Redesigning the Operations Research Project Surveillance System

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Acronyms

CA	Comparison Area
CAR	Contraceptive Acceptance Rate
CDR	Crude Death Rate
CMR	Child Mortality Rate
CMWRA	Currently Married Women of Reproductive Age
CPR	Contraceptive Prevalence Rate
CWFP	Concerned Women for Family Planning
DEFT	Design Effect
FPHSP	Family Planning and Health Service Project
FP	Family Planning
IA	Intensive Area
ICDDR,B	International Centre for Diarrhoeal Disease Research, Bangladesh
IMR	Infant Mortality Rate
MCH-FP	Maternal and Child Health-Family Planning
NIA	Non-intensive Area
NIPHP	National Integrated Population and Health Programme
NGO	Non-government Organizations
ORP	Operations Research Project
ORSS	Operations Research Project Surveillance System
QED	Quasi-experimental Design
RA	Randomly Assigned
SS	Surveillance System
UHEP	Urban Health Extension Project
USS	Urban Surveillance System

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Tables and Annexures

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Summary and Recommendations

The National Integrated Population and Health Programme (NIPHP) represents a new era of national-level health planning that focuses on the integrated delivery of health and family planning services. The Operations Research Project (ORP) of the ICDDR,B: Centre for Health and Population Research is one of the seven major components of the NIPHP. The Project is mandated to improve the effectiveness and efficiency of the NIPHP through applied research and dissemination of research findings and by providing technical assistance to other components. The ORP has instituted a surveillance system to generate basic data to: (i) evaluate the impact of project interventions, (ii) monitor the changes of indicators, and (iii) provide feedback on project impact.

The ORP survey design should be cost-and time-effective and valid for both rural and urban areas.

Considering the many changes that took place during the last years while implementing the design, the authority decided to evaluate the existing design to examine its effectiveness and efficiency and to meet the objectives of the ORP. The present report thoroughly examines various aspects of the surveillance system, its coverage, comparability and applicability and also to what extent the design is sensitive toward generating reliable and valid data for measuring the impact of interventions and monitoring the changes of indicators. The report highlighted the merits and demerits of the design, with a particular emphasis on how the design lacks uniformity from area to area in respect of: (i) design, (ii) sample size, and (iii) implementation procedures.

The report also highlighted various sampling designs that are generally used in operations research. A theoretical framework has also been presented. The report compared the merits, demerits and suitability of the panel sample, sampling on two occasions (mixed and new samples) with efficiency of each design. The report finally establishes that the panel sample is most appropriate for the ORP.

The issue of drop-out has been taken into consideration and has been discussed at length. The recommended sample sizes for intervention and comparison areas are given in Annexure 1. The recommendations of the study are:

Quasi-experimental, non-equivalent control group design may be continued. The surveillance should be carried out only in the intervention area and comparison area. The comparison area must be closed to the intervention area. The surveillance system is not applicable to the non-intervention area.

Each union of the project thanas should be considered an independent intervention unit, since the project unions have separate programmes and also have different starting dates.

The minimum sample size for each union and control area has been determined to be 812 households.

Eight hundred twelve households will be the final sample size for 2003, and the sample size for the preceding years has been adjusted for drop-outs and also for design effects. Findings of the second year should be compared with those based on households, excluding the drop-outs.
Results of the previous year and characteristics of the retained households should be compared with drop-outs to see whether a particular socio-demographic group has left the area. If so, the analysis should be adjusted accordingly.
Allocation of the number of households to selected unions in the comparison areas should be carried out, following a proportional allocation scheme.
Three unions--a high-performing, a medium-performing and, finally, a low- performing union--should constitute the comparison area.
In all areas, the panel sample should be used, since the main objective of the ORP is to measure the changes over time.
The panel sample will be retained for 5 years, provisionally up to 2003, and then a new panel sample will be drawn. The new panel sample will include both old and new households and be used for 5 additional years.
The criteria used for selecting project areas, intervention unions, comparison thanas, and unions in comparison thanas need to be properly documented.
In the base year, the indicators of the intervention and comparison union should be equivalent as far as possible. The indicators used for the determination of areas should be highly correlated with the programme variables.
In case of split-up houses, the household with the respondent in the previous survey should be retained, and other split-up houses be considered as drop-out houses.
Some additional suggestions are that both panel sample for change and independent sample for new-comers (houses) should be used. In that case, separate estimates of the minimum sample size for both the groups would be necessary, since one would have to be sure that each sample is representative of its own group.
One comparison area for Dhaka city should be selected. As reported, there is no intervention activity in Lalbagh area, and it may, therefore, serve the purpose of a comparison area for Sher-e-Bangla Nagar.
The findings suggest that a complete overhaul of the existing ORP data collecting system is necessary to make the system more effective. The recommendations given above are expected to be very useful.

Background

The National Integrated Population and Health Programme (NIPHP) is a follow-on project to the Family Planning and Health Services Project (FPHSP). It was a ten-year project that concluded on 31 July 1997, through which the Maternal and Child Health (MCH-FP) Extension Projects (Urban and Rural) were funded. The NIPHP spans from 1 August 1997 to 30 June 2004 and represents a new era of national-level health planning that focuses on integrated delivery of health and family planning services.

The NIPHP comprises the following seven major components:

i. Urban Service-delivery;
ii. Rural Service-delivery;
iii. Quality Improvement;
iv. Urban Immunization;
v. Operations Research;
vi. Social Marketing; and
vii. Contraceptive Logistics Management.

The mission and vision of the NIPHP are to enhance the quality of life of poor and under-privileged Bangladeshis by reducing fertility and improving family health through a basic package of high-quality and high-impact services and products, with effective management support.

Strategic Objectives of NIPHP

Fertility Reduced and Family Health Improved

In August 1997, the Operations Research Project (ORP) was initiated as the sole source of operations research for the USAID-funded NIPHP, as a follow-up to rural and urban components of the Maternal and Child Health and Family Planning (MCH-FP) Extension Project.

Mandate of Operations Research Project

The Operations Research Project is mandated to improve the effectiveness and efficiency of the national population and health programme of Bangladesh through applied research and dissemination of research findings, and by providing technical assistance to scale up and adapt solutions.

Operations Research Project Surveillance System (ORPSS)

- The primary objective of the ORP's survey and surveillance system (ORPSS) is to generate basic data for evaluating the impact and effectiveness of different project interventions.
- The system was designed to monitor changes in health, family planning and demographic indicators in both intervention and comparison areas so that the effects of interventions can be readily observed.

- This longitudinal data collection system was designed to produce rapid and continuous feedback on project impact from a representative sample in the Project intervention sites and comparison sites.
- The design was also intended to keep data collection at a relatively inexpensive scale and to be flexible and expandable to incorporate additional data as research needs change.
- The surveillance is conducted in both urban and rural field sites of the Project. The comparison area should be very close and similar to project area.

The rural and urban ORPSS includes:

a. Longitudinal data on health, family planning and demographic events and service use;

b. Longitudinal data to monitor interventions;

c. Intervention-specific surveys linkable with longitudinal data in the project sites;

d. The non-projects sites covered by cross-sectional survey data.

Objectives

Given the changes that have occurred in the surveillance system over the years, the present design was evaluated to examine its effectiveness and efficiency in meeting the needs of the ORP. Specifically the report:

- examines the coverage, comparability, and applicability of the design
- examines the extent to which it generates reliable and valid data for measuring the impact of interventions and monitoring the changes in indicators in both rural and urban areas
- determines the sample size based on review of different methods used
- examines the merits and demerits of the design with particular emphasis on the lack of uniformity between areas of the design, sample size, and implementation procedures.

