SENSITIVITY OF ALTERNATIVE FERTILITY INDICES

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I. Introduction

The purpose of this paper is to examine the sensitivity of selected fertility indices to true differences in fertility levels over time and space. Such examination requires an understanding of the statistical variations in these indices. Variability is to be expected even in the case of complete and accurate measurement of fertility, since the behavioral and biological mechanisms which produce births are subject to random variations. When data from sample surveys are used to construct indices, another type of variation is produced by the sampling mechanism itself. Better understanding of the effect of these variations on alternative fertility indices is essential if efficient and accurate indicators of fertility change are to be identified.

This investigation focuses on the sensitivity of certain conventional fertility indices as well as indices based on the birth intervals. The data used in this study were generated through a Monte Carlo simulation model, POPREP. POPREP is a computer simulation model developed by the Department of Biostatistics at the University of North Carolina. It generates the reproductive histories of a hypothetical female population under a set of assumed conditions regarding probabilities of marriage, marital dissolutions, deaths of women and their spouses, conception, spontaneous and induced abortion, use of contraception, and other factors related to fertility performance. The structure of the model is similar to that of POPSIM, but unlike POPSIM, POPREP explicitly considers biological factors underlying fertility. This biological approach to population simulation is closely related to the REPSIM model developed by Ridley and Sheps (1966). Further details of the model are given in the User's Manual for POPREP (1975).

II. Design of Experiments

The first step in the present investigation was to establish an initial population with characteristics approximating that of a developing society. For the sake of internal coherence, and because empirical data were more readily available than for other countries, most of the parameters used in establishing the initial population were derived from data on India.

The initial population was assumed to consist of 10,000 women between age 0 and age 50 who had survived to the initial simulation year. The age distribution was based on census data for India for 1961 and resembles the broad-based age pyramid characteristic of societies with relatively high growth rates.

Although marriage (which is here defined as representing any form of sexual union) was assumed not to occur before age 15, the population was characterized by an early age at marriage. Slightly over half of the women were assumed to have married by age 16. The age of husbands was determined as a function of the age of wives at marriage, but in general, husbands were about seven years older than their spouses. Divorce was assumed not to occur. The probability of widowhood was based on the probability of male mortality from Regional Model Life Table South, Level (e^o = 51.0). Remarriage from widowhood was assumed not to occur. Table 1 shows the distribution of women by marital status at the start of simulation.

The assumptions made in regard to factors affecting reproduction within marriage were as follows: Fecundability, the monthly chance of conception in the absence of contraception, varied among women and, for a given woman, with her age. The parameters used to determine fecundability implied a mean fecundability of approximately .20 at the age when fecundability was highest. The probability of a spontaneous fetal loss was determined as a function of age, reaching a minimum for women in their twenties at a level of about .20 and rising to a maximum of over .50 for women in the oldest age groups. The distribution of age at sterility postulated for these simulations implied a mean age of 42.14 years, with a standard deviation of 4 years. The distribution of length of pregnancies ending in fetal losses had a mean of 1.9 months and a variance of 3.1 months, while all pregnancies ending in live births were assumed to last exactly nine months. The distribution of length of postpartum anovulation following a live birth was assumed to be relatively long, with a mean of 12 months; such a distribution would be consistent with a society where breastfeeding was practiced widely and for substantial periods of time.

These parameters were assumed to operate during the first five years of simulation to establish a baseline against which the three experimental patterns of contraceptive use could be compared. During the five year baseline period, mortality among women was also assumed to occur. Probabilities of female deaths were derived from Regional Model Life Tables, South, Level 13 (e^o = 50.0).

Three patterns of contraceptive use were postulated to begin to operate at the end of the fifth year of simulation. In all three, the chance of becoming a contraceptor was assumed to vary negatively with age and positively with parity. The rate of acceptance for the first contraceptive use pattern implied moderate acceptance of contraception and the second pattern assumed somewhat higher acceptance rates.

