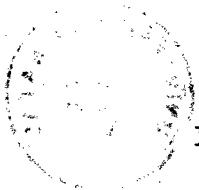


EVALUATION
OF A
MEASLES IMMUNISATION
CAMPAIGN IN
NATAL/KWAZULU



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SUMMARY

Routinely collected data on vaccines supplied and administered, measles notifications and hospital admissions for measles were used to evaluate the 1990 measles immunisation campaign in Natal/KwaZulu. Comparisons of the monthly averages during the 12 month period before the campaign, 4 months of the campaign and 12 months after the campaign indicated that the 1990 measles campaign in Natal/KwaZulu demonstrated that the campaign was limited, not by design, to blacks only. The campaign galvanised a high degree of participation from almost all health services in this region and resulted in a rapid and marked plunge in the incidence of measles as reflected by declines in both measles notifications and measles hospital admissions. There was no deleterious short-term residual effect of the measles campaign on routine measles immunisation services. The spillover effects of the measles campaign on routine immunisation services against polio, tuberculosis and tetanus was generally beneficial. While the campaign was a success in generating involvement of health services in Natal/KwaZulu and reducing the burden of measles in this region, this disease has not been eliminated. Vigilance and continued routine vaccination efforts are required to prevent further epidemics of measles in Natal/KwaZulu.

INTRODUCTION

Measles is a major cause of morbidity and mortality throughout South Africa (1) and especially in Natal (2,3). During 1989, over 18 000 cases of measles were notified in South Africa (4). Notwithstanding the fact that notifications under-estimate the true extent of measles (5), the available data are alarming since a safe and effective vaccine against this disease has been available for about 15 years.

There has been much debate about the value of measles immunisation campaigns (6,7). Successful immunisation campaigns, followed by longer-term programmes which capitalised on the momentum generated by the campaigns, have been undertaken in Turkey (8) and Brazil (9). In contradistinction, strengthening the existing health infrastructure and setting targets for vaccination levels demonstrated a marked effect on measles incidence in Finland (10).

During May and June 1990, a measles immunization campaign was undertaken in Natal/KwaZulu as a joint venture by the Department of National Health and Population Development, KwaZulu Health Department, Natal Provincial Administration and the various Local Authorities in Natal. This campaign was part of the "Measles Strategy" (11) and its main objectives were

to improve measles vaccination coverage, to reduce the incidence of measles and ultimately to eradicate measles from South Africa.

In Natal/KwaZulu, the measles immunisation campaign took the form of an intensified vaccination effort within existing health services and did not involve the creation of special vaccination teams. Public media, such as the radio, were used to inform the public about the campaign and stressed the importance of taking children to clinics for vaccination.

The staff of existing government health services undertook the task of identifying and vaccinating unvaccinated children between the ages of 9 months and 5 years. Staff in these facilities were motivated to increase vaccination efforts and re-trained on vaccine storage, vaccination procedure and correct completion of road-to-health cards. Emphasis during their in-service training focused both on maintaining the cold chain and on targeting areas and communities which were common sources of measles cases.

Immunisation campaigns, as with all other health interventions, can be evaluated using input, process and outcome measures (12). Regarding outcome measures, the World Health Organisation recommends that indirect broader impact measures be included in

addition to direct measures of effectiveness (13).

An evaluation of the measles campaign was undertaken in each province by the Departments of Community Health at the various Medical Schools. These evaluations (14) focused almost entirely on assessing changes in vaccination coverage, a process measure which necessitated large scale community based surveys.

This study, which used only routinely collected data, is a broader evaluation of the 1990 measles immunisation campaign since it incorporates input (vaccines supplied), process (vaccines administered), outcome (measles notifications and hospital admissions) and impact (effects on other immunisation services) measures.

PURPOSE

To evaluate the 1990 measles immunisation campaign in Natal/KwaZulu, using only routinely collected data.

OBJECTIVES

1. For the pre-campaign, campaign and post-campaign

periods, to determine, using routinely collected data, the number of:

- i. doses of measles vaccines supplied to health services in Natal and KwaZulu
 - ii routine measles vaccinations administered by health services in Natal and KwaZulu
 - iii. routine BCG, polio and tetanus vaccinations administered by health services in Natal and KwaZulu
 - iv. measles notifications in Natal/KwaZulu
 - v. measles admissions to Clairwood hospital.
2. To assess the effects of the campaign by comparing the number of measles, BCG, polio and tetanus vaccinations, measles notifications and hospital admissions for measles during the pre-campaign, campaign and post-campaign periods.
 3. To make recommendations regarding measles control in Natal/KwaZulu.

DEFINITIONS

Measles immunisation campaign: Intensified effort by the government health service to increase vaccination

coverage.

Routinely collected data: Data which are customarily and regularly collected by health services ie. data not collected specifically for the purpose of evaluating the measles campaign.

Routine vaccinations: Vaccinations provided by health services as part of their usual immunisation services.

Measles notifications: Official notifications, in terms of the Health Act (No 63 of 1977), of individuals diagnosed as having measles.

Measles admissions: Admitted to the measles wards at Clairwood hospital, Durban with a diagnosis of measles.

Pre-campaign period: The 12 months, April 1989 to March 1990, prior to the measles campaign.

Campaign period: The 4 months, April 1990 to July 1990, of the measles campaign.

Post-campaign period: The 12 months, August 1990 to July 1991, after the measles campaign.

REDUCTION OF BIAS

1. Undercounting bias:

Each dose of (any) vaccine administered is recorded in all government and some private health services and subsequently collated and compiled for submission as statistical returns to the Department of National Health and Population Development.

These data are likely to undercount the actual number of vaccinations administered, particularly when the health service is busy and recording of vaccinations administered is less rigidly adhered to. Further, data on the number of vaccinations administered by private medical practitioners, although comprising a small fraction of all vaccinations administered, were not available.

It is important to note that although the undercounting bias is present, it is likely to be present to similar degrees in data from both before and after the campaign. Therefore, the comparisons between these two periods should produce reasonably accurate relative measures of association ie. although the actual data underestimate the true situation, the comparative ratios should produce reliable estimates of the difference.

2. Selection bias:

Since the incidence of measles demonstrates seasonal trends, the time intervals which comprised the pre-campaign and post-campaign periods were selected to be comparable. Each of the 12 months was included once and only once in both periods.

To reduce potential interference by spillover of campaign activities of May and June 1990, and hence affect the comparisons between the pre-campaign and post-campaign periods, the month immediately preceding and subsequent to the campaign was not included in the pre-campaign and post-campaign periods respectively.

3. Classification bias:

Regarding hospital and notification data, the diagnosis of measles was undertaken in most instances by a medical practitioner. While the classification of an individual as having measles may not have emanated from study-specific pre-set criteria; it is reasonable to expect that misclassification of other diseases as being measles and vice versa by medical practitioners is uncommon.

The notification and hospital admission data are therefore unlikely to have more than a minor degree of misclassification bias. The predominant bias in these data is undercounting; a problem which can be largely

avoided by interpreting comparisons only.

METHOD OF DATA COLLECTION

1. Study design:

This study uses before-and-after comparisons to assess the effects of the measles campaign. A control group in which the campaign was not undertaken was not ethically or logistically feasible since the measles campaign was undertaken nationally and public media (eg. radio) were used extensively to encourage clinic attendance for immunisation. Therefore, data from the period before the campaign were compared with data obtained during and after the campaign to assess the effects of the campaign.

2. Determination of pre-campaign, campaign and post-campaign periods:

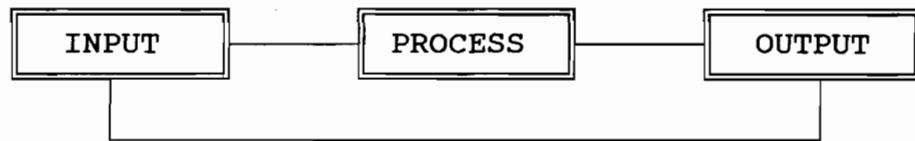
Since the measles campaign was undertaken during May and June 1990, the 4-month period 1 April 1990 to 31 July 1990 was designated as the campaign period. The months of April and July were included to allow for spillover of the campaign onto the months immediately prior to and after the official months of the campaign. The 12 month period before the campaign, 1 April 1989 to 31 March 1990, comprised the pre-campaign period. The 12 month period after the

campaign, 1 August 1990 to 31 July 1991, was designated the post-campaign period.

