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The Cost-Effectiveness of Immunization Strategies in Ecuador

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REACH

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THE COST-EFFECTIVENESS OF IMMUNIZATION STRATEGIES IN ECUADOR

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LIST OF ACRONYMS USED IN THIS REPORT

BCG:	Bacilis Calmette - Guerin vaccine against tuberculosis
CEPLAES:	Ecuadorean Social Science Research Organization
DPT:	Diphtheria - pertussis - tetanus vaccine
EPI:	Expanded Programme on Immunization
HCF/LAC:	Health Care Financing in Latin American and the Caribbean Project
HEALTHCOM:	Project for Health Communications
HIID:	Harvard Institute for International Development
INNFA:	National Institute for Children and the Family (Ecuador) (Institute Nacional de Nino y la Familia)
KAP:	Knowledge, attitudes, and practices survey
MOH:	Ministry of Health
ORT:	Oral rehydration therapy
PAHO:	Pan American Health Organization
PREMI:	Program for Reduction of Maternal and Childhood Illness (Ecuador) (Programma de Reduccion de Enfeedad Materno y Infantil)
PRICOR:	Project for Operations Research on Primary Health Care
REACH:	Resources for Child Health Project
SAYTEC:	Ecuadorean economic research organization
TT:	Tetanus-toxoid vaccine for women
UNICEF:	United Nations International Children's Educational Fund
USAID:	United States Agency for International Development
WHO:	World Health Organization

EXECUTIVE SUMMARY

This analysis attempts to measure the cost-effectiveness of immunization services based in fixed facilities and a mass campaign held during 1985 and 1986 in Ecuador. The campaign was planned and organized under the PREMI Project which gained wide popular and political support. The purpose behind the campaign was to accelerate immunization activities throughout the country and to complement immunization services already provided by the Ministry of Health, the Social Security system and private organizations.

Data on the contribution of the campaign and routine services to total vaccination coverage were derived from a national survey conducted in June 1986, under the auspices of the Ministry of Health, the PREMI Project, and in collaboration with several Ecuadorean organizations, including CEPLATES. Based on this survey, the PREMI campaign contributed 13% to total coverage of 64% and made significant contributions in vaccinating younger children less than two years of age.

Cost analyses revealed that the average cost per dose was $0.29 for fixed facilities and $0.83 for the campaign. Total national costs were calculated as $653,000 and $1,667,000 for fixed facilities and the campaign, respectively. The cost per fully vaccinated child ranged from $4.77 for routine services to $8.13 for the PREMI campaign.

On the basis of these figures, we conclude that the campaign, though more costly than routine services in fixed centers had a strong impact on vaccination coverage of younger children who were previously missed by routine services.

I. INTRODUCTION

In October 1985, Ecuador launched a national vaccination campaign under the coordination and direction of the PREMI[1] child survival program, with support from UNICEF, PAHO, USAID, and other international donors involved in the EPI. Three rounds of the campaign took place throughout the country: each over a period of three days in October 1985 and in January and June 1986. The first two rounds were on weekdays and the last round took place over a weekend. The campaign mobilized all health workers in the country, as well as the national army, and the Ministry of Education. Other Ecuadorean agencies including Social Security, health institutions, and numerous private clubs contributed facilities, personnel, equipment, and publicity for the campaign. Among the international community, UNICEF, PAHO, and USAID played a role in furnishing supplies and vaccinations.

During the campaign, vaccinations were provided in a variety of health facilities including hospitals, health centers and health posts. Each campaign site offered measles, polio, tetanus, diphtheria, pertussis, and BCG vaccines to children less than five years of age and tetanus toxoid for pregnant women. The third round of the campaign also included other child survival activities, such as the promotion of growth monitoring, and use of oral rehydration therapy.

The campaign had a large mass media component which utilized television and radio messages to promote vaccination and other child survival activities; and to increase the knowledge and awareness of families as to the importance of preventive care for child health. Support by the First Lady contributed to the campaign's high visibility and strong political support.

The purpose of the PREMI campaign was to accelerate immunization activities in the country and to improve the population coverage rate of 43% of children less than five fully vaccinated. The campaign was designed to complement the activities and achievements of the routine EPI services, which have been traditionally implemented through fixed centers and mobile brigades attached to these centers or operating at provincial levels.

Routine vaccination services are provided at some MOH facilities on a weekly basis, but these schedules vary considerably among types of facilities. Auxiliary nurses usually administer vaccinations, but often other health personnel (physicians and licensed nurses) are involved in vaccination activities. Mobile brigades provide outreach vaccination services and are based out of facilities. Pre-PREMI immunization campaigns have taken place in Ecuador since 1981 to supplement routine activities based out of the fixed facilities as well. The pre-PREMI campaigns also used mass media, but these earlier campaigns were less elaborate than PREMI, and focused only on immunization.

1 Programma de Reduccion de Enfermedad Materno y Infantil, a child survival program which focuses on immunization, ORT, and growth monitoring interventions.

To date, there has been no evaluation of the relative costs and benefits of delivering vaccination services through each of these strategies. Cost-effectiveness analysis is one method of evaluating the impact and contribution of the national mass campaign in Ecuador to the goal of the EPI of universal coverage by 1990. This cost-effectiveness analysis compares the full resource cost of the campaign and of routine vaccination services with their respective coverage of children less than five years fully vaccinated.

Results from this cost-effectiveness analysis may be used to answer the following types of questions of program strategy:

1. What are the similarities and differences in the average costs of vaccination services in the fixed centers and for the national campaign?

2. What was the additional cost of the campaign to the government, above the level of expenditure for the routine services? How does this incremental cost compare to the increased benefits of the campaign strategy?

3. What was the contribution of the national campaign to the overall coverage of children less than five years of age? What was the age group that benefited most from the campaign versus the fixed center strategy?

4. What role did the campaign play in the national immunization program in 1986?

5. How could the costs of the immunization services offered through fixed centers and through the campaign be reduced in the future?

6. How could coverage of the population be increased in the future, and by what combination of strategies?

7. How does the cost-effectiveness of the mass campaign in Ecuador compare with those in other Latin American countries and around the world?

The results from this analysis may be used to improve the operations and reduce the costs of both routine services and campaigns in the future.

II. COVERAGE OF THE POPULATION

Levels of vaccination coverage were assessed in July, 1986, during a national household survey conducted by the PREMI program. The survey examined mothers' knowledge, attitudes, and practices (KAP) related to the use of oral rehydration therapy (ORT), growth monitoring, and immunization. The study was a cluster-sample survey which interviewed 2,702 households for a total sample of 3,697 children. Of these children, 51.3% lived in urban areas and 48.7% lived in rural areas. Most informants were mothers (94%). Appendix 4 contains more information about the national KAP survey.

Vaccination status was determined by examining each child's vaccination card, whenever possible. The card contained information on the type of vaccination and the date when the child was innoculated. Vaccinations ascertained from these cards (94 percent) were considered "documented". Six percent of Ecuadorean children did not have a documented vaccination history because the child never received a card, the card was not available at the time of the survey, or the card was incomplete. In these cases, the interviewer documented coverage with "verbal histories" based on the respondent's knowledge of vaccinations. This information was considered a reliable supplement to the study's data base.

A major objective of the survey's vaccination questions was to assess the contribution of the PREMI campaign to total coverage. Coverage results were analyzed separately for each one-year age cohort of children. The analysis also distinguished vaccination doses administered by routine services from those given during the campaign. All doses administered during the month of a campaign round were considered to be campaign doses. Although the duration of each campaign cycle was officially only three days, an analysis was performed which showed a minimal statistical difference between assigning doses to routine or campaign strategies based on exact dates of vaccination or the month of vaccination.

Analysis of coverage rates for children under one year of age required special treatment. Children are scheduled to receive BCG at birth; the first doses of DPT and polio between three and five months of age; and measles between nine and eleven months of age. Overall coverage for children under one year of age was assessed in the survey as the coverage in the age group between 9 and 11 (or less than 12) months. The coverage rate was apportioned between routine and campaign approaches based on the share of doses of that vaccine for all vaccinated children under one.

For vaccines that required multiple doses (DPT and polio), only the third dose has been analyzed here, as that is the dose that is expected to make the child immunized against the disease.

Table 1 shows the percentage of fully vaccinated children by age and source. Table 2 shows the percent total coverage of the population by source; and Table 3 illustrates the percent contribution of PREMI to total coverage. The coverage rate rises steadily with age, indicating that children have continued to complete their vaccination series well beyond age one. Figure 1 illustrates the contribution of the PREMI to total coverage in comparison to pre-PREMI coverage figures.

TABLE 1

Percent Coverage of Children
Fully Vaccinated by Age[1]

Source of Vaccination	Age (Years) <1	1	2	3	4	0-4
Routine Services[2]	16	38	48	54	61	42.7
Pre-PREMI Phase	0	3	15	12	11	7.9
PREMI Campaign	11	21	12	9	5	12.9
Total[3]	27	62	75	75	77	63.5

[1] Based on National KAP survey results
[2] Includes fixed center and mobile brigades.
[3] Based on National KAP survey results

TABLE 2

Percent Contribution of the PREMI Campaign to
Total Vaccination Coverage[1]

Antigen/Age Group	<1 year	1 year	2 years	3 years	4 years
BCG- TOTAL	92.1	98.9	97.3	96.4	97.3
PREMI	30.3	7.6	3.9	5.4	3.6
Pre-PREMI	61.8	91.3	93.4	91.0	93.7
DPT1- TOTAL	69.5	97.7	95.2	96.4	96.8
PREMI	28.8	26.9	10.2	10.8	5.7
Pre-PREMI	40.7	70.8	85.0	85.6	91.1
DPT3- TOTAL	39.0	74.3	83.2	85.9	89.5
PREMI	12.9	32.1	19.4	12.7	8.5
Pre-PREMI	26.1	42.2	63.8	73.2	80.0
Polio3-TOTAL	13.7	74.0	81.9	85.9	89.3
PREMI	4.7	31.5	20.4	13.2	9.3
Pre-PREMI	9.0	42.5	61.5	72.4	80.0
Measles TOTAL	17.3	82.6	86.4	89.4	89.9
PREMI	7.9	40.9	20.2	13.0	7.6
Pre-PREMI	9.4	41.7	66.2	76.4	82.3

[1] Unknown source of vaccination not allocated to the PREMI Campaign
TOTAL = Based on KAP survey, 1986, percent coverage of vaccines by service (see Appendix 11 for details).
PREMI = (TOTAL coverage) - (pre-PREMI coverage)
Pre-PREMI = TOTAL coverage - [TOTAL coverage x (#doses for PREMI/total doses)]

NB: PREMI refers to the campaign, and Pre-PREMI refers to all activities prior to the PREMI campaign beginning October 1985.

