DOUBLE ROUND SURVEY ON PREGNANCY AND ESTIMATE OF TRADITIONAL FERTILITY RATES

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PREFACE

The Cholera Research Laboratory (CRL) operates under a bilateral project agreement between the government of Bangladesh and the United States of America. Research activities of CRL center on the inter-relationships between diarrheal disease, nutrition, fertility and their environmental determinants. CRL issues two types of papers: scientific reports and working papers which demonstrate the type of research activity currently in progress at CRL. The views expressed in these papers are those of authors and do not necessarily represent views of the Cholera Research Laboratory. They should not be quoted without the permission of the authors.

The paper titled 'Double round survey of pregnancy and estimate of traditional fertility rates' by A.K.M. Alauddin Chowdhury, was prepared for presentation at the XVIII General Conference of International Union for the Scientific Study on Population in Mexico City August 8-13, 1977.

ABSTRACT

This paper describes a new survey method which estimates the traditional fertility rates for a future twelve month period. Twice a year, with a six month interval, two cross-sectional surveys are to be conducted for the same group of women.

One empirical analysis of this method is made and compared the results with an extensive vital registration system maintained by Cholera Research Laboratory in a rural area of Bangladesh. It is found that the fertility rates estimated by the new method are as good as those of the vital registration system.

INTRODUCTION

Most of the developing countries in Africa and in Asia are presently facing huge problems in nutrition, health, education, unemployment and housing. To minimize human suffering and to plan optimally for development, these countries need to understand their demographic situation and its interaction with national development.

Because of their immediate need and limited funds, these countries often depend on single round retrospective surveys (Lunde, 1976) to obtain information on vital events for estimating fertility and mortality rates. The advantages of such methods include their simplicity, flexibility, short time span and low cost. However, such surveys have been found to be associated with high non-sampling errors because of under-reporting and misreporting of births and deaths (Seltzer, 1973).

Good estimates of birth and death rates, infant mortality rates and age specific fertility rates are difficult to determine, using single round surveys. Although several analytical techniques (Brass et al., 1968, UN 1967, Shryock et al., 1974) have been developed for the adjustment of missing events, these techniques are not equally successful in providing a sound basis for estimates in all countries.

In this paper, a method of pregnancy prevalence survey will be described which will give an estimate of traditional fertility rates for the next 12-month period, in addition to rates for the past 12-month period; including a discussion of methods, field work, biases and its comparison with extensive registration data based on an example from Bangladesh.

METHODOLOGY

In this pregnancy prevalence survey, the sampling unit may be a household or a "bari" (geographical cluster of related households), with the sampling plan based on the principles of probability. However, the whole sample design will depend on the purpose of the study, how much detailed data is required, time and allocated funds.

The data are to be collected twice in one year from the same sample at an interval of three or six months.

In the first round survey, variables to be included are similar to those in the usual retrospective demographic surveys such as age, sex parity, marital status and number of live births and deaths during last 12 months, etc.

In addition to the above variables, another variable will be asked: whether a married woman age (15-49) at the time of the survey is pregnant or not (by interview technique or pregnancy test or both), and if pregnant, data on the number of months of gestation will be collected.

In the second round survéy, information on household change, pregnancy status and month of gestation will be included. In addition, those who were reported or detected as pregnant in first survey will be questioned to determine the fate of those pregnancies on or before the second survey.

<u>Theoretical Aspects of the Method</u>

Notations:

t_1 = Calendar time of first round survey.

t_2 = Calendar time of second round survey.

$Zi(t_1)$ = Proportion of women who are pregnant at time t_1 and who are at ith month of gestation.

$Zi(t_2)$ = Proportion of women who are pregnant at time t_2 and who are at ith month of gestation.

