

ECONOMIC ANALYSIS OF THE VACCINATION STRATEGIES ADOPTED IN BRAZIL IN 1982¹

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INTRODUCTION

The economic crisis affecting Latin America in recent years has seen widespread reduction in resources earmarked for government programs in social sectors—including the health sector. In Brazil, this trend aggravated the situation that was already emerging in the period preceding the crisis when, despite economic growth and the availability of extensive financial resources, such resources were generally being allocated to the directly productive sectors of the economy, with social sector projects being given a secondary status.

Internationally, the shortage of public resources drew attention to the need to rationalize use of those available and to identify areas of action that should receive priority. Among the priority areas identified were activities of the PAHO/WHO Expanded Program on Immunization (EPI) directed at providing the vaccines that serve as effective

tools for controlling preventable communicable diseases.

Among other things, the EPI developed a methodology for economic evaluation of different Member Country vaccination strategies and later promoted studies applying that methodology. This article analyzes implementation of the EPI in Brazil in 1982 by comparing the economic performance (including the cost of vaccination services and the number of vaccinations given) of the three basic vaccination strategies being implemented in the country at that time. The three strategies, consolidated under the National Program on Immunization and implemented by various institutions at the federal, state, and municipal levels of government, can be described as follows:

- There was, first, a routine vaccination program for immunization against measles, tuberculosis (BCG vaccine), poliomyelitis (oral vaccine), and diphtheria, whooping cough, and tetanus (DPT vaccine). All of these immunizations were being routinely provided by a wide range of different health units.

¹ The study reported here was carried out at the Public Health Services (SESP) Foundation of the Ministry of Health of Brazil, with advice provided by economist Andrew Creese, author of the methodology employed. This article has also been published in Portuguese in the *Boletín de la Oficina Sanitaria Panamericana*, vol. 103, no. 6, 1987, pp. 675–694.

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- Second, the routine program was intensified by short-duration vaccination services provided at designated times by mobile teams. These teams served both peripheral urban areas of headquarters districts, where the supporting health units were located, and rural areas of particular municipalities that were thinly populated and therefore not served by a permanent health unit. Such intensification of the routine program was planned and implemented by full-time personnel of the supporting health units involved. These intensified efforts sometimes provided only one or two kinds of vaccination, and sometimes provided the full range of vaccinations called for by the EPI program.

- Finally, mass vaccination campaigns of short duration were conducted. (In 1982 these were limited to providing a single vaccine in most states.) Specific resources were earmarked for these campaigns, in which a range of organizations and individuals—including local governments, health units, schools, private organizations, and volunteers—participated by contributing human and material resources.

MATERIALS AND METHODS

Each of these vaccination strategies was studied, using a sample of 55 health units (Annex 1) from 15 municipalities located in two Brazilian states, Pará in the north and Pernambuco in the northeast. These municipalities exhibited notably different characteristics in terms of size, urban or rural

features, and the responsible health institutions involved (the Public Health Services Foundation, state secretariats of health, or other agencies).

The types of health units involved were as follows:

- Forty of the units were health posts with primary care personnel trained in simplified techniques. These posts were linked to health centers that provided support and supervision.

- Ten of the units were health centers providing regular medical and health care in four basic specialties—clinical medicine, minor surgery, obstetrics and gynecology, and pediatrics. This care was provided for ambulatory patients by general practitioners.

- Four of the units were mixed, consisting of a health center and inpatient facility under a single administrative structure. These units, which were providing medical-health and dental care, lent support to the health centers and posts within their areas of responsibility.

- One unit was a local hospital providing care in the aforementioned basic medical specialties and clinical surgery for a defined population.

Some of the units were urban and some rural, with varying degrees of accessibility. Several, in riverine parts of Pará State, could be reached only by boat. As indicated in Annex 1, a variety of federal, state, and municipal institutions provided support for the study units. Table 1 shows the recorded vaccination coverage provided by the routine vaccination services of the study municipalities in 1982, combined in the case of the second polio vaccination with coverage provided by the mass campaign.

Since the question at hand was not whether vaccination services were economically feasible but how such ser-

TABLE 1. Recorded vaccination coverage among children one year of age in the study municipalities that was provided by the routine vaccination services. In the case of the second polio immunization the data also include coverage provided by the mass campaign.

Municipalities (by state)	% coverage with indicated vaccine				
	Polio (second dose) ^a	Polio (third dose)	Measles	DPT (third dose)	BCG ^b
Pará:					
Bragança	131.7	39.9	43.6	37.1	82.5
Breves	92.5	26.5	21.0	25.6	21.2
Capanema	105.8	65.2	48.9	55.1	92.4
Portel	37.6	6.9	13.5	6.7	14.4
Rondon do Pará	118.3	40.9	29.5	25.0	53.8
Santa Isabel do Pará	105.8	59.8	56.7	71.2	100.0
São Caetano de Odivelas	142.1	17.5	11.9	16.8	84.3
Pernambuco:					
Cortês	197.4	57.7	58.7	79.9	54.0
Escada	206.6	62.9	40.7	71.4	32.76
Joaquim Nabuco	144.0	49.0	61.9	55.1	78.6
Lagoa dos Gatos	134.3	7.6	5.1	6.8	7.7
Palmares	170.1	40.7	42.3	62.0	73.2
Ribeirão	126.7	79.5	78.8	79.7	122.3
Rio Formoso	136.0	57.5	39.6	51.0	49.0
São João	126.9	32.8	25.8	39.3	41.8

^a Percentages over 100 reflect double vaccinations or vaccination of children outside of the indicated age bracket.

