferred from the EPI budget to the government's revenue budget. Therefore, the role of the government is underestimated in the EPI budget and the recent decline in the GOB's contribution is likely due to changes in accounting procedures rather than actual changes in the funding level of the government.

Fourth, analysis of the expenditure patterns also indicates the problem of using expenditure levels as an indicator of the cost of running the program. Although EPI activities must be carried out on a regular and continuous basis over the whole year, significant variations in the expenditure levels can be observed, due to the periodic procurement of supplies, initial capital investments, irregular lumpy expenses, irregular fund disbursement, and so on. Thus, an economic analysis should examine the total costs associated with the activities of EPI rather than the expenses incurred in different years.

3.1.2 Current Recurrent and Capital Costs: 1997/98

This section presents total expenditures and total costs for the year 1997/98 for both recurrent and capital items.

3.1.2.1 Recurrent Expenditures and Costs

As described in Section 2.2, recurrent costs for 1997/98 are estimated on the basis of a three-year average of annual expenditures calculated in 1997 prices, using the overall rate of inflation in Bangladesh since 1995. Table 3 shows expenditures paid through the EPI program for recurrent cost items for the years 1995/96 to 1997/98, as well as average expenditures by line item. Data for 1997/98 is for nine months through March 1998; consequently, proportional adjustments were made to convert the nine month expenditures to annual equivalents. Evaluation of the EPI program expenditure data in Table 3 shows that vaccines consume the largest share of recurrent spending at 76.5 percent, followed by supplies (6.6%) and personnel (6.3%).

[8] Note that this five country average is for costs (in 1994 dollars) of a fixed facility strategy, not expenditures, and thus is a loose comparison.

Table 3: Recurrent EPI Expenditures for the Years 1995/96 to 1997/98 (in Lakh Taka)*

	Expenditure Levels in 1997–98 Prices				
Recurrent Cost Items	1995/96	1996/97	1997/98**	Avg. per Year	% of Total
Vaccines	4,001.4	1,762.5	4,600.0	3,454.6	76.5
Personnel	276.6	336.3	243.2	285.4	6.3
Supplies	473.1	284.5	130.5	296.1	6.6
Transportation	51.5	60.1	88.0	66.5	1.5
Op. & Maint.	345.9	270.4	120.8	245.7	5.4
Training	309.1	130.4	60.0	166.5	3.7
TOTAL	5,457.6	2,844.2	5,242.5	4,514.3	100.0
(Inflation factor)	1.114	1.054	1.000		

* Lakh Taka = 100,000 Taka
** Expenditure data for 1997/98 were available for July 1997 to March 1998. The expenditure levels were adjusted to convert the numbers into annual equivalents.

As the basis for generating recurrent cost estimates, the average annual expenditures over the last three years are used from Table 3. For supplies, transport, operations and maintenance and training, the same expenditure values were used for costs. Although this is likely to lead to an underestimate of real costs, it should not be significant. Such is not the case, however, with the vaccine and personnel line items whose costs will be substantially more than expenditures. The methods used for estimating vaccine and personnel costs are described briefly below.

Vaccine needs and costs can be estimated using either a population-based method or a method based on the number of immunization sessions held each month. The population-based method uses projections of the target population, that is, the number of infants and mothers (see Table 4). We have assumed that the vaccine usage rate (the ratio of average number of vaccines acquired by the program in a year to the average number of vaccines actually used) will remain at the level observed during the years 1994 to 1997. To ensure an adequate level of vaccine supply, the target population figures used to calculate vaccine needs are estimated at a higher level (based on the level in 1995/96) than what is expected to be the number of births in 1997/98. In 1997/98, the number of eligible infants should be about 2 percent lower than the number used in Table 4.

Using the current price of vaccines, total vaccine costs were derived for the current year.[9] The total vaccine costs, based on this method, is US$6.5 million for 1997/98.

[9] Prices used: BCG 20-dose vial: $1.10, plus 16 percent freight and handling; DPT 10-dose vial: $0.70 plus 22 percent freight and handling; OPV 10-dose vial: $0.82 plus 16 percent freight and handling; Measles 10-dose vial: $1.15 plus 20 percent freight and handling; TT 10-dose vial: $0.45 plus 30 percent freight and handling. Fifteen percent for loss or breakage was then added to the price of all vaccines.

Table 4: Vaccine Requirements and Costs, 1997–98, Using the Population-Based Method of Estimated Needs

Vaccine Type	Average Vaccine Doses, per year 1994–97		Wastage Ratio (Supplied/Used)	Target Pop. ('000)	Vaccine Doses	Price per Vial** (US$)	Total Cost (US$ '000)
	Supplied	Used*					
BCG	20,166,150	3,309,910	6.093	2,968	18,084,024	1.467	1,327
DPT	15,722,350	9,689,536	1.623	2,968	14,451,192	0.982	1,419
OPV	15,055,363	11,645,802	1.293	2,968	11,512,872	1.094	1,260
Measles	11,941,588	3,200,114	3.732	2,908	10,852,656	1.587	1,722
TT	16,564,763	9,514,124	1.741	3,461***	12,051,202	0.673	811
TOTAL	67,508,626	37,359,486	1.807		66,951,945		6,539

* Vaccines used represents the number of vaccines reported to have been administered by EPI's routine system of reporting vs. those supplied to the field from central stores.
** Ten-dose vials are used for all vaccines, except BCG, which comes in 20-dose vials. Prices include shipping and handling charges, plus 15% for loss and breakage.
*** Number of pregnancies for the year has been estimated by inflating total live births by 1.128, the ratio of pregnancy to live births in Matlab during the years 1995–1996 (ICDDR'B, 1996 and 1998).

The second method of estimating vaccine requirements is based on the number of immunization sessions held in a year. For each session, at least one vial is opened, irrespective of the number of doses used, and is then discarded at the end of the day. If at least one vial of vaccine is used per session, the number of vials needed will be higher than the population-based estimates. To illustrate, if the total number of births (using 1995/96 data), adjusted for neonatal deaths, is divided by the number of sessions held in a month (110,000), the average number of infants per immunization session becomes 2.24. For vaccines that require three doses, and assuming that all children complete the three-dose series, the average number of infants expected per session is 6.72 (2.24 x 3). If the expected number of births in 1997/98 are considered, the average will be about 6.57 infants per session for three-dose vaccines. Given these figures, it is highly unlikely that more than one vial of any vaccine will need to be opened during any one session.[10] Therefore, we can estimated that since the EPI organized 110,000 sessions per month during the current year, the number of vials needed for each of the vaccines should be 110,000 per month.

Allowing for a loss and breakage rate of 15 percent, the total cost of vaccines per year comes to about US $7.7 million ($1.9 million for BCG, $1.3 million for DPT, $1.4 million for OPV, $2.1 million for measles, and $0.9 for TT). The annual vaccine cost estimate used should be the higher of the two estimates (i.e., the $7.7 million estimate based on the number of sessions vs. the $6.5 million population-based estimate). Consequently, for 1997/98, the estimate used for the total cost of vaccines is US$ 7.7 million.

Concerning personnel, costs and expenditures also differ significantly, since the EPI financial statements include only direct program expenditures and exclude the salary and benefits of many other individuals working on EPI activities. For example, at the local level, the Health Assistants and FWAs actually deliver the vaccines to the target population and all of them are paid from the revenue head of the MOH&FW's budget. Identification of all such individuals, as well as the share

[10] Note that all vaccines are procured in 10-dose vials, with the exception of BCG, which comes in 20-dose vials.

of their time spent on immunization activities, was obtained by interviewing EPI officials, and is shown in Annex C.

Excluded from Annex C are personnel involved in the delivery of EPI services in urban areas. The urban immunization program is implemented primarily through a number of NGOs, although vaccines are supplied by the EPI Unit of the MOH&FW. Consequently, it is difficult to estimate operational costs for the delivery of urban immunization services. However, ignoring the personnel costs associated with the urban program will underestimate the total cost of EPI.

To obtain an estimate the personnel costs of the urban EPI, we used data from the 1991 Census, which estimated the proportion of the population living in urban areas to be 17 percent, which increased to about 20 percent by 1995/96. The 1995 crude birth rate (CBR) for rural and urban Bangladesh has been reported as 27.8 and 19.0 per thousand, respectively. If these CBRs are used, the number of births in urban areas is about 17 percent of rural births. For this analysis, 20 percent of the personnel costs estimated at the union and *thana* levels in the rural areas will be considered the personnel costs of the urban immunization program (see Annex D). Using this figure, urban personnel costs at the community level was estimated at about $1.09 million. To examine the sensitivity of this assumption, urban personnel costs were also estimated using the following two arbitrary proportions as well: 14 percent and 25 percent of rural costs. At 14 percent and 25 percent, the urban personnel cost estimates become $761,650 and $1.36 million, respectively. Note that the new assumptions change the grand total of EPI costs by less than 2 percent.

3.1.2.2 Capital Costs

Capital costs include buildings, vehicles, equipment and long-term training. Estimation of these costs is described below. A cost estimate should value the resources used rather than the financial outlays of the program. Therefore, excluded from capital costs are import taxes and value added taxes imposed on imported goods such as vehicles. In addition, all local taxes should be excluded. However, it is difficult to exclude taxes from locally procured items such as fuel and spare parts. The inclusion of these taxes should not create a significant over-estimation of costs for two reasons. First, these are not major items in terms of total EPI costs and second, it was not possible to include a number of cost items which should be included. One example of items excluded is the flow of services, or benefit that the EPI program receives from thana health complexes (THCs). The THCs allocate a room for EPI, and thus, a full costing the EPI should include a share of THC construction costs after appropriately discounting the values. It is possible that these minor cost items cancel out each other without affecting the aggregate cost significantly. Annex D provides details on EPI funding from the GOB revenue budget.

