OBJECTIVES AND REQUIREMENTS FOR MEASUREMENT OF VITAL RATES

Forrest E. Linder and Walt R. Simmons
National Center for Health Statistics

I. Introduction

Perhaps the most traditional and firmly established cornerstone of any national statistical system is the periodic decennial census and the continuous registration of births and deaths. In every advanced country of the world these statistics have long been well organized and operate to a high degree of effectiveness. In the lesser developed countries, efforts are being made to initiate and perfect these systems. Numerous international recommendations underline the basic character of these systems as elements of the national statistical program. Many of the activities of the United Nations and the World Health Organization are directed toward developing standards, definitions, and classifications for these systems and assisting countries to create the statistical organizations to compile census and vital event data.

Traditionally the periodic census has been recognized as the vehicle for tracing demographic and economic history of a nation; for describing the growth, migration, and composition of its people; and for providing a wide spectrum of information for administrative and research purposes.

The vital statistics system, an essential companion to the census for many analytical purposes, has provided death rate information which is the crucial index for appraisal of a nation's health problems and a measure of success in reaching national health goals. The birth rate and the current rate of natural increase, the other major products of the vital statistics system, have in the past been of interest primarily to the theoretical demographers. These fertility measures had, except in a few instances, no significant relationship to explicit national objectives or governmental action programs.

Recently, however, the statistical output of the vital statistics system has been raised to an entirely new level of importance. More and more countries of the world are now developing specific plans and programs to accelerate their economic and social development. There is sharp realization that if this rate of social and economic development, however fast it may be, is less than the rate of growth of the population, the resultant effect is not likely to be improvement in the level of living for that nation's people. The birth rate, the death rate, and the difference between these two measures have now become crucial indicators as to whether any developmental plan, however successful technically, will achieve its real objective.

Viewed in this light, many countries are now accepting the fact that their present rate of population growth presents a too difficult pacemaker for their economic development capacity. Such countries are having to develop policies, programs, and organizations which accompany plans for economic development with programs to reduce the rate of population expansion.

These family planning programs if they are to be effective are necessarily large, complicated, and expensive. The current birth rate, its components, and related factors now emerge as essential criteria for developing, guiding, and appraising the effectiveness of family planning activities.

Unfortunately, in most countries where the race between economic development and population expansion is most acute, the traditional vital statistics system and even census tabulations are inadequate to provide data of sufficient currency and accuracy to satisfy requirements for national planning and current evaluation of family planning programs. There is thus an urgent need for new statistical techniques to provide the necessary indicators. The statistical profession has not yet provided an adequate answer to this challenge.

In considering more precisely the problems that the statisticians must solve in meeting these needs for vital rate measurement, the objectives and requirements for several distinctly different situations must be distinguished. These different situations correspond somewhat to the geographic scope of the area for which vital rate measurements are to be made, but are more fundamental than geography alone implies. We shall consider

the objectives for measurement at (1) the national level, and (2) the level of subnational intensive family planning program development areas. A third level is recognized but not here discussed: namely, the smaller and more intensive studies in which, under laboratory or experimental conditions, still more incisive study is made of the relationship between fertility and one or more of its components.

II. Measurement of Vital Rates for the Nation as a Whole

At the national level the prime objective is to obtain indexes of the trend of the total birth and death rate or related total measures of fertility and mortality. These are the prime indexes which will reflect total population growth and its relation to economic development. It is this purpose that an accurate periodic census and a current vital statistics system can serve. Eventually these systems will be created, since over the long run they are indispensable.

Family planning programs are not applied with uniform effectiveness throughout a country, and programs of either birth or death control represent large and ponderous national activities. National levels of birth or death rates will ordinarily change slowly and any change in the rate of total population growth will show great inertia.

For these reasons the measurement methods for the nation as a whole can be relatively slow in producing results. The week-to-week or month-to-month change is not likely to be of great significance, but observations at, say, decennial intervals are hardly sufficiently current. Although a certain amount of deliberateness can be accepted, the final measurements for longer periods must be obtained with some care since a small change in rates could have important meaning and could influence major policy decisions relating to national development plans or the degree of emphasis placed on family planning programs.

While at the national level the crucial items of statistical information are the vital rates that permit an assessment of overall rates of population growth, it also would be highly advantageous to have additional variables which permit a somewhat more penetrating analysis of what factors are related to any change. Age-specific rates would be essential as well as data relevant to broad effects of national changes in such components as age at marriage, urbanization, or employment of women. Since socioeconomic changes would not be occurring uniformly throughout a nation, data for geographic subdivisions become highly desirable.