In both the first and the second contraceptive pattern, contraception was assumed to be 100% effective, and the women who adopted contraception were assumed to practice until the end of their reproductive lives. Thus, these two patterns can be viewed as simulating the results of a sterilization program. In the third pattern, however, although women were assumed to accept contraception according to the higher hazard function of pattern 2, effectiveness of contraception was assumed to be 90%. Moreover, in this pattern, if a woman practicing contraception became pregnant,

she was assumed to return to the noncontracepting state and her chance of reaccepting contraception was no different from that of a woman of the same age and parity who had never previously used contraceptive methods. Thus pattern 3 can be thought of as representing the use of a fairly effective method of contraception for a period of time determined by the advent of the next conception. Each of these patterns of acceptance was assumed to operate over a ten year period.

Table 2 shows the number of acceptors and the acceptance rates for each of the patterns of acceptance. Somewhat surprisingly, the number of acceptors declines over the 10 year period of program operation for each acceptance pattern. That this is in part due to reduced numbers of women eligible for acceptance is indicated by the data on person-years exposure to the risk of acceptance. These also decline from year 5 to about year 12, and then become approximately stable. The annual acceptance rates decline for the two high acceptance rate patterns. The sharpest decline is observed for the high acceptance rate, 100% effectiveness pattern. Under this pattern, the women who are non-acceptors at the end of the simulation period are likely to be young women of low parity and a correspondingly reduced risk of becoming a contraceptor. In the high acceptance rate, 90% effectiveness pattern, acceptance rates are influenced by the number of women who have accidental pregnancies and, thus, drop out of contraceptive practice. When these women complete their accidental pregnancies, they are again exposed to the risk of acceptance and may again become acceptors. This process of dropping out and reentering operates to keep acceptance rates from declining as much as in the high acceptance rates, 100% effectiveness pattern. In the moderate acceptance rates, 100% effectiveness pattern, annual acceptance rates are consistently lower than for the other two patterns, but the pattern of decline over time is not nearly so marked as in the high acceptance rate pattern.

III. Sensitivity of Fertility Indices: An Examination of Patterns

Conventional Fertility Indices

The results of these simulations, expressed in terms of specific fertility rates and indices summarizing these rates, are given in Tables 3 and 4. Table 3 shows age specific fertility rates for each of the five years of the baseline period when no contraception is used. The most noteworthy feature of this table is the substantial fluctuation in rates from one year to the next. The largest fluctuations, with a range of 8.3% of the highest value, appear for the gross reproduction rate, which for these simulations, has been calculated on the basis of the number of female births actually occuring in each simulation, rather than as a multiple of the total fertility rate. The smallest variation, about 2.4% of the highest observed value, appears for the general fertility rate. For the total fertility rate, the range of variation is approximately 3%.

Table 4 shows age specific fertility rates and associated summary indices for each pattern of contraceptive use over the ten year period. As expected, all of these fertility rates show a tendency to drop. The decline is sharpest between simulation years 6 to 10. The first and second contraceptive patterns, those with 100% effectiveness, continue to show a moderate change in years 11 through 15. These changes in fertility rates are quite consistent with the data on contraceptive acceptance shown in Table 2. However, fertility indices for the third contraceptive pattern, with 90% effectiveness, reach a low point in the tenth year of program operation and remain virtually constant thereafter. This latter result is perhaps to be expected in view of the consequences of discontinuation of contraception which occur only under the 90% effectiveness pattern. Under this pattern of acceptance, the reduction in fertility attributable to new acceptors appears to be counterbalanced by the increase in fertility resulting from "accidental" pregnancies and discontinuance of use.

It should be noted that whereas the trend of fertility is continuously downward for each successive year of the first five years of program operation, irregularities occur in all three patterns during the eleventh to the fifteenth year.

Birth Interval Indices

In recent years, considerable interest has been expressed in using data on the intervals between successive births to develop sensitive indicators of fertility change. The commonly used indices are the mean of all closed birth intervals, the mean of the last closed birth intervals and the mean of the interval since the last birth (the open interval). The latter intervals are often calculated on a parity specific basis. Despite the intuitive appeal of these indices, they are subjected to large biases due to effect of truncation (for details, see Sheps et. al. (1969)). A number of attempts have been made to construct refined birth interval indices which control for the effects of truncation as well as for age and parity composition. These indices include life table estimates (Sheps (1965)) and the estimates developed by Poole (1973).