^b Percentage of all children under one year of age.

vices should be provided by the government, our study's aim was to identify the most efficient means of providing these services without losing sight of the EPI goals. For purposes of this analysis, it was felt most suitable to employ the cost-effectiveness method described by economist Andrew Creese in the WHO document "Expanded Program on Immunization: Costing Guidelines."³

Within this context, the relationship between cost and effectiveness indicates the relative success of each strategy. For purposes of the analysis, cost was defined as social cost—i.e., the resources spent by society as a whole, including but not limited to the resources spent by the responsible institutions—of imple-

menting the National Program on Immunization (Programa Nacional de Imunização—PNI). Effectiveness was defined in terms of the number of children under one year of age who were fully vaccinated with each type of vaccine, and the number of vaccinations they received.

Costs

The costs calculated included costs at all the administrative levels involved in the PNI, stratified as follows:

- Level I: the implementing entities, i.e., the health units or field vacci-

³ World Health Organization, Geneva, 1979.

nation posts performing the vaccinations;

- Level II: the regional supervisory and coordinating bodies, these consisting of the regional health boards of the state health secretariats;

- Level III: the national program's state coordinating bodies, these being the state health secretariats and the regional boards of the Public Health Services (SESP) Foundation; and

- Level IV: the program's national coordinating bodies, i.e., the health ministry's National Secretariat for Basic Actions (SNABS) and SESP Foundation; and the Ministry of Social Security and Welfare's Drug Supply Center, which was responsible for distributing the vaccines.

Data on the capital costs (of buildings, vehicles, and equipment) and operating costs (of personnel, consumables, travel, etc.) involved in carrying out the national program in 1982 were gathered at each of these four administrative levels. In most cases where a cost could not be attributed exclusively to the vaccination service, this cost had to be apportioned in accordance with the share applicable to the program. Thus, the costs of personnel directly or indirectly involved in the program were calculated according to the estimated percentage of working time devoted to vaccination program work. Similarly, the costs of equipment, materials consumed, and other goods and services (water, electricity, telephones, etc.) were apportioned according to the percentage of total consumption used for the national program.

For the health units, the costs were merely calculated in this manner. However, costs at other administrative levels were apportioned to each health unit involved. In this way, the total estimated cost of the vaccination service consisted of the vaccination cost at each

health unit plus that portion of the costs at other levels apportioned to each unit.

Besides considering the social costs to the health sector, the calculations included the costs incurred by the users of vaccination services. For that purpose, a one-month survey was taken at one routine vaccination service and two campaign posts (one urban and one rural) for each municipality in the sample. This survey sought to determine the time and money spent by the users for each vaccination. In addition, in the case of the vaccination campaign (which involved participation by several social sectors) contributions received in the form of voluntary labor, donations, and loans were added to the social costs.⁴

Since effectiveness was measured in terms of the number of vaccinations provided to infants, the unit for comparing performance of the different vaccination services was the ratio of total cost to the number of such vaccinations, which was known as the "unit vaccination cost." Similarly, when considering effectiveness from the standpoint of complete vaccinations (i.e., three doses of DPT and poliomyelitis vaccines) the unit of comparison was the ratio of total cost to the number of complete vaccinations, termed the "unit cost of complete vaccination."

To compare strategies, the cost to the user of each vaccination was added to the unit cost of vaccination for

⁴ The methodology used in the one-month survey is described in greater detail in the appendix of a document entitled "Detalhamento do modelo de cálculo adotado no estudo de custo-eficiência das estratégias de vacinação," which is available from the author.

the health unit involved. And, since the strategies in question were undertaken at different times, the costs derived were converted to December 1982 equivalents, based on the General Price Index.

EXECUTION OF VACCINATION STRATEGIES IN THE MUNICIPALITIES STUDIED

Delivery of routine vaccination services in each municipality was organized through the supporting health center. Partly for this reason, there were variations in the way the work was done from one unit to the next. For instance, certain units, instead of offering all the PNI (national program) vaccines on a daily basis, chose to set aside a specific day of the week for each vaccine, so as to avoid major losses when using bottles with many doses. Or, to cite a more extreme example, certain health posts in Pará State that served small populations offered vaccination services only once a month, on a predetermined date. These posts did not keep vaccines in stock; rather, they received them monthly from the support units, to which they returned the unused vaccines. Nevertheless, the most common practice in the health units studied was to provide vaccinations daily, on a comprehensive basis, offering the full range of PNI vaccines. Six health posts included in the Pará study sample were closed during the period covered by the study and thus were not considered (even though they represented immobile, unproductive capital).

Intensification of routine services in 1982 was carried out by 10 units in the Pernambuco sample and six in the Pará sample. Certain health centers (such as the one at Santa Isabel do Pará) directed these intensified services at pe-

ripheral areas of the municipal seat. Others, located in the sugar cane region of Pernambuco, dispatched their teams to areas where the cane was grown and processed; this was done on working days, with the team returning each day to the support unit. In general, the success of these intensification efforts depended greatly upon how well the schedule of visits to the local population was planned, and also upon prior publicity given to the dates of the vaccination days.

The National Poliomyelitis Vaccination Campaign, which had been launched in 1980 with the "National Days of Poliomyelitis Vaccination" aimed at children under five years of age, was continued in 1982. A number of Pará State municipalities used the structure of this poliomyelitis campaign to simultaneously administer DPT vaccine to children of the same age group in urban areas. Indeed, São Caetano de Odivelas was the only Pará municipality in the study sample that did not include DPT vaccine in the campaign.

COST ANALYSIS

The analysis was carried out in two ways. First, the costs at the various health units were compared, taking into account the units' different characteristics and the cost structures of the various strategies employed. And second, the costs of the various strategies were compared, together with the results obtained by each. For purposes of this study, the two types of analysis are referred to as "intra-strategy" and "inter-strategy" analysis, respectively.

