PN-ABF-945

REPORT ON THE COST-EFFECTIVENESS OF THE EXPANDED PROGRAM OF IMMUNIZATION IN THE REPUBLIC OF SUDAN

VOLUME III: National Capital Region

February 1990

USAID/Khartoum

Resources for Child Health Project

REACH

John Snow, Inc.
1100 Wilson Boulevard, 9th Floor
Arlington, VA
22209 USA
Telex: 272896 JSIW UR
Telephone: (703) 528-7474

PN-ABF-945
ISN 67995

REPORT ON COST-EFFECTIVENESS OF THE EXPANDED PROGRAMME OF IMMUNIZATION IN THE REPUBLIC OF SUDAN

VOLUME III: NATIONAL CAPITAL REGION

February 1990

Khin-Sandi Lwin, UNICEF/Khartoum
Logan Brenzel, REACH
Allison Percy, REACH

Prepared by the Resources for Child Health (REACH) Project. USAID Contract No. DPE-5927-C-00-5068-00.

TABLE OF CONTENTS

List of Tables. ii

Acronyms. iv

Acknowledgements. v

Executive Summary 1

I. Introduction. 5

II. Background. 5

III. Methodology 10

IV. Sampling Frame. 15

V. Results for Mobile Teams and Fixed Facilities . 16

VI. Results at District and Regional Levels 28

VII. Conclusions and Recommendations 37

Appendices. 40

1. Itinerary of Field Activities

2. Background Tables

LIST OF TABLES

II.1 Sites for Mobile Team Activities in National Capital Region . .7

II.2 Comparison of Coverage Rates: 1987 and 1988 8

II.3 Coverage Indicators for a sample of 210 Children in National Capital Region 9

IV.1 Delivery Sites Sampled for the Cost-effectiveness Study in National Capital Region 16

V.1 Cost of the EPI for Mobile Teams in National Capital Region . 17

V.2 Indicators of Activity for Mobile Teams in National Capital Region 18

V.3 Drop-Out Rates for Mobile Teams Compared with Coverage Survey Results 19

V.4 Vaccine Wastage Rates for Mobile Teams in National Capital Region 20

V.5 Mobile Teams: Indicators of Cost and Effectiveness 21

V.6 Cost of the EPI for Fixed Facilities in National Capital Region 22

V.7 Comparison of Drop-Out Rates for Health Facilities in National Capital Region 24

V.8 Comparison of Wastage Rates Among Facilities in National Capital Region 25

V.9 Classification of Health Facilities in Khartoum by Cost/Dose . 26

V.10 Health Facilities: Indicators of Cost and Effectiveness . . . 27

V.11 Comparison of Strategies 28

VI.1 Cost of the EPI at the District Level in National Capital Region 29

VI.2 Comparison of Drop-out Rates for Districts in National Capital Region 30

VI.3 Comparison of Wastage Rates Among Districts in National Capital Region 31

VI.4 Comparison of Districts in Khartoum 32

VI.5 Districts: Indicators of Cost and Effectiveness 33

VI.6 Total Cost of the EPI at the Regional Level in National Capital Region 34

VI.7 Sensitivity Analysis of the Cost-effectiveness of the EPI in National Capital Region 36

ACRONYMS

AIRA	Arab International Relief Assistance
BCG	Bacillus Calmet-Guerin tuberculosis vaccine
DOO	District Operations Officer
DPT	Diphtheria-Pertussis-Tetanus vaccine
EPI	Expanded Programme of Immunization
GOAL	Irish international aid agency
LS	Sudanese Pound (exchange rate used: LS 4.45 = US $1.00)
MT	Mobile team
NGO	Non-governmental organization
OPV	Oral Polio Vaccine
PHC	Primary health care
RDMS	Regional Director of Medical Services
RHSP	Rural Health Support Project (USAID)
ROO	Regional Operations Officer
TT	Tetanus Toxoid vaccine
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

ACKNOWLEDGMENTS

This study would not have been possible without the help and cooperation of the Regional Operations Officer, Ibrahim Mohammed Hussain, who not only provided all the background information and details of the EPI program in National Capital Region but took active part in the study which took over two weeks of his valuable time. Special thanks is also due the District Operations Officers of the three out of four districts covered by the study: Samira of Khartoum District, Jamal of Khartoum North District and Afaf of Ombdurman District. As fixed sites could not be matched with the clusters selected by the coverage survey (a criterion of site selection), the fourth district, East Bank, could not be covered by the study. Thanks as well to Mr. Rashid of the National Operations Section, who also took part in the study.

EXECUTIVE SUMMARY

From February through April, 1989, a Resources for Child Health (REACH) team conducted a cost-effectiveness study of the Expanded Programme of Immunization (EPI) in Sudan. Fieldwork in National Capital Region took place during the month of March, and was conducted in collaboration with UNICEF, the Ministry of Health, and the EPI.

Objectives

The overall objectives of the cost and cost-effectiveness study in Sudan are to: 1) determine and compare the costs of delivering EPI services through mobile team and fixed facility strategies; 2) compare cost figures with the numbers of fully immunized children as determined by the coverage survey; 3) assess and propose recommendations for improving the efficiency of service delivery for both strategies and for improving program management of EPI resources; and 4) estimate the contributions to the EPI by the city commission and donor organizations.

National Capital Region is one of four regions included in the cost-effectiveness study of EPI in Sudan. The other regions studied are Kordofan, Darfur, and Middle Region. Because National Capital region has the highest coverage levels in Sudan, this region was included to represent a case of high resource availability, easy access, and good performance.

The EPI in National Capital Region

The goals of the EPI in National Capital Region are to reduce the incidence of six target childhood diseases: primary pulmonary tuberculosis, diphtheria, tetanus, pertussis, measles, and poliomyelitis. In addition, the program aims to protect newborns from neonatal tetanus through immunization of women of childbearing age with tetanus toxoid (TT). The specific objectives of the EPI are to increase coverage with all antigens to 70 percent in 1989 and 90 percent by 1990.

The two principal strategies used by the EPI in National Capital region are fixed facilities and mobile teams. Fixed facilities include health centers, primary health care units, dressing stations, dispensaries, and hospitals. Mobile teams provide services or bring vaccines to health workers in health facilities, as well as providing services in private homes.

Coverage

According to the routine EPI reporting system, in 1988 coverage for children under one year of age ranged from 71 percent for measles to 112 percent for BCG (the fact that coverage was over 100 percent is probably due in large part to underestimation of the size of the target population). However, the 1989 coverage survey found coverage of children under one to be 84 percent for BCG, 76 percent for DPT3/OPV3, and 77 percent for measles.

Sixty-one percent of children were found to be fully immunized by their first birthday. In addition, over 50 percent of mothers were found to be covered by TT1 and TT2.

Methods

The methods used for calculating costs are those developed by Creese (1976) and revised by REACH (1988) and WHO (1988). Recurrent costs included were personnel (salaries, per diem, staff support), vaccines, supplies, transportation, maintenance/operation, and training. Annualized capital costs included equipment, vehicles, and buildings. Total costs were compared with the number of doses delivered and the number of fully immunized children (FIC) to calculate a cost per dose and cost per FIC.

Results

The analysis was performed at four levels: mobile teams, fixed facilities, district, and regional. A summary of the results follows.

For **mobile teams**, the average annual total cost was $19,377 (LS 86,228). The average number of doses delivered was 14,821, and the average number of DPT3 doses (a proxy for FIC) was 3,610. The resulting average cost per dose delivered was $1.31 (LS 6), and the average cost per FIC was $5.24 (LS 23).

At **fixed facilities**, the average annual total cost of providing EPI services was $4,963 (LS 22,085). The average number of doses delivered was 8,112, and the average number of measles doses (another proxy for FIC) was 517. The average cost per dose was thus $0.61 (LS 2.7), and the average cost per FIC was $35.14 (LS 156).

At the **district level**, the average annual total cost of the EPI was $220,910 (LS 983,049). The average number of doses administered was 235,172, and the average number of FIC was 16,693. The resulting average cost per dose $1.02 (LS 4.5), and the average cost per FIC was $12.35 (LS 55).

At the **regional level**, the annual total cost of the EPI was $1.7 million (LS 7.7 million). The total number of doses delivered was estimated at 994,777, and the number of FIC was calculated from the coverage survey results to be 58,342. The cost per dose administered was $1.74 (LS 7.7), and the cost per FIC was $26.91 (LS 120).

These results do not demonstrate the wide variation in cost-effectiveness found. These differences result in large part from differing levels of performance as demonstrated by the number of doses administered and the number of fully immunized children. The results point to a number of conclusions and recommendations, which are summarized below.

Conclusions and Recommendations

The results of the 1989 coverage survey show that the EPI has raised the number of children fully immunized by their first birthday against the six target diseases to over 60 percent in National Capital Region, a tremendous accomplishment for the region. In addition, over 50 percent of mothers have been immunized with tetanus toxoid.

The cost-effectiveness study of the EPI has shown that there is a wide variation in the performance and efficiency of health facilities, mobile teams, and districts. These variations should be used to indicate ways to reduce costs and increase the effectiveness of the program. A summary of the important conclusions and recommendations follows:

High Overall Costs May be Traced to Vertical Program: The high cost of the EPI may be due in part to the vertical nature of the program. Integration of immunization with other health services may help reduce costs. Missed opportunities for immunization may also be reduced if services were integrated.

Performance of Health Facilities Varies More than Costs: Among the 10 health facilities studied, total costs ranged from $3,406 to $6,747, a ratio of approximately 1:2. In terms of fully immunized children, the ratio was 1:49. These differences highlight the importance of increasing mobilization and outreach services in order to reach a larger number of children. Current redundancies between health facilities and mobile teams increase costs, and the role of mobile teams should be to provide services to the population without access to facility care.

Cost-effective Service Providers Should be Studied Further: The mobile teams, health facilities, and districts which are the most productive and least costly should be analyzed from an operational point of view. Differences in cost-effectiveness may be due to different populations or to inefficiencies. These inefficiencies (e.g. a high-cost delivery site serving a small population; lack of outreach leading to low attendance at immunization sessions; supply wastage; staff larger than necessary; low staff productivity; and unnecessary use of transport) should be addressed to improve performance and lower costs. The factors which make some sites particularly successful should be studied to see if they can be exported elsewhere in the region in order to strengthen the program.

Vaccine Wastage Rates are High: With few exceptions, vaccine wastage rates at all levels were high. Teams and facilities with high wastage rates should be studied to ascertain the causes of high rates and whether wastage can be reduced, although vaccinators should be encouraged to open vaccine bottles even if only one child or mother attends an immunization session.

Drop-Out Rates Could be Reduced Through Outreach: The drop-out rates calculated for the study indicate significant drop-out rates between DPT1 and DPT3 and between TT1 and TT2. Immunization records should be studied at each delivery site on a regular basis to identify drop-outs. Infants or women who do not show up for subsequent doses should be visited and encouraged to return to complete their vaccination schedule.

Record-keeping is Inconsistent or Inadequate: Throughout the study, the team had difficulty in finding complete and accurate records at health facilities. If health workers can be shown how the records can be useful to them and not only to the central office, they might take more interest in keeping accurate and complete records. In the short run, health workers should be encouraged to keep a copy of each of the required forms at the facility rather than just sending them to district headquarters.

In summary, the achievements of the EPI have been significant over the past few years. However, additional attention placed on increasing performance and reducing inefficiencies could increase the success of the program as a whole by releasing additional resources for implementation. A successful, cost-effective program could have an even greater impact in reducing the number of preventable child deaths in National Capital Region and Sudan as a whole.

