Chapter IV

TRUSSELL VERSION OF THE BRASS METHOD

This version of the Brass method was developed during the late 1970s by T. J. Trussell (United Nations, 1983b, chap. III). It is based on the Coale-Demeny model life tables, and it has the advantage over earlier versions of producing estimates both of probabilities of dying from birth to different ages in childhood and of the time point to which each probability refers.

The following section presents step by step the computational procedure to be followed in applying the Trussell version. The case of Bangladesh is then used to give a detailed example of its application.

COMPUTATIONAL PROCEDURE

Step 1. *Calculation of average parity per woman*

Average parity is the average number of children ever borne by women in a given five-year age group. It is calculated as

$$P(i) = \frac{CEB(i)}{FP(i)} \qquad (4.1)$$

where $P(i)$ is the average parity of women of age group i, $CEB(i)$ is the total number of children ever borne by these women, and $FP(i)$ is the total number of women in the age group irrespective of their marital or reporting status. Although parity values are needed only for age groups 15-19, 20-24 and 25-29—$P(1)$, $P(2)$ and $P(3)$, respectively—it is worth calculating the whole set up to age group 45-49 in order to check the quality of the basic data. Note that the denominator, $FP(i)$, should include even those women who did not respond to the questions on children ever born (those of not-stated parity). Their inclusion is based on the assumption that they are childless, an assumption supported by evidence from a large number of surveys showing that the vast majority of younger women reported as being of not-stated parity are, in fact, childless.

Step 2. *Calculation of the proportions dead among children ever born*

The proportion of children dead is given simply by the ratio of the total number of dead children to the total number of children ever born (including those who have died) for each age group. Thus,

$$D(i) = \frac{CD(i)}{CEB(i)} \qquad (4.2)$$

where $D(i)$ is the proportion of children dead for women of age group i, $CD(i)$ is the number of children dead reported by those women, and $CEB(i)$ is the total number of children ever borne by those women.

Step 3. *Calculation of the multipliers,* k(i)

The basic estimation equation for the Trussell method is

$$q(x) = k(i)\,D(i) \qquad (4.3)$$

where

$$k(i) = a(i) + b(i)\,\frac{P(1)}{P(2)} + c(i)\,\frac{P(2)}{P(3)} \qquad (4.4)$$

Thus, the mortality measure $q(x)$, the probability of dying by exact age x, is related to the proportion dead $D(i)$ by a multiplying factor $k(i)$ that is determined by the parity ratios $P(1)/P(2)$ and $P(2)/P(3)$ and three coefficients $a(i)$, $b(i)$ and $c(i)$. These coefficients were estimated by regression analysis of simulated model cases. Table 4 shows the coefficients for the seven age groups of women, from ages 15-19 through ages 45-49 ($i = 1, \ldots, 7$), and for the four regional families of the Coale-Demeny model life tables.

Step 4. *Calculation of the probabilities of dying by age* x, q(x)

Once $D(i)$ and $k(i)$ have been calculated for each age group i, estimates of $q(x)$ are obtained simply as their product, as already indicated in equation 4.3:

$$q(x) = k(i)D(i)$$

Step 5. *Calculation of the reference dates for* q(x), t(i)

As explained earlier, under conditions of steady mortality change over time, a reference time, $t(i)$, can be estimated for each $q(x)$ estimated in step 4. This reference time is expressed in terms of number of years before the survey or census and is estimated through the use of coefficients applied to parity ratios. As before, the coefficients were estimated by regression analysis of simulated model cases. The estimating equation is

$$t(i) = e(i) + f(i)\frac{P(1)}{P(2)} + g(i)\frac{P(2)}{P(3)} \qquad (4.5)$$

Table 5 shows the coefficients $e(i)$, $f(i)$ and $g(i)$ for use in equation 4.5 for each age group of women and for each of the four Coale-Demeny model-life-table families.

Once values of $t(i)$ are obtained, they can be converted into actual dates by subtracting them from the reference date of the survey or census expressed in decimal terms, as illustrated in the detailed example below.

Step 6. *Conversion to a common index*

Steps 4 and 5 provide estimates of $q(x)$ for ages x of 1, 2, 3, 5, 10, 15 and 20 and of $t(i)$, the number of years

TABLE 4. COEFFICIENTS FOR THE ESTIMATION OF CHILD-MORTALITY MULTIPLIERS, $k(i)$, TRUSSELL VERSION OF THE BRASS METHOD, USING THE COALE-DEMENY MORTALITY MODELS

