Chapter V

PALLONI-HELIGMAN VERSION OF THE BRASS METHOD

Another version of the Brass method was developed in the early 1980s by A. Palloni and L. Heligman (1986). It is based on the United Nations model life tables for developing countries and, like the Trussell version, produces estimates of the probabilities of dying from birth and of the time to which those probabilities refer. It differs from the Trussell version in that it uses information on births in a year in addition to the data required by the Brass method. The additional data are used to compute the mean age at maternity, an indicator of the average age difference between mothers and their children.

This chapter starts by describing the additional data requirements of the Palloni-Heligman version. It then describes the steps of the computational procedure to be followed in applying it and ends by providing a detailed example of its application to the case of Bangladesh.

DATA REQUIRED

The data required to apply the Palloni-Heligman version of the Brass method are essentially the same as those needed for the application of the Trussell version, namely:

1. Number of children ever born classified by age group of mother;

2. Number of children dead classified by age group of mother;

3. Total number of women (irrespective of marital or reporting status) classified by age.

However, the Palloni-Heligman version requires an additional set of information:

4. Number of births occurring in a given year classified by age group of mother

Information on births in a year is used to estimate an indicator of the timing of child-bearing, namely, the mean age at maternity (that is, the mean age of the mothers of the children born in a particular period), denoted by M. When information on births is not available, a rough estimate of M may be used in applying the Palloni-Heligman version (a convenient estimate is $M = 27$).

The first three items of data listed above can be compiled using the worksheets presented in displays 6 and 7 of chapter II. To compile the data on births in a given year, display 9 has been prepared. Note that the information on births need not be available by sex of child and that it is important to establish whether the information was derived from a registration system or from a survey or census. Generally, it is assumed that a registration system records births as they occur and consequently that the age of mother recorded by the registration system is her age at the time of the birth. Surveys, on the other hand, usually obtain the necessary information on births by asking whether or not a woman gave birth during the year preceding interview. When such data are later tabulated by a woman's age at the time of interview, a systematic bias is introduced in the timing of births. To correct that bias, it is assumed that births occur uniformly throughout the year. Hence, on average, women aged 17, say, at the time of interview would have been aged 16.5 at the time they gave birth. For that reason the exact-age groups listed in the lower panel of display 9 referring to census or survey data have been shifted back half a year.

COMPUTATIONAL PROCEDURE

The application of the Palloni-Heligman version of the Brass method is very similar to that of the Trussell version. To maintain comparability with the latter in the numbering of steps, step 3 is divided here into two parts: 3 (*a*) and 3 (*b*).

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

$$P(i) = \frac{CEB(i)}{FP(i)} \tag{5.1}$$

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 justified on the assumption that they are 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 of women. Thus,

$$D(i) = \frac{CD(i)}{CEB(i)} \tag{5.2}$$

Display 9. Worksheet for the compilation of data on births in a year by age group of mother for the Palloni-Heligman version of the Brass method

Source and reported age group of mother		*Exact-age group of mother at birth of child*[a]	*Midpoint of exact-age group*	*Births in a year*
Vital registration	15-19	[15,20)	17.5	
	20-24	[20,25)	22.5	
	25-29	[25,30)	27.5	
	30-34	[30,35)	32.5	
	35-39	[35,40)	37.5	
	40-44	[40,45)	42.5	
	45-49	[45,50)	47.5	
Census or survey	15-19	[14.5,19.5)	17	
	20-24	[19.5,24.5)	22	
	25-29	[24.5,29.5)	27	
	30-34	[29.5,34.5)	32	
	35-39	[34.5,39.5)	37	
	40-44	[39.5,44.5)	42	
	45-49	[44.5,49.5)	47	

[a]The notation $[x,y)$ indicates that exact ages at the time women gave birth range from x to y, exclusive of the latter, that is, age y is not quite reached.

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

Step 3. *Calculation of the mean age at maternity,* M *(Palloni-Heligman version only)*

The value of the mean age at maternity, M, is estimated from the number of births occurring in a given year classified by age group of mother. As indicated earlier, when those data are compiled for use in the estimation procedure, it is important to establish whether they were obtained from vital registration (a registration system) or from a census or survey.

M is calculated by multiplying the midpoint of each age group by the number of births to women in that age group, summing the resulting products, and then dividing the sum by the total number of births (excluding those to women of not-stated age). Thus,

$$M = \frac{\sum_{i=1}^{7} (B(i)\ mp(i))}{\sum_{i=1}^{7} B(i)}$$

where the symbol Σ denotes sum, $B(i)$ denotes the number of births to women in age group i and $mp(i)$ is the midpoint in years of age group i.

The values of $mp(i)$ are shown in display 9 and clearly depend on the type of exact-age group being dealt with. The term "exact-age group" is used here to denote the true range of variation of the ages of mother in each reported age group. Generally, women belonging to a given age group, say 20-24, are all those whose age at last birthday was 20, 21, 22, 23 or 24, that is, women whose exact ages may vary anywhere from 20.0 to 24.99 . . . without quite reaching 25. The notation [20,25) is used to denote that range of exact ages. The midpoint of that range is 22.5 years.

