# Technical Papers

# MEASUREMENT OF BIRTH AND DEATH REGISTRATION COMPLETENESS

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## FOREWORD

The United Nations Principles and Recommendations for a Vital Statistics System devotes considerable attention to the need for evaluating the reliability of the statistical data derived from a CR/VS system. Both the quantitative accuracy and the qualitative accuracy of the data require periodic evaluation. This Technical Paper discusses the various approaches to measurement of registration coverage, the special problems involved in such measurements, and the recommended approaches to measuring registration completeness for countries whose CR/VS systems are at differing levels of development.

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# MEASUREMENT OF BIRTH AND DEATH REGISTRATION COMPLETENESS

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The completeness with which births and deaths are registered is an important determinant of the usefulness of vital statistics derived from these vital records. Because of this, the United Nations Demographic Yearbook publishes estimates of the completeness of birth registration for various countries. These assessments of registration completeness are those made by the national authorities responsible for civil registration or for the national compilation of vital statistics. In some cases, the evaluation is based on completeness checks made by identifying individual births and deaths in the population census or in demographic sample surveys and matching them against the registered events. In others cases, estimates of the number of vital events are derived by various methods, direct or indirect, and these are compared with the aggregate number of vital events registered in the same area in the same period of time. In many cases, the reported level of registration completeness of vital events for a particular country represents the best guess of the national authorities. By and large, these assessments can be accepted more or less at their face value. It is not likely that the registration of births and deaths will be complete for countries that are rated unsatisfactory. Nor is it likely that registration will be complete for countries for which information on registration completeness is not available. On the other hand, there may be some countries rated complete which, in actuality, do not meet the criterion of 90 percent or more registration completeness. The problem with the latter statement is that there is no easy way of validating it because of the absence of a simple test of registration.

Some insight into the problems of obtaining statistics on births and deaths from various sources may be gained from a historical review of the development of the vital statistics system in the United States, and of the efforts made to measure the completeness of registration in the United States and other countries. The various approaches to the study of registration coverage will then be discussed followed by suggested methods for the measurement of registration completeness for countries at various levels of development.

## U.S. Historical Review

Although the registration of births and deaths for a number of States in the United States dates back to the colonial period, attempts to compile national death statistics did not begin until 1870 when questions about deaths occurring in the year preceding the census were introduced in the population census schedule. The resulting statistics were published for each decennium up to and including 1900. For the 1880 census enumeration, a comparison was made of the number of deaths registered in two states and the District of Columbia where death registration was considered complete with the number of deaths enumerated in the same geographic areas. This showed a serious shortfall in the mortality figures obtained in the census. Similar findings for the 1890 and 1900 census enumerations led to the abandonment of the enumeration procedure for the compilation of national statistics of deaths.

In 1900, a National Death Registration Area was established starting with 10 States and the District of Columbia. In order to obtain comparable statistics from State to State, certain conditions were stipulated for admission to the U.S. Death Registration Area. These requirements were the adoption of a model vital statistics law and the adoption of a prescribed standard death certificate. Finally, each State was required to demonstrate to the satisfaction of the U.S. Bureau of the Census, the agency then responsible for the national compilation of vital statistics, that at least 90 percent of the deaths occurring in the State were registered. Other States were admitted to the death registration area as they qualified. In 1933, the U.S. Death Registration Area included every State in the Union.

The U.S. Birth Registration Area was established in 1915. The requirements for admission were similar to those of the Death Registration Area. In 1933, nationwide birth statistics also became available.

The early tests of death registration coverage in the United States involved the compilation of lists of deaths from various sources such as obituary notices in newspapers, interments in cemeteries, and casket sales. The names were then matched against the death certificates on file. For births, lists compiled from birth notices in newspapers, school censuses and baptismal records were used. Also, infant death records were matched against birth records to detect missing birth certificates. Many of these estimates of death and birth registration completeness were biased upward because the sources of information were incomplete or not independent of the registration process.

To avoid this bias, another kind of test methodology was used. In this test, a postage-free card was distributed by the postal service to every known household. The postcard requested information on deaths and on births occurring during the previous 12-month period. This canvass of the general population was an improvement over obtaining information from selected sources, but the method was not free of errors and biases. In addition to the response errors inherent in any retrospective survey, households with unregistered vital events are less likely to return the postcards than households with registered births and deaths. A low response rate may also be expected from the poorly educated in the population for which the birth and deaths rates will be high. Another problem with a method involving the postal delivery system is that it will tend to miss the poorer segment of the population where the registration coverage is deficient. All in all, these tests overestimate the completeness of birth registration.