Model	Age group of mother (1)	Age group Index i (2)	Age x of children (3)	Coefficients $a(i)$ (4)	$b(i)$ (5)	$c(i)$ (6)
North	15-19	1	1	1.1119	−2.9287	0.8507
	20-24	2	2	1.2390	−0.6865	−0.2745
	25-29	3	3	1.1884	0.0421	−0.5156
	30-34	4	5	1.2046	0.3037	−0.5656
	35-39	5	10	1.2586	0.4236	−0.5898
	40-44	6	15	1.2240	0.4222	−0.5456
	45-49	7	20	1.1772	0.3486	−0.4624
South	15-19	1	1	1.0819	−3.0005	0.8689
	20-24	2	2	1.2846	−0.6181	−0.3024
	25-29	3	3	1.2223	0.0851	−0.4704
	30-34	4	5	1.1905	0.2631	−0.4487
	35-39	5	10	1.1911	0.3152	−0.4291
	40-44	6	15	1.1564	0.3017	−0.3958
	45-49	7	20	1.1307	0.2596	−0.3538
East	15-19	1	1	1.1461	−2.2536	0.6259
	20-24	2	2	1.2231	−0.4301	−0.2245
	25-29	3	3	1.1593	0.0581	−0.3479
	30-34	4	5	1.1404	0.1991	−0.3487
	35-39	5	10	1.1540	0.2511	−0.3506
	40-44	6	15	1.1336	0.2556	−0.3428
	45-49	7	20	1.1201	0.2362	−0.3268
West	15-19	1	1	1.1415	−2.7070	0.7663
	20-24	2	2	1.2563	−0.5381	−0.2637
	25-29	3	3	1.1851	0.0633	−0.4177
	30-34	4	5	1.1720	0.2341	−0.4272
	35-39	5	10	1.1865	0.3080	−0.4452
	40-44	6	15	1.1746	0.3314	−0.4537
	45-49	7	20	1.1639	0.3190	−0.4435

Estimation equations:

$$k(i) = a(i) + b(i)\frac{P(1)}{P(2)} + c(i)\frac{P(2)}{P(3)}$$

$$q(x) = k(i)\ D(i)$$

Source: *Manual X: Indirect Techniques for Demographic Estimation,* Population Studies, No. 81 (United Nations publication, Sales No. E.83.XIII.2), p. 77.

before the survey to which each estimate applies. In order to analyse trends and facilitate comparison both within and between data sets, each estimated $q(x)$ is converted to a single measure. Although any index from the model-life-table family can be used for that purpose, it is suggested that a measure of mortality in childhood that is not particularly sensitive to the pattern of mortality be selected. The common index recommended is the probability of dying by age 5, $q(5)$, also called under-five mortality. The use of infant mortality as the common index is not recommended because, as will be seen, the estimates of $q(1)$ obtained from the conversion are very sensitive to the mortality pattern underlying the different models.

The $q(x)$ values corresponding to the model-life-table family being considered can be used to carry out the required conversions. The tables in annex I contain the necessary values of $q(x)$ ordered by mortality level and expectation of life for each of the Coale-Demeny families of model life tables (see chap. I) and for males, females and both sexes separately. The actual conversion is carried out by linear interpolation between tabulated values, as explained below.

Suppose that an estimated value of $q(x)$, denoted by $q^e(x)$, is to be converted to the corresponding $q^c(5)$ where, of course, $x \neq 5$. For a given model-life-table family and sex, it is first necessary to identify the mortality levels with $q(x)$ values that enclose the estimated value, $q^e(x)$. Thus, the task is to identify in the appropriate table of annex I levels j and $j+1$ such that

$$q^j(x) > q^e(x) > q^{j+1}(x) \qquad (4.6)$$

where $q^j(x)$ and $q^{j+1}(x)$ are the model values of $q(x)$ for levels j and $j+1$, respectively, and $q^e(x)$ is the estimated value. Then, the desired common index $q^c(5)$ is given by

$$q^c(5) = (1.0 - h)\, q^j(5) + h\, q^{j+1}(5) \qquad (4.7)$$

where h is the interpolation factor calculated in the following way:

TABLE 5. COEFFICIENTS FOR THE ESTIMATION OF THE TIME REFERENCE, $t(i)$[a], FOR VALUES OF $q(x)$, TRUSSELL VERSION OF THE BRASS METHOD, USING THE COALE-DEMENY MORTALITY MODELS

