RECENT TRENDS IN THE METHODOLOGY OF DEMOGRAPHIC SURVEYS IN DEVELOPING COUNTRIES

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INTRODUCTION

Vital registration systems which achieve complete and accurate coverage of births and deaths are rare in developing countries. This situation can be traced to the passive nature of registration systems coupled with the general perception by individuals in developing countries that they derived little or no benefit from the registration of births and deaths. Given these perceptions, the collection of vital event data requires active procedures such as household surveys in which trained interviewers visit dwelling units and follow a specific protocol to obtain demographic data.

Significant developments have occurred in the methodology of demographic surveys in the last 25 years. These developments can be dichotomized depending on whether they pertain to direct or indirect estimation techniques. Direct estimation techniques require the collection of information about the occurrence of events during a specified reference period. The procedures for performing this task range in complexity from single-and multiround surveys to dual record systems. Single and multiround surveys involve a straight-forward conversion of observed data into estimated rates. Dual record systems involve adjustments to the data prior to the estimation of rates. These adjustments are based strictly on mathematical relationships rather than assumptions about demographic interrelationships, exogeneous to the observed data. The second section of this report describes recent trends in direct estimation techniques.

Indirect estimation is based on a strategy which employs observed data in conjunction with complex demographic models. The rationale is that, in populations where the reporting of events for a reference period is unreliable, other types of more accurate demographic data may be obtained and then transformed into the desired vital rate estimates. The models for converting the data collection process are such that the reliability of results depends on both the accuracy of the basic data collected and the degree to which the assumptions of the models are met by a particular population. The third section of this report provides a brief overview of developments in the field of indirect estimation and focuses on one well-established technique--the estimation of childhood mortality rates from survivorship statistics.[1]

ESTIMATION OF DEMOGRAPHIC PARAMETERS BY DIRECT METHODS

Single Round Surveys

We use the term *single-round retrospective survey* (SRS) to refer to a one-time data collection effort. SRS surveys use either of two alternative approaches for the collection of birth and death data: (1) *the reference period procedure* or (2) *the pregnancy/birth history procedure*. The reference period approach asks a knowledgeable adult member of a household to report information concerning events that occurred in the household during a specified reference period (usually the 12 or 24 months preceding the survey, although sometimes this period is extended). This procedure is frequently flawed by the underreporting of events. The problem is especially serious with infant and childhood death reporting. There is a general consensus that this underreporting is the result of reference period error, age misreporting, and respondent forgetfulness or concealment of events. Mauldin (1966, p. 639) writes, "the use of single surveys for obtaining estimates of births and deaths is a questionable procedure. Sample surveys tend to undercount vital events, but there is no assurance that the undercount is uniform over time, among different groups, or even that there will be undercounts." He concludes that "single round retrospective surveys can not be depended upon to provide valid and reliable estimates of births and deaths."

The pregnancy/birth history approach attempts to record the time sequence and spacing of all pregnancies/births and their survivorship along with the date of death (or age at death) for births which have died. This information is usually collected from the women whose fertility experience is being documented. Because the pregnancy history approach attempts to obtain data pertaining to all reproductive events directly from the women concerned, and because it employs probing questions to aid respondents in recalling events, it is generally considered to collect more complete period-specific data than does the reference period approach. Nevertheless, pregnancy history data can suffer from the omission of events and from the misreporting of dates of occurrence. For these reasons, this approach does not necessarily yield accurate period-specific estimates of fertility levels or time trends in fertility.

Multiround Surveys

Multiround surveys (MRS) attempt to circumvent some of the problems of event reporting to which SRS surveys are susceptible. The strength of the MRS approach is that information obtained in the earlier round(s) facilitates subsequent reporting of events. In the initial survey round, the composition of the household and characteristics of household members are recorded. In subsequent rounds, events are detected by identifying changes in the household composition and, in addition by asking specific questions about events which have occurred since the previous round.