Some attempts have been made to find statistical mechanisms that will provide these important vital measurements in the absence of a routine vital registration system. The Indian National Sample Survey has made serious efforts to measure vital rates through nationwide household interview surveys, and the Indian Statistical Institute has published a number of papers on some of the methodological problems involved. The Pakistan Population Growth Estimation Project and the Thai Survey of Population Change have attempted to obtain national estimates through an interrelated combination of intensive registration efforts in sample areas and independent interview surveys covering the same population. In Egypt, there are experiments with a so-called "busybody" technique, in which a vital-event inventory is attempted through the offices of a careful observer stationed in each village of a sample of several communities. In several other areas a solution is sought through periodic cross-section population surveys.

A very great deal needs be done, however, before adequately proven survey methods are a part of our statistical arsenal. For this national or global level, it is agreed that minimum requirements are modest in scope, at least in the early stages of study: perhaps age-specific vital rates for each of a few sectors of the economy. The difficulties are legion.

This is not the occasion and indeed we are not able to present a blueprint for an ideal survey procedure. We do offer three principles as guidelines for research and for action.

The first of these is that many methods must be tried—the more unsuccessful being discarded, and the better being retained, improved, and adapted to the specific land. This process of research and gradual development should characterize almost every phase of measurement of vital rates, and it is scarcely revolutionary to take note of it. Even so, it is well to remember that this is the state of the art.

The best approach will vary from one place to another. For example, the National Center for Health Statistics, Agency for International Development, and Research Triangle Institute are engaged in a cooperative project in North Carolina,

attempting to develop under nearly ideal conditions a one-time retrospective interview which will satisfactorily reflect birth and death rates in North Carolina. If the effort is successful, it will be one step along the road we're trying to go, although it obviously will need modification and further testing in lands of differing cultural background. If it fails, under even the favorable circumstances, additional questions are raised as to whether it is feasible or possible to devise an acceptable interview procedure of this type.

Somewhat parenthetically, and illustrative of the search for new techniques, mention is made of a specific interviewing procedure which is being tested in the North Carolina project. It is a modification of an idea advanced by Stanley L. Warner, known as a randomized response technique. The procedure is one in which the individual respondent is able to reply "yes" or "no" to one of two questions, without the interviewer knowing which question is being answered. Yet at the close of the survey, the statistician can estimate the proportion of the population replying "yes" to each question. This machinery facilitates handling a delicate question which the respondent might otherwise refuse to answer. It is one instance of a whole family of related approaches which deserve investigation, and which may augment substantially the informational power of social surveys.

A second principle is that the *mechanics* of survey design and execution are critical to success. Here also alternatives need be tested and compared. Shall the principal sampling units be geographic areas, or tribal or family entities, or formed on some other basis? The length of reference period is a significant factor, as are the related questions of whether a single sampling unit should be measured more than once, or perhaps observed continuously; and if more than once whether the reference periods of the different measurement occasions should be overlapping. A long list of relevant sampling factors could be displayed. But the matter can be covered, without exaggeration, by saying simply that all the tenets of good sample design may profitably be taken into account. And no matter how superior the design, it is likely to fail its purpose unless the conduct of the survey is faithful to that design. This precept is true of any survey, but it is especially true of vital rate population surveys because they are subject to so many operational hazards under good conditions, and so often are carried out under unfavorable conditions. Accordingly, the total survey plan must include a surveillance system which provides a review of validity. The best system will vary with the particular design, but commonly it will be based on a second or alternative measurement for a probability subsample of the main sample.

Our third principle is that an adequate technical plan must be supported by effective management, administration, and public relations. It is necessary that the survey operate in a climate of adequate budget, political and public acceptance, sufficient competent personnel, and continuing management control. Officials and managers cannot expect or promise miracles and must be prepared to face and carry out extensive and difficult tasks. Large samples will be required, even when the design has maximum possible efficiency. For example, with a 1-year reference period, a sample of the order of 12,000 persons is needed to estimate with 95 percent confidence the birth rate within 10 percent and the death rate within 20 percent. If one asks for age-sex specific birth and death rates for each of several domains, the required sample size moves quickly into the hundreds of thousands of persons. The administration must recognize, too, that the survey data still will fail their purpose unless after collection, they are carefully processed, converted into estimates, displayed in such useful forms as life tables or traditional population projections, and appropriately interpreted by demographers.

III. Measurement of Vital Rates in Family Planning Program Developmental Areas

The planning and conduct of a definite action program to affect the level of the birth rate of a large and populous country is a major undertaking and in most situations cannot be carried on initially on a full nationwide basis. The required organization may take a long time to build, and effective operational procedures must be tested and perfected.

