The Sample Registration System: An Innovative System for Monitoring Demographic Dynamics*

The International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) has been at the forefront of the development of longitudinal systems for demographic surveillance. The Demographic Surveillance System from the Metlab study area is internationally recognized as a unique source of accurate and complete demographic data for a large rural population within a developing setting. In this paper, an overview is presented of a second demographic surveillance system – the Sample Registration System (SRS) – which has been in operation for six years in two other areas of rural Bangladesh.

Overview

The field operation

The SRS was developed at ICDDR,B to assess the demographic impact of the Maternal and Child Health – Family Planning (MCH-FP) Extension Project. That action-research project aims to improve health and family planning services in two rural subdistricts in Bangladesh by transferring service innovations from an ICDDR,B project in MatIab to the government service system. Barriers to the transfer of Matlab operations were the initial focus of the project; more recently, the focus has expanded to involve research on capacities of the public programme to undertaken systematic change and the development of health and family planning services.

* The authors of this paper are A.B.M. Khorshed Alam Mozumder, Senior Demographer, MCH-FP Extension Project, International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Michael A. Koenig, Scientist and Population Council Associate at ICDDR,B; James F. Phillips, Senior Associate, Centre for Policy Studies, the Population Council, and Shahed Murad, formerly Statistical Officer with the Extension Project at the time this paper was prepared. The Sample Registration System is a component of the MCH-FP Extension Project; the latter is funded by grants to ICDDR,B from the United States Agency for International Development (USAID). Collaborative work on developing the SRS has been funded by grants to the ICDDR,B and the Population Council from USAID.

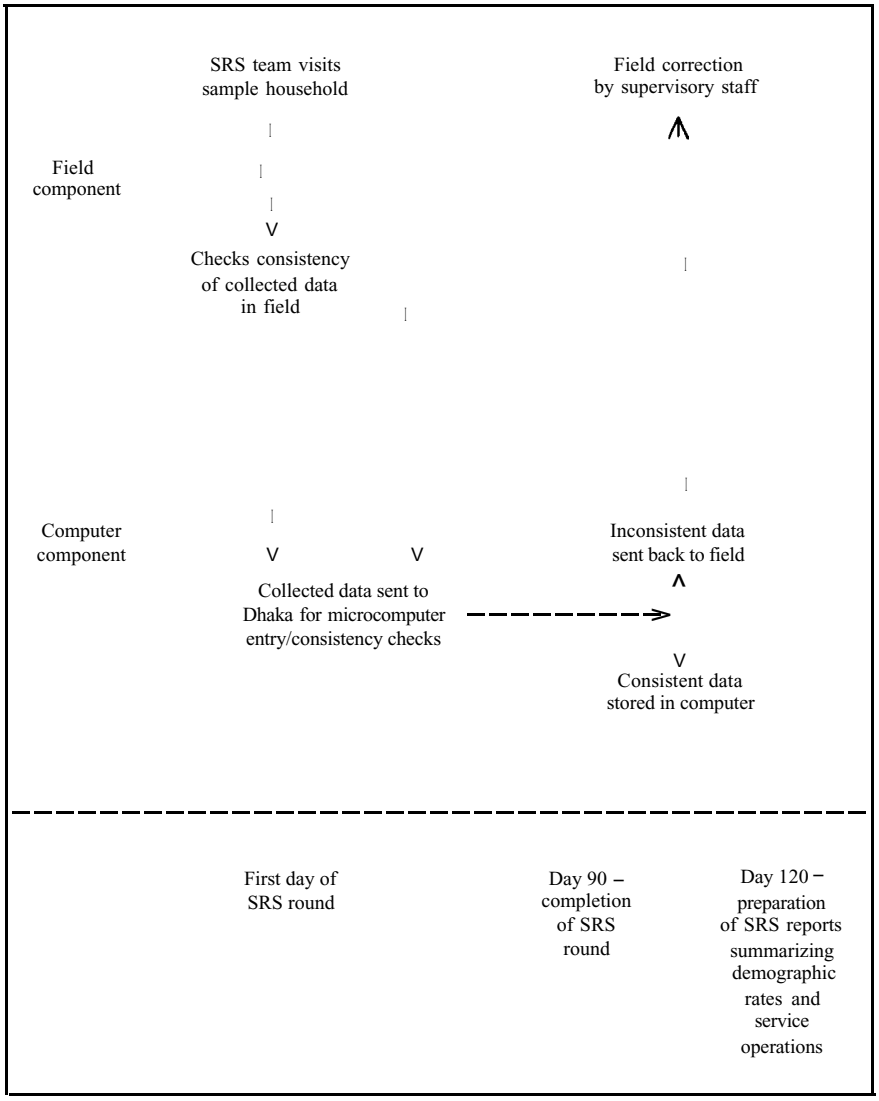
Originally established in 1982, the SRS operates in field sites in parts of four *upazila* (subdistricts consisting of approximately 200,000 population each) in two rural areas of Bangladesh: in Abhoynagar *upazila* in Jessore district in the south-western part of the country and in Sirajgonj *upazila* in Sirajgonj district in the northcentral part of the country.[1] Comparison areas have been designated in neighbouring districts in areas which are contiguous to each treatment area.

