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An Examination of the Method of Estimating Infant and Childhood Mortality : A Simulation Approach

Introduction

BRASS (1968) has developed a method to estimate infant and childhood mortality from fertility data. The technique requires observations on average number of everborn and surviving children in standard age groups for a population to derive approximate ${}_xq_0$ values. Brass obtained a set of multiplying factors to convert the proportion of children who had died of women in various age groups to the ${}_x q_0$ values. Selection of an appropriate multiplying factor depends on the shape of the fertility schedule of the population which, according to him, is indicated by the index P_l/P_2, the ratio of the average number of children born by women of age-groups 15-19 to 20-24, or m, the mean age of the fertility schedule. In fact, these multipliers have been developed by investigating a series of fertility curves formulated under the assumption of a specific relationship between fertility and age at menarche. Later, Sullivan (1972) and Trussell (1975) have studied further the Brass' multipliers by bringing in modifications in the index to measure the shape of the fertility curve, and carried their investigations by considering various other shapes for fertility curve. These two studies illustrate that the multiplying factors obtained by them could be more appropriate than the original Brass' multipliers.

Usefulness of studies on infant and childhood mortality has long been recognized and needs no elaboration. Realising the fact that most of the developing countries do not possess adequate data on deaths in infancy and childhood age, the Brass method and the later two modifications have gained considerable importance in obtaining indirectly the estimate of infant and childhood mortality.

The present study seeks to examine how effectively the methods given by Brass, Sullivan or Trussell can estimate the infant and childhood mortality under certain given patterns of fertility and mortality. Such an assesssment will be easy and efficient if number of ever born and surviving children are available for a population with given level of infant and childhood mortality. This can be accomplished with the help of a Simulation model. The aim of the study is two fold. First is to enhance our knowledge and confidence in these methods by making available more informations in this regard, and second is to illustrate the usefulness of employing simulation technique in undertaking such an investigation.

Model

A micro simulation model has been developed here to generate the distribution of number of ever born and surviving children for a group of currently married women under given fertility and mortality schedules. A group of 5000 women has been considered for this purpose. Current age of a woman is assigned in accordance with the distribution of currently married women by their age (by single year) as given by Sebastian (1970) (see Table A.I). Age at marriage for individual woman is determined next by utilizing the distribution of married women by age at marriage as given by Ridley and Sheps (1965) (see Table A.I) Fertility history of a woman is then simulated in a retrospective manner starting from age at marriage to the current age. Births to a woman have been generated in a way that the original age specific marital fertility rates (ASMFR) considered for the population gets represented (Immerwahr, 1972). Time unit for deciding the occurrence of a birth is a year. Let f_x, denote the ASMFR (per woman) for women aged x and R $(0 \leq R < 1)$ be a random number generated from a uniform rectangular distribution. If $R < f_x$, the woman is assumed to have given a birth in the year constituting the age x. However, it has been assumed that the probability for a woman to give birth in a year is zero if she has already given a birth in the previous year (Immerwahr, 1972). Consequently, the probability of a woman, who did not give birth last year, to give birth in the current year is inflated in order to simulate the given ASMFR.

It is thus possible to obtain the number of ever born children for women belonging to different age groups. In order to obtain the number of surviving children, it is necessary to test whether a child born to a woman will survive till the mother reaches her current age. This is accomplished by the help of the mortality schedule. Let ${}_x p^t_0$ $(= 1 — {}_x q^t_0)$ denote the probability that a child born at time / will survive upto age x. Sebastian (1973) has obtained the values of ${}_x p^t_0$ at an interval of one month upto the age of 3 years, and beyond that age they are given by single year for different levels of e^0_0. Assuming the level of e^0_0 for the population, the corresponding ${}_x p_0$ values have been utilized from the same study to test the survival of a child. In the model, therefore, whenever a woman is found to give a birth, a decision is taken as to which month of the year it has occurred. This has been done with the assumption that births occur uniformly over twelve months in a year. A round figure for the duration (in years) for which the child should be survived is obtained whenever the same exceeded 35 months.