Parity specific interval indices have been computed for each of the first nine birth intervals. These indices are summarized by weighting the results for each of the first nine intervals by the number of women attaining each parity. Table 5 presents these weighted index for four survey points, years 5, 7, 10 and 15. As can be seen, only the unadjusted mean open interval shows a consistent tendency to lengthen at each successive time point. Moreover, the differences between year 5 and year 7 are quite small, with the largest difference appearing for the 90% effectiveness contraceptive use pattern. By year 10, differences are much more distinct. The longest interval is observed for the high acceptance rate, 100% effectiveness pattern, but the 90% effectiveness pattern continues to produce a longer interval than the moderate acceptance rates. Not until year 15 are the differences among the three patterns distinct.

The summary adjusted indices fail to show any change in birth interval length at year 7. Although longer intervals are consistently indicated by Poole's Index in year 15, the observed differences are slight.

IV. Power and Sensitivity of Fertility Indices Under Alternative Sample Sizes: Some Estimates from Replication

The results presented thus far pertain to the total simulated populations. As will be examined in more detail in the next section, decisions made on the basis of samples are subject to additional sources of error, even when the period of observation is relatively long. The major question to be answered is whether, when changes in fertility are to be inferred on the basis of sample values rather than population values, the values observed in a sample of a given size are consistent with what is occurring in the total population.

To investigate the variability of fertility indices for these experimental populations, a series of replicated samples was created. For each series, samples of women who were alive at a given time point and were between the ages of 15 and 50 were selected. A particular woman could appear only once in each sample (sampling without replacement) but could be selected into more than one sample in a given series.

Table 6 shows the results from the various sets of replicated samples. The relative variation of the sampling distributions of these indices, as measured by their coefficients of variation (the standard deviation of the values of the indices from each set of replicated runs divided by the mean value of the index), exhibits a quite consistent pattern for all sets of replicates. The coefficients of variation are highest for the age specific birth rates, at an intermediate level for the total and general fertility rates and the open interval, and lowest for the other interval measures. This pattern of relative variability sheds some light on the total population results presented earlier. The very small amounts of change seen in most of the indices based on closed intervals is likely to be in part due to the extreme stability of these indices. The somewhat erratic behavior of the age specific indices is, in contrast, partly due to their relatively high standard errors.

To investigate the significance of observed differences in fertility, the value of each fertility index was determined at years 5, 10, and 15 for each replicated sample. From these data, it was possible to calculate sets of replicated differences between year five and year fifteen, a ten year span, and over the two five year intervals from year five to ten and from year ten to fifteen. The standard errors of the differences were estimated from the distribution of the differences between time points in each replicate. Standard normal tests were then applied to test the hypothesis of no change. The results are shown in Table 7. For the high acceptance rate, 100% effectiveness pattern, all birth rate indices show significant changes over the ten year period between year five and year fifteen, except for the age specific birth rates for the youngest and oldest age groups. Among the interval indices, however, only the open interval shows a significant change. The power of these indices to detect changes declines when comparisons are made over shorter spans of time. When year five results are compared with those of year ten, only the total fertility rate and the open interval indicate a significant change. When year ten is compared with year fifteen, the open interval is the only index which would lead to rejection of the "no change" hypothesis. Quite possibly this measure is influenced by changes in the relatively distant past. To the extent that this is true, the open interval may be an inadequate index for studying current fertility changes.

When the high acceptance rate, 90% effectiveness pattern is considered, fewer indices differ significantly. Only the general fertility rate and the open interval detect the change occurring over the ten year period from year five to year fifteen. The total fertility rate shows a statistically significant difference for the period from year five to year ten, while the open interval indicates a difference from year ten to year fifteen, again raising a question about the short term sensitivity of interval indices.

These results indicate that the general fertility rate, the total fertility rate and the open interval are the measures that are likely to detect changes in fertility. Table 9 shows the power of these indices in detecting an assumed amount of change for various periods. The power is determined as the proportion of the samples showing a significant change when the amount of change observed for the total population is assumed as the true change. For all contraceptive use patterns, the general fertility rate and the total fertility rate appear to be more powerful in detecting changes over the first five years of program operation than the open interval. Over the ten year period and for the period between year ten and year fifteen, the open interval appears to be more powerful than the other two indices, except in the case of the last five years of the 100% effective pattern. The table also shows a 10% increase in the power of the total and general fertility rate with doubling the sample size from 500 to 1000 in the comparison of year five with year fifteen, 100% effectiveness.