Study Areas

The study areas include both rural and urban areas. The basic study design is a quasi-experimental non-equivalent control group design. Accordingly, the ORP Surveillance System has had both intervention and comparison areas in both rural and urban areas. At the beginning of the 1999, the areas were:

Rural Areas

Intervention areas	Comparison areas
1. Abhoynagar Thana, Jessore	1. Bagherpara and Keshabpur Thanas, Jessore
2. Mirsarai Thana, Chittagong	2. Satkania Thana, Chittagong
3. Patiya Thana, Chittagong	3. Lohagara Thana, Chittagong

Urban Areas

Intervention areas	Comparison area
1. Lalbagh in Dhaka city	1. Lalbagh (non-intensive) in Dhaka city
2. Sher-e-Bangla Nagar in Dhaka city	

The sample list, as of 01 March 1999 (Annexure 2), shows that Bagherpara thana in Jessore, as a comparison unit, has been excluded, while Lohagara thana in Chittagong has been brought under the ORPSS as a comparison thana. There has also been an expansion of the programme within the intervention and the comparison thanas by including more unions. It is also planned that, since no intervention exists in the Lalbagh area, the slum households of the Lalbagh area will be retained as a comparison group for Sher-e-Bangla Nagar. This is apparent from Table 1.

Rationale for the Study

The ORP has been collecting longitudinal data on health, family planning, and demographic events and service use. The management observed that the sampling design and the sample size used in different intervention and comparison areas lack uniformity. This poses a threat to the analysis, particularly when the intervention is to make comparisons between the project areas. The proposed design and the recommended sample sizes for different areas, based on a thorough review of different methods generally used to achieve the objectives similar or equivalent to the ORP, would provide a sound basis for determining the impact of the ORP interventions on both rural and urban areas.

Indicators

A long list of indicators has been selected under the following broad categories:

1. Vital/demographic events
2. Programmatic variables

In the list of reporting output, the indicators have been classified as

a. Demographic rates
b. Programmatic indicators
c. Intervention-specific indicators.

Sampling Design

The general rationale underlying the selection of areas and the determination of the sample-size emanates from the design-quasi-experimental non-equivalent pre-post intervention-control group design. This design provides longitudinal character and systematic data collection every 90 days.

Sample sizes by selected areas

The Table 1 presents the areas selected with sample size as of 1 January 1998 and 1 March 1999.

Table 1. Population size and sample size for intervention and comparison areas of selected thanas

Rural

Intervention/ comparison	Thanas	No. of unions	Household (population)	Sample household	Sampling fraction
Intervention area	Abhoynagar	4 (1998) 5 (1999)	16906 (1998) 23848 (1999)	2874 (1998) 3601	.17 (every 6th HH) .151
Comparison area	Bagherpara	2 (1998) - (1999)	19135 -	3253 -	.170 (Bagherpara + Keshabpur)
Comparison area	Keshabpur	2 (1998) 2 (1999)	11428	1977	.173 (every 6th H.H)
Intervention area	Mirsarai	5 (1998) 7 (1999)	16036 31922	4009 6576	.25 (every 4th H.H) .206
Intervention area	Patiya	3 (1998) 5 (1999)	6880 14725	1720 3431	.25 (every 4th H.H) .233
Comparison area	Satkania	2 (1998) 3 (1999)	6324 9956	1581 2260	.25 .23
Comparison area	Lohagara	1 (1999)	5959	1392	.23

Table 1 *(contd.)*

Table 1 *(Contd.)*

Urban

Intervention/ comparison	Thanas	No. of wards	Household (population)	Sample household	Sampling fraction
Intervention area	Sher-e-Bangla Nagar	Ward No. 40, 41	22143 (1999)	2981 (1999)	.13
Intervention area	Lalbagh slums Zone 3	intensive area	17987 (1994)	5189 (1999)	.28
Intervention area	Lalbagh slums Zone 7	non-intensive area	13353 (1994)	1754 (1999)	.13

The sampling fraction for each area is shown as a proportion in the last column of the table. In Abhoynagar, Bagherpara, and Keshabpur, the sampling fraction has been every 6th household. But in other areas, the sampling fraction has been every 4th household. The 1999 corresponding values are different from those of 1998.

In Lalbagh, the intervention area includes NGO intensive areas (IAs) and comparison areas as NGO non-intensive areas (NIAs). The sampling approach was the cluster approach. In total, 160 clusters, consisting of approximately 40 households distributed by slum and non-slum areas, have been covered. The clusters were selected through a selective approach, and the exact number of total households in the area was ascertained by the household lists while creating a primary sample unit.

Sampling Procedures Adopted in Selection

Rural Areas

For each selected thana, a two-stage sampling design is being used. The first-stage units are unions, and the second stage units are households. The first-stage units are selected by using a simple random-sampling design (equal probability). The households are selected by using a systematic random approach, in some cases every 4th household or every 6th household or any other interval.

The sample size is not fixed. The number of unions in both intervention and comparison areas are different. The number in the intervention thana increases with the decision of expanding the programme to more unions or decreases with the decision of discontinuing the programme in the intervention unions.

The number of unions in the comparison area was two for Keshabpur, three for Satkania, and one for Lohagara in 1999.

In both intervention and comparison areas, the sampling fraction was close to 0.15 in the Jessore areas whereas in the Chittagong area, it varied from 0.23 to 0.25.

Urban Areas

For the selected study areas, intervention and comparison, cluster-sampling design was followed. In each area, clusters of different sizes ranging from 20 to 60 were formed. The systematic sampling design of every 8th cluster was used. In the actual operation, the sampling fraction was found to be 0.286 for Zone 3, 0.131 for Zone 7 of Lalbagh thana, and 0.134 for Sher-e-Bangla Nagar for the slum population.

Determination of sample size for intervention and comparison areas

The theoretical framework for determining the sample size of both intervention and comparison areas has been discussed in Appendix C of the project document developed by James F. Philips. The salient features of the framework are discussed in the section to follow.

The sample surveillance system has been developed and implemented for monitoring changes. Periodic sample surveys linking the surveillance will be carried out to test the effects of interventions. In such situations, baseline and longitudinal surveys are essential to understand the impact of the project over time.

The design first provides the sample size for the intervention areas and comparison areas. The sample size of the intervention areas is first allocated to sample thanas and then to selected unions within selected thanas.

The formula used for the determination of the sample size was:

$$m_0^1 = \frac{Z^2 pq}{d^2} = 5991 \text{ for } Z = 2.58 \ (p \le .01),\ d = .01 \text{ and } p = .1)$$

a plausible assumption for crude death rate (CDR) or contraceptive prevalence rate (CPR). The allocation to Sirajganj thana and Abhoynagar thana (Noapara) has been made as follows. It was decided to include 4 of the 9 unions in Sirajganj, giving first stage fraction .4444, in Abhoynagar, the first stage fraction is 0.5.

The total number of households was 33,793 in Sirajganj, 27,062 in Abhoynagar, and 60,855 for the intervention area.

$$mo = \frac{m_o^1}{1 + m_o^1 / MO} = 5454 \quad \text{where} \quad M_o = 60855$$

The overall sampling fraction = $5454/60855 = 0.0896$

The allocation of sample size to thanas was done, so that sampling within thanas can produce an equal probability of a household being selected. Thus,

$f = f_{11}.f_{12} = f_{21}.f_{22}$ where $f=0.0896$, $f_{11}=.44$, $f_{21}=.5$.

Thus, the union fraction for Sirajganj = $f_{12} = \frac{f}{f_{11}} = 0.2037$

Thus, the union fraction for Abhoynagar = $f_{22} = \frac{f}{f_{21}} = 0.1792$

The above scheme leads to proportional allocation. The sample size in Sirajganj and Abhoynagar was determined on the basis of

$$\frac{mo}{Mo} = \frac{m_1}{M_1} = \frac{m_2}{M_2} = .0896 \quad \text{where} \quad \begin{array}{l} m_1 + m_2 = m_0 \\ M_1 + M_2 = M_0 \end{array}$$

Thus, the sample sizes were:

m_1 = sample size for Sirajganj = 3,029 (.0896. M_1)

m_2= sample size for Abhoynagar = 2,425 (.0896. M_2)

The document does not, however, mention how the allocation has been made to selected unions in each selected thana. But, in practice, a systematic random-sampling technique was followed to select households within unions.