Since the MRS approach collects information for a bounded recall period, errors due to incorrect dates and the erroneous inclusion of events are reduced. Also, this approach should reduce omission of certain types of events, i.e., deaths of persons listed in an earlier round and births to women noted as being pregnant in an earlier round. Although this process can potentially reduce error from various sources, some problems should be noted:

1. Multiround surveys are more costly and require identification of households for follow-up visits.

2. The periodic visits to the same household may result in respondent or interviewer fatigue.

3. The quality of fieldwork may vary from round to round.

4. While multiround surveys potentially reduce nonsampling errors, there is no built-in mechanism for the measurement of coverage error.

Dual Record Systems

Dual record systems (DRS) represent a further refinement in the effort to collect accurate and complete reference period data. The methodology of this approach is described in detail in the literature (Marks et al., 1974, Krótki, 1978) and is succinctly summarized by various authors (Coale, 1963). In brief, the DRS obtains data on events in well-defined areas by two independent data collection systems: typically (1) either a civil registration system or a wholly new registration scheme, and (2) a periodic household survey. Reported events must be identified in sufficient detail to allow "matching" between systems. All events are classified into three categories:

(1) events reported in both systems,
(2) events reported only in system 1,
(3) events reported only in system 2.

An estimate of events missed by both systems and an estimate of total events are then made with the aid of the well-known Chandrasekaran-Deming formula (Chandra Sekar and Deming, 1949).

Since the DRS has a built-in mechanism for detecting coverage errors and for correcting them; dual record systems represent an advance over SRS and MRS surveys. As Mauldin (1978) points out, "dual record systems have one striking advantage for the statistician who seeks certainty of knowledge as to the accuracy of results. If the two systems give somewhat different results, the statistician knows that there are deficiencies in at least one system and field checks will disclose whether the deficiencies are confined to one system or if they exist in both systems."

It should be pointed out, however, that there are a number of conditions in which the DRS approach can result in an incorrect estimate of the total number of events. The three major sources of error are: (1) a lack of independence between the two systems, (2) inclusion of events which are geographically or temporally out-of-scope in one or both systems, and (3) matching errors (Seltzer and Adlakha, 1974). Failure to achieve a zero net error among these sources will result in a biased estimate of total events.

In addition, the DRS, like the MRS, is complex to design and administer and suffers from the problems of cost, respondent and interviewer fatigue and other non-technical problems. Accordingly, the literature is full of controversy over the cost-effectiveness of a DRS. Wells and Horvitz (1978) argue that accuacy of estimates in terms of mean square error may more than offset the added cost in the well-executed dual record system. On the basis of a limited review, Brass (1973) concludes, on the other hand, that DRS systems are costly and may not accurately measure demographic parameters or rates of population growth.

The Use of SRS, MRS, and DRS in Developing Countries in Recent Years

From a methodological perspective it is clear that MRS and DRS surveys are superior to SRS surveys. Yet, the popularity of these methods is affected by operational considerations, such as financial and personnel constraints. Multiround surveys and dual record systems require substantial inputs of money, skilled manpower, and a high level of administrative organization. These resources are among the most scarce in developing countries and this fact has probably restricted the popularity of multiround surveys and dual record systems.

An inventory of large-scale demographic surveys in developing countries from 1960 to 1973 has been compiled by the International Statistics Program Office of the U.S. Bureau of the Census (Baum et al., 1974). The inventory includes 175 surveys (mostly national or regional in scope). The distribution of these by type of survey was 69 percent SRS, 24 percent MRS, and 7 percent DRS. Since 1973 there has been no comprehensive review of demographic survey activity in developing countries. However, information is available for two large survey programs: The World Fertility Survey (WFS) and the International Program of Laboratories for Population Statistics (POPLAB). WFS is a major fertility and mortality measurement effort involving demographic surveys in about 40 developing countries. WFS surveys follow the SRS format and rely on the pregnancy/birth history approach to data collection. POPLAB, under the Birth and Death Data Collection Project, is projected to conduct 14 surveys in developing countries during 1978-1983. While primarily relying on the SRS format, this effort employs the reference period approach (Sullivan et al., 1980). Of course, other demographic surveys have been carried out in various countries since 1973 but their frequency and type is not centrally documented.