Intra-Strategy Analysis

Routine services: structure of vaccination costs. Regarding the composition of vaccination costs, fixed costs (taken as the costs of buildings, vehicles, equipment, and administrative personnel) were found to average 35.1% of the health units' total vaccination costs in the Pernambuco health units and 48.3% of the total costs in the Pará health units. The considerable share of total vaccination costs accounted for by these fixed costs means, in essence, that in order to lower costs, either the number of vaccinations must be increased or else the fixed costs must be reduced.

Such reduction could be accomplished, among other things, by reducing the idle capacity of unused or underused capital resources. For example, underused vaccination rooms (found most notably at health posts that vaccinate only once a month) could be used for other activities. The existence of such idle capacity in the health units studied is shown by the high share of health post vaccination costs attributed to the category "buildings," which in certain Pará units accounted for between 58% and 88% of all the costs reported.

Regarding variable costs, the largest component was found to be the cost of directly involved personnel, which averaged 37.1% of all variable costs in Pará and 51.8% in Pernambuco. The actual vaccines employed accounted for about 4% of the total vaccination program costs in the units studied.

Routine services: vaccination costs. In seeking to compare overall vaccination costs at different units, the costs incurred

at other administrative levels were initially omitted so as to avoid reducing contrasts between the units' costs by adding the prorated costs of the other levels. Table 2 (the only table from which these upper-level costs were omitted) shows the costs found for 14 different units pertaining to one institution (the Public Health Services Foundation or SESP), selected because these units all had the same basic cost factors—especially with regard to personnel costs, which constituted the largest single item.

For the units in Pernambuco, it was found that the average cost per vaccination tended to decrease with increased output, and that marginal costs were much lower than average costs (except for the São João and Aripubu units). This trend, graphed in Figure 1, suggests that most of the health units were operating far below their most productive capacity.

This trend was less clear-cut in Pará because the units that vaccinated the most people tended to be the hardest to reach (such as Breves) or to serve dispersed rural populations (such as Rondon do Pará)—circumstances that led to increased average vaccination costs.

Tables 3 and 4 show the costs per vaccination, by type of vaccination, for all the study units. Generally, throughout Pernambuco and in most of the Pará municipalities, the larger (higher-ranking) types of units had the lowest average costs per vaccination, due mainly to economies of scale. That is, the smaller units administered fewer vaccinations and were forced to operate with fixed costs that constituted a considerable share of the total cost.

Another factor that should be considered in this regard is the now-recognized tendency of users to turn preferentially to health units that provide higher levels of care (even though they are further away); for at such units the

TABLE 2. Vaccination costs at health units of one institution, the Special Public Health Service (Serviço Especial de Saúde Pública—SESP), in the study municipalities of Pará and Pernambuco, 1982.

State and health units ^a	No. of vaccinations administered	Total cost (\$Cr) ^b	Average cost (\$Cr) ^b
Pará:			
Mirasselas	823	791,397	962
Tauri	1,015	931,498	918
Rondon do Pará	3,745	3,999,015	1,068
Santa Isabel do Pará	7,091	2,680,838	378
Breves	9,316	6,848,503	735
Capanema	10,051	8,725,723	868
Pernambuco:			
Serro Azul	531	878,835	1,655
Estreliana	655	684,060	1,044
Stº Antonio dos Palmares	693	863,049	1,245
Pumaty	1,168	776,924	655
Newton Carneiro	1,243	584,847	470
José Mariano	1,355	445,372	329
Aripibu	1,770	641,335	362
São João	2,214	1,936,252	875
Joaquim Nabuco	3,425	1,382,235	404
Palmares	9,929	3,198,037	322
Ribeirão	10,214	2,203,654	216

^a Two health units pertaining to the Special Public Health Service (see Annex 1), those of Curumuru and São Miguel dos Macacos in Breves (Pará State), were not included here because they had only been in existence a short time and their services were still being established.

^b The average free market exchange rate in 1982 was 1 dólar (US) = 279 cruzeiros.

FIGURE 1. Average costs of vaccination versus the number of vaccinations administered at the health units of one institution, the Special Public Health Service (SESP), in the study municipalities of Pernambuco State, 1982.

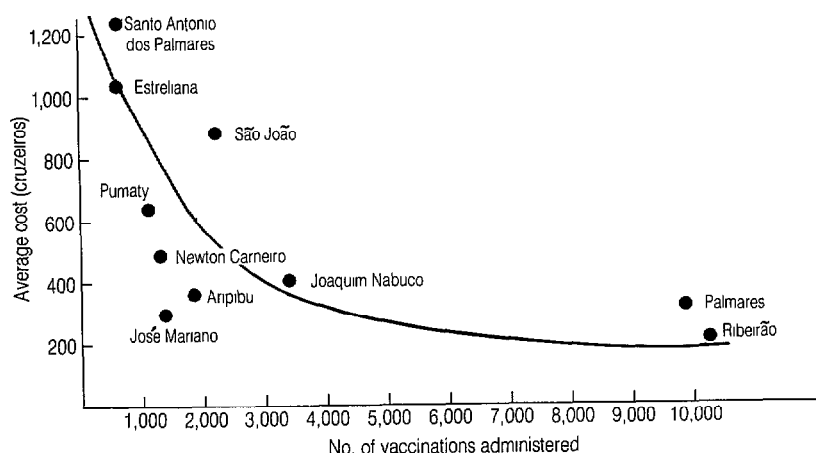


TABLE 3. Unit costs of vaccination in routine programs of the Pará health units studied—by type of vaccine and age of recipients (< 1 year or all ages) in cruzeiros (1982).^a