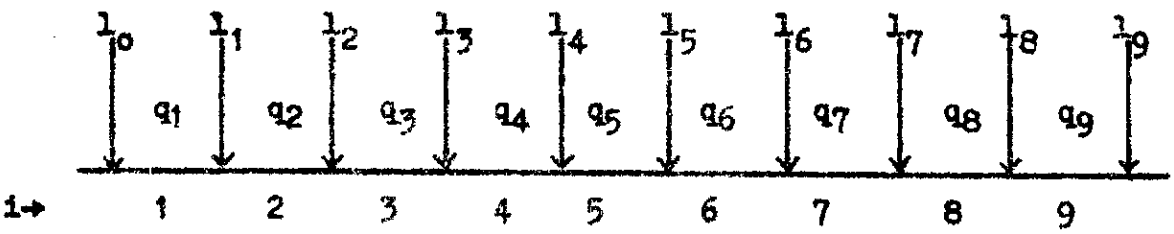
qi = Probability that a pregnancy which survived (i-1)th month of gestation terminates to non-live birth during gestation month i.

li = Probability that a pregnancy survives ith month of gestation = $\prod_{J=1}^{i} (1-qj)$

$lo = 1$

l_9 = Probability that a pregnancy terminates in a birth

Diagram showing the relationship of i's, qi's, and li's.



Total number of live births (TB) out of all the pregnancies reported in the 1st Round Survey at time t_1 will be distributed over the next 9-month period.

$$TB = \sum_{i=1}^{9} Zi(t_1)\ l_9/li \quad \text{- - - - - - - - - -} \ (1)$$

As these live births cover only a 9-month period, the estimate for the next 12-month period could have been expanded from equation (1) by multiplying by a constant ratio, if there is no seasonality of conceptions. However, in many populations, there exists a seasonality of births (Stoeckel et al., 1972) resulting from seasonality of conception.

In order to overcome the difficulty resulting from observed seasonality of these events, a second round survey at time t_2 should be done, either (1) exactly three months subsequent to the first round survey, or (2) at exactly six months subsequent to the first round survey.

Total live births during the 12-month period since t_1 (3 months)

$$TB = 1/2 \Big[\sum_{i=1}^{9} Zi(t_1)\ l_9/li + \sum_{i=1}^{9} Zi(t_2)\ l_9/li + \sum_{i=7}^{9} Zi(t_1)\ l_9/li + \sum_{i=1}^{3} Zi(t_2)\ l_9/li \Big] \quad \text{- - - - - - - - - - -} \ (2)$$

Total live births during the 12-month period since t_1 (6 months):

$$TB = \sum_{i=4}^{9} Zi(t_1)\ l_9/li + \sum_{i=4}^{9} Zi(t_2)\ l_9/li \quad - - - - \quad (3)$$

In equation (2), all pregnancies at t_1 as well as t_2 are considered. But in equation (3), only second and third trimester pregnancies are taken into account for both the first and second round surveys.

Estimation of Zi or Number of Pregnancies

One difficulty of such a study is the detection of pregnancies in early gestation. In the experiences of the Khanna study (Wyen et al., 1971) in India, some pregnancies were not reported until two or three months after conception. In Bangladesh, early pregnancies are often reported as unknown. However, pregnancies in the second and third trimesters are generally detectable and reported by respondent even when the conception occurred during postpartum amenorrhea (Huffman et al., 1976).

Apart from the interview technique, an immunological pregnancy test can be used as an independent method for detecting pregnancies. Some of these tests (based on the presence of HCG in the urine) are very sensitive and can be set up for field work (Hunt II, 1975). Moreover, the bias of sensitivity and specificity of the test is measurable and an estimate of real pregnancy prevalence is possible (example in Appendix 1).

Estimate of qi or number of fetal deaths

A precise estimate of qi ideally requires a large cohort of pregnancies to be determined and followed prospectively until termination. However, this, itself, is an independent and complex study.

Estimates of qi may be borrowed from some of the longitudinal studies done in different countries (Abramson, 1973, French et al., 1962). With changing trends in induced abortion, borrowing data may be misleading. Instead of using qi in determining l_9/li, a direct method can be used as a part of this survey by looking at pregnancies in the first round and how many of them terminated as live births on or before the second round. This direct estimate of l_9/li will be more suitable if the second round survey is conducted after six months as in equation (3), and may be used for both first and second round surveys to estimate live births, assuming l_9/li has no seasonality.

Applicability of the survey method in the field

Although no specific study using this method has yet been conducted, an example will be presented treating a set of data with a similar methodology. These data were taken from a prospective study of "Nutritional and Physiological Determinants of Natural Fertility" (Chowdhury et al., 1975).

This study, conducted by Cholera Research Laboratory, has been continuing since October 1975 in Matlab, Bangladesh. Ten villages were selected for the study. Household information on these villages was taken from a census done independently in 1974 by CRL in 234 villages covering a population of 260,000 persons. All the women, who are married and under 50 years old, in these 10 villages have been interviewed monthly. Along with other reproductive and nutritional variables, data on pregnancy status of women were collected (Appendix II).

