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SURVEY METHODS, BASED ON PERIODICALLY REPEATED INTERVIEWS, AIMED AT DETERMINING DEMOGRAPHIC RATES

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La mayoría de los países menos desarrollados no pueden medir las tasas de natalidad y mortalidad debido a fallas en el registro de estos datos. Por otra parte, las posibilidades de un pronto mejoramiento a nivel nacional son pocas.

Bajo estas condiciones se necesita diseñar encuestas especiales que permitan obtener los datos por medio de los cuales se puedan calcular estimadores de natalidad y mortalidad, dentro de un margen de confianza aceptable.

Este informe describe un sistema de procedimientos para este propósito, que consiste en tomar muestras de la población y realizar entrevistas periódicas sucesivas. El mayor obstáculo en la obtención de este tipo de datos es, "no respuesta debido a olvido"; el procedimiento de hacer visitas cada tres o cuatro meses evita en gran parte esta dificultad. Estableciendo cuidadosamente procedimientos para detectar todo suceso demográfico importante (nacimiento, muerte, matromonio, migración, etc.), las caracteristicas de la población expuesta a cada suceso y el tiempo correspondiente, es posible construir un procedimiento que es simple de operar, no demasiado caro y que puede manejarse rápidamente para obtener mediciones de las estadísticas vitales, dentro de unas pocas horas luego de haberse completado el trabajo en el terreno.

I. INTRODUCTION

The measurement of fertility and mortality in a population, especially the determination of specific sex and age fertility and death rates, is a basic task upon which the results of almost all demographic studies are founded.

Despite its fundamental nature, it is not a task which can be satisfactorily performed in most of the underdeveloped countries because of a lack of adequate statistical information. In most developing nations the registration of births and deaths is incomplete; even the population censuses quite frequently display shortcomings. Errors due to omissions affecting vital statistics tend to have greater relative importance as compared to those due to censal underenumeration, with the result that the rates obtained when the omitted number of deaths and births are expressed as ratios of counts from the population censuses are below the real values.

It is very difficult to correct these shortcomings, particularly those due to omissions in the records of births and deaths. The rather modest progress made in some countries which have had special programs to reduce underregistration in vital statistics offers little hope for greatly improving present conditions in the near future.

This need for demographic rates which are not available has caused demographers to experiment with an alternative method, namely, to collect vital statistics by means of special surveys. Thus far the basic principle underlying this type of survey has usually been to obtain information about the present population and the events which have affected it in the past in one single interview. A serious obstacle to this type of survey is that people are unable to recall completely and correctly events that have happened some time in the past. Consequently, not all the events are recorded in the survey or some of the circumstances, such as the date of occurrence, are reported incorrectly.

Here again, as in the case of data derived from vital statistics mentioned above, the tendency toward omission of the declared events leads to a systematic underestimation of the levels of fertility and mortality. Ingenious procedures have been devised in order to correct these deficiencies of incomplete and biased recall, but they are in no way a final solution to the problem. The low cultural level and

lack of understanding of research activities which characterize many nations lead to the conclusion that for many years to come it will be impossible to reconstruct in an exact way vital events that occurred in the recent past—even though the past be only a short number of years (say three or five).

It can be concluded from the previous points that omission—be it in vital statistics or due to errors of recall in a survey—is a very serious obstacle which must be overcome in underdeveloped countries when the measurement of fertility and mortality is attempted.

This article describes a survey procedure which has been devised as an attempt to obtain results free from omissions or, more properly, only slightly affected by them. It will be almost impossible to eliminate errors of recall altogether, but it is believed the procedure described below limits the errors to such levels that the resulting demographic rates are reasonably accurate.

It may be presumed that if a population were surveyed permanently, say daily, omission of births and deaths would be almost impossible. These events would be known on the very same day or on the day following their occurrence and would not be omitted owing to forgetting by respondents. The problem would, in all likelihood, be solved. The method which is proposed is inspired by the above observation. Although it does not advocate daily visits to the homes of a population in order to study what has happened day by day, it proposes periodically repeated visits in order to establish what has taken place within comparatively short intervals.

The first practical problem to be coped with is that of the frequency with which the population must be interviewed in order to prevent omissions of events owing to errors of recall. There is no single answer to this question, for it is almost certain that the required frequency of the visits will depend on many factors which will vary from one population to another (and from one individual to another within the same population), such as, for instance, the educational level of the people studied. It is thought, however, that errors of recall in a low-literacy population would be of minor importance if the intervals between the visits were less than a year (three or six months, for instance) and if the events were recorded starting with the second visit, so that from the very beginning there would be a concrete date of reference (that of the first visit) which would be useful in defining the period of observation.