Pará municipality and health unit	Type of unit ^b	Cost of administering vaccines of indicated types to recipients of indicated ages:								Recipient cost of obtaining each vaccination	Total cost per vaccination for recipients < 1 year old			
		< 1 year old				All ages					Polio	Measles	DPT	BCG
		Polio	Measles	DPT	BCG	Polio	Measles	DPT	BCG					
Bragança:														
Bragança	HC	244	959	850	841	179	554	532	535	303	547	1,262	1,153	1,144
Bacuritena	HP	4,115	1,675	1,141	1,667	2,014	634	613	615	303	4,418	1,978	1,444	1,970
Gessé Guimarães	HP	591	1,169	954	662	212	648	627	631	303	894	1,472	1,257	965
Tracuatena	HP	637	1,201	1,616		273	831	811		303	940	1,504	1,919	
Vila Fátima	HP	1,233	14,039	2,843		317	1,021	1,002		303	1,536	14,342	3,146	
Breves:														
Breves	M	6,219	2,043	1,867	3,187	3,648	1,008	992	994	125	6,344	2,168	1,992	3,312
Curumu	HP	1,264	15,329	3,150	10,425	347	1,052	1,031	1,035	125	1,389	15,454	3,275	10,550
São Miguel dos Macacos	HP	1,104	4,556	3,481	4,430	330	1,139	1,116	1,120	125	1,229	4,681	3,606	4,555
Capanema:														
Capanema	HC	503	1,540	1,649	1,605	389	1,181	1,178	1,120	438	941	1,978	2,087	2,043
Mirasselas	HP	1,141	2,374	3,487	3,005	517	1,554	1,543	1,547	438	1,579	2,812	3,925	3,443
Tauari	HP	971	2,368	2,761	3,696	488	1,426	1,460	1,462	438	1,409	2,806	3,199	4,134
Portel:														
Portel	M	469	1,584	556	2,603	321	977	366	959	139	608	1,723	695	2,742
Rondon do Pará:														
Rondon do Pará	HC	906	3,061	2,581	2,413	548	1,652	1,637	1,639	357	1,263	3,418	2,938	2,770
Santa Isabel do Pará:														
Santa Isabel do Pará	HC	226	846	799	612	172	532	510	514	301	527	1,147	1,100	913
Americano	HC	4,258	20,960	13,191	27,257	2,401	7,452	7,441	7,434	301	4,559	21,261	13,492	27,558
São Caetano de Odivelas:														
São Caetano de Odivelas	HC	1,402	3,586	4,338	2,456	571	1,722	1,706	1,706	94	1,496	3,680	4,432	2,550
Deolândia	HP	400	4,050	2,662	2,383	200	810	826	829	94	494	4,144	2,756	2,477
Guarajuba	HP	0	—	1,463	1,242	0	507	502	505	94	94	—	1,557	1,336
Marabitanas	HP	11,904	29,727	25,188	5,928	1,984	5,945	5,927	5,928	94	11,998	29,821	25,282	6,022
Rio Branco	HP	5,117	25,619	28,163	10,231	3,655	10,248	10,241	10,231	94	5,211	25,713	28,257	10,325
São João da Ponta	HP	568	557	1,367	890	142	433	408	412	94	662	651	1,461	984
São João dos Ramos	HP	10,182	—	122,130	20,359	6,788	—	20,355	20,359	94	10,276	—	122,224	20,453
Vila Nova	HP	151	720	1,475	555	113	288	267	271	94	245	814	1,569	649

^a The average free market exchange rate in 1982 was 1 dollar (US) = 279 cruzeiros.

^b M = mixed unit; HC = health center; HP = health post.

TABLE 4. Unit costs of vaccination in routine programs of the Pernambuco health units studied—by type of vaccine and age of recipients (< 1 year or all ages) in cruzeiros (1982).^a

Pernambuco municipality and health unit	Type of unit ^b	Cost of administering vaccines of indicated types to recipients of indicated ages:								Recipient cost of obtaining each vaccination	Total cost per vaccination for recipients < 1 year old			
		< 1 year old				All ages					Polio	Measles	DPT	BCG
		Polio	Measles	DPT	BCG	Polio	Measles	DPT	BCG					
Cortês:														
Cortês	HC	158	694	409	504	69	222	201	205	152	310	846	561	656
Usina Pedrosa	HP	331	1,337	1,063	840	147	452	432	432	152	483	1,489	1,215	992
Escada:														
Hospital Nossa Senhora da Escada	M	136	331	423	376	69	187	167	170	95	231	426	518	471
Usina Barão de Suassuna	HP	486	2,723	1,399		176	545	520		95	581	2,818	1,494	
Casa de Saúde Maria Dias Lins (Usina União)	HP	379	1,096	1,024		179	548	529		95	474	1,191	1,119	
Frecheiras	HP	421	1,295	1,655		332	1,007	995		95	516	1,390	1,750	
Usina Massauassú	HP	443	1,461	1,493		229	703	680		95	538	1,556	1,588	
Joaquim Nabuco:														
Joaquim Nabuco	HC	258	70	931	1,441	171	36	504	508	240	498	310	1,171	1,681
Usina Pumaty	HP	1,440	2,511	2,008	3,364	838	859	836	686	240	1,680	2,751	2,248	3,604
Lagoa dos Gatos:														
Entroncamento	HP	626		6,892	10,806	464		1,378	1,380	166	792		7,058	10,972
Igarapeasso	HP	439	1,897	4,096		375	1,138	1,123		166	605	2,063	4,262	
Lagoa do Souza	HP	1,142	2,674	6,028		621	1,888	1,859		166	1,308	2,840	6,194	
Lagoa dos Gatos	HP	449		3,523	9,072	312		923	926	166	615		3,689	9,238
Palmares:														
Palmares	M	176	698	613	492	131	403	383	388	317	493	1,015	930	809
Newton Carneiro	HP	308	1,129	1,122		211	646	623	625	317	625	1,446	1,439	
Santo Antônio dos Palmares	HP	960	4,361	3,090	3,060	539	1,620	1,599	1,602	317	1,277	4,678	3,407	3,377
Serro Azul	HP	917	6,300	3,610	9,892	693	2,100	2,084	2,088	317	1,234	6,617	3,927	10,209
Ribeirão:														
Ribeirão	HC	155	532	466	561	100	313	291	295	81	236	613	547	642
Anpibu	HP	386	1,218	887	2,239	188	576	554	559	81	467	1,299	968	2,320
Estrelliana	HP	762	2,639	2,362	1,749	494	1,501	1,472	1,476	81	843	2,720	2,443	1,830
José Mariano	HP	266	1,044	872	1,675	160	495	472	476	81	347	1,125	953	1,756
Rio Formoso:														
Rio Formoso	H	191	673	587	883	97	303	283	288	43	234	716	630	926
Saué	HP	258		1,512		559		765		43	301		1,555	
Tamandaré	HP	269	1,133	777		117	366	344		43	312	1,176	820	
Usina Cocaú	HP	315	1,230	981	1,257	163	501	644	479	43	358	1,273	1,024	1,300
São João:														
São João	HC	648	2,786	1,435	1,535	380	1,152	1,129	1,132	354	1,002	3,140	1,789	1,889