Model	Age group of mother (1)	Age group Index i (2)	Estimated $q(x)$ (3)	Coefficients $e(i)$ (4)	$f(i)$ (5)	$g(i)$ (6)
North	15-19	1	$q(1)$	1.0921	5.4732	−1.9672
	20-24	2	$q(2)$	1.3207	5.3751	0.2133
	25-29	3	$q(3)$	1.5996	2.6268	4.3701
	30-34	4	$q(5)$	2.0779	−1.7908	9.4126
	35-39	5	$q(10)$	2.7705	−7.3403	14.9352
	40-44	6	$q(15)$	4.1520	−12.2448	19.2349
	45-49	7	$q(20)$	6.9650	−13.9160	19.9542
South	15-19	1	$q(1)$	1.0900	5.4443	−1.9721
	20-24	2	$q(2)$	1.3079	5.5568	0.2021
	25-29	3	$q(3)$	1.5173	2.6755	4.7471
	30-34	4	$q(5)$	1.9399	−2.2739	10.3876
	35-39	5	$q(10)$	2.6157	−8.4819	16.5153
	40-44	6	$q(15)$	4.0794	−13.8308	21.1866
	45-49	7	$q(20)$	7.1796	−15.3880	21.7892
East	15-19	1	$q(1)$	1.0959	5.5864	−1.9949
	20-24	2	$q(2)$	1.2921	5.5897	0.3631
	25-29	3	$q(3)$	1.5021	2.4692	5.0927
	30-34	4	$q(5)$	1.9347	−2.6419	10.8533
	35-39	5	$q(10)$	2.6197	−8.9693	17.0981
	40-44	6	$q(15)$	4.1317	−14.3550	21.8247
	45-49	7	$q(20)$	7.3657	−15.8083	22.3005
West	15-19	1	$q(1)$	1.0970	5.5628	−1.9956
	20-24	2	$q(2)$	1.3062	5.5677	0.2962
	25-29	3	$q(3)$	1.5305	2.5528	4.8962
	30-34	4	$q(5)$	1.9991	−2.4261	10.4282
	35-39	5	$q(10)$	2.7632	−8.4065	16.1787
	40-44	6	$q(15)$	4.3468	−13.2436	20.1990
	45-49	7	$q(20)$	7.5242	−14.2013	20.0162

Estimation equation:

$$t(i) = e(i) + f(i)\frac{P(1)}{P(2)} + g(i)\frac{P(2)}{P(3)}$$

Source: *Manual X: Indirect Techniques for Demographic Estimation*, Population Studies, No. 81 (United Nations publication, Sales No. E.83.XIII.2), p. 78.

[a]Number of years prior to the survey.

$$h = \frac{q^e(x) - q^j(x)}{q^{j+1}(x) - q^j(x)} \quad (4.8)$$

If the data on children ever born and children dead are for both sexes combined, the model $q^j(x)$ values should be taken from the tables for both sexes combined in annex I. If, however, the data are for male and female children separately, the estimated values of $q(x)$ will be sex-specific, and the conversion to a common index should use the model $q^j(x)$ values from the tables for the relevant sex, also presented in annex I.

Step 7. *Interpretation and analysis of results*

Once seven estimates (one for each age group i of women) of the selected common index—$q^c(5)$ as suggested above—have been obtained, it is recommended that they be plotted against time. As noted in step 5, the $t(i)$ values can be converted into reference dates by subtracting them from the survey or census reference date (or the approximate midpoint of the field-work), and the $q^c(5)$ estimates can then be plotted against the resulting dates. Graphical presentation of the results is essential to assess the consistency and general trend of the estimates, as the example below illustrates.

A DETAILED EXAMPLE

Compilation of the data required

The data gathered by the 1974 Bangladesh Retrospective Survey of Fertility and Mortality will be used to illustrate the application of the Trussell version of the Brass method. In chapter II, the data necessary to apply the method were compiled in displays 6 and 7 (they are shown here again for convenience). Since the basic data are available by sex, they will be used to check the internal consistency of the information on children ever born.

Table 6 illustrates how the sex ratio at birth is calculated from the data on children ever born for different age groups of mother by dividing the number of male children by the number of female children ever born. The sex ratio at birth is biologically determined and varies relatively little, ranging usually between 1.03 and 1.08 male births per female birth. Table 6 shows that up

Display 6. Second step in the compilation of data on children ever born and children dead for Bangladesh

	Age group of mother	Children ever born (1) = (2) + (3) = (2) + (4) + (5)	Children dead (2) = (1) − (3) = (1) − (4) − (5)	Children surviving (3) = (4) + (5)	Children living at home (4)	Children living elsewhere (5)
Both sexes	15-19	1 160 919	215 365		921 227	24 327
	20-24	4 901 382	997 384		3 820 649	83 349
	25-29	9 085 852	1 937 955		6 927 908	219 989
	30-34	9 910 256	2 261 196		7 126 473	522 587
	35-39	10 384 001	2 490 168		6 974 267	919 566
	40-44	9 164 329	2 415 023		5 472 460	1 276 846
	45-49	6 905 673	1 959 544		3 664 328	1 281 801
Male	15-19	597 248	117 165		469 036	11 047
	20-24	2 507 018	529 877		1 938 220	38 921
	25-29	4 675 978	1 047 294		3 545 904	82 780
	30-34	5 109 487	1 204 582		3 780 859	124 046
	35-39	5 435 726	1 333 957		3 925 071	176 698
	40-44	4 883 599	1 291 745		3 323 724	268 130
	45-49	3 714 957	1 030 737		2 393 149	291 071
Female	15-19	563 671	98 200		452 191	13 280
	20-24	2 394 364	467 507		1 882 429	44 428
	25-29	4 409 874	890 661		3 382 004	137 209
	30-34	4 800 769	1 056 614		3 345 614	398 541
	35-39	4 948 275	1 156 211		3 049 196	742 868
	40-44	4 280 730	1 123 278		2 148 736	1 008 716
	45-49	3 190 716	928 807		1 271 179	990 730

Source: Bangladesh, Census Commission, *Report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality* (Dacca, 1977), table 8, p. 37 (reproduced in display 3 above).