I. INTRODUCTION

A. Purpose of the Study

National Capital Region is one of four regions included in the cost-effectiveness study of EPI in Sudan. Because National Capital region has the highest coverage levels in Sudan, this region was included to represent a case of high resource availability, easy access, and good performance. Results from National Capital region will be compared with regions having less access to resources and lower coverage levels. The data collection interviews for the study in National Capital Region were performed by Khin-Sandi Lwin, Programme Development, Monitoring, and Evaluations Officer of UNICEF/Khartoum, who joined the REACH team.

The overall objectives of the cost and cost-effectiveness study in Sudan are to: 1) determine and compare the costs of delivering EPI services through mobile team and fixed facility strategies; 2) compare cost figures with the numbers of fully immunized children as determined by the coverage survey; 3) assess and propose recommendations for improving the efficiency of service delivery for both strategies and for improving program management of EPI resources; and 4) estimate the contributions to the EPI by the city commission and donor organizations.

II. BACKGROUND: THE EPI IN NATIONAL CAPITAL REGION

A. Organization

The Director-General of the Commissionerate of Health of National Capital oversees the EPI Operations in the Regions. The Regional Operations Officer (ROO) supervises the four District Operations Officers (DOO). Given the proximity to the National EPI Warehouse and Transport Workshop, the Region does not have its own warehouse and vehicle maintenance facilities. Supplies and equipment required by the Districts are requested through the ROO who obtains release approval from National EPI for direct distribution to the DOOs. The National Operations and Accounts Sections provide technical supervision and assistance where necessary to the ROO.

The DOOs are responsible for the supervision and support to health facilities which provide EPI services and the operation of mobile teams based at the District level. The ROO provides technical guidance in efforts to increase coverage (in finding new strategies and approaches) and in the smooth operations of EPI in the districts.

The regional plan of action is drafted annually based on the submission of the district plans of action. This regional plan is submitted to the National EPI through the Regional Health commissionerate. Monthly reports are channelled in the same way, with feedback coming directly from National EPI. Copies of the District reports are given to the District Medical Directors.

The regional health budget covers all basic expenditures. In addition, a monthly disbursement of LS 3,000 ($674) is advanced to the ROO from National EPI for purchase of items not available in EPI stores and small requirements such as stationery, office supplies, spare parts and minor repairs (see 1987 Revision of "EPI Funds (Temporary) for Regional Programmes"). Upon submission of receipts, the next month's advance is released.

B. Goals

The goals of the Expanded Programme of Immunization began in National Capital Region are to reduce the incidence of six target childhood diseases: primary pulmonary tuberculosis, diphtheria, tetanus, pertussis, measles, and poliomyelitis. In addition, the program aims to protect newborns from neonatal tetanus through immunization of women of childbearing age with tetanus toxoid (TT). The specific objectives of the EPI are to increase coverage with all antigens to 70 percent in 1989 and 90 percent by 1990.

C. Strategies

The two principal strategies used by the EPI in National Capital region are fixed facilities and mobile teams. Fixed facilities include health centers, primary health care units, dressing stations, dispensaries, and hospitals. Mobile teams provide services or bring vaccines to health workers in health facilities, as well as providing services in private homes.

The region is currently focusing on ways to improve coverage levels. Some of these efforts are listed below:

1) Public awareness is being increased through promotional work by students, scouts and voluntary organizations such as the Sudan Red Crescent; training of teachers; and participating and supporting health campaigns organized by private groups (e.g. medical students) and public health campaigns (meningitis epidemic).

2) Operations are being expanded to areas not yet covered through outreach services where no health facilities exist. Outreach sites are selected depending on the level of coverage "output." Sites which have low coverage are still left open for at least a year with reduced service days since people know of its availability. Outreach sites can be at clubs, kindergartens, schools, mosques, and in private homes (sheiks). In October 1988, there were at least 40 outreach sites throughout the region.

3) The EPI supports non-government organizations (NGOs) and private clinics which provide services through provision of cold chain equipment (ROW cold boxes, vaccine carriers, vaccines, vaccine monitors, thermometers and syringes). Private clinics are provided with vaccines and some receive vaccine carriers if no cold chain equipment is available. Technical supervision is also provided and NGO personnel such as vaccinators, community mobilizers, supervisors and nutritionists are

included in the training sessions of government staff of the same categories. In Ombdurman District, 30 NGO staff were trained during 1988.

4) Efforts are being made to ensure that all urban health facilities provide EPI services.

5) Efforts are also being made to expand rural fixed sites through recruitment of vaccinators and orientation/training of personnel in rural health facilities. The 1989 plan of action includes expansion of the cold chain to rural facilities.

In addition, a new practice in Ombdurman District has been vaccine delivery to rural facilities by the mobile teams rather than mobile team services in areas where health facilities have recently begun EPI services. In 1989, only three percent of mobile team service sites were health facilities that provide routine EPI services (see Table II.1).

TABLE II.1
SITES FOR MOBILE TEAM ACTIVITIES IN NATIONAL CAPITAL REGION

Type of Site	Number	Percent of Sites	Routine EPI	Percent w/ Routine EPI
Health Center	3	5	1	33
Dispensary	11	17	1	9
Dressing Station	11	17	0	0
PHC Unit	10	15	0	0
SecondaryHospital	0	0	0	--
Houses	19	29	0	0
Schools	0	0	0	--
Youth Centers	11	17	0	0
Tree	0	0	0	--
TOTAL	65	100	2	3

D. Outcomes

The computerized EPI reporting system shows reported coverage rates to be very high. As Table II.2 shows, in 1988 over 70 percent of children under one year of age were reported to be covered by measles, and over 100 percent of the target population was reported to have received the BCG vaccine. These numbers may be due to the fact that children from outside the official catchment area for the regional health system (and thus not included in the estimated target population) are brought into Khartoum for health services and receive vaccinations. Another explanation could be a serious underestimation of the target population due to the large and growing population of displaced persons in the area of Khartoum.

TABLE II.2
COMPARISON OF COVERAGE RATES: 1987 and 1988
(percentage)

YEAR	1987	1988
BCG	97	112
DPT1	99	112
DPT3	79	91
MEASLES	54	71

SOURCE: Computerized EPI reporting system.

As Table II.3 shows, the results of the coverage survey undertaken in the region in March, 1989, show significantly different coverage rates. However, coverage for all antigens is high compared to other regions, with 61 percent of children fully immunized by their first birthday. Coverage of mothers with tetanus toxoid vaccine (TT) lags behind somewhat, but is over 50 percent for TT1 and TT2.

TABLE II.3
COVERAGE INDICATORS FOR A SAMPLE OF 210 CHILDREN IN NATIONAL CAPITAL REGION
(percentage)

Antigen	Total Coverage	Coverage before 1st birthday	Coverage after 1st birthday
Children:			
BCG	84	81	3
DPT1/OPV1	86	83	3
DPT2/OPV2	84	n.a.	n.a.
DPT3/OPV3	76	73	3
Measles	77	68	9
Fully Immunized	70	61	9
Mothers:			
TT1	58	n/a	n/a
TT2	51	n/a	n/a
TT3+	8	n/a	n/a

Source: EPI National Coverage Survey: Regional Report for Khartoum, Expanded Programme of Immunization, Ministry of Health, Sudan, April 1989. Coverage based on history and card information. Figures rounded to nearest whole number.
n.a.: data not available.
n/a: not applicable.

Monthly reports for months when mobile services alone were undertaken were compared with those from months when static and outreach sites were introduced. The results indicated that coverage increased dramatically during the latter periods. Use of mobile team staff to make public announcements in the afternoons in urban areas near outreach sites also increased coverage.

E. Constraints for the EPI in the National Capital Region

Based on the interviews conducted by the cost-effectiveness study team, a number of constraints to effective performance by the EPI in the region were identified by the team:

1) Considerable lack of involvement of non-EPI health personnel at the health facilities was noted. Public awareness could be considerably increased if those coming for curative care were advised by doctors, medical assistants, Health Visitors (responsible for maternal and child health), and other staff to immunize their children. The health provider's advice to the patient carries considerable weight.

2) The verticality of the EPI was very apparent. In all health facilities covered, most of the other medical/curative care personnel were not involved nor wished to assist. Only in one rural fixed site surveyed in Ombdurman District did the Medical Director personally collect the vaccines from the DOO and supervise immunization workers.

   Although vaccinators at fixed sites do not receive staff support, their colleagues (nurses, health visitors, etc.) expect to receive such a salary top-up if requested to assist in providing vaccination services. Without such an incentive, many are unwilling to assist even in the absence of vaccinators or in periods of heavy workload. However, there are exceptions as witnessed by the interviewer.

3) The ROO felt that proximity to national level resources is in some ways a constraint and there is no warehouse separate from national headquarters for this region. Lack of storage space at the district level makes requests for supplies (including spare parts, vaccines, syringes) difficult to process in a timely manner. An example given was the shortage of syringes in the past six months. While other regions were given syringes in bulk, Khartoum region received them in small quantities and therefore suffered from shortages when the national stock was depleted.

III. METHODOLOGY

The methodology which was developed for the study was founded on providing the EPI with practical and relevant results in order that financial and economic information about the program could be used for better planning and management in the future. The approach combined the use of operational data collected in the field by the study team with cost data obtained both from the Districts and Regional Headquarters in Kordofan and from the National Headquarters, UNICEF, and other organizations in Khartoum. This chapter describes the data collected during field visits, the methods used for estimating EPI costs, the sampling process, and limitations of the methodology.

A. Questionnaires

The field data were collected using structured questionnaires, developed and field tested in National Capital Region, which were designed to collect information on:

1) the numbers and types of personnel working on EPI at each level, and the hours per week spent on EPI;

2) the numbers and types of vehicles and equipment used in the last year for EPI, and how many of each type was not working at the time of the interview;

3) the numbers of supplies (syringes, needles, Road to Health cards, cold chain monitor cards, etc.) used in the program;

4) the number of kilometers travelled for different immunization activities, such as mobile team rounds, publicity, meetings and replacement of stock; the mode of transport used in each case;

5) information on the type and quantity of fuel, oil and other lubricants used for the program in the last year;

6) the number of doses of each antigen administered to children, by age (under and over one year of age) and dose, and to pregnant women (by dose);

7) the catchment population and the number of FIC;

8) the number of training courses and the number and type of staff trained during the last year;

9) the amount of local radio and television time for EPI publicity; and

10) the size and age of buildings used for EPI, and the percent of time for which this space was used by the program.

The questionnaires were pretested in the National Capital Region with the help of the ROO and the DOO for Khartoum District. Through the pretest, it was determined that the reference period for number of doses, supplies and fuel should be the previous month (February 1989) instead of the previous year, because of the incompleteness of records and problems of recall.

B. Calculation of Costs

The methods used for calculating costs are those developed by Creese (1976) and revised by REACH (1988) and WHO (1988). The methodology of this study uses not only budgetary and price data, but also an analysis of the operations of the program's delivery system.

Personnel costs were based on the number of hours spent working on EPI by different cadres of health staff. Hours worked per week on EPI was divided by the number of hours in a full-time week to estimate the number of full time equivalents (FTEs) in each staff category working on EPI. These estimates were multiplied by the monthly gross salary (including transport allowance, working allowance, housing and social security) for each member of staff; if exact salary data were not available, the average for that person's cadre was used. Per diem costs were based on reported rates received in the field per month by health workers and administrative personnel. In some Districts, the Councils were paying additional benefits for overtime and travel allowance. Staff support, an additional payment from the EPI, was paid to some staff at Regional level. Average salaries for staff working on EPI in National Capital are shown in Appendix 2.