^a The average free market exchange rate in 1982 was 1 dollar (US) = 279 cruzeiros.^b M = mixed unit; H = hospital; HC = health center; HP = health post.

users can receive other services, in addition to vaccinations, during a single visit. This obviously contributes to drawing users away from the more basic units, lowering the latter's output.

Intensified services. Providing intensified vaccination services involves shifting some health unit personnel of a given municipality to that municipality's marginal urban or rural areas. The main cost components here are personnel, vaccines, other materials, and transportation (vehicles and fuel). As Table 5 indicates, the average costs of vaccinations tended to be quite uniform (generally on the order of 200 cruzeiros) except at certain units such as Santa Isabel do Pará and Palmares that were at the two ex-

tremes in terms of program duration (one and 33 days, respectively). This suggests that in the first case there may not have been enough time to provide a satisfactory number of vaccinations, while in the second the time dedicated to intensified program activities may have been excessive relative to the target population's size. Such higher costs could also have been linked to the manner in which availability of the intensified services was publicized in the target communities.

TABLE 5. Unit costs of vaccination in the intensified programs carried out by 16 of the Pará and Pernambuco health units studied—by the type of vaccine, the age groups vaccinated (<1 year or all ages), and the health units involved, in cruzeiros (1982).^a Note that the costs to recipients in the intensified programs were not considered significant.

State, health unit, and length of intensified program	Cost of administering vaccines of indicated types to recipients of indicated ages:							
	Polio		Measles		DPT		BCG	
	< 1 year	All ages	< 1 year	All ages	< 1 year	All ages	< 1 year	All ages
Pará:								
Bragança (23 days)	440	79	717	248	857	227	1,637	232
Breves (8 days)	456	101	3,006	314	1,375	294	785	298
Curumu (2 days)	907	79	4,736	252	2,364	231		
Portel (4 days)	709	156			2,052	462		
Santa Isabel do Pará (1 day)	675	405	2,128	1,277	4,605	1,256		
São Caetano de Odivelas (3 days)			91	65	128	47	113	
Pernambuco:								
Aripibu (8 days)	204	71	551	223	502	203	1,145	207
Estrelilana (7.5 days)	83	37	339	126	213	104	337	108
Hospital Nossa Senhora da Escada (3 days)							77	35
Joaquim Nabuco (48 days)	2,335	146	5,790	439	1,497	432	1,910	436
José Mariano (3.5 days)			1,223	262	575	242		246
Palmares (33 days)	1,321	326	5,077	996	3,599	976		
Pumaty (3 days)	259	94			429	274	778	278
Ribeirão (6 days)			1,149	146	378	125	385	129
São João (10 days)			850	80	313	59		
Usina Cocaú (1 day)	90	34	258	114			338	97

^a The average free market exchange rate in 1982 was 1 dollar (US) = 279 cruzeiros.

Campaign activities. Total costs of the campaign varied a good deal from one municipality to the next. Because many of the actual costs were social costs (including volunteer work, donations, and so forth), these variations were due largely to differing degrees of public mobilization in the different communities studied.

Regarding elements contributing to the campaign's vaccination costs, publicity was significant, accounting for 5.8% of the total cost in the Pará municipalities and 10.8% in the Pernambuco municipalities. Likewise, transportation (9.7% of the total cost in the Pará municipalities, 8.2% in the Pernambuco municipalities) was an expensive element because of the need to move human and material resources to health posts in the interior.

Overall, the cost of providing polio vaccinations to children under one year old were relatively low compared to the costs recorded for the routine and intensified programs, ranging from 106 to

594 cruzeiros in Pará and from 220 to 933 cruzeiros in Pernambuco (Tables 6 and 7). However, the polio campaign's goal in Brazil was to vaccinate all children under four years of age; and, in this context, it should be noted that the campaign cost of providing vaccinations to all children under one year old (without considering vaccination of other age groups) would be considerably higher than the campaign costs reported here.