The above model can, therefore, generate the number of ever born and surviving children for a group of currently married women if the fertility and mortality schedules are specified. The advantage in this approach lies in the fact that the estimates of infant and childhood mortality which are now possible to obtain by applying Brass, Sullivan or Trussell's technique could be compared directly with the actual values (which are assumed for the population in terms of ${}_X q_0$ values). Three replications have been taken for each population which enables us to obtain some idea about the standard error of the estimates.

It is known that the effectiveness of Brass' method may depend on the age pattern of fertility and mortality of the population. It may also depend on the mode in which these vital rates have been changing in the population over time. Another factor which is likely to influence the estimates is the error in reporting a dead child in the survey due to recall lapse. Survey data often suffer from such an error which is probably more common in case of the developing countries. It is, therefore, desirable to consider these aspects while trying to examine the three methods. Investigation presented subsequently has been subdivided into three sections. The distinguishing feature of these sections has been the fact that the methods of estimation of infant and childhood mortality are examined under the following assumptions respectively:

(i) level of fertility and mortality of the population remain constant throughout the period of observation, and the reporting of births and deaths are accurate,

(ii) level of fertility remains constant, but mortality changes over time according to a specified manner, and reporting is accurate, and

(iii) levels of fertility and mortality remain constant, but the reporting of dead children suffers from recall lapse error.

It is clear that no effort has been made in this study to examine the estimates under the assumption of changing fertility schedule. However, three different sets of ASMFR have been taken to understand whether a change in the age pattern of fertility would affect the efficiency of the estimates. These levels are indicated below.

TABLE 1—THREE SETS OF AGE SPECIFIC MARITAL FERTILITY RATES*
(ASMFR)

Age Croup	*Age Specific Marital Fertility Rates (ASMFR)*		
	High[1]	*Low*[2]	*Medium*[2]
15-19	223.0	263.9	351.3
20-24	310.2	228.6	238.0
25-29	280.3	110.2	128.4
30-34	222.6	44.7	57.3
35-39	158.7	15.9	21.0
40-44	69.0	4.1	2.9
45-49	27.3	0.8	

NOTE : The single year age-specific marital fertility rates were obtained by drawing a smooth free hand curve approaching the plotted points as closely as possible.

SOURCES: 1. Rao, S. L. N. : Differential Fertility in India by States. Seminar paper submitted to DTRC, 1966-67, (Mimeographed) Appendix 2, p. 20.

2. Jerzy, Berent: Cause of Fertility Decline in Eastern Europe and the Soviet Union, *Population Studies,* 1970, Vol. 24, No. 1, Table 8, p. 50.

The three levels have been designated as 'High', 'Medium' and 'Low' on the basis of their total fertility rate. The criterion behind selecting these levels was that they differed significantly in the age patterns of fertility.

It should be mentioned at this stage that the intention of the present paper is not to simulate any realistic population and, therefore, effort has not been made to consider all the inputs from one particular population. Attempt has not been made in the present study to take different levels for the distribution of currently married women by age or the distribution of married women by age at marriage.

Results and Discussion

1. *Mortality Schedule Constant and no Recall Lapse*

Five different levels of e_0^0 have been considered in this section and the data regarding number of ever born and surviving children were generated by the above model independently for the 15 combinations (5 levels of mortality and 3 levels of fertility) of fertility and mortality. Three replications have been taken for each of the 15 populations. Estimates of ${}_1q_0$, ${}_2q_0$, ${}_3q_0$ and ${}_5q_0$ are then obtained by employing Brass, Sullivan and Trussell's method. Average values of these estimates for three replicates along with their sampling and standard errors are presented in Table A.2. Actual values of these estimates, which are taken directly from the mortality schedule corresponding to a given e^0_0, are also indicated in these tables.