Figure 1

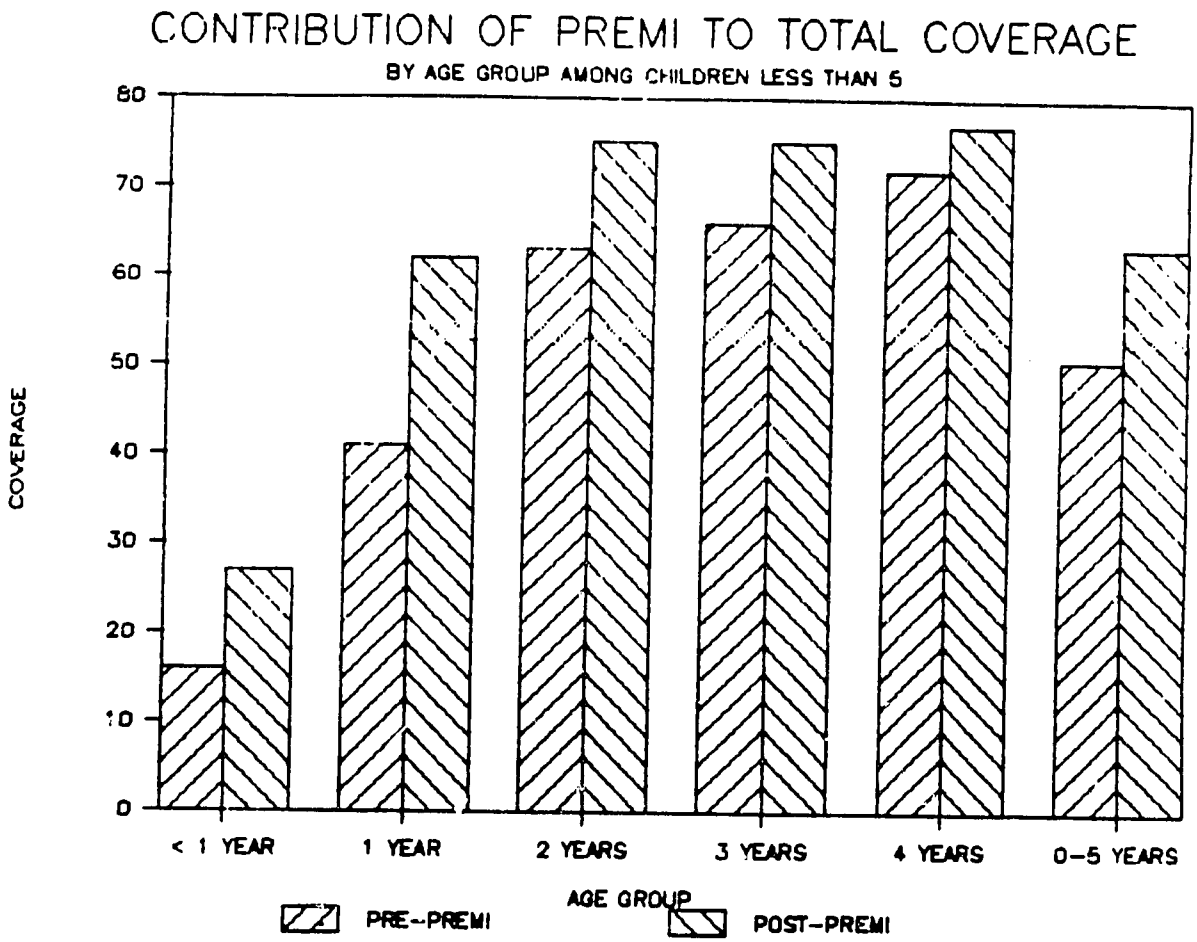
CONTRIBUTION OF PREMI TO TOTAL COVERAGE
BY AGE GROUP AMONG CHILDREN LESS THAN 5
COVERAGE
80
70
60
50
40
30
20
10
0
< 1 YEAR
1 YEAR
2 YEARS
3 YEARS
4 YEARS
0-5 YEARS
AGE GROUP
PRE-PREMI
POST-PREMI

TABLE 3

PERCENT OF TOTAL COVERGE ATTRIBUTABLE
TO THE PREMI CAMPAIGN

Vaccine	<1 year	1 year	2 years	3 years	4 years
BCG	32.9	7.7	4.0	5.6	3.7
DPT1	41.4	27.5	10.7	11.2	5.9
DPT3	33.0	43.2	23.3	14.8	9.5
Polio3	34.2	42.6	24.9	15.4	10.4
Measles	45.9	49.5	23.4	14.5	8.5

Based on KAP survey, 1986. Percent calculated using following formula: doses administered during the PREMI campaign/total doses.

Several conclusions can be drawn from these tables. First, before the PREMI campaign, BCG coverage was high in all age groups, even for those children less than one year of age (62 percent). These figures may reflect the relatively good access of children and mothers to health facilities in Ecuador.

Second measles coverage is low in younger age groups (11.7% in one year olds and 66.1% in two year olds). The coverage rates improve in older age groups. However, the sample of 9-11 month olds would have had only narrow exposure to the health system. These data suggest that vaccination efforts in routine services may not focus enough attention on younger children who are at great risk for disease. This conclusion is also supported by figures on DPT and polio coverage, which shows the same trend toward higher coverage rates in older age groups. The rates for DPT3 and polio3 are moderate in higher age groups and may be a reflection of a high drop-out rate between the first and third doses of these antigens.

The PREMI campaign has made an impact on the overall coverage of children less than five years of age. The PREMI campaign resulted in 13% percent increase in children fully vaccinated within a one-year period of time, bringing Ecuador's rate to 64 percent by July 1986. The PREMI campaign also improved the coverage rates of children in younger age groups (11 percent for children less than one, and 21 percent in one-year olds).

Based on the percent contribution of the PREMI campaign to total coverage, the campaign did not have a great impact on DPT3, polio3 and measles coverage rates in younger age groups, especially for children less than one year of age, (see Table 2). For children less than one year of age the PREMI campaign contributed approximately one-third to total coverage of DPT3 and polio3. The low DPT3 and polio3 coverage rates may be due to a sampling bias toward children of lower ages, cultural factors inhibiting return for the third dose which contributes to a drop-out between doses, and/or the child was thought to be too young or sick to be re-exposed to vaccination complications. Low measles coverage during the campaign may reflect the narrow time frame of exposure of 9-11 month olds.

As the Pan American Health Organization (PAHO) and its member states have made polio eradication a goal by 1990, the pattern of polio coverage is examined in more detail here. The maximum level achieved prior to the PREMI campaign for polio3 was 60% in the oldest age group. Sixteen percent of total coverage for polio was due to the pre-PREMI campaigns in 1983-85 when children in this cohort were between two to three years old.

PREMI only contributed 34% to total polio coverage. Lower than expected results for polio during the campaign may be due to logistical factors relating to cold chain, distribution, and vaccine supply as well. In addition, it may also be more difficult to reach those children not vaccinated after reaching a level of 60% coverage. Among the under one population the third dose coverage of polio (14%) is considerably below the target of 80% urged by immunization experts.

The number of fully vaccinated children (FVC), defined here as a child who has received the full series of primary vaccinations (ignoring boosters), is one of the best measures of the effectiveness of a vaccination program. This measure has been recommended by the World Health Organization (WHO, 1979).

In this study, the proportion of children in each age group who were fully vaccinated was allocated between routine and campaign approaches based on the proportion of doses of all last required vaccine doses administered to that age group. At last required dose is a dose of BCG or measles (as only one was required for these vaccines) and the third dose of DPT or polio (since three doses of each were required).

For example, 63 percent of one-year old children were fully vaccinated. Of all last required vaccine doses received by one-year olds in the household survey, one third were received during a round of the PREMI campaign. Therefore, the percentage of one-year olds considered fully vaccinated due to PREMI was 21 percent (one third of 63 percent).

It was assumed that children who received their final required dose through a campaign would not have received that dose at all, or at least at a later age, if the camapign had not occurred. While the intermittent timing of campaigns makes this assumption plausible, only a controlled trial (which is not feasible for a national program) could have provided a definitive test.

Also, credit for fully vaccinated children was apportioned among approaches based on aggregate statistics for all surveyed children, rather than just fully vaccinated children. Computations at the level of an individual child would not have been feasible with the type of data processing available, and would not have been preferable in any case. Analysis at the level of the individual child would have increased sampling error by excluding data from children who were immunized against one disease but not another. Appendix 9 contains details on the methods used.

III. COSTS OF IMMUNIZATION SERVICES

A. Fixed Centers

1. General Methodology

The detailed methodology used to collect cost information on the routine immunization services offered through fixed health facilities is found in Appendix 1. Cost information was based on two separate data collection efforts: 1) a sample of 22 health facilities in primarily two regions (Costa and Sierra), and 2) national and/or provincial-level records of vaccination program costs.

The sampled health facilities included seven MOH sub-centers, eight health posts, and seven hospitals. Health centers (urban facilities whose scope lies between hospitals and subcenters) were not sampled as they were not part of the HCF/LAC study. Costs of vaccination services were calculated from the costs estimated for primary health care activities in these facilities. Costs were collected and analyzed according to a methodology developed for a related study[2]. Health facilities were selected because they were believed to represent the experience in Ecuador. Data were collected by a research team of Ecuadoreans and international consultants in 1986.

For each type of facility, the average cost of vaccination services was calculated by dividing the total cost of vaccination services by the number of doses administered per facility for 1985. Components of vaccination services included personnel, transportation, vaccines and syringes, other vaccination supplies, buildings, equipment and furniture, training, promotion, and indirect facility costs.

Indirect costs include personnel time that could not be allocated directly to vaccination services; the management and support of vaccination services in the facilities sampled; overhead costs of delivering services, including rent, utilities, telephone, and office supplies; and, national and provincial-level costs, such as promotion and training, but not general administration.

In addition to facility-specific costs, national- or provincial-level costs were apportioned to each type of facility based on their proportion of total doses of vaccine administered in 1985. One example was the cost related to promotion of preventive health services performed on a provincial-level basis by INNFA[3].

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[2] Robert Robertson, 1986

[3] Institute Nacional de Nino y la Familia: INNFA encouraged mothers to bring their children for vaccination for both routine and campaign services.

National average cost per dose was calculated by weighting the average costs for each type of facility by the number of such establishments in the nation during 1985. The average cost per dose of health centers was estimated by averaging the values for hospital and sub-centers. To estimate the total national cost of routine vaccination services for children less than five years of age, the national average cost per dose (U.S. $0.29) was multiplied by the total number of routine EPI vaccinations administered to children less than five years of age and pregnant women.