Vaccine costs were based on the number of vials of vaccine used during February 1989, multiplied by 12 to estimate annual doses consumed. The approach of costing vaccine consumption rather than doses administered accounts for wastage, which is a real cost to the immunization program. Stock data on doses issued (i.e., consumed) were taken from the monthly reports at District and Regional levels. For mobile teams and health facilities, stock data were not always available, and vaccine consumption was estimated by the staff being interviewed. The cost per vial for each antigen was estimated from UNICEF and MOH shipping reports of all vaccines received in 1988; since EPI National Headquarters receives vaccine shipments every quarter, the shipping reports for 1988 represented all vaccine needed for Sudan in a 12-month period. Costs per vial were: BCG $0.760, DPT $0.732, OPV $0.678, measles vaccine $1.137, TT $0.199. International freight charges, which were another 14 percent in addition to the value of vaccine, have not been included in the costs per vial at regional level, but are included under transportation costs at National level. Details of all these vaccine costs are given in Appendix 2.

The cost of supplies was also based on the number of each item used during February 1989, multiplied by 12 to estimate annual use. The unit price of each item (e.g. 1 cc syringe, 2 cc syringe) was multiplied by the annual quantity of that item used, to obtain the total annual cost of supplies (see Appendix 2).

Transportation cost was estimated from the number of kilometers travelled in the last month (or if available, the last year), the number of kilometers travelled per gallon of fuel, and the price per gallon of fuel. If data on distances travelled by the mobile team were not available (e.g. the log book was out with the vehicle), the number of kilometers was estimated by tracing the team's routes to obtain kilometers per month, then multiplying by the number of rounds per year, which varied between five and 12. For transportation at District level, the kilometers travelled by each vehicle in the last year could usually be obtained. The DOOs were asked about the number of gallons of fuel, oil and lubricants used each month and the price per gallon (or per can); there was some variation in prices between Districts, reflecting the cost of transporting the goods to more remote areas. These data were used to estimate the annual cost of fuels, engine oil and lubricants.

Maintenance and operation of vehicles could not be obtained from records of repairs undertaken, as damaged vehicles were sometimes shipped to the Regional or National Headquarters for repairs, or vehicles were mended with parts cannibalized from others which could have been repaired if spares had been available. Thus, maintenance costs were estimated using two sources. One was an analysis undertaken by the Cold Chain Section, National EPI Headquarters. The second was the total value of spare parts purchased in 1988, divided by the total number of vehicles in the fleet. This came to 23 percent of the annualized cost of the vehicle, excluding the cost of oils and lubricants. A separate study of vehicle maintenance costs in Niger estimated a figure of 24 percent, corroborating the methods used for the Sudan.

Capital investments for vehicles, buildings and equipment last for periods longer than one year. The total purchase price cannot be allocated to the year of purchase, but is spread over the lifetime of the investment. Economists also adjust for the fact that money today is worth more than money in the future, and therefore the purchase price of a vehicle or equipment or the construction cost of a building is not spread evenly over its lifetime. An interest rate (r) is needed to make this adjustment; for this study, the official interest rate of 25 percent was used, reflecting the level of administrative charges levied on loans to Sudan from other Islamic countries.

The procedure (known as amortization) used for calculating the annualized value of capital investments gives an annual capital cost which is used in estimating the total annual cost of the program. For Sudan, the useful life of capital equipment was determined through discussion with EPI staff, and by using data from this study's inventories which showed the proportion of vehicles which were out of order. The use-life of vehicles is assumed to be five years; for large cold chain equipment it is five to 10 years, and two to eight years for cold boxes and vaccine carriers. (A sensitivity analysis in Chapter VI shows the effect on costs of reducing the use-life of vehicles to three years.) Details of the purchase price of each type of vehicle and equipment, its use-life, and the annualized cost are given in Appendix 2. Costs are reported in U.S. dollars. An exchange rate of LS 4.45 was used to convert the purchase price of locally procured items into U.S. dollars. This rate of exchange was the average of the UN rate (LS 4.40) and the official rate in 1988 (LS 4.50). A sensitivity analysis shows the effect of changing this exchange rate to the 1989 market rate of LS 12 on program costs at Regional level (see Chapter IV).

The cost of buildings was estimated by measuring the amount of space (square meters) used by the EPI and collecting data on construction costs per square meter. If the space was not used all the time for EPI, a proportion of time for EPI was estimated (hours per week for EPI divided by full-time hours at that facility). Construction costs were amortized over the expected life of the building. Fired brick and cement buildings were assumed to have a 25 year use-life, sun-dried brick structures (usually self-help or cooperatives) were assumed to have a 10 year use-life, and grass structures were assumed to last for five years.

Data were entered onto Lotus 1-2-3 spreadsheets; each cost category (e.g. personnel, vaccine, supplies, transportation) had an individual worksheet and separate set-ups for calculating the line items within each category. The final cost figure for each category was imported into a summary table for each level or strategy. Results are shown in Chapters V and VI.

C. Cost-Effectiveness Measures

For each service delivery strategy (mobile teams and fixed facilities) and for District and Regional levels of the program, the cost per dose was calculated using the total annual cost divided by the number of doses (all antigens, all ages) given per year (based on February 1989 reports).

Cost per FIC was estimated for the EPI at Regional level using the data from the 1989 coverage survey. The cost per FIC for children who completed their immunization schedule of eight doses before the program's targeted age of one year was used for the main analysis. In the sensitivity analysis (see Chapter VI), the cost per FIC was calculated including "out of target," that is, children (aged 12-23 months) who had completed their immunizations by the time they were sampled in the coverage survey. (Note that this is not the same as FIC under two years of age, because none of the children surveyed had yet reached their second birthday, and some were only a month or two past their first birthday.)

The number of children fully immunized was estimated by multiplying the target population from the EPITrack information system (itself an estimate based on the 1983 Census) by the percentage of FIC from the April coverage survey:

$$\text{Number of FIC} = \text{Target Population in Region} \times \text{\% FIC less than One Year of Age from Survey}$$

The annual cost attributable to child immunizations ("total child cost") was calculated by using the percent of all doses that had been administered to children and taking this share of total annual cost:

$$\text{Cost of Immunizing Children} = \left[\frac{\text{Doses given to children}}{\text{All doses given}} \right] \times \text{Total Cost}$$

This cost was then divided by the number of children fully immunized, to give cost per FIC:

$$\text{Cost per FIC} = \frac{\text{Cost of Immunizing Children}}{\text{Number of FIC}}$$

This approach was also used at District level. Cost per FIC for mobile teams and health facilities required a modified approach described in Chapter V.

D. Constraints in Data Collection

There was considerable variation in the quality of the records kept at district and provincial levels. Data on doses received and used during the month (as reported on monthly summary sheets) did not always tally with stock remaining at the end of the month. In many cases, negative wastage rates were reported, which shows that the worker or DOO is not clear about which figures should be included in the form. DPT and OPV doses given were considered to be the same in all cases and therefore there was not an active counting of OPV activity.

Records of supplies were often not maintained on the required forms and registration books. In addition, coverage data (i.e., the monthly forms) were incomplete at the health facility, while the information was available at the district level by each health facility.

IV. SAMPLING FRAME

A. Selection Process

Because the cost-effectiveness study evaluated the mobile team and facility strategies, the team surveyed several regions which had varying degrees of coverage and approaches to service delivery in order to capture the range of experience found in Sudan. National capital region was selected for its high coverage and easy access to the population.

For security reasons, it was impossible to include any of the three southern regions in the study. In addition, logistical difficulties prevented the inclusion of the Eastern Region (Kassala). Because the size of the team did not permit data collection in all of the five remaining regions, it was decided to conduct fieldwork in Darfur, Kordofan, Central, and National Capital regions. The Northern region was not included because of the idiosyncratic nature of population distribution in the region, which would make it difficult to generalize findings there to the country as a whole.

The regional team's objective in National Capital was to sample 15 fixed sites and mobile teams from half the districts in the region. The criteria given for selection were to match the sites to the clusters included in the coverage survey as well as to cover equal numbers of urban and rural sites.

B. Constraints in Sample Selection

It was not possible to match all the available EPI fixed sites to the list of clusters, especially in rural areas where there were few EPI static sites. There were no fixed sites in East Bank since most of that district is covered by mobile teams. Also, most of the health facilities providing EPI services in the region were found in urban areas. Therefore, 10 urban sites were covered, and only one rural site in Ombdurman could be matched.

Two of the Districts shared an office, which meant that many of the supplies and equipment were shared. Thus, Khartoum North and East Bank district costs were difficult to separate.

All mobile teams could not be included in the sample. In Ombdurman District, for example, the two mobile teams shared transport and equipment with each other and with the District Operations Office. Thus, only two mobile teams were included (one from Ombdurman and the only one operating in Khartoum). Khartoum North and East Bank districts were excluded since they shared various supplies, complicating the analysis.

Table IV.1 summarizes the delivery sites sampled in National Capital Region. All delivery sites visited were associated with clusters sampled by the coverage survey.

TABLE IV.1
DELIVERY SITES SAMPLED FOR THE COST-EFFECTIVENESS STUDY IN NATIONAL CAPITAL REGION

Interviews Conducted					
Districts Visited	ROO	DOO	Health Facilities Urban	Health Facilities Rural	Mobile Teams
Khartoum	1	1	4	1	1
Khartoum North		1		1	
Ombdurman		1	3	1	1
Total	1	3	7	3	2

V. RESULTS FOR MOBILE TEAMS AND FIXED FACILITIES

A. Mobile Teams

1. Total Cost

Table V.1 summarizes the breakdown of total costs for the mobile teams in National Capital Region. The two teams studied were similar in their total annual costs of approximately $19,000. Personnel costs were the highest cost category at 35 and 29 percent for the Khartoum and Ombdurman teams respectively. Per diem accounted for 30 and 24 percent of total cost. Vaccine costs were $472 per year for the Khartoum team and $2,069 for the Ombdurman team, depending upon the vaccination activity and wastage rates. The Ombdurman team had the highest vaccine cost of the two.