As noted above, when the data on births in a year are obtained from a vital registration system, it can be assumed that the reported age of mother is her age at the time she gave birth. In contrast, in surveys or censuses gathering information on the births occurring during the year immediately preceding interview, mothers were on average half a year younger at the birth of their reported children than at the time of interview. Hence, as shown in display 9, the exact-age groups of mothers are shifted back by half a year—for example [19.5,24.5) rather than [20,25). As indicated in that display, the midpoints of those intervals are also moved back by half a year.

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

The basic estimation equation for the Palloni-Heligman version is the same as for the Trussell version shown in equation 4.3:

$$q(x) = k(i)\,D(i) \tag{5.4}$$

but the equation to calculate $k(i)$ now includes M as input:

$$k(i) = a(i) + b(i)\,\frac{P(1)}{P(2)} + c(i)\,\frac{P(2)}{P(3)} + d(i)\,M \tag{5.5}$$

Table 10 shows the coefficients $a(i)$, $b(i)$, $c(i)$ and $d(i)$ for the seven age groups of women, from ages 15-19

TABLE 10. COEFFICIENTS FOR THE ESTIMATION OF CHILD-MORTALITY MULTIPLIERS, $k(i)$, PALLONI-HELIGMAN VERSION OF THE BRASS METHOD, USING THE UNITED NATIONS 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)	$d(i)$ (7)
Latin American	15-19	1	1	0.6892	−1.6937	0.6464	0.0106
	20-24	2	2	1.3625	−0.3778	−0.2892	−0.0041
	25-29	3	3	1.0877	0.0197	−0.2986	0.0024
	30-34	4	5	0.7500	0.0532	−0.1106	0.0115
	35-39	5	10	0.5605	0.0222	0.0170	0.0171
	40-44	6	15	0.5024	0.0028	0.0048	0.0180
	45-49	7	20	0.5326	0.0052	0.0256	0.0168
Chilean	15-19	1	1	0.8274	−1.5854	0.5949	0.0097
	20-24	2	2	1.3129	−0.2457	−0.2329	−0.0031
	25-29	3	3	1.0632	0.0196	−0.1996	0.0021
	30-34	4	5	0.8236	0.0293	−0.0684	0.0081
	35-39	5	10	0.6895	0.0068	0.0032	0.0119
	40-44	6	15	0.6098	−0.0014	0.0166	0.0141
	45-49	7	20	0.5615	0.0040	0.0073	0.0159
South Asian	15-19	1	1	0.6749	−1.7580	0.6805	0.0109
	20-24	2	2	1.3716	−0.3652	−0.2966	−0.0041
	25-29	3	3	1.0899	0.0299	−0.2887	0.0024
	30-34	4	5	0.7694	0.0548	−0.0934	0.0108
	35-39	5	10	0.6156	0.0231	0.0298	0.0149
	40-44	6	15	0.6077	0.0040	0.0573	0.0141
	45-49	7	20	0.6952	0.0018	0.0306	0.0109
Far Eastern	15-19	1	1	0.7194	−1.3143	0.5432	0.0093
	20-24	2	2	1.2671	−0.2996	−0.2105	−0.0029
	25-29	3	3	1.0668	0.0017	−0.2424	0.0019
	30-34	4	5	0.7833	0.0307	−0.1103	0.0098
	35-39	5	10	0.5765	0.0068	−0.0202	0.0165
	40-44	6	15	0.4115	0.0014	0.0083	0.0213
	45-49	7	20	0.3071	0.0111	0.0129	0.0251
General	15-19	1	1	0.7210	−1.4686	0.5746	0.0095
	20-24	2	2	1.3115	−0.3360	−0.2475	−0.0034
	25-29	3	3	1.0768	0.0109	−0.2695	0.0021
	30-34	4	5	0.7682	0.0439	−0.1090	0.0105
	35-39	5	10	0.5769	0.0176	0.0038	0.0165
	40-44	6	15	0.4845	0.0034	0.0036	0.0187
	45-49	7	20	0.4760	0.0071	0.0246	0.0189

Estimation equations:

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

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

Source: Alberto Palloni and Larry Heligman, "Re-estimation of structural parameters to obtain estimates of mortality in developing countries", *Population Bulletin of the United Nations,* No. 18 (United Nations publication, Sales No. E.85.XIII.6), table 2B, p. 17; figures in column 4 have been corrected.

through ages 45-49 ($i = 1, \ldots, 7$), and for the five regional patterns of the United Nations models.