3. Indicators used in the evaluation:

A systems approach was adopted to determine which indicators should be measured to evaluate the measles campaign.

SYSTEMS APPROACH



Input indicators: Data on the number of doses of measles vaccine supplied to hospitals and clinics.

Process indicators: The number of measles vaccines administered by health services. This indicator approximates the number of children vaccinated if vaccines administered to children who were already immunised account for only a small proportion of all vaccines administered.

Output indicators: Direct output indicators included notified measles cases and measles admissions to a referral hospital in Natal. Impact

(indirect output) indicators included the number of doses of polio, BCG and tetanus vaccines administered by health services.

4. Objective (1.i):

The number of doses of measles vaccine that were supplied each month to health services in Natal was extracted from the vaccine supply registers obtained from the Pharmaceutical Section of the Natal Provincial Administration. This section supplies measles vaccines all Local Authorities, hospitals and all other government and non-governmental health services in Natal (See Annexure 1). Records for the first 6 months of the pre-campaign period, April 1989 to August 1989, were not available; data for Natal were available only from September 1989 to July 1991.

The number of measles vaccines supplied each month to KwaZulu health services, both hospitals and clinics, was obtained from the Pharmaceutical Section of the KwaZulu Department of Health.

Unfortunately, records of measles vaccines supplied were not available for the first 8 months of the pre-campaign period; data for KwaZulu were available only from December 1989 to July 1991.

5. Objective (1.ii):

The number of measles vaccinations administered by health services in Natal each month during the pre-campaign, campaign and post-campaign periods for each race group was obtained from statistical returns submitted to the regional office of the Department of National Health and Population Development.

The data emanate from the following health services in Natal; Natal Provincial Administration clinics operating in Section 30 (Health Act, No 63 of 1977) and Trust areas, Local Authority clinics, hospitals (Mission, Private and Provincial) and clinics run by non-governmental welfare organisations (See Annexure 1).

Data on measles vaccinations administered by clinics in KwaZulu were available in an aggregated form for each quarter of the year. These data applied to the period April 1989 to June 1991. The quarterly data were transformed into a monthly moving average to ensure comparability with the Natal data.

6. Objective (1.iii):

Statistical returns received by the Department of National Health and Population Development served as the source of data on the number of doses of BCG, polio and tetanus vaccines administered by health

services in Natal for each month from April 1989 to July 1991. The KwaZulu Department of Health was able to provide data, aggregated for each quarter of the year, on the number of polio and BCG vaccines administered; data on tetanus vaccinations were not available. These data were also transformed into monthly moving averages.

7. Objective (1.iv):

Data on measles notifications were obtained from the Epidemiology Directorate of the Department of National Health and Population Development. Measles notifications in KwaZulu and Natal, together with data of sex, race and age were obtained for each month from April 1989 to July 1991.

8. Objective (1.v):

Data on measles hospital admissions were collected from Clairwood hospital in Durban, Natal. Clairwood hospital is a provincial referral centre for children with communicable diseases and is the only hospital in Natal with wards specifically designated for patients with measles.

The total number of admissions, for all diagnoses, to Clairwood hospital, which was obtained from the hospital in-patient register, was used as an indication of whether the size of the hospital's

catchment population was changing. All admissions, adult and paediatric, were used because data on the number of paediatric admissions only were not available. The number of patients admitted with a diagnosis of measles to Clairwood hospital during the pre-campaign, campaign and post-campaign periods was obtained from the measles ward admissions book. Demographic and mortality data on measles patients were also collected from the measles ward admissions book. The vaccination status of patients was unfortunately not available.

DATA COLLATION AND ANALYSIS

Data on measles vaccine doses supplied, vaccines administered, measles notifications and measles hospital admissions during the pre-campaign, campaign and post-campaign periods were collated and transferred from routine statistical records onto specifically designed collation forms.

Data for the 12 months before the measles campaign were compared to the 12 months after the campaign using non-parametric statistical tests. The Kruskal-Wallis test was first performed to determine if any differences existed between the pre-campaign, campaign and post-campaign periods. If the Kruskal-Wallis test

produced a statistically significant result, the Wilcoxon 2 sample test was performed for each of the following 2 comparisons; pre-campaign vs campaign and pre-campaign vs post-campaign. Where appropriate, the statistical analysis included the chi-square test.

The data were analysed using EPIINFO Version 5 (15) and SAS (16).

LIMITATIONS OF THE STUDY

1. Quantitative evaluation methods:

Quantitative methods of evaluation are persuasive because they are able to demonstrate the amount of change achieved. This fundamentally requires the use of measurable indices unlike qualitative methods of evaluation which involve assessing processes that are not ostensibly measurable.

When evaluations rely solely on quantitative methods and do not incorporate qualitative components as well, information on how much has changed is available but information on how the change occurred is not available. This study is solely quantitative and the subtle qualitative effects of the campaign were not assessed.

2. Choice of indicators:

Since this study was undertaken using only routinely collected data, there were many constraints on the choice of indicators. In keeping with systems approach, at least one input, process, direct output and impact indicator was selected. But the choice of indicator was limited by the availability of data eg. in selecting process indicators, it was not possible to use indicators such as vaccination coverage since these data are routinely collected by the health services in Natal and KwaZulu.

3. Numerator data:

The most potent measure of the success of a measles immunisation campaign is to demonstrate the magnitude of the change in the incidence of measles. However, incidence rates can seldom be calculated from notifications or hospital cases since the "denominator" ie. the number of persons at risk, is often not available. In this study the "numerators" ie. number of new cases of measles (notified or hospitalised), are compared between 2 periods on the assumption that changes in the denominators are sufficiently small as a result of the temporal proximity of the periods being compared.

4. Data quality:

Routinely collected data are notoriously low in

accuracy eg. only about 1 out of 8 hepatitis B cases gets notified (17). This problem is reduced, if not eliminated, by interpreting only comparisons which should be reliable if the degree of undercounting does not change substantially between the periods being compared.

5. Data availability:

Data on vaccines supplied to health services both in Natal and KwaZulu were incomplete. KwaZulu data on vaccines administered included only clinic services; equivalent data from KwaZulu hospitals were not available. This should not affect the findings since the number of measles and polio vaccines administered by KwaZulu hospitals is insignificant compared to that provided by clinics.

No data on tetanus vaccines administered by KwaZulu health services were obtainable. Data on measles, polio and BCG vaccines administered in KwaZulu were not available for each month; the data were aggregated for each quarter of the year.

To make the KwaZulu data comparable to the Natal data; monthly moving averages were calculated. This procedure, however, precludes any interpretation of the rate of change in the number of vaccine doses administered in KwaZulu. Further, the results of

statistical tests on the quarterly data were not meaningful and have, therefore, not been presented.

5. **Economic evaluation:**

This study did not include any economic indicators and no economic analysis of costs and benefits was undertaken. The methodology for economic evaluations is well established (18) and requires an in depth investigation into the financial matters relating to the intervention being evaluated. This study is an epidemiological evaluation only.

6. **Regional evaluation:**

This study is limited to the Natal/KwaZulu region only and its findings may not be applicable to the rest of South Africa. With the possible exception of measles hospital admissions, the findings of this study are applicable to the whole of Natal/KwaZulu, since data from the entire region was included in this evaluation.

Hospital admissions for measles, although limited to one hospital, was undertaken at a regional referral hospital for measles. This hospital admits the most severe cases of measles from both Natal and KwaZulu health services.