TABLE V.1
COST OF THE EPI FOR MOBILE TEAMS
IN NATIONAL CAPITAL REGION
(in US$)

Cost Category	KHARTOUM Total EPI	KHARTOUM Percent	OMBDURMAN SOUTH Total EPI	OMBDURMAN SOUTH Percent	Average Cost	Percent
RECURRENT COST						
1. Personnel	6,742	0.4	5,655	0.3	6,198	0.3
2. Staff Support		0.0		0.0	0	0.0
3. Per diem	5,730	0.3	4,706	0.2	5,218	0.3
4. Vaccines	472	0.0	2,069	0.1	1,271	0.1
5. Supplies	427	0.0	1,187	0.1	807	0.0
6. Transportation	95	0.0	65	0.0	80	0.0
-Fuel	95		65		80	
7. Maintenance/Op.	1,251	0.1	1,251	0.1	1,251	0.1
-Vehicle	1,251		1,251		1,251	
-Equipment						
8. Promotion		0.0		0.0		0.0
9. Other		0.0		0.0		0.0
TOTAL RECURRENT	14,717	0.8	14,933	0.8	14,825	0.8
CAPITAL COSTS						
1. Equipment	222	0.0	253	0.0	237	0.0
2. Vehicles	4,315	0.2	4,315	0.2	4,315	0.2
TOTAL CAPITAL	4,536	0.2	4,568	0.2	4,552	0.2
TOTAL COST	19,254	1.0	19,500	1.0	19,377	1.0

DOSES ADMINISTERED	7,524	27,808	14,821
COST/DOSE	$2.56	$0.70	$1.31
PERCENT TT DOSES	0.0%	6.1%	3.0%
TOTAL CHILD COST	$19,254	$18,311	$18,782
COVERAGE (FIC)	3,334	3,887	3,610
COST/FIC	$5.77	$4.71	$5.24

2. Doses Administered and Number of Children Fully Immunized

The Ombdurman team delivered over three times the number of doses of the Khartoum team, 27,808 vs. 7,524, respectively. However, as indicated by the number of DPT3 doses administered (used here as a proxy for FIC), both teams achieved approximately the same number of FIC: 3,887 for the Ombdurman team and 3,334 for the Khartoum team. The number of doses of DPT3 delivered was used because the number of FIC was difficult to ascertain for each team from either routine record-keeping or coverage survey results. DPT3 was chosen because it is one of the last vaccinations delivered and requires at least three successive contacts before the dose can be administered.

3. Average Cost per Dose and Cost per Fully Immunized Child

The average cost per dose ranged from $0.70 in Ombdurman to $2.56 in Khartoum. The high cost in Khartoum may be due to the low levels of activity (less than one-third the of the Ombdurman team). The cost per FIC was $4.71 for the Ombdurman mobile team and $5.77 for the Khartoum mobile team.

4. Indicators of Activity

Table V.2 summarizes some important indicators of activity for two mobile teams studied.

TABLE V.2
INDICATORS OF ACTIVITY FOR THE MOBILE TEAMS IN NATIONAL CAPITAL REGION

Indicator	Ombdurman	Khartoum	Average
Cost per Dose[1]	$0.70	$2.56	$1.31
Doses per Mobile Team per Day[2]	82	40	61
Doses per Staff per Day[3]	21	8	14
Doses per Site per Month[4]	47	23	35
Days per Round	20	17	19
Sites Visited per Round	35	30	33
Returns to HQ per Round	1	17	9
Kilometers per Dose	.25	.58	.42

[1]Total annual cost divided by total doses administered per year.
[2]Monthly doses administered by team divided by number of days per round.
[3]Monthly doses administered by team divided by number of staff (excluding drivers) divided by the number of days per round (month).
[4]Monthly doses administered by team divided by the number of sites visited.

When the characteristics of the two teams are evaluated, the differences in costs become clearer. The Ombdurman team visits 35 sites per months versus 30 for Khartoum. The Ombdurman team also spends more days in the field per round and uses fewer staff (four versus five). The number of kilometers per dose is 0.25 for Ombdurman and 0.58 for Khartoum, and the number of doses per staff person per day is 21 for Ombdurman and eight for Khartoum. Therefore, it appears that the Ombdurman team is more efficient, delivering more doses and completing the immunization of somewhat more children for approximately the same costs as the Khartoum team, making Ombdurman the more cost-effective of the two.

5. Drop-Out Rates

As shown in Table V.3 below, the drop-out rates for the Ombdurman mobile team are much lower than those of the Khartoum team. In fact, the Ombdurman team shows a negative drop-out rate between DPT2 and DPT3, which may indicate the team made special efforts to reduce the drop-out rate and complete the immunization of children. Determined follow-up to ensure children are brought to the team for their first and each succeeding immunization is important because it not only protects children earlier, but also makes the delivery of services more cost-effective.

TABLE V.3
DROP OUT RATES FOR MOBILE TEAMS
COMPARED WITH COVERAGE SURVEY RESULTS
(percentage)

Mobile Team	DPT1-DPT2 OPV1-OPV2	DPT2-DPT3 OPV2-OPV3	DPT1-DPT3 OPV1-OPV3	TT1-TT2 TTI-TT2
Khartoum (MT1)	45	6	48	n.a.
Ombdurman (MT2)	19	-14	8	42
Coverage Survey	n.a.	n.a.	11	12

Figures rounded to nearest whole percentage point.
n.a.: not available.

6. Vaccine Wastage Rates

As shown in Table V.4 below, the Ombdurman mobile team had much higher wastage rates for all vaccines than the Khartoum team. One possible explanation for this difference would be a more widely dispersed population with few children at any given site, making it necessary for the team to open vaccine bottles for only a small number of children. Even if the populations of served by the two teams were similar in terms of geographical dispersion, the wastage rates could differ significantly if the team members were more willing to open a vaccine bottle for only one or two children or women, even if this would mean wasting over half the bottle. In addition, problems in the

quality of the cold chain could result in higher vaccine wastage. In combination with the higher number of doses delivered by the Ombdurman team, the higher wastage rate accounts for the fact that the vaccine cost for this team is nearly four times that of the Khartoum team.

TABLE V.4
VACCINE WASTAGE RATES FOR MOBILE TEAMS IN NATIONAL CAPITAL REGION
(percentage)

Antigen	Khartoum MT1	Ombdurman MT2
BCG	22	71
DPT	13	35
OPV	13	35
MEASLES	60	70
TT	n.a.	74

n.a.: not available.

7. Summary of Results

The above analysis shows that while both teams were similar in terms of total costs, comparison of the cost information with output indicators suggests that the Ombdurman team is more efficient in delivering services and more cost-effective. Comparison with other regions shows that both mobile teams are in the mid-range of costs, while in terms of doses administered the Khartoum team could be characterized as a low-output team and the Ombdurman team could be characterized as a medium- to high-output team.

The features which may contribute to making a mobile team more or less cost-effective have been identified and listed in Table V.5. Of course, any given mobile team would likely exhibit a combination of these characteristics, and thus the table merely illustrates the best and worst combinations in terms of costs and outputs.

TABLE V.5
MOBILE TEAMS: INDICATORS OF COST AND EFFECTIVENESS

	HIGH COST	LOW COST
	CASE 1	CASE 2
HIGH OUT-COME	Days out per month is high, with many returns to HQ Many centers, far apart, with large target pop. Kilometers (& fuel) high Large team spends time on identifying eligibles, following up drop outs	Days out per month is high, with few returns to HQ Few centers with large target population Short distances Small team of health workers High utilization by eligibles Community enumerates and follows up
	CASE 3	CASE 4
LOW OUT-COME	Size of team exceeds that needed for the workload Many returns to HQ for restocking/rotating staff Many centers, far apart, with small target pop. Low utilization Ineffective follow-up	Small team of health workers Few days per round Few rounds per year (low per diem) Few centers are visited, with small target populations Low percentage of eligibles is contacted; no follow-up

B. Fixed Facilities

Data were collected at 10 fixed facilities in National Capital Region: four in Khartoum District, four in Ombdurman, and two in Khartoum North. As with mobile teams, both cost and output data were analyzed. The results show a wide range of cost and outcome results.

1. Average total cost

Table V.6 summarizes the breakdown of total costs for the fixed facilities studied. The overall annual cost of the EPI at health facilities ranged from $3,400 to $6,750, with the average being $4,963. This indicates that in terms of total cost, fixed facility sites are less expensive to operate than mobile teams. As expected, the largest cost category was for salaries and benefits, followed by vaccines and equipment. These proportions of total cost are similar to what has been found in other regions and elsewhere in Africa.

TABLE V.6
COST OF THE EPI FOR FIXED FACILITIES
IN NATIONAL CAPITAL REGION
(in US$)

Cost Category	HF1 Khartoum	HF2	HF3	HF4	HF5 Ombdurman	HF6	HF7	HF11	HF8 Khartoum	HF9 North	Average
RECURRENT COST											
1. Personnel	1,476	1,711	2,665	2,420	2,360	2,392	2,431	2,300	1,720	3,527	2,300
2. Vaccines	340	795	1,160	440	686	584	615	90	135	1,257	610
3. Supplies	278	537	826	183	151	313	196	338	101	457	338
4. Transportation	24	119	54	108	118	140	9	51	70	8	70
5. Maintenance/ Operations	123	140		396			123	125	41	41	141
TOTAL RECURRENT	2,240	3,301	4,705	3,547	3,316	3,429	3,374	2,904	2,067	5,289	3,417
CAPITAL COSTS											
1. Equipment	492	431	562	406	488	395	379	898	135	1,092	528
2. Vehicles	423	481		669			423	431	141	141	387
3. Buildings	3,591	28	4		707	777	707	565	1,063	28	
TOTAL CAPITAL	4,506	940	566	1,075	1,194	1,172	1,509	1,895	1,339	1,262	1,546
TOTAL COST	6,747	4,241	5,271	4,622	4,510	4,601	4,883	4,799	3,406	6,551	4,963
NUMBER OF DOSES	8,256	12,120	30,540	2,064	3,492	4,452	4,344	1,536	660	13,656	8,112
COST PER DOSE	$0.82	$0.35	$0.17	$2.24	$1.29	$1.03	$1.12	$3.12	$5.16	$0.48	$0.61
PERCENT TT DOSES	23.3%	12.9%	13.4%	15.1%	0.0%	12.1%	12.4%	17.6%	3.6%	10.3%	12.1%
TOTAL CHILD COST	$5,175	$3,694	$4,565	$3,924	$4,510	$4,045	$4,277	$3,954	$3,284	$5,877	$4,330
NUMBER OF FIC	804	1,140	1,320	264	120	156	120	48	24	1,176	517
COST/FIC	$6.44	$3.24	$3.46	$14.86	$37.59	$25.93	$35.64	$82.38	$136.82	$5.00	$35.14

2. Doses Administered and Number of Children Fully Immunized

The total number of doses delivered annually by the health facilities studied ranged from 660 to 13,656, with the average being 8,112. In this case, the number of measles doses was used as a proxy for the number of fully immunized children. Because of the static nature of health facilities, it was assumed that a normal immunization schedule would be followed for most children attending EPI sessions at fixed facilities. In this case, measles would be the last dose delivered, and thus was used as a measure of FIC. Using this assumption, the number of children fully immunized by each facility ranged from only 24 to over 1,300, with an average of just over 500. This wide range of experience may result from different target populations or widely varying levels of effectiveness in delivering EPI services.

3. Average Cost per Dose and per FIC

The average cost per dose for the health facilities studied was $0.61, with a range from $0.17 to $5.16. When compared with the average cost per dose of the mobile teams ($1.31), it appears that the fixed facility strategy is more cost-effective in Khartoum on a dose-by-dose basis. The cost per FIC ranged from $3.24 to $136.82, with an average of $35.14. This extremely wide range of costs per FIC (much greater than the range of total costs) demonstrates that the effectiveness of health facilities in delivering immunization services is essential to ensuring a cost-effective EPI. Improved follow-up to ensure that children are brought back for each succeeding dose is crucial not only to improving the outcomes of the program as a whole, but also in improving the cost-effectiveness of expenditures on the EPI.

4. Drop-Out Rates

Table V.7 summarizes the estimated drop-out rates for the 10 health facilities studied. The drop-out rate from DPT1 to DPT3 ranges from -17 to 62 percent, once again indicating a wide range of experience. As with mobile teams, negative drop-out rates could imply that facilities were redirecting their efforts toward completing the immunization of children without accompanying efforts to increase the number of children being given their first dose. High drop-out rates at some facilities, such as that shown for Khartoum HF1, may indicate either poor efforts at follow-up or increased efforts to bring in new children for their first immunization. The coverage survey in the region found a drop-out rate of 11 percent from DPT1 to DPT3.

