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A COMPARISON OF A 30-CLUSTER SURVEY METHOD USED IN INDIA AND A PURPOSIVE METHOD IN THE ESTIMATION OF IMMUNIZATION COVERAGES IN TAMIL NADU

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ABSTRACT

A 30-cluster survey method that is employed for estimating immunization coverages by the Government of India (GOI) was compared with a Purposive method, to investigate whether the likely omission of SC/ST and backward classes in the former would lead to the reporting of higher coverages. The essential difference between the two methods is in the manner in which the first household is selected in the chosen first stage sampling units (villages). With the GOI method, it is often close to the village centre, whereas with the Purposive method it is always in the periphery or in a pocket consisting of SC/ST or backward classes. A concurrent comparison of the two methods in three districts in Tamil Nadu showed no real differences in the coverage with DPT and BCG vaccines. However, the coverage was consistently higher by the GOI method in the case of the Polio vaccine (by 1.5%, 3.1% and 5.3% in the 3 districts), and the Measles vaccine (by 4.8%, 13.3% and 13.9%); the average difference was 3.3% for Polio vaccine (p=0.08) and 7.3% for Measles vaccine (p=0.01).

Key words: *Immunization coverage, SC/ST and Backward classes, 30-cluster survey.*

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Surveys for rapid estimation of immunization coverages in children are undertaken (for monitoring purposes) in India using a two-stage sampling technique(l), which is an adaptation of the 30-cluster survey method recommended by the World Health Organization^). In the method used by the Government of India (GOI), 30 first stage sampling units are selected by linear systematic sampling, and within each selected unit *(e.g.,* village), a household is selected that is often close to the village centre, and a cluster of 7 children is assessed for immunization status. It is claimed that the findings in these 210 children (30 clusters x 7 children per cluster) will provide an estimate of the immunization coverage in the community with 95% confidence limits of ±10 percentage points. With this method, households located at the periphery of the village are not likely to be included in the survey unless the village is small. This could result in some distortion, as persons living in the outskirts of villages in India are

often of poorer socio-economic status, and there is evidence from some States in North India that such persons have immunization coverages that are lower by 10-25 percentage points(3). To examine the magnitude of this distortion (if any) in Tamil Nadu, it was decided to study the GOI method along with another in which the first household is purposively selected in the village periphery or in a pocket containing scheduled castes, scheduled tribes or other backward classes. A concurrent comparison of the two methods was undertaken in three districts in Tamil Nadu, and the findings are reported in this paper.

Material and Methods

The detailed methodology of the two-stage survey employed in India is spelt out in the GOI manual(l). In brief, the first stage consists of identifying 30 areas of study *(e.g.,* villages) using a PPS (probability proportional to size) linear systematic sampling technique. Next, within each selected area, the field worker goes to the village centre *(e.g.,* market, place of worship, school), selects at random one of the paths leading to the centre, counts or estimates the number of houses from the centre to the boundary along that path, and selects a random number between 1 and the total number of households; with the selected household as the starting point, he/she visits a cluster of households in a pre-specified manner until 7 children aged 12-23 months are assessed for immunization status.

In the Purposive method, the same first stage units as above were employed. Within each such unit, however, the first household was deliberately selected (but randomly) in a pocket (usually in the periphery) comprising of scheduled castes, scheduled tribes or other backward classes; in the case of multiple pockets (especially in urban areas) one pocket was selected at random. Subsequent to the identification of the first household, the procedures were identical to those for the GOI method.

In the event of a 30-cluster survey by either method (GOI or Purposive) with 7 children per cluster not providing estimates with the required degree of precision, it is possible that a larger cluster size may do so. The magnitude of the difference of interest (between the estimates by the two methods) may also alter with increased cluster size. To obtain information on these aspects, 12 children were assessed in each first stage unit chosen for study, instead of the usual number of 7.

Survey Procedures

The surveys were undertaken in Dharmapuri, Pudukkottai and Dindigul districts in February-March 1993. Information was collected by post-graduate investigators after they had received intensive training in interviewing techniques and the 30-cluster survey methodology. All the investigators spoke the local language, Tamil, fluently and could elicit information accurately by in-depth interrogation of the mother. To avoid the possibility of any differences in efficiency between the investigators affecting the outcome of the comparison, their postings were rotated on a daily basis to the two methods so that "balance" was maintained and, on the whole, each of them spent the same amount of time on the two methods.

Definition of Coverage

A child was defined as having been "immunized", if he/she satisfied the following conditions:

DPT/Polio: First dose was given at any

time 6 weeks after birth. Subsequent two doses were given with intervals of at least 4 weeks between successive doses, and all three doses were administered before the child had completed one year.

