Chapter VII

BRASS-MACRAE METHOD

This chapter describes a method proposed only recently by W. Brass and S. Macrae (1984) to estimate mortality in childhood. The Brass-Macrae method is in some ways complementary to the original Brass method. It has the advantage of producing estimates for recent periods (about two years before the time of interview) and is based on data that may be collected at relatively low cost. Its main drawback is that the data it uses may not be representative. Indeed, since the Brass-Macrae procedure envisages that only women about to give birth will be asked about the survivorship of their previous child, the children whose mortality is being measured may not be representative of all children. In cases where only women giving birth in hospitals or in government clinics are interviewed, the data will be even less representative of the total population. Strategies to make the data used more representative and efforts to understand the possible biases to which they are subject or to devise means of eliminating such biases are currently being pursued.[3] Yet, it is likely that those efforts may result in a considerably more complex estimation procedure than the one presented in this *Guide*.

Simplicity is an important advantage of the Brass-Macrae method, and thus may be worth maintaining even at the expense of full representativeness or perfect accuracy of the data. So far, the method has been largely applied to data gathered in specific areas—a given town or city or even a given hospital.[4] Consequently, it has been clear from the start that the population under study was not representative of the whole population of a country. In certain circumstances, nationally representative data may not be required, as, for instance, when a programme to improve child nutrition operates only in a given region. In such cases, the Brass-Macrae method may be used by programme managers to monitor changes in child mortality only in the region of interest. It can also be argued that, for purposes of monitoring change, biases affecting the Brass-Macrae estimates may be discounted as long as they remain constant. The researcher must, however, be aware of the possible sources of bias, in order to be able to ascertain the likelihood of biases remaining constant through time.

Owing to its recency, the Brass-Macrae method is still in the process of being tested. Several organizations, including UNICEF, the Latin American Demographic Centre (CELADE) and the London School of Hygiene and Tropical Medicine, are currently engaged in experimental applications of the method and are trying to determine how best to gather the basic information needed for its use.[5] Although the method seems promising, it is still difficult to judge its efficacy or to evaluate its performance under a variety of circumstances. Hence, the conclusions presented in this chapter are necessarily tentative and may err on the side of caution.

NATURE OF THE BASIC DATA

The Brass-Macrae method derives measures of child mortality from information obtained at or near the birth of a child about the survival of the mother's previous child (and sometimes about the child born prior to that one also). Unlike the Brass method, the information used in applying the Brass-Macrae method is derived from administrative sources (such as health-centre records) rather than from population censuses or surveys. The additional costs of data collection are thus small, since all that is generally required is the addition of two or three questions to an existing administrative form. The questions could be:

1. Have you been pregnant before? Yes/No
2. If yes: Was the child of your previous pregnancy born alive? Yes/No
3. If yes: Is that child still alive? Yes/No

An advantage of these questions is that they require very simple answers that do not even involve numbers. In that respect, they are likely to elicit more reliable information than the questions used to gather the data required for the Brass method.

As already mentioned, the Brass-Macrae method uses data that do not necessarily reflect the mortality experience of all children in a given population. In particular, deaths among the last-born children of all women in the population remain unrecorded. Also, because women are interviewed only at the time they give birth, the experience of the highly fecund is more likely to be recorded. Biases arising from such selectivity will always be in operation, even if all women giving birth in a country are interviewed. However, there is reason to believe that in populations where fertility is still moderate to high, the resulting biases would be minimal.

In general, it is not expected that the data necessary for the application of the Brass-Macrae method would be obtained from a nationally representative sample. A hospital or clinic is the typical setting envisaged for the collection of the basic information, although it has been suggested that midwives aiding in home deliveries might be trained to gather the necessary data. Such an approach to data collection would be mandatory in countries or regions where a majority of women give birth at home. Although nationally representative data may not be necessary for monitoring and evaluating local interventions aimed at reducing mortality, it is still important to define the target population and take steps to ensure that the data gathered are in effect representative of that population.

Derivation of the method and its rationale

It is easy to understand intuitively how the method works. Let us assume that all live-birth intervals are 2.5 years long and that every woman is asked at the time of delivery whether she has previously given birth and, if so, whether the previous-born child is still alive. Then, each previous child will have been exposed to the risk of dying for exactly 2.5 years, and the proportion dead will equal the cohort probability of dying by age 2.5, $q(2.5)$, provided that all last-born children have the same mortality experience as children whose birth is followed by that of a sibling.

In practice, of course, birth intervals are not all exactly 2.5 years long, though almost all are within the range of one to five years. Thus, the proportion dead of previous children represents a weighted average of the probabilities of dying between birth and ages 1-5 for cohorts born between one and five years before interview, the weights being the proportions of women having each length of birth interval.