The sampling and organizational phase of the SRS parallels designs typically employed in sample surveys, whereby a two-stage cluster sample is drawn. Within each *upazila* chosen for the project, a sample of unions (administrative subunits in Bangladesh consisting of a population of approximately 20,000 each) was selected randomly as a first stage in the cluster sampling procedure. A complete household listing was subsequently carried out in each sample union, and households were randomly selected, each with an equal probability of se1ection.[2] Among sample households, an enumeration was carried out to identify all household members, collect basic socio-economic and demographic information about each, and to assign unique identification numbers to each individual in the SRS.[3] Data on each household were augmented by a separate in-depth baseline KAP (knowledge, attitudes and practice) survey which was carried out for each household in 1982. These procedures led to the surveillance of 7,428 households consisting of 41,269 individuals at the start of the SRS in 1982.

This information was subsequently entered into the computer at Dhaka, printed and bound in the form of household record books, SRS interview teams, each consisting of one male and one female interviewer, then began visiting each sample household at regular 90-day intervals to inquire about vital events which occurred since their last visit. Such events include pregnancy terminations, deaths, in- or out-migrations, or marital status changes.

Actual interviews are carried out by the female member of the SRS team, with reproductive-a ed female members of the household being the respondents of preference.[4] Interview teams are assigned an average of 15-20 households per day, with one team covering an average of 800-900 households during a typical 90day round.

The data collected are entered into the household record book which remains with the interviewer except after the completion of a round when the books are sent briefly to Dhaka for computerization.[5] The household record book is a central element of the surveillance system, since it provides a longitudinal summary of events for each household under surveillance, and enables field workers to evaluate the validity of new data through the linkage of reported events at the time of data collection. In this manner, primary responsibility for logical editing is borne by the field staff, where errors are



often readily correctable, rather than by the microcomputer and data management staff, thus eliminating a high proportion of all errors. The collection of accurate data is facilitated by a well-developed supervisory system, with 5 per cent of all sample households undergoing supervised interviews and an additional 5 per cent receiving independent re-interviews by supervisors.

The computer component

The data storage design of the SRS is conceptually simple : each household is treated as a storage unit, much like an accountant maintains records on financial transactions. Individuals are checked into the household when births or in-migrations occur and checked out when deaths or out-migrations occur. In accounting fashion, the days of observation are counted, as well as other information of interest about households, individuals, or events. This design is referred to as a "relational model" in the computer literature. It differs substantially from "sequential models" that have been used widely in longitudinal studies in the past.

Although this design is seemingly complex, it actually simplifies the management of data considerably. The scope for designing data content is highly flexible. While the demographic component of the SRS provides the basic structure of the SRS (household size and composition, interrelationships among members, member characteristics and their demographic events history), the information posted to the database can be either longitudinal histories or fixed entries. The SRS is designed, for example, to record in 90day rounds each respondent's recall of service worker visits, the type of services received and whether services were adopted. In addition to the routine longitudinal data, special purpose one-time modules have been added intermittently to collect data on issues such as husbands' and wives' reproductive preferences, breast-feeding, women's status and perceptions about the quality and availability of services. The scope and content of these special modules is limited only by the time available for interviewing (usually 15-20 minutes per household).

Use of database methods also facilitates continuous and comprehensive editing. The SRS software includes a comprehensive editing sequence that checks the logical integrity of input data against all other available data on each sample individual and household. This on-line interactive entry and processing system ensures prompt feedback to field workers when problems need to be resolved.

The database design not only simplifies data management, it greatly facilitates demographic analysis. Recording the visit date and dates of movement into and out of households permits immediate calculation of the population at risk of vital events at a given point in time. Calculation of demographic rates can be done from simple tabulations that require no special-purpose software or data management tasks. Simple-to-use software is available which accumulates, at the closure of an SRS visitation round, the person-days of observation of each individual to be accumulated as denominators for vital rates.