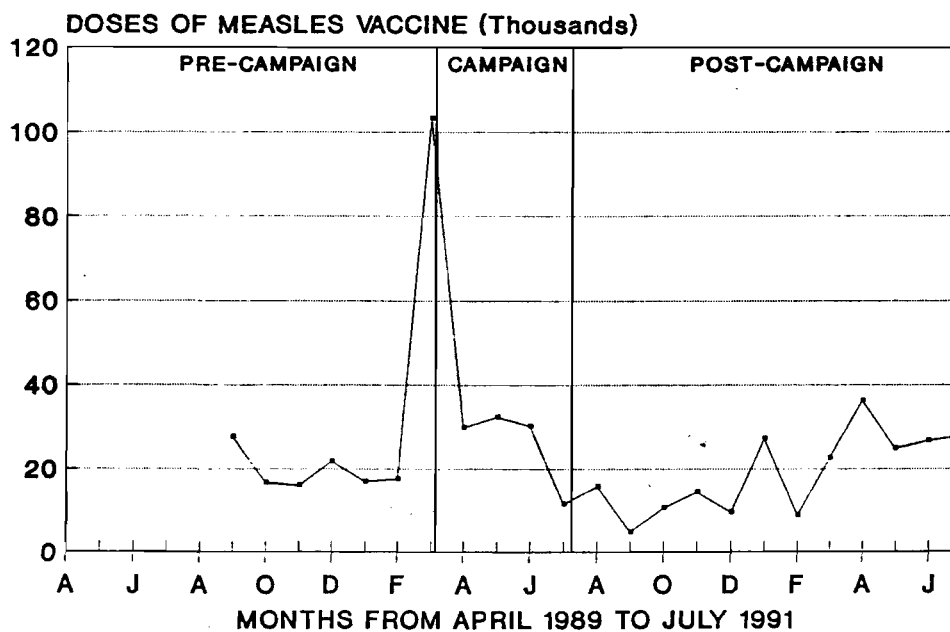
RESULTS

1. Vaccine supply:

In March 1990, at the end of the preparatory phase of the measles campaign, health services in Natal were supplied 103 190 doses of measles vaccine (Figure 1). This quantity of vaccine is more than 5 fold higher than the average of 19 457 doses supplied each month during the preceding 6 months.

FIGURE 1

Measles vaccines supplied in Natal September 1989 - July 1991



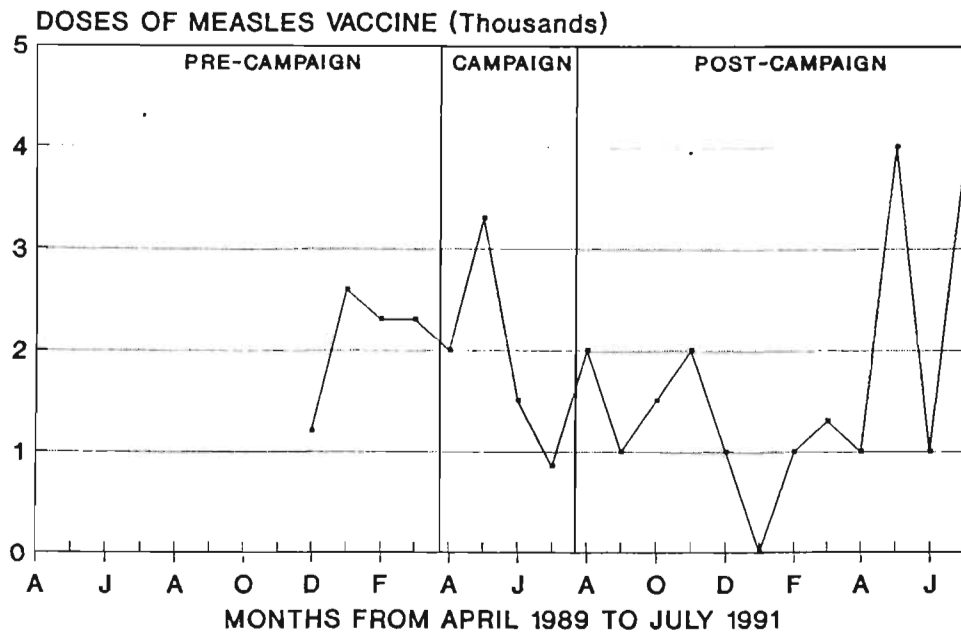
During the period immediately after the campaign (Figure 1), there was a drop in the supply of vaccines to health services in Natal but by early 1991, the

quantity of measles vaccines supplied returned to pre-campaign levels.

Measles vaccines are supplied in single, 5 and 10 dose vials. The changes in the quantity of measles vaccines supplied (Figure 1) occurred almost entirely as a result of an increased supply of 10 dose vials; the number of single and 5 dose vials supplied did not increase in March 1990.

FIGURE 2

**Measles vaccines supplied in KwaZulu
December 1989 - July 1991**



Vaccine supply in KwaZulu (Figure 2) did not show a similar trend. Notwithstanding the measles campaign, there was considerable month-to-month variation in the

quantity of measles vaccines supplied to KwaZulu health services.

During the first 4 months of 1990, part of the pre-campaign period, an average of 2 300 doses of measles vaccines was supplied to KwaZulu health services. In May 1990, the start of the campaign, 3 300 doses of measles vaccines were supplied in KwaZulu.

Other than the slight increase in measles supply in May 1990, there were no other significant effects on measles vaccine supply associated with the measles campaign in KwaZulu.

Vaccines are supplied to individual clinics and hospitals from a central store in response to requisitions placed by them. Hence, the supply of vaccines to clinics and hospitals is dependent on their demands. During the entire period April 1989 to July 1990, only the Swartz vaccine was supplied in both Natal and KwaZulu.

2. Routine measles vaccinations:

Vaccinations according to race

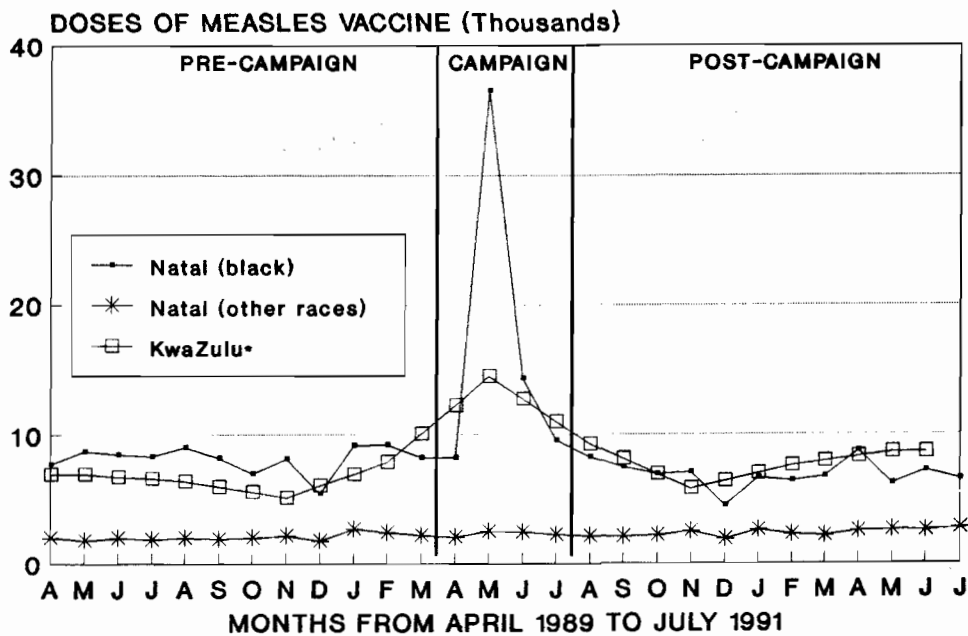
Since the campaign was intended to include all race groups, data on the number of measles vaccines administered to each race group was collected from Natal health services. KwaZulu data were not analysed

according to race since KwaZulu health services administer only a negligible number of vaccines to races other than black.

There was no increase in the number of measles vaccines administered to whites, Indians and coloureds during the campaign (Figure 3).

FIGURE 3

Doses of measles vaccines administered in Natal and KwaZulu: Apr 1989-July 1991



* Note: Data from KwaZulu health services is represented as a monthly moving average due to the quarterly aggregation of the data.

A substantially higher number of measles vaccines were administered to blacks during the campaign. As the

campaign, in practice (and not by intention), was limited to blacks, subsequent analyses were restricted to blacks.

Level of participation in measles campaign

The level of participation in the measles campaign was measured by comparing the average monthly measles vaccines administered during the campaign and pre-campaign periods. This comparison is expressed as a ratio; 1 represents no participation, while higher ratios indicate greater participation in the campaign.