The first nationwide test of birth registration in the United States[1] was conducted in conjunction with the 1940 population census. This was a modification of the 1931 test in Canada[2] where a sample of babies born in the one-year period preceding the census was matched against a file of birth records. The proportion matched was taken as the estimate of registration coverage.

The assumption that the enumerated infants represent the total universe of babies born in a one-year period is subject to various kinds of errors. For example, the babies who were born but died in the one-year period would not be included; neither would the infants who were not enumerated because of memory lapse or excluded because of misdating of the event. To avoid errors of recall in enumerating babies born over a one-year period, the 1940 test in the United States was limited to infants born during a 4-month period prior to the census. To account for babies that died in the 4 months preceding the census, death records were matched against the birth records in the registration files.

In 1950, another nationwide test of birth registration completeness was conducted in the United States.[3] This test method was essentially the same as that of the 1940 test. The major difference was that the recall period was shortened from 4 to 3 months, and that a good part of the matching of the infant cards to birth records was performed mechanically.

Finally, in 1970, another birth registration test was conducted in the United States using the household survey rather than the census to obtain reports on births. A report form was completed by interviewers for children under 5 years of age enumerated in the Current Population Survey and the Health Interview Survey. These reports were matched manually with the birth records for the years 1965-1970.

A number of countries in Latin America and in Asia conducted birth registration completeness tests in conjunction with the 1950 and 1960 decennial population censuses. With the availability of sample household surveys and with the development in recent years of indirect methods of estimating birth and death rates, more estimates of completeness of registration of vital events may now be found. However, little is known about the accuracy and meaningfulness of these estimates.

Problems of Measurement

The difficulty of obtaining complete counts of vital events through the enumeration procedure has been amply demonstrated. The shortening of the recall period from one year to a shorter span of time (3 to 4 months) did much to reduce errors of recall. Then there are in retrospective inquiries, the failure to report the births of babies that died before the time of enumeration. In the developing countries, the high infant mortality would have an important impact on birth registration tests and an even greater effect on death registration completion tests.

In order to avoid some of the errors of recall, various indirect methods of estimating vital events have been devised.[4] These methods are based on statistical models of one sort or another involving certain assumptions. Unfortunately, there is no assurance that the assumptions underlying the

models are being met. Another problem is the input to the model. This is usually in the form of some kind of accumulated experience like the number of children ever born. While these data may not have the same problems of recall as the enumeration of a single event in a specific period of time, it cannot be assumed that they are free of errors. If the model requires the age distribution of the population as some of them do, there is the problem of obtaining a reasonably accurate statement of age in some populations where many do not know their exact age. Another problem with the estimates from indirect methods is that they represent some form of average over a period of years and do not refer to events occurring in a specific calendar year. Another problem with indirect methods estimates is that they refer to vital events no matter where they occurred. The fact that it will not be possible to pinpoint the geographic area in which the event occurred or time period in which they occurred are reasons enough to rule out the use of indirect methods as standards for the precise measurement of registration completeness.

It is also possible to obtain data on the number of vital events for comparative purposes from direct methods such as the population census or demographic surveys. However, such aggregate figures may also conceal various kinds of errors which, if known, would invalidate any test of registration completeness. Therefore, for accurate measurements of registration completeness, tests should not be based on comparison of aggregated totals but on the identification of individual vital events so that they can be matched case-by-case with the vital events that have been registered. The unmatched cases would then have to be examined and determination made as to whether they represent genuine registration omissions.

Special Problems in Measurement of Registration Completeness

Vital events occur in space and time to individuals. In virtually every country, there are laws that require the registration of these events at the place of occurrence of the event within a specified period of time. The problem in a registration study is to identify these vital events through an independent source such as a census or survey, and ascertain if they have been registered.

In some cases, an event may not be reported at all in the census or survey because of deliberate attempts to conceal the event or because of the lack of knowledge of the event as in the case of proxy respondents. There may be other failures to report an event because of memory lapses. Errors may also arise when some vital events will be erroneously reported inside of the time period of the study while others which actually occurred in the period under study will be placed outside of the time frame and not reported. There will also be vital events reported in the census or survey that actually occurred outside of the geographic area in which the household is located. These are some of the problems of census or survey data which need to be addressed.