Table 9

Power of Selected Fertility Indices in Detecting an Assumed Amount of Change for Various Periods

	High Acceptance Rates, 100% Effectiveness			
	Year 5 Vs. 15		Year 5 Vs. 10	Year 10 Vs. 15
	N=1000	N=500	N=500	N=500
General Fertility Rate	0.9984	0.9049	0.5139	0.4168
Total Fertility Rate	0.9990	0.9162	0.8315	0.6950
Open Interval	1.0000	1.0000	0.6443	0.4013
	High Acceptance Rates, 90% Effectiveness			
		N=500	N=500	N=500
General Fertility Rate	- -	0.6736	0.6443	0.0359
Total Fertility Rate	- -	0.4960	0.6950	0.0455
Open Interval	- -	0.8289	0.4013	0.5160

V. Conclusions

It should be noted that the conclusions drawn about the statistical properties of these indices pertain to the particular set of conditions governing this investigation. Their generality to other circumstances may be limited. It is especially important to note that the simulated data studied here are free of response and other types of nonsmapling errors which are

often the major problems of real-life data. Extension of this research by incorporating these factors might be very useful.

Nevertheless, these results do suggest that conventional fertility measures such as the total and general fertility rates may be more sensitive to short term changes than other types of measures. They also indicate that, under the conditions postulated for those simulations, long term effects of alternative patterns of contraceptive practice may not be easily estimated from short term results.

References

Poole, K. (1973). Fertility Measures Based on Interval Data. Theoretical Population Biology 4: 357-387.

Sheps, M.C. (1965). An Analysis of Reproductive Patterns in an American Isolate. Population Studies 19: 68-80.

Sheps, M.C., Menken, J.A., Ridley, J.C., and Lingner, J. W. (1970). The Truncation Effect in Birth Interval Data. Journal of American Statistical Association 65: 678-694.

Ridley, J.C., and Sheps, M.C. (1966). An Analytical Simulation Model of Human Reproduction with Demographic and Biological Components. Population Studies 19: 297-310.

User's Manual for POPREP and INTRVL. (1975). Department of Biostatistics, University of North Carolina at Chapel Hill.

Table 1

Distribution of Women by Age and Marital Status at the Beginning of Simulation

Age	Single	Currently Married	Widowed	Total
<1	405	0	0	405
1-4	1470	0	0	1470
5-9	1523	0	0	1523
10-14	1295	0	0	1295
15-19	441	674	3	1118
20-24	105	862	22	989
25-29	16	812	45	873
30-34	7	652	37	696
35-39	5	565	66	636
40-44	6	443	93	542
45-49	7	350	97	454
Total	5280	4358	363	10001

Table 2

Number of Acceptors Per Year, Estimated Number of Person Years Exposed to the Risk of Acceptance, Annual Acceptance Rates Per Currently Married Woman, and Proportion of Currently Married Women Using Contraception at the End of Each Simulation Year by Pattern of Contraceptive Use

	Year									
	5	6	7	8	9	10	11	12	13	14
Moderate Acceptance Rates, 100% Effectiveness										
Number of Acceptors	298	323	323	283	285	257	268	262	273	221
Estimated Number of Person Years Exposed to Risk of Acceptance	3737	3597	3446	3363	3267	3190	3113	3070	3055	3065
Annual Acceptance Rates	7.97	8.98	9.37	8.42	8.72	8.06	8.61	8.73	8.94	7.21
Proportion Using At End of Year	.0581	.1146	.1697	.2057	.2431	.2690	.2960	.3183	.3405	.3506
High Acceptance Rates, 100% Effectiveness										
Number of Acceptors	473	468	435	396	361	336	319	267	280	235
Estimated Number of Person Years Exposed to Risk of Acceptance	3671	3420	3185	3004	2845	2720	2653	2604	2594	2619
Annual Acceptance Rates	12.88	13.68	13.66	13.18	12.69	12.35	12.02	10.25	10.79	8.97
Proportion Using At End of Year	.0903	.1717	.2411	.2949	.3424	.3748	.4016	.4170	.4346	.4407
High Acceptance Rates, 90% Effectiveness										
Number of Acceptors	497	495	404	425	365	389	381	352	350	318
Estimated Number of Person Years Exposed to Risk of Acceptance	3665	3388	3185	3072	2993	2919	2890	2910	2949	2933
Annual Acceptance Rates	13.56	14.61	12.69	13.84	12.20	13.33	13.18	12.10	11.87	10.66
Proportion Using At End of Year	.0938	.1681	.2172	.2599	.2848	.3070	.3239	.3286	.3359	.3347

