Chapter III

RATIONALE OF THE BRASS METHOD

The Brass method derives estimates of $q(x)$—the probability of dying between birth and exact age x—from the proportion of children dead among those ever borne by women in different age groups by allowing for the duration of exposure to the risk of dying. The duration of exposure is related to the age of the woman and to the timing of child-bearing. On average, the older the women, the longer ago their children would have been born and the longer the children would have been exposed to the risk of dying.

The basic relationship between the proportion of children dead by age group of mother and the probability of dying in childhood can be illustrated by a very simple example. Suppose that all women have all their children at exactly age 20. Suppose further that mortality risks are constant over time. The children of women of exact age 22 will have been exposed to the risk of dying for exactly two years, so that the proportion dead will be exactly the probability of dying by age 2, $q(2)$. Proportions dead of children ever born for women of exact ages 23 and 25 will similarly estimate $q(3)$ and $q(5)$. Note that it is the age of the women in relation to the time of child-bearing that determines the children's duration of exposure to the risk of dying and thus the relationship between the proportion dead and some $q(x)$ value.

If mortality is assumed constant, the measures of $q(2)$, $q(3)$ and $q(5)$ will be applicable to any point in time during the period preceding enumeration. Now let us consider what would happen if mortality were falling. Assume again that all women have all their children at age 20 and that we are considering women aged 22 in 1978. Then the proportion dead of the children borne by those women would estimate $q(2)$ for the cohort of children born in 1976. With mortality falling, this cohort value would be somewhat lower than the $q(2)$ in effect during 1976 (which would reflect the experience of children born during 1974, 1975 and 1976), but somewhat higher than the value for 1978 (which would reflect the experience of children born in 1976, 1977 and 1978). The $q(2)$ for the 1976 birth cohort would thus estimate the value of $q(2)$ for some time point between 1976 and 1978 (somewhat closer to 1976 than 1978 because most of the child deaths for the cohort born in 1976 would have occurred close to birth). Similarly, the proportion of children dead for women aged 23 in 1978 would estimate $q(3)$ for the cohort of children born in 1975, approximating a value of $q(3)$ for some time point close to that date. Thus, when mortality has been changing, information on the proportion of children dead can yield not only estimates of child mortality but also estimates of its trends.

The above example is, of course, greatly oversimplified. In practice, women start to bear children at different ages and have subsequent children after variable birth intervals. The proportion of children dead for women of a five-year age group represents a complex average of different probabilities of dying for varying periods. That complex average, however, depends largely on the age pattern of fertility of the women considered—which determines the distribution of children by duration of exposure to risk—and on the level and age pattern of mortality risks affecting the children.

ALLOWING FOR THE AGE PATTERN OF CHILD-BEARING

The age pattern of child-bearing plays an important role in determining the relationship between the proportion of children dead among those borne by women of a particular age group and the children's probability of dying. To return to the simplified example above, if all women had their children at age 18 (instead of age 20) the proportion of children dead of women aged 22 would estimate the probability of dying by age 4, not age 2. Since in a life table the probability of dying by age 4, $q(4)$, must be greater than the probability of dying by age 2, $q(2)$, a given proportion of children dead for women aged 22 would indicate lower mortality risks in an early-fertility population than in a late-fertility population. Put another way, the children of women of a given age in an early-fertility population would, on average, have been born longer ago and would therefore have been exposed longer to the risks of dying than children of women of the same age in a late-child-bearing population. It is for this reason that fertility patterns must be taken into account in converting proportions of children dead into probabilities of dying.

The Brass method makes allowance for the pattern of fertility in a population by considering the lifetime fertility of women in different age groups. The measure of lifetime fertility used is called average parity, which is defined as the average number of children ever born per woman of a given age group. (It is calculated by dividing the total number of children ever borne by women of a given age group by the total number of women in that age group.)

If fertility has been constant, the average parity of women now aged, say, 15 to 19 will be the same as the average parity five years ago of women who are now aged 20 to 24. Thus, the current distribution of average parities by age group can be used as an indicator of the shape of the lifetime fertility distribution that needs to be considered in converting proportions of children dead into probabilities of dying in childhood. Specifically, using $P(1)$, $P(2)$ and $P(3)$ to denote the average parities of women in age groups 15-19, 20-24 and 25-29, respectively, allowance for the pattern of fertility is made by using the parity ratios $P(1)/P(2)$ and $P(2)/P(3)$. Note that, because parity ratios are used, the actual level of fertility does not matter, only its age pattern. For example, the greater $P(1)/P(2)$, the earlier the pattern of child-bearing.

Derivation of the method

The actual derivation of a Brass-type estimation procedure involves the use of simulation to generate proportions of children dead, the probabilities of dying that they are related to, and the parity ratios $P(1)/P(2)$ and $P(2)/P(3)$ that link them. Regression analysis is used to derive estimation equations, which make the application of the procedure straightforward.

It is worth nothing that there are several versions of the Brass method. They differ mostly in the type of models used to simulate the quantities of interest. The two versions described in this *Guide* are those proposed by Trussell (1975) and by Palloni and Heligman (1986). They differ mainly in that the former uses the Coale-Demeny regional model life tables to simulate mortality, while the latter uses the United Nations model life tables for developing countries. Both versions are presented here in order to provide the analyst with a wide choice of possible mortality models.