To determine the sample size, the paper used the CDR, and elaborated further that the sample size should provide information about other events, such as neonatal mortality. Assuming a birth rate of 30 per 1,000 population, and also the death rates of infants, we can use the sample data to study the impact of intervention on infant and neonatal mortality over a stipulated period.

In the actual allocation, the selection was carried out by using either every 6th household (sampling fraction=0.17) at or every 4th household (sampling fraction=0.25) for the rural areas and 0.28 or 0.13 in the urban areas. The basis for such an allocation has not been documented for the project sites in Chittagong district.

Observations

Table 2 provides some basic characteristics of study areas. Using the data of Table 2 observations are made separately for rural and urban areas.

Rural Areas

Abhoynagar is one intervention area with 8 unions. At the outset, 4 unions were brought under the intervention. The corresponding comparison areas were 2 unions from Fultala which were dropped in 1989. Subsequently, 2 unions from Keshabpur and 2 unions from Bagherpara thanas, originally selected for field-testing of FWA density in 1986, began to serve as a comparison area. The total unions in the comparison area were equal to the number of unions in the intervention area. However, the total number of households covered in the comparison areas was higher (about 13%) than that in the intervention areas. The variation was due to be difference in the size of thanas and unions.

Changes have been made over time. Bagherpara thana has been excluded in 1999. One more union in Abhoynagar has been added to make a total of 5 unions. Due to inclusion of one more union and also due to substitution for the drop-out houses, the total number of sample households increased by 25% in 1999 over 1998. There is a substantial change in the sampling fraction too.

Mirsarai was previously the only intervention thana, and Satkania was the comparison thana. The surveillance has been expanded to Patiya intervention area in 1998 and Amirabad union of Lohagara thana in 1999. Lohagara now serves as the comparison area for Patiya. There have also been expansions in Mirsarai and Patiya. Two more unions were added in Mirsarai and 3 unions in Patiya. As regards the numbers of households, the difference is big. The total number of households in both the intervention thanas (31,922 in Mirsarai, 14,725 in Patiya) was quite big compared to the comparison thana (9,956 households). Satkania is being used as the comparison thana for intervention in Mirsarai.

A marked variation has been observed in respect to eligible women per household, contraceptive acceptance rates (CAR), infant mortality rate (IMR) between the intervention and comparison areas, and between unions within a thana. The sample size itself might be responsible for some of these variations.

Another remarkable observation was the variation of sampling fraction among the unions within each thana and also the change over time. The changes are due to:

i. expansion of programme
ii. drop-out of initial sample households
iii. both in-and out-migration
iv. inclusion of new households to match
v. use of a different selection procedure for the comparison and experimental areas.

Urban Areas

Lalbagh

Lalbagh zone 3 was an operational area of both Urban Health Extension Project (UHEP) and Concern Women for Family Planning (CWFP), and had a mixed population with about 21% slum-dwellers. This is why zone 3 was selected for the surveillance system.

Zone 3 was divided into 4 areas: 3 Intensive Areas (IA) and 1 Non-intensive Area (NIA). The IAs are areas of the CWFP. The areas were divided into clusters of different size.

For each IA, a total of 40 clusters, 15 slum and 25 non-slum clusters, and for each NIA, a total of 40 clusters, 15 slum, and 25 non-slum clusters were selected.

The sample size was determined as mentioned in the paper, "on the basis of the experience of the Urban Surveillance System (USS) of UHEP, it was assumed that a sample of 1,500 households from about 6,000 households, meaning sampling fraction 0.25, would be a representative sample to do the specified research". The cluster size, 40 households, has been used. But, it is not clear why the IA was divided into 3 small IAs.

Sher-e-Bangla Nagar

The ORP launched its intervention in the catchment area of the Government Outdoor Dispensary (GOD) in December 1997. With the intention of measuring the impact of the intervention, the Project decided to bring the adjacent area of the GOD into the surveillance system. The exit interview data revealed that 75% of all the clients and 24% of all the clients come respectively from Ward 41 and 40. In view of the above, Ward 41 and part of Ward 40 were brought into the surveillance system. Ward 41 is the largest slum within the Dhaka City Corporation.

The underlying rationale used in developing the design is very close to that used for Lalbagh urban areas. The study area has been divided into a number of clusters, each with a varying size, ranging from 20 households to 60 households. These clusters are categorized as slum clusters or non-slum clusters depending on the number of permanent structures or katcha/semi-pucca structures of households. If a cluster has predominantly pucca houses, it is non-slum cluster, otherwise it is a slum cluster. Every 8th cluster is selected using a systematic sampling design for selection of cluster which ensures proportional allocation.

Of the 515 clusters, 348 slums, 167 non-slum, and every 8th household cluster result in 64 clusters in the sample (44 slum, 20 non-slum), giving slum and non-slum the proportion of 70:30. The number of households in each strata may or may not be in strict proportion to the number of clusters because of varying sizes of clusters. The study area has 22,143 households, and the number of sample households stands at 2,981, giving a sampling fraction of 13.4%.

A constant cluster-size approach has many advantages, from theoretical as well as an operational point of view. It is, therefore, recommended that the constant cluster size be used.

If the cluster sampling design is used instead of a simple random-sampling design, it is necessary to take into account the design effect (DEFT). The design effect for any estimate is defined as the ratio between the standard error using the given sampling design and the standard error that would result if a simple random sample had been used. In Bangladesh, for socioeconomic and demographic estimators, the DEFT is generally greater than one (Mitra *et al*., 1997).

AG Turner, Sampling Specialist of the UN Statistical Division, New York, prepared a report titled "A modified cluster sampling technique for goal monitoring surveys." It was found that, for EPI design, the DEFT used was 2, while for the modified EPI design the suggested DEFT was 1.75 (UNICEF, 1994).

If the cluster sampling design is used instead of a simple random sampling for determining the sample size for cluster sampling, the sample size for Sample Registration System (SRS) should be multiplied by the design effect, which is taken to be approximately 1.75 as per the suggestion given above.

Parameters/variables used in determining the sample size

Parameters/variables: CPR and CDR were used for determining the sample size.

Table 2. Comparison of basic characteristics of intervention and comparison areas

Mirsarai: Intervention site

Unions	HH	CAR	IMR	ORP sample size	
				HH	% = f
Dhum	2632	49.7	74.7	658	25.0
Durgapur	3374	54.1	36.9	844	25.0
Mithanala	4049	57.7	45.9	1012	25.0
Mayane	3017	61.2	24.3	754	25.0
Haith Kandi	3146	58.6	28.9	787	25.0
Hinguli	5568	55.6	30.7	1389	25.0
Mirsarai	4528	61.6	36.0	1132	25.0
Total	**26314**	**57.7**	**39.8**	**6576**	**25.0**

Satkania: Comparison site

Kanchana	3235	62.0	48.5	808	25.0
Keochia	3148	45.0	20.1	787	25.0
Eochia	2659	56.5	21.4	626	24.4
Total	**9042**	**53.1**	**29.1**	**2260**	**24.8**

Patiya: Intervention site

Kusumpura	4231	56.9	38.1	905	21.3
Dhalghat	3123	63.8	27.2	667	21.9
Haidgaon	3536	62.5	49.2	749	21.1
Kharana	2229	53.8	46.4	475	21.3
Barolia	2541	55.2	20.0	600	24.1
Total	**15660**	**59.9**	**37.0**	**3431**	**22.1**

Table 2 *(Contd.)*

Table 2. *(contd.)*

Lohagara: Comparison site

Unions	HH	CAR	IMR	ORP sample size	
				HH	% = f
Amirabad	5549	53.9	33.3	1392	25.4
Total	**45186**	**57.2**	**34.9**	**1392**	**25.4**

Abhoynagar: Intervention site

Rajghat	4986	66.9	42.4	831	17.1
Paira	2392	71.2	42.7	389	16.2
Sreedharpur	3361	68.5	55.1	531	16.2
Siddipasha	3397	71.3	23.0	568	17.2
Bagutia	3597	71.3	76.7	583	16.0
Total	**17733**	**70.7**	**40.3**	**3601**	**16.5**

Keshobpur: Intervention site

Sagardari	3924	73.4	10.7	654	17.1
B. Kati	4038	68.8	26.0	673	17.1
Total	**7962**	**69.5**	**28.8**	**1977**	**17.1**

Lalbagh: Intervention/Comparison

Lalbagh Zone 3	20350	NA	NA	5189	25.50
Lalbagh Zone 7	15108	NA	NA	1754	11.60
Sher-e-Bangla Nagar Ward 40, 41	22143	NA	NA	2981	13.40
Total	**57601**	NA	NA	**9924**	**17.20**

NA = Not available; HH = Household; CAR = Contraceptive Acceptance Rate
IMR = Infant Mortality Rate.