Table 3

Age Specific Fertility Rates and Marital Fertility Rates by Year Since Start of Simulation, Year One to Five, No Contraception

	Year				
	1	2	3	4	5
Age Group	Age Specific Fertility Rate				
15-19	189.9	203.1	196.0	205.1	205.3
20-24	369.5	352.1	366.8	364.5	369.3
25-29	384.9	395.8	397.6	359.8	384.3
30-34	312.1	344.7	291.1	341.1	289.6
35-39	212.2	215.2	220.3	219.3	207.8
40-44	87.0	80.8	74.3	81.9	91.8
45-49	2.2	2.1	2.0	6.0	7.8
General Fertility Rate	247.8	252.6	246.6	249.9	247.6
Total Fertility Rate	7789.0	7969.0	7740.0	7889.0	7780.0
Gross Reproduction Rate	3678.0	3982.0	3653.0	3895.0	3693.0

Age Group	Age Specific Marital Fertility Rate				
15-19	318.5	344.6	323.6	337.8	342.7
20-24	418.5	397.8	412.9	411.4	414.9
25-29	410.1	422.0	425.2	385.4	412.6
30-34	334.8	365.6	312.8	368.8	313.1
35-39	237.7	240.0	246.5	243.6	225.7
40-44	103.3	97.1	88.1	94.9	107.9
45-49	2.9	2.8	2.6	5.2	10.3
General Marital Fertility Rate	300.7	306.1	297.9	301.4	299.0
Total Marital Fertility Rate	9128.9	9349.1	9058.8	9235.7	9135.9

Table 4

Age Specific Fertility Rates by Pattern of Contraceptive Use and Year of Simulation