It seems clear that the SRS approach has been and will continue to be the primary source of fertility and mortality data in developing countries in the near future. The heavy reliance on SRS surveys is probably due to their relative flexibility, ease of administration, short time span and low cost. Additionally, it is worth noting that the SRS approach is becoming more attractive because of recent developments in the field of indirect estimation--a topic which is discussed in the following section.

ESTIMATION OF DEMOGRAPHIC PARAMETERS BY INDIRECT METHODS

The field of indirect estimation covers such a wide variety of procedures that its common elements must be stated in quite general terms; even then there are exceptions. For our purpose, it is useful to emphasize two factors common to the majority of these techniques: their use of data obtainable in SRS surveys and their use of demographic models in estimating vital rates. The fact that the SRS can be used to collect the data necessary for the implementation of indirect techniques as well as data suitable for direct estimation, creates the opportunity to apply both approaches with data obtained in a single survey.

The indirect techniques currently available involve procedures as diverse as (1) the estimation of vital rates from information on age structure, (2) the adjustment of defective data with model fertility and mortality schedules, (3) the adjustment of period fertility data with cohort fertility data, and (4) the estimation of mortality rates from widowhood, orphanhood, and child survival statistics, to name a few. Each of these techniques rests on different methodological bases and makes somewhat different assumptions about demographic conditions in a population. Unlike developments in the field of direct estimation, the indirect procedures do not necessarily follow a logical progression from less to more reliable techniques. Instead, each technique must be considered in terms of its data requirements, the assumptions of the demographic model on which it is based, and its robustness when applied under conditions which deviate from those assumptions. Accordingly, we consider all of these factors for the most well-established indirect technique: the technique for estimating childhood mortality rates from childhood survivorship statistics.

Indirect Childhood Mortality Estimation

Censuses and surveys frequently collect data indicating the number of children ever born (CEB) and children surviving (CS) to women of childbearing age. The data are tabulated for women classified in standard five-year age intervals. For each age interval, the proportion dead of CEB is calculated and denoted by D_i, where i represents an age interval (i = 1 for women aged 15-19, i = 2 for women 20-24, etc.).

D_i statistics represent the average mortality of all births to women of an age interval (i.e., children exposed to mortality for various durations) and are ambiguous mortality indices. William Brass (Brass and Coale, 1968) pioneered the methodology for transforming these statistics into q(a) statistics: the probability of dying between birth and exact age a. Brass and other scholars have employed the following correspondence between observed D_i statistics and estimated probabilities of dying upto specific childhood ages, $\hat{q}(a)$:

Age Interval of Women	Proportion Dead of CEB	Estimated Mortality Probability
15-19	D_1	$\hat{q}(1)$
20-24	D_2	$\hat{q}(2)$
25-29	D_3	$\hat{q}(3)$
30-34	D_4	$\hat{q}(5)$
35-39	D_5	$\hat{q}(10)$

For the indirect models to be applicable to a particular population, certain conditions must be approximately met. The most important of these are assumptions about:

1. *Accurate survivorship data* -- namely, that respondents accurately report data on CEB and CS

2. *Knowledge of the shape of fertility and mortality schedules* -- namely, that the schedules prevailing in a particular population follow an age pattern similar to those embedded in the estimation models

3. *Stationary demographic conditions* -- namely, that fertility and mortality levels have been constant for the past 15 or 20 years

4. *Homogeneous mortality experience* -- namely that the children of women in different age groups experience the same mortality levels.

In situations where application of the indirect models is desirable, one or more of these assumptions sometimes are not met. Recent methodological research has developed improved procedures for collecting survivorship data and has extended the basic models so that indirect estimation is possible under less restrictive conditions than those specified above. We briefly review those developments.