BCG: The vaccination was given at any time before 12 months.

Measles: Immunization was undertaken after completion of 9 months but before the completion of 12 months.

Estimates of Coverage and its Sampling Error

An estimate of the coverage is given by the expression $\Sigma\hat{p}=\Sigma fi/\Sigma ni$ where n_i is the number of children assessed in i^{th} cluster and f_i is the number of children that are immunized. The variance of this estimate is, strictly speaking, not determinable since the 30 clusters were identified by systematic sampling with a random start, and not by simple random sampling; however, in practice, it is usually approximated by the expression $\frac{1}{m(m-1)} \Sigma (p_i-\beta)^2$ where $p_i = f_i / n_i$ and m is the number of clusters(4).

The significance of differences between the estimated coverages by the two methods was determined by using a paired t-test, as the first stage sampling units (*e.g.,* villages) were the same for the two methods. For the same reason, the sampling error of the estimates could not be compared directly by the conventional variance ratio test. Instead, the null hypothesis of equality of variances was tested by computing the correlation coefficient between the sum and the difference of the findings in each first stage sampling unit *(e.g.,* village), and testing the correlation coefficient for equality to zero.

Results

The estimated coverages by the two methods, the difference and its 95% confidence interval are presented in *Table I.* In District A, the GOI coverage was higher than the Purposive method coverage by 2.9% for DPT, 3.1% for Polio and 13.3% for Measles, and lower by 2.0% for BCG. A similar pattern was seen in District B. In District C, the Polio and Measles cove-rages were higher whereas the DPT and BCG coverages were lower. The findings for each vaccine are summarized in *Table II* and show that the coverage was, on average, higher by the GOI method for DPT (by 1.8%), Polio (by 3.3%) and Measles (by 7.3%), but lower for BCG (by 1.0%). The difference was clearly non-significant in the case of DPT and BCG vaccines ($p>0.2$), very suggestive in the case of Polio vaccine ($p = 0.08$), and statistically significant in the case of Measles vaccine ($p = 0.01$). This is also evident from the 95% confidence intervals in the last column.

An analysis of variance of the number of children immunized in the 90 clusters in the three districts *(Table III)* showed that there were significant differences between the three districts in the coverages with each of the four vaccines (term b); the nonsignificance of Interaction M x D (term e) indicates that the differences were of the same order with the GOI and Purposive methods. Next, the difference between the coverages by GOI and Purposive methods (term d) was statistically significant in the case of Measles vaccine coverage ($p <0.01$) and was very suggestive in the case of the Polio vaccine ($p = 0.1$). The analysis was also undertaken with the proportions immunized (instead of the numbers), after employing an angular transformation to homogenise the variances of the propor-

TABLE I- *Findings with GOI Method and Purposive Method in Three Districts in Tamil Nadu (7 children per cluster)*

District	Vaccine	Estimated coverage (%)±1.96 SE		Difference	
		GOI (a)	Purposive (b)	(a-b)	95% CI
A	DPT	62.0± 8.1	59.1 ± 7.4	2.9	-2.8 to 8.6
	Polio	60.6 ± 8.1	57.5 ± 7.7	3.1	-3.0 to 9.2
	BCG	71.3±10.5	73.3 ±10A	-2.0	-10.8 to 6.8
	Measles	36.7 ±9.5	23.4 ±6.9	13.3	4.3 to 22.3
B	DPT	74.8 ±8.7	71.4 ±9.7	3.4	-4.4 to 11.2
	Polio	76.7 ±8.4	71.4 ±9.4	5.3	-2.0 to 12.6
	BCG	88.7 ±4.7	89.3 ±4.9	-0.6	-5.9 to 4.7
	Measles	45.3 ±8.0	41.4± 8.4	3.9	-4.3 to 12.1
C	DPT	74.5 ±6.2	75.5 ± 5.5	-1.0	-7.1 to 5.1
	Polio	73.1 ±5.9	71.6 ±5.5	1.5	-4.7 to 7.7
	BCG	92.9 ±4.9	93.3 ±4.9	-0.4	-6.9 to 6.1
	Measles	52.2 ±9.6	47.4 ±8.5	4.8	-6.3 to 15.9

TABLE II-*Summary of Findings in Three Districts with GOI and Purposive Methods*

Vaccine	Coverage with GOI method minus coverage with purposive method (%)				
	District A	District B	District C	Mean	95% CI
DPT	2.9	3.4	-1.0	1.8	-1.9 to 5.5
Polio	3.1	5.3	1.5	3.3	-0.4 to 7.0
BCG	-2.0	-0.6	-0.4	-1.0	-5.0 to 3.0
Measles	13.3	3.9	4.8	7.3	1.8 to 12.8

tions; the conclusions were exactly the same.