Taking data only on pregnancy status from the first and seventh visits, a set of data was developed, assuming the first visit was round one and the seventh visit was round two. Coding, punching, and analysis of the data were done separately. The estimated births by this method was then compared with the vital registration data of those villages for that period.

Vital Registration System of Cholera Research Laboratory

The CRL vital registration system is independent of this prospective study, covering a population of 260,000 in 234 villages, a geographically clustered, rural area of Bangladesh. A detailed methodology of this registration system has been published elsewhere (Mosley et al., 1970). A short summary is given below:

The vital registration system includes periodic census and registration of vital events. This registration system is extensive; it started with a census in April, 1966 where all individuals were identified by a unique number corresponding to village (geographical location), household and individual. Four copies of the census were made. One copy, left with the respective household, was termed as family visiting card. The three other copies were bound by village. One is used by the Field Assistant, another copy is kept for the supervision of work and a copy is with the CRL Statistics Department file for future processing and matching with vital events.

Surveillance for births and deaths are being maintained by several levels of workers. A local female resident of each village visits each household daily and inquires about births and deaths. A male field assistant supervises from 10 to 15 of these lady field workers. These men, with the equivalent of a high school education, visit each family once a month and register all births and deaths on standard forms. Supervision of this phase of the work is maintained by the Sanitary Inspectors who visit each household once every three months to check on the completeness of birth and death registrations. These workers are under the Field Surveillance Supervisor and his deputies who are responsible for the coordination of the field work. Because of the intensive and regular surveillance by the three levels of workers and the close supervision of the field staff, the data on events that can be directly verified such as births, deaths or migrations are highly reliable.

Basic Assumptions of the Pregnancy Prevalence Survey

(1) By the beginning of the fourth month (second trimester) after conception, women know that they are pregnant.

(2) There is no seasonality of fetal deaths.

RESULTS

Before going to the detailed estimates of fertility, the validity of the assumptions may be examined. In Table 1, the distribution of pregnant women by their responses about their pregnancy status is given. These pregnancies were detected by the prospective follow up of their menstrual period. The responses were for the first round interview. The month of

TABLE 1

DISTRIBUTION OF WOMEN WHO WERE PREGNANT BY THEIR RESPONSE REGARDING THEIR PREGNANCY AND MONTH OF GESTATION

Month of Gestation	Yes	No or Unknown	Total	Percent Responded Correctly
01	13	17	30	43.33
02	11	6	17	67.71
03	19	3	22	86.36
04	30	1	31	96.77
05	39	-	39	100.00
06	26	1	27	96.30
07	40	1	41	97.56
08	27	-	27	100.00
09	30	1	31	96.77
All Pregnancies	235	30	265	88.70

gestation reported by the respondents were counted from the last menstrual period and the expected termination at 10 months. In this paper, to make a correction of gestation from conception time, instead of the last menstrual period, a constant of 1 was substracted from the women's responses. As in Table 1, nearly 90 percent of the pregnant women responded correctly. Pregnant women with gestation month four and above had the most accurate response. Over 95 percent responded correctly. Justifying the first assumption.

With regard to the second assumption, Table 2 presents the stillbirth to live birth ratio in the Matlab area for several years by month of conception. The data used here were taken from the vital registration system. As early fetal wastage are generally under-reported by this system, only stillbirths were taken. Table 2 showed that there is no seasonality of stillbirth to live birth ratio by month of conception.

TABLE 2

STILLBIRTH TO LIVE BIRTH RATIO BY MONTH AND YEAR OF CONCEPTION

Month of Conception	1968-69	69-70	70-71	71-72
April - July	.034 (3401)	.037 (3449)	.038 (3790)	.043 (3668)
August - November	.038 (2494)	.031 (2408)	.034 (2254)	.042 (2155)
December - March	.030 (4801)	.029 (4765)	.040 (4901)	.033 (4653)

Figures in the parenthesis are the number of live births.

Table 3 gives the distribution of women who reported being pregnant in the first and second round surveys, and the expected number of live births. The l_9/l_i is calculated by taking the pregnancies of the first round survey and the numbers that terminated in live births or continued on or before the second round survey by each gestational month.