All costs were reported in constant 1985 dollars using the mid-1985 (June 30, 1985) exchange rate of 115.51 sucres per U.S. dollar.

2. Cost results[4]

Tables 4 and 5 summarize the average cost per dose per facility type, national average cost per dose across the facilities sampled, and estimated national costs for routine services at fixed facilities for Ecuador.

The national average cost per dose was 33 sucres or US $0.29; and the total national cost of vaccination services based at fixed facilities was estimated to be $653,000 (the average cost per dose of $0.29 multiplied by 2,286,015 doses for 1985). Table 4 shows a difference in average costs among hospitals, sub-centers, and health posts, from 28 sucres per dose for hospitals to 44 sucres per dose for sub-centers. The range in average cost per dose was most notable for hospitals, between 18 and 158 sucres per dose, possibly as a result of the difference in the number of doses administered per facility.

Table 5 indicates the distribution of vaccination service cost categories (cost profiles) for three levels of health facilities. These categories include personnel, vaccines, buildings, and indirect costs. Between 16 to 38 percent of total costs were incurred for personnel directly involved with vaccinations. Vaccines and syringes constituted another important cost category, ranging from 50 and 32 percent of total costs. Indirect costs were particularly important for health posts and sub-centers, and accounted for between 47 and 26 percent of total costs respectively. This is largely due to the fact that their overall costs are lower than those for hospitals, and therefore the overhead cost burden them disproportionately.

Indirect costs were the largest cost component in fixed facilities primarily as a result of the level of "down time" of personnel: time for which a health worker is paid but not directly involved in patient care services.

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[4] Cost results for this study were calculated based on figures derived from the USAID-funded Health Care Financing in Latin America Project (HCF/LAC) in Ecuador. These figures are currently under revision by the HCF/LAC Project.

TABLE 4

Average Cost[1] Per Dose
for Vaccination Services in Fixed Facilities

Facility Type/ Indicator	Number of Facilities		Mean Number of Doses[2]	Average Cost Per Dose[3]	Range in Cost Per Dose[4]
	Country	Sample			
Hospitals	114	7	40,808	28	18-158
Health Centers	54	0	21,454	36	na
Sub-Centers	817	7	2,100	44	28-82
Health Posts	232	8	952	34	23-74
Total[5]	1,217	22	6,366	33	18-158

1 In sucres, 1985
2 Per sampled facility records for 1985
3 In sucres, 1985
4 Health centers not included in sample for routine vaccinations. Average cost and number of doses approximated by interpolation between hospital and sub-center average cost figures.
5 Total mean numbers of doses and average cost are weighted averages; the means by type of facility were weighted by the number of facilities of each type.

TABLE 5

Cost Profiles for Vaccination Services in Fixed Facilities
(percent of total cost)

Category/Facility[1]	Hospitals	Sub-Centers	Health Posts
DIRECT COSTS:			
Personnel	37.8	35.5	16.1
Vaccines and Syringes	49.8	32.7	31.8
Other Supplies	0.0	0.0	0.0
Buildings[2]	--	--	--
Equipment & Furniture[2]	--	--	--
Transport[2]	--	--	--
Training[2]	--	--	--
Promotion[3]	0.1	--	--
Misc. & Other[2]	--	--	--
TOTAL DIRECT COSTS	87.7	68.2	47.9
INDIRECT COSTS[4]:			
Allocated National & Regional Provincial Costs	5.1	5.8	5.3
Allocated Facility Costs: (General Support)	7.2	26.0	46.8
TOTAL INDIRECT COSTS	12.3	31.8	52.1
GRAND TOTAL	100.0	100.0	100.0

[1] Health centers are excluded from the summary cost profiles, because detailed data were not available for them. Their mean costs are approximated by the average of costs for hospitals and sub-centers.

[2] Costs in these categories were not assigned to vaccinations directly, but were included under General Support (under Indirect Costs); small amount of local promotion at a hospital is assigned directly as shown.

[3] All such costs shown are national level shared costs of promotion (and minor training).

[4] Includes cost of cold chain equipment, facilities overhead, down-time of personnel, and other expenses not directly allocable to vaccination services.

3. Discussion of routine program costs

The sampling method used to determine the costs of routine vaccination services at fixed centers was part of a broader study of primary health care in Ecuador (HCF/LAC Study). While the linkage provided a number of advantages, it was one of the reasons why a random sample of facilities was not feasible. A number of limitations will be noted here.

First, the provinces sampled have higher than average population densities, thereby providing a greater opportunity to have more doses per facility. The authors do not think, however, that this characteristic created a large bias. Although other studies (Cresse et al., Robertson et al., 1984) have found that facilities with higher volumes tend to have lower average costs, that pattern was not found consistently for all types of facilities for the costs of vaccinations in this study. One reason may be that vaccinations were just one of many services performed by the facilities, so that when staff were not administering vaccinations, their time and associated direct and indirect costs could be allocated to other activities.

Furthermore, a sensitivity analysis indicates that the maximum possible bias that could result from oversampling of larger facilities does not seriously affect the results. At most, unit costs could be 26 percent higher or 42 sucres, which is still considerable less than the cost of the PREMI campaign.[5]

Second, the sample was not necessarily representative of the proportions or types of facilities administering vaccinations on a routine basis in Ecuador. The sample represented 2% of the total facilities in the country, but 6% of hospitals and less than 1% of sub-centers. Therefore, an additional bias toward a lower average cost per dose may result from the types and numbers of facilities sampled in each province. If these facilities that most often give vaccinations are disproportionately represented in the sample, weighting of average cost by proportion of facilities by type would tend to minimize this bias.

Finally, due to the linkage with the HCF/LAC study, it was not feasible to collect information on costs of mobile brigades. Mobile brigades operate from some fixed facilities and provincial headquarters. The doses delivered by mobile brigades are, however, included in the Ministry's total statistics on doses. The average costs provided here included only routine doses through fixed facilities. National costs have been approximated by multiplying total national doses by the weighted average cost per dose derived from fixed facilities. Hospitals were the predominant source of vaccinations, and mobile brigades are thought to deliver a relatively small share of total doses.

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[5] Suppose that only direct costs, which average about 68 percent of total costs in the cost profile in Table 4, vary with volume, and that indirect costs remain fixed. The sensitivity analysis was based on decreasing volume by 45%, which is the drop from the sample average of 6,366 doses to the all-facility average of 3,495 doses. Then total cost would be 30 percent lower (68 percent of 45 percent equals 30 percent. With volume 45% lower, unit cost is 26% higher [(1 - .30)/(1 - .45) = 1.26]).

B. PREMI Campaign

1. General Methodology

Cost information on the mass campaign was collected from a sample of 30 health facilities in six provinces for the last round of the campaign in June 1986. These cost data were then used to extrapolate the total cost of the three rounds of the campaign. Further details about the collection of cost information is found in Appendix 2.

Costs of the campaign, like those of routine services, were assessed at different levels of the health system: local, provincial, and national. Costs at the facility level were obtained directly with the assistance of data collectors from the MOH. A total of 30 facilities in six provinces from all three regions were sampled (Guayas, Los Rios, and Esmeraldas in the costa; Pichincha and Chimborazo in the sierra; and Napo in the oriente - see Appendix 3). Each sampled facility was visited by data collectors who used a standard questionnaire.

Procedures to estimate the national campaign costs in 1985 were adapted from guidelines used previously by Robertson (1986) in the 1985 El Salvador campaign. For consistency with routine vaccination services in fixed facilities, the costs of the campaign were adjusted to 1985 prices.

To estimate campaign costs, these 30 facilities were grouped into four types: hospitals, health centers, sub-centers, and health posts. Satellite vaccination sites (mobile brigades, schools, and public parks) were included in the total cost of the facility to which they were attached. The total cost of providing vaccination services for each facility was calculated, as well as the average cost per dose per facility type by dividing by the number of doses of vaccine provided during the third round. This figure was then multiplied by three to result in average costs for the entire three-round campaign.

2. Cost results

Table 6 illustrates the average cost per dose by facility type for the campaign. The average cost ranged from 109 sucres per dose in the hospitals sampled to 87 sucres per dose in the health centers for the three rounds of the campaign. The overall weighted average cost per dose was estimated to be 96 sucres or $0.83 per dose. The authors suggest that since there was no significant variation across types of facilities, the overall average cost per dose represents a typical value for Ecuador.

Table 7 illustrates the cost profiles by type of facility for the campaign. Costs were tabulated for personnel, vaccines, medical supplies, buildings, equipment, training, promotional activities, and transportation. Transportation costs accounted for the largest proportion of total costs for all types of facilities (40% for hospitals to 23% for health posts). Promotional activities and training were also high cost elements, with national-level activities accounting for 14% of hospital costs and 17% of health center costs. Personnel costs ranged from 16% to 33 percent of total cost, and vaccine costs ranged from 6 to 9 percent of total cost.

The total national cost for the PREMI campaign was estimated to be US $1,667,000 or approximately 193 million sucres.

TABLE 6

Average Cost per Dose in
PREMI Campaign by Facility Type

Facility type/ Indicator	Number of Facilities Sampled	Mean Number of Doses for Campaign	Average Cost Per Dose[1]	Range in Cost Per Dose
Hospitals	9	1,320	109	76-186
Health Centers	4	2,653	87	66-154
Sub-Centers	8	494	92	69-427
Health Posts	9	186	95	97-166
Total	30	609	96	66-190

[1] In sucres, 1985

TABLE 7

Percentages of Costs by Categories for
the PREMI Campaign by Facility Type

Cost Category/ Facility Type	Hospitals	Health Centers	Sub-Centers	Health Posts	Simple Average
Personnel	16	22	22	33	23
Vaccines	7	9	9	6	8
Vaccination supplies	4	6	6	4	5
Vaccination cards	2	2	2	2	2
Buildings	2	0	0	1	1
Equipment	0	0	0	0	0
Transportation	40	26	25	23	29
Training - local	0	0	0	0	0
- provincial	6	8	5	7	7
- national	0	0	0	0	0
Promotion - local	1	1	4	2	2
- provincial	1	2	2	1	2
- national	14	17	17	12	15
Other - local	2	0	3	3	2
- provincial	4	5	3	3	4
- national	0	0	0	0	0
TOTAL	100	100	100	100	100

3. Discussion of campaign costs

The methodology used to calculate the cost of the campaign is comparable to that used for the routine services of fixed facilities. In interpreting the data, several points should be kept in mind. First, the total cost and overall average cost per dose for the campaign was based on activities of the third round of the campaign. This round differed from previous rounds because it included other child survival activities. Campaign costs were allocated equally among all other child survival activities, thereby reducing the direct costs of vaccination for that round of the campaign. Therefore, the yearly total may be an underestimate of the total cost of the campaign.