(a) Buildings and Construction

Table 5 shows expenditures on the construction of cold rooms, warehouses and other EPI-related buildings since 1985. To derive these estimates, all the expenditures incurred since 1985 have been considered. For each year, expenditure figures were converted into 1997/98 prices using the construction price indices. Data on expenditures incurred on buildings during the first phase of the EPI program could not be obtained. However, less than two million dollars were spent during the first phase on all EPI activities and so ignoring the capital expenditures during these years

should not affect the results significantly. Assuming the standard 20 year life of a building and a discount rate of 5 percent, the annuity value of buildings and construction in 1997/98 prices becomes 18.539 lakh Taka, or US$ 40,303.

Table 5: Cost of Buildings and Construction, 1985 to 1997

Year	Construction Cost in Lakh Taka*	Construction Cost Price Adjustment		Cost in 1997/98 in Lakh Taka
1985 to 89	10.38	1.678		17.419
1989 to 93	153.69	1.279		196.522
1993/94	0.00	----		0.000
1994/95	9.70	1.182		11.464
1995/96	0.49	1.114		0.546
1996/97	4.75	1.054		5.007
1997/98	0.00	1.000		0.000
TOTAL			Lakh Taka	230.957
Annuity Value: (20 years of life and 5% discount rate)			Lakh Taka	18.539
			US$	40,303

* The exchange rate used is US$1 = 46 Taka; Lakh = 100,000.

(b) Vehicles

To estimate the annualized value of services derived from the use of vehicles, the procedure followed was to list all the vehicles being used by the EPI during May 1998. This information was obtained from the EPI Transport Officer. Prices for each type of vehicle were obtained either from the project proforma or from vehicle dealers in Dhaka. Using the prices and nine years of useful life for each of the vehicles, the total annualized cost of vehicles was obtained. Table 6 lists the vehicles used by the EPI and the total annualized cost.

Table 6: Value of Services Derived from the Use of Vehicles for EPI

Type of Vehicle	Number in Use	Price in Lakh Taka *	Value in Lakh Taka	Life Years	Annuity Value in Lakh Taka
Refrig. Van	3	15	45.00	9	6.331
Pickups	2	7	14.00	9	1.970
Polio-plus Van	1	15	15.00	9	2.110
Pajero jeep	1	22	22.00	9	3.095
Microbus	1	12	12.00	9	1.688
Land Cruiser	2	20	40.00	9	5.627
Pathfinder	1	20	20.00	9	2.814
Prado	1	15	15.00	9	2.110
Jeep	3	15	45.00	9	6.331
Pickup	8	7	56.00	9	7.879
Bicycle	900	.005	45.00	9	6.331
Motorcycle	653	.5	326.50	9	45.935
TOTAL				Lakh Taka	92.221
				US$ (‘000)	$200.5

* The exchange rate used is US$1 = 46 Taka; Lakh = 100,000.

(c) Equipment

The largest share of capital equipment is related to the cold chain. Data on the type and quantity of equipment, as shown in Table 7 were provided by the Cold Chain Engineer’s office. Because only equipment that is currently in use has been considered, excluded are items that have been purchased but are not in use for whatever reason. Consequently, this leads to an underestimate of actual resource costs. All items were valued at the current market prices given in the project proforma. The useful life values were also taken from the project proforma. The discounted annualized value of equipment, using the above quantities and prices, becomes lakhs Taka. 516.19 or US $1,122,144.

Table 7: Cold Chain Equipment Costs

Item	Quality	Price (Taka)*	Value (Lakh Taka)*	Useful Life	Annuity Value (Lakh Taka)
Refrigerators	3, 434	46,000	1,579.64	8	244.41
Cold Boxes	2,200	14,538	319.84	8	4.95
Carriers	102,000	773	788.26	4	222.29
TOTAL				Lakh Taka	516.19
				$US	1,122,144

* The exchange rate used is US$1 = 46 Taka; Lakh = 100,000.

(d) Training Cost

Training that falls under capital costs consists of long-term training that is non-recurring. The cost of this item was identified through discussions with the EPI accounting office. Assuming that the effect of training will last for eight years, the annual flow of training benefits was estimated. Although the benefits derived from long-term training should last a long period of time, the benefits to EPI will be relatively shorter, since the trained personnel may be transferred to another department of the government or they may decide to leave public service due to low job satisfaction, low pay or a variety of other reasons. The annualized cost of long-term training for EPI was estimated at approximately US $15,180.

3.1.3 Total Cost of EPI

Using the estimates of recurrent and capital costs reported above, the total cost of EPI has been estimated. Table 8 lists all the major cost items related to the delivery of EPI services in Bangladesh during the year 1997/98.

Table 8: Estimated Annual Total Cost of EPI, 1997/98

Capital Items	$US (in '000)	% of Total
Buildings	40.30	0.22
Vehicles	200.50	1.09
Equipment	1,122.14	6.12
Training	15.18	0.08
Subtotal	1,378.13	7.51
Recurrent Items		
Vaccines	7,700.00	41.98
Personnel	7,577.82	41.32
Supplies	643.70	3.51
Transport	144.57	0.79
Maintenance	534.13	2.91
Training	361.96	1.97
Subtotal	17,696.66	92.49
GRAND TOTAL	18,340.29	100.00

From the data shown in Table 8, it can be seen that the EPI activities cost about $18 million in 1997/98 prices. With recurrent costs accounting for over 92 percent of total costs, it becomes clear that EPI activities are intensive in recurrent types of resources, such as personnel and consumables rather than durable items. Among recurrent costs, vaccine costs consume the largest share of total costs at nearly $7.7 million (42%), followed by personnel at $7.58 million (41.3%). The third largest cost item is equipment at $1.12 million (6% of total), indicating that cold chain equipment is an important component in the delivery of EPI services. By way of comparison, a

1994 study of four countries (Tanzania, Mauritania, Philippines and Turkey) found that, using a fixed facility strategy, salaries and wages consumed 36 percent of immunization costs while vaccines accounted for 15 percent of total costs in 1992 dollars (Brenzel and Claquin, 1994). The comparative figure for vaccine costs support the assertion that vaccine usage rates are low in Bangladesh (i.e., wastage rates are high), and that this is an area where considerable cost savings can be generated.

Note should be made also of the differences between total costs and total expenditures. Over the last three years, total expenditures averaged approximately $15 million (see Table 2). Total costs, on the other hand, were approximately $18 million per year.

3.2 Effectiveness Indicators

3.2.1 Immunizations Administered

There are three means of estimating the number of immunizations administered through the Bangladesh EPI, as described in Section 2.3.3. The number of doses given, as shown in Table 4 and as reported by the EPI's routine reporting system, averaged 37.4 million during the last three years. This compares with 67.51 million doses supplied to the field by central stores, resulting in an overall usage ratio of 1.807 (doses supplied divided by doses used).

The other two measures of the number of vaccines administered—the number of children under one year who are FIC and the CFIC—are based on the CES. Based on the current coverage rates of immunizations given within the first 12 months FIC, the total number of doses of BCG, DPT, OPV and measles vaccines expected to be administered during 1997/98 will approximate 17.7 million. Allowing two additional immunizations for TT per pregnancy, the total number of doses given using the effective coverage rate should approximate 24.6. Using the crude coverage rate for each of the vaccines used, the number of doses given becomes 26.2 million. Annex E shows the calculations to derive the number of doses given by effective and crude coverage rates.

3.2.2 Number of Fully Immunized Children

The 1998 CES reported that 54 percent of eligible children were fully immunized by 12 months of age. Using this coverage rate, the number of fully immunized children in Bangladesh during 1998 should be 1.56 million.

The crude rate of Fully Immunized Children in Bangladesh was reported at 69.8 percent by the 1998 CES. Using this rate, the number of CFICs approximates 2.02 million for 1998.

3.2.3 Cumulative Number of Deaths Averted Since 1987

One important measure of the effectiveness of EPI activities is the number of deaths prevented over the years. In this section, estimates are made of the number of deaths prevented by

immunizations since 1987, when the immunization coverage rate improved to more than 5 percent of children.

Using the population estimates from the 1981 and 1991 censuses and the CBR and CDR reported by the BBS, the total number of births was estimated for each of the years since 1981. Assuming that about 50 percent of infant deaths occur within the first month of life, the total number of children alive at one month of age was calculated. The number of children alive at nine months of age was also estimated by assuming that 75 percent of all infant deaths occur within nine months.

For tetanus, it is assumed that the death rate would have been 40 per thousand live births if mothers were not immunized with TT. This rate is derived by examining the neonatal tetanus death rate in Matlab before the introduction of TT immunization. The death rate reported in Matlab was more than 50 per thousand live births prior to TT immunizations. Since the health care delivery system has improved over the last 15 years, neonatal tetanus deaths should have declined as a result of improved delivery practices. Allowing for the effect of better maternity care, the death rate without TT probably would have remained at around 40 per thousand. With the coverage of TT at the 90 percent level, the death rate has declined to six per thousand live births, implying that 34 deaths per thousand live births are being prevented by TT vaccinations. To be conservative in estimating the number of deaths prevented, the calculation assumes that the effectiveness of TT is 80 percent. Using the coverage rate of TT since 1987, the total number of infant deaths that have been prevented in the last ten years is estimated at approximately 769,000. In addition, TT vaccinations also saved the lives of an estimated 12,000 mothers during this period by preventing tetanus-related maternal mortality.