For these reasons it is probable that most national family planning programs will concentrate initially on what might be called "Family Planning Program Developmental Areas" which will constitute social laboratories for the development of the organizational and operational programs that eventually can be applied to the whole country.

Even an assumption that biological or clinical methods have been perfected does not imply that a control device is infallible or that the public health problem of applying such methods to a large population has been solved. The problem of application embraces the total range of questions related to levels and interrelations of governmental organizations, questions of effective communication with the population, the logistics of training, supply, treatment, clinical follow-up, acceptance, and continued utilization by the population. The ultimate effect on the population growth rate is the consequence of the net effectiveness of all the elements of the total program.

The design and appraisal of a family planning program comprising these elements can be undertaken only in an area with a population large enough to present at least a principal part of the total range of problems to be considered. For this reason, Family Planning Program Developmental Areas must be visualized as including populations of the order of magnitude of 1,000,000 persons.

In this situation the requirements for vital rate measurement are rigorous and extensive. The stakes are large because the investment of substantial public funds is involved. But, more important, the stakes are large because decisions based on the results obtained in such social laboratories will presumably be applied on a national basis and will determine the character of the total national family planning effort.

Vital rate measurement must consequently be rapid, sensitive to change, and precise. For these objectives it will not be adequate to obtain a measure of the crude birth rate nor merely of age-specific rates. The variables obtained here must permit a more profound analysis of the fertility changes that are transpiring. Factors such as child spacing, number of previous children, and changes in the level of pregnancy wastage may be critical variables for analysis. Of particular note is the fact that analysis of family planning programs usually will concentrate on the impact over 1, 2, 3, 5, or 10 years, and yet is a part of the broader study of likely changes over 1, 2, or 3 generations.

These are severe specifications—particularly when it is added that the timetable is an urgent one. Under some circumstances, service statistics, such as numbers of condoms sold, or numbers of other conventional devices accepted by families, or vasectomies performed, can be helpful. But this type of information only begins to be useful when it is accompanied by knowledge of a considerable variety of other specific factors which permit translation of service statistics to an estimate of impact on population change.

We should like to argue that the most promising attack on this measurement and analysis problem is a coordinated two-pronged endeavor. One of the two lines of attack is intensified effort to develop and utilize more incisive survey procedures. It was earlier noted that the application of survey techniques to determine relatively simple birth and death rates requires much care and effort. Yet the survey process has been and will be used further as a main instrument for measuring the even more elusive components of population growth: such factors as marriage, separation, and remarriage rates; number of children wanted; desired spacing of children; effectiveness of specific methods of birth control in the applied biological sense; and the relationship to birth rate of education, urban-rural residence, religion, race, economic status, parity, migration, health status. The difficulties are not quite so severe as they may seem at first, for at least two reasons. One is that the first stage of sampling can be of geographic areas, and thus operations need be carried out only in limited and concentrated regions, with consequent fewer demands on personnel and resources, and easier control. The other reason is that for many purposes the required estimate is a ratio or relative number, which may make much less demand on survey capabilities than would the estimate of an aggregate. Further, the universe of study will be the Family Planning Developmental Area rather than an entire nation.

We speak of a two-pronged attack. The companion to the tine of survey measurement is theoretical analysis accomplished through microsimulation and Monte Carlo techniques. This methodology, being developed by Orcutt, Hyrenius, Ridley, Sheps, Lachenbruch, Horvitz, and others is a flexible and powerful tool. It enables one to build a miniature universe in which people are identified only by those characteristics that are relevant to vital rates, and by modifying appropriate parameters condense into hours or even minutes of running time on electronic computers the course of affairs which could be observed in the real world only in years or perhaps generations, if at all. We must forego ex-

tended discussion of the process, including its weaknesses and difficulties. In building simulation models, the strategy is to take advantage of all the knowledge one possesses, including results from conventional analysis and the evidence from surveys, to discover what would happen to vital rates and population change given specified values of the key parameters.

This recommended route toward solution can be summarized in the following terms. The critical process is use of a micro-simulation model to determine the sensitivity of vital rates to changes in their component factors, and then either (1) to be able to *measure* those component factors in the real world, mostly through surveys, or alternatively (2) to be able to identify program actions which would change specific components by identifiable amounts, and thus to quantify their effect on population change. It follows that we seek to identify also those components to which birth rates are *not* sensitive, and so to avoid wasteful expenditure attempting careful measurement of such components. And further, analysis and model-building need be tempered by including only elements which are *capable* of measurement in the technological sense and which are *feasible* in the political or social sense.

We urge others to consider this type of two-pronged attack. The problems are large enough for all who wish to tackle them. The rewards of success may be substantial. The price of failure to solve the problems will be high.

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