Second, the individual facilities' costs were based, in large part, on the number of doses administered per facility for the third round. An assumption was made that the cost of administering vaccines during the campaign was a function of the number of doses, which may not be the case, given the cost of inefficiency, "down time", and possible variations in application time. In addition, there was evidence from the national survey that vaccination activity decreased during the third round because the campaign took place over a weekend rather than on weekdays, as the first two rounds. As a result, the cost per dose in June 1986 round could have been atypically high.

Third, a sensitivity analysis was performed on transportation costs to determine the effect on total costs of changing the use of vehicles to five and one-half days (one work week) rather than three days during the third round of the campaign. This longer time is the maximum possible time that the vehicle could have been used for the PREMI round, including preparation and follow up. Calculated across all facility types, this change in assumption would result in an appreciable increase in the weighted average cost per dose of 16.3 sucres per dose, and would raise national costs by approximately 32.9 million sucres (283,000). Total national campaign costs would be increased from $1.67 million to $1.95 million, a rise of about 17%.

IV. COMPARISON BETWEEN THE PREMI CAMPAIGN AND FIXED CENTER COSTS AND COVERAGES

The most simple estimate of unit cost in this study was the average cost per dose (see Table 8). This unit cost differs markedly between the two strategies. The overall national average cost of routine public (Ministry of Health) vaccinations was about 33 sucres or US $0.29, while it was about 96 sucres or US $0.83. The average cost for the routine program of US $0.35 is well below that of many other countries.

TABLE 8

Total National Costs[1] of Immunization Strategies in Ecuador

Indicator/Strategy	Fixed Facilities	PREMI Campaign
Number of Doses Administered	2,286,015 [2]	2,005,815 [3]
Average Cost per Dose (sucres)	33	96
(dollars)	$0.29	$0.83
National Cost[4] (sucres)	75,438,000	192,588,000
(dollars)	$653,000	$1,667,000
Cost Per Fully Vaccinated Child	$4.77	$8.13

[1] In 1985 prices
[2] From Appendix 10, Table 2
[3] Total third round doses (668,605) multiplied by 3
[4] Per year and rounded to nearest whole dollar

The cost per fully vaccinated child for routine services was estimated to be $4.77, which is low compared to other campaigns. For this study, a comparison was also made between the incremental cost of the PREMI campaign above the cost of routine services with the incremental contribution of the campaign to total coverage. The campaign was responsible for an increase in 12.9% of total coverage or an additional 206,400 children under five years fully vaccinated (using a figure of 1.6 million children less than five in Ecuador). In terms of cost, the total campaign cost was $1,667,000. Therefore, incremental campaign cost per fully vaccinated child is $8.13 ($1,667,000/206,400). This figure is within the range of figures that have been reported elsewhere (WHO, 1987).

V. CONCLUSIONS

The cost analysis demonstrated that immunization expenditures were higher for the campaign than those for immunizations provided by the fixed facilities ($1,667,000 versus $653,000 respectively). The incremental cost per fully vaccinated child during the PREMI campaign was estimated to be $8.01, which is within a range of other campaigns around the world. For fixed facility services, personnel and indirect costs represented the largest components of cost, whereas, the campaigns resulted in higher promotional and transport costs.

Comparisons between countries may give an idea of the range of average costs, but should be interpreted with caution. Each study uses a different definition of cost and faces different constraints in data collection. The average cost per dose in fixed facilities in Ecuador is below that of some other developing countries in which related studies have been done, such as Brazil, the Gambia, and the Ivory Coast in the early 1980s. Creese's (1984) report on Brazil indicates 1982 average costs of US $1.59 to $4.63 for routine vaccinations and $0.68 to $1.42 for ones in a special campaign. A study of 1980-81 Gambian vaccinations in an on-going routine program with extensive outreach shows a national average cost per dose of US $1.09 (Robertson, et al. 1984).

A. What beneficial effects have there been from the two vaccination strategies in Ecuador, and what do cost-effectiveness analyses suggest about them?

First of all, routine services (according to coverage survey data) achieved 50% coverage of the population by 1986, which is a major accomplishment.

Secondly, prior to the PREMI campaign, coverage in older age groups for all antigens was high, as was coverage for BCG in lower age groups. However, these data point to the weakness of routine services in younger age groups by maintaining essential contact with children between their first and third doses of DPT and polio.

The PREMI campaign had an impact on the vaccination coverage of younger children and contributed 13% to total coverage. Nevertheless, the high drop-out rate between the first and third doses of vaccine still remained throughout the campaign as evidenced by low polio3 and DPT3 coverage. Because polio eradication is a goal of PAHO, future strategies should address this drop-out rate.

The coverage of young children, the most important target group, lags significantly behind older groups. The MOH has had a policy of waiting three months between successive doses of DPT and polio, which may account for the difficulty in completing the series before age one. A shorter interval between doses is now being considered.

Another potential contribution of the campaign was that it shortened the time period between a child receiving the first and last doses of EPI vaccine.

A major concern about vaccination campaigns in Ecuador (and elsewhere) is that they take personnel, funding, enthusiasm, and hence effectiveness away from routine vaccinations. In the absence of good historical data on vaccination coverage, the question is difficult to answer systematically. A comparison across age groups in the national coverage survey of Ecuador suggests that there might have been a small erosion of routine services.

B. How can the effectiveness of these strategies be improved and their costs reduced?

First, the effectiveness of the campaign could be improved if efforts concentrate on children less than one year of age, because the benefits of the campaign is to shorten the interval required to completely vaccinate children.

Secondly, because of the scarcity of data on coverage for different types of routine services, it is difficult to elaborate on how the effectiveness of routine immunization services could be improved. However, we believe strongly that attention should be paid in the future to strengthening routine immunization service delivery, through development of management, supervision, and surveillance capabilities, in order to improve the access of the population to vaccination services.

The cost data of both the campaign and fixed facility services did not permit an analysis of how costs could have been reduced because the data on the operations of individual facilities were outside the cope of this study. However, from previous studies, we know that vaccination services require significant inputs of labor, not only for the administration of vaccines, but also for supervision and logistic systems. Therefore, it may be speculated that to reduce the overall costs of EPI strategies, emphasis should be placed on improving the efficiency of these systems and integrating vaccination services into other primary health care activities more fully.

Since the primary data for this study were compiled in June and July, 1986, PREMI has continued to conduct vaccination campaigns with the same frequency as in the preceding year. Another three vaccination rounds were held in the twelve months ending June, 1987. These rounds were held in November, 1986, April, 1987 and June, 1987.

Recent PREMI campaigns have endeavored to promote several child health practices and to strengthen the links between the campaign and routine services. For example, PREMI messages encourage mothers to bring their children for well baby checks at regular health facilities.

PREMI has streamlined mass campaigns by making the two latest rounds (June and August, 1987) both one-day events. The PREMI round in November, 1986 had lasted two days, and previous ones had taken three days.

Finally, Ecuadorean health officials have taken important steps to improve the vaccination coverage of younger children. First, the recommended interval between successive doses of vaccine has been shortened from three to two months. This change shortens the time required to complete a series of vaccinations. In addition, PREMI has emphasized the goal of having a child complete his vaccinations by his first birthday. If a child achieves this, a gold star of commendation is placed on his vaccination card.

APPENDIX 1

METHODOLOGY FOR ESTIMATING COSTS OF VACCINATION SERVICES IN FIXED FACILITIES

As mentioned previously, the costs of routine vaccinations were obtained by a collaborative effort of two projects supported by AID, REACH, and HCF/LAC.[1] In 1986, a research team of Ecuadoreans and international consultants studied the costs of primary health services in intermediate level facilities of the MOH, the rural Social Security program, and certain non-profit private organizations in Ecuador (HCF/LAC, 1987). National costs of routine vaccinations were based on data from a representative but non-probability sample of seven public (MOH) sub-centers, eight health posts, and seven hospitals. Because of their consistency in costs and the readily available data on vaccination quantities, only the public sub-sector health units were used to estimate routine vaccination costs.

For each establishment, total and average costs of about 12 types of services, including vaccinations, were estimated for the calendar year 1985, based on detailed guidelines (Robertson, 1986). Data were obtained from visits to the facilities and offices from higher administrative levels (national and provincial or regional) of the organizations involved.[2]

Detailed methods of estimating costs of the routine program are presented in the report of all primary health services (HCF/LAC, 1987). Briefly, the methodology apportioned direct costs among the final services according to the personnel time and other resources used by each. Indirect costs were generally allocated in proportion to direct costs. All resources used were considered to be costs, whether or not the MOH itself paid for them during the study period.

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1 This work represented one of several studies under the AID-funded project, "Health Care Financing in Latin America and the Caribbean" (HCF/LAC), directed by Dieter Zschock from the State University of New York at Stony Brook.

2 This work was conducted for posts by Julio Perrone, Paul Meissner, and Robert Robertson of the HCF/LAC team, using techniques previously employed for sub-centers with financial support from the "Resources for Child Health" (REACH) project that receives AID funds. For hospitals, the REACH study of campaign vaccinations was extended to include routine ones for 1985; data collection was under the direction of Pedro Saturno, in association with Donald Shepard and Robert Robertson. Dr. Saturno also collected some information from one special governmental source (INNFA) concerning promotional and other costs chargeable to the routine program.

Direct labor time for vaccinations was based on the estimate by MOH officials that every vaccination dose required five minutes, on average, and staff of the HCF/LAC study familiar with primary health care services. As these officials felt that the campaigns in Ecuador (where vaccinations were done in greater volume) required only two minutes per dose, the five-minute assumption for routine doses appeared reasonable. The HCF/LAC study, who were studying all primary health services. As direct labor time for other primary health care services were developed similarly, the method provided a consistent way of allocating time of nurses and other providers among their various tasks. The officials developing the estimates had no reason to try to bias the estimates for or against any tasks.

In addition to direct time, vaccinations at posts and subcenters were charged for a share of time which could not be assigned to any specific service (unknown time uses and "down time"), and for other shared general costs (e.g., for administration). Also, this step would automatically adjust for any systematic underestimate of direct time to all tasks. A small administrative cost was assigned directly to some hospitals.

Costs of promotion of routine vaccinations in 1985 were mostly for media use and special retreats supported at the national level. These were estimated from data on the first half of 1986 provided by the National Child and Family Institute, INNFA.