TABLE 1

Level of participation in the measles campaign by the various health services in Natal/KwaZulu

Average monthly measles vaccines

	<u>Pre-campaign</u>	<u>Campaign</u>	<u>Ratio*</u>
	<u>4/89 - 3/90</u>	<u>4/90 - 7/90</u>	
Section 30	3183(21%)	7346(24%)	2.3:1 (P=NS)
Trust Area	3016(20%)	5435(18%)	1.8:1 (P=NS)
Local Authority	1255 (9%)	2377 (8%)	1.9:1 (P<0.05)
Hospitals	<u>686 (5%)</u>	<u>1994 (7%)</u>	2.9:1 (P<0.05)
Natal(Subtotal)	8140(55%)	17152(57%)	2.1:1 (P<0.05)
KwaZulu	<u>6587(45%)</u>	<u>13173(43%)</u>	2.0:1
TOTAL	<u>14727(100%)</u>	<u>30325(100%)</u>	2.1:1

* Campaign to pre-campaign ratio

Measles immunisation services in Natal were analysed in sub-groups as follows; Section 30 clinic services, Trust Area clinic services, hospitals and Local Authorities (Table 1). Annexure 1 lists the institutions which comprise each sub-group.

Overall in Natal/KwaZulu, more than twice as many measles vaccines were administered during each month of the measles campaign than during each month of the year preceding the campaign. Health services in Natal and KwaZulu had similar levels of participation in the campaign (Table 1). Within Natal, hospitals (2.9:1) and Section 30 clinics (2.3:1) made substantial contributions to the campaign.

At the peak of the campaign in May 1990, 36 504 doses of measles vaccine were administered to blacks by health services in Natal. This represents a 4.5 fold increase on the pre-campaign monthly average of 8 140 doses. This high ratio is diminished (4.5 vs 2.1) when the entire 4 month campaign period is taken into account reflecting the short-lived nature of the campaign.

The measure used in this study to assess participation in the campaign takes the initial peak of the campaign in May 1990 and its sustainability over 3 months into account.

Short-term residual effects of the campaign on
routine measles vaccinations

Overall, the average number of measles vaccines administered each month during the pre-campaign and post-campaign periods in Natal and KwaZulu (Table 2) were similar (14 727 vs 14 589; P=NS).

TABLE 2
**Monthly average number of measles vaccines
administered before and after the measles campaign**

	<u>Average monthly measles vaccines</u>		
	<u>Pre-campaign</u>	<u>Post-campaign</u>	<u>% change</u>
	<u>4/89 - 3/90</u>	<u>8/90 - 7/91</u>	
Section 30	3183(21%)	3005(21%)	- 6% (P=NS)
Trust Area	3016(20%)	1713(12%)	-43% (P<0.05)
Local Authority	1255 (9%)	1529(10%)	+22% (P<0.05)
Hospitals	<u>686 (5%)</u>	<u>650 (4%)</u>	<u>- 5%</u> (P=NS)
Natal(Subtotal)	8140(55%)	6897(47%)	-15% (P<0.05)
 KwaZulu	<u>6587(45%)</u>	<u>7692(53%)</u>	<u>+17%</u> (P=NS)
TOTAL	<u>14727(100%)</u>	<u>14589(100%)</u>	<u>- 1%</u> (P=NS)

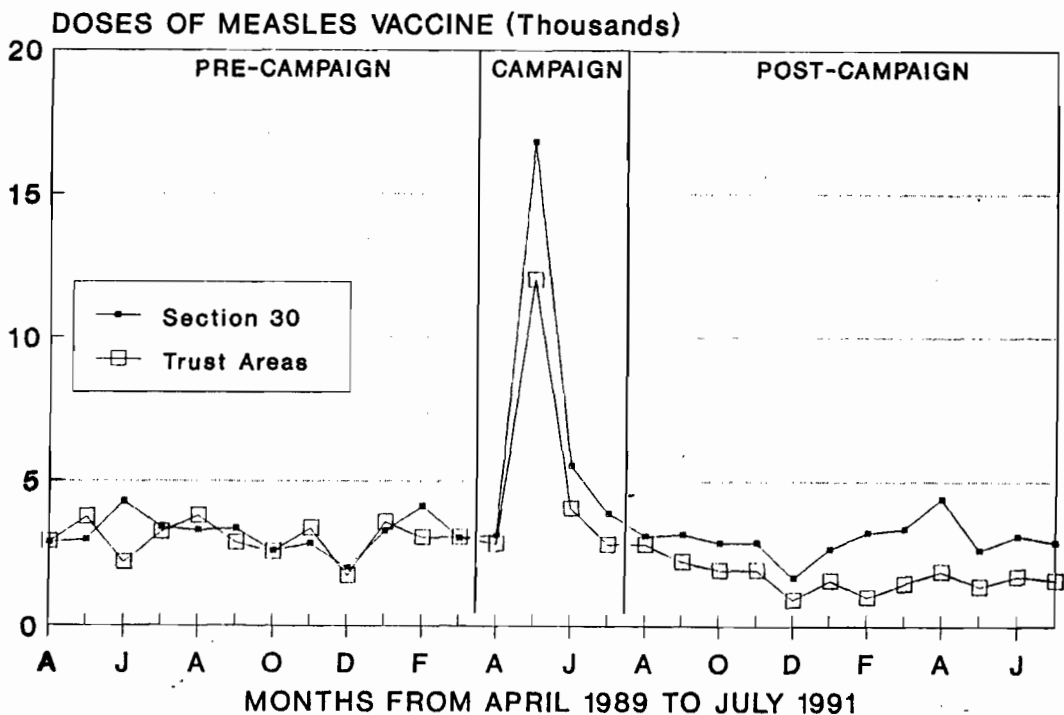
Health services in Natal administered 8 140 (95% confidence interval (CI): 7 536 - 8 744) doses of measles vaccine to blacks during the pre-campaign period compared to 6 897 (CI: 6 292 - 7 502) during the post-campaign. This 15% decline in measles

vaccines administered by health services in Natal (Table 2) was statistically significant ($P < 0.05$).

On the other hand, measles vaccines administered by KwaZulu health services rose by 17% following the campaign (6 587 vs 7 692; $P = NS$).

FIGURE 4

Measles vaccines by Section 30 and Trust Area Clinics: April 1989 - July 1991



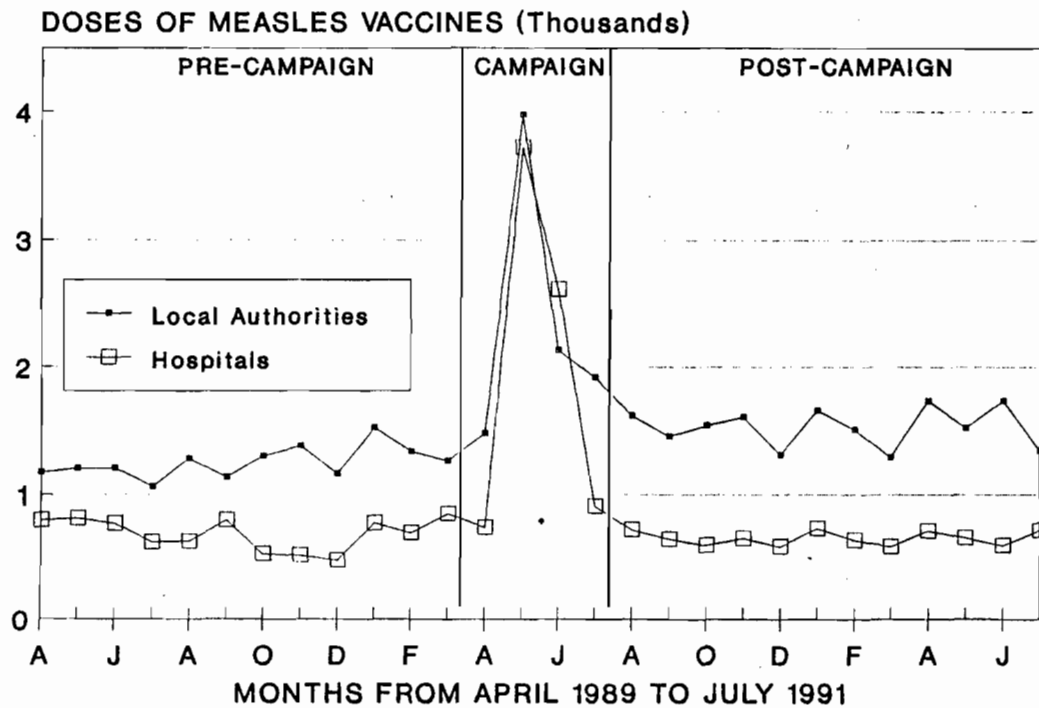
Trust Area clinics experienced a marked (43%) decline in measles vaccines administered (Table 2) while Section 30 clinics experienced only a minor (6%) reduction. The lower numbers of measles vaccines administered by Trust Area clinics was present consistently (Figure 4) during the post-campaign

period.