TABLE 3

DISTRIBUTION OF WOMEN WHO REPORTED PREGNANT IN 1ST VISIT AND IN 2ND VISIT BY GESTATIONAL MONTHS

Month of Gestation	No. of Women Pregnant at 1st Visit	No. of Women Pregnant at 2nd Visit	l_9/l_i	Expected No. of Births
4	31	55	1.00	86
5	39	52	0.92	84
6	27	56	0.96	80
7	41	40	0.95	77
8	27	16	0.96	41
9	31	11	0.97	41
	196	230		409

There were 196 pregnancies observed in the first visit and 230 in second visit, estimating the number of live births at 409. However, the sample size taken in this study seemed to be smaller to have the consistent estimate of l_9/l_i. Three pregnant women who migrated out or changed marital status before the second round survey there, also included in the estimate of births.

Table 4 shows the total population number of women in the first and second round surveys and crude birth rate by different methods. There were 407 live births registered during October 1975 through September 1976 in the vital registration system, giving a crude birth rate of 31.1 per thousand.

TABLE 4

BASE POPULATION OF TEN SAMPLED VILLAGES AND CRUDE BIRTH RATES BY TWO METHODS

Total Population	= 13069
No. of women, currently married, and age less than 50 at 1st Round	= 1980
No. of women migrated out or changed in marital status	= 86
No. of married women migrated in	= 115
No. of women, currently married and age less than 50 at 2nd Round	= 2009
No. of births observed in this population reported by vital registration system	= 407
No. of births estimated by Pregnancy Prevalence Survey	= 409

CBR = 31.1 (By Registration System)

CBR = 31.3 (Pregnancy Prevalence Survey)

The pregnancy prevalence survey method estimated 409 births for the same population almost in the same period of time. The crude birth rate was 31.3 per thousand population.

Table 5 shows the seasonality of birth by both pregnancy prevalence survey data and registration data. Seasonality of births by the pregnancy prevalence survey were estimated according to the following diagram.