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 5.4:

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

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

An estimate of the time reference, $t(i)$, of each estimated $q(x)$ value is calculated by applying the coefficients in table 11 to the parity ratios $P(1)/P(2)$ and $P(2)/P(3)$ in the same way as for the Trussell version:

$$t(i) = e(i) + f(i)\,\frac{P(1)}{P(2)} + g(i)\,\frac{P(2)}{P(3)} \qquad (5.6)$$

However, in the Palloni-Heligman version, the values of $e(i)$, $f(i)$ and $g(i)$ appearing in equation 5.6 are based on the United Nations models (see table 11). Once the $t(i)$ values are calculated, they can be converted into reference dates by subtracting them from the reference date of the census or survey, as illustrated 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 before the survey or census 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, it is suggested that a measure of child mortality that is not particularly sensitive to the pattern of mortality be

TABLE 11. COEFFICIENTS FOR THE ESTIMATION OF THE TIME REFERENCE, $t(i)$,[a] FOR VALUES OF $q(x)$, PALLONI-HELIGMAN VERSION OF THE BRASS METHOD, USING THE UNITED NATIONS 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)
Latin American	15-19	1	$q(1)$	1.1703	0.5129	−0.3850
	20-24	2	$q(2)$	1.6955	4.1320	−0.1635
	25-29	3	$q(3)$	1.8296	2.9020	3.4707
	30-34	4	$q(5)$	2.1783	−2.5688	9.0883
	35-39	5	$q(10)$	2.8836	−10.3282	15.4301
	40-44	6	$q(15)$	4.4580	−17.1809	20.4296
	45-49	7	$q(20)$	6.9351	−19.3871	23.4007
Chilean	15-19	1	$q(1)$	1.3092	1.9474	−0.7982
	20-24	2	$q(2)$	1.6897	4.6176	−0.0173
	25-29	3	$q(3)$	1.8368	2.6370	4.0305
	30-34	4	$q(5)$	2.2036	−3.3520	9.9233
	35-39	5	$q(10)$	2.9955	−11.4013	16.3441
	40-44	6	$q(15)$	4.7734	−17.8850	20.8883
	45-49	7	$q(20)$	7.4495	−19.0513	23.0529
South Asian	15-19	1	$q(1)$	1.1922	0.7940	−0.5425
	20-24	2	$q(2)$	1.7173	4.3117	−0.1653
	25-29	3	$q(3)$	1.8631	2.8767	3.5848
	30-34	4	$q(5)$	2.1808	−2.7219	9.3705
	35-39	5	$q(10)$	2.7654	−10.8808	16.2255
	40-44	6	$q(15)$	4.1378	−18.6219	22.2390
	45-49	7	$q(20)$	6.4885	−22.2001	26.4911
Far Eastern	15-19	1	$q(1)$	1.2779	1.5714	−0.6994
	20-24	2	$q(2)$	1.7471	4.2638	−0.0752
	25-29	3	$q(3)$	1.9107	2.7285	3.5881
	30-34	4	$q(5)$	2.3172	−2.6259	9.0238
	35-39	5	$q(10)$	3.2087	−9.8891	14.7339
	40-44	6	$q(15)$	5.1141	−15.3263	18.2507
	45-49	7	$q(20)$	7.6383	−15.5739	19.7669
General	15-19	1	$q(1)$	1.2136	0.9740	−0.5247
	20-24	2	$q(2)$	1.7025	4.1569	−0.1232
	25-29	3	$q(3)$	1.8360	2.8632	3.5220
	30-34	4	$q(5)$	2.1882	−2.6521	9.1961
	35-39	5	$q(10)$	2.9682	−10.3053	15.3161
	40-44	6	$q(15)$	4.6526	−16.6920	19.8534
	45-49	7	$q(20)$	7.1425	−18.3021	22.4168

Estimation equation:

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

Source: Alberto Palloni and Larry Heligman, "Re-estimation of structural parameters to obtain estimates of mortality in developing countries", *Population Bulletin of the United Nations*, No. 18 (United Nations publication, Sales No. E.85.XIII.6), table 5A, p. 19.

[a] Number of years prior to the survey.

selected. The common index recommended is under-five mortality, $q(5)$.

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 II contain the necessary values of $q(x)$ ordered by mortality level and expectation of life for each of the United Nations models 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 $x \neq 5$. 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 II levels j and $j + 1$ such that

$$q^j(x) > q^e(x) > q^{j+1}(x) \tag{5.7}$$

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

$$q^c(5) = (1.0 - h)\, q^j(5) + h\, q^{j+1}(5) \tag{5.8}$$

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

$$h = \frac{q^e(x) - q^j(x)}{q^{j+1}(x) - q^j(x)} \tag{5.9}$$

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 II. 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 II.

Step 7. *Interpolation and analysis of results*

Once seven estimates (one for each age group i of women) of the selected common index—$q^c(5)$—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 1974 Bangladesh Retrospective Survey of Fertility and Mortality will be used once more to provide an example. The data on children ever born and children dead and the total number of women have already been compiled in displays 6 and 7 (reproduced again here). In this example, estimates of the risks of dying in childhood will be estimated for male children. Hence, the data of interest are those referring to male children ever born and male children dead in display 6.