TABLE V.7
COMPARISON OF DROP-OUT RATES FOR HEALTH FACILITIES IN NATIONAL CAPITAL REGION
(percentage)

Health Facility	DPT1-DPT2 OPV1-OPV2	DPT2-DPT3 OPV2-OPV3	DPT1-DPT3 OPV1-OPV3	TT1-TT2
Khartoum District				
HF1	51	24	62	43
HF2	16	-2	15	27
HF3	3	-4	-1	0
HF4	42	7	46	70
Ombdurman District				
HF5	17	-42	-17	13
HF6	18	-17	4	57
HF7	40	-19	28	45
HF11	5	-6	0	-7
Khartoum North District				
HF8	64	-125	18	n.a.
HF9	12	47	53	33
HF10	8	18	25	n.a.
Coverage Survey	n.a.	n.a.	11	12

n.a.: not available.

5. Vaccine Wastage Rates

Vaccine wastage rates were calculated by comparing the number of vials consumed during a month with the number of vials stocked and left on hand at the end of the month. As indicated in Table V.8 below, vaccine wastage rates for many facilities studied were high. The accuracy of these figures depends on the quality of records kept. High wastage rates may indicate that on average, only a small number of doses is administered during any given immunization session, making it necessary to discard the remaining vaccine not used at the end of the day.

TABLE V.8
COMPARISON OF WASTAGE RATES AMONG FACILITIES
NATIONAL CAPITAL REGION
(percentage)

Facility	BCG	DPT	OPV	Measles	TT
Khartoum District					
HF2	33	19	15	58	56
HF4	60	79	79	73	33
Ombdurman District					
HF5	85	69	69	90	60
HF6	60	50	50	90	83
HF7	67	68	68	92	70
Khartoum North District					
HF8	67	60	60	0	75
HF11	80	67	67	50	71

Note: Health facilities for which data were not available or which reported information resulting in negative wastage rates for any vaccine were omitted.

6. Summary of Results

Using total annual cost and total number of doses delivered, the health facilities studied were organized into a cost and outcome matrix (see Table V.9).[1] After each facility, the cost per dose administered is listed in parentheses. It can be seen from this matrix that, despite high total costs, the three health facilities in the high cost/high outcome category are among the most cost-effective because the high number of doses they deliver outweighs the importance of their higher total costs. In the same manner, although Khartoum North HF8 is inexpensive in terms of total costs, it is the least cost-effective in terms of cost per dose ($5.16/dose) because it provided so few doses.

[1]All health facilities with costs below the median were placed in the "low cost" category; all those with costs above the median were placed in the "high cost" category. In the same way, facilities were divided into low and high outcome categories based on the number of doses delivered. Because the median was used in each case, there may in fact be little difference in costs or outcomes between two facilities that were placed in different categories.

TABLE V.9
CLASSIFICATION OF HEALTH FACILITIES IN KHARTOUM BY COST/DOSE

	HIGH COST	LOW COST
HIGH OUT-COME	Khartoum HF1 ($0.82) Khartoum HF3 ($0.17) Khartoum N. HF9 ($0.48)	Khartoum HF2 (0.35) Ombdurman HF6 ($1.03)
LOW OUT-COME	Ombdurman HF11 ($3.12) Ombdurman HF7 ($1.12)	Khartoum N. HF8 ($5.16) Ombdurman HF5 ($1.29) Khartoum HF4 ($2.24)

Note: Cost per dose shown in parentheses.

As for the mobile teams, factors which contribute toward making health facilities more or less cost-effective have been summarized in a matrix in Table V.10. Of course, the cases shown represent extremes and each health facility would likely exhibit a mixture of these characteristics.

TABLE V.10
HEALTH FACILITIES: INDICATORS OF COST AND EFFECTIVENESS

	HIGH COST	LOW COST
	CASE 1	CASE 2
HIGH OUT-COME	Cold chain maintained at facility Resupply uses EPI vehicle Large staff spends time on enumeration & follow-up of defaulters EPI sessions occupy a large space Many sessions held, well attended	Easy access to cold store Minimal equipment Resupply by public transport Small staff Few sessions per week High utilization, follow-up done by community
	CASE 3	CASE 4
LOW OUT-COME	Cold chain equipment is out of order Resupply with EPI vehicle Large staff, low utilization, low activity EPI occupies a large space Many sessions held, poorly attended Time spent on social mobilization is not effective	Minimal equipment Small staff Resupply by public transport Low utilization by target group, low activity Passive approach to follow-up of drop outs

C. Comparison of Alternative Strategies

Table V.11 compares the average cost and outcome measures of the mobile teams and health facilities studied in order to compare the two strategies in terms of cost-effectiveness. As can be seen, while on average mobile teams are much more expensive to operate, they deliver more doses and achieve a higher number of FIC, resulting in a much lower cost per FIC. This result suggests that fixed facilities in the region may not be performing sufficient outreach and mobilization to generate a desirable level of utilization given the cost of providing immunization services at these facilities. Experience elsewhere indicates that in urban areas fixed facilities should be able to provide the most cost-effective services, and the fact that the team did not find this to be true in the National Capital Region, a highly urbanized setting in comparison with most of Sudan, may point toward the need for improvements in the performance of many facilities.

TABLE V.11
COMPARISON OF STRATEGIES

Indicator	Mobile Teams	Fixed Facilities	Difference (%)
Annual Cost	$19,377	$4,963	-74
Number of Doses	14,821	8,112	-45
Number of FIC	3,610	517	-86
Cost per Dose	$1.31	$0.52	-60
Cost per FIC	$5.24	$27.94	433

However, the two strategies should normally be serving different population groups and thus do not represent true alternatives. Rather, the comparison could indicate the need to focus attention on increasing the volume of services delivered at fixed facilities.

VI. RESULTS AT DISTRICT AND REGIONAL LEVELS

In addition to the comparison of alternative delivery strategies, analyses were undertaken at the district and regional levels. At these levels, administration, management, social mobilization, and supervision costs were included. These costs were excluded from the earlier analysis because of the difficulty in allocating these costs among the teams and facilities studied. Contributions of District Councils and the Khartoum City Commission are also included in this analysis.

A. District Analysis

1. Total Cost

As shown in Table VI.1, the total cost of the EPI was similar for the three districts studied, averaging approximately $220,910 annually. The annualized capital cost of buildings made up the single largest category at nearly 40 percent of total costs. Personnel costs made up almost one-quarter of the total, with equipment and vaccines each making up over 10 percent. The most costly district was Ombdurman, largely due to higher recurrent costs.

TABLE VI.1
COST OF THE EPI AT THE DISTRICT LEVEL
IN NATIONAL CAPITAL REGION
(in US$)

Cost Category	Knartoum	Ombdurman	Khartoum North	Average	%
RECURRENT COST					
1. Personnel	51,331	58,759	43,863	51,318	0.2
Salary					
Staff Support					
Per Diem					
2. Vaccine	18,239	32,325	24,496	25,020	0.1
3. Supplies	11,303	14,052	5,553	10,303	0.0
4. Transportation	2,525	4,499	2,691	3,238	0.0
-Fuel	2,165	4,049	2,422	2,879	
-Oil	360	449	270	360	
5. Maintenance/Operat.	3,794	4,505	2,278	3,526	0.0
6. Training	737	902	682	774	0.0
7. Other					
Subtotal	83,398	109,635	76,604	89,879	0.4
CAPITAL COSTS					
1. Vehicles	16,497	19,586	9,905	15,329	0.1
2. Equipment	48,331	11,074	30,974	30,127	0.1
3. Buildings	72,876	106,212	77,637	85,575	0.4
4. Other					
Subtotal	137,703	136,872	118,516	131,031	0.6
TOTAL COST	$221,101	$246,508	$195,120	$220,910	1.0
PERCENT TT DOSES	0.1	0.1	0.1	0.1	
TOTAL CHILD COST	$198,477	$214,132	$174,908	$195,839	
TOTAL DOSES	277,704	290,772	137,040	235,172	
COST PER DOSE	$0.80	$0.85	$1.42	$0.94	
TARGET POPULATION	29,544	34,442	18,113	27,366	
COVERAGE (NO. FIC)	18,022	21,010	11,049	16,693	
COST/FIC	$11.01	$10.19	$15.83	$11.73	

NB: Building costs estimated from average annual cost of EPI rooms for different types of health facilities. Building costs shared between Khartoum North and East Nile Districts. One-half of total shown here under Khartoum North.

2. Doses Administered and Number of Children Fully Immunized

Table VI.1 also shows the number of doses administered in each district and the number of children fully immunized. While Khartoum and Ombdurman districts are similar in terms of total doses and number of FIC, Khartoum North district's output indicators are considerably below those of the other two districts. This may be due to different population size, difficult accessibility, or less efficient service delivery.

3. Average Cost per Dose and per Fully Immunized Child

The average cost per dose at the district level was $.94, ranging from $0.80 in Khartoum to $1.42 in Khartoum North. The average cost per FIC was $11.73 and ranged from $10.19 in Ombdurman to $15.83 in Khartoum North. The higher costs per dose and per FIC for Khartoum North can be traced to the lower output measures, since as was noted above Khartoum North was the least expensive district in terms of total cost. These figures are similar to those found in other countries. The cost per FIC is lower than that found in the other regions studied, which may be a result of higher population density in the capital region than elsewhere in Sudan.

4. Drop-Out Rates

Table VI.2 compares the drop-out rates for the three districts studied in the National Capital Region. The results show a higher drop-out rate from DPT1 to DPT3 than that found in the coverage survey, although the drop-out rate from TT1 to TT2 is very similar.

TABLE VI.2
COMPARISON OF DROP-OUT RATES FOR DISTRICTS IN NATIONAL CAPITAL REGION
(percentage)

District:	DPT1-DPT2	DPT2-DPT3	DPT1-DPT3	TT1-TT2
Khartoum	23	10	31	19
Khartoum North	18	10	26	10
Ombdurman	11	0	10	13
Average (unweighted)	17	7	23	14
Coverage Survey	n.a.	n.a.	11	12

Figures rounded to nearest whole percentage point.
n.a.: not available.

5. Vaccine Wastage Rates

Table VI.3 shows the vaccine wastage rates calculated for the three districts studied. The results show that wastage rates overall are quite high. Khartoum district has lower wastage rates for all vaccines except DPT than the other two districts, although a wide range of wastage rates was found.

TABLE VI.3
COMPARISON OF WASTAGE RATES AMONG DISTRICTS IN NATIONAL CAPITAL REGION
(percentage)

District	BCG	DPT	OPV	Measles	TT
Khartoum	52	94	32	31	51
Khartoum North	81	41	80	89	82
Ombdurman	86	48	52	68	67
Average (unweighted)	73	61	55	63	67

Figures rounded to nearest whole percentage point.

6. Summary of Results

Although the number of districts compared (three) is small, a matrix of costs and outcomes was developed in order to categorize the three districts studied. In terms of total costs, Khartoum and Ombdurman districts were similar and significantly higher than those of Khartoum North. Therefore, the former two were categorized as high cost, while the latter was categorized as low cost. In terms of outcomes (measured as number of doses delivered), once again Khartoum and Ombdurman districts were similar and much higher than Khartoum North, and thus the first two were categorized as high output while the last was categorized as low output. Table VI.4 illustrates the resulting matrix, with the cost per dose listed in parentheses.