In the case of the registered events, there will be a separate file for the various events, i.e., births and deaths, that occurred in the registration district (primary registration unit) and registered during the year. Because registration is by place of occurrence of the event, the files will include events occurring to members of households living outside of the registration district as well as to household members residing in the area. In addition, because registration is by date of registration rather than by date of occurrence of the event, the registration records will include events that occurred in previous years as well as during the current year. In a number of countries, large increases in late registrations occur when the parents find that a proof of age is needed at the time of enrollment of children in grade school.

◦ Because the geographic and time coverage of vital events reported from the two sources differ, every effort will have to be made to eliminate the out-of-scope cases. To accomplish this, the matching operation needs to be as accurate and reliable as possible, and a thorough field investigation should be made of, at least a sample of the potential out-of-scope events, to minimize this source of bias.

Considerations in Designing Registration Completeness Tests

There are now many methods available for measuring the completeness with which births and deaths are registered. These methods will provide estimates of varying precision, and they differ considerably in complexity and cost. Therefore, an important consideration in deciding on a registration completeness check is the current state of development of the civil registration system. For areas where the registration is poor, a precise method for measuring registration completeness cannot be justified, and almost any procedure for detecting incomplete registration may be used. On the other hand, for areas where registration of births and deaths is close to complete, it will be

inappropriate, as well as a waste of time and effort, to resort to any but the most precise method available.

For a large number of developing countries, any reasonably good vital statistics estimation method should provide more accurate estimates of the number of vital events than the registration system. Also, there are a number of useful procedures that can be routinely followed to detect incomplete registrations. One of these is to tabulate the numbers of birth and death records registered each year by the year of occurrence of the events. This will provide an index of current registration which may be compared from year to year and from area to area. Another possibility is to prepare a check list of the number of birth and death records received from each local registration office to be compared with the numbers received in previous years. Except for epidemics and other usual events, there should be a certain degree of consistency in the number of records filed each year in each local office. Still another possibility is to compare the numbers filed locally with expected numbers based on some assumption of the birth and death rates for the population served by the local registration office.

Routine matching of infant death records to the birth record has been useful in identifying missing birth records. It is also possible to compile lists from various sources such as churches (baptisms), hospitals and schools to match against the birth registration file. Similar lists of events may be compiled for deaths in hospitals, from funeral services, and burials in cemeteries. These and other evaluation techniques suggested by the United Nations[5] will serve as a useful starting point for detecting and studying the problem of incomplete registration of births and deaths in an area.

As mentioned previously, any reasonably good estimation method should provide an adequate basis for evaluating the completeness of registration for a poor registration system. On the other hand, it is not easy to find a source of data that can out-perform a good registration system for producing information on births and deaths. For a test of birth registration completeness, a well-conducted population census has been found to be effective, provided that the recall period is reduced to 3 or 4 months, and the matching operation is performed accurately with reconciliation of questionable matches and non-matches. Also, provisions need to be made to identify the babies that were born and died during the period of the study. To piggyback a birth registration completeness test on a population census should not add too much to the cost of the census, relatively speaking. However, population censuses are usually conducted only once every 10 years so that the time of any test will have to be on the census cycle.

Single round demographic surveys have much the same problems as the census in identifying births, but they have the advantage in that they can be conducted at any time. Shortening the recall period will make it necessary to enlarge the sample size which will impinge on the cost of the survey. The magnitude of the sampling error is another problem to consider.

Experience has shown that it is difficult to enumerate completely infants and young children living in a household. It is much more difficult to identify deaths in the household because this involves locating an individual no longer present in the household. Also, there are problems when the death occurs to the head of the household which results in the dissolution of the household. To deal with these problems as well as others inherent in retrospective inquiries, multiround surveys have been suggested for following a cohort of individuals. Such prospective studies when coupled with an independent data collection procedure would be a form of a dual records system which is, at present, the most powerful statistical method available for the measurement of birth and death rates.

In the dual system, coverage or completion estimates are based on matching reports from two different sources to obtain reports of vital events in the same population. One source is a registration system which may be the official registration system or a special system for canvassing the population for information on vital events. The other source is a household survey. In preparing estimates for developing countries where registration of births and deaths is poor, a special canvass of the population is usually made in search of vital events because more events can be identified in the special search than in the official registration system. Therefore, this will result in better estimates. However, if a dual system is to be used in countries where the registration of vital events is close to complete, the official registration system would be the preferred source of registration data. Another important advantage of this latter source is that it will eliminate the field cost of a special canvass. This saving can be used to advantage in conducting multiround household surveys and in the matching and reconciliation of the records obtained from the two sources.