Table 3 indicates how all Brass-type estimation procedures link estimated $q(x)$ values with the observed proportions of children dead by age of mother, denoted by $D(i)$. As indicated in the table, an estimate of the probability of dying by age 1, $q(1)$, can be derived from the proportion of children dead reported by women aged 15-19, $D(1)$; the probability of dying by age 2, $q(2)$, can be obtained from the proportion of children dead for women aged 20-24, $D(2)$, and so on.

TABLE 3. CORRESPONDENCE BETWEEN OBSERVED PROPORTIONS OF CHILDREN DEAD BY AGE GROUP OF MOTHER AND ESTIMATED PROBABILITIES OF DYING

Age group of mother	*Age group index* i	*Proportion of children dead* $D(i)$	*Estimated probability of dying by age x* $q(x)$
15-19	1	$D(1)$	$q(1)$
20-24	2	$D(2)$	$q(2)$
25-29	3	$D(3)$	$q(3)$
30-34	4	$D(4)$	$q(5)$
35-39	5	$D(5)$	$q(10)$
40-44	6	$D(6)$	$q(15)$
45-49	7	$D(7)$	$q(20)$

Estimating time trends of mortality

The method originally developed by Brass assumed that mortality was constant, so that cohort and period probabilities of dying were identical. That assumption was later relaxed through the work of Feeney (1980), Coale and Trussell (1978) and others. Those authors showed that if the rate of change of mortality over time was approximately constant, the reference date of each $q(x)$ could be estimated by making allowance for the age pattern of fertility by means of the $P(1)/P(2)$ and $P(2)/P(3)$ ratios.

Since the measurement of child mortality trends is a major objective of this *Guide*, the use of the Brass method to detect or quantify changes in such trends resulting from programme activities requires further discussion. The procedure for estimating the reference dates of $q(x)$ values assumes that mortality has been changing steadily over time. A programme that speeds mortality decline will invalidate this assumption. Such a change in trend will have a greater effect on the proportions of children dead of younger women—a higher proportion of whose children will have been exposed to the recently lower mortality risks—than on the proportions of children dead of older women. It will also have some effect on such proportions for women of any age having significant numbers of recent births. Consequently, the Brass method will smooth out any sharp change in trend, transforming it into a gradually accelerating decline and thus making it harder to associate a decline with programme activities.

It should also be noted that the Brass method is unlikely to indicate any change in trend until at least two years after the change occurs. This lag arises from the observation, discussed in greater detail below, that mortality estimates based on reports of women aged 15-19—which reflect the most recent mortality—are generally unreliable.

Limitations of the Brass method associated with its simplifying assumptions

The Brass method is based on certain simplifying assumptions that may not be entirely satisfied in practice and that have implications for the interpretation of the estimates obtained.

The Brass method assumes that the mortality risks of children of women who do not report their child-bearing experience are the same as those of children whose mothers do. Aside from the problem of women who do not provide information, women may have moved away from the survey area before being interviewed or may have died. Thus, the estimates obtained assume, among other things, that the survivorship of children is independent of that of their mothers.

The method also assumes that fertility has remained constant during the 30 or 35 years preceding the survey or census. If fertility has been changing, the parity ratios will be affected, and the allowance made for the age pattern of child-bearing will not be correct. In particular, if fertility has been declining, the parity ratios will be too low, indicating a later age pattern of fertility than the actual one and leading to an overestimate of child mortality.

Perhaps the most basic assumption of the method is that the reported proportions of children dead are correct.

If some of the children that have died are reported as being alive or if dead children are omitted to a greater extent than living children, the mortality estimates obtained will be too low. If, as is generally the case, omissions and other errors are more prevalent among older than younger women, certain patterns in the data may indicate that errors have occurred. For example, the mortality estimates based on reports of women aged 40 and over may fail to increase with age of mother at the same pace as those based on the reports of younger women. Furthermore, the average parities of women aged 35 and over may not increase with age (or may actually decrease at older ages), indicating possible omissions of dead children.

Lastly, the Brass method assumes that mortality risks among children depend solely on their age and not on other factors, such as age of mother or birth order. If, for example, the mortality risks of children borne by young mothers (under age 20) were higher than average, then the proportion of children dead reported by women aged 15-19 would be too high and therefore would overestimate overall mortality levels. In addition, the estimates derived from data on women aged 20-24 might also be upwardly biased, since a significant proportion of the children reported by women aged 20-24 would have been born when the women were 15-19. By age group 25-29, however, a high proportion of all children would have been borne by mothers aged 20 and over, so that the effect of the abnormally high risks experienced by children of young mothers on the estimate of $q(5)$ would be small.

In practice, child mortality estimates based on reports of women aged 15-19 and, to a lesser extent, on those of women aged 20-24 are generally unreliable, often being higher than estimates based on reports of older women. The detailed example presented in the next chapter illustrates this effect and shows why the Brass method is not capable of providing reliable estimates of very recent mortality conditions (those prevalent during the two or even three years preceding interview).