Display 7. Compilation of data on the total number of women by age group for Bangladesh

Age group of women	Total number of women (1) = (2)+(3) = (4)+(5)	Ever-married women (2)	Single women (3)	Women of stated parity (4)	Women of not-stated parity (5)
15-19	3 014 706				
20-24	2 653 155				
25-29	2 607 009				
30-34	2 015 663				
35-39	1 771 680				
40-44	1 479 575				
45-49	1 135 129				

Source: Bangladesh, Census Commission, *Report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality* (Dacca, 1977), table 3, p. 28 (reproduced in display 4 above).

to age group 30-34 the reported numbers of male and female children ever born yield sex ratios at birth within the expected range. Over age 35, however, the sex ratios at birth are too high, implying that too many males were reported relative to females. Such a pattern suggests that the data on children ever born corresponding to older women (aged 35 and over) are probably affected by the omission of female children, though misreporting of the children's sex also could give rise to the same pattern.

TABLE 6. CALCULATION OF THE SEX RATIO AT BIRTH FROM DATA ON CHILDREN EVER BORN, CLASSIFIED BY SEX, FROM THE 1974 BANGLADESH RETROSPECTIVE SURVEY

Age group of mother (1)	Male children ever born (2)	Female children ever born (3)	Sex ratio at birth (4)=(2)/(3)
15-19	597 248	563 671	1.060
20-24	2 507 018	2 394 364	1.047
25-29	4 675 978	4 409 874	1.060
30-34	5 109 487	4 800 769	1.064
35-39	5 435 726	4 948 275	1.099
40-44	4 883 599	4 280 730	1.141
45-49	3 714 957	3 190 716	1.164

Computational procedure

Step 1. *Calculation of average parity per woman*

To apply the method, average parities are used to calculate the parity ratios $P(1)/P(2)$ and $P(2)/P(3)$. Thus, parities need to be calculated only for women aged 15-19, 20-24 and 25-29. However, it is good practice to calculate parities for all seven age groups of women, because they can reveal problems with the basic data.

In this example mortality will be estimated for both sexes combined, so parities should be calculated using the data on children ever born of both sexes appearing in the top panel of display 6. Each parity $P(i)$ will therefore be obtained by dividing those numbers by the total number of women shown in display 7, age group by age group. Thus, for women aged 25-29 ($i=3$),

$$P(3) = \frac{9,085,852}{2,607,009} = 3.4852$$

Column 3 of table 7 shows the complete set of average parities by age group. Notice that they do not increase steadily with age. In particular, the average parity for women aged 45-49 is lower than that for women aged 40-44, which is not consistent with the existence of constant fertility in the past. The increase in the average parity from age group 35-39 to age group 40-44 also seems too small. Such a pattern of change with age in the average parities, coupled with the high sex ratios at birth noticed among the children of older women, strongly suggests that there are omission errors in their reports of lifetime fertility. Because dead children are more likely to be omitted than live ones, evidence of omission requires that the resulting mortality estimates be interpreted with caution.

Step 2. *Calculation of the proportions dead among children ever born*

The proportions dead, denoted by $D(i)$, are calculated as the ratios of the number of children dead to the number of children ever borne by women of each age group i. Such ratios are obtained in this case by dividing the entries in column 2 of display 6 by those of column 1

TABLE 7. APPLICATION OF THE TRUSSELL VERSION OF THE BRASS METHOD TO DATA ON BOTH SEXES FROM THE 1974 BANGLADESH RETROSPECTIVE SURVEY

Age group of mother *(1)*	*Age group index* *(i)* *(2)*	*Average parity* *P(i)* *(3)*	*Proportion dead* *D(i)* *(4)*	*Multiplier* *k(i)* *(5)*	*Age* *x* *(6)*	*Probability of dying by age x, q(x)* *(7)*	*Time reference* *t(i)* *(8)*	*Reference date* *(9)*	*Common index* $q^c(5)$ *(10)*
15-19	1	0.3851	.1855	0.9169	1	.170	1.2	1973.1	.294
20-24	2	1.8474	.2035	0.9954	2	.203	2.6	1971.7	.248
25-29	3	3.4852	.2133	0.9907	3	.211	4.6	1969.7	.230
30-34	4	4.9166	.2282	1.0075	5	.230	7.0	1967.3	.230
35-39	5	5.8611	.2398	1.0294	10	.247	9.6	1964.7	.229
40-44	6	6.1940	.2635	1.0095	15	.266	12.4	1961.9	.237
45-49	7	6.0836	.2838	0.9973	20	.283	15.5	1958.8	.239

$P(1)/P(2) = .2085$
$P(2)/P(3) = .5301$

Multipliers based on South model.
Sex ratio at birth = 1.05

for both sexes combined. Thus, for women aged 25-29 and $i = 3$,

$$D(3) = \frac{1,937,955}{9,085,852} = .2133$$

Results for all age groups, $i = 1, \ldots, 7$, are shown in column 4 of table 7.