Age Group	Year 6	7	8	9	10	11	12	13	14	15
	Moderate Acceptance Rates, 100% Effectiveness									
15-19	191.2	183.2	193.9	190.6	181.1	197.2	199.6	200.1	213.0	190.8
20-24	383.1	334.2	330.2	333.1	323.1	296.2	285.5	317.6	306.9	298.5
25-29	397.7	358.8	345.9	334.6	317.4	304.8	306.1	286.7	263.6	281.2
30-34	318.6	307.8	278.3	263.0	248.4	239.1	222.1	233.6	201.0	216.8
35-39	224.0	218.1	162.0	149.7	164.8	133.5	133.8	142.4	129.3	98.2
40-44	80.5	78.4	82.4	44.9	49.9	33.1	36.1	41.6	33.1	35.9
45-49	5.6	9.2	8.9	0.0	5.1	3.4	5.0	1.7	0.0	3.3
General Fertility Rate	253.4	234.7	224.0	214.0	208.2	197.8	194.8	201.0	191.5	187.0
Total Fertility Rate	8004.0	7448.0	7008.0	6580.0	6449.0	6036.0	5941.0	6118.0	5733.0	5624.0
Gross Reproduction Rate	3929.0	3579.0	3538.0	3116.0	3255.0	2958.0	2867.0	2811.0	2778.0	2834.0
Age Group	High Acceptance Rates, 100% Effectiveness									
15-19	189.6	193.5	185.4	185.6	183.5	186.2	203.5	204.8	204.4	188.4
20-24	370.8	337.2	327.9	323.0	304.2	268.0	289.2	280.3	300.0	269.9
25-29	391.3	357.2	318.8	302.9	282.6	259.9	246.1	257.1	243.5	263.3
30-34	305.2	305.3	246.9	230.2	225.5	171.1	169.4	169.7	150.5	156.5
35-39	230.1	178.9	142.1	150.3	129.0	114.6	122.2	85.7	104.1	82.78
40-44	80.4	70.2	55.8	42.7	41.9	26.8	41.7	34.2	13.04	39.2
45-49	5.6	5.5	1.8	5.2	1.7	3.3	3.3	0.0	1.6	0.0
General Fertility Rate	248.5	230.8	207.1	201.5	190.9	170.5	178.3	173.4	172.4	167.2
Total Fertility Rate	7865.0	7239.0	6394.0	6204.0	5842.0	5150.0	5377.0	5159.0	5087.0	5000.0
Gross Reproduction Rate	3899.0	3466.0	3057.0	3081.0	3001.0	2531.0	2458.0	2499.0	2660.0	2425.0
Age Group	High Acceptance Rates, 90% Effectiveness									
15-19	189.6	192.0	193.3	184.0	181.3	191.9	187.9	210.1	197.3	197.8
20-24	395.3	320.7	332.8	329.4	307.6	326.0	325.4	308.2	329.7	300.2
25-29	384.0	345.8	339.6	333.0	302.1	334.3	320.8	336.8	311.2	334.2
30-34	309.8	309.4	288.7	255.8	256.7	235.2	239.4	245.6	254.7	238.1
35-39	214.2	170.8	210.0	180.6	156.2	136.7	147.4	133.3	119.7	145.3
40-44	77.2	62.4	57.5	62.3	39.1	52.8	44.2	42.4	39.3	31.9
45-49	5.6	3.7	5.3	1.7	0.0	0.0	3.4	1.7	3.3	4.9
General Fertility Rate	250.5	224.4	227.5	215.6	201.3	208.2	206.6	209.7	206.5	205.0
Total Fertility Rate	7883.0	7024.0	7137.0	6734.0	6215.0	6384.0	6342.0	6391.0	6276.0	6261.0
Gross Reproduction Rate	3882.0	3316.0	3546.0	3350.0	3130.0	3021.0	3204.0	3033.0	2980.0	3121.0

Table 5

Weighted Mean Interval Indices,
Currently Married Women by Year of Simulation
(in months)

Year	Unadjusted Means: Open	Last Closed	All Closed	Median Poole's Index	Life Table Median
	Moderate Acceptance Rates, 100% Effectiveness				
5	34.00	31.44	29.05	26.47	26.67
7	34.44	31.60	29.02	26.49	26.59
10	38.06	30.96	28.69	26.47	26.81
15	48.39	29.79	27.78	26.56	27.22
Year	High Acceptance Rates, 100% Effectiveness				
5	34.00	31.44	29.05	26.47	26.67
7	34.84	31.70	29.01	26.50	26.64
10	40.22	31.12	28.57	26.75	27.24
15	54.32	30.07	28.13	27.11	27.93
Year	High Acceptance Rates, 90% Effectiveness				
5	34.00	31.44	29.05	26.47	26.67
7	35.00	31.60	29.04	26.48	26.57
10	38.31	31.35	28.68	26.65	27.00
15	43.25	32.12	29.01	26.87	27.48

Table 6

Comparison of the Effect of Varying Sample Size,
High Acceptance, Rate, 100% Effectiveness Pattern of Contraceptive Use