INNFA encouraged mothers to bring their children for vaccination for both the routine and the campaign modes. For routine vaccinations, INNFA provided development and broadcasting of television and radio messages, development and printing of brochures and posters, and training. In cases where the promotional efforts were directed jointly toward three types of health interventions (vaccinations, ORT, and growth monitoring), one-third of the costs were allocated to vaccinations. The six-month values were doubled to yield annual equivalents and deflated to eliminate the 24% increase in urban consumer prices in Ecuador between mid-1985 and mid-1986 (Central Bank of Ecuador statistics, reported on January 15, 1987). Promotion costs were allocated to individual health facilities according to the number of doses provided.

The overall national average cost (per dose) was calculated by weighting the average costs for each type of facility by the number of such establishments in the nation during 1985. The average cost of health centers (urban facilities whose scope lies between hospitals and sub-centers) was estimated by interpolating or averaging of values for hospitals and sub-centers. To estimate the total national cost of routine vaccinations to children under five at health facilities during the year, the overall average cost per dose (US $0.29) was multiplied by the total number of routine vaccinations reported to WHO's Expanded Program on Immunization under MOH supervision.

APPENDIX 2

METHODOLOGY FOR ESTIMATING THE COSTS OF THE PREMI CAMPAIGN

Costs of the campaign, like those of routine services, were assessed at three levels: local, provincial, and national offices. Costs at the facility level were obtained directly. Those at higher levels were allocated, on a per-dose basis, using data collected centrally on separate visits. Such data covered many central costs, such as promotion and transport, but excluded on-going administrative costs at higher levels.

Procedures to estimate the national campaign costs in 1985 were adapted from guidelines used previously by one of the authors (Robert Robertson) and colleagues from El Salvador to study the costs of the country's three special vaccination days in 1985. As the methodology for routine costs in HCF/LAC study were also developed by the same economist from this Salvadoran experience, methods for cost accounting for the routine and campaign strategies were similar. Each cost category is described below. Another of the authors (Dr. Pedro Saturno) directed data collection for the campaign, and Dr. Donald Shepard and Mr. Charles Cameron performed cost computation.

Capital Costs

The cost accounting distinguished between capital costs (for long-lived resource inputs) and operating costs. Capital costs were computed for transportation, buildings, medical, equipment, and transportation equipment used in the immunization campaign, including 524 vehicles (Jeeps and Land Rovers), two boats, and two helicopters. For this analysis, average annualized capital costs were determined separately for all vehicles and all boats. The 1986 replacement price was used as the basis for all vehicles. An average vehicle was estimated to cost 2.7 million sucres ($23,000) in 1986 vendor prices. Prices are adjusted at the end to 1985 prices for 24% for inflation from 1985 to 1986. All vehicles were assumed to have a useful life of 1 [illegible] s. The replacement cost was annualized at a real discount rate of 1 [illegible] percentage assumed also for capital inputs in the routine program). [illegible] ized capital costs for a vehicle averaged approximately 851,000 [illegible] All vehicles were fully used for the 3 days of the campaign, ar [illegible] e MOH vehicles) were used for an additional preparatory day. Total annualized costs were multiplied by the ratio 3.1/250, to allocate capital costs in proportion to fraction of work days per year, yielding capital costs of 7,000 sucres per vehicle for the cycle. When capital costs were shared among several facilities, they were allocated based on the share of doses at each facility.

Building capital costs were calculated using roughly estimated 1986-replacement prices of the facilities, an average life span of 15 years (again, consistent with the assumption for routine activities), and a 10 percent discount rate. Cost of furniture was estimated to be 8% of the

building cost, and to have a useful life of 10 years. In all cases, as stated above, a three days' equivalent figure was calculated for the campaign cycle. Allocation to campaign costs was made on the basis of the estimated proportion of space used for vaccination activities in each facility.

Equipment capital costs for the vaccination campaign were mostly attributable to cold chain equipment: refrigerators, ice boxes, thermos, and ice packs. Small instruments other than single-use needles and syringes were also considered as capital costs. Allocation to the campaign was based on three days of use, including freight costs paid by donors (mainly AID and UNICEF). Local replacement prices were estimated for equipment not provided by donors. Annualization calculations were based on an estimated useful life of five years.

Recurrent Costs

Costs for resources consumed or fully used within a one-year span were calculated for the remaining categories of resource inputs: personnel, vaccines, other supplies, buildings, and transportation (their recurrent costs), training, and promotion.

Personnel compensation, based on MOH payments of salaries and benefits in 1985, was based on individuals' participation in the vaccination campaign. Workers who participated in the campaign were paid for four work days (or 20% of a full month's work), so that portion of monthly compensation was charged to the campaign cycle. Given that the campaign also included ORT demonstrations and growth monitoring, only the costs of personnel doing vaccination-related activities were attributed to vaccinations. Personnel performing shared activities affecting all campaign components, such as supervision, general information, and physical check-up, were assumed to have devoted one-third of their campaign time to vaccinations. Personnel involved only in ORT or growth monitoring activities were not included. Personnel without special health training (For example, teachers and military personnel) were costed according to their salaries. Labor costs for non-professional voluntary personnel (e.g., high school students and Red Cross volunteers) were estimated using the salary for non-professional local workers. Information on salaries was obtained at various levels in Ecuador, including provincial offices of the MOH.

The cost of vaccines was calculated using the price per dose (including freight costs) incurred by the Ministry of Health in 1985. (This was generally below the prices for the PAHO Revolving Fund and locally-made vaccine in 1986.) The number of doses costed was equal to the number of vaccinations administered multiplied by an empirical wastage factor derived from five of the facilities for the campaign. Wastage factors (1.20 for DPT, 1.27 for polio, 1.76 for measles, 1.51 for BCG, and 2.10 for TT) indicate the number of doses of vaccine that must be procured to administer one dose of that type. As expected, these factors were slightly lower than the ratio of calculated by the MOH of vaccine distributed to doses administered in a full year. With a high volume of vaccinations per session during the campaign, the partly used opened vials

that needed to be discarded at the end of a campaign session could represent a smaller share of total doses than for routine vaccination.

Local current prices were used for calculating alcohol and cotton costs as well as other supplies (soap, pencils, erasers, ball pens, toilet tissue). An average number of vaccination diplomas (given when the child is fully vaccinated) and vaccination cards per dose were calculated at the provincial level, and were allocated to each facility according to its number of doses. Only half of the costs of vaccination cards were allocated to the campaign, because they also served for growth monitoring. The most important supplies other than vaccines were needles and syringes.

Operating costs of buildings were divided between the campaign and other uses by following the same rule used for capital costs. Annual costs were multiplied by the product of the estimated proportion of building space used for the campaign and the duration of the campaign as a proportion of the year (3/250).

Operating costs for the vehicles were calculated for two items: fuel and maintenance. The estimated number of gallons of fuel used in the campaign was provided by the provincial organizers and the PREMI national headquarters. Maintenance costs were calculated by estimating an annual maintenance expense for one vehicle and extrapolating costs to the provincial level. Total annual maintenance costs per vehicle were multiplied by the 3/250 factor to represent the three-day period. To obtain the total cost of such maintenance, that value was multiplied by the number of vehicles used. For the two boats, current rental rates per day were used. For helicopters it was assumed that they were airborne approximately four hours per day. Costs of the two helicopters used in the campaign sample could not be determined from field data but were approximated at $500 per hour (1986) from a limited market survey of helicopter rental firms in Massachusetts, USA.

Additional costs at the provincial level for per diem, promotion, and training were supplied by the provincial MOH departments. For these and the other categories, costs were put on a per facility basis, depending on doses provided there. In a similar fashion, a per dose cost of national level operating costs for the categories of transportation, per diem, training, and promotion was calculated by combining data from the several institutions participating in the campaign, inclusive of INFFA. It was then possible to calculate those costs for each facility in the sample. For both provincial and national level costs, only those expenses directly related to the campaign were included. Furthermore, as promotion (e.g., advertising) expenses for vaccinations often were shared with those for ORT and growth monitoring, only one-third of the combined expense was allocated to campaign vaccinations.

APPENDIX 3

FACILITIES STUDIED FOR PREMI CAMPAIGN
JUNE 1986

REGION	PROVINCE	CANTON	CENTER
Sierra	Pinchincha	Quito	Hosp. Carlos Andrade Marin Centro de Salud #8 Disp. IESS Cotocollao
		Cayambe	Hosp. Cantonal Subcentro de Salud Ayora Puesto de Salud INNFA Puesto de Salud Oton
	Chimborazo	Riobamba	Hosp. Policlinico Centro de Salud Riobamba
		Guamote	Hosp. Cantonal Subcentro de Salud Palmira Puesto de Salud Sablog
Costa	Guayas	Guayaquil	Hosp. Matern. E. Sotomayor Centro de Salud #1
		Milagro	Hosp. Cantonal L. Becerra Subc. de Salud R. Astudillo Subc. de Salud L. Garaicoa Puesto de Salud Rio Chico Puesto de Salud Ines Maria Puesto de Salud Soldedad Gr.
	Esmeraldas	Esmeraldas	Centro de Salud #1
		Quininde	Hosp. Cantonal Subc. de Salud Viche
	Los Rios	Quevedo	Hosp. Cantonal Subc. de Salud San Camilo Subc. de Salud Mocache
Oriente	Napo	Tena	Hosp. Viejo (Cantonal) Subc. de Salud Misahualli Disp. IESS Pano Puesto de Salud Pto. Napo

APPENDIX 4

FACILITIES STUDIED FOR THE ROUTINE PROGRAM

REGION	PROVINCE	ESTABLISHMENT	NAME/LOCATION
Sierra	Pichincha	Hospital, CSH*	Hospital Rouil Moldanado (Cayambe)
	Chimborazo	Hospital	Polioclinico de Riobamba
	Chimborazo	Hospital, CSH*	CSH, Guamote
Costa	Guayas	Hospital, CSH*	CSH No. 1, Guayaquil
	Esmeraldas	Hospital, CSH*	Hosp. Alberto Dufoni (Quinindi)
	Los Rios	Hospital	Hosp. de Quevedo
Oriente (near Sierra)	Napo	Hospital, CSH*	Hosp. Provincial del Ten
Sierra	Pichincha	Sub-center	Carcelen
		Sub-center	Pifo
		Sub-center	Puembo
Costa	Manabia	Sub-center	Abdon Calderon
		Sub-center	Crucita
		Sub-center	Rio Chico
		Sub-center	San Antonia
Sierra	Pichincha	Post	Chambespamba
		Post	La Merced
		Post	Oton
		Post	Perucho
		Post	Santa Rosa
		Post	Tupigachi
Costa	Manabi	Post	Colon
		Post	Naranjo

* "CSH" is "Centro de Salud Hospital", a particular class of general hospital

APPENDIX 5

METHODOLOGY USED IN THE NATIONAL KAP SURVEY

Administrative units were chosen from a list which enumerated the population of each province, county (cantones), and smaller administrative units (such as parraguias and periferias), and clusters were chosen with probability proportional to size. The survey included 2,702 household interviews. On average, each household had 1.4 children less than five years of age (exactly the rate assumed in the design of the survey), resulting in a total sample of 3,697 children.