If such a procedure of repeated visits does produce valid and reliable data, it is apparent immediately that we should seek to accomplish more than just getting data to calculate age-specific birth and death rates. It would be feasible to classify the population, and also the births and deaths occurring during the period of observation, with respect not only to sex and age but also to other characteristics which are of research interest. Examples are urban and rural status, social status, marital status, economic status, and so forth. Thus greater depth can be given to the study of fertility and mortality by taking additional characteristics into account. Rates can be obtained which not only are specific by sex and age but also with respect to a variety of other traits. Furthermore, with only a slight additional effort, the scope of inquiry can be extended to other topics apart from fertility and mortality which could be of demographic or non-demographic nature. For instance, with only a very moderate expansion it is possible to obtain rates of unemployment, rates of change from one employer to another or from one occupation to another, migration rates, morbidity rates, or rates of change in marital status, and so forth.

It seems hardly necessary to stress the importance which information of these types could have in underdeveloped countries. In these countries where statistics are scarce, incomplete, and inadequate and where there is, nevertheless, a pressing need to know the actual demographic,

social, and economic conditions, a statistical procedure by which such a wealth of information can be obtained is an attractive and promising possibility which merits serious consideration.

The procedures described below are based upon the experience of conducting two field experiments to measure vital rates by repeated visits. A pilot study was conducted in Guanabara, Brazil, and another in Cauquenes, Chile, following the methodology proposed here. The first was conducted in 1961 as a joint project between the Instituto Brasileño de Geografía y Estatística (EBGE) of Brazil and the United Nations through the Regional Centre for Demographic Training and Research in Latin America (CELADE). Fertility, mortality, migration, and changes in marital status were investigated in the state of Guanabara, an area which is predominantly urban. The final report on this survey was published by the United Nations. The second pilot survey is being performed and is carried out jointly by the National Bureau of Statistics and the National Health Service of Chile and the United Nations CELADE. It studies the same aspects as the Guanabara survey but pertains to a predominantly rural population, in the departments of Cauquenes and Chanco in the province of Maule, Chile.

II. DESCRIPTION OF THE SYSTEM FOR IDENTIFYING DEMOGRAPHIC EVENTS

We wish to undertake a survey, the objectives of which are to establish, over a period of one year of study, the following rates:

RATES OF MORTALITY

a) By sex and by five-year age groups.
b) By urban and rural residence and by five-year age groups.
c) By social status and by ten-year age groups.

RATES OF FEMALE FERTILITY

d) By urban and rural residence and by five-year age groups.
e) By marital status and by ten-year age groups.
f) By social status and by ten-year age groups.

RATES OF CHANGES IN MARITAL STATUS

g) Nuptiality rates of unmarried females by five-year age groups.
h) Nuptiality rates of unmarried males by social status.

MIGRATION RATES

i) In-migration rates by sex and by ten-year age groups.
j) Out-migration rates by sex and by ten-year age groups.
k) Urbanization rates by sex (urbanization defined as the balance between the movements from rural to urban areas minus the reverse movements, occurring within the area of investigation).

This set of rates determines the scope and the depth of the study, that is, the events to be investigated in the survey and the way in which the population must be classified in order to obtain rates with the degree of specificity required.

In order to compute the rates listed above, the individuals of which the population under study is comprised must be classified according to the following criteria: (*a*) by *sex* in two categories—male and female; (*b*) by *five-year age groups*, in eighteen categories—0-4, 5–9 . . . , up to 80–84, and, for practical reasons, an open group comprising individuals of 85 years of age and over; (*c*) by *social status* in, say, four categories (in the Guanabara survey, for instance, five groups were defined on the basis of three characteristics of the heads of households—educational level, monthly income and occupation); (*d*) by *urban and rural residence*, in two categories; and (*e*) by *marital status* in, say, four categories—single, married-united (including people living in consensual unions), separated-divorced, and widowed.

If a cross-classification of these groupings is made, 1,056 cells are defined. The number is not 1,152, as would result from multiplying the number of categories for each classification ($2 \times 18 \times 4 \times 2 \times 4$), as there are two age groups (0–4 and 5–9) which necessarily have only one possible condition with regard to marital status

(single). This limits the number of possibilities to 1,056 instead of 1,152.

Each individual in the population must on registration belong to one, and only one, of the 1,056 cells, which defines his status. The survey must obtain data for each of the five characteristics which define him. There is the possibility that an individual may change his status during the study, that is, move from one cell to another, but he cannot be in more than one cell simultaneously. A change of cell is equivalent to a change in status. Possible changes are those connected with marital status and age. The other characteristics—sex, social status, and urban-rural status (insofar as the individual does not change his place of residence)—are supposed to remain the same throughout the investigation.

By grouping the 1,056 cells previously defined (which is the finest classification which can be made of the population by using the five criteria of classification given above), the subdivisions needed in order to estimate the rates desired are constituted. For instance, when computing the rates of mortality by sex and by five-year age groups, the cells for the same sex and five-year age group become united irrespective of the social status, urban-rural residence, and marital status. The number of groups formed is (2×18), defining thirty-six specific rates of mortality by sex and by five-year age groups.