TABLE VI.4
COMPARISON OF DISTRICTS IN KHARTOUM

	HIGH COST	LOW COST
HIGH OUT-COME	Khartoum ($0.80) Ombdurman ($0.85)	
LOW OUT-COME		Khartoum North ($1.42)

Cost per dose shown in parentheses.

As Table VI.4 shows, despite the lower total costs of Khartoum North District, it is the least cost-effective district in terms of cost per dose because the total number of doses delivered lags far behind the other two districts. This could be a result of a smaller or more dispersed population, more limited EPI services, or a less efficient program.

Some of the factors which might contribute toward making a district more or less cost-effective are shown in Table VI.5 below.

TABLE VI.5
DISTRICTS: INDICATORS OF COST AND EFFECTIVENESS

	HIGH COST	LOW COST
	CASE 1	CASE 2
HIGH OUT-COME	High equipment costs High personnel cost High level of activity Resupply uses EPI vehicle Large staff spends time on enumeration & follow-up of defaulters EPI sessions occupy a large space Many sessions held, well attended	Low equipment costs Low personnel costs High level of activity Resupply by public transport Small staff Few sessions per week High utilization, follow-up done by community
	CASE 3	CASE 4
LOW OUT-COME	Low output High transport cost High personnel cost	High transport costs Low output Low personnel cost

B. Regional Analysis

1. Total Cost

The regional-level analysis includes all administrative costs of the program and contributions made by NGO's and other donor organizations. As is shown in Table VI.6, the total cost of providing EPI services in National Capital Region was $1.7 million. Seventy-eight percent of the total resources were financed by UNICEF cash assistance to the EPI. The role of the MOH is restricted mainly to building costs and some personnel. The City Commission does not contribute a substantial amount at less than one percent. The Irish international aid agency, GOAL, and Arab International Relief Assistance (AIRA) contributed some buildings.

TABLE VI.6
TOTAL COST OF THE EPI AT THE REGIONAL LEVEL IN NATIONAL CAPITAL REGION

Category	MOH	City Commission	EPI/ UNICEF	GOAL	AIRA	Total	Percent
RECURRENT COST							
Personnel	$23,938		$23,303			$47,241	0.0
Salary/Benefits	$23,938					$23,938	
Per Diem			$19,191			$19,191	
Staff Support			$4,112			$4,112	
Vaccine			$860,932			$860,932	0.5
Supplies			$271,180			$271,180	0.2
Transportation		$5,723	$30,382			$36,105	0.0
Fuel		$5,723	$3,143			$8,866	
Oil			$27,239			$27,239	
Maintenance/Oper.		$930	$19,702			$20,633	0.0
Cold Chain							
Vehicles			$19,702			$19,702	
Building		$930				$930	
Training			$5,769			$5,769	0.0
Social Mobilization							
Other	$11,236		$11,185			$22,421	0.0
SUBTOTAL RECURRENT	$35,174	$6,653	$1,222,454	$0	$0	$1,264,281	0.7
CAPITAL COST							
Equipment			$49,202			$49,202	0.0
Vehicles			$85,662			$85,662	0.0
Buildings	$334,549			$1,015	$226	$335,790	0.2
Other							
SUBTOTAL CAPITAL	$334,549	$0	$134,863	$1,015	$226	$470,653	0.3
TOTAL COST	$369,723	$6,653	$1,357,317	$1,015	$226	$1,734,934	1.0
PERCENT	0.2	0.0	0.8	0.0	0.0	1.0	
TOTAL COST						$1,734,934	
PERCENT TT DOSES a/						9.5%	
TOTAL CHILD COST						$1,570,115	
TOTAL DOSES b/						994,777	
COST PER DOSE						$1.84	
TARGET POPULATION						95,643	
COVERAGE (NO. FIC)						58,342	
% FIC < 1 YEAR						61.0%	
COST/FIC -- US $						$26.91	
COST/FIC -- LS						120	

a/ From computerized EPI reporting system, recorded in EPI Third Quarter Report for 1988.
b/ Total doses delivered estimated from total reported doses January-September 1988 from computerized EPI reporting system. Includes TT and doses administered to children over one year of age.

2. Number of Doses Administered and FIC

The total number of doses delivered in National Capital Region was estimated from the EPI Third Quarter Report from 1988. Based on the figures for January through September, the total number was estimated at 994,777. The percentage of reported doses which were TT doses was 9.5 percent. Using the results of the regional coverage survey and the estimated size of the target population, the total number of FIC was calculated. According to the coverage survey, 61 percent of children surveyed were fully immunized by their first birthday, resulting in 58,342 FIC in the region.

3. Average Cost per Dose and per FIC

Comparing the total cost of the program with the estimated number of doses delivered, the cost per dose was calculated at $1.84. This figure is lower than the $2.09 cost per dose found in Darfur, but higher than the $1.62 found in Kordofan. When the total child cost is compared to the estimated number of FIC in the region, the cost per FIC was calculated at $26.91. This number is slightly more than $1 per FIC lower than that found in Darfur and over $3 higher than that found in Kordofan.

4. Sensitivity Analysis

In order to assess what effect some of the assumptions used had on the results, a sensitivity analysis was conducted on the regional results. This analysis examined three scenarios: 1) a change in the exchange rate used from LS 4.45 to the 1989 market rate of LS 12 per U.S. dollar; 2) inclusion of all FIC in the calculations regardless of the age at which they completed their immunizations; and 3) shortening of the vehicle life from five to three years to reflect road conditions in the region. Table VI.7 shows the results of this sensitivity analysis.

TABLE VI.7
SENSITIVITY ANALYSIS OF THE COST-EFFECTIVENESS OF THE EPI IN NATIONAL CAPITAL REGION

Scenario	Description	Total Child Cost	Number FIC	Cost/ FIC	Percent Change
	Original estimate	$1,570,115	58,342	$26.91	
A	Exchange rate of 12 Sudanese pounds/1 USD	$1,523,690	58,342	$26.12	-2.94
B	All children fully immunized	$1,570,115	66,472	$23.62	-12.23
C	Vehicle life reduced to three years rather than five years	$1,605,377	58,342	$27.52	2.27

a) Exchange rate

The cost-effectiveness study used an exchange rate of 4.45 Sudanese pounds per U.S. dollar, which is an average of the official rate (LS 4.50) and the United Nations rate (LS 4.40) for the first ten months of 1988. All donor assistance funnelled through UNICEF is subject to the 4.40 exchange rate and therefore, it was felt important to average the two rates for the study. Because the exchange rate for the U.S. dollar rose from 4.50 to 12 in October 1988, a sensitivity analysis was undertaken to see what would happen to the cost of the program if the new exchange rate is used. This results in a reduction of nearly three percent in the cost per FIC less than one to nearly $26.12.

b) All children fully immunized

The coverage survey calculated that 61 percent of the children in the sample had been fully immunized by their first birthday; however, 69.5 percent of the total sample were fully immunized. This sensitivity analysis uses the figure of 69.5 percent to assess the impact on the cost-effectiveness of the program if children had been immunized earlier. This results in a 12 percent reduction in the cost per FIC to $23.62 or LS 105. This demonstrates that a relatively minor improvement in the number of children fully immunized (8.5 percent) could have a noticeable impact on cost per FIC.

c) Vehicle life of three years

If the estimated useful life of vehicles is reduced from five to three years to reflect more accurately the driving conditions in National Capital Region, the total child cost of the EPI increases to $1,605,377, and the cost per FIC increases 2.27 percent to $27.52 or LS 122. This slight change indicates that the assumption of a five year vehicle life had little effect on the cost per FIC.

In summary, the sensitivity analysis showed relatively small changes in the cost per FIC when three of the major assumptions were changed. The modification which had the largest effect on the cost per FIC was the increase in the number of children considered to be fully immunized, reflecting the importance of expanding coverage levels.

VII. CONCLUSIONS AND RECOMMENDATIONS

The EPI in Sudan uses a combination of fixed site and mobile immunization services to reach the target population of 95,643 infants and 119,556 pregnant women. The results of the 1989 coverage survey show that the EPI has raised the number of children fully immunized by their first birthday against the six target diseases to over 60 percent in National Capital Region, a tremendous accomplishment for the region. In addition, over 50 percent of mothers have been immunized with tetanus toxoid.

The cost-effectiveness study of the EPI has shown that there is a wide variation in the performance and efficiency of health facilities, mobile teams, and districts. These variations should be used to indicate ways to reduce costs and increase the effectiveness of the program. A few important conclusions, with accompanying recommendations, follow:

High Overall Costs May be Traced to Vertical Program

The high cost of the EPI in National Capital Region may be due in part to the vertical nature of the program. Integration of immunization with other health services may help reduce costs. It is likely that significant missed opportunities for immunization occur when parents who bring their children in for curative care are not encouraged to have their children immunized at that time. Health workers who provide both curative and immunization services are more likely to take advantage of these opportunities to increase coverage.

Performance of Health Facilities Varies More than Costs

Among the 10 health facilities studied (eight health centers and two dispensaries), total costs ranged from $3,406 to $6,747, a ratio of approximately 1:2. In terms of the total number of doses, however, the ratio was 1:46, and for FIC the ratio was 1:49. These differences highlight the importance of increasing mobilization and outreach services in order to reach a larger number of children. Low immunization activity may be due to an overlap between mobile team and health facility services. Since health

facilities are less costly in terms of total costs, efforts should be made to strengthen this approach to immunization. If low output is due to a very small target population, the area might be better served through outreach services from other fixed facilities. Current redundancies between health facilities and mobile teams increase costs, and the role of mobile teams should be to provide services to the population without access to facility care.

Cost-effective Service Providers Should be Studied Further

The mobile teams, health facilities, and districts which are the most productive and least costly should be analyzed from an operational point of view. Differences in cost-effectiveness may be due to target populations that vary in their size and accessibility. However, differences may also be due to inefficiencies. These inefficiencies (e.g. a high-cost delivery site serving a small population; lack of outreach leading to low attendance at immunization sessions; supply wastage; staff larger than necessary; low staff productivity; and unnecessary use of transport) should be addressed to improve performance and lower costs. The factors which make some sites particularly successful should be studied to see if they can be exported elsewhere in the region in order to strengthen the program.

Some of the teams, facilities, and districts which should be examined further because of their high cost-effectiveness are listed below:

Mobile team:	team surveyed in Ombdurman District
Health Facilities:	Khartoum HF3 (Taisha/Mygoma) Khartoum HF2 (Azozab) Khartoum North HF9 (Shembat West/El Safia) Khartoum HF1 (Mayo Ext.)
Districts:	Ombdurman Khartoum

Vaccine Wastage Rates are High

With few exceptions, vaccine wastage rates at all levels were high. This could indicate problems in the cold chain, poor record-keeping, or low attendance rates at immunization sessions. Teams and facilities with high wastage rates should be studied to ascertain the causes of high rates and whether wastage can be reduced. While vaccinators should be encouraged to open vaccine bottles even if only one child or mother attends an immunization session, EPI managers should also emphasize the importance of making more active efforts to mobilize families to bring their children to the immunization site.

Drop-Out Rates Could be Reduced Through Outreach

While the drop-out rates calculated for the study compare only the number of doses of each type given in a single month, they indicate in many cases significant drop-out rates between DPT1 and DPT3 and between TT1 and TT2. Immunization records should be studied at each delivery site on a regular basis to identify drop-outs. Infants or women who do not show up for subsequent doses should be visited and encouraged to return to complete their vaccination schedule.