Step 3. *Calculation of the multipliers*, k(i)

The multipliers $k(i)$ are calculated for each age group i using a set of coefficients from table 4 and the ratios of average parities $P(1)/P(2)$ and $P(2)/P(3)$. Those ratios can be computed from column 3 of table 7:

$$\frac{P(1)}{P(2)} = \frac{.3851}{1.8474} = .2085$$

$$\frac{P(2)}{P(3)} = \frac{1.8474}{3.4852} = .5301$$

The regression coefficients $a(i)$, $b(i)$ and $c(i)$ in table 4 are specified for each family of the Coale-Demeny model life tables. The South family has been selected for use in this example, so that the coefficients in the second panel of table 4 will be used. For each age group i, $k(i)$ is computed using equation 4.4. Thus, for age group 3, in which women are aged 25-29,

$$k(3) = 1.2223 + (.0851)(.2085) + (-.4704)(.5301)$$
$$= .9907$$

The complete set of $k(i)$ values is shown in column 5 of table 7.

Step 4. *Calculation of the probabilities of dying by age* x, q(x)

The $q(x)$ is computed for each age group i by multiplying the proportion of children dead, $D(i)$, by the multiplier $k(i)$. The correspondence between x values and i values is shown in table 3. Hence, for age group 3, in which women are aged 25-29, x is equal to 3, and $q(3)$ is given as

$$q(3) = k(3)\,D(3) = (.9907)(.2133) = .2110$$

indicating a probability of dying by age 3 of 21.1 per cent. The probabilities of dying, $q(x)$, for all seven age groups of mother are shown in column 7 of table 7.

Step 5. *Calculation of the reference dates for* q(x), t(i)

The time reference $t(i)$ for each estimated $q(x)$ in number of years before the survey is calculated according to equation 4.5 from the two parity ratios $P(1)/P(2)$ and $P(2)/P(3)$ and the three coefficients $e(i)$, $g(i)$ and $h(i)$ that correspond to the model-life-table pattern selected.

In the case of Bangladesh, the coefficients shown in the second panel of table 5, corresponding to the South model, will be used. Considering once more age group 3 (women aged 25-29), one gets

$$t(3) = 1.5173 + (2.6755)(.2085) + (4.7471)(.5301)$$
$$= 4.59$$

That is, under conditions of steady mortality decline, the estimate of $q(3)$ obtained from the proportion of children dead among those ever borne by women aged 25-29 would refer to a period nearly four and a half years before the survey. Since, in this particular case, the survey's field-work was carried out mostly during April 1974, the survey's reference date can be taken to be 1974.3—15 April corresponds to day number 105 in the year, which, divided by the total number of days in a year, is 105/365 = 0.29, a figure that is rounded to 0.3 in decimal terms. Hence, the reference date for the estimated $q(3)$ is

$$1974.3 - 4.6 = 1969.7$$

or towards the end of the calendar year 1969. The other values of $t(i)$ and the reference dates calculated from them are shown in columns 8 and 9 of table 7.

Step 6. *Conversion to a common index*

In order to study trends in child mortality, the $q(x)$ values obtained in step 4 need to be converted to a common index. Under-five mortality, $q(5)$, will be used here as the common index. The conversion is carried out by interpolating between the $q(x)$ values of the model life tables presented in annex I. The table used for interpolation—table A.I.10—is that for model South and both sexes combined (the values it displays were derived assuming a sex ratio at birth of 1.05 male births per female birth).

As an example, consider the conversion of the estimated $q^e(3)$ to a $q^c(5)$ according to model South.

The estimated value of $q^e(3)$ is .211. According to table A.I.10, this value falls between the $q(3)$ of level 12, $q^{12}(3) = .22564$, whose $q^{12}(5)$ equivalent is .24592, and that of level 13, $q^{13}(3) = .20640$, whose $q^{13}(5)$ equivalent is .22430. Substituting the $q^j(3)$ and $q^e(3)$ values in equation 4.8 to find h, the interpolation factor, one obtains

$$h = \frac{.21100 - .22564}{.20604 - .22564} = .7469$$

The $q^c(5)$ equivalent for the estimated $q^e(3) = .211$ is then derived using equation 4.7 as follows:

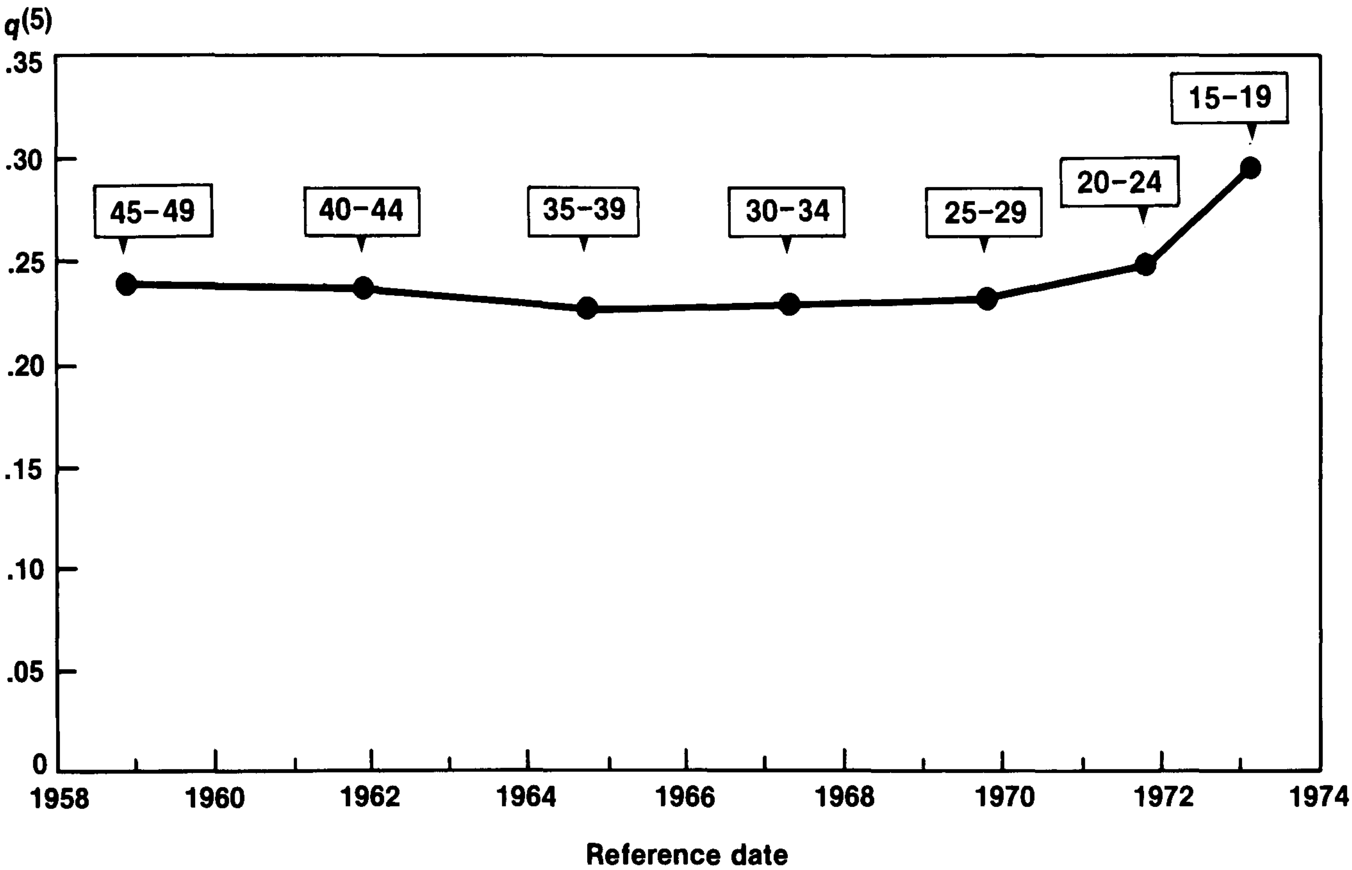
$$q^c(5) = (1.0 - .7469)(.24592) + (.7469)(.22430)$$
$$= .230$$

That is, in the South model life tables, the $q^c(5)$ corresponding to a $q^e(3)$ of .211 is .230. The complete set of $q^c(5)$ values equivalent to the estimated $q(x)$ values is shown in column 10 of table 7.

Step 7. *Interpretation and analysis of results*

Once the values of the common index $q^c(5)$ have been derived for all age groups of women, they can be plotted against the reference date for each estimate, as shown in figure 7. That figure shows clearly that the estimated $q^c(5)$ values are fairly similar for most of the period 1959-1970 and that they increase markedly after 1970. Therefore, taken at face value, those estimates imply that in Bangladesh mortality in childhood increased during the early 1970s after varying within a narrow range during the preceding decade. Such an interpretation is not correct. As figure 7 indicates, the estimates referring to recent periods (1972 onwards) are those derived from the reports of younger women (age groups 20-24 and 15-19) and hence reflect the higher than average risks of dying to which the children of those women are subject. Furthermore, given the evidence available on the existence of omissions of children ever born in the reports of older women (aged 35 and over), it is likely that the estimates referring to periods furthest in the past (1959-1965 or thereabouts) may be biased downward. As a result of both biases, the curve displayed in figure 7 probably fails to reflect the actual trend of under-five mortality, $q(5)$, in Bangladesh. Unfortunately, the true trend cannot be derived with certainty from the data available. However, it can be established with a high degree of confidence that during the 1965-1970 period under-five mortality in Bangladesh was approximately .230, that is, during the late 1960s slightly more than one out of every five children born would die before reaching the fifth birthday.

Figure 7. Under-five mortality, $q(5)$, for both sexes in Bangladesh, estimated using model South and the Trussell version of the Brass method



Source: Table 7.