A short review of the documents pin-points the following important issues which need special attention:

1. Specification of both intervention and comparison areas
2. Selection of unions within the intervention and comparison areas
3. Choice of study design in operations research
4. Determination of sample size
5. Allocation of sample to unions, particularly in comparison thana
6. Formation and selection of clusters in urban areas
7. Drop-outs and turnover
8. Out-migration to other areas

9. In migration from other areas
10. Split-up of houses
11. Change in the composition of CMWRA with time
12. Change in the composition due to marriage, divorce, separation, mortality, etc.
13. Change in the headship of households
14. Participants in programme areas
15. Non-participants in programme areas.

These issues will be covered in the following sections.

1. Specification of both Intervention and Comparison Areas

The main purpose of the Operations Research Project is to improve quality, efficiency and effectiveness of service-delivery in the national health programmes by undertaking full-cycle operations research. To measure the impact of any intervention, it is necessary to develop an appropriate study design. The purpose of selecting the comparison areas is to compare the changes in the intervention area relating to the changes in the comparison area over time. The rationale for selection has been discussed in the section, "Choice of Design in Operations Research."

The intervention areas and the comparison areas in the surveillance system over the years are given in page 6 (Study areas) of the report.

2. Selection of Unions within Intervention and Comparison Areas

It was observed that not all the unions in a thana were intervention areas at the same time. The starting dates of interventions in different unions were different. Moreover, the interventions were not exactly same in unions with different starting dates. In view of the above, it is suggested that each union of the project be considered as an independent intervention unit.

There should be at least one comparison area for the same intervention programme started simultaneously in one or more intervention unit(s). In the past, the comparison areas were not selected as per the rules.

Ideally, there should be one comparison area for each intervention area. The comparison area at the onset of the intervention programme must be similar to the intervention area, in respect to the indicators, for which the difference in the changes will be observed over time. The location of the comparison area should be within the same district, so that both the areas have the same cultural context.

One comparison union for each intervention union would incur a huge cost. The cost factor leads us to consider one comparison thana for several similar intervention unions located not necessarily in the same thana. The unions of the thanas are more often than not heterogeneous in respect of the indicators of our interests. It is expected that the sample respondents represent the low- medium- and high-performing areas. It is, thus, recommended that three unions--one low, one medium, and one high-performing unions--constitute the comparison area. The allocation of sample to unions should be in proportion to the number of households.

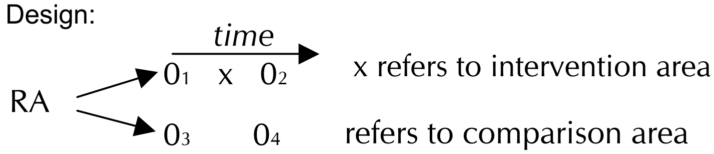
3. Choice of Study Design in Operations Research

A full discussion on the study design covering various issues is considered important to recommend an appropriate design for surveillance system in operations research.

Most commonly used designs in family planning ORP are true experimental designs. If a random assignment is not possible, then it is called quasi-experimental.

The notations used are those developed by Cambell and Stanley (1996).

True Experimental Design:



In this design, all subjects are randomly assigned (RA) to both intervention and comparison groups. Initial measurements are: 0_1 and 0_3 for intervention and comparison groups respectively; O_2 and O_4 refers to measurements for intervention and comparison areas respectively after the intervention.

Hypothesis (a) $0_1 = 0_{3,}$
(b) $0_4 < 0_2$ in cases like CPR
$0_4 > 0_2$ in cases like mortality.

True experimental design: It is one of the strongest in terms of controlling for validity.

Gross outcome = $(0_2 ! 0_1)$=Effect of X+ Effect of other factors.

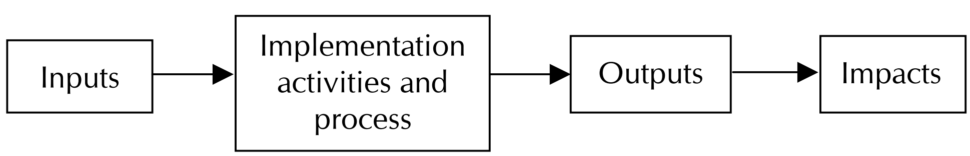
Effect of intervention = Effect of X=Gross effect ! Effect of other factors.

$= (0_2 ! 0_1) ! (0_4 ! 0_3)$

$= (0_2 ! 0_4) ! (0_1 ! 0_3)$

$= (0_2 ! 0_4)$ if $0_1 = 0_3$ under the hypothesis (a).

The simplified model of the project implementation process is:



Implementation refers to the transformation of inputs through a set of technical and organizational systems and procedures that produce a specified output and impacts. Inputs are defined as financial, human, and material resources available to implement the project as planned. Outputs are the services or products that a project delivers to a target population to produce the expected impact.

Assessing the Efficiency of Project Implementation

Five measures of project performance can be used for comparing the performance of different components.

1. Speed of implementation: Delays increase cost. This is measured through Gantt Charts.
2. Cost of implementation: Compare actual cost with the budget estimate or with the cost of similar projects.
3. Quality of final product/services: This is measured through ranking/or imputed value.
4. Accessibility of services to intended beneficiaries.
5. Beneficiaries - vis-a-vis - target group.
6. Replicability of the project.

Quasi-experimental Design for Estimating the Size of Project Impact

Quasi-experimental Design (QED)

Operations research is mostly carried out to obtain answers to questions of whether interventions (programme) have produced their intended impacts, or whether they have benefited intended target groups.

QED is designed to measure changes in the intervention group minus the changes in the comparison group, i.e. the general trend.

The general trend is the change in the comparison group = $O_{C2} - O_{C1}$ where C= comparison group, O_{C1} measures the variable level in comparison group before the intervention, O_{C2} measures the variable level in comparison group after the intervention.

Gross intervention outcome = $O_{I2} - O_{I1}$ where I = intervention group
Net Intervention outcome = $(O_{I2} - O_{I1}) - (O_{C2} - O_{C1})$
= Gross intervention outcome - the general trend

This implies that a minimum of 4 observations, 2 in each group--one before and the other after intervention--is required to determine whether the change occurred due to the intervention alone.

To know whether the observed change is statistically significant, it is required to determine the sample size and the design following tenets of probability sampling.

To determine the trend in both the groups, several observations on both the groups, particularly on comparison groups, are recommended. A detailed discussion on sampling design has been provided in the following section.

Multi-round Surveys

Multi-round longitudinal surveys provide a basis for making estimates of parameters (indicators) not only for the existing period but also for the change that has taken place since the previous observation period and also of the average over a given period.

Given the data from a series of samples, there are three kinds of quantities for which we may wish estimates:

i. The change in Y from one occasion to the next (change)
ii. The average value of Y over all occasions (average of sum)
iii. The average value of Y for the most recent occasion (current estimate)

An interesting question to consider is: should the same sample be used on all occasions, or a completely new sample, or a mixture of the old and new?