In summary, the SRS addresses the need for data collection systems that are: (a) longitudinal and capable of monitoring not only events, but also the population at risk of events; (b) accurate and complete, with minimum scope for internal logical inconsistencies to arise;(c) expandable and flexible to register not only vital events, but also proximate and background determinants of demographic dynamics; (d) simple, inexpensive and portable, placing minimum technical demands on users; (e) quickly implemented and designed to produce timely results; and (f) suitable for large populations, yet compatible with micro-computer technology.

Results

Demographic rates tabulated from the SRS for the 1983-1988 period are presented in tables 1 and 2. Given the comparatively small number of demographic events occurring in the population under surveillance, data are presented in this paper on an annual basis and for the two field sites as a whole, with no distinction made between treatment and comparison areas.

Fertility rates for the 1983-1988 period in the Sirajgonj and Abhoynagar study areas are shown in table 1. Although considerable fluctuation in rates is evident for all measures of fertility considered, it is apparent that significantly higher fertility levels are found in the Sirajgonj area. Crude birth rates during this period range from 40.146.5 per thousand population in Sirajgonj, compared to 26.7-34.7 per thousand in Abhoynagar.

Consideration of other fertility measures which are not influenced by age structure provides a similar picture. Total fertility rates (TFRs) in Sirajgonj are almost 50 per cent higher than in Abhoynagar in most years, ranging from 5.3 to 6.4, compared with TFRs of 3.1 to 4.3 in Abhoynagar. As shown in the age-specific fertility rates, differences between areas are most pronounced among women aged 30 years and above, with rates in Sirajgonj generally twice as high as rates in Abhoynagar. In both areas, there is evidence of modest but discernible declines in fertility levels over time, although their magnitude is likely obscured by data from the treatment and comparison areas having been combined. A careful analysis of this differential has established that differences in levels of contraceptive use explain most of the area1 variance apparent in SRS fertility data.[6]

Table 2 presents data on mortality levels in the two field sites. Once again, a substantial difference is apparent between Sirajgonj and Abhoynagar, with the former characterized by significantly higher mortality rates. Infant mortality rates in Sirajgonj range as high as 173 per thousand live births and are never lower than 147 per thousand, during this six-year period. In contrast, infant mortality levels in Abhoynagar range from 102 to 142 per thousand live births.

Table 1: Fertility rates, Sample Registration System, 1983-1988

	Sirajgonj						Abhoynagar					
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
Crude birth rate	44.0	46.5	44.3	40.1	40.6	41.4	34.7	29.4	33.1	26.7	29.5	28.6
General fertility rate	196.0	205.2	193.3	173.7	176.1	181.1	150.3	124.6	137.9	110.0	121.6	117.8
Age-sperifk fertility rate												
15-l9 years	189.9	184.7	175.3	143.0	152.5	165.6	172.1	118.8	150.2	135.1	144.2	137.4
20-24 years	272.4	293.3	261.7	257.2	273.6	269.2	223.0	208.6	232.6	160.7	193.6	207.0
25-29 years	251.1	284.2	270.6	238.6	222.3	238.3	183.3	164.9	151.7	145.2	146.2	150.7
30-34 years	242.7	246.7	225.4	220.1	222.5	177.3	148.8	99.2	140.7	90.8	96.9	74.9
35-39 years	180.9	188.3	197.0	143.7	143.4	165.3	95.0	95.0	65.1	50.9	64.4	52.1
40-44 years	71.3	83.4	68.2	75.3	54.4	72.8	26.7	38.0	32.3	28.3	26.9	24.6
45-49 years	4.7	11.3	8.9	6.8	0	7.4	3.4	3.2	3.1	3.0	3.0	3.1
Total fertility rate	6.1	6.4	6.0	5.4	5.3	5.5	4.3	3.6	3.9	3.1	3.4	3.2