Field work and data cleaning were performed by CEPLAES, an Ecuadorean social science research organization selected by PREMI. CEPLAES conducted the survey with attention to supervision and quality control by establishing a supervisory network of national, regional, sub-regional, provincial, and local supervisors overseeing the interview teams. CEPLAES repeated 20 percent of interviews for quality control and terminated interviewers whose work was considered of inadequate quality.

APPENDIX 6

ADDITIONAL METHODOLOGICAL CONSIDERATIONS

Brief consideration of several elements of study methodology and scope can help in the interpretation of the relative costs of the two vaccination strategies. None of the points individually or in combination plausibly accounts for a large point of the appreciable the large difference in average cost per dose between the two.

The strategies differed in their coverage because the fixed facilities costs did not include those of mobile outreach. That affected the relative total national costs but not necessarily of average costs (due to internal consistency in estimating each set of unit costs). Even if, as some observers might believe, the mobile brigades had higher average costs, their effect on each strategy's overall results probably was small, increasing the relative value for the campaign by far less than the apparent amount of the difference. For example, if brigades vaccinated five percent of the children at a unit cost twice that of doses in fixed facilities, their inclusion would increase average campaign costs by only 10%.

Although the samples of facilities studied were not random, they covered provinces in at least the two major regions of Ecuador. Since no marked differences in average costs among types of facilities or among provinces of those regions (or of the orients where sampled) emerged, the national estimates of costs, both total and average, should not have been biased appreciably.

The quality of the data used for cost estimation bears comment. Although uncertainties in some figures for individual facilities were unavoidable, their impact on final national costs was minimized through two levels of averaging (within type and across types of establishments). There is no obvious reason to believe that the quality of information was appreciably different between the two strategies. While the HCF/LAC project has not yet released its final report and may continue to make small revisions to their data, they are not expected to affect overall average costs noticeably.

In order to by-pass questions of correct reporting by local provider staffs of their time spent on each activity, including most final services, for routine program cost accounting, the direct time spent on vaccinations was considered to be five minutes per dose. This assumed value was consistent with some others used in the primary health services study and plausible in view of shorter average time per dose apparently spent in the campaign. Determination of actual mean times would have required a time motion study, which was not feasible within the constraints of the present study. Even if the actual times differed from the estimates used here, there would be little effect, provided that the relative times for several kinds of services were correct. All unaccounted for local time was allocated to the directly assigned activities, including vaccinations. Thus, any systematic under or over-estimate of direct times was compensated for by a corresponding over or under- allocation of unassigned staff time.

APPENDIX 7

COST-EFFECTIVENESS ANALYSES OF IMMUNIZATION STRATEGIES

The costs of vaccination programs around the world have been estimated for a variety of developing countries as reviewed elsewhere (Haaga, 1986; Robertson, 1985). In a smaller number of cases, the cost-effectiveness of the program has been assessed (see, for example, Creese et al, 1982 and Robertson et al, 1985). Very few studies, however, have compared cost-effectiveness of alternative delivery strategies, such as campaigns and routine programs (see, for example, Creese, 1984; Qualls, 1986; and WHO, 1987). Therefore, the studies on Ecuador reported here may help clarify the relative economic value of routine and campaign strategies. This report may be of special value in view of the recent proliferation of campaigns in the Americas and elsewhere in the developing world and the early judgement of PREMI campaign successes in Ecuador. Among the countries of the Latin American and Caribbean region that have had recent vaccination campaigns are Brazil, Colombia, Ecuador, El Salvador, and Jamaica. Countries outside the Americas in which campaigns have occurred recently include Burkina Faso, Mauritania, Turkey, and Cameroon.

APPENDIX 8

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APPENDIX 9

ESTIMATION OF FULLY VACCINATED CHILDREN BASED ON NUMBER OF DOSES

In order to be able to examine the consistency between survey results and program statistics, it was necessary to determine the number of doses administered per fully vaccinated child. Theoretically, a child required 8 doses to be considered fully vaccinated (1 BCG, 3 DPT, 3 polio, and 1 measles). In addition, he could receive boosters for BCG, DPT and polio, though these were not required. Tetanus toxoid doses to pregnant women represent additional doses.

If a child does not complete his full series of vaccinations, then the program must administer more than 8 doses per FVC (the 8 doses to the child who completes his series, plus some additional doses to other children who do not become fully vaccinated). The number of doses per FVC in any age group is calculated, in effect, by dividing the total number of doses given to children in that age group by the number of children fully vaccinated. An equivalent but more convenient way of expressing the same calculation is on the basis of pre child surveyed.

Suppose, hypothetically, that 200 doses were given to 40 surveyed children in an age group, and that 10 of these children were fully vaccinated. then in this age group, 20 doses are given (200/10) per FVC. On a per child basis, there are 5 doses per child surveyed (200/40 = 5), and 0.25 of the children surveyed were fully vaccinated. Again, the doses administered by FVC is 20 (5/0.25 = 20).

Using the per child formulation makes it easy to compute the number of doses per child. That number is simply the sum of the coverage rates of each dose of each vaccine.

To apply this method to actual data, a child under 1 received 3.36 required doses and approximately .10 dose of each of 3 boosters for a total of 3.66 doses. Total doses received were obtained by adding coverage rates, as decimal fractions, for each dose. The proportion of this age group fully immunized is 27.7%, or 0.2777 when converted to a decimal. The number of doses per FVC for this age group. For child under five as a whole, 10.4, subsequently rounded to 10 doses, are required for full immunization.

Table 9-1 shows that the number of doses per fully vaccinated child decreases in higher age groups with higher coverage. Doses given to a child who did not complete his required vaccinations were considered wasted and increased the number of doses per fully vaccinated child. This problem is more severe the lower the coverage rate. Booster doses were too infrequently received to be a major factor in this population.

TABLE 9-1

Number of Doses of Vaccine Administered to Cohort to Produce One Fully Vaccinated Child (FVC)

Age	Total Coverage[1]	Doses/ FVC
<1	28	13.2
1	63	11.4
2	74	10.0
3	75	10.1
4	78	9.9
<5	64	10.4

[1] From KAP Survey, 1986

APPENDIX 10

COMPARISON BETWEEN SURVEY RESULTS AND PROGRAM STATISTICS

The number of doses per fully vaccinated child (FVC) provides a way of checking for consistency between coverage rates from the national survey and facility statistics. To perform this check, the Ministry of Health's report on vaccination doses for 1985 was first adjusted for consistency in scope with the coverage survey. That survey covered only children under 5 and their mothers or guardians, and only the vaccines in the EPI. (The first comparison is further restricted to the routine program.)

Table 10-1 shows how the number of primary (non-booster) doses to children under 5 were derived from MOH data on the routine program by excluding a number of doses. These include diptheria-tetanus (DT) doses, which were generally given to children age 5 and over, Yellow Fever, which is not part of the EPI. Also excluded are doses of EPI vaccines given to children age 5 and over, tetanus toxoid (TT) doses to women, booster doses, and campaign doses during 1985 from the Pre-PREMI phase and the first PREMI cycle. (As the MOH is the implementing agency for the campaigns, it was found that their statistics included campaign doses.) Subtracting these exclusions leaves 1,389,770 doses through the routine program of EPI vaccines to children under 5.

Table 10-2 derives the total number of doses administered to the EPI population through the routine program, which comprises both primary and booster doses, and both children and women as recipients. As the MOH's records did not allocate according to percentages for primary doses.

Table 10-3 computes the number of doses implied by the coverage survey and compares the result with facility data. The population of children under 5 (1.6 million) is multiplied by the proportion fully immunized through routine and PREMI program. The result is divided by the number of years in the cohort in the survey and 1 year for PREMI (the duration of PREMI at that time). Finally, the number of children covered per year is multiplied by 10 doses per FVC. The results for the PREMI program agree to within 2.8 percent -- an excellent level of agreement.

Several factors could account for the divergence of 40.2 percent in the number of doses through the routine program. First, children might have lost or not presented a vaccination card and been revaccinated. Two doses would have been administered and recorded in program statistics, but the survey would have counted only one. Second, a child might have received multiple booster doses for a single vaccine, with only one was recorded in the survey. These are both legitimate reasons why the routine program data should be higher than the survey. Third, the MOH statistics might have inadvertently double counted some doses provided by brigades if they were reported both to the Ministry and to the health facility to which they were responsible. Since the estimates of routine program costs are based on numbers of doses reported by the Ministry, the cost of the routine program would have been overstated if some doses were double counted. As the routine program operated over longer time than each round of PREMI, routine program statistics are more susceptible to these divergences.

This comparison obviously makes a number of approximations and assumptions. It assumes that the routine program has continued at steady rate over the past 5 years, and that the number of doses administered in the June, 1986 PREMI cycle represents about a third of all PREMI doses for three cycles. Also, a number of approximations were made in counting both routine and PREMI doses. These include allocating doses between routine and campaign approaches based on dates, excluding booster doses from the facility counts of the routine programs of agencies other than the Ministry of Health, such as the social security system, are not counted in the facility data. Ecuadorean health officials consider these non-MOH sources to be a minor element of the vaccination program.

The close agreement between facility and survey data for PREMI, and the legitimate explanations for routine data, lend support to the validity of these assumptions and approximations.