As regards the precision of the estimates, 11 of 12 with each method had the desired 95% confidence limits of under 10 percentage points *(Table I);* the lone exception was BCG coverage in District A with limits of ±10.5 and ±10.4 percentage points, respectively,, for the GOI and Purposive methods.

The differences between the coverages by the two methods are summarized in

TABLE III-*Analysis of Variance a/the Findings*

Term source	Degrees of freedom	DPT Mean square	F	Polio Mean square	F	BCG Mean square	F	Measles Mean square	F
(a) Between clusters (C)	89	4.23		4.16		4.28		4.40	
(b) Between districts (D)	2	16.09	4.07*	17.12	4.44*	33.87	9.41**	29.96	7.86*
(c) Clusters within district C(D)	87	3.95		3.86		3.60		3.81	
(*d*) Between GOI & Purposive methods(M)	1	0.56	0.70	2.22	2.71	0.36	0.38	11.76	6.88*
(e) Interaction (M x D)	2	0.36	0.45	0.21	0.26	0.07	0.07	2.02	1.18
(*f*) Residual	87	0.80		0.82		0.96		1.71	

* $p < 0.05$; ** $p < 0.01$.

Table IV for larger cluster sizes *i.e.,* 8 to 12. No change in pattern is observed. It is to be noted that the measles coverage with the GOI method is consistently higher than the corresponding coverage with the Purposive method in the three districts and for all cluster sizes, and that the mean of the differences in the three districts is statistically significant for all cluster sizes.

Discussion

In the methodology proposed by the World Health Organization for rapid estimation of immunization coverages(2), the first household in the selected first stage unit is to be chosen at *random* and the cluster of 7 children developed from this starting point. In applying this method under Indian conditions, an important modification has been made for operational convenience(l) and that is the first household is chosen by a process that often results in it being close to the village centre; in consequence, people living in the periphery (poorer socio-economic groups with lower coverages) are less likely to be included in the survey and this is a potential source of bias. The present study has compared clusters that were deliberately formed with a starting point in lower socio-economic groups with clusters formed by the GOI method, and therefore provides *maximal* estimates of the potential bias. No real differences were observed in the case of coverages with DPT and BCG vaccines. However, the Polio vaccine coverages were 1.5% to 5.3% higher, and the Measles vaccine coverages were 3.9% to 13.3% higher, with the GOI method than with the Purposive method. Appreciably lower coverages in SC/ST children than in the other have been reported in the case of all four vac-

TABLE IV- *Summary of Findings in Three Districts with GOI and Purposive Methods for Larger Cluster Sizes*

Vaccine	Cluster size	Coverage with GOI method minus coverage with purposive method (%)				
		District A	District B	District C	Mean	p
DPT	8	1.7	0.8	-0.1	0.8	>0.2
	9	2.9	3.0	-1.2	1.6	>0.2
	10	1.5	3.0	-0.7	1.3	>0.2
	11	1.1	3.1	-0.6	1.2	>0.2
	12	1.2	2.6	-2.6	0.4	>0.2
Polio	8	1.9	2.5	2.0	2.1	>0.2
	9	3.8	4.5	0.7	3.0	0.1
	10	3.0	4.4	1.0	2.8	0.1
	11	2.1	4.1	1.2	2.5	0.1
	12	1.7	3.5	-0.9	1.4	>0.2
BCG	8	-2.7	-0.9	0.0	-1.2	>0.2
	9	0.2	0.3	0.0	0.2	>0.2
	10	1.3	1.0	0.0	0.8	>0.1
	11	3.3	-0.4	0.3	1.1	>0.2
	12	3.6	-0.7	0.3	1.1	>0.2
Measles	8	11.6	5.7	4.0	7.1	0.01
	9	11.7	5.0	2.8	*6.S*	0.01
	10	9.6	6.3	2.9	6.3	0.01
	11	10.4	3.8	4.2	6.1	0.01
	12	8.6	2.5	2.4	4.5	0.03

cines in four northern States of India, namely, Bihar, Uttar Pradesh, Rajasthan and Madhya Pradesh; the average difference was 13% for DPT, 10% for Polio, 9% for BCG and 8% for Measles(3). These findings indicate the need for: *(a)* special effort to promote health education amongst the backward classes and SC/ST communities and *(b)* paying greater attention to them at micro level planning of the operational aspects of the immunization programme. They also raise the possibility that the method currently used in India may be over-estimating coverages vis-a-vis the method recommended by the WHO. This aspect is being investigated more directly by a concurrent comparison of the two methods in five districts in Tamil Nadu, and will be the subject of a separate communication.

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