In both Section 30 and Trust Area clinics, the measles campaign was short-lived (Figure 4); one month after the start of the campaign, the number of measles vaccines administered had returned to almost the pre-campaign levels. The same did not occur in Local Authority clinics and hospitals (Figure 5).

FIGURE 5

Measles vaccines by Local Authorities and Hospitals: April 1989 - July 1991



The rapid rise in measles vaccines administered by Local Authority clinics tapered off slowly and reached pre-campaign levels after 3 months (Figure 5). The number of measles vaccines administered in hospitals

returned to pre-campaign levels by the third month.

Following the measles campaign, Local Authority services continued administering more measles vaccines each month; the monthly average number of measles vaccines (Table 2) administered by Local Authority services rose by 22% (1 255 vs 1 529; $P < 0.05$). Hospitals experienced a small (5%) reduction in the measles vaccines administered following the campaign.

Considering the overall situation for Natal/KwaZulu, it is noteworthy (Table 2) that Natal health services administered 55% of all measles vaccines administered in Natal/KwaZulu before the campaign but only 47% of all measles vaccines administered after the campaign.

3. Short-term spillover effects of the measles campaign on routine BCG, polio and tetanus vaccinations:

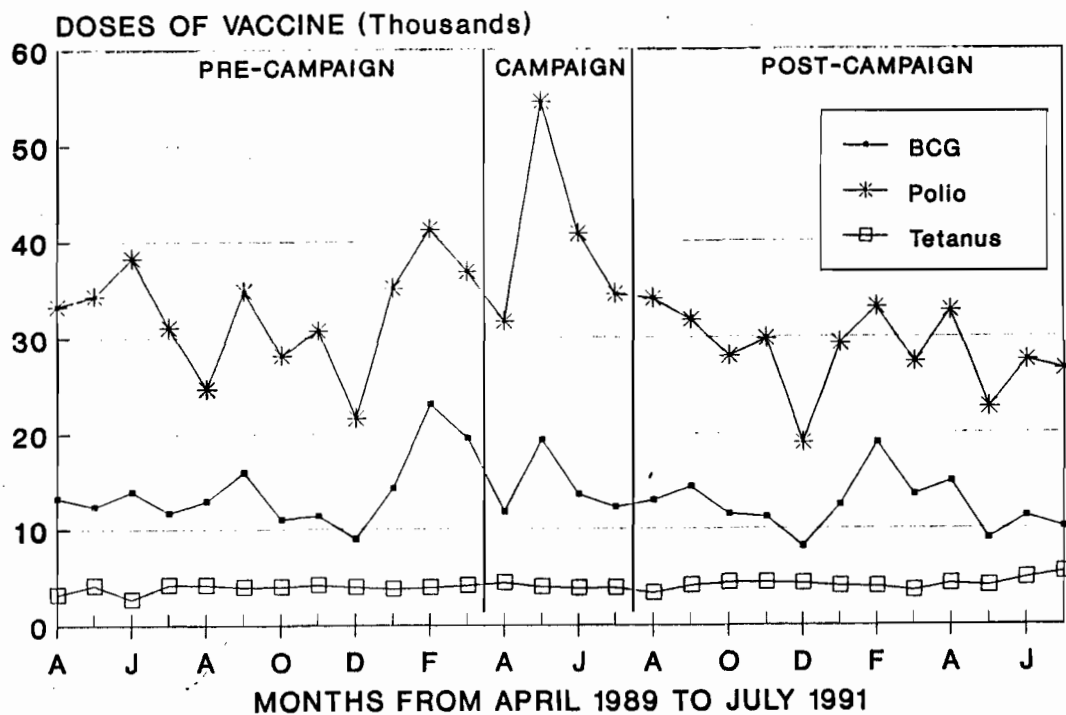
There were no significant changes (Figure 6), in relation to the measles campaign, in the number of BCG and tetanus vaccines administered in Natal.

During the peak month of the campaign, May 1990, the combined number of first, second, third and fourth doses of polio vaccine administered to blacks by health services in Natal rose to 1.6 times the pre-campaign monthly average (54 475 vs 33 355). However,

following the measles campaign, the monthly average number of polio vaccines administered by health services in Natal was 15% lower than that before the measles campaign (33 355 vs 28 506; $P < 0.05$).

FIGURE 6

Polio, BCG & tetanus doses administered to blacks in Natal: April 1989-July 1991



The changes demonstrated overall for Natal health services were not uniformly applicable to individual health services in Natal. Individual services in Natal demonstrated interesting changes in pre-campaign and post-campaign monthly average numbers of BCG, polio and tetanus vaccinations.

Trust Area clinics showed a decline in BCG (3 582 vs 2 502; $P < 0.05$) and polio (10 006 vs 6 452; $P < 0.05$) vaccinations while tetanus vaccinations rose (728 vs 839; $P < 0.05$) after the campaign. In Trust Area clinics, the monthly average number of BCG vaccines administered dropped by 30% while polio vaccines administered by Trust Area services dropped by 36%. However, tetanus immunisations rose in the post-campaign period by 15% from 728 to 839 per month ($P < 0.05$).

Local Authority services experienced an increase in BCG (2 013 vs 2 353; $P < 0.05$), polio (5 228 vs 6 272; $P < 0.05$) and tetanus (342 vs 434; $P = \text{NS}$) vaccinations. Local Authority services demonstrated a 17% rise in BCG vaccinations while polio vaccinations rose by 20%. Although tetanus immunisations administered by Local Authority services rose by 27%, this difference was not statistically significant ($P = 0.053$).

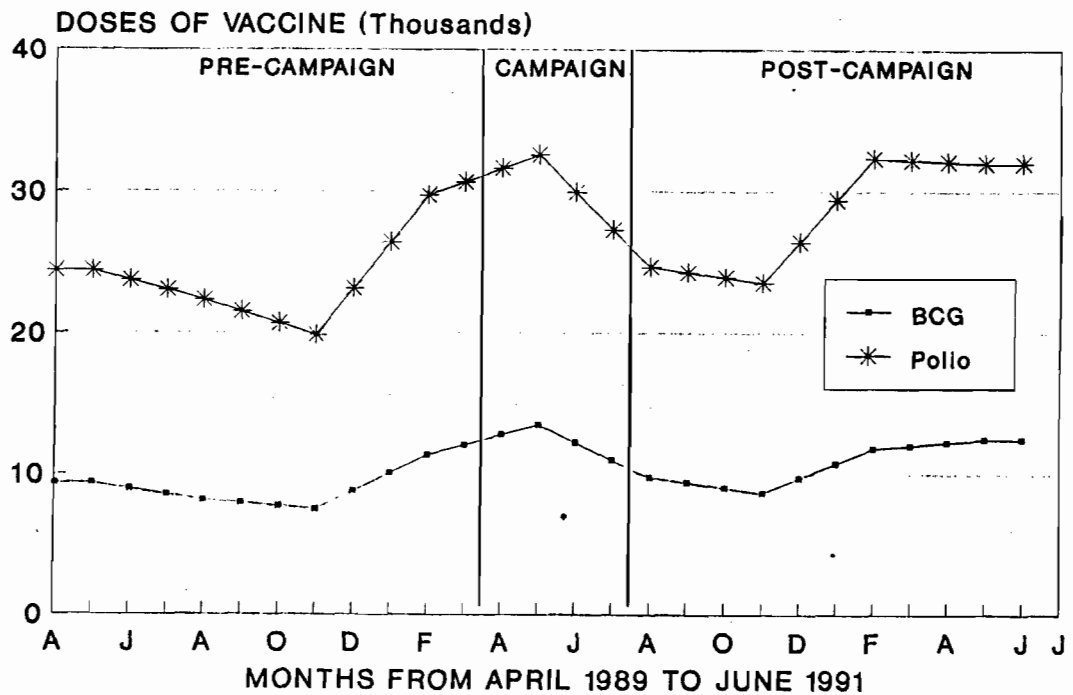
Hospitals and Section 30 clinics showed no statistically significant differences between the pre- and post-campaign periods for any of the 3 vaccines.

KwaZulu health services showed increases (Figure 7) in the number of BCG and polio vaccines administered during the measles campaign; data on tetanus vaccine were not available for KwaZulu.