For pertussis, the prevalence rates and death rates reported by the EPI office are used. However, it is assumed that pertussis deaths are distributed over five years of life. Identifying the age distribution of deaths provides a better estimate of the number of deaths prevented in a particular year. Without immunization, approximately 50 percent of pertussis deaths will occur within the first year of life, another 20 percent during the second year of life and 10 percent in each of the subsequent years. From 1987 to 1998, the number of pertussis deaths prevented is estimated at approximately 151,000.

Measles cases also occur among the young age groups, usually within the first six years of life. The approximate age distribution of measles deaths was derived from the measles prevalence rates reported by the EPI (GOB, 1997). The year-specific deaths prevented due to immunizations indicate that the total number of deaths prevented from measles since 1987 was 207,000.

Polio deaths averted were also estimated assuming the parameters used by the EPI in their calculations. The number of polio deaths prevented from 1987 to 1998 was about 10,000.

Summing the number of deaths prevented for these vaccine-preventable deaths indicates that EPI activities in Bangladesh have prevented more than 1.15 million deaths since the program's inception in 1987. The tables in Annex F show the detailed calculations for estimating the number of deaths averted due to tetanus, pertussis, measles and polio immunizations.

3.2.4 Number of Deaths Averted by 1997/98 EPI Activities

The estimated number of deaths averted by 1997/98 EPI activities is needed to carry out a cost-effectiveness analysis of the EPI. The estimated number of deaths in this case will be different from the number of deaths calculated for the lifetime of the program. In cost-effectiveness analysis, the deaths averted in the future will be considered as a benefit of 1997/98 after appropriately discounting the benefits. For discounting the benefits, a discount rate of 5 percent is used, the same rate that is used for discounting costs.

Table 9 shows the discounted number of deaths averted by the activities of the EPI in 1997/98. Note that for tetanus and polio, no discounting was used. It is implicitly assumed that the deaths from tetanus occur within the first year of life. Although deaths from polio do not occur during the first year, the number of deaths is sufficiently low (about 1,000) that no attempt was made to distribute the deaths among the different age groups. If the discounted deaths prevented for all these four diseases are added together, the total number of discounted deaths averted for 1997/98 becomes 134,000. Note that more than 70 percent of the deaths averted are due to tetanus immunization (TT and DPT).

Table 9: Estimates of the Discounted Number of Deaths Prevented by EPI Activities in 1997/98

	Number of Deaths (in 000s) in Year:						
Illness/Disease Type	One	Two	Three	Four	Five	Six	Discounted Deaths ('000)
Tetanus	96						96
Pertussis	7.9	3.1	1.6	1.6	1.6		15
Measles	4.1	6.3	6.3	5.0	1.8	0.5	22
Polio	1.0						1.0
TOTAL							134

3.2.5 Number of Life Years Saved

From the estimate of the number of deaths prevented by EPI activities, the number of life years saved can also be calculated. Assuming that the life expectancy at age one is 60 years, preventing a death at age one will save 60 years of life. Discounting the 60 years of life at a 5 percent rate, the total number of life years saved for tetanus becomes 1,908,000 years (96,000 deaths averted x 19.876 discounted years). Similarly, for polio, the number of life years saved becomes 20,000. The last column of Table 9 has already converted all future deaths into 1997/98 terms. Therefore, the total number of life years saved by 1997/98 activities can be calculated by multiplying the 134,000 deaths averted by 19.876 discounted life years saved per death (equivalent to 60 years of life at a 5% discount rate). As shown in Table 10, the total number of years of life saved by EPI activities in 1997/98 becomes approximately 2,663,000.

3.2.6 Number of Healthy Life Years Saved

Healthy life years saved takes into account the morbidity and disability prevented by EPI preventable illnesses. The morbid days associated with EPI diseases were used to estimate the total number of healthy life years saved. For polio, the long-term disability was also considered.

The following assumptions, based on expert opinions (subjective evaluation by physicians knowledgeable about childhood diseases), were used to estimate the number of healthy life years lost due to morbidity and disability. The acute stage of tetanus, pertussis and measles are considered to last about seven days, one month and seven days, respectively. These diseases are also given the weights 0.8, 0.6 and 0.5, respectively, corresponding to the degree of severity of morbidity that is assumed for each condition. That is, the severity of the acute condition for neonatal tetanus is such that it represents a loss of 80 percent of healthy life days; the acute stage of measles is not as serious and has a loss of 50 percent of healthy days. For polio, however, healthy life years lost is defined in terms of disability rather than the loss related to the acute condition of the disease. The disability associated with polio is considered quite severe with a weight of 0.7 (i.e., 70% loss of healthy life years).

Table 10 shows the estimated number of healthy life years saved by EPI. In the table, only polio morbidity lasts more than a year and so the duration of illness must be discounted. The discounted year equivalent of 45 years of disability is about 18.66 years. Since there are an estimated 8,000 new cases of polio morbidity per year, the number of life years saved by preventing polio morbidity should be 8,000 cases times the discounted years lost (18.66), multiplied by the severity weight of 0.7. This comes to 104,500 healthy life years saved by polio immunization. The total number of healthy life years saved through the EPI activities of 1997/98 is estimated at 2,797,000. Note again that tetanus immunization accounts for more than two-thirds of all the health life years saved from EPI.

Table 10: Estimated Number of Life Years and Healthy Life Years Saved by EPI Activities in 1997/98*

Disease	Years Saved from Death ('000)	Number of Cases ('000)	Duration of Condition (in Years)	Life Years Saved from Morbidity & Disability ('000)	Total Healthy Life Years Saved
Tetanus	1,908.00	96	0.0192	1.47	1,909
Pertussis	298.14	15	0.0833	0.75	299
Measles	437.27	2,894	0.0192	27.78	465
Polio*	19.87	8	45.00 (discounted year equivalent = 18.66)	104.50	124
TOTAL	2,663.28			134.50	2,797

* Polio cases are calculated as a multiple of the number of polio deaths. It is also assumed that all children will get measles in Bangladesh if not immunized. Tetanus and pertussis cases are considered identical with the number of deaths. This actually underestimates the years of life lost due to morbidity.

3.3 Cost-Effectiveness of EPI

Table 11 presents the effectiveness measures and cost-effectiveness ratios for EPI activities carried out during the year 1997/98. The cost per dose of effective immunization (all vaccines given within one year of age) is relatively low, at an estimated US$0.75. If all immunizations are considered, irrespective of age at immunization, the cost per dose decreases to $0.70. Depending upon the proportions used to estimate urban personnel costs, as discussed in Section 3.1.2.1 above, the cost per dose varies between $0.69 and 0.71. The cost per FIC is also relatively low (about $11.76) compared to the cost per FIC in comparable low-income countries, which averaged $13 per FIC (in 1987 dollars) and which ranged from $7 to $19 (REACH, 1990). A sensitivity analysis in which 14 percent and 25 percent of rural personnel costs are assumed to be the cost of urban personnel, results in a range of $11.58 to $11.96 per FIC.

Table 11: Cost-Effectiveness Ratios for EPI Activities in Bangladesh During 1997/98

Effectiveness Measure	Effectiveness	Cost-Effectiveness Ratio*
Number of immunizations given:		
By administrative reporting	37.4 million	$0.49 per dose
By survey: immunizations within 12 months of age	24.6 million	$0.75 per dose
By survey: crude number of immunizations	26.2 million	$0.70 per dose (0.69 to 0.71)
Number of Fully Immunized Children:		
FICs	1.56 million	$11.76 per FIC ($11.58 to 11.96)
Crude FICs	2.02 million	$ 9.08 per CFIC ($8.94 to 9.23)
Number of deaths averted	134,000	$136 per death averted ($134 to 138)
Number of life years saved	2.663 million	$ 6.89 per life year saved ($6.79 to 7.01)
Number of healthy life years saved	2.797 million	$ 6.56 per healthy life year saved ($6.46 to 6.67)

* The costs in parentheses represent cost-effectiveness when urban personnel costs are assumed to be 14% and 25% of rural personnel costs respectively.

The cost per death averted and cost per life year saved is also relatively low in Bangladesh. The cost per death averted through EPI approximates US$136, and thus, in purely economic terms, the benefits of saving lives through immunizations will be at least 10 to 12 times the cost of preventing a death. The cost life year saved is found to be around $7 and the cost per healthy life year is about $6.50.

While not strictly comparable, some examples of cost-effectiveness ratios from other low-income countries are of interest. The World Bank and others estimate that the cost per FIC ranges from $15–$17 and the cost per healthy life-year saved to be $12–$17 (World Bank, 1993). Further, the alternative to not immunizing a child is to treat the sick child, which bears a

substantially greater cost. The World Bank estimates that the cost of managing a sick child is $30–$50 per disability adjusted life-year saved. Consequently, one of the best ways to generate savings in the entire health sector is to reduce the needs in the highly visible curative sector by reducing its demand—precisely what a strong immunization program does.

3.4 Projected Cost of EPI Activities: 1997/98 to 2002/2003

The data in Table 2 of Section 3.1.1 show that funding for EPI activities has fluctuated rather significantly since 1985. This is probably one of the factors contributing towards gaps in the delivery of immunization services. Given the current level of immunization coverage of around 54 percent of children under one year fully immunized and the plateauing of coverage rates over the last three years, it has become important to have EPI funding assured in order to sustain and improve coverage rates so that the benefits of EPI are maximized in future years. The purpose of this section is to provide some indication of projected costs over the next five years so that planning and budgeting processes can be enhanced.

Because vaccines and personnel consume the largest share of the budget, emphasis is placed on costing these two line items.