Suppose we are free to retain or alter the composition of the sample, and that sample size remains same on all occasions, let us consider the following:

If observations on the same unit are taken on two occasions, say y_{2i} and y_{1i}, then if the change is measured by $d_1 = y_{2i} - y_{1i}$ then $v(d_{1)}) = s^2 + s^2 - 2l\, s^2$, l is correlation-coefficient and generally +ve and high. But if the change is measured by

$d_2 = y_{2i} - y_{ij}$ i.e. two different units are used; $v(d_2) = s^2 + s^2$, $COV(y_{2i}\, y_{ij}) = 0$
$v(d_2) > v(d_1)$

i) Thus, regarding replacement policy, we can say that for estimating the change, it is better to retain the same sample throughout all occasions. This implies the use of a panel sample for estimating the change.

The overall mean for the two occasions

(a) when the same unit is used on both the occasions

$$í_1 = (y_{2i} + y_{1i}) / 2, \quad v(í_1) = \frac{s^2 + s^2 + 2\ell s^2}{4}, \ell > 0 \textit{ and high}$$

when two different units are used

$$í_2 = (y_{2i} + y_{1j})/2, \quad v(í_2) = \frac{s^2 + s^2}{4}$$

ii) Thus, for estimating the average over all occasions it is best to draw a new sample from the remaining on each occasion.

Current Estimate

One unit : y_{1i} is any unit on first occasion

$v(y_{1i}) = s^2$

y_{2j} is the any unit on second occasion

$v(y_{2j}) = s^2$

Two units: $í_1 = (y_{1i} + y_{ij})/2$, $V(í_1) = 2\ s^2/4$

$í_2 = (y_{2i} + y_{2j})/2$, $V(í_2) = 2\ s^2/4$

$í_3 = (y_{2k} + y_{2l})/2$ $v(í_3) = 2\ s^2/4$

$í_2$ and $í_3$ have an equal precision.

iii) Thus, an equal precision is obtained either by keeping the same sample or by changing on every occasion. It is necessary to examine whether the replacement of part produces a better result than that for no replacement or full replacement. This has been investigated in the next section.

Sampling on two occasions

Assumption

The sample size n remains same on both the occasions, $s_1^2 = s_2^2 = s^2$, no change in the population variance.

Design = simple random sampling

The population values are:

y_{11} y_{12} .... y_{1N} on first occasion with mean $í_1$
y_{21} y_{22} .... y_{2N} on second occasion, with mean $í_2$

Let us consider two samples of size n and the composition is as follows:

(i) y_{11} y_{12} .... y_{1m} the m units of the first sample are common in second sample
y_{21} y_{22} .... y_{2m} are the values on the second occasion

(ii) the remaining u= n-m units of the first sample are replaced by the new units drawn randomly from (N-n) units

Thus, y_{1m+1}, y_{1m+2} .... y_{1m+u} are u units of the first sample. The replaced u units are:
y_{2m+1}, y_{2m+2} .... y_{2m+u}

The means

$$\bar{Y}_{1m} = \frac{1}{m}\sum_{1}^{m} y_{1i}, \qquad \bar{Y}_{1u} = \frac{1}{u}\sum_{1}^{u} y_{1u}, \qquad \bar{Y}_{1} = \frac{m\bar{Y}_{1m} + u\bar{Y}_{1u}}{n}$$

$$\bar{Y}_{2m} = \frac{1}{m}\sum_{1}^{m} y_{2i}, \qquad \bar{Y}_{2u} = \frac{1}{u}\sum_{1}^{u} y_{2u}, \qquad \bar{Y}_{2} = \frac{m\bar{Y}_{2m} + u\bar{Y}_{2u}}{n}$$

Estimate of $\bar{Y}_2$

(a) Based on new u units

unmatched: $\bar{Y}_2 u = \frac{1}{u}\sum Y_{2u}$ variance = $s^2/_u$ = $^1/W_1$

Matched (a) Double sampling regression estimate

$\bar{Y}_{2lr}$= í$_{2m}$ + b(í$_1$ - í$_{1m}$) with variance = $\frac{s^2(1-\ell^2)}{m} + \frac{\ell^2 s^2}{n} = \frac{1}{W_2}$

(b) Double sampling for difference estimate with k=1 = $^1/_{w2}$

í$_{2d}$ =(í$_{2m}$ - y_{1m}) + í$_1$ with variance $s^2/_m$[1+(1-) (1-2l)] = $^1/_{w2}$
where (= $^m/_n$), l = correlation-coefficient

<u>The combined estimate</u> of the matched and unmatched samples

The best combined estimate is obtained if weighted by respective w_1 and w_2

$$\bar{Y}_{2(lr)} = \frac{W_1\bar{Y}_{2u} + W_2\bar{Y}_{2lr}}{W_1 + W_{2(lr)}} \text{ with variance } \frac{1}{W_1 + W_{2(lr)}} = \frac{s^2(n-u\ell^2)}{n^2 - u^2\ell^2}$$

$$\bar{Y}_{2d} = \frac{W_1\bar{Y}_{2u} + W_2\bar{Y}_{2d}}{W_1 + W_{2d}} \text{ with variance } \frac{1}{W_1 + W_{2d}} = \frac{s^2}{n}[1+(1-2\ell)\mu][1+(1-2\ell)\mu^2]^{-1}$$

The best value of u and m are, in case of regression

$$u = \frac{n}{1+\sqrt{1-\ell^2}}, \quad m = \frac{n\sqrt{1-\ell^2}}{1+\sqrt{1-\ell^2}}, \quad u + m = n$$

in case of difference

$$u = \frac{n}{1+\sqrt{2}\sqrt{1-\ell^2}} \;,\; m = \frac{n\sqrt{2}\sqrt{1-\ell^2}}{1+\sqrt{2}\sqrt{1-\ell^2}}$$

$$V_{opt}(\overline{Y}_{2d}) = \frac{s^2}{n}[\frac{1}{2} + \sqrt{\frac{1-\ell}{2}}]$$

$$V_{opt}(\overline{Y}_{2(lr)}) = \frac{s^2}{2n}\left[1+\sqrt{1-\ell^2}\right]$$

It is seen that $V(\overline{Y}_{2\ell}) = \frac{s^2}{n}$ when $u = 0$ or $u = n$

$$V(\overline{Y}_d) = \frac{s^2}{n} \text{ when } u = 0 \text{ or } u = n$$

Thus, for the current estimate, retaining the same sample or replacing the sample by the same sample on the second occasion gives the same precision.

If part is retained, the remaining is replaced, i.e.

$$m \neq n, m \neq o, u \neq o, u \neq n,$$

The formula for u and m and v:$_{opt}$(í$_2$) shows that the optimum or best values depend on l, the correlation-coefficient.

Table 3 shows, for a series of l, the optimum per cent which should be matched and relative gain in precision as compared with no matching.

Table 3. Optimum percent matched and gain in precision

l	Optimum percent matched	Gain in precision
.5	46	7
.6	44	11
.7	42	17
.8	38	25
.9	30	39
.95	24	52
1.00	0	52

Source: Cochran WG. Sampling techniques, New York: Willey, 1960:287.

The best m never exceeds 50 per cent and decreases as l increases for l less than 0.7, the gain is very small. When l is 1, the formula gives m=o which lies outside the preview of our assumption, since m has been assumed reasonably high. The correct procedure in this case is to take m=2, then variance is minimum, and also gain is the maximum.

Estimation of change

The best linear unbiased estimator (Des Raj) is

ì$_{2(opt)}$ = a(ì$_{1u}$- ì$_{1m}$)+c ì$_{2m}$+(1-c) ì$_{2u}$

ì$_{1(opt)}$ = b(ì$_{2u}$- ì$_{2m}$)+d ì$_{1m}$+(1-d) ì$_{1u}$

$$\hat{\Delta} = \overline{Y}_{2(opt)} - \overline{Y}_{1(opt)} = \frac{1}{1-\mu\ell}[\mu(1-\ell)(\overline{Y}_{\overline{2u}} - \overline{Y}_{1u}) + \lambda(\overline{Y}_{2m} - \overline{Y}_{1m})$$

$$V(\hat{\Delta}) = \frac{2(1-\ell)^2}{n(1-\varpi\ell)}, \text{minimum when } \mu = 0,$$

This points to **complete matching of the sample on the two occasions for making estimates of the change,** and leads to the choice of panel sample for surveillance system.