During the measles campaign, the number of BCG vaccines administered by KwaZulu health services rose by 39% from an average of 9 046 during each of the 12 months preceding the campaign to an average of 12 543 during each of the 4 campaign months. The number of polio vaccines administered by KwaZulu health services also rose, albeit by a smaller margin, by 18% (24 062 vs 28 436) during the campaign.

FIGURE 7

Polio and BCG doses administered in KwaZulu: April 1989 - June 1991



More BCG vaccinations were administered each month by KwaZulu health services during the post-campaign period than during the pre-campaign period (9 046 vs 10 752). Similarly more polio vaccines were

administered by KwaZulu health services following the campaign than before the campaign (24 062 vs 28 440).

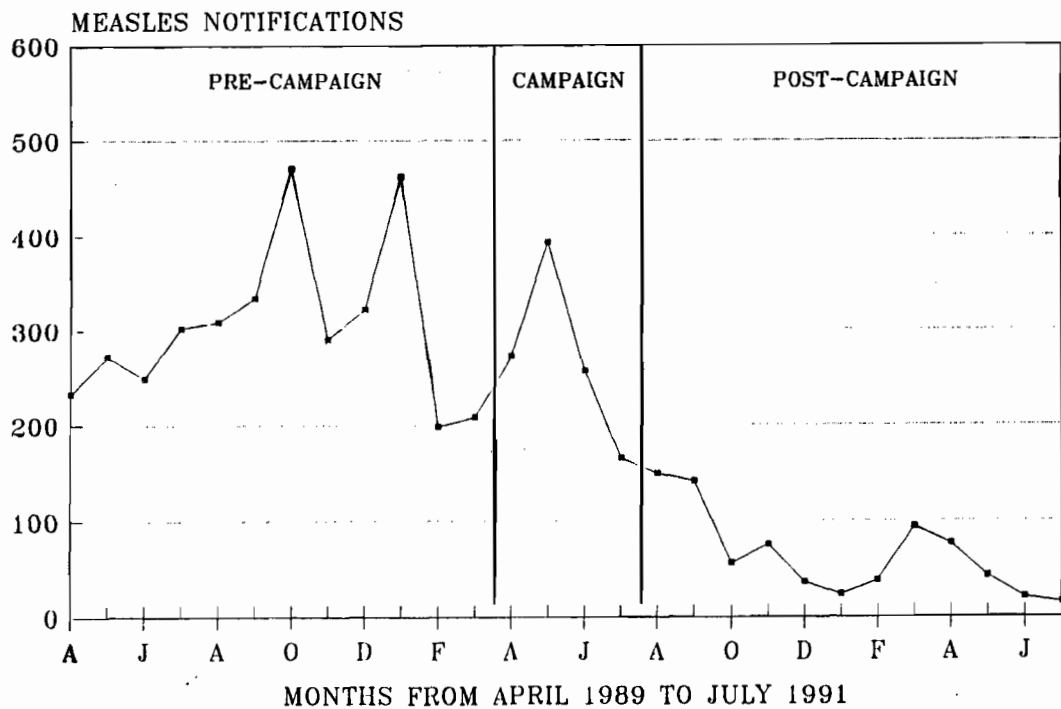
Statistical analysis of the KwaZulu data, using non-parametric tests could not be interpreted meaningfully because of the quarterly aggregation of the data.

4. Measles notifications:

There was a marked drop in measles notifications in Natal/KwaZulu almost immediately following the measles campaign (Figure 8).

FIGURE 8

Measles notifications for blacks in
Natal/KwaZulu: April 1989 – July 1991



The rapidity of the fall in measles notifications (Figure 8) indicated that there was a very short lag time between the start of the measles campaign and the onset of the decline in measles notifications; by July, 2 months after the start of the campaign, the decline in measles notifications became apparent.

TABLE 3
Age, gender and racial distribution of measles
notifications in Natal/KwaZulu
in relation to the measles campaign

	<u>Pre-campaign Campaign Post-campaign</u>		
	<u>4/89-3/90</u>	<u>4/90-7/90</u>	<u>8/90-7/91</u>
Notifications:			
Blacks (mean)	3649(304)	1087(272)	764(64)
Other races	73	15	28
Measles deaths	40	6	1
Case mortality rate	1.1%	0.6%	0.1%
Male:female ratio:	1.04:1	1.05:1	1.08:1
Age Distribution:			
< 1 year	27.5%	28.7%	29.6%
1 - 4 years	39.8%	38.4%	38.6%
> 4 years	32.7%	32.9%	31.8%

The monthly number of measles notifications among blacks (Table 3) during the post-campaign period was reduced to only one fifth the pre-campaign level (304 vs 64; $P < 0.01$). Among the remaining race groups, whites, Indians and coloureds, measles notifications in the post-campaign period were reduced to two fifths of the pre-campaign level (Table 3).

Data on age was available in only 3 categories; hence, a more detailed analysis of infant notifications was not possible. The age distribution (Table 3) of measles notifications across these 3 age groups did not show any meaningful changes after the measles campaign.

The gender distribution of the measles cases notified (Table 3) was similar during the pre-campaign, campaign and post-campaign periods.

Notifications of measles deaths declined 8-fold (1.09% vs 0.13%) after the measles campaign. In the year following the campaign, only 1 measles death was notified as compared to 40 notified measles deaths in the year preceding the measles campaign.

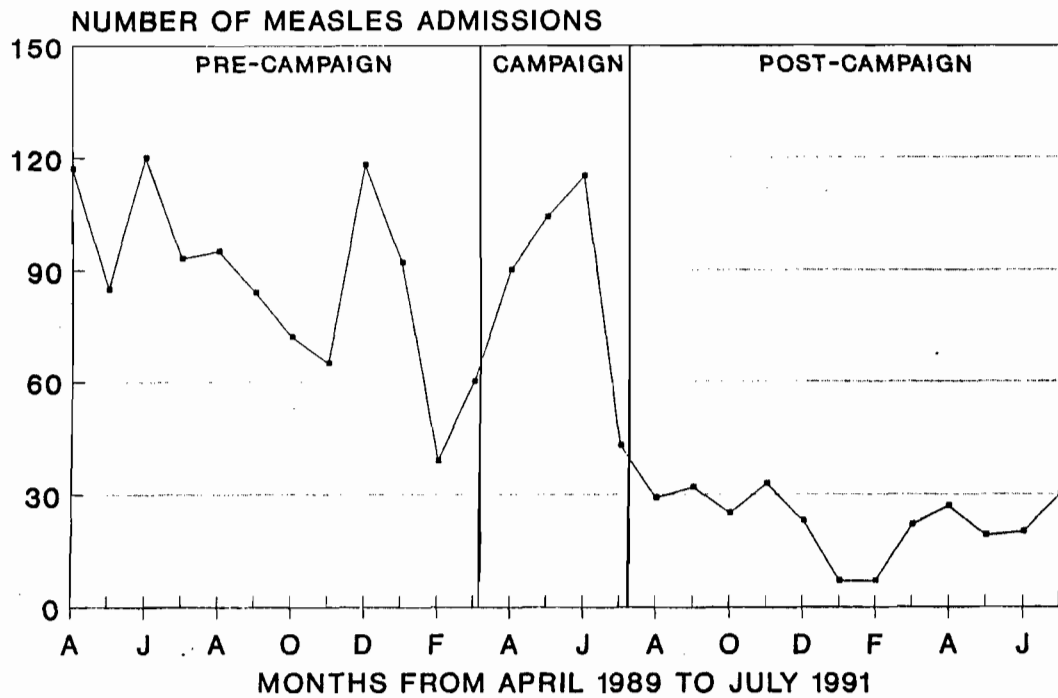
5. Measles admissions to a tertiary hospital:

Measles admissions to Clairwood hospital declined during July 1990 and remained low for the entire post-

campaign period of 1 year (Figure 9).

FIGURE 9

**Measles admissions to Clairwood Hospital
April 1989 - July 1991**



Since the measles immunisation campaign, the average number of measles admissions has fallen by 74% from 87 to 23 ($P < 0.01$) per month (Table 4).

There was little difference in the monthly average of the number of patients admitted to Clairwood hospital for all diagnoses (Table 4) during the pre-campaign and post-campaign periods (2 703 vs 2 528; $P = NS$) indicating that there was little change in the catchment population of the hospital.