It could be seen that the estimates of ${}_xq_0$ (x = 1, 2, 3 and 5) by all the three methods are quite close to the corresponding actual values. In Brass method the estimates of ${}_2q_0$ and ${}_1q_0$ have minimum and maximum sampling error respectively. This fact, which has been emphasized by Brass (1968), could be observed almost invariably for all the populations. Brass has suggested that instead of estimating ${}_1q_0$ by his method, it should be read from an appropriate life table by comparing the estimated value of ${}_2q_0$. In the case of Sullivan or Trussell's method, however, the estimates of ${}_3q_0$ and ${}_5q_0$ appear to have lesser error than ${}_2q_0$ No specific pattern could be observed as to whether a change in the level of fertility or mortality affects the efficiency of the estimates. In general, the sampling error of the estimates of ${}_xq_0$ by Trussell's or Sullivan's method is less than those obtained by Brass' method. But the estimate of ${}_2q_0$ by Brass' method is found to have less error in many populations, particularly in the case of high fertility level. Another point which is not brought out very systematically but is worth mentioning is that there is a tendency in Brass' or Trussell's method to overestimate the values of ${}_xq_0$ whereas Sullivan's method underestimates them more often. Standard errors of the estimates are based on only three observations and, therefore, are likely to possess some erratic fluctuations.

2. Mortality Declining and no Recall Lapse

To judge the accuracy of the estimates in this case is difficult as there is no unique value of $_xq_0$ with which to compare the estimates. The actual $_xq_0$ values change over the years under the specific assumption of declining mortality. The three methods will provide estimates of average $_xq_0$ values and estimates will depend on the distribution of births occurring in different years as well as on how the level of mortality is changing in these years in the population. In order to have an effective comparison of these estimates, a weighted average of the $_xq_0$ values from appropriate sets of $_aqt_0$ values are obtained as the actual values. Weights are taken as the expected number of births that would occur under the given fertility schedule. Three different levels of declining mortality have been assumed. The changing e^0_0 values considered for these levels are given in Table 2. Estimated and actual values of $_xq_0$ for all the 9 different populations (3 levels each for fertility and mortality) are displayed in Table A.3.

These tables reveal that the methods provide satisfactory estimates of weighted average $_xq_0$ values and the standard errors of the estimates do not change appreciably. There is practically no change in the observations made earlier in case of constant mortality.

3. Mortality Constant but with Recall Lapse

In this case there is little change in the procedure of generating the distribution of women by ever born children for a population. It has been assumed that there exists a possibility for a woman not to report her dead children. Thus while generating the histories of a woman, if it is found that a child fails to survive till her mother reaches the current age, an additional test is carried out to see whether the child will be reported (i.e. to be included in getting her ever born children) or not. This test is made by considering appropriate probability of recall lapse. Som (1970) has studied extensively the incidence of recall lapse error and has shown that it depends on the recall period. In this paper two different levels of recall lapse have been considered which are shown in Table 3.

TABLE 2-CHANGING e^0_0 VALUES FOR THREE LEVELS OF DECLINING MORTALITY SCHEDULES

Level of Mortality	*Year of reference*														
	*t**	*t-1*	*t-2*	*t-3*	*t-4*	*t-5*	*t-6*	*t-7*	*t-8*	*t-9*	*t-10*	*t-11*	*t-12*	*t-13*	*t-14*
I	53.31	52.77	52.23	51.69	51.14	50.58	50.02	49.46	48.89	48.32	47.74	47.16	46.47	45.98	45.38
II	53.32	53.31	52.77	52.77	52.23	52.23	51.69	51.69	51.14	51.14	50.58	50.58	50.02	50.02	49.46
III	44.78	44.71	44.18	44.18	43.57	43.57	42.96	42.96	42.34	42.34	41.72	41.72	41.10	41.10	40.47

Level of Mortality	*Year of reference*														
	t-15	*t-16*	*t-17*	*t-18*	*t-19*	*t-20*	*t-21*	*t-22*	*t-23*	*t-24*	*t-25*	*t-26*	*t-27*	*t-28*	*t-29*
I	44.78	44.18	43.57	42.96	42.34	41.71	41.10	40.47	39.84	39.20	38.57	37.93	37.28	36.64	35.99
II	49.46	48.89	48.89	48.32	48.32	47.74	47.74	47.16	47.16	46.57	46.57	45,98	45.98	45.38	45.38
III	40.47	39.4	39.84	39.20	39.20	38.57	38.57	37.93	37.93	37.28	37.28	36.64	36.64	35.99	35.99

* ' t' refers to the initial period where the current age for married woman is assigned.