Inter-Strategy Analysis

It would be incorrect to analyze the three strategies independently of one another, since both the intensified and campaign strategies depended heavily upon the support structure provided by the fixed units conducting the routine program. The issues in question are (a) whether the complementary strategies (the intensified efforts and the campaign) pay off in terms of cost-effectiveness, and (b) given these considerations, what is the best combination of strategies.

Cost. Tables 3 and 4 show the routine program costs of providing each vaccination (including the costs of the health

TABLE 6. Unit costs of vaccination in the Pará polio and DPT campaign (second doses)—by age group and municipality, in cruzeiros (1982).^a

Pará municipalities	Cost of administering polio and DPT				Recipient cost of obtaining each vaccination ^b	Total cost per vaccination of recipients < 1 year old	
	< 1 year		All ages			Polio	DPT
	Polio	DPT	Polio	DPT			
Bragança	106	391	34	95	62.5	168.5	453.5
Breves	389	1,311	100	292	107.0	496	1,418
Capanema	594	1,780	134	547	127.5	721.5	1,907.5
Portel	374	1,143	85	248	63.5	437.5	1,206.5
Rondon do Pará	155	506	50	155	114.0	269	620
Santa Isabel do Pará	558	1,788	135	397	53.0	611	1,841
São Caetano de Odivelas	283		89		87.0	370	

^a The average free market exchange rate in 1982 was 1 dollar (US) = 279 cruzeiros.

^b Weighted average of costs to users of rural and urban posts.

TABLE 7. Unit costs of vaccination in the Pernambuco polio campaign (second dose)—by age group and municipality, in cruzeiros (1982).^a

Pernambuco municipalities	Cost of vaccinating recipients		Recipient cost of obtaining each vaccination ^b	Total cost per vaccination of recipients < 1 year old
	< 1 year old	All ages		
Cortês	491	116	67	558
Escada	220	67	114	334
Joaquim Nabuco	933	177	42	975
Lagoa dos Gatos	225	55	79	304
Palmares	545	138	21	566
Ribeirão	667	120	43	710
Rio Formoso	276	65	83	359
São João	408	95	87	495

^a The average free market exchange rate in 1982 was 1 dollar (US) = 279 cruzeiros.

^b Weighted average of costs to users of rural and urban posts.

unit's vaccination service and the apportioned costs of the other administrative levels providing coordination and supervision). In addition, they show the estimated costs to users of obtaining each vaccination (essentially the cost of transportation and lost parental work time).

In general, the estimated costs to users were less for vaccination through the campaign or intensified program than they were for vaccination through the routine program. In the case of the campaign, this was due largely to the many field posts established, which reduced the distances people had to travel. In the case of intensified vaccination, it was because the costs to users were not considered—the vaccination effort being geared mainly to workers in the sugar industry (and being implemented at the sugar mills) and to small peripheral populations in outlying areas where vaccination posts were set up in easily accessible locales.

Data provided on the cost per vaccination of children under one year old (see the right-hand columns of Tables 3 through 7) indicate that so far as the study samples are concerned, the campaign was the strategy with the lowest average unit vaccination costs in both states. In Pará State, the average costs of a vaccination administered through the campaign, the intensified program, and the routine program were 439, 637, and 2,550 cruzeiros, respectively. In Pernambuco State, the respective average costs were 538, 983, and 629 cruzeiros, the cost difference between the campaign and the routine program being less significant.

It should be stressed that these were average costs, and that in some municipalities (mainly in Pernambuco) the routine program was more cost-effective than the campaign. Also, the average figures cited cannot be taken as representative of the intensified efforts' costs, since the widely varied circumstances in which the intensification strategy was implemented led to an enormous disparity of costs.

Also, the campaign vaccination costs were not so low as they appear. That is, if the campaign vaccinations of children who had already received three doses of polio vaccine through the routine program were not considered, then the costs per effective dose of vaccine administered by the campaign strategy would be higher than those shown.

Coverage. The campaign provided the greatest vaccine coverage, apparently reaching 100% in all the study municipalities except Breves and Portel in Pará State. (These two municipalities have hard-to-reach populations dispersed in large rural areas with difficult access by water.) These high rates of coverage (100%) suggest that the child population of the municipalities was probably underestimated.

Coverage achieved through routine vaccination (see Table 1) was generally greater for BCG than for measles vaccine, the third dose of polio vaccine, or the third dose of DPT vaccine. This is probably because multiple vaccinations were not needed for BCG and the vaccine could be administered during the child's first month, when the mother's ongoing contact with the health unit was relatively strong. The coverage achieved by routine vaccination was very poor at the health posts of the interior that only offered vaccinations once a month. For example, at São Caetano de Odivelas municipality, routine coverage was 17.5% for poliomyelitis vaccination, 11.9% for measles, and 16.8% for DPT. Coverage was also poor at health posts that served municipalities with large areas or dispersed populations that travel by river (for example, Portel in Pará

State). Nonetheless, in some municipalities (such as Ribeirão and Santa Isabel do Pará) the routine program achieved results that could be compared to those of the campaign, and that appeared almost as good if combined with the results of the intensified program.

Resource allocation. The strategies can also be compared in terms of the way resources earmarked for them were used. For example, it was found that only 27% of the campaign's vaccinations in Pará and 24.4% of those in Pernambuco were administered to individuals in the priority (under one year) age group. In a sense this is wasteful, even considering the importance of propagating of the vaccine virus in the community as a whole (in the case of Sabin vaccine). In the case of DPT vaccine, where the issue of propagation does not come into play, the problem is more pronounced.

In a similar vein, vaccinations administered through the intensified efforts appear to have been administered indiscriminately to children up to four years old. By comparison, the routine program distributed its vaccinations more rationally, giving 59.7% in Pará and 51.4% in Pernambuco to children under one year old. Nonetheless, there was no opportunity for these percentages to approach 100%, given the large number of children who had passed the age of one year without being vaccinated.