Estimation of mean on two occasions

$$\overline{Y} = (\overline{Y}_{2(opt)} + \overline{Y}_{1(opt)})/2 = \frac{1}{2(1+\ell\mu)}[\mu(1+\ell)(\overline{Y}_{2u} + \overline{Y}_{1u}) + \lambda(\overline{Y}_{2m} + \overline{Y}_{1m})$$

$$V(\overline{Y}) = \frac{1}{2n}\frac{(1+\ell)s^2}{1+\mu\ell}, \text{ If } \ell \text{ is positive, V}(\overline{\text{Y}}) \text{ becomes smallest when } \lambda = 0,\ \mu = 1$$

This means that taking an independent sample at the second occasion provides the better result.

The panel study analyses based on mixed samples and independent samples, have been further elaborated in the next section.

Related (Panel), Independent, and Mixed Samples

Panel Sample

If same units (subjects) of the first sample are reinterviewed in a second survey, they are treated as a panel sample. To use a panel sample, it is necessary to prepare maps of the precise location of houses or to use some other similar devices to ensure that the original households (subjects) can be easily relocated. At times it will be difficult to identify the same households two or three years later since the area may have new houses, streets/approach roads may be different, and even house members may be changed. In some areas, particularly in slum areas, houses do not have addresses and approach roads, hence landmarks are used for referring people to a particular location.

Besides, household composition and the name of the household head can change. For a panel sample, the impact of drop-out is important. In poor areas, particularly in urban slum areas, the drop-out rate is high. In the case of moderate or high drop-out, the impact is also considerable, and must be considered. It is necessary to consider the effects that the decrease will have on the representativeness of the final sample. It is therefore, advisable to analyze the data of the first occasion at the end of the second survey and to compare the characteristics of the households that moved out with the characteristics of households that have been retained in the community, to determine whether the area has retained individuals (household) of a particular ilk. The change may sometimes be due to a programme, for example, if rich people moved out, the incomes of the area, as worked out from the retained sample, would underestimate the average income of all families at the time of the first survey. Thus, changes in the distribution of characteristics must be taken into account when interpreting the findings of an analysis that deals only with units remaining in the community.

Independent Samples

In this design, a second sample is selected for the second survey. Other than sampling error, no additional sampling problems exist. This design is used because it has current estimates.

Mixed Sample Design

This design is most complicated to administer. It follows the same procedure as the panel study except that replacements are made for original families/subjects who are no longer available for interview. The replacements are required for

i. individuals who left the locality
ii. difficulty in tracing their current address
iii. individuals who refuse to continue to participate in the study
iv. clusters demolished from time to time.

In addition, newcomers to the locality are excluded. The problem is how to replace or include new comers. The problem is difficult.

A better approach is to select a new sample for the replacement. The sample should be selected from all households/subjects who moved to the community since the time of the previous survey. But with the surveillance system, we are more interested in the changes as well as the current status.

The drawbacks of a mixed sample are related to the estimation of ∂ sample size, particularly size of a new sample - How many of the old samples should be retained and how many new units to be included?

One suggestions is: (i) a panel sample for change, and (ii) a independent sample for new comers be drawn. Separate estimates of the required sample size for both the groups would be necessary, since one would have to be sure that each sample is representative of its own group.

A threadbare discussion on the design in operations research recommends that the panel sample is most appropriate for surveillance system in operations research.

4. Determination of Sample Size

The main determinants of s sample size are the variance of the indicator being estimated, the precision required of the sample estimate, and the number of sub-groups for which an estimation is needed. Cost is another consideration in determining the sample size.

It is important to know the procedures used for determining what sample size is required to estimate the

i. difference between proportions, and
ii. difference between means.

Difference between proportions

The problem is to determine the sample size in both intervention and comparison groups to be 95% confident that the observed difference was not due to the chance. Generally, 5%, 7½% and 10% difference are considered. The formula used is

$$n = \frac{4(0.75 + p_2 q_2)}{(p_2 - p_1)^2} = \frac{4}{(p_2 - p_1)^2}$$

Based on the difference of P_2-P_1, Table 4 has been prepared.

Table 4. Sample size required to be 95% confident so that an observed difference is statistically significant

Minimum difference (%) between project and control groups	Required sample size		
	Project	Control	Total
5	1600	1600	3200
7.5	711	711	1422
10	400	400	800
15	178	178	356
20	100	100	200

Source: Monitoring and evaluating social programme in developing countries. Washington DC: World Bank, 1994:383

Difference between means

If it is intended to test whether the observed difference between means of project and comparison areas are statistically significant, the formula used is (given equal variance in both the groups.)

$$n = \frac{4(S^2 + S^2)}{(p = \bar{x}_1 - \bar{x})^2} + 1$$

We need the knowledge of S^2. If n is >50, the precision of the estimate is fairly good.

Estimation of proportion

More often than not, programme managers are interested in knowing the level of the indicator with higher precision. In that case the sample size is given by

$$n = \frac{Z_x^2 PQ}{d^2} \text{ where } Z_x = 1.96 \text{ for } 95\% \text{ confidence level}$$

$$\text{d} = \text{margin of error}$$

$$= \frac{3.84PQ}{d^2} \quad Q = 1 - \text{P}$$

Therefore, the value of n depends on the proportion p and margin of error. For some variable, such as CPR, p is nearly equal to 0.5, and margin of error may be taken to 0.1, but for the child mortality rate where p=0.034, d should be smaller, either 0.01 or 0.02.

The ORP attaches greater importance to the indicators: IMR, CMR and/or under 5 mortality, immunization coverage rate, CPR, and proportion of pregnant women receiving antenatal care. Table 5 below gives the number of sample units to provide a given margin of error with 95% confidence level and also the number of households to be visited to cover the required sample units.

It is clear that for a given sample size different indicators will have different margins of error for a 95% confidence level. It is, thus, required to make a compromise between cost and margin of error. If a sample of 812 households is taken for any area, the margins of error for different indicators are:

i. 0.05 for IMR
ii. 0.017 for CMR
iii. 0.0266 for under 5 mortality
iv. 0.034 for CPR
v. 0.11 for proportion of pregnant women receiving antenatal care.

Table 5. Sample size required to be 95% confident so that the estimate will not have a margin of error more than the given one

Indicator	Sample size for d					Households required to cover for d				
	.01	.02	.03	.04	.05	.01	.02	.03	.04	.05
IMR P=.0822	2897	724	322	181	116	20279	5068	2254	1267	812
CMR (1-4) P=.0365	1350	338	150	84	54	2468	618	274	154	99
Under 5 mortality P=.1158	3932	983	436	246	157	5751	1438	638	360	230
CPR P=.5	9600	2400	1067	600	384	9357	2339	1040	585	374
Proportion of pregnant women receiving antenatal care P= .30	8064	2016	896	504	322	104832	26208	11648	6552	4186

It is also seen that the sample size of 812 will detect 7% difference between comparison and intervention groups with 95% confidence level (page 23, Table 4).

The above sample size is recommended when households are selected using simple random sampling. If cluster sampling design is used, the design effect should be taken into consideration. Generally, the design effect e=1.75 (page 12, Table 2). Then for urban areas, the sample households should be 1421 = 812 (1.75).

5. Allocation of Sample to Unions

Previously thanas were selected for both intervention and comparison areas. Allocation of samples to selected unions was made following a proportional allocation scheme.

In the proposed design, it is recommended that the union be the independent intervention unit (see section on selection of unions). The minimum sample size for the union (intervention unit) is shown in Annexure 1.

It is also recommended that one thana be selected as a comparison thana. For each comparison, three thana comparison unions would be selected. The rationale for the selection has been discussed earlier. The allocation of total sample size of the comparison thana to the selected three unions would be carried out following the proportional allocation scheme (Annexure 1).

6. Formation and Selection of Clusters in Urban Areas

The sampling design for urban areas has been the cluster-sampling design because it is easy to implement in the urban areas compared to simple random sampling.