Year	5						15					
Type of Index	(50 Replicates of 500)			(50 Replicates of 1000)			(50 Replicates of 500)			(50 Replicates of 1000)		
	$\bar{x}$	S.D.	C.V.	$\bar{x}$	S.D.	C.V.	$\bar{x}$	S.D.	C.V.	$\bar{x}$	S.D.	C.V.
Age Specific Rates												
15-19	175.6	35.6	20.27	178.1	24.4	13.70	163.9	33.3	20.32	154.6	24.8	16.04
20-24	365.3	49.8	13.63	361.2	37.4	10.35	275.3	43.2	15.69	289.8	33.8	11.66
25-29	395.4	52.7	13.33	400.6	35.2	8.79	251.6	37.7	14.98	247.4	34.2	13.82
30-34	308.3	47.9	15.54	301.4	34.9	11.58	162.9	51.7	31.74	176.4	34.7	19.67
35-39	230.0	66.2	28.78	223.4	36.8	16.47	102.1	46.7	45.74	97.9	22.2	22.68
40-44	100.5	45.2	44.98	95.6	25.1	26.26	38.4	25.7	66.93	36.9	13.7	37.13
45-49	12.9	19.4	150.40	10.9	10.6	97.25	1.4	5.7	407.14	2.7	5.5	203.70
General Fertility Rate	245.0	19.5	7.96	240.5	11.6	4.82	162.7	16.8	10.35	163.7	9.3	5.68
Total Fertility Rate	7938.3	653.0	8.23	7856.1	401.4	5.11	4978.3	556.9	11.19	5028.4	333.6	6.63
Interval Measures												
Open	33.66	2.40	7.13	34.40	1.51	4.39	54.23	2.28	4.20	54.03	1.68	3.11
Last Closed	31.19	0.95	3.05	31.23	0.69	2.21	29.99	0.90	3.00	30.04	0.63	2.10
All Closed	28.82	0.57	1.98	28.81	0.39	1.35	28.07	0.60	2.14	28.11	0.42	1.49
Median Poole's Index	26.35	0.49	1.86	26.36	0.35	1.33	27.19	0.57	2.10	27.11	0.37	1.36
Life Table Median	26.30	0.68	2.59	26.41	0.51	1.93	27.80	0.70	2.52	27.85	0.45	1.62

Table 7

Comparison of Sampling Distribution Characteristics for Selected Time Points,
High Acceptance Rates, 100% Effectiveness Pattern of Contraception Use
(50 Replicates of 500)

Year	5			7			10			15		
Type of Index	$\bar{x}$	S.D.	C.V.	$\bar{x}$	S.D.	C.V.	$\bar{x}$	S.D.	C.V.	$\bar{x}$	S.D.	C.V.
Age Specific Rates												
15-19	175.6	35.6	20.27	162.4	36.1	22.23	161.0	29.0	18.01	163.9	33.3	20.32
20-24	365.3	49.8	13.63	318.2	48.8	15.34	315.5	46.0	14.58	275.3	43.2	15.69
25-29	395.4	52.7	13.33	366.1	46.7	12.76	281.2	42.8	15.22	251.6	37.7	14.98
30-34	308.3	47.9	15.54	320.1	52.8	16.49	229.9	52.3	22.75	162.9	51.7	31.74
35-39	230.0	66.2	28.78	200.0	59.3	29.65	142.9	44.4	30.83	102.1	46.7	45.74
40-44	100.5	45.2	44.98	70.0	35.0	50.00	52.2	26.8	51.34	38.4	25.7	66.93
45-49	12.9	19.4	150.40	11.2	15.3	136.61	1.1	5.2	472.73	1.4	5.7	407.14
General Fertility Rate	245.0	19.5	7.96	225.3	19.2	8.50	188.4	12.3	6.51	162.7	16.8	10.35
Total Fertility Rate	7938.0	653.0	8.23	7240.0	638.8	8.82	5920.0	398.7	6.73	4978.3	556.9	11.21
Interval Measures												
Open	33.66	2.40	7.13	34.47	2.56	7.43	39.92	2.34	5.86	54.23	2.28	4.20
Last Closed	31.19	0.95	3.05	31.88	1.10	3.45	30.67	1.08	3.52	29.99	0.90	3.00
All Closed	28.82	0.57	1.98	29.05	0.67	2.31	28.43	0.57	2.00	28.07	0.60	2.14
Median Poole's Index	26.35	0.49	1.86	26.55	0.52	1.96	26.74	0.55	1.93	27.19	0.57	2.10
Life Table Median	26.30	0.68	2.59	26.50	0.86	3.25	27.03	0.73	2.70	27.80	0.70	2.52

Table 8

Observed Differences in Fertility Indices, Estimated Standard Errors and Z Values for Various Periods