Accurate Survivorship Data

In general, the techniques of indirect estimation of demographic parameters were designed for use with demographic data which are, in some respect, incomplete or defective. Each technique overcomes or circumvents specific types of data defects and each should be employed only with data sets which suffer from those specific deficiences. In the case of mortality estimation, the indirect models are designed to transform D_i statistics, which are ambiguous with respect to duration of exposure to mortality, into precisely defined mortality rates. The models contain no mechanism for detecting inaccuracies in childhood survivorship data or for adjusting inaccurate D_i statistics. This point has been insufficiently recognized in some applications of the models--a situation which reflects misplaced confidence in the power of the technique, the origins of which can be traced to the initial applications of the models.

The indirect models were first tested with survivorship data collected in historical European censuses (United Nations, 1967). While these censuses were not specifically designed to ensure the collection of high quality survivorship data, these applications were successful in the sense that the estimated rates closely approximated the registered rates. This gave rise to the impression that, for the purpose of indirect estimation, sufficiently accurate survivorship data could be collected without paying careful attention to the data collection process. This view was, perhaps, justified for European populations having a tradition of reporting information in household surveys. However in a number of developing countries, efforts to collect survivorship data have resulted in unacceptably low D_i statistics due to the underreporting of children who have died (Feeney, 1977; Coale et al., 1980), primarily due to inappropriate data collection procedures.

Experience accumulated in the last 10 to 15 years has resulted in a consensus concerning the minimum procedures necessary for the collection of reliable survivorship data. Four aspects of data collection which are particularly important follow. First, the data on CEB and CS to women in the child-bearing ages should be collected directly from the women themselves. Reliance on proxy respondents invites the underreporting of events, particularly live births ending in early infant deaths. Second, the survey instrument should be designed so that respondents are asked to report separately, for sons and daughters, the number of children living in the household, the number living elsewhere, and the number who have died. To preclude premature closure on the aggregate number of CEB, a question concerning total CEB should be asked only at the end of the above sequence. Third, interviewers should be trained to explain to respondents what events to include on their reports. In particular, it should be explained that all births showing signs of life including breathing or crying should be reported. Finally, whenever possible, female interviewers should be used because, for the collection of data on fertility and child mortality, they generally develop better rapport with female respondents than male interviewers.

The Shape of Fertility and Mortality Schedules

The development of the Brass model involved the use of simulation analysis with analytical representations of fertility and mortality schedules to generate D_i statistics, mortality rates [q(a)], and parity ratios (P_1/P_2, P_2/P_3). These simulated data were the basis for specifying a procedure in which parity ratios estimate multipliers for converting observed D_i statistics into q(a) estimates. Since the Brass model relied heavily on analytical fertility and mortality schedules, a general test of its applicability with empirical schedules was needed.

Sullivan (1972) and Trussell (1975) undertook the task of testing the Brass model. Both attempts employed mortality schedules representing four distinct mortality patterns (the West, North, East and South patterns of Coale and Demeny (1966)) and a broad collection of empirically-based fertility schedules.[2] Separate data sets were generated for each mortality pattern, and estimation models, specific to each mortality pattern, were developed. The Brass model was tested by comparing mortality rates estimated from it with rates estimated from the new models of Sullivan and Trussell.

The work of Sullivan and Trussell clarified several points. First, and most important, it substantiated the conceptual basis of the Brass approach with a broad set of empirically-based data. Second, it produced new models which are preferable to the Brass model. Third, it revealed the preferability of the West models when the true mortality pattern is unknown. Finally, it indicated that when schedules in an actual population conform to the well-documented patterns employed in the models, mortality estimates are within tolerable limits of error--in most cases not in excess of 8 or 10 percent of true values.

The investigation of the effect of variability in age pattern of fertility and mortality schedules suggests, in general, that this is not a serious problem. Nevertheless, under extreme conditions, the problem could be serious. There are at least two procedures for circumventing error from this variability in age patterns in fertility and mortality schedules. The first by Preston and Palloni (1978) involves the use of a model which employs observed age distributions of surviving children. Since this procedure obviates the need to estimate c(a) functions, it completely circumvents the problem of variability in the age pattern of fertility. The principal drawback of this approach, however, is the necessity for information on the age of each surviving child.