Table 2: Mortality rates, Sample Registration System, 1983-1988

	Sirajgonj						Abhoynagar					
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
Crude death rate	18.5	19.2	14.4	13.9	13.4	14.6	11.8	11.2	11.2	10.2	7.8	7.8
Infant mortality rate*	157.7	172.5	158.8	147.7	149.5	165.5	120.8	142.1	117.6	136.3	104.0	102.4
Neonatal mortality rate*	89.2	103.5	91.9	94.3	92.0	100.2	63.6	72.0	50.6	88.2	58.4	59.6
Post-neonatal mortality rate*	68.5	69.0	66.9	53.4	57.5	65.3	7.2	70.1	67.0	48.1	45.6	42.8
Age-specific death rates												
1-4 years	35.1	36.0	22.8	22.9	18.1	21.4	13.7	10.5	9.5	9.1	4.6	8.0
5-14 years	4.1	3.9	2.4	2.0	2.6	1.5	2.9	2.5	1.3	1.5	0.6	1.4
15-44 years	2.9	2.7	1.2	2.7	2.0	2.5	2.5	2.4	3.3	2.0	2.5	2.6
45+ years	32.5	31.2	23.6	23.5	24.5	25.5	29.1	29.2	31.6	30.6	20.3	17.2
Denominators:												
Live births	1 065	1 159	1 121	1 029	1 044	1 088	629	542	612	499	548	537
Person years												
1-4 years	3 249.0	3 306.6	3 378.9	3 448.1	3 366.4	3 412.1	2 261.1	2 296.3	2 211.7	2 092.3	1 960.6	1 864.4
5-14 years	6 586.7	6 646.7	6 631.5	6 583.3	6 623.3	6 845.5	4 781.1	4 733.4	4 727.9	4 806.2	4 820.4	4 880.1
15-44 years	10,062.3	10,566.1	10,832.0	11,158.3	11,256.8	11,390.1	7 973.5	8 287.9	8 483.6	8 708.3	8 666.7	8 772.6
45+ years	3 353.0	3 399.9	3 435.7	3 485.2	3 512.2	3 647.6	2 512.5	2 538.3	2 560.5	2 583.1	2 608.2	2 726.4

Note: * Per thousand live births.

Closer examination shows that most of the difference in levels of infant mortality is attributable to significantly higher neonatal mortality levels in the Sirajgonj field site, with neonatal mortality levels approaching or exceeding rates of 100 per thousand live births in all years. In both areas, infant mortality levels reached a peak in 1984, possibly as a result of serious flooding which occurred in the autumn of that year, which led to both a serious subsequent diarrhoeal disease epidemic among young children and the disruption of normal health services.

The mortality differentials between areas is even more pronounced during ages 14 years, with rates generally two to three times higher in Sirajgonj than in Abhoynagar in all year.[7]

There is some evidence suggesting a modest decline in levels of infant and particularly child mortality over time.[8] although the evidence is less conclusive than in the case of fertility and substantial fluctuation is apparent owing to the frequently small number of cases involved. Little difference is evident between areas in levels of adult mortality.

Discussion

The mortality and fertility rates reported in this paper are substantially higher than those reported from other intensive demographic surveillance systems such as Matlab, and considerably higher than those reported for rural Bangladesh as a whole.[9] The infant and child mortality levels reported for the Sirajgonj study area represent some of the highest recorded levels in rural Bangladesh in recent years.[10]

Of particular interest is the finding of extensive variation between the two study areas in fertility and mortality levels. The extent of variation in basic demographic parameters within rural Bangladesh is not fully appreciated, due in large part to the absence of accurate demographic data at the sub-national level. While initial work has been undertaken on this issue (Rob, 1987), considerable scope remains for further investigation of the factors responsible for area variation in demographic parameters.

In this paper, we have focused on the demographic component of the SRS. The potential exists for adaptation of the SRS to the surveillance of a diverse range of other issues such as nutrition, morbidity, or service programme surveillance. The expandability and flexibility of the SRS demonstrates the utility of this technology for special research projects, many of which have been fielded in Asia where analytical interests extend beyond demographic assessment to questions concerning the determinants of demographic dynamics and feasible policy interventions for improving health and well-being.

Footnotes

1. In 1986, the SRS was expanded to two additional upazila in Jessore district. Rates reported in this paper are based only on the original field sites.
2. Based on estimates of vital rates, comparisons of interest and the degree of confidence required, a sample size was selected that allows three-celled comparisons for annual data. The overall sampling fraction to achieve this was slightly in excess of 19.
3. The field operations and instructions to field staff are described in detail in Mozumder *et al*. (1985).
4. A team of one male and one female interviewer is required largely because of the difficulties facing women travelling alone in the conservative setting of rural Bangladesh. In many other settings, it should be possible to operate the SRS with female interviewers only. If only female interviewers are used, the estimated annual cost of surveillance per household is $US8.65 (Koenig *et al*., 1988).
5. A simple procedural modification would involve field processing the data on a "laptop" computer or stationary computer. Field registers could be brought to a central field location and quickly processed. However, such a design is not recommended for Bangladesh owing to the novelty of computing in remote areas and the unpredictable distortions to work relations that could arise from introducing new technology into study areas. Nonetheless, other settings or other projects in Bangladesh with established field operations could decentralize processing.
6. See U. Rob, 1987.
7. Recent nutrition surveillance carried out in Sirajgonj suggests that high rates of malnutrition may be a central factor in accounting for the high rates of child mortality observed in this area. (SRS Sirajgonj Post-Flood Nutrition Assessment - 1988).
8. A possible explanation for the observed declines in neonatal and child mortality levels is the testing of tetanus toxoid immunization interventions by the Extension Project in Abhoynagar and Sirajgonj treatment areas during 1986 and 1987, respectively, as well as the introduction of the national immunization programme in the Abhoynagar treatment and comparison areas in 1987. In addition, other research from Matlab suggests that the adoption of family planning may also have been a contributing factor (see Phillips *et al*., 1987; Koenig, 1988).
9. Demographic estimates for Bangladesh vary from study to study. National estimates based on survey data (e.g. Mitra, 1988) are typically higher than estimates from the national sample dual recording system (Bureau of Census and Statistics, 1984). The accuracy and completeness of various systems have been the subject of considerable debate (Population and Development Planning Unit, Ministry of Planning, 1984).
10. A summary of available data on Bangladesh has been published by ESCAP (1981).