TABLE 3-RECALL LAPSE ERROR BY DIFFERENT RECALL PERIOD

Recall Period	*Levels of Recall Lapse*	
	I*	*II***
Less than 5 years	.060057	.105794
5-10 years	.105794	.167095
10-15 years	.167095	.247808
15-19 years	.247806	.325000

*Ajit Das Gupta *et al. :* Couple Fertility, The National Sample Survey, No. 7, p. 188,
**Arbitrary.

Impact of these two levels of recall lapse on the estimates of ${}_xq_0$ have been investigated under three different assumptions regarding recall lapse error and mortality. Estimated values of ${}_xq_0$ along with their sampling and standard errors are presented in Table A.4.

Effect of recall lapse on these estimates may not always be negligible. It depends not only on the level of recall lapse error, but also on the level of fertility and mortality of the population. Higher the level of fertility or mortality more will be the effect of recall lapse on the estimates. It is obvious that amount of underestimation will increase with the increase in the level of recall lapse. Sullivan's estimates are affected more by the incidence of recall lapse. This is expected because, as is mentioned in Section 1, his method has a tendency to underestimate the ${}_xq_a$ values even in the absence of recall lapse.

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17.	15-19	$_1q_0$		.05193	.05257	.05194	—	—.00064	—.00001	—	.01392	.01377	—
18.	20-24	$_2q_0$	$e_0^0=63.69$*	.05821	.05528	.05579	.05546	.00297	.00242	.00275	.02051	.01252	.01265
19.	25-29	$_3q_0$		.06153	.06069	.05963	.05882	.00084	.00190	.00271	.00476	.00487	.00490
20.	30-35	$_5q_0$		.06394	.06579	.06416	.06300	—.00185	—.00022	.00094	.00316	.00333	.C0316

B. Medium Level of Fertility

1.	15-19	$_1q_0$		.20677	.19168	.19982	—	.01509	.00695	—	.01617	.01576	—
2.	20-24	$_2q_0$		.25917	.26956	.26748	.25672	—.01039	—.00831	.00245	.00606	.00638	.00784
3.	25-29	$_3q_0$	$e_0^0=35.34$	.29421	.30308	.28741	.28012	—.00887	.00680	.01409	.00527	.00677	.00686
4.	30-34	$_5q_0$		.31212	.33399	.31592	.30858	—.02187	—.00380	.00354	.00920	.00697	.00742
5.	15-19	$_1q_0$		.17294	.18205	.19135	—	—.00911	—.01841	—	.01830	.02015	—
6.	20-24	$_2q_0$	$e_0^0=40.47$	.21739	.22606	.22359	.21226	—.00867	—.00620	.00513	.00995	.01002	.00990
7.	25-29	$_3q_0$		.24391	.25449	.23931	.23268	—.01058	.00460	.01123	.01148	.01085	.01039
8.	30-34	$_5q_0$		.2 876	.28080	.26286	.25693	-.02204	-.00410	.03183	.01094	.00926	.00927
9.	15-19	$_1q_0$		.13816	.11683	.12249	—	.02133	.01567	—	.00790	.00835	—
10.	20-24	$_2q_0$		.17397	.17570	.17392	-.17410	—.00173	.00005	.C0013	—.00524	.00513	.00436
11.	25-29	$_3q_0$	$e_0^0=46.57$	.19262	.19690	.18544	.19232	—.00428	.00718	—.00030	.00346	.00262	.01568
12.	30-34	$_5q_0$		.20401	.22259	.20871	.20535	—.01858	—.00470	—.00134	.00899	.00868	.00500
13.	15-19	$_1q_0$		.09857	.09906	.10391	—	—.00049	—.00534	—	.00445	.00457	—
14.	20-24	$_2q_0$		.11836	.12445	.12326	.10924	—.00609	—.00490	.00912	.00614	.00604	.00917
15.	25-29	$_3q_0$	$e_0^0=54.17$*	.12708	.13929	.13135	.12386	—.01221	- .00427	.00322	.00100	.00110	.00716
16.	30-34	$_5q_0$		.13270	.14650	.13746	.13236	—.01380	—.00476	.00034	.00177	.00177	.00374
17.	15-19	$_1q_0$		.05193	.05096	.05319	—	.00097	—.00126	—	.01110	.01164	—
18.	20-24	$_2q_0$	$e_0^0=63.69$*	.05821	.06171	.06120	.05865	—.00350	—.00299	—.00044	.00340	.00332	.00316
19.	25-29	$_3q_0$		.06153	.07288	.06904	.06727	—.01135	.00751	—.00574	.00377	.00364	.00374
20.	30-34	$_5q_0$		.06394	.06630	.06246	.06103	—.00236	.00148	.00291	.00107	.00086	.00100