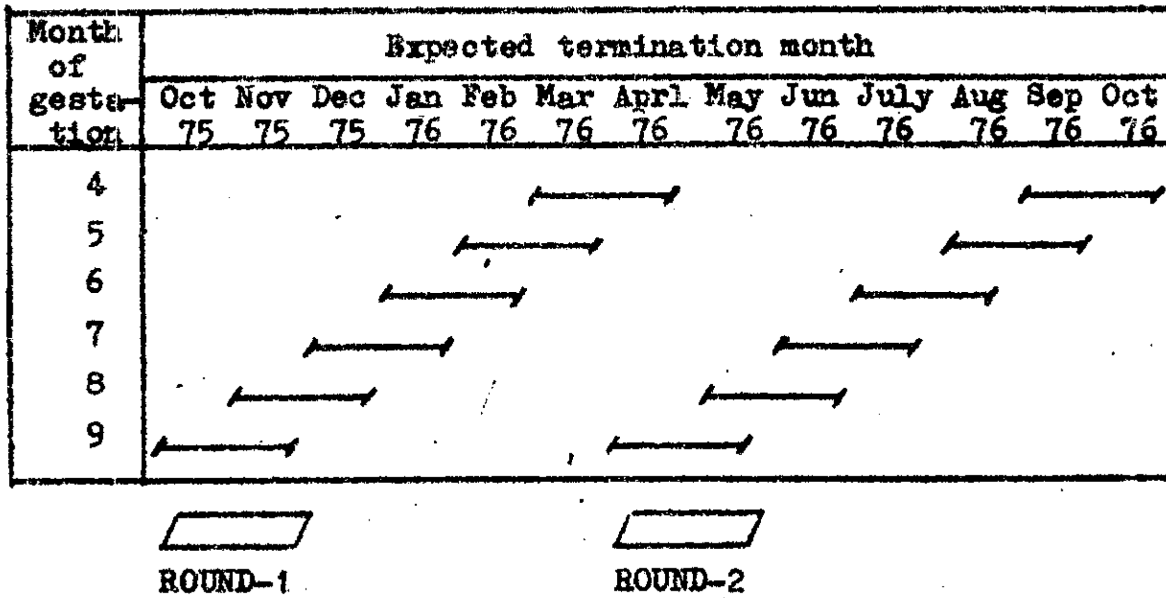


TABLE 5 SEASONALITY OF BIRTHS

Month and Year		Estimated from Pregnancy Prevalence Survey		Observed from Vital Registration	
		Number	Percentage	Number	Percentage
Oct	75	42.5*	10.4	29	7.1
Nov	75	28	6.8	37	9.1
Dec	75	32.5	7.9	25	6.1
Jan	76	32.5	7.9	34	8.3
Feb	76	31	7.6	37	9.1
Mar	76	33.5	8.1	38	9.3
Apr	76	21	5.1	28	6.9
May	76	13	3.2	21	5.2
June	76	26.5	6.5	25	6.1
July	76	46	11.2	39	9.6
Aug	76	51	12.5	50	12.3
Sept	76	51.5	12.6	44	10.8
TOTAL		409	100.0	407	100.0

* Expected births of October 1976 added with October 1975.

This diagram assumed that the termination in live birth occurred during the ninth or 10th month of gestation since conception and have uniform distribution.

In New York City, for 1963 and 1967, Abramson showed that approximately 90 percent of all live births occurred in the ninth and 10th month of gestation since conception (Abramson, 1976). In developing countries where maternity facilities are negligible, this percentage is expected to be higher because the proportion of premature termination to live birth is lower.

Both the pregnancy prevalence survey data and the vital registration data show similar seasonality pattern (Figure 1). K-S two sample test (Siegel, 1956) showed an insignificant difference in the distribution of births by months between these two methods. (p>.4).

FIGURE 1

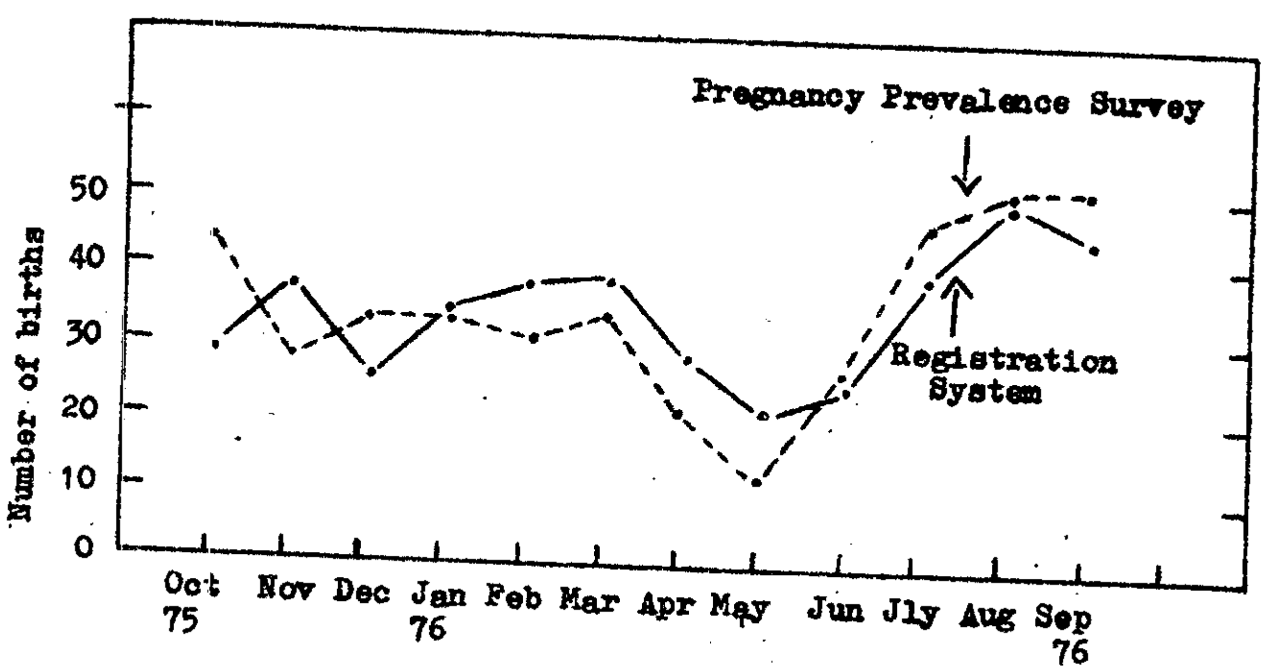


Table 6 showed the marital age specific fertility rates by the two methods.