High Acceptance Rate, 100% Effectiveness

Type of Index	Year 5 Vs. Year 15			Year 5 Vs. Year 10			Year 10 Vs. Year 15		
	Observed Differences	S.E.[1]	Z	Observed Differences	S.E.[2]	Z	Observed Differences	S.E.[2]	Z
Age Specific Rates									
15-19	-16.9	34.42	-0.49	-21.8	46.56	-0.47	4.9	40.27	0.12
20-24	-99.4	56.50	-1.76*	-65.1	76.81	-0.85	-34.3	62.66	-0.55
25-29	-121.0	50.59	-2.39***	-101.7	70.49	-1.44	-19.3	58.10	-0.33
30-34	-133.1	48.09	-2.77***	-64.1	56.67	-1.13	-69.0	70.74	-0.98
35-39	-125.0	46.43	-2.69***	-78.8	81.42	-0.97	-46.2	65.17	-0.71
40-44	-52.6	28.24	-1.86*	-49.9	46.28	-1.08	-2.7	37.78	-0.07
45-49	-7.8	11.26	-0.69	-6.1	20.85	-0.29	-1.7	7.94	-0.21
General Fertility Rate	-80.40	17.54	-4.58***	-56.7	22.31	-2.54***	-23.7	19.75	-1.20
Total Fertility Rate	-2.78	0.59	-4.71***	-1.94	0.75	-2.59***	-0.84	0.68	-1.24
Interval Measures									
Open	20.32	2.33	8.72***	6.22	3.09	2.01**	14.10	3.47	4.06***
Last Closed	-1.37	1.09	-1.26	-0.32	1.51	-0.21	-1.05	1.38	-0.76
All Closed	-0.92	0.62	-1.48	-0.48	0.76	-0.63	-0.44	0.91	-0.48
Median Poole's Index	0.64	0.56	1.14	0.28	0.74	0.38	0.36	0.70	0.51
Life Table Median	1.26	0.79	1.59	0.57	0.80	0.71	0.69	0.90	0.77

High Acceptance Rates, 90% Effectiveness[2]

Type of Index	Year 5 Vs. Year 15			Year 5 Vs. Year 10			Year 10 Vs. Year 15		
	Observed Differences	S.E.[1]	Z	Observed Differences	S.E.[2]	Z	Observed Differences	S.E.[2]	Z
Age Specific Rates									
15-19	-7.5	50.55	-0.15	-24.0	44.30	-0.54	16.5	52.24	0.32
20-24	-69.1	62.76	-1.10	-61.7	71.44	-0.86	-7.4	63.63	-0.12
25-29	-50.1	77.16	-0.65	-82.2	72.56	-1.13	32.1	82.60	0.39
30-34	-51.5	81.16	-0.63	-32.9	67.53	-0.49	-18.6	72.71	-0.26
35-39	-62.5	73.03	-0.86	-51.6	80.16	-0.64	-10.9	71.38	-0.15
40-44	-59.9	51.40	-1.17	-52.7	59.12	-0.89	-7.2	51.65	-0.14
45-49	-2.9	26.28	-0.11	-7.8	19.47	-0.40	4.9	13.54	0.36
General Fertility Rate	-42.60	20.35	-2.09**	-46.30	22.99	-2.01**	3.70	24.43	0.15
Total Fertility Rate	-1.52	0.93	-1.63	-1.57	0.73	-2.15**	0.05	0.85	0.05
Interval Measures									
Open	9.25	3.57	2.59***	4.31	3.10	1.39	4.94	2.92	1.69*
Last Closed	0.68	1.44	0.47	-0.09	1.23	-0.07	0.77	1.28	0.60
All Closed	-0.04	0.88	-0.05	-0.37	0.86	-0.43	0.33	0.91	0.36
Median Poole's Index	0.40	0.73	0.55	0.18	0.65	0.28	0.22	0.78	0.28
Life Table Median	0.81	1.00	0.81	0.33	0.88	0.38	0.48	1.07	0.45

* significant at 5% level
** significant at 1% level
*** significant at 0.1% level

1 Standard Errors estimated on the basis of 50 replications of 1,000 women aged 15-49.

2 Standard Errors estimated on the basis of 50 replications of 500 women aged 15-49.