TABLE 4

Age and gender distribution and geographical source of patients admitted for measles to Clairwood hospital

	<u>Pre-campaign</u>	<u>Campaign</u>	<u>Post-campaign</u>
	<u>4/89-3/90</u>	<u>4/90-7/90</u>	<u>8/90-7/91</u>
Measles admissions:	1040	357	274
Monthly average	87	89	23
Measles deaths (%)	57(5.5%)	22(6.2%)	9(3.3%)
All admissions(SE):	2703(185)	2471(161)	2528(152)
Male:female ratio:	1.15:1	1:1	1:1.08
Age distribution in months (%):			
< 7	15.4	12.6	11.3
7 - 9	19.8	23.2	24.1
10 - 12	18.6	12.9	12.0
13 - 60	39.0	39.2	43.1
> 60	7.2	12.0	9.5
Five most common geographical sources of patients:			
	Umlazi	Umlazi	Umlazi
	KwaMashu	KwaMashu	KwaMashu
	Inanda	Inanda	Inanda
	Umbumbulu	Lamontville	Umbumbulu
	Lamontville	Umbumbulu	Ntuzuma

During the pre-campaign period, the measles mortality rate (Table 4) was 5.5% (57/1040) compared to 3.3% (9/274) during the post-campaign period (P=NS).

The mean age during the pre-campaign period was 22.8 months compared to 26.8 months during the post-campaign period (P=NS). During the pre-campaign period, 19.8% of measles patients admitted were aged 7 to 9 months compared to 24.1% (P=NS) during the post campaign period (Table 4). Ten to 12 month old children comprised 18.6% and 12.0% of measles admissions during the pre-campaign and post-campaign periods respectively (P<0.05).

During the pre-campaign period there was a slight preponderance of male admissions which changed to a slight preponderance of females during the post-campaign period (Table 4); but none of these differences were statistically significant (P=NS).

During both the pre-campaign and post-campaign periods the 4 most commonly recorded residential addresses of patients admitted to Clairwood hospital for measles were the same; (in order of decreasing frequency) Umlazi, KwaMashu, Inanda and Umbumbulu. During the pre-campaign period, 5 or more measles patients admitted to Clairwood hospital came from each of 32 areas throughout Natal. Since the campaign, at least

1 measles patient has been admitted to Clairwood hospital from 28 (87.5%) of these areas.

DISCUSSION

Following the measles immunisation campaign in Natal/KwaZulu, there was a marked fall in the incidence of measles as indicated by fewer measles notifications and fewer measles admissions to Clairwood hospital. The decline, which occurred shortly after the start of the campaign, can be ascribed to the measles campaign since there were no other interventions which could have had such a large influence on measles during mid-1990.

The measles campaign in Natal/KwaZulu was almost entirely limited to blacks. Although only blacks received more measles vaccines during the campaign, the number of measles notifications for the other races had also declined. This is probably an effect of reaching levels of vaccination coverage closer to herd immunity (19) in Natal/KwaZulu.

Regarding vaccine supply, there were 2 distinct methods of preparing for the campaign; Natal health services, which have not been involved in a measles campaign before, adopted the "stock up" approach while

the KwaZulu services, which have more experience in vaccination campaigns, had the necessary vaccines available in the clinics and hospitals and did not have to "stock up" just before the campaign.

The measure of success achieved by the measles campaign is likely to be, at least partially, due to the high level of participation in the campaign by almost all health services in Natal/KwaZulu. Of particular note in the evaluation of the measles campaign, are the beneficial and deleterious residual effects on routine measles vaccinations and spillover effects on other routine vaccination services.

Measles campaigns have been viewed with scepticism because of their potential to undermine routine immunisation services (6). The findings of this study suggest that this is too simplistic a view and the short-term (1 year) effects of the measles campaign in Natal/KwaZulu challenge this perception. The measles campaign on the whole did not negatively influence measles vaccinations following the campaign; in the year preceding the campaign 14 727 measles vaccines were administered each month by health services in Natal/KwaZulu as compared to the 14 589 measles vaccines administered each month by these services during the year following the campaign.

Individual health services showed varying residual effects on routine measles vaccinations after the campaign. Trust Area services experienced a considerable fall in routine measles vaccinations while KwaZulu and Local Authority health services experienced an expansion in routine measles vaccinations following the campaign. Hospitals and Section 30 services showed no significant changes in routine measles vaccinations following the campaign.

The reasons for such wide variation in the residual effect of the campaign, while not specifically studied, could include differing perceptions of the measles campaign and differing capacities to cope with a large short-lived spurt of activity such as a campaign.

Vaccinations for polio, tetanus and tuberculosis were used to assess the spillover effects of the measles campaign on routine vaccination services for diseases other than measles. These vaccines were selected since they encompassed 3 distinct age groups; most BCG is given at birth, polio between 4 and 7 months and tetanus to pregnant women.

Since polio vaccines are administered to children at an age similar to that recommended for measles, the spillover effect should have been most apparent for

this vaccine. Indeed, a small beneficial spillover effect was present in both Natal and KwaZulu health services.

A similar uniform increase was not present with regard to BCG vaccine; hospitals and Section 30 clinics did not demonstrate a spillover effect while Trust Area services experienced a deleterious effect and Local Authorities and KwaZulu health services showed positive spillover effects of the campaign.

Tetanus vaccination was included in this evaluation because it is not administered during routine childhood vaccinations, but is limited almost exclusively to pregnant women. A very small proportion of tetanus vaccines is administered to patients with injuries; these were not analysed separately because of their small number. Not a single health service showed a decline in tetanus vaccinations following the campaign; suggesting a generally raised awareness of the importance of tetanus vaccination during pregnancy.

It is not clear what role the measles campaign played in increasing awareness of tetanus vaccination since this was not included in the staff in-service training programmes. The possibility that the changes in tetanus vaccinations are not solely due to the measles

campaign must be contemplated because the changes in tetanus vaccinations are in different to that of BCG, polio and measles vaccines while the trends in the latter 3 vaccines are similar to one another.

Besides establishing the existence of residual and spillover effects and estimating their size, this evaluation included a measure of the degree of participation in the measles campaign. This measure takes 3 factors into account; baseline number of vaccines administered before the campaign, the increase in vaccines administered during the first month of the campaign and the degree to which this was sustained during the 3 months following the start of the campaign. Hence it is possible for a service which increased its vaccinations 6 fold in the first month of the campaign followed by 2 months of usual levels of vaccinations to have the same degree of participation as a service which maintained a 2 fold increase in vaccinations for the 3 months following the start of the campaign.

Using this indicator, it is evident that all health services in Natal/KwaZulu participated satisfactorily in the measles campaign, but some contributed more than others. As a whole, the health services in Natal participated to the same degree as the services in KwaZulu. However, within Natal, the individual

services showed varied degrees of participation; hospitals and Section 30 clinics making the biggest contributions.

Regardless of the variations between individual health services in their levels of participation, the reduction in measles notifications was marked. The translation of measles notifications and admissions into measles incidence is conditional on there being no major changes in the catchment population during 1990. Given the close temporal proximity of the 2 periods being compared, this is highly unlikely. This contention is further supported by the similarity in the number of admissions during the pre-campaign and post-campaign periods to Clairwood hospital for all diagnoses. It is, therefore, reasonable to conclude that changes in measles notifications and admissions indicate changes in the incidence of measles.

Based on measles notifications, it is estimated that the incidence of measles in Natal/KwaZulu fell by 79% among blacks and 62% among the other races as a result of the campaign. This decline is confirmed by a 74% reduction in measles admissions to Clairwood hospital.

The incidence of measles usually demonstrates marked seasonal variation (20). During 1990 the seasonal variation in the incidence of measles was interrupted

by the campaign, an effect similar to the loss of seasonal peaks in measles incidence in Finland following the nationwide vaccination programme (10).

Another effect of the campaign has been a reduction in the measles case fatality rate; an 8 fold reduction among measles notifications and almost 2 fold reduction among measles admissions to Clairwood hospital.

The expected upward trend in the age of patients who developed measles after the campaign had not materialised. Between 20% and 30% of measles patients admitted to Clairwood hospital were aged 7 to 9 months (Table 4). Similar percentages of measles patients younger than 9 months have been reported elsewhere; 27.2% in Cape Town (21), 28% at Clairwood hospital in 1985/86 (3) and 36% at Baragwanath hospital (22).