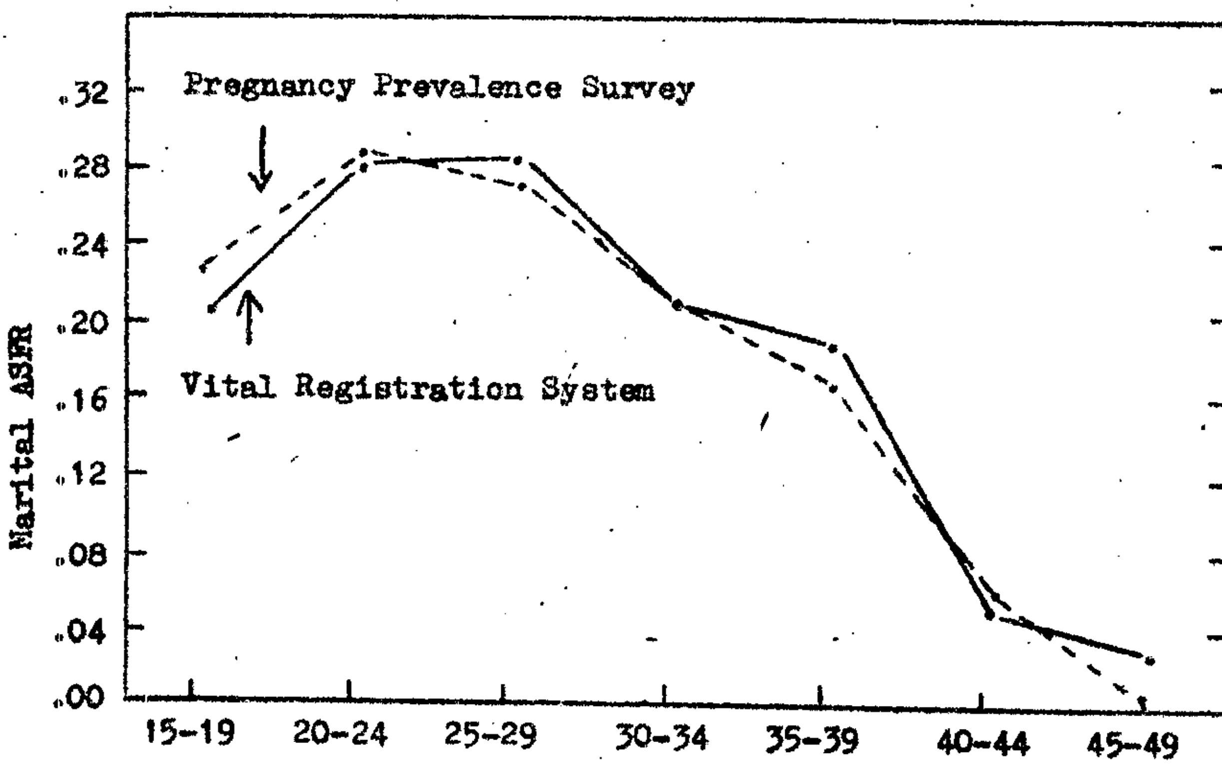
TABLE 6

MARITAL AGE SPECIFIC FERTILITY RATES AND TOTAL FERTILITY RATES ESTIMATED BY TWO METHODS

Age	Number of Married Women	Number of Births (Vital Registration Method)	Marital ASFR	Number of Births (P.P. Survey)	Marital ASFR
15-19	262	54	.206	61	.233
20-24	405	114	.281	116	.286
25-29	305	86	.282	84	.275
30-34	393	83	.211	84	.214
35-39	276	53	.192	47	.170
40-44	252	14	.056	16	.063
45-49	116	3	.026	1	.009
TFR	(2009)		6.27		6.25

The denominator used for both methods was the number of married women, age 15-49, found in the second round survey, i.e. in mid-year. The pregnancy prevalence method estimated the equal Marital ASFR as it was observed in the vital registration system. The pattern shown in Figure 2 looks similar; however the pregnancy prevalence method gives a smoother curve than the registration system. The TFR was equal for both the methods.