The second procedure involves the use of models which employ data organized according to marital duration intervals of women rather than according to their age intervals. These models, developed by Sullivan (1972) and Trussell (1975), represent a significant extension of the indirect estimation technique. The pattern of fertility schedules graduated by marital duration exhibit less variability across populations than schedules graduated by age, with the result that the duration models are less susceptible to error from variability among fertility patterns (Sullivan, 1970; Nosseir, 1975). Of course, the application of these models is problematic in populations where the point of entry into a cohabitating relationship and the concept of marriage are ambiguous due to the existence of unstable or consensual unions. This problem may be alleviated with further research which investigates the use of surrogate variables for marriage duration such as the age of the oldest surviving child plus one year.

Stationary Demographic Conditions

The age and duration models of Brass, Sullivan and Trussell assume unchanging levels of fertility and mortality. Application of these models under dynamic conditions will, in general, produce biased estimates. The degree of bias depends on the speed, duration, and structural aspects of the trend, a set of factors which are generally unknown. In spite of these difficulties, several procedures have been proposed to circumvent the problems created by dynamic conditions.

In the case of changing fertility, there are persuasive reasons for preferring the Preston-Palloni model or the marriage duration models over the Brass, Sullivan or Trussell age models. As described above, the Preston-Palloni model is based on observed rather than on estimated age distributions and, as such, it is not adversely affected by fertility change. Similarly, the duration models, when restricted to shorter duration intervals, partially circumvent the problem of fertility change. Since World War II the most common mechanisms of fertility change in developing countries seem to be an increased in the mean age at marriage and an increase in use of contraception in the later phases of family building. The marriage models explicitly allow for changes in age at marriage whereas the latter type of change does not substantially affect fertility performance in the marriage duration intervals 0-4 and 5-9.

In the case of changing mortality, the problem has proved amenable to an analytic solution--at least in the special case of linear declines in mortality. Under the assumption of linearly declining mortality, Feeney (1976) and Sullivan and Udofia (1979) showed that it is appropriate to interpret the estimates as specific to a point of time in the recent past, t^*. The significance of this finding arises from the fact that, to a close approximation, the value of t^* is constant, no matter what the rate of mortality decline. Thus the estimates $\hat{q}(2)$, $\hat{q}(3)$, $\hat{q}(5)$, and $\hat{q}(10)$ can be assigned to dates in the recent past (t^* estimates). Conversion of the $\hat{q}(a)$ estimates to a single mortality parameter, say $\hat{q}(1)$, creates a time series of estimated infant mortality rates and leads to the possibility of estimating the rate of mortality decline.

Several operational models exist for estimating t^*. A major distinction occurs between those which specify mortality decline in period-specific terms (Feeney, 1976; Coale and Trussell, 1978) and those which specify decline in cohort-specific terms (Preston and Palloni, 1978; Palloni 1978, 1979, and 1980). These models have provided persuasive evidence of the existence of mortality trends in a number of populations (Coale et al., 1980; Feeney, 1977, Palloni, 1979), in spite of the fact that the precision of specific $\hat{q}(1)$ estimates is sometimes suspect. The problem of precision arises from data inaccuracies, violation of the homogeneity assumption (considered below), and uncertainty about the prevailing mortality pattern. Uncertainty about the prevailing mortality pattern is important because mortality patterns differ in terms of the relationship between q(1), on the one hand, and q(a) for a = 2, 3, 5, and 10 (the rates estimated by the indirect models) on the other hand. Hence, the models based on different mortality patterns imply $\hat{q}(1)$ estimates which can differ for older women by as much as 15 or 20 percent.[3]

Homogeneous Mortality Experience

The objective of the indirect models is to estimate average childhood mortality rates in a population. Nevertheless, specific $\hat{q}(a)$ estimates are derived from D_i statistics pertaining to children segregated into subgroups by the age group to which their mother belongs. For these estimates to represent the average mortality experience it is necessary for the same mortality rates to be experienced by each subgroup of children. The models require that this is the case.