3.4.1 Vaccine Cost Estimates

To estimate the future costs of vaccinations, the first step is to estimate the number of vaccines needed if all children are immunized. The calculations assume a 15-percent loss and breakage rate as was used previously. Although the crude birth rate is declining rapidly in Bangladesh, a linear declining trend of the CBR is used, and the CDR is assumed to remain constant at 8.5 per 1,000 population. From this, vaccine needs were projected. Table 12 presents the number of vials needed of different types of vaccines if all children are immunized. The estimates in Table 12 do not take into account the vaccine usage rate or the wastage rate, which depends on the delivery system adopted.

Table 12: Estimating Vaccine Requirements based on Population Projections: 1997/98 to 2002/03

Year	CBR	No. of	No. Alive	Vials Needed to Immunize All Children (in mil.)*				
	(/1,000 pop.)	('000)	@1 mo.	BCG	DPT	OPV	Measles	TT
1997/98	23.6	2,991	2,894	0.166	0.998	0.998	0.166	0.688
1998/99	23.0	2,959	2,863	0.165	0.988	0.988	0.165	0.681
1999/00	22.5	2,936	2,841	0.163	0.980	0.980	0.163	0.675
2000/01	22.1	2,925	2,830	0.163	0.976	0.976	0.163	0.673
2001/02	21.8	2,924	2,829	0.163	0.976	0.976	0.163	0.673
2002/03	21.6	2,936	2,841	0.164	0.980	0.980	0.164	0.675

* Ten-dose vials for all vaccines, except BCG, which comes in 20-dose vials.

The actual amount of vaccines required will depend on the number of sessions organized per year for the delivery of immunizations. Each session uses at least one vial of BCG, DPT, OPV,

measles and TT. The vaccine requirements will be either the requirements shown in Table 12 or the number of vials needed to provide vaccinations in all the sessions organized, whichever is larger.

Table 13 shows an estimate of the number of vials needed when the number of sessions per month varies from 110,000 to 22,000. Currently, vaccinations are delivered through 110,000 sessions per month. A proposal to reduce the number of sessions to 55,000 per month is also being considered. A third option is to deliver immunization through union-level fixed sites, each site operating five days a week, making the total number of sessions organized in a month to be about 22,000. The number of vials needed for DPT and OPV remains constant irrespective of the number of sessions organized in a month. This is because the number of children to be immunized with DPT and OPV is, on average, about eight per session when the number of sessions per month is 110,000. If the number of sessions is cut in half, the average number of children to be immunized per session increases to about 16 and each session will need to open two 10-dose vials rather than one. In making these estimates, it is implicitly assumed that coverage rates will remain unchanged with the reduction in the number of monthly outreach sessions.

Table 13: Estimating Vaccine Requirements based on the Number of Monthly Immunization Sessions

Number of Sessions per Month	Number of Vials of Vaccines Needed (in Millions of Vials)*				
	BCG	DPT	OPV	Measles	TT
110,000	1.518	1.518	1.518	1.518	1.518
55,000	0.759	1.518	1.518	0.759	0.759
22,000	0.304	1.518	1.518	0.303	0.660

* Assumes 15% loss and breakage. Ten-dose vials for all vaccines, except BCG, which comes in 20-dose vials.

Comparing the requirements estimated in Table 13 with those of Table 12, it is clear that the requirements for all years for all vaccines other than TT will be defined by the figures in Table 13, since they are larger. For TT, if there are 22,000 monthly sessions, the requirements in Table 12 exceed the requirements shown in Table 13 (.688 million vs. .660 million). Thus, when the number of sessions are 22,000 per month, the number of vials required for TT will be 688,000 vials.

Given the estimate of vaccine requirements and the price of vaccines, the cost of vaccines becomes $7.7 million in 1997/98 for 110,000 sessions (as discussed in Section 3.1.2.1), $5.9 million for 55,000 monthly sessions and $4.4 million for 22,000 monthly sessions.[11] Allowing for a 5-percent increase in the prices of vaccines each year, the total cost of vaccines for the years 1998/99 to 2002/03 should be $44.7 million if 110,000 sessions are organized per month, $34.7 million if there are 55,000 monthly sessions, and $25.4 million if the number of sessions is further reduced to 22,000 per month.

[11] Current prices used: $1.10 for BCG with 16 percent transport and handling; $0.70 for DPT plus 22 percent transport and handling; $0.82 plus 16 percent for OPV; $1.15 plus 20 percent for measles; $0.45 plus 30 percent for TT. Fifteen percent for loss and breakage were added to these prices.

3.4.2 Personnel and Other Costs

Personnel costs, currently the second largest cost item, are expected to rise substantially over the next two years, especially because of an increase in the salaries of government officials (20% in 1998/99 and an additional 20% during 1999/2000). After these initial two years of salary adjustments, it is assumed that salaries will increase at the rate of 5 percent per year. Total personnel costs are estimated to be about $56.13 million over the next five years if 110,000 sessions are organized. Lowering the number of sessions will not reduce personnel costs proportionately, since health workers will have to work longer hours to cover more children per session. It is assumed that personnel costs will decline by 20 percent when the number of sessions is reduced from 110,000 to 55,000. When the number of sessions is reduced to 22,000 per month, personnel costs will decline by an estimated 40 percent.

The capital costs presented in Table 8 can be used to project total capital costs over the next five years. In 1997/98, approximately $1.4 million was needed to buy capital equipment. Again, using a 5-percent rate of inflation, the capital costs during the next five years should be around $8.12 million.

Using the estimates of other recurrent costs reported in Table 8 and allowing 5 percent for inflation, other costs over 1998/99 to 2002/03 should approximate $9.8 million.

3.4.3 Additional Social Mobilization Costs Required to Increase Immunization Coverage Rates

The estimated current coverage rates are 54 percent of children fully immunized by age one (FIC) and around 70 percent of all children immunized, regardless of age (crude coverage rate or CFIC). The goal of the Bangladesh EPI is to reach a 90-percent coverage rate by the year 2000. It is not clear from the project documents if the goal of 90-percent coverage means full immunization by age one or the crude coverage rate. We assume that the project intends to cover 90 percent of infants using CFIC as the definition of coverage. This section estimates the additional cost of increasing coverage—primarily through social mobilization. These projections for the period 1998/99 to 2002/03 are summarized below in Table 14.

It is unrealistic to assume that the coverage of EPI will remain constant with the reduction in the number of sessions carried out. One of the reasons for the low utilization of immunization services at *thana* health complexes is the distance of the THCs from patient's homes. In most THCs, more than 75 percent of all patients come from within a two-kilometer radius. With 110,000 outreach sessions organized per month, the average distance of households from a delivery point is less than 0.6 km. If the number of monthly sessions is reduced to 55,000, this average distance increases to about one kilometer. A further reduction in the number of sessions to 22,000 per month from about 4,500 fixed centers (union-level health centers) will increase the average distance of households to delivery points to more than three kilometers. With the increase in the distance from the household to immunization delivery points, it is likely that the current coverage rates will decline unless more rigorous social mobilization is carried out.

For the purpose of deriving an estimate of the costs of maintaining or increasing coverage, it is assumed that the reduction in the number of sessions will reduce the coverage rate (in terms of crude FIC) from the current 70 percent to around 50 percent. Therefore, even to maintain the current coverage rates, the program needs to allocate more resources for social mobilization, health education and communication activities.

The additional resources needed to increase immunization coverage rates can be approximated using average cost data reported in a study conducted by the NGO, Bangladesh Rural Advance Committee (BRAC) (Chowdhury, 1990). During 1987/88, BRAC and CARE assisted the GOB to deliver EPI services in more than 200 *thanas* of the country. The involvement of these NGOs improved the coverage of EPI activities. (It appears from the BRAC report that the coverage in BRAC and CARE-assisted areas were defined by crude FIC rates.) The study found that the average additional cost of increasing CFIC by one more unit (over and above the number covered by the GOB program) was approximately Tk. 347. In 1997/98 prices, this level of expenditure is equivalent to about Tk. 540 or about US $11.74. The additional resources needed today should be lower than what was needed ten years ago. At that time, EPI was virtually new to the majority of the population in Bangladesh, and any new activity at the initial stage needs very intensive social mobilization. Currently, most mothers are aware of the immunization program and the benefits of immunization, and thus the resources needed for health education and communication should be lower. Therefore, we assume that the cost per additional CFIC today will be half of what the NGOs had to spend in 1987/88, making the cost per crude FIC $5.87.[12]

To maintain the current crude immunization coverage rate after the reduction in the number of EPI sessions (which would, in theory, lower coverage to 50%), the program will have to bring in an additional 579,000 children to be immunized. This alone will cost an additional $3.4 million per year. If the program intends to reach the target of 90-percent coverage, an additional $3.4 million will be needed for social mobilization, communication and health education activities, for a total of about $6.8 million.

We therefore estimate that, with a 50-percent reduction in the number of sessions (from 110,000 to 55,000 per month), and assuming the coverage of crude FIC declines from 70 % to 50%, the program should allocate an additional $19.73 million for social mobilization over the next five years ($3.4 million x five, plus inflation) just to maintain current coverage rates (see Table 14). In order to achieve 90-percent coverage via 55,000 sessions, the additional resources needed over the next five years will be about $39 million ($19.73 million to maintain the 70% coverage rate and another $19.73 million to increase coverage to 90%).

If the number of sessions is further reduced to 22,000 per month via 4,500 fixed union-level health centers, coverage rates will likely decline further and more resources—an estimated $29.6 million—will be needed just to maintain the current level of coverage. Increasing coverage to 90 percent via 22,000 monthly sessions will require an estimated additional $19.73 million, for a total of approximately $49 million additional funds required.