FIGURE 2



DISCUSSION

The period covered in the above example was October 1975 to September 1976; unfortunately, the year was very unusual for the fertility rate of the Matlab area in Bangladesh. Crude birth rate during the period May 1975 to April 1976 was found to be 27.6 per 1000, by the vital registration system. Table 7 shows the trend of crude birth rate for the last 10 years. The decline of CBR in 1975-76 over 1974-75 was more than 30 percent. This may have been due to extensive migration to urban areas, separation, disruption, dissolution of families and postponement of marriages from the socioeconomic side, and, malnutrition and disease caused by a famine in 1974-75. This, itself, is a separate study, and beyond the scope of this paper.

TABLE 7

TRENDS IN BIRTH RATE, DEATH RATE AND INFANT MORTALITY RATE IN MATLAB FOR LAST 10 YEARS

Year	CBR	CDR	IMR
1966-67	46.8	16.0	110.7
1967-68	45.2	17.2	125.4
1968-69	46.4	15.7	123.8
1969-70	45.2	15.1	127.5
1970-71	43.6	14.6	131.3
1971-72	44.5	21.3	146.6
1972-73	41.8	16.4	129.2
1973-74	47.8	14.6	128.8
1974-75	40.1	20.0	155.9
1975-76	27.6	18.2	150.4

Table 8 shows the comparison of the census population of different years and the estimated population by adjustment of vital events. There is a little difference between census and population adjusted by vital events. The consistencies and trends in the vital rates as shown in Table 7 and the slight difference in the adjusted and census population in Table 8, point out the reliability of the CRL vital registration system.

Comparisons between the two methods described earlier were at the macro level. As in macro-analysis, however consistent is the comparison may sometime lead to a fallacious conclusion when both the methods suffer from some kind of deficiency. As both the methods are conducted in the same population, an attempt is made here to match the pregnant women reported in pregnancy prevalence survey with the mothers of live births reported in the vital registration system or vice-versa.

TABLE 8

POPULATION IN MATLAB BY PERIODIC CENSUS AND BY ADJUSTMENT OF VITAL EVENTS (OLD TRIAL AREA)

Type of Estimation	1966	1970	1974
	Year		
Population enumerated in the census	111,722	120,694	134,038
Population by adjustment of vital events	-	121,757	134,059
Difference over Census		0.8%	0.0%

Because of some time difference between the two methods - such as births from the vital registration system covered from October 1, 1975 to September 30, 1976 and pregnancy prevalence in the first round survey were spread over one month during October - November 1975, and in the second round survey during April - May 1976 - the matching procedure is done in two ways.

(1) All the 196 pregnancies in the first round survey expected to terminate during the registration period to be matched with the birth reports.

(2) All the birth registered during December 1 to September 30, where mothers were expected to be pregnant either in the first or second round surveys, are to be matched with the pregnancy prevalence data.

Table 9 gives the matching of first round survey pregnancies with the registered births by reported month of termination. Out of 196 pregnancies, eight terminated in fetal deaths and four could not be matched in the registration system, a total of 98 percent matched with the birth reports.

TABLE 10

MATCHING OF LIVE BIRTHS REGISTERED WITH PREGNANCIES
REPORTED IN PREGNANCY PREVALENCE SURVEY

Month of Gestation of Reported Pregnancies	Month of Termination Registered										Total
	Dec 75	Jan 76	Feb 76	Mar 76	Apr 76	May 76	Jun 76	Jul 76	Aug 76	Sept 76	
Round - 1											
4				4	14	12	1				31
5			4	19	11	1					35
6		3	12	10							25
7	2	17	17	1							37
8	11	12									23
9	7										7
Round - 2											
4								1	2	8	11
5							1	1	10	17	29
6							3	12	17	9	41
7						1	5	16	14		36
8							5	5	4		14
9						2	6	2			10
Sub-total	20	32	33	34	25	16	21	37	47	34	299
Pregnant with lower gestational month and reported non-pregnant	2	2	-	1	3	4	-	2	1	8	23
Unknown because of absence and migration-in	3	-	4	3	-	1	4	-	2	2	19
Total	25	34	37	38	28	21	25	39	50	44	341

ever, when such a difficulty arises, one can always use pregnancy tests, ask questions about the last menstrual period, or merge gestational months into trimesters. Merging of gestational months to trimester cancels out the errors in the response of gestational month.