Record-keeping is Inconsistent or Inadequate

Throughout the study, the team had difficulty in finding complete and accurate records at health facilities. Health workers may have little incentive to complete records well, or may not have received adequate training in how to fill out the required forms and how to use the resulting information for management purposes. If health workers can be shown how this information can be useful to them and not only to the central office, they might take more interest in keeping accurate and complete records. In the short run, health workers should be encouraged to keep a copy of each of the required forms at the facility rather than just sending them to district headquarters.

In summary, the achievements of the EPI have been significant over the past few years. However, additional attention placed on increasing performance and reducing inefficiencies could increase the success of the program as a whole by releasing additional resources for implementation. A successful, cost-effective program could have an even greater impact in reducing the number of preventable child deaths in National Capital Region and Sudan as a whole.

APPENDICES

Appendix 1:

Itinerary of Field Activities

Given the small size of the region, data collection at EPI static sites and District Operations Offices (for mobile teams and district level interviews) was undertaken in five separate day-trips from Khartoum. The itinerary was:

11 March:	Site selection meeting at Regional Operations Office with the four District Operations Officers and ROO.
12 March:	Khartoum District - four urban health facilities.
13 March:	Ombdurman District - three urban facilities and one mobile team.
15 March:	Khartoum North District - one rural facility, one mobile team and District questionnaire.
16 March:	Ombdurman District - one rural facility, one mobile team and District questionnaire.
19 March:	Khartoum District - one rural facility (mobile team supported); one mobile team and District questionnaire.

Appendix 2:

Background Tables

ESTIMATION OF TRAVEL COST AND OTHER INDICATORS
FOR MOBILE TEAMS IN NATIONAL CAPITAL

MOBILE TEAM/ INDICATOR	MT1 OMBDURMAN TOTAL	MT2 KHARTOUM	AVERAGE
Kms travelled per round	869	400	635
Scheduled rounds per year	24	12	18
Actual rounds last year	16	11	14
Percent scheduled to actual rounds	66.7%	91.7%	79.2%
Kms travelled per year	6,490	4,400	5,445
Sites visited/round	35	30	33
No. returns/round	1	17	9
Days per round	20	17	19
Staff per team	4	5	
Doses given/month	1,641	684	1163
Doses given/year	26,256	7,524	16890
No. FIC/month	208	65	137
No. FIC/year	3,328	715	2022
Population served <1 year	2,400	11,824	7112
Days/site	0.6	0.6	0.57
Kms/Dose	0.25	0.58	0.42
Kms/Contact (DPT1 <1)	31	41	36
Kms/FIC	1.95	6.15	4.05
Doses/site/month	46.89	22.80	34.84
Doses/FIC/month	7.89	10.52	9.21
Doses/day	82.05	40.24	61.14
Doses/person/day	21	8	14
FIC/day	10.40	3.82	7.11
Kms/day	43.45	23.53	33.49
Dose/population	10.94	0.64	5.79
FIC/population	1.39	0.06	0.72

FIC for Ombdurman mobile team based on DPT3 doses given.
FIC for Khartoum mobile team based on DPT3 doses given.
Population served by Khartoum mobile team estimated as 4% of total population.

WORKSHEET FOR VACCINE COST, WASTAGE AND DROP-OUT RATES FOR NATIONAL CAPITAL REGION

ANTI-GEN	DOSES/ VIAL	OPENING BALANCE	STOCK RECD	CLOSING BALANCE	TOTAL VIALS USED	DOSES GIVEN <12 MOS	DOSES GIVEN >12 MOS	TOTAL DOSES	TOTAL VIALS GIVEN	WAST-AGE	DROP-OUT	PERCENT OUT-OF TARGET	ANNUAL DOSES	ANNUAL VIALS	TOTAL COST (DOSES)	TOTAL COST (VIALS)
BCG	20	82,970	20,000	57,940	2,252	6,908	797	7,705	386	82.9%		10.3%	92,460	4,632	$3,513	$20,538
DPT	20	68,730	20,000	52,380	1,818	19,930	3,004	126,965	6,349	-249.2%		10.1%	1,523,580	76,188	$55,763	$15,969
DPT1						7,752	868	7,245	363		-171.2%	11.9%	86,940	4,356		
DPT2						6,380	865	19,646	983		0.0%	6.5%	235,752	11,796		
DPT3						18,375	1,271	19,646	983		-171.2%	6.5%	235,752	11,796		
OPV	20	57,130	30,000	46,118	2,051	20,006	3,104	23,110	1,156	43.6%		13.4%	277,320	13,872	$9,401	$16,687
OPV1						7,754	918	8,672	434		22.5%	10.6%	104,064	5,208		
OPV2						5,809	915	6,724	337		-5.7%	13.6%	80,688	4,044		
OPV3						5,833	1,271	7,104	356		18.1%	17.9%	85,248	4,272		
MEASLES	10	49,680	15,000	49,220	1,546	4,015	2,796	6,811	682	55.9%		41.1%	81,732	8,184	$9,293	$21,094
						ADULT WOMEN										
TT	20	60,860	16,000	56,720	1,007	7,258		7,258	363	64.0%			87,096	4,356	$867	$2,405
TT1						3,938		3,938	197		15.7%		47,256	2,364		
TT2						3,320		3,320	166				39,840	1,992		
PERCENT TT/EPI DOSES								4.2%								
PERCENT TT/EPI VIALS									4.2%							
TOTAL						58,117	9,701	171,869	8,936				2,062,188	107,232	$78,837	$76,693

	COST/DOSE	COST/VIAL
BCG	$0.038	$0.760
DPT	$0.037	$0.732
OPV	$0.034	$0.678
MEASLES	$0.114	$1.137
TT	$0.010	$0.199

SENSITIVITY ANALYSIS B:
TOTAL COST OF THE EPI AT REGIONAL LEVEL IN NATIONAL CAPITAL
ALL CHILDREN FULLY IMMUNIZED

CATEGORY	MOH	CITY COMMISSION	EPI/ UNICEF	GOAL	AIRA	TOTAL	PERCENT
RECURRENT COST							
Personnel	$23,938		$23,303			$47,241	2.7%
Salary/Benefits	$23,938					$23,938	1.4%
Per Diem			$19,191			$19,191	1.1%
Staff Support			$4,112			$4,112	0.2%
Vaccine			$860,932			$860,932	49.6%
Supplies			$271,180			$271,180	15.6%
Transportation		$5,723	$30,382			$36,105	2.1%
Fuel		$5,723	$3,143			$8,866	0.5%
Oil			$27,239			$27,239	1.6%
Maintenance/Oper.		$930	$19,702			$20,633	1.2%
Cold Chain							
Vehicles			$19,702			$19,702	1.1%
Building		$930				$930	0.1%
Training			$5,769			$5,769	0.3%
Social Mobilization							
Other	$11,236		$11,185			$22,421	1.3%
SUBTOTAL RECURRENT	$35,174	$6,653	$1,222,454	$0	$0	$1,264,281	72.9%
CAPITAL COST							
Equipment			$49,202			$49,202	2.8%
Vehicles			$85,662			$85,662	4.9%
Buildings	$334,549			$1,015	$226	$335,790	
Other							
SUBTOTAL CAPITAL	$334,549	$0	$134,863	$1,015	$226	$470,653	27.1%
TOTAL COST	$369,723	$6,653	$1,357,317	$1,015	$226	$1,734,934	100.0%
PERCENT	21.3%	0.4%	78.2%	0.1%	0.0%	100.0%	

TOTAL COST	$1,734,934
PERCENT TT DOSES a/	9.5%
TOTAL CHILD COST	$1,570,115
TOTAL DOSES b/	994,777
COST PER DOSE	$1.74
TARGET POPULATION	95,643
COVERAGE (NO. FIC)	66,472
% FIC < 1 YEAR	69.5%
COST/FIC -- US $	$23.62
COST/FIC -- LS	105

a/ From computerized EPI reporting system, recorded in EPI Third Quarter Report for 1988.
b/ Total doses delivered estimated from total reported doses January-September 1988 from computerized EPI reporting system. Includes TT and doses administered to children over one year of age.

SENSITIVITY ANALYSIS C:
TOTAL COST OF THE EPI AT REGIONAL LEVEL IN NATIONAL CAPITAL
VEHICLE LIFE REDUCED TO THREE YEARS

CATEGORY	MOH	CITY COMMISSION	EPI/ UNICEF	GOAL	AIRA	TOTAL	PERCENT
RECURRENT COST							
Personnel	$23,938		$23,303			$47,241	2.7%
Salary/Benefits	$23,938					$23,938	1.3%
Per Diem			$19,191			$19,191	1.1%
Staff Support			$4,112			$4,112	0.2%
Vaccine			$860,932			$860,932	48.5%
Supplies			$271,180			$271,180	15.3%
Transportation		$5,723	$30,382			$36,105	2.0%
Fuel		$5,723	$3,143			$8,866	0.5%
Oil			$27,239			$27,239	1.5%
Maintenance/Oper.		$930	$26,988			$27,918	1.6%
Cold Chain							
Vehicles			$26,988			$26,988	1.5%
Building		$930				$930	0.1%
Training			$5,769			$5,769	0.3%
Social Mobilization							
Other	$11,236		$11,185			$22,421	1.3%
SUBTOTAL RECURRENT	$35,174	$6,653	$1,229,740	$0	$0	$1,271,567	71.7%
CAPITAL COST							
Equipment			$49,202			$49,202	2.8%
Vehicles			$117,339			$117,339	6.6%
Buildings	$334,549			$1,015	$226	$335,790	
Other							
SUBTOTAL CAPITAL	$334,549	$0	$166,540	$1,015	$226	$502,330	28.3%
TOTAL COST	$369,723	$6,653	$1,396,280	$1,015	$226	$1,773,897	100.0%
PERCENT	20.8%	0.4%	78.7%	0.1%	0.0%	100.0%	

TOTAL COST	$1,773,897
PERCENT TT DOSES a/	9.5%
TOTAL CHILD COST	$1,605,377
TOTAL DOSES b/	994,777
COST PER DOSE	$1.78
TARGET POPULATION	95,643
COVERAGE (NO. FIC)	58,342
% FIC < 1 YEAR	61.0%
COST/FIC -- US $	$27.52
COST/FIC -- LS	122

a/ From computerized EPI reporting system, recorded in EPI Third Quarter Report for 1988.
b/ Total doses delivered estimated from total reported doses January-September 1988 from computerized EPI reporting system. Includes TT and doses administered to children over one year of age.