Table A.2 *(contd. on page* 208)

Table A.2 *(contd. from page* 207)

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
C. Low Level of Fertility													
1.	15-19	${}_1q_0$		.20677	.19113	.19856	_	.01564	.00821	_	.01317	.01303	—
2.	20-24	${}_2q_0$		.25917	.27724	.27343	.26040	—.01807	- .01426	—.00123	.00268	.00267	.00200
3.	25-29	${}_3q_0$	$e_0^0=35.34$	.29421	.30491	.28476	.28013	—.01070	.00945	.01408	.00313	.00357	.00100
4.	30-34	${}_5q_0$		.31212	,33816	.31825	.31290	—.02604	— .C0513	—.00078	.00800	.00870	.00812
5.	15-19	${}_1q_0$		.17294	.14267	.14738	—	.03027	.02556	—	.00931	.00934	—
6.	20-24	${}_2q_0$	$e_0^0=40.47$	.21739	.20857	.20728	.19882	.00882	.01011	.01857	.00806	.00767	.00648
7.	25-29	${}_3q_0$		.24391	.24664	.23396	.22899	—.00275	.00995	.01492	.00892	.00759	.00748
8.	30-34	${}_5q_0$		.25876	.28094	.26621	.26123	—.02218	—.00745	.00247	.00243	.00165	.00100
9.	15-19	${}_1q_0$		.13816	.10785	.11124	—	.03031	.02692	—	.02709	.02822	—
10.	20-24	${}_2q_0$		.17397	.18218	.18120	.17410	—.00320	—.00723	—.00013	.00284	.00317	.00424
11.	25-29	${}_3q_0$	$e_0^0=46.57$	.19262	.20661	.19634	.19232	—.01399	—.00372	.00030	.01610	.01602	.01568
12.	30-34	${}_5q_0$		.20401	.22040	.20912	.20535	—.01639	—.00511	—.00134	.00602	.00515	.00500
13.	15-19	${}_1q_0$		.C9857	.08102	.08353	—	.01755	.01504	—	.01617	.01708	—
14.	20-24	${}_2q_0$		11836	.11427	.11366	.10924	.00409	.00470	.00912	.00967	.00954	.00917
15.	25-29	${}_3q_0$	$e_0^0=54.17$*	.12708	.13305	.12645	.12386	—.00597	.00063	.00322	.00660	.00630	.00616
16.	30-34	${}_5q_0$		.13270	.14200	.13480	.13236	—.00930	—.00210	.00034	.00310	.00407	.00374
17.	15-19	${}_1q_0$		.05193	.05053	.05237	—	.00140	—.00044	—	.01836	.01902	—
18.	20-24	${}_2q_0$	$e_0^0=63.69$*	.05821	.06321	.06270	.05981	—.00500	— .00449	—.00160	.00147	.00149	.00173
19.	25-29	${}_3q_0$		.06153	.06817	.06434	.06292	—.00664	—.00281	—.00139	.00600	.00549	.00539
20.	30-34	${}_5q_0$		.06394	.06851	.06467	.06350	—.00457	—.00073	.00044	.00205	.00185	.002CO

*For taking *lx* values corresponding to $e^0_0 = 54.17$ and $e^0_0 = 63.69$ the use of United States Life Tables and Acturial Tables prepared by Thomas N. E. Greville has been made.