[12] It should be pointed out that information on the costs of social mobilization for preventive health activities is very scarce in Bangladesh. Here, we have used the results of one study which may not be an accurate measure of actual costs of mobilization. In addition, the marginal cost of social mobilization should increase with increasing coverage, but due to the lack of data on marginal costs, we have used the average cost per CFIC to predict the additional cost at any level of coverage.

Table 14: Summary of Projected EPI Costs (in US$) for the Years 1998/99 to 2002/03

Cost Items	Number of Sessions Organized per Month		
	110,000 Sessions	55,000 Sessions	22,000 Sessions
Capital	$ 8.12 million	$ 8.12 million	$ 8.12 million
Recurrent:			
Vaccines	$44.67 million	$34.65 million	$25.44 million
Personnel	$56.13 million	$44.90 million	$33.68 million
Other	$ 9.80 million	$ 9.80 million	$ 9.80 million
Subtotal	$118.72 million	$97.47 million	$74.04 million
Crude coverage rate	70%	50%	40%
Additional social mobilization costs to maintain 70% coverage (CFIC)	$ 0.00	$19.73 million	$29.60 million
Additional social mobilization costs to increase coverage from 70% to 90% (CFIC)	$19.73 million	$19.73 million	$19.73 million
TOTAL COST (with 70% crude coverage)	$119 million	$117 million	$107 million
TOTAL COST (with 90% crude coverage)	$139 million	$137 million	$127 million

Adding these costs, the resources needed for EPI over the next five years are estimated to be between $107 and $119 to maintain current coverage rates and between $127 million and $139 million to increase coverage, depending on the number of immunization sessions organized. As discussed in Section 3.1.3, the program is currently costing an estimated $18.34 million per year. At the current spending level, the cost over the next five years, with inflation, will be approximately $92 million. Therefore, additional funds required to increase coverage during this period will therefore be between $35 million and $47 million.

3.5 Options for Improving the Financing and Sustainability of the Bangladesh EPI

As discussed above, during 1997/98 the total cost of the EPI is expected to be approximately US$18.34 million. The Government of Bangladesh provides around $8.3 million, both directly through the program and indirectly through the payment of salaries and benefits of personnel involved in the delivery of EPI activities. The government's share of total EPI costs is therefore around 45 percent, with donors funding the remaining 55 percent. Thus, at the current level of costs, the gap between the resources needed for EPI and available domestic resources is approximately $10 million. To maintain the current levels of immunization coverage, the *minimum* resource requirements over the years 1998/99 to 2002/03 will approximate $107 million, as shown in Table 14 above. Assuming that the GOB will continue its level of funding of EPI in relative terms, the resource gap over these five years will be close to $70 million. If the EPI wants to

achieve the goal of increasing coverage to 90 percent by the year 2003, the resource gap will increase by $35 to $47 million, for a total of $105 to $117 million.

The analysis thus far has shown a substantial gap between immunization resource needs and resources available to meet the needs. Can the government mobilize additional resources to support EPI activities in the future? Generally, there are two options available for reducing the gap: a) increasing revenues through economic growth, reallocation of resources from within Bangladesh, or from external sources, and b) reducing costs by paying lower prices for goods and services purchased, or by reducing inefficiencies through improved management. Alternatives within both of these options need to be considered. Each of these areas are briefly discussed below, beginning with the option of increasing revenues.

3.5.1 Increasing Revenues

In 1997/98, the cost of the EPI as a percentage of GDP of Bangladesh will be approximately 0.06 percent. This compares with an average for thirteen Asian countries of 0.05 percent and 0.10 percent for 28 African countries in 1987 dollars (REACH, 1990). However, the revenue effort of the GOB is also quite low, and as a percentage of GOB domestic resources ($3.7 billion), the EPI activities costs about 0.5 percent. The Ministry of Health and Family Welfare budget in 1997/98 is $448 million, with about $290 million budgeted for health services, including preventive care. The remainder, $158 million, is for family planning services. Since the personnel paid through the family planning section are also involved with the EPI, and if we assume that one-half of the total family planning budget is for personnel, we can consider approximately $370 million ($290 million plus one-half of $158 million or around $80 million) to be the relevant portion of the Ministry's budget within which to assess sustainability options.

In the current fiscal year, the EPI costs about 5 percent of the MOH&FW budget, excluding the expenditures on family planning supplies and services. This compares with an average of 6.19 percent for thirteen Asian countries and 11.6 percent for 28 African countries in 1987 dollars (REACH, 1990).[13]

The MOH&FW's budget is likely to increase in the future, but probably only at a rate of growth of less than 5 percent. Even if the budget grows by 5 percent from the current level, the total budget relevant to EPI (including a portion of the family planning budget) for the period 1998/99 to 2002/03 should be about $2,146 million. Over the next five years, the Ministry will need to allocate 6 percent of its budget to EPI to allow the immunization coverage rate to increase to 90 percent. At the present time, the MOH&FW is allocating only about 2.2 percent of its budget, directly or indirectly to the EPI, with donors covering the remaining costs. Therefore, increasing the government allocation for EPI to 5 or 6 percent within the next five years is unlikely to occur.

[13] The Asian and African figures are immunization expenditures as a percentage of total health expenditures and consequently are not exactly comparable.

3.5.2 Reducing Costs

The EPI Review team identified during their field visits a number of areas of waste and inefficiency—for example, quantities of cold chain equipment such as refrigerators lying idle in a storage area because they needed repairs—which are documented in the main EPI Review Report. Reducing this waste and inefficiency could generate some cost savings.

In addition, and from a donor perspective, Bangladesh is no exception to the world-wide decline in donor support for immunization activities. Concurrent with this decline has been increasing interest among countries to decrease their dependence on donors to finance their vaccines. World-wide, three main mechanisms have been established to assist countries to assume greater financial responsibility: a) the Vaccine Revolving Fund established by the Pan American Health Organization, b) the VII set up by UNICEF, WHO, and other organizations, and c) the European Union Initiative established in eight countries in West Africa. Of these, the VII is of particular relevance to Bangladesh, especially since it already has experience with this program.

3.5.2.1 Vaccine Independence Initiative

The basic features of the VII include a revolving fund which serves as a line of credit against which the GOB purchases vaccines through UNICEF. The GOB reimburses UNICEF in taka which UNICEF then uses for a share of its expenses in Bangladesh. There is a ceiling on the value of the VII which is partly determined by UNICEF's local absorptive capacity. Typically, VII agreements call for each country to increase its share of the financing each year until self-reliance in vaccine supply is reached. Scarce foreign exchange earnings are therefore saved and reallocated.

A close review of the VII agreement between the GOB and UNICEF may find areas which can be strengthened in order to move towards greater sustainability of the vaccine supply. Examining the VII and other alternatives could also be part of the case study on immunization financing discussed below in Section 3.5.2.3, should Bangladesh be chosen for the study.

3.5.2.2 Closer Linkages with NGOs and the Private Sector

Partly because of the absence of rigorous performance incentives in the public sector, it has been suggested that achieving full immunization coverage in a government-managed immunization program may be difficult. Furthermore, the need to strengthen different aspects of the management of the EPI program was a consistent finding of the EPI review team during the field visits.

As a means of dealing with the limitations of government-provided services, contracting out the management of selected aspects of health services to non-governmental organizations (NGOs), communities or the private sector is increasingly being done in several countries. Under such an arrangement with NGOs, the government and/or donors continue to finance or subsidize the service and the government continues to own the assets. However, the program is managed by the NGO, (which is selected through a competitive bidding process), according to the terms of a contract worked out between the government and the NGO. For a variety of reasons—such as stronger performance incentives for both the NGO and its staff, and the ability to hire and fire

personnel as necessary—NGOs are often able to achieve lower costs through greater efficiencies and with higher coverage rates. There are a number of ways to achieve higher coverage rates, but key to this are the built-in performance incentives for staff and the fact that the NGO typically is well known and trusted in the community. The NGOs BRAC and CARE, among others in Bangladesh, have rich experiences in community development and have provided assistance to the EPI in the past.

While there are many possible configurations and many details to work out under such arrangements, they should be seen as opportunities to identify and test alternative methods of reducing infant and child mortality in more cost-effective ways. Pilot testing with different NGOs using different methods in different regions of the country, and with regular comprehensive performance reviews, could be an important means of achieving this. The upcoming World Bank-supported Health and Population Sector Program (HPSP) is not only supportive of such initiatives, but actually includes them in the program design. In addition, an agreement is apparently in its final stages for an Asian Development Bank (ADB) soft loan of $70 million to test out such alternative financing arrangements in several city corporations and municipalities.

3.5.2.3 Other Ways to Enhance Sustainability

There are several other methods available to finance priority health services and enhance sustainability which have been identified in discussions with various officials and which are being implemented in other countries. Without further comment, three are simply identified: a) as part of a larger health system, the use of pre-payment and insurance mechanisms as well as user fees, b) cross-subsidies from higher priced curative services, and c) enhancing local capacity for the production of vaccines. In addition, the EPI program may also encourage communities to get involved directly in social mobilization and health education activities. This should reduce the cost of EPI from the program's point of view. Social mobilization at the community level conducted by community-based organizations or local leaders should cost relatively little compared to the costs of these activities if carried out by the government or other organizations.