The general validity of the homogeneity assumption is highly questionable. The assumption is usually incorrect with respect to the children of women aged 15-19 and frequently suspect with respect to the children of women aged 20-24. These two subgroups of children contain a high proportion of first-order births and, to the extent that early marriage is concentrated in a particular socioeconomic class, may contain a high proportion of children from that social class. Both effects suggest that the mortality experience of these children may differ from the average experience of all children, probably by being more severe. In fact, relative severe mortality among the children of women aged 15-19 has long been implicitly recognized by the common practice of disregarding relatively high $\hat{q}(1)$ estimates derived from D_1 statistics. In addition, the possibility of severe mortality among children of women aged 20-24 has recently been pointed out, primarily by Feeney (1977).

The models which deal with changing mortality estimate a series of $\hat{q}(1)$ and t* values from survivorship data reported by women in consecutive age intervals. The $\hat{q}(1)$ estimates derived from young women apply to time periods close to the survey date while the estimates from older women apply to time periods more distant from the survey date. It is quite clear that implausibly high $\hat{q}(1)$ estimates from women aged 15-19, and $\hat{q}(1)$ estimates derived from women aged 20-24 which exceed the estimates of $\hat{q}(1)$ derived from women aged 25-29 imply either that mortality increased in the years immediately preceding the survey or that the homogeneity assumption is invalid for younger women. Of course, a plausible time trend of $\hat{q}(1)$ estimates could also incorporate relatively severe mortality among the children of younger women and underrepresent the true rate of mortality decline. Thus, extreme caution must be exercised when interpreting mortality estimates in which nonstationary and nonhomogeneous mortality conditions may exert an influence. Existing practices have considered relatively high $\hat{q}(1)$ estimates from women aged 15-19 or 20-24 as reflecting nonhomogeneous mortality (Feeney, 1977) or have estimated $\hat{q}(1)$ and t* values from women in the broad age group 20-29 under the strategy that such an estimate will be more representative of overall mortality conditions (Palloni, 1979). An approach not yet attempted, but which may be fruitful is to employ the marriage duration model, perhaps for the broad duration interval 0-9. This approach amalgamates a high proportion of all births in the years immediately preceding the survey into a single group and this may substantially mitigate the effect of biological or socioeconomic factors specific to a more narrowly defined subgroup of births.

SUMMARY

The past two decades have witnessed significant developments in both direct and indirect approaches to vital rate estimation. Several trends are discernible: (1) the development of elaborate survey procedures in conjunction with direct estimation techniques, (2) the development of complex indirect models, and (3) the improvement of questionnaire design and field procedures for data collection. The more elaborate survey procedures require considerable contributions of funds and manpower which appear to have restricted their popularity. Single-round surveys and indirect procedures have the advantage of being relatively inexpensive and the latter has the potential for continued rapid improvement in the near future. Nevertheless, the indirect models are becoming more complex so that their propoer application requires the services of highly sophisticated technical analysts. The approach which focuses on the collection of more accurate data through improved field procedures has promise but requires commitment on the part of the implementing agencies. No doubt, advances will continue in all of these areas and, at least for the present, a heavy reliance on single-round surveys for demographic data collection will continue.

The recent emphasis on the development of elaborate survey procedures and complex models is both encouraging and troubling. This trend reflects the ability of demographers and statisticians to apply their skills in research settings which are remote from the field aspects of data collection. To some extent, this emphasis has overshadowed and diverted attention from the more mundane aspects of field work. It would appear that demographic estimation would be better served in the future if this imbalance were redressed by more attention being paid to questionnaire design, the training and supervision of interviewers, and the problems of nonresponse and the identification of knowledgeable respondents.

Notes

[1]This is an abbreviated version of a more comprehensive paper which is available upon request to the authors.

[2]The collection of fertility schedules used by Trussell was more extensive than that used by Sullivan and, in particular, included more schedules with an early age at onset of childbearing.

[3]Uncertainty about the prevailing mortality pattern affects the reliability of all the models which convert D_i statistics reported by older women into $\hat{q}(1)$ estimates. However, this problem is not evident in the Feeney model, based on a single mortality pattern; but it is evident in the Coale-Trussell and Preston-Palloni models which are compatible with $\hat{q}(a)$ estimates derived from models based on four mortality patterns.

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