The primary purpose of the dual records survey is to produce estimates of vital events, but in matching the records from the two sources, it will be possible to estimate the proportion of events missed by each source as well as the events missed by both sources by the Chandra Sekar-Deming[6] method. A comprehensive description and discussion of all facets of conducting a dual records survey may be found in the handbook by Marks, Seltzer and Krotki,[7] and in the collection of papers edited by Krotki.[8] The pioneering efforts of Linder, Wells and others in the POPLAB program in promoting experimenting with dual records survey methodology in various developing countries should be recognized. Some of their reported experiences may be found in the Appendix.

The study design should take into consideration a number of factors. First, it should be a cluster sample because following the total population over a course of the year will be prohibitively expensive. Second, the sampling unit must be the primary registration unit or a group of primary registration units so that the survey area and the registration area coverage can be identical. Furthermore, it should be kept in mind that the vital events reported in the survey will include events occurring in the sample area as well as events occurring outside of the sample area. On the other hand, the registration records will include events occurring to members of the household and to residents outside of the sample area. The registration completeness study will have to be limited to vital events occurring in a primary registration unit of the selected sample to members of the sample households. Third, every household and resident institution in the cluster must be included in the survey. Special care should be taken to identify household members in short stay institutions in the same area, e.g., hospitals, health centers, jails, etc. Lastly, whenever a household moves out of the sample area, there should be an inquiry to make sure that no vital event occurred before the move. Also, the household which moved must be replaced by the new household in the dwelling unit. Periodically, a systematic canvass should be made of all vacant and newly built dwelling units in the sample area and new occupants of these dwelling units must be added to the study population.

The first step of the household survey would be a census to identify the members of the cohort to be followed. For a birth registration test, the population at risk would be women of childbearing age. Identifying information on women such as name, age and relationship to the head of the household should be collected. Most of the women scheduled to be delivered in the first quarter of the study should show physical signs of pregnancy, and all of them should know of their pregnancy status, including approximate date of expected delivery. For proxy respondents, there should be special probes about the pregnancy status of other women of childbearing age in the household. In the subsequent interviews, women of childbearing age not pregnant in the previous interview should be asked for information such as the date of last menses to flag women for subsequent follow-up. The follow-up is terminated with the ascertainment of the pregnancy outcome of a live birth or fetal death.

For deaths, the entire population is at risk. In the developing countries, at special risk of death will be children under 5 years of age. Therefore, in the initial visit to the household there should be special probes about infants and young children in the household, a group frequently overlooked in enumerations. Also at special risk of death in developing countries would be pregnant women, young adult males and elderly people.

Intense follow-up should be made of the at-risk population using every means to uncover the occurrence of births and deaths in the survey population at quarterly intervals. In anticipation of the possible movement of the population, it will be well to obtain in the initial interview the name and address of several close friends or relatives not living in the same household in the event that the sample household should break up or move out of the area. By recording the changes in the population composition of the households, it will be possible to determine the individuals added to the cohort through birth and in-migration and those deleted through death and out-migration. The registration records can then be compared with the events identified in the survey.

New members of the household identified at subsequent visits to the household are added to the household roster and followed to the end of the survey. Information about births such as name of child, name of father and mother, place and time of birth is recorded on a special form for matching with the file of birth records. Any members of the cohort not present at any subsequent rounds are identified and their whereabouts ascertained. If the loss is through death, the name of the individual with other identifying information and the facts about the death such as place and time of death are recorded for subsequent matching against the registration records.

Because of common names and possible name changes, the name of the child or of the decedent will frequently not be sufficiently unique. Therefore, they must be supplemented by other information

such as name and age of father, maiden name and age of mother, place of birth or death, place of registration, etc. It is important that there be a set of reasonable criteria to determine if there is a match of two records. This is more easily said than done because the more rigorous the matching rules, the fewer the matches, and vice versa. For guidance on establishing matching criteria, see Marks, et al.

The dual record system assumes that the two sources of record are independent. This poses no problem unless the survey in some way encourages registration of the event. Therefore, it is important to keep the true purpose of the study from the interviewers. The study should not be labelled as a registration completeness test nor should the interviewers reveal to household members how the information being collected will ultimately be used.

The registration completeness study should cover a period of 12 months to remove the effects of seasonality of births and deaths. Also, reasonable allowances should be made for some delay in registration. Although the registration laws specify when the event should be registered (e.g., 7 days after the event for deaths and 14 days, or a month, etc., for births), events occurring during the study period but registered 2 or 3 months after the 12 month period of the study should probably be accepted as a registered event.