3.5.3 Client Ability and Willingness to Pay for Immunization Services

In many countries around the world, user fees and other cost sharing mechanisms increasingly are being used as a means to enhance the sustainability of the health care system. Should cost sharing mechanisms through the introduction of immunization-specific user fees be seriously examined in Bangladesh, an important question to address is whether households will be willing and able to pay for the EPI services, and if so, what are the opportunity costs. The total cost of the EPI in 1997/98 is equivalent to more than 4 percent of total household expenditures on allopathic medicine. If we take total household health expenditures, the proportion remains more than 2 percent. Preventive health activities usually have a low market demand with high price elasticity. In such a situation, the willingness to pay for preventive services may be sufficiently low that it makes the introduction of user fees difficult. It is unlikely that households will accept immunization services if it requires allocation of more than 1 percent of their health care budget. Partial cost recovery through specific user fees for immunization is theoretically feasible but may not be desirable, if it means a loss of beneficial externalities through reduced utilization and given that the objective is to improve the immunization coverage rate from less than 70 percent (or 54% if coverage is defined by FICs within 12 months of age) to more than 90 percent.

Empirical evidence on immunization-specific user fees is sparse but several general sources to consult include: Levin et. al. (1997), Yazbeck and Leighton (1996), a series of articles in the *International Journal of Health Planning and Management* (1997), Bennett et. al. (1997) and Waters (1995). The Levin et. al. study in Bangladesh, for example showed a willingness to pay for EPI services ranging from 93 percent in Rajghat Union to 71 percent in Dhum Union. The study broke down willingness to pay by income group, but did not find significant differences. Studies that examine the range of complex questions surrounding user fees would clearly be useful and are encouraged.

4. Comments on the Health and Population Sector Program

At the time of the EPI review, the GOB is finalizing agreements with the World Bank for the HAPP-5 for 1998 to 2003—now called the HPSP—at an estimated cost of US$3.5 billion. What are the implications of this program for financing EPI?

Since the plan is not yet publicly available, our comments are derived from discussions with various officials, as well as from a review of existing documentation. Further, to capture accurately all the complexities of the plan, as it relates to EPI, in a short space is not possible. Nevertheless, several of the key components of the plan are identified to provide a context for how the reforms may affect EPI activities.

The plan evolves around a set of policy and institutional reforms. The policy reforms focus on the "client-centered delivery of an ESP [that is designed to] benefit vulnerable groups", including women, children and the poor. Included in this package are reproductive and child health services, communicable disease control, and limited curative care. These interventions have been selected on the basis of their contribution to reducing the burden of disease in the most cost-effective manner. Additional policy reforms include cost recovery and an enhanced role for NGOs and the private sector. EPI activities fall under the child health component.

Institutional reforms include integration of the directorates of health services and family welfare divisions of the Ministry with a particular focus on integrated service delivery under a single line of command from the *thana* level down. Decentralization of decision-making that includes managerial and financial authority is also intended, as is the testing of autonomous management of public sector hospitals.

Financing of the US$3.5 billion program is based on a sector-wide financing model in which all donors contribute to one pool of funds which can be disbursed to prioritized activities following one jointly agreed mechanism. How this program is to be financed is not fully determined, although it currently includes an Institute for Development Assistance loan of US$ 200 million. Thus far, donor pledges have not been forthcoming. Several financing options are available, including project-based funding as has been the practice in the past.

In light of this background, the key concern for EPI is that there be sufficient resources available to finance immunization activities. We offer the following comments for consideration:

- *The most critical issue is the financial sustainability of the immunization program. Although World Bank officials have stated that they will not let the government experience a shortage of funds for immunization activities, and despite the strong historical commitment of the GOB for the immunization program, the plan is not fully funded and the financing of immunization activities remains unclear. Donor investments are part of the pool of funds for the HPSP, rather than being designated for special*

projects like EPI. Furthermore, funds for immunization activities are spread throughout the budget, rather than showing up under a single line item. Consequently, development of a long-term plan for financial sustainability of immunization activities is critical.

- *Although the plan is based on what the World Bank calls a "realistic scenario" of macroeconomic projections for GDP growth, inflation, and other factors, it is not clear what will happen if these projections fail to materialize. In spite of the HPSP calling for at least 60 percent of sector funding going to the essential services package, under which immunization falls, competition for scarce resources will certainly increase, particularly for more high profile curative services, thus putting the immunization program at risk. Consequently, a contingency plan to ensure the availability of resources for the immunization program should be developed to handle such circumstances.*

- *The apparent flexibility in institutional arrangements for the delivery of health services in general provides for the opportunity to test different alternatives for delivering immunization services. Because of varying physical conditions and characteristics throughout Bangladesh, there is no single method of delivering immunization services that is best for all areas of the country. Pilot testing of both different delivery strategies (fixed sites, home-based, or mobile units), and institutional arrangements (such as "contracting out" with private and/or non-governmental organizations to deliver immunization services) should be explored. Careful evaluation of the options, through cost-effectiveness studies, should be done to help determine the most appropriate institutional arrangements and delivery methods. The objective is full immunization coverage; the methods to achieve this will vary in different parts of the country.*

- *The transition to an integrated and decentralized management system is a substantial undertaking that could lead to possible gaps in services and declines in immunization coverage. It is important that mechanisms be implemented that minimize this possibility.*

- *In that the HPSP calls for the development of system-wide cost recovery mechanisms, direct fees for immunizations should be approached very cautiously because of potential losses in beneficial externalities through reduced utilization of immunization services, particularly among low income groups.*

5. Summary

The expenditure level of the EPI increased from US $406,000 in 1985/86 to $16.3 million in 1993/94. After 1993/94, the annual expenditure remained around $13 to 14 million, except in 1995/96, when the expenditure level dipped to about $8 million. This dip in expenditures may be due to the fact that the latest phase of the project was not formally approved by the GOB until November 1996.

The government's contribution to EPI expenditures through the program increased from zero during the years 1985–87 to about 45 percent in 1994/95. In recent years, the GOB's role as a funding source appears to have declined. In the current fiscal year, the government's contribution to the program is estimated at about 14 percent of total expenditure. However, this level of government support is over and above GOB expenditures on EPI-related activities provided through the government's general revenue budget, as described below.

The total cost of the EPI differs from the actual annual expenditure due to capital acquisitions and the exclusion of a number of EPI-related costs from the program's expenditure accounting (e.g., costs of many personnel who deliver EPI services). The costing exercise made an effort to calculate all resources used for the delivery of EPI activities from the "provider's" point of view.

The total *cost* of EPI in the current year is expected to be around $18.3 million. Personnel costs account for 41.3 percent of the total, while the cost of vaccine ($7.7 million) represents another 42 percent of total cost. About 38 percent of total EPI cost was paid by the government directly through the revenue budget, which increases the GOB contribution to the annual cost of EPI activities from about 14 percent (direct support to the project) to 45 percent.

The number of deaths averted by the EPI since 1987 is about 1.15 million. The number of deaths prevented over the last 10 years clearly indicates the importance of EPI in Bangladesh. In fact, given the present effective coverage rate of more than 50 percent (versus coverage rates of less than 10 percent in the initial years of the EPI), the number of deaths that will be averted over the next 10 years will be much higher than the deaths prevented over the last ten years. A summary of the results for 1997/98 are presented below:

Effectiveness Measures

Number of doses given in 1997/98 (based on the crude coverage rate of 70%):	26.2 million
FIC within 12 months of age:	1.56 million
CFIC at the time of the survey:	2.02 million
Number of deaths prevented:	134,000
Number of life years saved:	2,663,000
Number of healthy life years saved:	2,797,000

Cost-Effectiveness Ratios (assuming that urban personnel costs are 20 percent of rural personnel costs)

Costs in parentheses represent cost-effectiveness when urban personnel costs are assumed to be 14% and 25% of rural personnel costs respectively.

Cost per dose of vaccine given (crude coverage rate)	$0.70 ($0.69 to 0.71)
Cost per FIC	$11.76 ($11.58 to 11.96)
Cost per CFIC	$9.08 ($8.94 to 9.23)
Cost per death prevented	$136 ($135 to 138)
Cost per life year saved	$6.89 ($6.79 to 7.01)
Cost per healthy life year saved	$6.56 (6.46 to 6.67)

Projected Costs

1998/99 to 2002/03 EPI costs with current crude coverage rate (70%):

with 110,000 sessions a month:	$119 million ($23.8 million/year)
with 55,000 sessions a month:	$117 million ($23.4 million/year)
with 22,000 sessions a month:	$107 million ($21.4 million/year)

1998/99 to 2002/03 EPI Costs with 90-percent crude coverage rate:

110,000 sessions a month:	$139 million ($27.8 million/year)
55,000 sessions a month:	$147 million ($29.4 million/year)
22,000 sessions a month:	$156 million ($31.2 million/year)

Financing and Sustainability

1997/98 total cost for EPI activities:	$18.3 million
GOB contribution to EPI activities:	$8.3 million
Resource gap between total cost and GOB's contribution:	$10.0 million
Current EPI cost as a percentage of total GDP:	$18.3 mil./$31,100 mil.= 0.06 percent
Current EPI cost to total GOB revenue:	$18.3 mil./$3,722 mil.= 0.5 percent
Current EPI cost to total MOH&FW budget:	$18.3 mil./$370 mil. = 4.95 percent
Current EPI cost as a percentage of total household expenditure on modern allopathic medicine	$18.3 mil./$430 mil. = 4.26 percent
Current EPI cost as a percentage of total household expenditure on medical care:	$18.3 mil./$812 mil. = 2.25 percent
Current EPI cost as a percentage of national health care expenditure:	$18.3 mil./1,316 mil. = 1.39 percent

6. Concluding Observations

The EPI activities in Bangladesh save lives at a very low cost. The cost per FIC—estimated at less than US$12 in Bangladesh—is somewhat lower than it is in many low-income countries. Therefore, in general, the Bangladesh EPI is relatively efficient in delivering immunization services at low cost.