Another conclusion that can be drawn from the estimates available so far is that mortality in childhood in Bangladesh probably did not change much during the 1960s. Of course, given the downward bias that probably affects earlier estimates, such an assertion cannot be made with absolute certainty. As the next section will show, the availability of further evidence may modify this preliminary conclusion.

Estimates of mortality in childhood by sex

As shown in display 6, the data on children ever born and surviving for Bangladesh are available by sex of child. It is therefore possible to estimate mortality by sex. To estimate male mortality, for instance, the procedure to be followed is essentially the same as that described above, except that parities and the proportions dead are calculated only on the basis of male children. In algebraic terms, letting the subindex *m* denote male, in step 1 equation 4.1 becomes

$$P_m(i) = \frac{CEB_m(i)}{FP(i)} \tag{4.9}$$

and in step 2 equation 4.2 becomes

$$D_m(i) = \frac{CD_m(i)}{CEB_m(i)} \tag{4.10}$$

That is, the average parities are calculated by dividing the number of male children ever born by the total female population, as in equation 4.9, and the proportion of male children dead, $D_m(i)$, for each age group is calculated by dividing the number of male children dead by the number of male children ever born. Steps 3 to 7 are then carried out as indicated in the computational procedure. Female mortality in childhood is estimated in the same way, substituting female children ever born and dead instead of the corresponding male children.

Tables 8 and 9 show the results of applying the Trussell version of the Brass method to the Bangladesh data classified by sex. Figure 8 plots the estimated under-five mortality, $q(5)$, for males and females. Note that for most age groups of mother the male estimates of $q(5)$ are higher than those for females. Since higher male than female mortality is the rule in most countries, the 1961-1974 estimates for Bangladesh seem acceptable. However, the reversal of the relationship between male and female mortality for the estimates derived from age group 45-49 is suspect, being in all probability caused by errors in the basic data rather than by the actual reversal of mortality differentials by sex. For that reason, the estimates derived from the reports of women aged 45-49 should be disregarded, even when they refer to both sexes combined.

TABLE 8. APPLICATION OF THE TRUSSELL VERSION OF THE BRASS METHOD TO DATA ON MALES FROM THE 1974 BANGLADESH RETROSPECTIVE SURVEY

Age group of mother (1)	Age group index (i) (2)	Average parity $P_m(i)$ (3)	Proportion dead $D_m(i)$ (4)	Multiplier k(i) (5)	Age x (6)	Probability of dying by age x, $q_m(x)$ (7)	Time reference t(i) (8)	Reference date (9)	Common index $q_m^c(5)$ (10)
15-19	1	0.1981	.1962	0.9104	1	.179	1.2	1973.1	.301
20-24	2	0.9449	.2114	0.9957	2	.210	2.6	1971.7	.256
25-29	3	1.7936	.2240	0.9923	3	.222	4.6	1969.7	.241
30-34	4	2.5349	.2358	1.0093	5	.238	6.9	1967.4	.238
35-39	5	3.0681	.2454	1.0312	10	.253	9.5	1964.8	.236
40-44	6	3.3007	.2645	1.0112	15	.268	12.3	1962.0	.240
45-49	7	3.2727	.2775	0.9988	20	.277	15.4	1958.9	.236