TABLE A.3—ESTIMATED $_xq_0$, VALUES AND ITS SAMPLING AND STANDARD ERRORS UNDER THREE DIFFERENT ASSUMPTIONS REGARDING DECLINING MORTALITY

	Age of women	*Proportion dead by age x* (*?o)	*Level of mortality*	*Weighted average*	*Estimate of ^q^ values by different methods*			*Sampling error of the estimated yfJa by different methods*			*Estimated standard error of the estimate* 0/rfo *bv different methods*		
					Brass	*Trussell*	*Sullivan*	*Brass*	*Trussell*	*Sullivan*	*Brass*	*Trusset*	*Sullivan*
	(1)	*(2)*	*(3)*	*(4)*	(5)	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*
					A.High level of fertility								
1.	15-19	$_1q_0$		.10681	.08766	.08757	_	.01915	.01924	—	.01523	.01545	—
2.	20-24	$_2q_0$	I	.14078	.13985	.14097	.13986	.00093	— .00019	.00092	.00402	.OC402	.00410
3.	25-29	$_3q_0$		.16396	.16292	.15976	.15755	.00104	.00420	.00641	.00413	.00416	.00407
4.	30-34	$_5q_0$		.19287	.18878	.18379	.18049	.00409	.00908	.01238	.00097	.00120	.00122
5.	15-19	$_1q_0$		.10576	.12449	.12412	—	—.01875	-.01836	—	.01530	.02581	—
6.	20-24	$_2q_0$	II	.13589	.13990	.14118	.14057	—.00401	.00529	.00468	.00468	.00415	.00401
7.	25-29	$_3q_0$		.15293	.15130	.14887	.14680	.00163	.00406	.00613	.00667	.OC570	.00560
8.	30-34	$_5q_0$		.17393	.17008	.16613	.16287	.00385	.00780	.01106	.00890	.00927	.00886
9.	15-19	$_1q_0$		.14819	.12804	.12752	—	.02015	.02067	—	.01376	.01338	—
10.	20-24	$_2q_0$	III	.19037	.18668	.18802	.18567	.00369	.00235	.00468	.00408	.00424	.00498
11.	25-29	$_3q_0$		.21786	.22139	.21391	.21110	—.00353	.00395	.00676	.00696	.00325	.00333 ,
12.	30-34	$_5q_0$		.24825	.23206	.22519	.22190	.01618	.02306	.02635	.00601	.00530	.00586

Table A.3 *(contd. on page* 210)

Table A. 3 *(contd. from page* 209)

(1)	(2)	(3)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
							B. Medium level of fertility						
1.	15-19	${}_1q_0$		.10697	.10510	.11203	—	.00187	-.00506	—	.01314	.01390	—
2.	20-24	${}_2q_0$	I	.14174	.13566	.13404	.12681	—.00608	.00770	.01493	.00892	.00875	.00822
3.	25-29	${}_3q_0$		.16649	.16950	.15898	.15444	—.00301	.00751	.01205	.00365	.00343	.00330
4.	30-34	${}_5q_0$		.19925	.20097	.18771	.18347	—.00172	.01154	.01578	.00213	.00212	.00233
5.	15-19	${}_1q_0$		.10583	.07840	.08297	—	.02743	.02286	—	.02045	.02169	—
6.	20-24	${}_2q_0$	II	.13636	.13778	.13650	.13012	—.00142	—.00014	.00624	.00372	.00353	.00274
7.	25-29	${}_3q_0$		.15445	.15958	.15053	.14660	—.00513	.00392	.00785	.00880	.00800	.00775
8.	30-34	${}_5q_0$		.17677	.18799	.17922	.17269	—.01122	—.00245	.00408	.00688	.00916	.00658
9.	15-19	${}_1q_0$		.14828	.14149	.15016	—	.00679	—.00188	—	.01077	.01174	—
10.	20-24	${}_2q_0$	II T	.91105	.19499	.19295	.18341	—.00394	—.00190	.00764	.00672	.00669	.00645
11.	25-29	${}_3q_0$		.22002	.23252	.21886	.21292	—.01250	.00116	.00710	.00395	.00376	.00362
12.	30-34	${}_5q_0$		.25248	.26227	.24578	.24031	—.00979	.00670	.01217	.00209	.00194	.02200