CONCLUSIONS AND RECOMMENDATIONS

This study's subject—the performance of vaccination strategies in Brazil—is dynamic and can be influenced by a wide array of sociocultural, political, geographic, demographic, and other factors. Hence, its findings cannot be ap-

plied in every context. Nevertheless, the results obtained suggest certain general patterns of economic behavior in the areas involved that permit a number of conclusions.

To begin with, the campaign proved effective at producing a short-term increase in vaccination coverage in the two Brazilian states studied. With few exceptions, coverage was excellent and vaccination costs were low. It should be recalled, however, that in some study municipalities the results attained by the routine program were quite similar to those of the campaign, especially when they are considered in combination with the results of intensified programs offering vaccination services at designated times.

The feasibility of maintaining the level of community mobilization that the campaign achieved in its first years for several more years should also be considered. It is possible that if this strategy is repeated annually, it will become regarded as routine and will lose some of its ability to elicit the wide-ranging social support that its exceptional character has generated to date.

In addition, the campaign strategy seems less applicable to some kinds of vaccinations. For example, some antigens such as BCG are more difficult to administer, thus requiring specialized human resources and limiting the usefulness of the massive voluntary labor force that Brazil's polio campaign enjoyed at the time of this study.

With a view to consolidating a network of satisfactory health services and confirming the positive experiences encountered in the routine programs of some study municipalities (in terms of both coverage and unit costs of vaccination), it is felt that strengthening the routine services and supplementing them with intensified programs providing vaccinations on designated days is a

viable option for increasing vaccination coverage at a unit cost not much greater than that of the campaign.

If such a course were followed, the response would not be limited to the vaccination program. Rather, if the routine program were carried out with the sort of community involvement found in the campaign, it should lead to increased demand for the rest of the health services offered by the units' other programs.

Along this line, the smaller health units have been found to operate with fixed costs that are very high relative to their total costs and that increase the unit cost of vaccinations. It would thus be interesting to study additional ways of making use of their physical structures—endeavoring, for example, to use such structures to support programs for basic sanitation, health education, and other activities related to community health.

Furthermore, bearing in mind that most of the intensified services proved efficient, and that the main current functions of the health posts are to provide vaccinations and basic health services, it is recommended that the intensification of services be stepped up in the interior of municipalities and on the periphery of urban areas, rather than simply increasing the number of fixed posts providing routine services. To this end, the vaccination services offered on designated days need to become an ongoing activity (no longer sporadic, as they are today in most units where they are offered), with a well-defined and well-structured annual work plan, and with services organized so that the peripheral populations are assured all the vaccine doses needed to fulfill the National Program on Immunization.

The success of such an undertaking will depend not only on technical planning, but also upon effective and profound interaction between health centers and the local communities they serve, upon a fostering of community awareness that community participation in the struggle against communicable diseases is important, and upon enlistment of community members as health promoters working with the health unit. Within this context, the National Program on Immunization would be able to facilitate sound structuring and dissemination of the schedules and locales for vaccination on designated days in a manner calculated to achieve desirable results.

If the trend found in this study is confirmed, i.e., if relatively greater vaccination cost-efficiency occurs at the health centers than at the health posts, it is recommended that the health center's activities be strengthened, so as to render its vaccination services more dynamic. In that way, in combination with the posts providing basic care, it would be possible to develop a program of routine vaccination and vaccination on designated days aimed at the populations of marginal urban and rural areas. Health posts in the interior would also participate in vaccination activities on designated days, and could become local poles for health education activities—serving small population centers and increasing the degree of interaction between health units and communities.

Unfortunately, the multiplicity of Brazilian institutions providing health services has proved an obstacle to structured development and organizational integrity of such a multi-tiered system. Also, Brazil still has no official system for estimating its population, especially in small population centers. Developing this is particularly important, as such estimates are fundamental

to sound development of public health activities (including vaccination programs), for which it is important to know the size of the target population. The study data in Table 1 showing campaign-related coverages consistently exceeding 100% reflects the fact that the current situation leaves much to be desired.

Finally, it should be emphasized that this study analyzed implementation of the EPI in just two Brazilian states, and so it should be regarded more as an experimental exercise than as an investigation permitting firm generalizations. Research efforts of this nature can be useful as planning instruments at the local level, and possibly the state level; but it is important to avoid their indiscriminate application outside the study regions, especially in countries like Brazil with great regional diversity.

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SUMMARY

As of 1982, Brazil was employing three basic strategies for vaccination against measles, polio, tuberculosis, diphtheria, pertussis, and tetanus. These were to provide vaccinations through

routine programs conducted at established health units, through intensified short-term efforts, and through annual mass campaigns. To assess how well these various strategies were working locally and to weigh their cost-effectiveness, a study was conducted of 55 health units in the states of Pará and Pernambuco. Forty of these units were health posts, 10 were health centers, four were mixed units with inpatient facilities, and one was a hospital.

The analytical method used was the cost-effectiveness method described in a WHO document entitled "Expanded Program on Immunization: Costing Guidelines." In general, the costs estimated were made to include not only the cost to the specific unit involved but also costs at higher administrative levels, costs to the families of vaccine recipients, and the social costs of unpaid volunteer labor, donations, and so forth. Effectiveness was rated in terms of the number of children under one year old who were vaccinated.