To apply the Palloni-Heligman version, it is also necessary to compile information on births occurring during a given year. Display 10 shows the published tabulation on that topic. Note that the 1974 Bangladesh survey gathered information on the time of occurrence of the most recent live birth of each ever-married woman and that such information was tabulated by year of occurrence. The analyst is thus apparently faced with a choice of which time period to use. Note that a woman who had a child in April 1972 and another one in March 1974 would report only the latter birth. Consequently the data for the period April 1972 to March 1973 do not cover all the births during that year. It is therefore necessary to use the most recent period—in this case April 1973 to March 1974, the year immediately preceding the survey. Because of the type of information gathered (the date of the most recent birth), only the most recent time period will cover all possible events (births) in a year.

The worksheet presented in display 9 may be used to compile the data on births in the year preceding the survey. Display 11 illustrates a completed worksheet. Note that data on births in a year for both sexes combined are adequate for the application of the method even when estimates of mortality by sex are desired.

Computational procedure

Step 1. *Calculation of average parity per woman*

Average parities are computed by dividing the number of children ever born by the total number of women, age group by age group. In this case, only male children ever born will be used, since male mortality is being estimated. As an example, the average parity of women aged 35-39, $P_m(5)$, where the subindex m indicates that only data on male children are used, is calculated below:

$$P_m(5) = \frac{5{,}435{,}726}{1{,}771{,}680} = 3.0681$$

The full set of parities in respect of male children is shown in column 3 of table 12. At the foot of the table, the values of the relevant parity ratios, $P_m(1)/P_m(2)$ and $P_m(2)/P_m(3)$ also are displayed. Note that, as in the case of both sexes combined, the average parity decreases from age group 40-44 to age group 45-49, which suggests the existence of omission errors.

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

As in the Trussell version, the proportions of children dead are calculated by dividing the number of children dead by the number of those ever born, for each age group of women. Again in this example, only male children are considered, and hence the subindex m is used. Thus, $D_m(5)$, the proportion of male children dead among those ever borne by women aged 35-39 is calculated as follows:

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	4 280 780	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).

$$D_m(5) = \frac{1{,}333{,}957}{5{,}435{,}726} = .2454$$

The complete set of proportions dead is displayed in column 4 of table 12. Note that, as expected, the proportion dead increases with age of mother.

Step 3 (a). *Calculation of the mean age at maternity,* M *(Palloni-Heligman version only)*

The mean age at maternity is calculated using the data compiled in display 11. As equation 5.3 states, M is the ratio of two quantities: the sum of the products of births times the midpoints of the age groups of mothers, and the sum of births. Both are calculated below:

$$\sum_{i=1}^{7} B(i)\,mp(i) = (320{,}406)(17) + (609{,}271)(22) + (561{,}493)(27) + (367{,}833)(32) + (237{,}297)(37) + (95{,}356)(42) + (38{,}124)(47) = 60{,}358{,}600$$

$$\sum_{i=1}^{7} B(i) = 320{,}406 + 609{,}271 + 561{,}493 + 367{,}833 + 237{,}297 + 95{,}356 + 38{,}124 = 2{,}229{,}780$$

Then

$$M = \frac{60{,}358{,}600}{2{,}229{,}780} = 27.07$$

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

Table 10 shows the values of the regression coefficients $a(i)$, $b(i)$, $c(i)$ and $d(i)$ needed to calculate the multipliers $k(i)$ for each regional pattern of the United Nations model life tables. In this example, the South Asian pattern will be used. As equation 5.5 shows, for each age group i, $k(i)$ is computed as the sum of $a(i)$, the product of $b(i)$ and $P(1)/P(2)$, that of $c(i)$ and $P(2)/P(3)$, and that of $d(i)$ and M. Thus, for age group 5, in which women are aged 35-39,

$$k(5) = .6156 + (.0231)(.2097) + (.0298)(.5268) + (.0149)(27.07) = 1.0395$$

Values of $k(i)$ for all age groups are shown in column 5 of table 12. Note that, as in the Trussell version, all values of $k(i)$ are close to 1.0.

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

The probabilities of dying by exact age x are computed by multiplying the proportions dead $D_m(i)$ by the corresponding multipliers $k(i)$. To estimate $q_m(10)$, for example,

$$q_m(10) = (1.0395)(0.2454) = .255$$

The full set of $q_m(x)$ estimates is shown in column 7 of table 12.

Display 10. **Tabulation of data on births in a year as appearing in the report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality**

BANGLADESH CENSUS 1974 RETROSPECTIVE SURVEY OF FERTILITY AND MORTALITY

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TABLE 10. EVER-MARRIED WOMEN BY AGE GROUP, DATE OF LAST BIRTH AND SURVIVAL OF CHILD