Using models of birth intervals and mortality in childhood, Brass and Macrae found that the proportion dead of previous children is, in most high-fertility populations, a close approximation to the probability of dying by exact age 2, $q(2)$, and that the proportion dead of next-to-previous children is a close approximation to the probability of dying by exact age 5, $q(5)$. Since the proportions dead are strongly influenced by the age pattern of mortality in childhood—that is, most child deaths occur at very early ages—the $q(x)$ estimates obtained from them are reasonably robust to variations in birth-interval distributions. Adjustments can be made for the effects of such variations if the necessary information on average birth-interval lengths is available.

Brass and Macrae found that the proportion dead of previous children approximates $q(0.8z)$, where z is the length in years of the average birth interval. For average birth intervals of 30 months (2.5 years), the proportion dead corresponds to $q(2)$. Because the distribution of birth intervals by length varies little with respect to fertility level, the method is not overly sensitive to changes in fertility, especially because fertility declines are mainly due to a reduction of completed family size rather than to the substantial lengthening of birth intervals.

The estimates of $q(2)$ and $q(5)$ yielded by the Brass-Macrae method refer to different birth cohorts and may be equated to period estimates provided that some allowance is made for the timing of deaths. Aguirre and Hill (1987) have estimated, on the basis of declared dates of birth and death for previous and next-to-previous children, that $q(2)$ refers to a point approximately two years preceding interview and $q(5)$ refers to a point between three and four years preceding interview. Although those estimates of timing refer to a particular case, they provide a good indication of the rough reference dates of the $q(x)$ estimates obtained.

Limitations of the Brass-Macrae method

Because of the data it uses and the simplifying assumptions made in its application, the Brass-Macrae method has certain limitations, which are discussed in some detail below.

First, the data used exclude information on all last-born children. Such exclusion is not serious in high-fertility populations, but in those populations where completed family size is small (two or three children per woman), a large proportion of first-born children will be included in the data used for estimation purposes, and their mortality experience may not be representative of average mortality levels in the total population of children. However, in contrast with the Brass method, the Brass-Macrae approach is based on data on recent births of all orders to women of all ages and is therefore less likely to display the biases associated with the increased mortality of children whose mothers are very young.

Secondly, the Brass-Macrae method as described below makes no explicit allowance for changing fertility and mortality conditions. Fertility declines due to significant increases in average birth intervals will lead to overestimates of mortality when the proportion dead of previous children is simply equated to $q(2)$. Mortality declines, on the other hand, will start to be reflected in the $q(2)$ estimates only two or three years after they occur and will be fully reflected in those estimates only five years after their inception. Thus, as with the Brass method, sharp declines in mortality will appear as a smoothed downward curve, but, in contrast with the Brass method, the downward trend will not pre-date the inception of mortality change.

Thirdly, a single application of the Brass-Macrae method does not allow the estimation of trends in child mortality. Data relating to several years of observation are required to obtain some indication of trends.

Fourthly, since the Brass-Macrae method does not rely on data obtained through surveys based on probabilistic samples, the estimates it yields often do not refer to the total population of a country or even of a region. Biases due to the selectivity of the population under consideration (that using health clinics, for example) are likely to affect the estimates obtained and should be taken into account by the analyst in making comparison with estimates yielded by other methods.

Application of the Brass-Macrae method

Data required

The Brass-Macrae method estimates probabilities of dying in childhood from proportions dead of previous and, if data are available, next-to-previous children, the information being collected from women at or just after the birth of the most recent child.

Hence, the only data required are the following:

1. The number of women giving birth who reported having had a previous child, irrespective of their age, marital status etc.;

2. The number of women giving birth who, having had a previous child, reported that that child had died.

If questions on the survival of the next-to-previous child are also posed, then the following will also be needed:

3. The number of women giving birth who reported having had a child before the previous one;

4. The number of women giving birth who, having had a child before the previous one, reported that that child had died.

Note that there is no need for information on the number of children ever born or the total number of women. The data needed can be easily collected at the time of delivery, and it is not strictly necessary to compile a year's worth of data to apply the method. Since any seasonal variation in child mortality will be largely smoothed out by variability in birth intervals, as long as a sufficient number of events are recorded, there is no minimum length of time for which the data-collection exercise must be maintained. As noted earlier, however, data collection must be maintained over a period of years to estimate trends in child mortality.

Computational procedure

The computational procedure is very simple, consisting of, at most, two steps.