C. Low level of fertility

1.	15-19	$_1q_0$		.10681	.09118	.09358	—	.01563	.01323	—	.02713	.02716	—
2.	20-24	$_2q_0$	I	.14122	.13096	.13044	.12598	.01026	.01078	.01524	.00376	.00391	.00439
3.	25-29	$_3q_0$		.16516	.17082	.16290.	.15957	—.00566	.00226	.00559	.00840	.00658	.00612
4.	30-34	$_5q_0$		.19735	.20075	.19023	.18652	—.00340	.00712	.01083	.00623	.00789	.00775
5.	15-19	$_1q_0$		.10575	.07524	.07774	—	.03051	.02801	—	.01478	.01549	___
6.	20-24	$_2q_2$	11	.13611	.14478	.14399	.13857	—.00867	—.00788	—.00246	.00482	.00503	.00552
7.	25-29	$_3q_0$		.15383	.16095	.15311	.14986	—.00712	.00072	.00397	.01563	.01563	.01547
8.	30-34	$_5q_0$		.17592	.18185	.17255	.16914	—.00593	.00337	.00678	.00376	.00321	.00313
9.	15-19	$_1q_0$		.14818	.13827	.14417	—	.00991	.00401	—	.01424	.01305	. __
10.	20-24	$_2q_0$	III	.19068	.19522	.19377	.18463	—.00454	— .00309	.00605	.01390	.01341	.01164
11.	25-29	$_3q_0$		.21914	.21934	.20707	.20260	—.00030	.01207	.01654	.00699	.00471	.00428
12.	30-34	$_5q_0$		.25117	.25112	.23716	.23310	.00005	.01401	.01807	00357	.00414	.00386

TABLE A.4— ESTIMATE OF ^$_0$ AND ITS SAMPLING AND STANDARD ERROR UNDER DIFFERENT LEVELS OF MORTALITY AND RECALL LAPSE

Age oj •women	Proportion dead by age x ($_xq_0$)	Level of mortality and probability of recall lapse*	Actual value of xqo (input)	Average estimated values of $_xqo$ by different methods			Sampling error of the estimated $_xq_0$ by different methods			Estimated standard error of the estimates of $_xq$^ bv different methods		
				Brass	Trussell	Sullivan	Brass	Trusell	Sullivan	Brass	Trussell	Sullivan
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		A. High level of fertility										
1. 15-19	$_1q_0$	I	.17294	.12648	.12455	—	.04646	.04839	—	.03718	.03651	—
2. 20-24	$_2q_0$		.21739	.20097	.20295	.20333	.01642	.01444	.01406	.00518	.00539	.00656
3. 25-29	$_3q_0$		.24391	.23242	.23014	.22691	.01149	.01377	.01700	.01149	.01276	.01249
4. 30-34	$_5q_0$		.25876	.24882	.24418	.23871	.00994	.01458	.02005	.00762	.00700	.00728
5. 15-19	$_1q_0$	II	.13816	.12585	.12437	—	.01231	.01379	—	.02982	.02953	—
6. 20-24	$_2q_0$		.17397	.15865	.16036	.16007	.01532	.01361	.01390	.00256	.00200	.00200
7. 25-29	$_3q_0$		.19262	.17055	.17065	.16822	.02197	.02197	.02440	.00606	.00283	.00283
8. 30-34	$_5q_0$		.20401	.17683	.17299	.16933	.02718	.03102	.03468	.00972	.01000	.00959
9. 15-19	$_1q_0$	III	.09857	.07993	.07897	—	.01864	.01960	—	.01485	.01466	—
10. 20-24	$_2q_0$		.11836	.10783	.10874	.10793	.01053	.00962	.01043	.00319	.00316	.00316
11. 25-29	$_3q_0$		.12708	.11962	.11729	.1 1568	.00746	.00979	.01140	.00698	.00728	.00714
12. 30-34	$_5q_0$		.13270	.12943	.12612	.12386	.00327	.00658	.00884	.00605	.00656	.00600