	AGE GROUP	TOTAL WOMEN	CHILDLESS WOMEN	APRIL 73- MARCH 74	APRIL 72- MARCH 73	BEFORE APRIL 72	1973 N.M.	1972 N.M.	NOT STATED
TOTAL	UNDER 15	315 530	271 224	6 842	3 896	16 563	408	757	15 840
	15-19	2 031 604	1 166 887	320 406	219 069	261 832	19 769	16 649	26 992
	20-24	2 530 026	431 225	609 271	492 384	878 863	33 199	37 224	47 860
	25-29	2 577 574	159 934	561 493	503 986	1 222 507	36 967	47 792	44 895
	30-34	2 005 083	79 049	367 833	326 551	1 131 739	27 994	31 909	40 008
	35-39	1 767 440	51 649	237 297	223 428	1 181 078	10 852	18 633	44 503
	40-44	1 475 299	49 573	95 356	105 376	1 157 209	6 681	11 657	49 447
	45-49	1 130 992	39 453	38 124	36 784	948 263	2 970	4 179	61 219
	50-54	1 043 611	40 848	8 702	14 775	897 732	1 233	4 147	76 174
	55+	2 249 264	103 726	6 599	6 775	1 845 939	1 139	2 049	283 037
	N.S.	819	204			615			
	TOTAL	17 127 242	2 393 772	2 251 923	1 933 024	9 542 340	141 212	174 996	689 975
CHILD ALIVE	UNDER 15	24 863		5 635	3 097	13 197	408	757	1 769
	15-19	759 221		280 716	200 411	236 600	17 643	15 637	8 214
	20-24	1 905 774		552 453	464 519	808 529	29 227	35 840	15 206
	25-29	2 214 326		513 568	473 360	1 133 773	35 018	46 600	12 007
	30-34	1 745 901		334 935	306 445	1 036 413	27 039	30 876	10 193
	35-39	1 534 253		213 951	207 410	1 075 709	10 038	18 050	9 095
	40-44	1 236 604		86 464	96 434	1 024 122	6 489	10 042	13 053
	45-49	907 485		33 241	32 270	816 039	2 970	3 561	19 404
	50-54	807 333		7 738	13 373	750 376	1 233	3 943	30 670
	55+	1 528 577		4 887	5 219	1 410 130	935	1 635	105 771
	N.S.	204				204			
	TOTAL	12 664 541		2 033 588	1 802 538	8 305 092	131 000	166 941	225 382
CHILD DEAD	UNDER 15	6 588		1 207	799	3 366			1 216
	15-19	99 582		39 690	18 658	24 821	2 126	1 012	13 275
	20-24	188 309		56 818	27 865	70 334	3 972	1 384	27 936
	25-29	200 173		47 925	30 626	88 551	1 949	1 192	29 930
	30-34	177 766		32 898	20 106	95 119	955	1 033	27 655
	35-39	179 187		23 346	16 018	105 369	814	583	33 057
	40-44	186 209		8 892	8 942	132 691	192	1 615	33 877
	45-49	181 285		4 883	4,514	131 848		618	39 422
	50-54	192 337		964	1 402	147 164		204	42 603
	55+	598 805		1 712	1 556	435 422	204	414	159 497
	N.S.	411				411			
	TOTAL	2 010 652		218 335	130 486	1 235 096	10 212	8 055	408 468
CHILD N.S.	UNDER 15	12 855							12 855
	15-19	5 914				411			5 503
	20-24	4 718							4 718
	25-29	3 141				183			2 958
	30-34	2 367				207			2 160
	35-39	2 351							2 351
	40-44	2 913				396			2 517
	45-49	2 769				376			2 393
	50-54	3 093				192			2 901
	55+	18 156				387			17 769
	N.S.								
	TOTAL	58 277				2 152			56 125

Source: Bangladesh, Census Commission, *Report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality* (Dacca, 1977), p. 39.

TABLE 12. APPLICATION OF THE PALLONI-HELIGMAN 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	0.9598	1	.188	1.1	1973.2	.311
20-24	2	0.9449	.2114	1.0278	2	.217	2.5	1971.8	.268
25-29	3	1.7936	.2240	1.0091	3	.226	4.4	1969.9	.249
30-34	4	2.5349	.2358	1.0240	5	.241	6.5	1967.8	.241
35-39	5	3.0681	.2454	1.0395	10	.255	9.0	1965.3	.237
40-44	6	3.3007	.2645	1.0204	15	.270	11.9	1962.4	.244
45-49	7	3.2727	.2775	1.0069	20	.279	15.8	1958.5	.245

$P_m(1)/P_m(2) = .2097$
$P_m(2)/P_m(3) = .5268$

$M = 27.07$ years
Multipliers based on South Asian model.

Display 11. Compilation of data on births in a year by age group of mother for Bangladesh

Source and reported age group of mother		Exact-age group of mother at birth of child[a]	Midpoint of exact-age group	Births in a year
Vital registration	15-19	[15,20)	17.5	
	20-24	[20,25)	22.5	
	25-29	[25,30)	27.5	
	30-34	[30,35)	32.5	
	35-39	[35,40)	37.5	
	40-44	[40,45)	42.5	
	45-49	[45,50)	47.5	
Census or survey	15-19	[14.5,19.5)	17	320 406
	20-24	[19.5,24.5)	22	609 271
	25-29	[24.5,29.5)	27	561 493
	30-34	[29.5,34.5)	32	367 833
	35-39	[34.5,39.5)	37	237 297
	40-44	[39.5,44.5)	42	95 356
	45-49	[44.5,49.5)	47	38 124

Source: Bangladesh, Census Commission, *Report on the 1974 Bangladesh Retrospective Survey of Fertility and Mortality* (Dacca, 1977), table 10, p. 29 (reproduced in display 10 above).