Step 1. *Calculation of the probabilities of dying,* q*(2) and* q*(5)*

The probability of dying by age 2, $q(2)$, is calculated by dividing the number of women reporting a previous child who has died by the total number of women reporting a previous child. Thus,

$$q^e(2) = \frac{NPCD(1)}{NPC(1)} \tag{7.1}$$

where $q^e(2)$ is the estimated probability of dying by age 2, $NPCD(1)$ is the number of women with a previous child dead, and $NPC(1)$ is the number of women who reported a previous child. Cases of non-response, where the mother does not report the survival status of the child, should be excluded from both the numerator and the denominator.

The probability of dying by age 5, $q(5)$, is similarly calculated by dividing the number of women reporting a next-to-previous child dead by the number of women reporting a next-to-previous child. Thus,

$$q^e(5) = \frac{NPCD(2)}{NPC(2)} \tag{7.2}$$

where the symbols have the same meanings as before, but refer to next-to-previous rather than to previous births.

Step 2. *Conversion to a common index*

In cases where estimates of both $q(2)$ and $q(5)$ can be obtained, conversion to a common index is necessary to compare them. For consistency's sake, it is recommended that $q(5)$ be used as the common index, just as in the application of the Brass method. It is therefore necessary to find a value $q^c(5)$ equivalent to the $q^e(2)$ estimate obtained above. As with the Brass method, a model-life-table family must be used to perform the necessary conversion. Ideally, the family used should reflect the mortality pattern prevalent in early childhood in the population being studied (see chapter I).

Having selected an appropriate model-life-table family from annex I or II, one needs to identify two mortality levels, j and $j+1$, whose $q(2)$ values enclose the estimated $q^e(2)$ so that

$$q^j(2) > q^e(2) > q^{j+1}(2) \tag{7.3}$$

The desired value of $q^c(5)$ is then obtained as

$$q^c(5) = (1.0 - h)q^j(5) + h\,q^{j+1}(5) \tag{7.4}$$

where $q^j(5)$ and $q^{j+1}(5)$ are the model values of $q(5)$ at levels j and $j+1$, respectively, in the selected family of model life tables, and h is an interpolation factor calculated as follows:

$$h = \frac{q^e(2) - q^j(2)}{q^{j+1}(2) - q^j(2)} \tag{7.5}$$

Once $q^c(5)$ is calculated, it can be compared with the $q^e(5)$ obtained in step 1. Since the latter refers to a slightly earlier period than $q^c(5)$, under conditions of declining mortality $q^c(5)$ should be lower than $q^e(5)$. The example presented below illustrates such a comparison.

A detailed example

The data for this detailed example were collected in five health facilities in Bamako, Mali, starting in January 1985 (Hill and others, 1985). A specially designed form was used to gather information about all deliveries and the previous two live births that each mother might have had. Table 20 shows the number of previous births and next-to-previous births recorded, and the number of children who had died by the time of observation.

TABLE 20. ESTIMATION OF THE PROBABILITY OF DYING $q(x)$, FOR BAMAKO, MALI, USING THE BRASS-MACRAE METHOD

	Number of births (1)	*Number dead* (2)	*Probability of dying* (3)
Previous	4 775	679	.1422
Next to previous	3 737	620	.1659

Source: A. G. Hill and others, "L'enquête pilote sur la mortalité aux jeunes âges dans cinq maternités de la ville de Bamako, Mali", in *Estimation de la mortalité du jeune enfant (0-5) pour guider les actions de santé dans les pays en développement,* Séminaire INSERM, vol. 145, (Paris, 1985), pp. 107-130.

Step 1. *Calculation of the probabilities of dying,* q*(2) and* q*(5)*

For each class of previous births, the probabilities of dying are calculated according to equations 7.1 and 7.2 by dividing the entries of column 2 of table 20 by those of column 1, as shown below:

$$q^e(2) = \frac{679}{4{,}775} = .1422$$

$$q^e(5) = \frac{620}{3{,}737} = .1659$$

The resulting $q^e(2)$ and $q^e(5)$ estimates are displayed in column 3 of table 20.