The cluster size is recommended to be 40 households for 2003. The number of clusters for 2003 will be equal to the total number of households required to be covered in 2003 (giving provision for drop-outs) divided by cluster size 40. The number of clusters will remain same for other years during 1999-2003, but the cluster size will be higher because of the higher household number.

The procedures of constructing strata and also the selection of clusters in both intervention and comparison areas will remain same.

The allocated sample sizes for urban intervention and comparison areas are shown in Annexure 1.

7. Drop-outs and Turnover

Drop-outs are the important sources of errors in any statistical data-collection system. It is necessary to take into account the number of drop-outs and their impact on the sample size and on the estimate and its variance.

In longitudinal surveys, many units selected in the first years can not be covered in the second and subsequent years for interviews. Units which can not be covered at the subsequent interview for any reason are grouped as drop-outs, and units which can be covered are grouped as turnover. Thus, the initial sample equals the sum of drop-outs and turn overs.

n = d+t where n = initial sample
d = drop-out
t = turnover

The drop-out rate is defined as the ratio between the drop-out and the initial sample size.

$$\text{Thus,}\quad p = \frac{d}{n} X100 \quad \text{where} \quad p = \text{dropout rate}$$

The turnover rate is defined as the ratio between the number available for interview and the initial sample size.

$$\text{Thus,}\quad q = \frac{t}{n} X\,100 = \left(\frac{n-d}{n}\right) X\,100 = 100\text{ - P} \quad \text{where} \quad q = \text{turn over rate}$$

Thus, the smaller the number of drop-outs, the higher the turnover.

Sample designs are required to compensate for drop-outs. The reasons for drop-outs are many. In some cases, units move out, and in other cases it is not possible to relocate the original units (households/subjects) at the time of the second or subsequent interview, because some changed their addresses and names, change of household head and household composition has occurred, families have merged or split up, buildings are divided or combined, etc.

The impact of drop-outs or turnovers depends on the drop-out or turnover rates. Suppose a minimum sample of size n is required to obtain a given predetermined precision. If the drop-out rate is p, then, on the second occasion, the sample is reduced to $n.(1-p)<n$. Hence, to keep the sample size n at the second occasion, the sample size on first occasion must be n/1-p.

The drop-out rate is associated with socioeconomic issues. In poor areas, particularly in slum areas, the drop-out rate is high, and the impact is also considerable. It is necessary to consider the effects that the drop-out rate will have on the representativeness of the sample.

Effect of turnover (drop-out) rate on sample size

In case of an independent sample on every occasion, the drop-out does not arise. Hence the sample size on every occasion is the minimum number required for a given precision.

The turnover rate is very important for a panel sample. When a panel sample is used, what should be the initial sample size (on occasion 1) to ensure a minimum required sample size n_t on t th occasion (i.e. after t-1 years), given a p% yearly drop-out.

We know $n_t = n_1(1-p)^{t-1}$, Here p = drop-out rate
or $n_1 = n_t/(1-p)^{t-1}$

In case of a panel sample, the sample size n_1 decreases to $n_1(1-p)$ on second occasion, $n_1(1-p)^2$ on 3rd occasion, and so on.

In case of a mixed sample, the sample size determined for the 1st occasion, taking into account drop-out, remains the same on all occasions, but the drop-out is being replaced every time. A comparative picture is shown in Table 6.

Table 6. Number of interviews required on the first, second and third occasions to ensure a sample of size 400 (hypothetical) when p=0.25

Sample design	First occasion	Second occasion	3rd occasion	Total
Mixed	711	711	711	2133
Panel	711	533	400	1644
Independent	400	400	400	1200

Protection for Drop-outs

Data in Annexure 3 show that the annual drop-out rate in rural areas is very small, ranging from 1.4 to 1.7 per cent. In urban areas, the drop-out rate is very large, being highest in urban slum areas, 25% compared to 17% in non-slum areas.

To have a minimum sample household for each union in the project areas by 2003 to be 812 for rural areas and 1,421 for urban areas, the sample household for the preceding year should be corrected with the corresponding annual drop-out rate up to the year 1999.

The formula for different years would be:

<u>Rural households</u>

$$n_{1999} = \frac{812}{(1-p)^4}, \text{ where p is the dropout rate}$$

$$n_{2000} = \frac{812}{(1-p)^3}$$

$$n_{2001} = \frac{812}{(1-p)^2}$$

$$n_{2002} = \frac{812}{1-p}$$

$$n_{2003} = 812$$

<u>Urban households</u>

$n_{1999} = 1421(1\text{-}p)^{-4}$

$n^{2000} = 1421(1\text{-}p)^{-3}$

$n_{2001} = 1421(1\text{-}p)^{-2}$

$n_{2002} = (1421)(1\text{-}p)^{-1}$

$n_{2003} = 1421$

The sample size for each area has been worked out and presented in Annexure 1.

8. Out-migration to Other Areas

Both out-migration (moved out from an area) and in-migration (moved in from another area) of households and subjects are common phenomena. Both events depend on many factors. The extent of out-migration in rural areas may be different from urban areas. Out-migration is the main source of drop-outs. The effect of drop-out on the study and the protection for drop-outs have been discussed earlier.

If out-migration is very small compared to the initial and final sample sizes, there is not much to worry about. But if the decrease in the sample size is big, it then demands a separate treatment. It is necessary to consider the effect the decrease will have on the representativeness of the final sample. It is, therefore, advisable to analyze the data of the first occasion at the end of the second survey and to compare the characteristics of the households that moved out with the characteristics of the households that have been retained in the community to determine whether the areas have retained households (subjects) of a particular ilk (details are given in the section on panel samples). If the difference between households that moved out and households that retained in is substantial, the change should be measured based on only households (subjects) that have retained.

9. In-migration from Other Areas

New households (subjects) move in the study area as some move out of the study area. If the number of such category is small, the issue may be ignored. But more often than not, the case is different, particularly in urban areas. The panel sample does not take account the new-comers, but in the independent sample and in the mixed sample designs, they are represented in the subsequent sample.

The new-comers do not move at the same time. The move-in is spread overtime. The problem is how to replace or include the new-comers. In our suggested design, we recommended that a new sample be drawn every 5 years to account for the new-comers.

10. Split-up of Household

Split-up of a household into two or more units is another problem in longitudinal studies. The problem is which units should be considered in subsequent interviews. The issue has been and still is controversial. It is always advisable to combine all the split-up household and treat them as one unit. But the combination process is not easy. In that case, the unit to which the household leader belongs may be considered for re-interview. If the household leader is not available (dropped-out), the remaining units may be considered.

11. Changes in Composition of CMWRA with Time

This issue is very important in cases of indicators based on CMWRA. Changes over time are due to crossing the boundary line of reproductive age and entry in the reproductive age. If the changes are similar or at least comparable in both intervention and comparison areas, adjustment may not be necessary; otherwise, adjustment for these changes is advisable.

12. Changes in Composition due to Marriage, Divorce, Separation, and Mortality

The importance of changes in the composition of population in the longitudinal study is quite evident. To isolate the impact of the intervention, it is necessary to take account for changes in composition in both comparison and intervention areas.

13. Changes in Household Headship

Change in headship is a rare event in Bangladesh. The change mostly takes place in case of death of the household head. In such cases, the household is retained in the sample. The issue of change of headship due to split-up of houses has been discussed earlier.

14 and 15. Participants and Non-participants in Intervention Areas

The households (subjects) in intervention areas may be classified into two groups: participants and non-participants.

In longitudinal studies, the size and performance of these two groups are very important. It is advisable that, in the analysis, these two groups are treated separately to understand the effectiveness of the intervention process.

Recommendations

The preceding sections provide an analysis of the various issues relating to the surveys and surveillance system for continuous monitoring and evaluating the ORP interventions. Based on the analysis, the following recommendations and the sample size for each intervention union and comparison area are put forward for consideration of policy makers.

1. Quasi-experimental, non-equivalent control group design may be continued. The surveillance should be carried out only in the intervention area and comparison area. The comparison area must be similar to the intervention area. The surveillance system is not applicable to non-intervention areas.