The EPI is also a highly cost-effective program in terms of cost per death prevented or life years saved. The cost per death averted is only $136, less than 55 percent of the per capita GDP of the country. In comparison, the cost per death prevented for most curative services in developing countries is usually more than $300.The cost per life year saved—less than $7– is also very low due to the high number of life years saved per death through infant immunizations.

The total cost of EPI makes up about 5 percent of the Ministry of Health's budget. In order to increase the coverage rate from the current crude rate of 70 percent to 90 percent, the cost of EPI will have to increase to 6 percent of the Ministry's budget. Currently, the MOH&FW allocates about 2 percent of its budget to EPI, with donors making up the difference. Thus, increasing the share to 5 or 6 percent may not be politically feasible in the short-run. Consequently, external assistance for EPI should continue in the medium-term with strict cost-sharing conditions agreed upon between the donors and the Government of Bangladesh. This will allow a gradual increase in the share of the government's contribution to the EPI.

The cost of EPI activities can also be reduced through improvements in efficiency in the delivery system by reducing the number of immunization delivery points and thus sessions held per month. With the reduction in the number of immunization sessions, the cost of social mobilization increases. A part of this cost can be gradually transferred from the EPI budget to the community by involving local organizations and community leaders in social mobilization efforts. Even a 50-percent reduction in social mobilization costs will reduce the total cost to the EPI program significantly. In other words, the total cost of the EPI required to achieve 90-percent coverage rates will be very sensitive to the cost of social mobilization. If social mobilization costs can be kept at a low level—i.e., by transferring many of those costs to local communities—the additional cost to the program of increasing coverage will be low.

Bearing in mind that the EPI uses more than 67 million doses of vaccines per year to administer 37 million doses, another way to increase efficiency and thus reduce costs would be to improve completion rates (fewer drop-outs) for infants. The cost per dose of vaccine (using crude coverage rates) in Bangladesh is approximately $0.70. Therefore, eight vaccinations (shots) per birth plus two life-time doses of TT per woman of childbearing age should cost not much more than $7.00 ($.70 x 10 doses). This compares with the current estimated cost per FIC of $11.76. By better targeting infants and ensuring that they are immunized by 12 months of age, the cost per FIC could therefore be reduced by some 40 percent without having to increase the supply of vaccines or health personnel.

The resource gap at the current level of costs is about $10 million, which over a five-year period will be close to $70 million. In order to reach the targeted 90-percent immunization coverage rate, the additional resources needed over the next five years for more intensive social mobilization efforts are estimated at between $35 to $47 million, depending on the number of immunization sessions held. This will increase the funding gap over five years to approximately $105 to $117 million. In addition to the funding gap, wide fluctuations in year-to-year expenditure levels for the EPI which can not be explained by capital acquisitions, threaten the smooth operation and success of the program. EPI activities are regular long-term activities and therefore, a long-term plan for financing EPI activities should be prepared. Donors and the GOB should agree on a long-term plan so that the activities can continue smoothly, and without significant disruptions.

Based on the analysis and findings of this study, the following recommendations are offered for consideration:

1. Develop a long-term plan for financing EPI activities, in particular for self-financing of the vaccine budget. Currently, there is a shortfall of approximately $10 million in the EPI budget, of which vaccines account for nearly $7.7 million. All else being equal, the funding gap will increase over the next five years, especially if efforts are made to increase the immunization coverage rates. Thus far, the shortfall has been met by contributions from external partners and international loans. This situation makes the program vulnerable to the vagaries of external funding sources.

2. Develop ways to expand the Vaccine Independence Initiative as a means of ensuring the needed supply of vaccines and to save scarce foreign exchange.

3. Improve the immunization completion rates for infants. With better completion rates (fewer drop-outs) for infants, the cost per FIC can be significantly reduced without increasing the supply of vaccines or health personnel.

4. Since historical patterns of EPI expenditure show significant year-to-year variability, the program should examine the causes of this variability to identify the expenditure items most susceptible to high variation and find ways to even out expenditure patterns. In searching for ways to reduce costs, attention should be focused on the big ticket cost items, such as vaccines and personnel.

5. Identify methods for reducing the resource gap in the longer run by conducting the following kinds of studies:

    - operations research activities to identify more cost-effective methods of delivering EPI services to the target population (Possible examples of such research activities are: finding ways to reduce the size of the EPI administration, achieving greater efficiency in the distribution of vaccines, using equipment more efficiently, ensuring higher attendance at fewer sites, and involving NGOs or the private sector to a greater extent in EPI activities);

    - research into cost-saving strategies for the delivery of EPI services that are quality-neutral or that improve quality (Examples include: an open vial policy on DPT and TT, sterilization of syringes at a central level instead of at the

point of delivery, primary school vaccination with tetanus-diphtheria, and the development of policy guidelines on handling open vials for outreach teams);

- studies on methods for generating more effective use of vaccine doses to reduce the total amount of vaccines needed in the country; and

- research into methods to strengthen communication in order to improve the demand for vaccinations and to reduce the cost of seeking out infants for immunization.

Annex A: Statement of Work

Participation in Joint WHO/USAID Review of Bangladesh's EPI, April 24–May 15, 1998

Specific Tasks/Responsibilities:

As Part of a joint WHO/USAID team, the consultants will:

- *Determine the total cost of the EPI from 1985 to 1997 (excluding polio NIDs) from available data;*
- *Conduct cost projections of the EPI for the next five years (1998–2003) to assist the government in planning and budgeting for their immunization needs;*
- *Analyze the current and anticipated financing of Bangladesh's EPI against projected costs to determine gaps in financing and their implications for the program;*
- *Develop approximations of the cost-effectiveness (in terms of cost per discounted year of life saved and cost per DALY (disability-adjusted life year) saved of the EPI in Bangladesh, as time and availability of data permit;*
- *Review the Government of Bangladesh/World Bank Fifth Health and Population project proposal, and contribute to the comments and recommendations of the team for strengthening EPI's role in light of the team's analyses and donor plans for supporting EPI.*

This assignment will require taking part in team meetings with appropriate government officials and counterparts, as part of the review team; obtaining data and information from counterparts and relevant donors; making field visits to districts, as appropriate; and taking part in the presentations and debriefings of the team for government and donor representatives.

Deliverables:

The consultants will be responsible for:

1. The cost, cost-effectiveness, and financing sections of the EPI Review Report, including relevant recommendations for the HAPP-5 proposal and

2. A brief trip report for PHR summarizing activities, major findings, and main cost/financing issues using the PHR trip report format (in WordPerfect 6.1)

Annex B: Method of Reclassifying EPI Accounting Reporting Form Components

Method of reclassifying EPI accounting reporting form components (line items) to Cost Study line items

Reclassified line items	% of EPI line item to reclass'd line item	EPI Accounting system classification description	Illustration of items
Recurrent:			
personnel	100%	salary and allowances: EPI staff	
	100%	salary and allowances: local consultants	
	100%	salary and allowances: external consultants	
	100%	contingency staff salary	
vaccines	100%	vaccines	
supplies	63%	cold chain vaccine equipment	needles, syringes, cards, cotton, etc
	56%	operational costs and related supplies	soap, stationary, kerosine oil, LP gas cylinders
	40%	contingency	stationary, electrical goods, spare parts
	20%	support to Chittagong Hill Tracts	
transport	44%	operational costs and related supplies	vaccine transport (carriers), vehicle POL and repairs
	100%	landing and transportation	includes import charges
	100%	maintenance of vehicles and POL	
	50%	support to Chittagong Hill Tracts	
maintenance & operations	100%	social mobilization & IEC	
	60%	contingency	telephone, utilities
	100%	planning, monitoring, surveillance and evaluation	
	100%	operational research	
	100%	repair & maint. of equip, including cold chain	includes both cold chain and other equipment
	30%	support to Chittagong Hill Tracts	
	100%	support to urban areas	
	100%	miscellaneous	maintenance of cold rooms, honoraria, garden at EPI HQ
training (in-service)	80%	training and fellowships	short term, in-service training (workshops), seminars, study tours
Reclassified line items	% of EPI line item to reclass'd	EPI Accounting system classification description	Illustration of items
Capital:			
buildings	100%	upgrading and maintenance of EPI buildings	includes construction
equipment	37%	cold chain vaccine equipment	computer hardware, freezers, refrigerators, furniture, sterilizers, air cond.
	100%	support to the Institute for Public Health	generators, spare parts, renovation works, boiler
vehicles	100%	vehicles	trucks, bicycles, motorcycles, vans
training (long term)	20%	training and fellowships	long term training (e.g. MPH)

(1) for details of items included under EPI expenditure classification, see EPI Project Proforma 1995/96–1999/2000