In general, fixed costs (of buildings, vehicles, and administrative personnel) were found to be quite high in the routine services, accounting for 48% of the health units' total vaccination costs in Pará and 35% in Pernambuco. Comparing units operating under the same institution (the Public Health Services Foundation), it was found that the average cost per vaccination in Pernambuco tended to decrease as the number of vaccinations increased—suggesting that most units were operating far below their most productive capacity. (This trend was less clear-cut in Pará because of complicating factors.) Overall, throughout the Pernambuco study areas

and in most of the Pará study areas, the larger units registered the lowest average costs per vaccination, due mainly to economies of scale.

Regarding the cost per vaccination of children under one year old, the mass campaign was found to cost less than either of the other two strategies in both Pará and Pernambuco. It should be noted, however, that these were average costs, and that in some study areas (mainly in Pernambuco) the routine program was more cost-effective than the campaign. Also, some of the children vaccinated had already received three doses of the vaccine administered (polio or DPT), and so the campaign costs per effective dose of vaccine administered were higher than those shown.

Similarly, the campaign provided the greatest coverage in the study areas—apparently providing 100% coverage in most places. But some municipalities achieved results that could be compared to the campaign results through the routine program supplemented by intensified services. Moreover, only about a quarter of the campaign vaccinations were administered to children under one year old (the priority age group), while over half the routine program vaccinations went to members of this group. There could also be difficulties in maintaining the level of community mobilization the campaign attained in its early years (including 1982), once its annual occurrence comes to be expected. And finally, the campaign strategy appears less applicable to certain vaccines (such as BCG) that are harder to administer, and so require more specialized personnel.

Therefore, with a view to consolidating a network of satisfactory health services, it is recommended that the routine services in the study area be strengthened and supplemented with intensified programs providing vaccina-

tions on designated days. Also, if it can be confirmed that relatively greater cost-effectiveness occurs at the larger centers, then it would seem advisable to strengthen health center activities so as to render their vaccination services more dynamic. In that way, in combination with the health posts providing basic care, they could help to develop a program of routine and intensified vaccination aimed at the populations of marginal urban and rural areas. It should be emphasized, however, that the data presented here deal only with study areas in two states, and that they provide no adequate basis for drawing firm conclusions applicable in a general way to other places.

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ANNEX 1. The health units in the states of Pará and Pernambuco that were included in the study.

State, municipality, and health unit	Supporting institution	Type of health unit
I. Pará State municipalities and units:		
Bragança:		
Bragança	SESPA ^a	Health center
Bacuriteua	SESPA	Health post
Caratateua	SESPA	Health post
Gessé Guimarães	SESPA	Health post
Tracuateua	SESPA	Health post
Vila de Broca	SESPA	Health post
Vila Fátima	SESPA	Health post
Breves:		
Breves	SESP ^b	Mixed unit
Curumu	SESP	Health post
São Miguel dos Macacos	SESP	Health post
Capanema:		
Capanema	SESP	Health center
Mirasselvass	SESP	Health post
Tauari	SESP	Health post
Portel:		
Portel	SESPA	Mixed unit
Rondon do Pará:		
Rondon do Pará	SESP	Health center
Santa Isabel do Pará:		
Santa Isabel do Pará	SESP	Health center
Americano	SESPA	Health center
Caraparú	SESPA	Health post
Conceição do Itá	SESPA	Health post
Jundiá	SESPA	Health post
Tacajós	SESPA	Health post
São Caetano de Odívalas:		
São Caetano de Odívalas	SESPA	Health center
Deolândia	SESPA	Health post
Guarajuba	SESPA	Health post
Marabitanas	SESPA	Health post
Rio Branco	SESPA	Health post
São João da Ponta	SESPA	Health post
São João dos Ramos	SESPA	Health post
Vila Nova	SESPA	Health post

ANNEX 1. (continued)

State, municipality, and health unit	Supporting institution	Type of health unit
II. Pernambuco State municipalities and units:		
Cortês:		
Cortês	FUSAM ^c	Health center
Usina Pedrosa	FUSAM	Health post
Escada:		
Hospital Nossa Senhora da Escada	FUSAM	Mixed unit
Usina Barão de Suassuna	FUSAM and Barão de Suassuna Sugar Mill	Health post
Casa de Saúde Maria Dias Lins (Usina União)	FUSAM and União Sugar Mill	Health post
Frecheiras	FUSAM	Health post
Usina Massauassú	FUSAM and Massauassú Sugar Mill	Health post
Joaquim Nabuco:		
Joaquim Nabuco	SESP	Health center
Usina de Pumaty	SESP	Health post
Lagoa dos Gatos:		
Entroncamento	FUSAM	Health post
Igarapeassú	FUSAM	Health post
Lagoa do Souza	FUSAM	Health post
Lagoa dos Gatos	FUSAM	Health post
Palmares:		
Palmares	SESP	Mixed unit
Newton Carneiro	SESP	Health post
Santo Antônio dos Palmares	SESP	Health post
Serro Azul	SESP	Health post
Ribeirão:		
Ribeirão	SESP	Health center
Aripibú	SESP	Health post
Estrelana	SESP	Health post
José Mariano	SESP	Health post
Rio Formoso:		
Hospital do Rio Formoso	Rio Formoso League for the Protection of Maternity and Children	Hospital
Saué	FUSAM and Santo André Sugar Mill	Health post
Tamandaré	Rio Formoso municipal government	Health post
Usina Cocaú	Rio Formoso municipal government and Cocaú Sugar Mill	Health post
São João:		
São João	SESP	Health center

^a Secretariat of Health for the State of Pará (Secretaria de Saúde do Estado do Pará).

^b Public Health Services Foundation (Fundação Serviços de Saúde Pública).

^c Secretariat of Health for the State of Pernambuco, Amaury de Madeiros Health Foundation (Secretaria de Saúde do Estado de Pernambuco, Fundação de Saúde Amaury de Madeiros).