2. Each union of the project thana should be considered an independent intervention unit, since the project unions have separate programmes and also have different starting dates.

3. The minimum sample size for each union and control area has been determined at 812 households.

4. Eight hundred twelve households will be the final sample size for 2003, and the sample size for the preceding years has been adjusted for drop-outs and design effects.

5. Findings of the second year should be compared with those based on households, excluding the drop-outs.

6. Results of the previous year and characteristics of the retained households should be compared with drop-outs to see whether particular socio-demographic groups have left the area. If so, the analysis should be adjusted accordingly.

7. Allocation of the number of households to selected unions in the comparison areas should be carried out following a proportional allocation scheme.

8. Three unions--one high-performing, one medium-performing and one low-performing union--should constitute the comparison areas.

9. In all areas, the panel samples should be used, since the main objective of ORP is to measure the changes over time.

10. The panel sample will be retained for 5 years, provisionally up to 2003, and then a new panel sample will be drawn. The new panel sample will include both old and new households and be used for 5 additional years.

11. The criteria used for selecting project areas, intervention unions, comparison thanas, and unions in comparison thanas need to be properly documented.

12. In the base year, the indicators of the intervention and comparison unions should be equivalent as far as possible. The indicators used for the determination of areas should be highly correlated with programme variables.

13. In case of split-up houses, the household with the respondent in the previous survey should be retained, and the other split-up houses be considered as drop-out houses.

14. Some additional suggestions are that both panel sample for change and independent sample for new-comers (houses) should be used. In that case, separate estimates of the minimum sample size for both the groups would be necessary, since one would have to be sure that each sample is representative of its own group.

15. One comparison area for Dhaka city should be selected. As reported, there is no intervention activity in the Lalbagh area, and it may, therefore, serve the purpose of a comparison area for Sher-e-Bangla Nagar.

The findings suggest that a complete overhaul of the existing ORP data collecting system is necessary to make the system more effective. The recommendations given above are expected to be very useful.

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Annexure-I

Recommended sample size for 1999-2003 (household)

Thana	Unions	1999	2000	2001	2002	2003	Drop-out rate (%)
Mirsarai	Dhum	859	847	835	824	812	1.4
	Durgapur	870	855	840	826	812	1.7
	Mithanala	863	850	837	824	812	1.5
	Mayani	863	850	837	824	812	1.5
	Haitkandi	845	837	828	820	812	1.0
	Hinguli	863	850	837	824	812	1.5
	Mirsarai	863	850	837	824	812	1.5
	Total	**6026**	**5939**	**5851**	**5766**	**5684**	
Satkania Proportion to Total HH	Kanchana	284	280	276	272	268	1.5
	Keochia	305	300	296	291	287	1.5
	Eochia	274	270	265	261	257	1.5
	Total	**863**	**850**	**837**	**824**	**812**	
Patiya	Kushumpur	863	849	836	824	812	1.5
	Dhalghat	862	850	837	825	812	1.5
	Haidgaon	863	849	836	824	812	1.5
	Kharana	862	850	837	825	812	1.5
	Borolia	863	850	838	824	812	1.5
	Total	**4313**	**4248**	**4184**	**4122**	**4060**	**1.5**
Lohagara	Amirabad	863	850	838	824	812	1.5
Abhoynagar	Rajghat	870	855	840	826	812	1.7
	Paira	870	855	840	826	812	1.7
	Sreedharpur	870	855	840	826	812	1.7
	Siddipasha	870	855	840	826	812	1.7
	Bagutia	870	855	840	826	812	1.7
	Total	**4350**	**4275**	**4200**	**4130**	**4060**	**1.7**
Keshabpur (PPS)	Sagardari	440	432	425	418	411	1.7
	Bidananda Kathi	430	423	415	408	401	1.7
	Total	**870**	**855**	**840**	**826**	**812**	**1.7**
Sher-e-Bangla Nagar*	Ward 40	1982	1586	1269	1015	812	20
	Ward 41	1982	1586	1269	1015	812	20
Lalbagh*	Lalbagh	1982	1586	1269	1015	812	20
	Total	**5946**	**4758**	**3807**	**3045**	**2436**	
	Grand Total	**22368**	**21775**	**20557**	**19537**	**18676**	

Annexure-1 *(Contd.)*

* If SRS design is used. If cluster design, use the sample size of the next table.
Please see sampling methodology (70% vs 30%)
Lalbagh would serve as a comparison area.

Annexure-1 *(Contd.)*

Thana	Ward/ Zone	1999 House-hold (cluster size)	2000 House-hold (cluster size)	2001 House-hold (cluster size)	2002 House-hold (cluster size)	2003 House-hold (Cluster size)	Drop-out rate (%)
Sher-e-Bangla Nagar	Ward 40 and 41	2351 (98) 1118 (102) 3469	1881 895 2776	1505 716 2221	1204 573 1777	963 (40) 458 (40) 1421 (40)	20 20 20
Lalbagh	Lalbagh	3469 (96)	2776	2221	1777	1421 (40)	20

70% slum-dwellers, 30% non-slum dwellers for Lalbagh and
68% slum and 32% non-slum in Sher-e-Bangla Nagar may be considered.

The number of strata for each category is obtained by dividing sample households by the cluster size in 1999 or 2003 and is given in parenthesis.

Annexure 2

Sample list as of 01 March 1999

Field site	Name of union	Total no. of households	CMWRA	Population
	Dhum	656	571	3607
	Durgapur	864	763	4501
	Mithanala	1001	893	5561
	Mayani	747	670	4171
	Haithkandi	804	686	4458
	Hinguli	1291	1291	7212
	Mirsarai	1076	1076	5931
Mirsarai	**Sub-total**	**6439**	**5950**	**35441**
	Kanchana	820	764	4761
	Keocia	783	747	4826
	Eochia	626	626	3756
Satkania	**Sub-total**	**2229**	**2137**	**13343**
	Rajghat	955	938	4473
	Paira	563	537	2575
	Sreedharpur	820	853	4123
	Siddipasha	682	700	3566
	Bagutia	582	595	2879
Abhoynagar	**Sub-total**	**3602**	**3623**	**17616**
	Sagardari	1004	1009	4749
	Bidananda Kathi	1007	1008	4916
Keshabpur	**Sub-total**	**2011**	**2017**	**9665**
	Kushumpura	887	1000	5993
	Dhalghat	666	763	4142
	Haidgaon	738	781	4411
	Kharana	471	525	3072
	Borolia*	600	599	3619
Patiya	**Sub-total**	**3362**	**3668**	**21237**
	Amirabad*	1392	1392	8352
Lohaghara	**Sub-total**	**1392**	**1392**	**8352**
	Total of sub-totals	**19035**	**18787**	**105654**
Lalbagh	Lalbagh slum	2411	2411	11298
SBN	Ward 40, 41	2979	2110	14895
	Sub-total	**5390**	**4521**	**26193**
	Grand total	**24425**	**23308**	**131847**

* New unions

Annexure-3

Information on retention of sample households

a. Basic information for Mirsarai and Satkania

Rural

Mirsarai Union	**Starting date**	**Total no. of sample households**	**Sample households as on 31/03/99 retained**	**Annual drop-out rate (%)**
Dhum	31/12/94	640	604	1.4
Mithanala	31/12/94	988	928	1.5
Mayani	31/12/94	747	704	1.45
Haithkandi	31/12/94	781	755	1.0
Durgapur	31/05/95	837	795	1.7
Mirsarai	25/02/99	1076		
Hinguli	11/03/99	1291		
Satkania Union				
Keochia	31/12/94	768	725	1.4
Kanchana	30/06/95	805	771	1.5
Eochia	10/03/99	626	626	-
Urban: Union				
Slum	31/12/94	2240	736	26
Non-slum	31/06/94	3700		

b. Active households of Lalbagh Area

Year 1994 (September 1994 - Dececber 1994)

Active slum households: 2240
Active non-slum households: 3700

Year 1998 (October 1998 - December 1998)

Active slum-households: 736
Active non-slum households: 1717