B. Medium level *of* fertility

1.	15-19	$_1q_0$	I	.17294	.16142	.16972	—	.01152	.00322	—	.01862	.01918	—
2.	20-24	$_2q_0$		.21739	.21575	.21299	.20215	.00164	.00440	.01524	.00620	.00624	.00640
3.	25-29	$_3q_0$		.24391	.23842	.22391	.21756	.00549	.02000	.02635	0.1111	.01025	.00989
4.	30-34	$_5q_0$		.25876	.24577	.23018	.2~441	.01299	.07858	.03435	.00523	.00566	.00538
5.	15-19	$_1q_0$	II	.13816	.12651	.13225	—	.01165	.00591	__	.01592	.01655	_
6.	20-24	$_2q_0$		.17397	.16661	.16489	.15820	.00736	.00908	.01577	.01650	.01664	.01709
7.	25-29	$_3q_0$		.19262	.18091	.17122	.16667	.00171	.02140	.02595	.00278	.00387	.00360
8.	30-34	$_5q_0$		.20401	.18867	.17777	.17317	.01534	.02624	.03084	.00871	.00849	.00812
9.	15-19	$_1q_0$	III	.09857	.07303	.07860	—	.02554	.01997	—	.01797	.01778	-
10.	20-24	$_2q_0$		.11836	.11327	.11203	.09914	.00509	.00633	.01922	.00867	.00854	.00837
11.	25-29	$_3q_0$		.12708	.12035	.11254	.11253	.00673	.01454	.01455	.00224	.00141	.00538
12.	30-34	$_5q_0$		.13270	.12649	.11913	.11720	.00621	.01357	.01550	.00567	.00539	.00400

Table 4 *(contd. on page 214)*

Table 4 *(contd, from page 213)*

(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(S)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*
					C. Low level of fertility							
1. 15-19	$_1q_0$		.17294	.13412	.13872	—	.03882	.03422	—	.02013	.02074	—
2. 20-24	$_2q_0$	I	.21739	.21174	.21035	.20166	.00565	.00704	.01573	.01150	.01170	.00114
3. 25-29	$_3q_0$		.24391	.22971	.21778	.21307	.01417	.02613	.03084	.00479	.00510	.00500
4. 30-34	$_5q_0$		.22876	.25847	.24367	.23903	.00029	.01509	.01973	.00709	.00510	.00479
5. 15-19	$_1q_0$		.13816	.12479	.12898	—	.01337	.00918	—	.01630	.01652	—
6. 20-24	$_2q_0$	II	.17397	.15241	.15141	.14506	.02156	.02256	.02891	.01640	.01609	.01476
7. 25-29	$_3q_0$		.19262	.17636	.16711	.16351	.01626	.02551	.02911	.00986	.00825	.00800
8. 30-34	$_5q_0$		.20401	.18756	.17156	.17424	.01645	.02645	.02977	.00640	.00574	.00575
9. 15-19	$_1q_0$		.09857	.07516	.07740	—	.02341	.02117	—	.00984	.01034	—
10. 20-24	$_2q_0$	III	.11836	.11525	.11491	.11088	.00311	.00345	.00748	.00455	.00424	.00412
11. 25-29	$_3q_0$		.12708	.17186	.11644	.11375	.00522	.01064	.01333	.00420	.00748	.00346
12. 30-34	$_5q_0$		.13270	.12022	.11432	.11208	.01248	.01838	.02062	.00367	.00332	.00316

*I : e^0_0 = 40.47 (First level of recall lapse)

II : e^0_0 = 46.57 (Second level of recall lapse)

III: e^0_0 = 54.17 (First level of recall