TABLE 10-1

DERIVATION OF NUMBER OF PRIMARY ROUTINE DOSES TO CHILDREN UNDER 5

1986

Item		Doses
Total Doses (MSP Annual Report)		4,253,166
Less Exclusions (Other Doses)	471,188	
DT and Yellow Fever		
Campaign Doses		
Pre-PREMI Phase, Feb. 1985	462,187	
PREMI - Oct. 1985	917,772	
Tetanus Toxiod to Women	79,765	
Boosters	752,838	
Primary Doses to Children 5 and over	79,646	
TOTAL OTHER DOSES		2,863,396
Primary Doses to Children under 5 Through Routine Services		1,389,770

TABLE 10-2

ALLOCATION OF DOSES

Recipient	Primary Doses	Percent	Booster Doses	Combined Doses
Children under 5	1,389,770	84.27	634,419	2,024,189
Women	179,765	10.90	82,061	261,826
Combined Target Group	1,569,535		716,480	2,289,015
Children 5 and over	79,646	4.83	36,358	116,004
TOTAL	1,649,181	100.00	752,838	2,402,019

TABLE 10-3

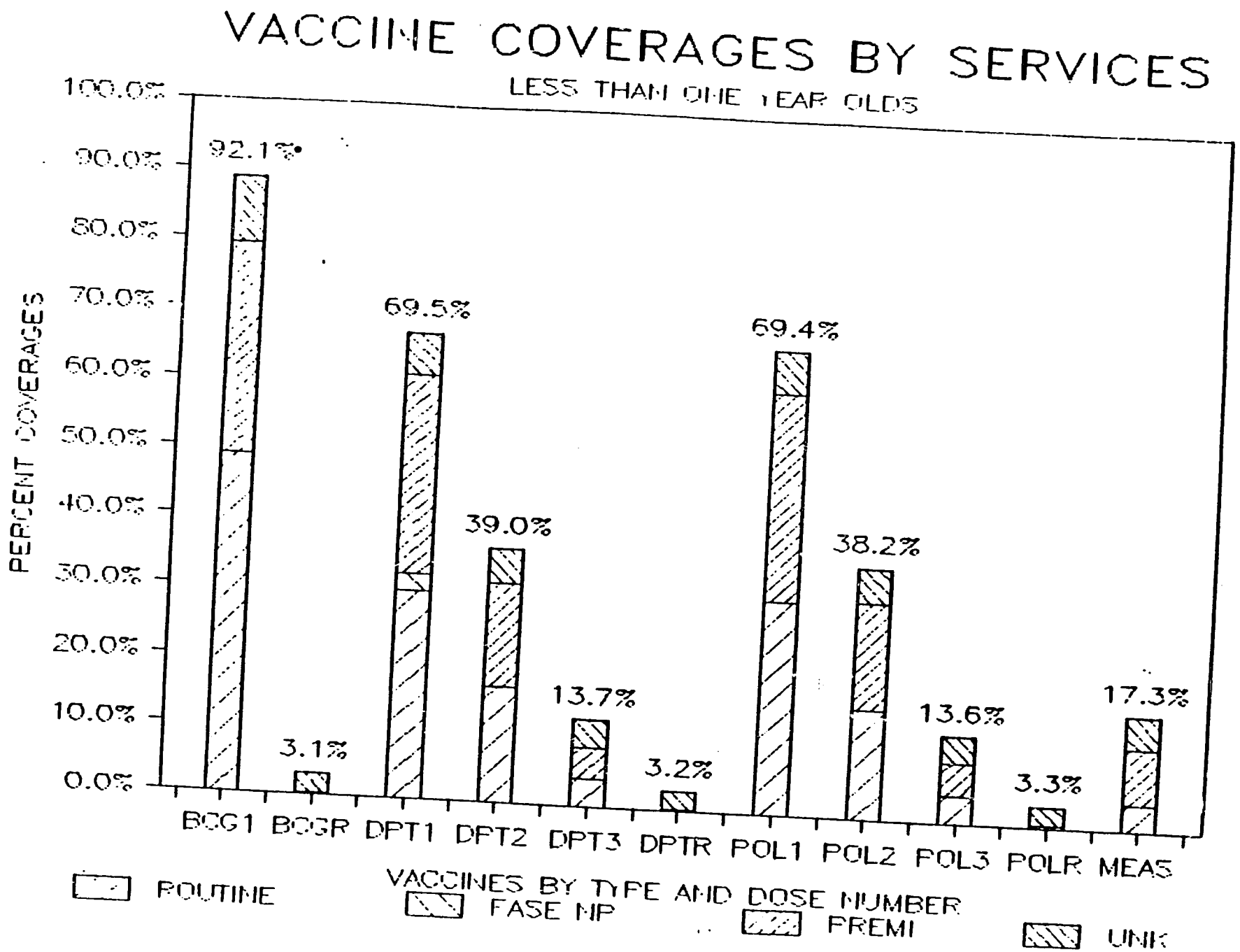
COMPARISION OF NUMBER OF VACCINATION DOSES FROM ROUTINE PROGRAM STATISTICS AND SURVEY RESULTS

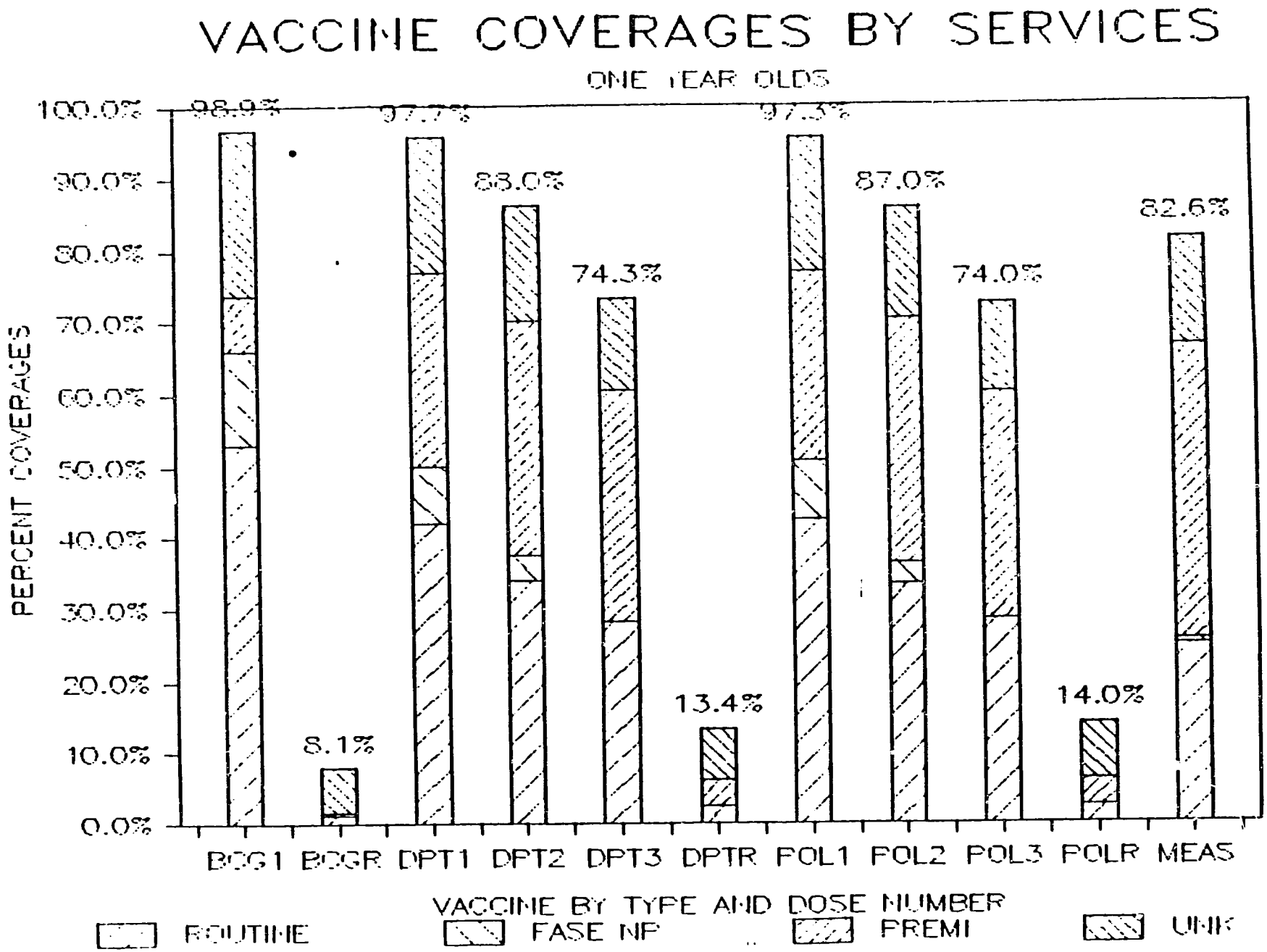
	ROUTINE SERVICES	PREMI CAMPAIGN
Number of children under 5	1,600,000	1,600,000
Net coverage	42.7	12.9
Years to achieve coverage	5	1
Children covered per year	136,640	206,400
Doses per child covered	10	10
National doses per year from survey results	1,367,000	2,064,000
National doses per year from facility statistics	2,286,015	2,005,815
Differences:		
Survey minus program (doses)	-919,015	58,185
As percent of program	-40.2	2.8

APPENDIX 11

VACCINE COVERGE BY SERVICE AND BY AGE
KAP SURVEY, 1986

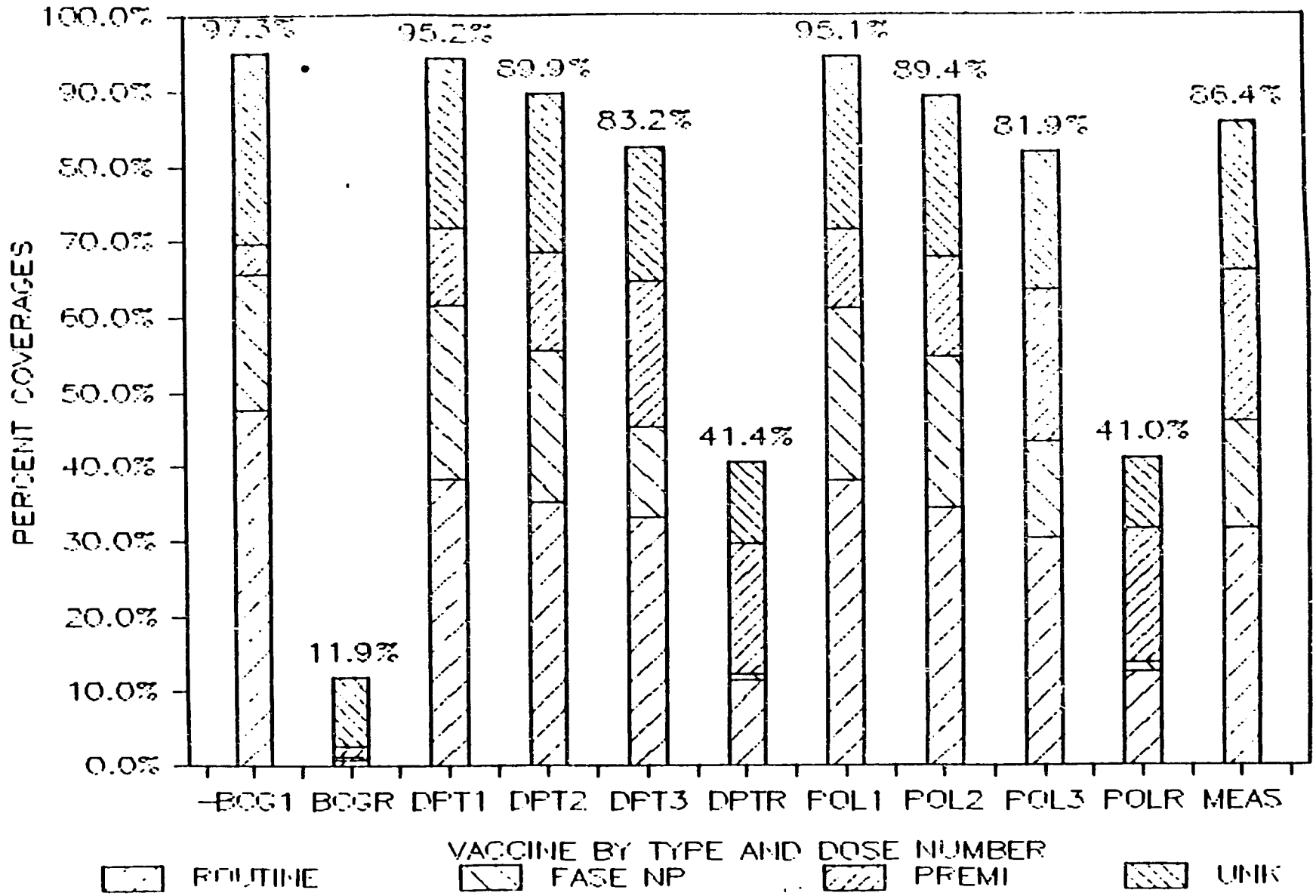
Figures used to calculate coverage rates in Table 2 in text. Survey was performed by the PREMI Program, with assistance from Dr. Marjorie Pollack.