(2) Customs Duty and Value Added Tax excluded from analysis

Annex C: Personnel Costs

	Total Post	Salary Scale (mnth)	Benefit 45%	Total Salary (mnth)	% In EPI	Total Salary/Year
Divisional level						
Medical officers-EPI	15	4320.0	1944.0	6264.0	100.0	1127520.0
Divisional Director (Health Service)	4	8400.0	3780.0	12180.0	5.0	29232.0
Divisional Health edu. Officer	4	5300.0	2385.0	7685.0	5.0	18444.0
Divisional Health Supervisor	4	4120.0	1854.0	5974.0	5.0	14337.6
Statistician	1	4002.5	1801.1	5803.6	5.0	3482.2
Assistant Director (dis. Cont.)	8	4120.0	1854.0	5974.0	17.5	100363.2
District Level						
District Civil Surgeon	64	7175.0	3228.8	10403.8	7.5	599256.0
District Civil Technician	64	4002.5	1801.1	5803.6	100.0	4457184.0
EPI Supervisor	64	3390.0	1525.5	4915.5	100.0	3775104.0
EPI Store Keepers (Assist.)	21	2122.5	955.1	3077.6	100.0	775561.5
Senior Health edu. Officer	64	5300.0	2385.0	7685.0	17.5	1032864.0
Junior Health edu. Officer	51	4320.0	1944.0	6264.0	17.5	670874.4
District Health Super	64	4320.0	1944.0	6264.0	30.0	1443225.6
District Sanitary Inspectors	64	2725.0	1226.3	3951.3	5.0	151728.0
Medical Officer, CS	128	4320.0	1944.0	6264.0	7.5	721612.8
Statistician	64	4002.5	1801.1	5803.6	15.0	668577.6
Thana Level						
EPI Technician	460	2122.5	955.1	3077.6	100.0	16988490.0
MO-Disease Control	460	2122.5	955.1	3077.6	50.0	8494245.0
Statistician	460	2122.5	955.1	3077.6	17.5	2972985.8
Family Planning Inspectors	460	2122.5	955.1	3077.6	20.0	3397698.0
Health Inspectors	460	2122.5	955.1	3077.6	20.0	3397698.0
Thana Health/Family Planning Officer	460	3390.0	1525.5	4915.5	7.5	2035017.0
Health Education Officer	460	3390.0	1525.5	4915.5	17.5	4748373.0
Ward Level						
Health Assistants	9000	2122.5	955.1	3077.6	40.0	132953400.0
FWA	4500	2122.5	955.1	3077.6	40.0	66476700.0

Annex D: Comparison of EPI Project Funding and GOB Revenue Budget Funding

A. EPI-project funds

Capital Costs (annualized)	US $ (in '000)	%
Building	40.30	0.22
Vehicles	200.50	1.09
Equipment	1122.14	6.12
Training	15.18	0.08
Subtotal	1378.13	7.51
Recurrent Costs		
Vaccines	7700.00	41.98
Personnel	634.22	3.46
Supplies	643.70	3.51
Transport	144.57	0.79
Maintenance	534.13	2.91
Training	361.96	1.97
Subtotal	10018.57	54.63
B. Revenue Budget Funding (Public Sector)		
Rural Areas		
Health Assistant + FWA's salary+benefit	4335.44	23.64
Personnel at thana level	1104.98	6.02
Personnel at district level	386.98	2.11
Personnel at division level	28.12	0.15
Subtotal	5855.51	31.93
Urban Areas		
20% of Health Assistant + FWA's salary and benefit	867.09	4.73
20% of personnel cost at Thana level	221.00	1.20
Subtotal	1088.08	5.93
Grand Total	18340.29	100.00

Annex E: Calculation of Number of Vaccine Doses Given

Calculation of number of vaccine doses given

Vaccine	National Coverage (%)	No. of vaccines given (in '000)	National Coverage (%)	No. of vaccines given (in '000)
	effective (<12 mo)		Crude	
BCG	91.1	2636.01	92.2	2667.84
DPT1	85.5	2473.98	91.1	2636.01
DPT2	78.0	2256.96	84.7	2450.83
DPT3	67.7	1919.45	77.9	2245.07
OPV1	85.2	2465.30	91.5	2647.59
OPV2	77.8	2251.17	85.1	2462.40
OPV3	68.1	1998.89	78.3	2265.64
Measles	61.5	1743.66	72.1	2086.24
Total		17,745.42		19,470.63

Annex F: Worksheet Tables

Table 1: Number of Children Eligible for Immunization in Bangladesh

Year	Population	CBR	CDR	IMR	CMR	Infants	No. alive @one mo
	(in '000)	(per 1000)	(per 1000)	(per 1000)	(per 1000)	(in '000)	(in '000)
1981	89912	35.4	11.5	121		3182.88	2990.32
1982	92061	34.8	11.9	120		3203.72	3011.50
1983	94169	35	12	117		3295.92	3103.11
1984	96335	34.8	12	119		3352.46	3152.99
1985	98531	34.6	12	118		3409.19	3208.05
1986	100758	34.4	11.9	117		3466.08	3263.32
1987	103025	33.3	11.4	115		3430.74	3233.47
1988	105282	33.2	11.3	116	13.5	3495.35	3292.62
1989	107587	33	11.3	98	13.6	3550.38	3376.41
1990	109922	32.8	11.3	94	14.2	3605.44	3435.98
1991	111455	31.6	11.2	92	13.6	3521.98	3359.97
1992	113729	30.8	11	88	13.2	3502.84	3348.72
1993	115981	28.8	10	84	12.6	3340.24	3199.95
1994	118161	27.8	9	77	12.1	3284.87	3158.41
1995	120382	26.5	8.4	71	12	3190.13	3076.88
1996	122561	25.6	8.1	67	11.8	3137.57	3032.46
1997	124706	24.6	8.4	65	11.5	3067.77	2968.07
1998	126726	23.6	8.5	65	11.5	2990.74	2893.54

Table 2: Estimation of deaths averted from TT, NT and DPT3 by year

Year	No. alive @one mo	TT2+ coverage	NT deaths w/o TT	NT deaths with TT	NT deaths prevented	Deaths of m o t h e r s prev	DPT3 coverage	Deaths prevented in current and future years t(wt=0.5)	t+1(0.2)	t+2(0.1)	t+3(0.1)	t+4(0.1)	Deaths avert in the year
	(in '000)	(proport)	(in '000)	(in '000)	(in '000)	(in '000)	(proport)	(in '000)	(in '000)	(in '000)	(in '000)	(in '000)	(in '000)
1981	2990.320		127.315	127.315	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
1982	3011.496		128.149	128.149	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
1983	3103.107		131.837	131.837	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
1984	3152.986		134.098	134.098	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
1985	3208.045		136.367	136.367	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
1986	3263.317		138.643	138.643	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
1987	3233.474	0.080	137.230	127.569	9.661	0.154	0.100	1.293	0.517	0.259	0.259	0.259	1.293
1988	3292.617	0.130	139.814	123.819	15.995	0.254	0.190	2.502	1.001	0.500	0.500	0.500	3.020
1989	3376.409	0.230	142.015	113.271	28.744	0.457	0.340	4.592	1.837	0.918	0.918	0.918	5.852
1990	3435.981	0.290	144.217	107.413	36.804	0.586	0.620	8.521	3.408	1.704	1.704	1.704	11.117
1991	3359.967	0.230	140.879	112.365	28.514	0.454	0.600	8.064	3.226	1.613	1.613	1.613	13.150
1992	3348.718	0.800	140.114	41.474	98.640	1.569	0.620	8.305	3.322	1.661	1.661	1.661	14.653
1993	3199.949	0.800	133.610	39.548	94.061	1.496	0.740	9.472	3.789	1.894	1.894	1.894	17.029
1994	3158.407	0.860	131.395	31.955	99.440	1.582	0.730	9.223	3.689	1.845	1.845	1.845	17.989
1995	3076.883	0.800	127.605	37.771	89.834	1.429	0.700	8.615	3.446	1.723	1.723	1.723	17.472
1996	3032.460	0.720	125.503	45.984	79.519	1.265	0.660	8.006	3.202	1.601	1.601	1.601	16.852
1997	2968.068	0.860	122.711	29.843	92.868	1.477	0.680	8.073	3.229	1.615	1.615	1.615	16.737
1998	2893.543	0.900	119.630	24.883	94.747	1.507	0.680	7.870	3.148	1.574	1.574	1.574	16.268
TOTAL					**768.826**	**12.231**							**151.434**

Table 3: Estimation of deaths averted from measles and polio by year

Year	Children alive @ 9 months	Coverage of Measles	Number of deaths averted during current and future years						No. of deaths averted ('000)	Coverage Polio 3	No. of deaths averted (000)
			Current yr t	t+1	t+2	t+3	t+4	t+5			
1981	2874.782		0	0	0	0	0	0			0
1982	2896.162		0	0	0	0	0	0			0
1983	2987.420		0	0	0	0	0	0			0
1984	3033.303		0	0	0	0	0	0			0
1985	3087.360		0	0	0	0	0	0			0
1986	3141.658		0	0	0	0	0	0	0		0
1987	3115.114	0.07	0.504	0.783	0.783	0.615	0.224	0.056	0.504	0.10	0.153
1988	3170.979	0.15	1.098	1.709	1.709	1.343	0.488	0.122	1.882	0.19	0.296
1989	3272.028	0.34	2.569	3.997	3.997	3.140	1.142	0.285	5.061	0.34	0.543
1990	3334.308	0.54	4.158	6.468	6.468	5.082	1.848	0.462	10.479	0.62	1.007
1991	3262.760	0.53	3.994	6.212	6.212	4.881	1.775	0.444	16.025	0.60	0.953
1992	3256.243	0.59	4.437	6.902	6.902	5.423	1.972	0.493	20.802	0.62	0.981
1993	3115.775	0.71	5.109	7.947	7.947	6.244	2.271	0.568	24.569	0.74	1.119
1994	3082.526	0.61	4.343	6.755	6.755	5.308	1.930	0.483	26.206	0.73	1.090
1995	3008.933	0.60	4.169	6.486	6.486	5.096	1.853	0.463	26.531	0.70	1.018
1996	2969.395	0.57	3.909	6.080	6.080	4.777	1.737	0.434	25.809	0.66	0.946
1997	2908.246	0.62	4.164	6.478	6.478	5.090	1.851	0.463	24.801	0.68	0.954
1998	2835.223	0.62	4.060	6.315	6.315	4.962	1.804	0.451	24.211	0.68	0.930
TOTAL									**206.881**		**9.991**

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