SENSITIVITY ANALYSIS A: TOTAL COST OF THE EPI AT REGIONAL LEVEL IN NATIONAL CAPITAL
EXCHANGE RATE LS 12 PER US DOLLAR

CATEGORY	MOH	CITY COMMISSION	EPI/ UNICEF	GOAL	AIRA	TOTAL	PERCENT
RECURRENT COST							
Personnel	$8,877		$15,505			$24,381	1.4%
Salary/Benefits	$8,877		--			$8,877	0.5%
Per Diem			$13,980			$13,980	0.8%
Staff Support			$1,525			$1,525	0.1%
Vaccine			$860,932			$860,932	51.1%
Supplies			$271,180			$271,180	16.1%
Transportation		$5,723	$30,382			$36,105	2.1%
Fuel		$5,723	$3,143			$8,866	0.5%
Oil			$27,239			$27,239	1.6%
Maintenance/Oper.		$930	$19,702			$20,633	1.2%
Cold Chain							
Vehicles			$19,702			$19,702	1.2%
Building		$930				$930	0.1%
Training			$2,140			$2,140	0.1%
Social Mobilization							
Other	$4,167		$11,185			$15,352	0.9%
SUBTOTAL RECURRENT	$13,044	$6,653	$1,211,025	$0	$0	$1,230,722	73.1%
CAPITAL COST							
Equipment			$49,202			$49,202	2.9%
Vehicles			$85,662			$85,662	5.1%
Buildings	$317,589			$376	$84	$318,049	
Other							
SUBTOTAL CAPITAL	$317,589	$0	$134,863	$376	$84	$452,913	26.9%
TOTAL COST	$330,633	$6,653	$1,345,889	$376	$84	$1,683,635	100.0%
PERCENT	19.6%	0.4%	79.9%	0.0%	0.0%	100.0%	

TOTAL COST	$1,683,635
PERCENT TT DOSES a/	9.5%
TOTAL CHILD COST	$1,523,690
TOTAL DOSES b/	994,777
COST PER DOSE	$1.69
TARGET POPULATION	95,643
COVERAGE (NO. FIC)	58,342
% FIC < 1 YEAR	61.0%
COST/FIC -- US $	$26.12
COST/FIC -- LS	313

a/ From computerized EPI reporting system, recorded in EPI Third Quarter Report for 1988.
b/ Total doses delivered estimated from total reported doses January-September 1988 from computerized EPI reporting system. Includes TT and doses administered to children over one year of age.

WORKSHEET FOR IMMUNIZATION EQUIPMENT FOR NATIONAL CAPITAL REGION

TYPE OF VACCINATION EQUIPMENTS	NATIONAL CAPITAL HQ	NATIONAL CAPITAL ALL	ANNUAL UNIT PRICE	TOTAL COST	TOTAL UNICEF	TOTAL OTHER
Toyota Hilux Double Cab	3	11	$4,314.91	$47,464.01	$47,464	
Toyota Hilux Single Cab	0	6	$3,959.80	$23,758.78	$23,759	
Motorcycles 2WD	0	15	$42[illegible].44	$6,351.63	$6,352	
Motorcycles 3WD	0	1	$527.00	$527.00	$527	
Bicycles	0	7	$141.44	$990.05	$990	
Fiat Panda	0	1	$1,884.36	$1,884.36	$1,884	
Land Rover	0	1	$4,685.83	$4,685.83		$4,686
Solar refrigerator	0	1	$1,438.45	$1,438.45		$1,438
RCW42 EK	0	43	$257.67	$11,079.67	$11,080	
TFW 791	1	1	$196.05	$196.05	$196	
TCW 1151	1	31	$481.54	$14,927.79	$14,928	
Electrolux fraezer	0	1	$312.28	$312.28		$312
Lec Ref Ltd	0	1	$334.66	$334.66		$335
Sibir	0	40	$334.66	$13,386.48		$13,386
Vaccine Carrier 1.7 lts	5	17	$7.48	$127.15	$127	
Vaccine carrier 3504/38	0	140	$6.15	$860.66		$861
Vax Carrier 0.3 ltrs	20	36	$6.25	$225.00	$225	
Ice Packs	400	400	$0.19	$77.87	$78	
Round Thermometer	10	10	$0.37	$3.72	$4	
Cold Box 20 litres	0	25	$102.14	$2,553.39	$2,553	
Cold Box 8.5 litres	4	18	$35.88	$645.90	$646	
Iron Cold Box	5	5	$50.00	$250.00		$250
RCW 25	0	4	$89.82	$359.28	$359	
Generator (4.5 KVA)	0	3	$483.40	$1,450.20	$1,450	
Ice Pack Indicator	0	20		$0.00	$0	
Public Address	0	5	$54.29	$271.45	$271	
Tape recorder	1	4	$32.64	$130.56	$131	
Table	0	5	$19.61	$98.03		$98
Chair-wooden	2	6	$10.13	$60.75		$61
Chair-metal	2	5	$15.04	$75.20		$75
File cabinet	1	3	$66.19	$198.57		$199
Desk	2	2	$69.23	$138.46		$138
TOTAL COST				$134,863	$113,024	$21,839
TOTAL VEHICLE COST				$85,662	$80,976	$4,686
TOTAL EQUIPMENT COST				$49,202	$32,048	$17,154

Toyota Hilux Double cab	$4,314.91
Toyota Hilux Single cab	$3,959.80
Land Cruiser Pickup Diesel	$4,685.83
Land Cruiser Saloon	$5,577.70
Land Cruiser	$6,693.24
Panda	
Motorcycle 70cc	$402.69
Motorcycle 80cc	$423.44
Motorcycle Three-Wheeler	$527.00
Motorcycle 125 cc	$465.79
Bicycles	$141.44
Air conditioner	$223.11
Solar refrigerator BP	$1,120.29
Solar refrigerator (Italy)	$1,438.45
RCW42 EK	$257.67
TFW 791	$195.05
TCW 1151	$481.54
Admiral refrigerator	$283.22
ColdAir refrigerator	$220.28
Electrolux refrigerator	$312.28
Philips Tropical fridge	$223.11
Sibir refrigerator S2325	$334.66
Step-in Refrigerator +3Deg	$1,036.47
Admiral freezer	$440.56
Electrolux Chest freezer	$117.63
Vestfrost HF5201 T Freezer	$50.97
?Chest freezer (Sussex)	$168.04
Vaccine Carrier 1.7 lts	$7.48
Vaccine carrier 3504/38	$6.15
Vaccine Carrier 0.3 lts	$6.25
Ice packs for Model II	$0.20
Ice packs w/vial holes	$0.19
Thermos ice-packs (box)	$39.45
Dial Thermometer (probe)	$17.60
Round Thermometer w/hook	$0.37
Cold Box 20 litres	$102.14
Cold Box 8.5 ltr Model 2	$35.88
RCW 25 (911 1501.01)	$89.82
Coleman Cold Box (E4/06)**	$50.00
Generator 4.5KVA	$483.40
Generator 15 KVA	$2,602.93
Generator 12.5 KVA	$1,264.28
Generator portable 0.5 KVA	$334.66
Generator, portable	$334.66
Generator 4.5 KVA	$483.40
Voltage Regulator(brown)	$98.17
Voltage Regulator(orange)	$183.33
Voltage Regulator (red)	$98.17
Voltage Regulator	$98.17
Public Address (Mobile)	$54.29
Public Address (Fixed) TOA	$165.84
Megaphone	$0.00
Tape recorder/Cassette	$32.64
Slide projector Hanimex	$81.46
Chair, metal frame	$15.04
Chair, wooden	$10.13
Table, wooden	$19.61

Small table/stool	$4.41
Desk with drawers, metal	$69.23
Shelves (4 stacked layers)	$30.21
Filing cabinet, 4-drawer	$66.19
Cupboard	$91.92
Duplicator Gestetner 4130	$253.97
Typewriter Arabic	$126.03
Typewriter English	$89.62
Oxyacetylene Gun & Hose	$92.96
Tank for Oxygen/Acetyline	$0.00
Regulator for tank	$0.00
Freon tank	$0.00

WORKSHEET FOR SUPPLIES COST AND WASTAGE FOR NATIONAL CAPITAL REGION

SUPPLY	OPENING BALANCE	STOCK REC'D	CLOSING BALANCE	TOTAL USED (month)	TOTAL USED (year)	TOTAL COST
1cc syringe	86,795	20,000	69,060	37,735	1,564,668	$65,181
2cc syringe	3,240	16,455	23,895	(4,200)	5,015,712	$157,744
BCG needles	0	0	0	0	0	$0
Vacc. monitor	10	0	5	5	60	$164
Reg books	0	0	0	95	1,140	$4,001
Road to Health	1,000	40,000	1,000	40,000	480,000	$24,000
Cotton (pack)	0	0	0	0	0	$0
Freezewatch	0	0	100	0	100	$90
Vaccine pack tape	0	0	0	0	0	$0
TOTAL COST						$271,180

ESTIMATION OF PERSONNEL COST FOR NATIONAL CAPITAL REGION

CATEGORIES OF PERSONNEL	NATIONAL CAPITAL HQ	NATIONAL CAPITAL ALL	SAL/BENEF PER MONTH	STAFF SUPPORT PER MONTH	PER DIE PER MON	MONTHLY EPI COST	ANNUAL COST (LS)	ANNUAL COST ($)
Regional Director Med Serv	0.13	0.13	1378	350	350	260	3117	$701
Asst Director Med Serv	0.00	0.05	1097	250	250	80	958	$215
Deputy Director Health Serv	0.00	0.33	607		250	286	3430	$771
Regional Operations Officer	1.00	1.00	995	350	525	1870	22440	$5,043
District Operations Officer	0.00	4.00	507		306	3251	39009	$8,766
Asst. D.O.O.	0.00	1.00	232		136	368	4419	$993
Vaccinators	0.00	108.00	327	100	400	89262	1071147	$240,707
Supervisors	0.00	7.00	391		360	5258	63093	$14,178
Statistician	1.00	1.00	385	150	0	535	6420	$1,443
Supply Officer	0.00	1.00	383	75	0	458	5497	$1,235
Driver	1.15	5.15	355		225	2987	35844	$8,055
Generator Operator	1.00	1.00	161		0	161	1926	$433
Accountant	0.02	0.02	865	150	0	21	254	$57
Cold Chain Technician	0.00	1.00	339		270	609	7307	$1,642
Typist/Recorder	0.25	0.25	465	100	0	141	1695	$381
Guard/Errand	2.00	3.00	390		0	1170	14040	$3,155
Total FTE	6.54	133.93						
TOTAL COST PER MONTH LS			8,877	1,525	3,072	106,716	1,280,595	$287,774
TOTAL COST PER MONTH $			$1,995	$343	$690	$23,981	$287,774	$64,668
TOTAL COST PER YEAR LS			106,524	18,300	36,858	1,280,595		
TOTAL COST PER YEAR $$			$23,938	$4,112	$8,283	$287,774		
Hours per week	48							
Hours per month	192							

BIBLIOGRAPHY

Abel-Smith Brian and Ajay Dua, "The Potential of Community Financing of the Health Sector in Developing Countries", in Health Care Financing, Asian Development Bank, the Economic Development Institute of the World Bank, and the East-West Center, Regional Seminar on Health Care Financing, Manila, Philippines 1987.

Asian Development Bank,
Economic Development Institute and East-West Center, Health Care Financing, Regional Seminar on Health Care Financing, Manila, Philippines 1987

Carrin, Guy, "Community Financing of Health Care", in World Health Forum, [B Vol.9, 1988

Declaration of Alma Ata, September 1978

Evlo, Kodjo, Health Financing in Africa: Tracking the AID Experience of the Child Survival Emphasis Countries. REACH Project, Arlington: VA, 1989

Galofré, Fernando (ed), Pobreza Crítica en la Niñez; América Latina y el Caribe. CEPAL/UNICEF, Santiago de Chile, 1981

Mora, José Obdulio, "Periodos óptimos de intervención en niños pobres", en Fernando Galofré (ed.)

Molina, Sergio, Introduction in Fernando Galofré (ed.)

Piñera, Sebastián, Se benefician los pobres del crecimiento económico?, Proyecto Interinstitucional de Pobreza Crítica, CEPAL, Santiago de Chile, 1978

UNICEF, The State of the World's Children 1990

U.S. Agency for International Development. Child Survival; A Fourth Report to Congress on the USAID Program

Walsh, Julia, Establishing Health Priorities in the Developing World. UNDP, 1988

2/28/90