One problem that may arise in field work is when conception occurs in postpartum amenorrhea. In the Matlab experience, where postpartum amenorrhea is very long - 18 months (Chen et al.) - women can respond about their pregnancies in the second trimester even if the conception occurred in amenorrhea. In "Nutritional and Physiological Determinants of Natural Fertility" study, an independent group of 200 women who were around 20 months of lactational amenorrhea were prospectively followed up. Six of them reported they were pregnant before the resumption of menstruation. Pregnancy tests (Dri-dot) showed five of them were positive. In this population, such pregnancies have a special colloquial term and can be reported by women with probable gestational month. However, for countries having longer postpartum amenorrhea, this problem may have a significant effect on the overall rates if not carefully examined.

The traditional fertility rates as estimated by the pregnancy prevalence survey were found to be as efficient as that of vital registration system, at least in Bangladesh. The method described is relatively simple, expedient and the cost lower than the vital registration system.

Non-sampling errors like missing events or erroneous dating of events because of memory lapse is minimal. Two independent visits will ensure a more complete reporting of persons. Validity and bias in the responses can be measured comparing the first round interview with the second round interview. The mid-year population and household change can be recorded. The estimate of seasonal fluctuations is also possible. The pregnancy prevalence method itself may be used as a tool to effectively evaluate family planning programs.

Because the method estimates Zi and l_9/li, to minimize the sampling error, a larger sample than is generally advocated for single round retrospective survey is required. One restriction of the method is a shorter time period for the field work in each round, and the interval between the first and second round surveys should be six months. This restriction may increase the operational cost over the usual retrospective surveys.

Lastly, the responses about the pregnancy status were found accurate in the Matlab area. This may be the result of (1) a blanket protection from the diarrheal disease by the Cholera Research Laboratory (2) the Cholera Vaccine Program and intensive surveillance of vital events for the last 10 years. This new method needs to be field-tested in an area in which intensive vital events registration have not been conducted.

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APPENDIX I

Estimate of pregnancy prevalence rate by pregnancy test with different level of sensitivity* and specificity** of the test, when the real rate in the population is 0.20 with proportion 0.40 in post-partum amenorrhea and another .40 in menstruating status.

Specificity \ Sensitivity	0.95	0.96	0.97	0.98	0.99	1.00
0.95	.210	.212	.214	.216	.218	.220
0.96	.206	.208	.210	.212	.214	.216
0.97	.202	.204	.206	.208	.210	.212
0.98	.198	.200	.202	.204	.206	.208
0.99	.194	.196	.198	.200	.202	.204
1.00	.190	.192	.194	.196	.198	.200

* Sensitivity = number of pregnant cases detected by the test / number of true pregnant cases

** Specificity = number of non-pregnant cases detected by the test / number of true non-pregnant cases

APPENDIX II

BIRTH INTERVAL DYNAMICS--2

VILLAGE ______________________ BARI ______________

NAME ______________________ CENSUS NO. ______________

PERIOD COVERED, FROM ______________ TO ______________

Events during the period covered				Other details, if Yes
1. Menstruation?	No ☐	DK ☐	Yes ☐	(Date, Days)
2. Pregnant?	No ☐	DK ☐	Yes ☐	(Gestation Month)
3. Preg. Termi?	No ☐	DK ☐	Yes ☐	(LB,SB,MIS.SEX,Date)
4. Breast feeding?	No ☐		Yes ☐	(Days, Date)
5. Supplementation?	No ☐	NA ☐	Yes ☐	(Days,Date,Type of food)
6. Husband away?	No ☐		Yes ☐	(Days, Date)
7. Practicing F.P.?	No ☐	NR ☐	Yes ☐	(Days,Date,Method)
8. Illness?	No ☐		Yes ☐	IC? /No/NR/Yes/
9. Break-through Bleeding?	No ☐	NR ☐	Yes ☐	(Days, Date)
10. Husband Illness?	No ☐	UK ☐	Yes ☐	IC? /No/NR/Yes/ (Days, Date)
11. Child Death?	No ☐		Yes ☐	(Sex,Date,Date of birth)
12. Absent?	No ☐		Yes ☐	(With/without husband Days)

APPENDIX II (Contd.)

13. Changed M.status? No /_/ Yes /_/ ______
(Kind, Date)

14. Wt.________ Wt. with Infant__________ Arm Circum__________

15. Blood sample collected /Yes/ No / Hct.________ Protein______
Albumin______

16. Name of the worker__________________________ Date____________

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