VACCINE COVERAGES BY SERVICES
LESS THAN ONE YEAR OLDS
PERCENT COVERAGES
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
92.1%
3.1%
69.5%
39.0%
13.7%
3.2%
69.4%
38.2%
13.6%
3.3%
17.3%
BCG1
BCGR
DPT1
DPT2
DPT3
DPTR
POL1
POL2
POL3
POLR
MEAS
VACCINES BY TYPE AND DOSE NUMBER
ROUTINE
FASE NP
PREMI
UNK


VACCINE COVERAGES BY SERVICES
ONE YEAR OLDS
PERCENT COVERAGES
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
98.9%
8.1%
97.7%
88.0%
74.3%
13.4%
97.3%
87.0%
74.0%
14.0%
82.6%
BCG1
BCGR
DPT1
DPT2
DPT3
DPTR
POL1
POL2
POL3
POLR
MEAS
VACCINE BY TYPE AND DOSE NUMBER
ROUTINE
FASE NP
PREMI
UNK

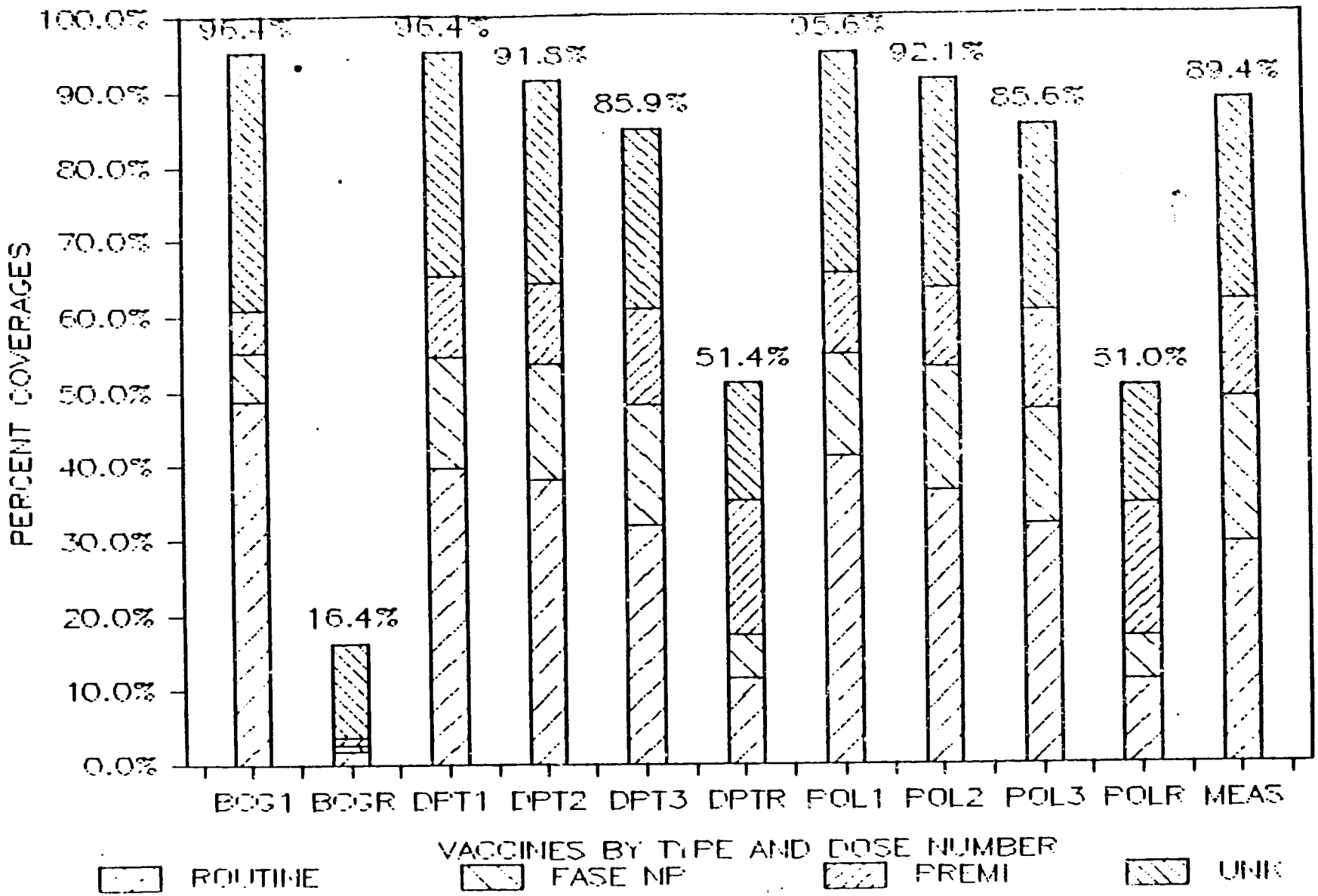
VACCINE COVERAGES BY SERVICES

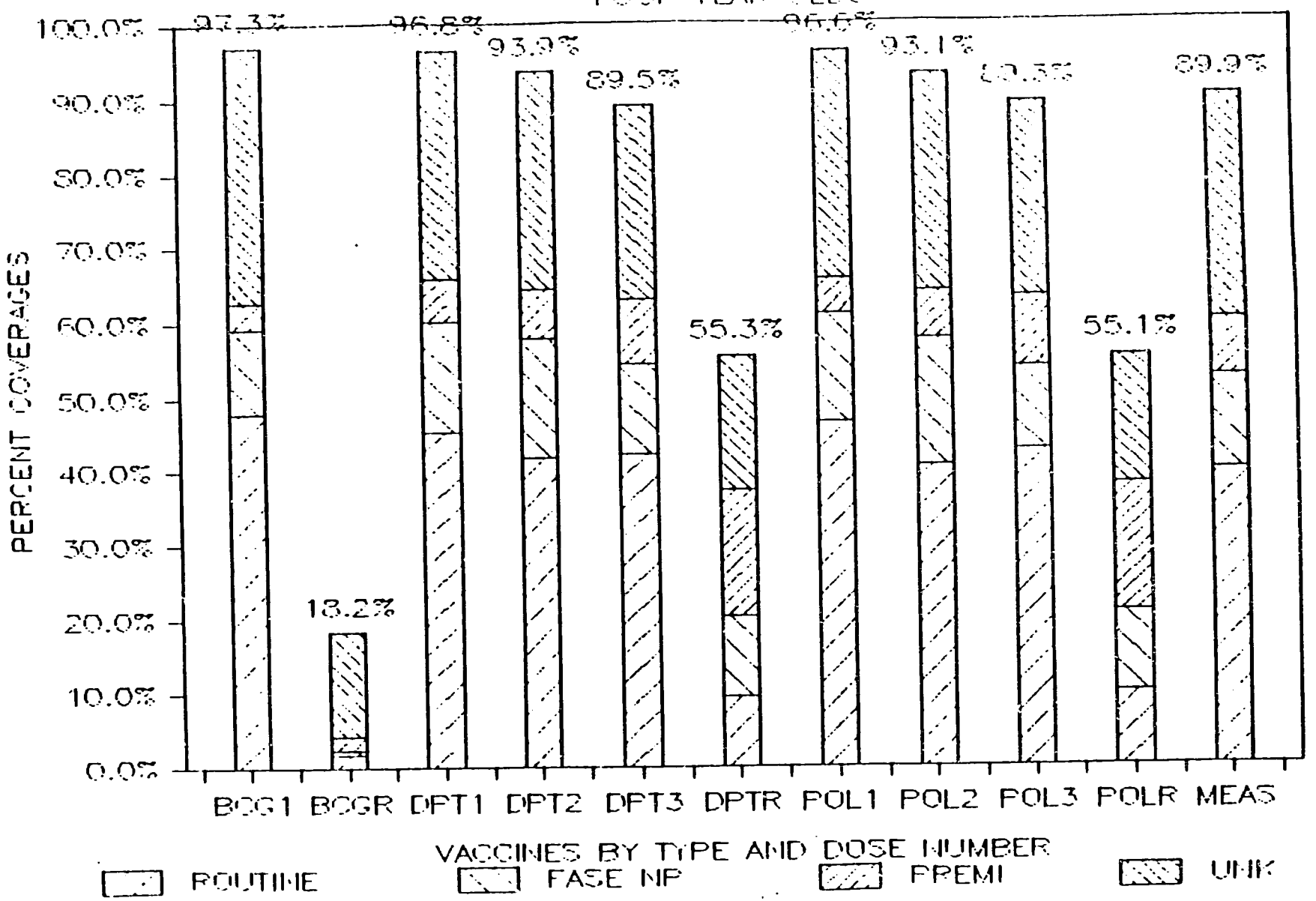
TWO YEAR OLDS



VACCINE COVERAGES BY SERVICES

THREE YEAR OLDS



VACCINE COVERAGES BY SERVICES

FOUR YEAR OLDS