References

Koenig, M., *et al*. (1988a). "Birth Intervals and Childhood Mortality in Rural Bangladesh" Working Paper No.23, The Population Council, New York.

Koenig, M., *et al*. (1988b). "An Overview of the ICDDR,B Sample Registration System", Working Paper No.25, MCH-FP Extension Project, ICDDR,B, Dhaka.

Leon, D. (1986a). "SRS Version 1.1 user's manual: The microcomputer software component of the Sample Registration System of the MCH-FP Extension Project, Inter-

national Centre for Diarrhoeal Disease Research, Bangladesh," Bangkok: Regional Office for South and East Asia, The Population Council.

_____(1986b). "SRS Version 1.1 technical manual: The microcomputer software component of the Sample Registration System of the MCH-FP Extension Project, International Centre for Diarrhoeal Disease Research, Bangladesh," Bangkok: Regional Office for South and East Asia, The Population Council.

_____(1987). "The Microcomputer Software Component of the Sample Registration System of the MCH-FP Extension Project, International Centre for Diarrhoeal Disease Research, Bangladesh", SRS Version 1.1, Demonstration Manual, The Population Council, Asia Regional Office, Bangkok.

Mitra and Associates (1988). "Bangladesh Contraceptive Prevalence Survey, 1985: Secondary Analysis", Dhaka.

Mozumder, K.A., *et al*. (1985). "A comprehensive overview of rules and field procedures of the demographic data component of the Sample Registration System," Documentation Note No.47, MCH-FP Extension Project, ICDDR,B, Dhaka.

Mozumder, K.A., *et al*. (1986). "The Sample Registration System: A Microcomputer System for Monitoring Demographic Dynamics and Health and Family Planning Service Operations in Rural Bangladesh", paper presented at the Annual Meeting of the Population Association of America, San Francisco, 3-5 April.

Mozumder, K.A., *et al* . (1984). "Sample Registration System procedures for interviewing and recording data on contacts between MOHPC workers and eligible women", Documentation Note No.16, MCH-FP Extension Project, ICDDR,B, Dhaka.

Population and Development Planning Unit (1984). "Recent Trends in Fertility and Mortality in Bangladesh", Proceedings of a National Seminar, Planning Commission, Dhaka, 29-31 January.

Phillips, J.F., *et al* (1988). "The application of microcomputer data-base technology to longitudinal studies of survival: Lessons from a field study in Bangladesh," paper prepared for the seminar "Community-based health research in Mexico: A proposal for the initial stage", National Institute of Public Health, Mexico, 25-28 October.

Phillips, J.F., *et al*. (1987). "The effect of a Maternal and Child Health Family Planning Project on Infant and Child Mortality in Matlab, Bangladesh", presented at the Annual Meeting of the Population Association of America, 30 April- 2 May, Chicago.

Phillips, J.F., *et al*. (1984). "Transferring health and family planning service innovations to the public sector: An experiment in organization development in Bangladesh, Studies in Family Planning, vol.15, No.2, pp. 62-73.

Rob, A.K.U. (1987). Regional Variations and Determinants of Fertility in Bangladesh. Unpublished Ph.D. dissertation, University of Michigan, Ann Arbor.

Sample Registration System (1988). "Sirajgonj Post-flood Nutrition Assessment" unpublished results of survey conducted in collaboration with Centre for Disease Control, U.S.A., during October 1988 - April 1989, MCH-FP Extension Project, ICDDR,B, Dhaka.

She ikh, Kashem *et al* (1985). "Demographic Surveillance System - Matlab," Scientific Report No.64, ICDDR,B, Dhaka.

United Nations (1981). *Population of Bangladesh*, United Nations ESCAP Country Monograph Series No.8, New York.