## Discussion

The dual records system was devised for the estimation of vital rates in the developing countries, and dual records surveys have been conducted with success in a number of countries. For estimation purposes, the demographic survey may be a series of single round surveys or a multi-round survey. If the former, a different sample of households is visited in each succeeding round. If the latter, as in the proposed registration completeness test, the same household is interviewed on successive rounds. In areas where there is no system of street addresses, it may be a problem to identify and cover every household in the sample in every round. In the event that any household is missed, a special effort must be made to obtain information on the members on the household roster at the final round of the survey.

One of the criticisms that has been leveled at multi-round surveys is that repeated visits to households may result in interviewer and respondent fatigue. It would not seem that four visits to the same household over a period of a year should be an undue burden on the interviewer or respondent. With each visit, there should be opportunities to build rapport and interest in the study. Certainly, the longitudinal studies on record for 20 years or more involving repeated visits over the years would not have been possible if fatigue were a factor.

Perhaps a more relevant problem is the follow up procedure in the succeeding rounds of the survey. This can be conducted in two ways. One of these is to provide the interviewer with the location of the household and a list of household members to check the whereabouts of the members. The other is to provide the interviewer with the location of the household and the name of the household head. The interviewer is then instructed to make an independent listing of the household members which is later checked against the household rosters obtained in the previous interviews. The latter is a more complex and costly operation but it does rule out the possibility of curbside interviews. A solution to this problem is stricter field supervision of the interviewers with possible re-interview of a sample of households.

Suitable interviewers will have to be recruited and trained to elicit appropriate responses to questions regarding pregnancy and pregnancy outcome, and to maintain good rapport with the respondents throughout the study. Sufficient information should be collected about each event to be used in the matching operation. Suitable criteria will have to be developed for determining a match when records from the two subsystems are compared. All unmatched records should be brought back to the field and adjudications made after discussion with a knowledgeable member of the household and/or the local registrar.

The prospective follow up of a cohort of individuals is an important although not an unique feature[9] of the proposed study. This type of follow up has been conducted in an urban community of New Delhi and in the urban and rural areas of South India[10] where censuses were taken to identify females of childbearing age. These cohort of women were then followed to pregnancy and to delivery to determine pregnancy outcome. A special problem was encountered in New Delhi where a significant number of women left the study area to be at their mother's home at the time of delivery. Because the resulting birth will be registered at the place of occurrence of the event, this kind of

movement will not affect birth registration completeness tests so long as the delivery did not take place in another area of the sample.

There are any number of examples of longitudinal studies involving the follow up of a cohort of individuals. The tracing of individuals in the cohort until death makes possible the studies of disease as related to various etiological factors. It would be quite impossible to conduct such investigations starting with retrospective inquiries about deaths. Such inquiries have never been successful because of the difficulty of eliciting information about persons not present without knowledge of the identity of the individual. When the identity is known, it is possible to trace a person and ascertain his status.

## Summary

The usefulness of vital statistics depends to a large extent on the completeness with which the vital events are registered. According to the established criterion of completeness of registration, coverage of births and deaths is incomplete in virtually all the developing countries despite the existence, for many years, of legal authority and infrastructure for the registration of vital events and for the compilation of vital statistics.

Although there are no prescribed methods for measuring registration completeness, a quantitative method requires an estimate of the number of vital events occurring in an area and comparing this number with the registered events during the same time period. There are many methods available for estimating the number of births and deaths occurring in an area. However, such aggregate figures conceal various kinds of errors. Therefore, this approach should be reserved for areas where only a rough approximation of registration completeness is needed. For countries where registration is approaching completeness, a more rigorous method is required.

Past experience has amply demonstrated the difficulty of enumerating births and deaths, particularly the latter, because of problems of recall. To overcome these problems, it is proposed that a prospective study be conducted. In the case of births, a cohort of pregnant women and women in the childbearing ages will be followed to the termination of pregnancy. For deaths, follow up will be made of the entire study population to identify the members of the cohort that died during the course of the study. These events would then be matched against the registration files to ascertain the completeness of registration.

It is suggested that all countries in need of substantial registration improvement utilize registration returns and registration completeness figures based on estimated numbers of vital events for their program of registration improvement. Countries where registration coverage is approaching completeness will need to go to a more precise method, that of matching records obtained from an independent source to the registration files. Vital events enumerated in a population census using a shortened recall period of 3 to 4 months may also serve the purposes of a birth registration test for these countries, but a prospective study such as that proposed will be needed for the conduct of a death registration completeness test. Finally, the matched records will make it possible to determine the proportion of births and deaths missed by one source but not by the other as well as an estimate of the proportion of events missed by both sources.

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