[a] The notation [*x*,*y*) indicates that exact ages at the time women gave birth range from *x* to *y*, exclusive of the latter, that is, age *y* is not quite reached.

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

Again using the South Asian model, the coefficients needed for the estimation of $t(i)$ are obtained from the third panel of table 11. Following equation 5.6, $t(5)$ is calculated below:

$$t(5) = 2.7654 + (-10.8808)(.2097) + (16.2255)(.5268) = 9.01$$

That is, the estimated value of $q_m(10)$ refers to a period approximately 9 years before the survey. A more illuminating reference date is obtained by subtracting each $t(i)$ value from the survey's reference date expressed in decimal form—1974.3 in this case (see step 5 of the detailed example for the Trussell version). Hence, the reference date for $q_m(10)$ is:

$$1974.3 - 9.0 = 1965.3$$

All estimated values of $t(i)$ and the reference dates derived from them are presented, respectively, in columns 8 and 9 of table 12.

Step 6. *Conversion to a common index*

The estimates of $q_m(x)$ for different values of x are now converted into equivalent estimates of $q^c_m(5)$ using the South Asian family of United Nations model life tables for males. Consider, for example, the estimated probability of dying by age 10, $q^e_m(10) = .225$. Using table A.II.3, one can identify the two life-table levels having $q(10)$ values such that:

$$q^j_m(10) > q^e_m(10) > q^{j+1}_m(10)$$

Those values are $q^{14}_m(10)$, which equals .25794 and whose $q^{14}_m(5)$ equivalent is .23986, and $q^{15}_m(10)$, which equals .24715 and has a corresponding $q^{15}_m(5)$ of .22989. Using equation 5.9, the interpolation factor h is obtained as follows:

$$h = \frac{.25500 - .25794}{.24715 - .25794} = .2725$$

Then, making use of equation 5.8, the desired $q^c(5)$ is calculated in the following way:

$$q_m^c(5) = (1.0 - (.2725)(.23986) + (.2725)(.22989)\cdot$$
$$= .237$$

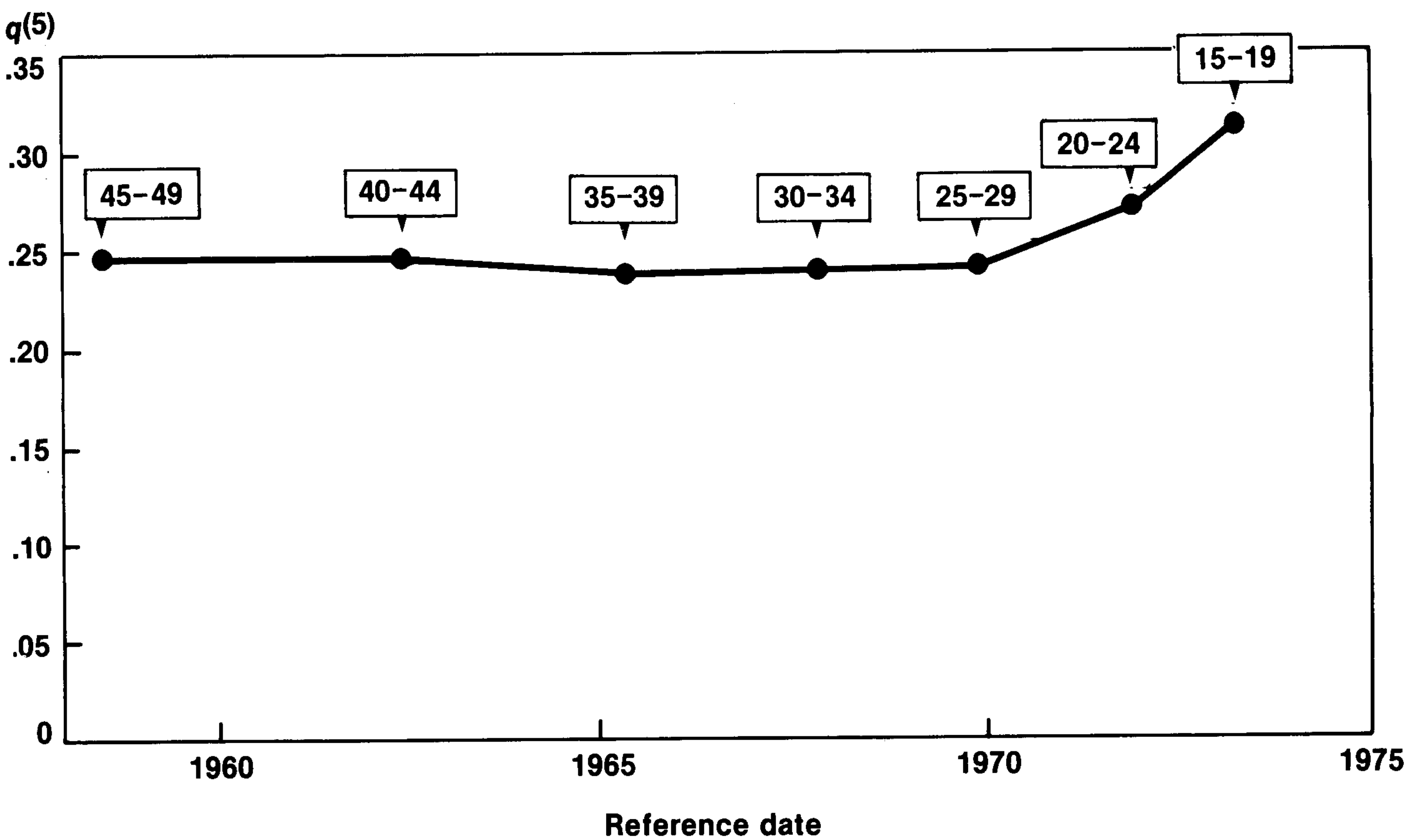
The full set of $q_m^c(5)$ equivalents is shown in column 10 of table 12.