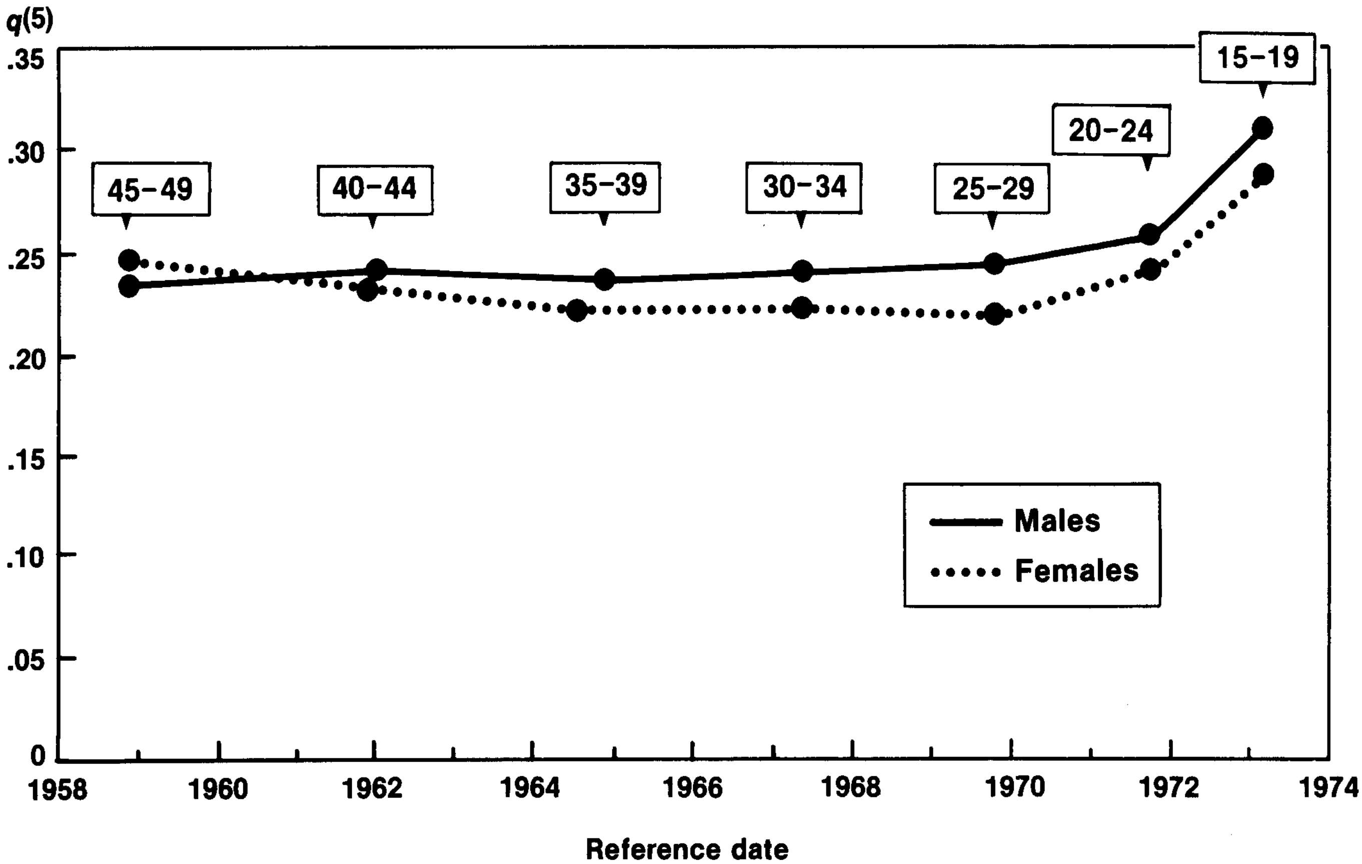
$P_m(1)/P_m(2) = .2097$
$P_m(2)/P_m(3) = .5268$
Multipliers based on South model.

TABLE 9. APPLICATION OF THE TRUSSELL VERSION OF THE BRASS METHOD TO DATA ON FEMALES FROM THE 1974 BANGLADESH RETROSPECTIVE SURVEY

Age group of mother (1)	Age group index (i) (2)	Average parity $P_f(i)$ (3)	Proportion dead $D_f(i)$ (4)	Multiplier k(i) (5)	Age x (6)	Probability of dying by age x, $q_f(x)$ (7)	Time reference t(i) (8)	Reference date (9)	Common index $q_f^c(5)$ (10)
15-19	1	0.1897	.1742	0.9238	1	.161	1.2	1973.1	.286
20-24	2	0.9025	.1953	0.9952	2	.194	2.6	1971.7	.240
25-29	3	1.6916	.2020	0.9890	3	.200	4.6	1969.7	.218
30-34	4	2.3817	.2201	1.0056	5	.221	7.0	1967.3	.221
35-39	5	2.7930	.2337	1.0275	10	.240	9.7	1964.6	.222
40-44	6	2.8932	.2624	1.0078	15	.264	12.5	1961.8	.234
45-49	7	2.8109	.2911	0.9957	20	.290	15.6	1958.7	.243

$P_f(1)/P_f(2) = .2072$
$P_f(2)/P_f(3) = .5335$
Multipliers based on South model.

Figure 8. Under-five mortality, $q(5)$, for males and females in Bangladesh, estimated using model South and the Trussell version of the Brass method



Sources: Tables 8 and 9.

As in the case of the data referring to both sexes, the estimates derived from information provided by younger women (age groups 15-19 and 20-24) seem to be biased upward and must be rejected. From the remaining estimates, it can be concluded that during the 1962-1970 period under-five mortality among males in Bangladesh remained mostly constant at a level of 238 or 239 deaths per 1,000 births, while that among females might have decreased slightly, from about 234 deaths per 1,000 births around 1962 to about 220 towards the end of the decade. The existence of such a decline may be further supported by the fact that our earlier analysis of sex ratios at birth showed that female children were under-reported among older women. If, as is likely, the omitted female children were dead children, the estimates for females derived from women aged 40-44 or 45-49 would underestimate mortality and hide or minimize the decline that has taken place. It is likely that the same biases may be operating on the estimates for males, especially if one accepts as improbable the reversal of the sex differential implied by the estimates derived from the reports of women aged 45-49.

If the conclusion that female mortality declined is accepted on the basis of the arguments presented above, the earlier conclusions regarding mortality levels for both sexes combined must be revised to reflect a decline in those levels, albeit slight, between the early and the late 1960s.

This example demonstrates the importance of analysing all available evidence before reaching definitive conclusions about the reliability of the different estimates yielded by the Brass method.