Step 2. *Conversion to a common index*

Using $q(5)$ as the common index, $q^e(2)$ needs to be converted into an equivalent measure of $q(5)$. For both sexes and a sex ratio at birth of 1.05 male births per female birth, the Coale-Demeny North model-life-table values in table A.I.9 show that the estimated $q^e(2)$ value is enclosed by $q^{13}(2) = .14701$, whose $q^{13}(5) = .19235$, and by $q^{14}(2) = .13158$, for which $q^{14}(5) = .17113$. Using equation 7.5 to estimate the interpolation factor h,

$$h = \frac{.14220 - .14701}{.13158 - .14701} = .3247$$

This value of h is then used in equation 7.4 to find the corresponding $q^c(5)$ as follows:

$$q^c(5) = (1.0 - .3247)(.19235) + (.3247)(.17113)$$
$$= .185$$

Note that this $q^c(5)$ value is considerably higher than the $q^e(5)$ value obtained in step 1, namely, .166. Such estimates would imply that under-five mortality among the children of interviewed women increased from .166 in 1981-1982 (three to four years before interview) to .185 around 1983 (about two years before interview). The unlikelihood of such an increase suggests that the estimates obtained may be subject to selection biases that affect their accuracy. Aguirre and Hill (1987) argue that $q^e(5)$ is more likely to be affected by those biases, since it is based on children whose mothers are older on average and who seem to represent only the better educated and socially advantaged group of the population (older Bamako women who have already had several children tend not to give birth in clinics). For that reason, $q^e(5)$ is lower than expected, and it would have to be rejected as a valid estimate of under-five mortality for 1981-1982. On the other hand, there is no reason to reject $q^c(5)$, which, at 185 deaths per 1,000 live births, would be an estimate of the 1983 probability of dying by age 5 among the children born to women who attended health clinics in Bamako.

Comments on the results of the method

As stated earlier, experience in the use of the Brass-Macrae method is limited, so no firm assertions can as yet be made about the validity of the estimates it provides. In the example presented above, the inconsistencies discovered should raise doubts about the accuracy of the estimates obtained. However Aguirre and Hill (1987) note that the estimated $q(2)$ value of .142 is in line with estimates obtained, using the original Brass method, from a large survey conducted by the Sahel Institute among a representative sample of Bamako households. Note that estimates obtained by applying the original Brass method are needed to validate the Brass-Macrae results. The assessment of new techniques in terms of the old is to be expected and will probably continue for a few years. For that reason, the reader should become familiar with both methods.

Mention has been made of the potential use of the Brass-Macrae method to assess trends in child mortality in specific subpopulations. Perhaps one of the best examples so far of that use is provided by the data gathered through the birth-notification scheme operating in Solomon Islands during the period 1968-1975 and analysed by Brass and Macrae in their 1984 article. Table 21 presents the basic data and the $q(2)$ estimates derived from them. Although for earlier years the $q(2)$ estimates vary in an unexpected fashion, the full set of estimates shows sustained mortality decline. Indeed, if the likely reference dates of the estimates are taken into account, mortality in childhood seems to have been cut almost in half between 1968 and 1975.

TABLE 21. ESTIMATION OF THE PROBABILITY OF DYING BY AGE 2, $q(2)$, FOR SOLOMON ISLANDS, USING THE BRASS-MACRAE METHOD

Year of notification	*Number of previous births (1)*	*Number dead (2)*	*Probability of dying q(2) (3)*
1968	1 769	209	.1181
1969	2 400	255	.1063
1970	2 796	331	.1184
1971	3 030	281	.0927
1972	3 861	333	.0862
1973	3 369	228	.0677
1974	2 390	159	.0665
1975	4 472	264	.0590

Source: W. Brass and S. Macrae, "Childhood mortality estimated from reports on previous births given by mothers at the time of a maternity: I. Preceding-births technique", *Asian and Pacific Census Forum*, vol. 11, No. 2 (November 1984), p. 7.

By permitting the estimation of child mortality over a period of years, the data for Solomon Islands provide an example of a more realistic use of the Brass-Macrae technique than does the case of Mali. Even if the estimated $q(2)$ values are not perfect, their declining trend is indicative of the changes taking place and might serve as an adequate evaluation tool. It is important, however, to confirm that the representativeness of the basic data has remained constant through time, especially in view of the variability evident in the numbers of women providing information (see column 1 of table 21). Brass and Macrae noted that "some selection bias is likely since the births notified may be to women who are better educated or otherwise socially advantaged",[6] but they discounted the effects of that bias. The existence of such selectivity could be assessed by gathering additional information on the women giving birth, including their age, parity, educational level, work status and usual place of residence. The distribution of reporting women according to those variables would shed light on the likelihood and possible extent of biases stemming from changes in selectivity.

Clearly, because of its simplicity and flexibility, the Brass-Macrae method deserves attention. The tests it is being subjected to will, it is hoped, show that the selectivity and other biases that may affect the estimates it yields may reasonably be discounted by analysts interested in assessing programme impact. It is unlikely, however, that the Brass-Macrae method will replace the original Brass method as the main technique providing national estimates of mortality in childhood. It is in providing estimates for selected subpopulations that the Brass-Macrae method has the greatest potential.