Step 7. *Interpretation and analysis of results*

The estimated probabilities of surviving by age 5, $q_m^c(5)$, are plotted against their respective reference dates in figure 9. Note that the general trend of the resulting curve is very similar to that obtained using the Trussell version with model South (see table 8 and figure 8). Once more, under-five mortality, $q(5)$, varies within a fairly narrow range between 1958 and 1970, only to rise sharply for the most recent period (1970-1973). Again, this apparent increase is probably spurious, since it is likely to be caused by the higher-than-average mortality characterizing the children of younger women.

On the other hand, estimates for the earliest period may be biased downward, since they are derived from information provided by older women. But the estimates for males considered in isolation do not provide clear evidence of the existence of such biases. If no further information were available, it would be relatively safe to conclude that male mortality changed little during the 1960s and to adopt as a reasonable estimate of its level the mean of the under-five mortality estimates associated with age groups 25-29, 30-34 and even 35-39, namely a $q_m(5)$ equal to .242 for the period 1965-1970. It should be noted that such a value is very close to that estimated in chapter IV using the Trussell version—a $q_m(5)$ of approximately .238 or .239 (see pp. 32-33). The following section will show that the sex differentials in mortality estimated using the United Nations South Asian model lead to the same conclusions reached when analysing the sex-specific estimates produced by the Coale-Demeny South model.

Figure 9. Under-five mortality, $q(5)$, for males in Bangladesh, estimated using the South Asian model and the Palloni-Heligman version of the Brass method



Source: Table 12.

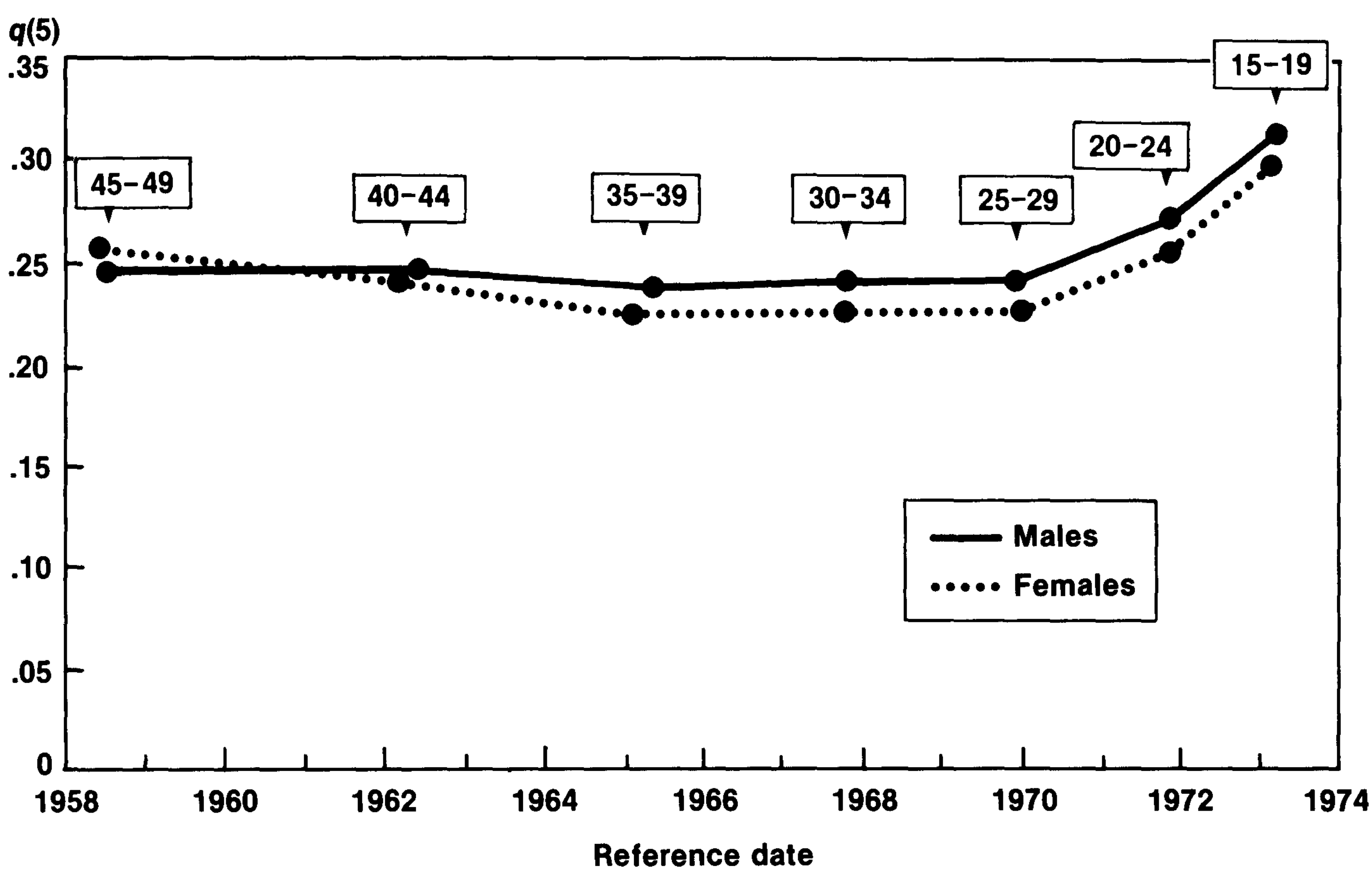
TABLE 13. APPLICATION OF THE PALLONI-HELIGMAN VERSION OF THE BRASS METHOD TO DATA ON FEMALES FROM THE 1974 BANGLADESH RETROSPECTIVE SURVEY