The increase, subsequent to the campaign, in the proportion of measles patients aged 7 to 9 months, accompanied by a decrease in the proportion of measles patients aged 10 to 12 months, highlights the need for measles vaccine at 6 months at age. This supports the World Health Organisation's recommendation to immunise children in developing countries at 6 months with 'high titre' Edmonston-Zagreb vaccine (23). This recommendation has been previously advocated for South

Africa (24) and is in the process of being implemented.

There was little change in the geographical source of measles admissions to Clairwood hospital after the campaign, indicating that transmission is continuing in the major black townships around Durban albeit at a lower level. Subsequent to the campaign, measles continued to spread in more than four fifths of the areas in which measles had been occurring prior to the campaign. It is, therefore, important to remain vigilant for foci of measles cases which may lead to epidemics.

Routinely collected data on measles vaccinations administered and measles notifications and admissions to Clairwood hospital can be useful to generate gross indicators to monitor the measles control efforts in Natal/KwaZulu. An attempt was made to use changes in the number of measles admissions at Edendale hospital as an indicator of the effectiveness of mass measles immunisation campaigns in the Edendale/Vulindlela districts of KwaZulu in 1987 and 1988 (25). However, this study reported only that there was a decrease in measles admissions but provided no indication of the extent of the decrease.

While the findings of this study demonstrated an

unequivocal increase in measles vaccinations with a concomitant decline in measles incidence, large scale community based vaccination coverage surveys undertaken before and after the campaign failed to demonstrate a significant increase in vaccination coverage following the campaign (14). Surprisingly, the surveys (14) showed a decrease of 3.9% in vaccination coverage, based on road-to-health card proof of vaccination, among blacks in Natal/KwaZulu following the measles campaign (68.9% [N=1223] vs 65% [N=1275]). Even if the more lax criterion of history of vaccination is also accepted, the improvement in the vaccination coverage is still a paltry 7.7%.

Despite the multitude of potential methodological flaws (26) which may creep into a large scale community based study, there is no apparent reason for the anomaly between this study and the vaccination coverage survey undertaken by the Department of Community Health at the University of Natal (14). Given the dramatic fall in measles incidence, there is little doubt that vaccination coverage escalated. The question is: why was the increase in vaccination coverage not demonstrated in the large-scale community based vaccination coverage surveys. One possible explanation is the age group studied; the vaccination coverage surveys (14) included only 12 to 23 month old children whereas the campaign included all children

below 6 years old.

The decline in measles notifications and admissions to Clairwood hospital was sustained throughout the post-campaign period. However, it is still too early to determine whether the post-campaign low levels of measles occurrence will continue into the long-term. Experience from other campaigns suggest that campaigns result in a temporary interruption in the transmission of the virus (27). An evaluation of a mass measles immunisation campaign in a peri-urban area demonstrated that the effects of the campaign were short-lived due to the high influx rate of unvaccinated children from rural areas (27).

If measles vaccination efforts wane and slump back to pre-campaign levels, a measles epidemic is likely to ensue due to the accumulation of susceptible newborns (28). This is an important consideration since the socio-economic conditions such as overcrowding (2) which contribute to the spread of measles remain.

CONCLUSION

The 1990 measles campaign in Natal/KwaZulu, which was limited to blacks, galvanised a high degree of participation from almost all health services in

Natal/KwaZulu and resulted in a rapid and marked plunge in the incidence of measles as reflected by declines in both measles notifications and measles hospital admissions.

The short-term (1 year) residual effects of the measles campaign on routine measles immunisation services were varied; there was a positive residual effect on KwaZulu and Local Authority services, no residual influence on hospitals and Section 30 clinics and a negative residual effect on Trust Area services. The spillover effects of the measles campaign on routine immunisation services against polio, tuberculosis and tetanus showed similar trends.

Routinely collected data can provide valuable information for the evaluation of a measles campaign. The methods used in this study can provide more information than large scale vaccination coverage surveys for the purposes of evaluating a measles campaign. More importantly, they can be used as ongoing indicators to monitor the medium- and long-term effects of a campaign.

RECOMMENDATIONS

The positive gains from the measles campaign are

encouraging, but it is necessary to establish reasons for the varied residual and spillover effects on routine immunisation services.

While the campaign was a success in generating involvement of health services in Natal/KwaZulu and reducing the burden of measles in this region, it is important to remember that this disease has not been eliminated. Vigilance and continued routine vaccination efforts are required to prevent further epidemics of measles in Natal/KwaZulu.

The methods developed in this study should be used on an ongoing basis to monitor the long-term effects of the campaign, routine vaccination services and the incidence of measles in Natal/KwaZulu.

It remains a challenge to all who were involved in the 1990 National Measles Immunisation Campaign to maintain the momentum for immunization and to continue the efforts to attain herd immunity against measles.

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ANNEXURE 1

Health services in Natal
that were included in this evaluation

A. Local Authorities

- | | |
|---------------------|------------------------|
| 1. Amanzimtoti | 2. Ballito |
| 3. Bendigo | 4. Bergville |
| 5. Colenso | 6. Dannhauser |
| 7. Darnall | 8. Dundee |
| 9. Durban | 10. Durban(Chatsworth) |
| 11. Empangeni | 12. Eshowe |
| 13. Estcourt | 14. Gingindlovu |
| 15. Glencoe | 16. Greytown |
| 17. Howick | 18. Isipingo |
| 19. Kloof | 20. Kingsburgh |
| 21. Kokstad | 22. Ladysmith |
| 23. Marburg | 24. Mandini |
| 25. Margate | 26. Matatiele |
| 27. Melmoth | 28. Mooi River |
| 29. New Germany | 30. Newcastle |
| 31. Paulpietersburg | 32. Pietermaritzburg |
| 33. Pinetown | 34. Port Shepstone |
| 35. Queensburgh | 36. Richards Bay |
| 37. Richmond | 38. Scottburgh |
| 39. Shelly Beach | 40. Stanger |
| 41. Umhlanga Rocks | 42. Umkomaas |
| 43. Umtentweni | 44. Umzinto |
| 45. Verulam | 46. Vryheid |

- | | |
|--|---------------|
| 47. Waterfall | 48. Westville |
| 49. Yellow Wood Park | |
| 50. Development and Services Board services in:
Shallcross, Craigieburn, Redcliffe, Shakaskraal,
Ottawa, Duffs Road, Tugela, Etete, Blackburn,
Welbedacht, Lions River and New Hanover. | |

B. Section 30 Clinics

Fixed and mobile clinics administered by the Natal Provincial Administration in the Section 30 parts of the following regions:

- | | |
|---------------------|----------------------|
| 1. Botha's Hill | 2. Dundee |
| 3. Empangeni | 4. Eshowe |
| 5. Estcourt | 6. Greytown |
| 7. Ixopo | 8. Kokstad |
| 9. Kwadabeka | 10. Ladysmith |
| 11. Matatiele | 12. Newcastle |
| 13. Newtown, Inanda | 14. Nondweni |
| 15. Nottingham Road | 16. Pietermaritzburg |
| 17. Pongola | 18. Port Shepstone |
| 19. Tongaat | 20. Umzinto |
| 21. Underberg | 22. Vryheid |

C. Hospitals

i. Provincial

- | | |
|--------------|------------|
| 1. Clairwood | 2. Darnall |
|--------------|------------|

- | | |
|-------------------|---------------------|
| 3. Dundee | 4. EG and Usher |
| 5. Emmaus | 6. Estcourt |
| 7. Gledhow | 8. Greys |
| 9. Imbalenhle | 10. Kearsney |
| 11. King George V | 12. Kingsway |
| 13. Ladysmith | 14. Lower Umfolozi |
| 15. Mt Edgecombe | 16. Murchison |
| 17. Newcastle | 18. Niemeyer |
| 19. Northdale | 20. Osindisweni |
| 21. R.K. Khan | 22. St Appollonaris |
| 23. Vryheid | |

ii. Private

- | | |
|--------------|-------------|
| 1. Isipingo | 2. Medicity |
| 3. Midlands | 4. Victoria |
| 5. Westville | |

iii. Mission

- | | |
|----------------------------------|------------|
| 1. C.G. Smith | 2. McCords |
| 3. Mt View | 4. Siloah |
| 5. Smith Mitchell Richmond Chest | |
| 6. St Marys - Melmoth | |
| 7. St Marys - Mariannahill | |

D. Clinics in Trust Areas

- | | |
|--------------------|--------------|
| 1. Botha's Hill | 2. KwaDabeka |
| 3. Newtown, Inanda | 4. Ladysmith |
| 5. Umzinto | |