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	0.9688	1	.169	1.1	1973.2	.296
20-24	2	0.9025	.1953	1.0267	2	.201	2.5	1971.8	.253
25-29	3	1.6916	.2020	1.0070	3	.203	4.4	1969.9	.226
30-34	4	2.3817	.2201	1.0233	5	.225	6.6	1967.7	.225
35-39	5	2.7930	.2337	1.0396	10	.243	9.2	1965.1	.225
40-44	6	2.8932	.2624	1.0208	15	.268	12.1	1962.2	.240
45-49	7	2.8109	.2911	1.0070	20	.293	16.0	1958.3	.251

$P_f(1)/P_f(2) = .2072$
$P_f(2)/P_f(3) = .5335$

$M = 27.07$ years
Multipliers based on South Asian model

Figure 10. Under-five mortality, $q(5)$, for males and females in Bangladesh, estimated using the South Asian model and the Palloni-Heligman version of the Brass method



Sources: Tables 12 and 13.

Estimates of mortality in childhood by sex

Tables 13 and 14 present the estimates of $q(5)$ obtained by applying the Palloni-Heligman version of the Brass method to the Bangladesh data referring to females and to both sexes combined (using in all cases the South Asian model). In addition, figure 10 presents a graphical comparison of estimated under-five mortality by sex. Figure 10 should be compared with figure 8, which shows the estimates by sex yielded by the Trussell version. Both sets of estimates have the same overall characteristics: with the exception of estimates derived from the reports of women aged 45-49, the estimated under-five mortality of males is, as is generally the case in most countries of the world, higher than that of females. The reversal in the trend observed for age group 45-49 is likely to be caused by errors in the basic data and should be disregarded.

In both sets, the estimates for females show a somewhat clearer declining trend during the 1958-1970 period than those for males. According to the Palloni-Heligman estimates, under-five mortality among females may have declined from approximately .240 in 1962 to around .225-.226 in 1970. According to the Trussell version, the decline during the same period would have been from .234 to .218. The magnitude of both declines is nearly the same, though the starting and ending points differ slightly. Such consistency is determined both by the basic data and by the similarity of the South and South Asian patterns used to derive the estimates considered here. In the next chapter, the effects of choosing different mortality models in estimating mortality in childhood will be considered in some detail.

TABLE 14. APPLICATION OF THE PALLONI-HELIGMAN 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	0.9642	1	.179	1.1	1973.2	.304
20-24	2	1.8474	.2035	1.0272	2	.209	2.5	1971.8	.261
25-29	3	3.4852	.2133	1.0081	3	.215	4.4	1969.9	.238
30-34	4	4.9166	.2282	1.0273	5	.234	6.6	1967.7	.234
35-39	5	5.8611	.2398	1.0396	10	.249	9.1	1965.2	.231
40-44	6	6.1940	.2635	1.0206	15	.269	12.0	1962.3	.242
45-49	7	6.0836	.2838	1.0069	20	.286	15.9	1958.4	.248

$P(1)/P(2) = .2085$
$P(2)/P(3) = .5301$
$M = 27.07$ *years*

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