It is proposed that six types of events be studied in a survey of this type: (*a*) deaths, (*b*) births, (*c*) arrivals, (*d*) departures, (*e*) changes in marital status, and (*f*) changes in age. In each periodical interview it is established which of those events have occurred in the population studied with reference to the period elapsed since the previous visit. On this principle, no events are recorded during the first visit, but only starting from the second, when, for the first time, a period of reference is defined.

Three of the events mentioned—deaths, arrivals, and departures—can affect any individual. All are exposed to them, while only some of the subdivisions of people can bear children (women who belong to certain age groups), change their marital status (over 10 years of age), or change their age group (under 85 years of age).

Any individual, as soon as he is registered in the survey, regardless of his status, is considered exposed to the risk of death. In each visit, after the first visit when registration takes place, it is established whether he is still living or not.

Once a definition of *born alive* is adopted, it is assumed that every woman belonging to the age groups between 10–14 and 45–49 (eight groups in all) is exposed to the risk of bearing children. During each periodical visit it must be established, with regard to each woman registered and belonging to those age groups, whether or not during the interval between two visits she has borne a child.

Arrivals and departures, events by which migrations are measured, imply the existence of an area of observation with reference to which the investigation is performed. It is useful to classify these areas into two types—urban and rural. For example, in the Cauquenes survey, the area studied is formed by a group of districts which define the rural section of the sample and by a group of selected blocks of streets in the cities and towns which constitute the urban section of the sample.

Arrivals.—Starting from the second visit, and in each of the following ones, it is established whether or not new individuals are to be incorporated into the population studied, that is people who, in the time interval between two visits, have settled their place of residence in the observation area. According to their places of origin, these arrivals can be classified into one of the following categories: (*a*) areas other than the one studied, (*b*) rural sections within the area studied, and (*c*) urban sections within the area studied. The arrival of individuals from areas other than the one studied, category *a*, are considered in-migrations.

The difference between categories *b* and *c* is important if it is wished to study

the urbanization (or ruralization) of the area under study. A feature of the arrival of people which characterizes this event as compared to the others investigated lies in that it cannot affect the individuals under observation. These may depart, die, bear children, change their marital status or their ages, but not arrive. Even in the case of a movement within the area studied, which is the displacement of a person from one place to another without leaving the area, it is better to consider the move as two different events: a departure and an arrival, to be studied separately and independently.

There are advantages to be derived from this procedure because the study is performed, in practice, through a sample. Inasmuch as not all of the individuals of the population are included, the arrivals and departures within the area studied do not coincide. This procedure is also helpful because it simplifies field work. The information about an arrival is obtained at the dwelling where the newly arrived individual establishes his place of residence, while information about a departure is collected at the place of origin of the movement, that is to say, at the place where the individual was registered. By treating arrivals and departures as independent events, information can be obtained in the order which is more convenient, with no danger of duplications or omissions.

The *departures* among the people observed can be classified into three categories, depending on the place of destination: to (*a*) an area other than the one studied, (*b*) rural sections of the area under observations, and (*c*) urban sections of the area under observation. The first category defines emigrations and the two others furnish relevant information about urbanization (or ruralization) of the studied area. In each interview, starting from the second one, it must be established with regard to each individual under observation whether the place of residence is still the same one originally registered or if there has been a change. In cases of change, the category of departure which has taken place must be established.

Urbanization (or ruralization) can be studied within this system from two different angles: (*a*) by studying the place of origin of the arrivals or (*b*) by studying the place of destination of the departures. In an investigation comprising the entire population, both events coincide, and through either of the approaches the results obtained will be identical. If, instead, the survey is based on a sample, two results will be obtained which, as a rule, will not be identical and which constitute two estimations for the same phenomenon.

Changes in marital status.—When discussing the classification of the population according to marital status, four categories were mentioned. It is worth pointing out that, unlike the other events studied, the possibilities of change in marital status depend on the present marital status. For a single individual there are two possibilities—either to remain single or to marry-unite; for a married-united there are three possibilities—to remain married-united, to separate-divorce, or to become widowed.

In the accompanying tabulation the possibilities of changes in marital status to be studied in the hypothetical survey are given schematically. In the first column are shown the four categories into which an individual may fall at registration during the first visit; in the first row are given the same four categories into which he can be classified during any of the subsequent visits. Each of the sixteen possibilities defined by the intersection of the two classifications represents a change in marital status logically possible from one category in the first column to one in the first row. Some of those changes are not actually possible, and they are indicated by 0 in the table (it is absurd, e.g., that a widower should become single). The possibilities in the main diagonal represent the cases in which a person keeps, in the second or subsequent visits, the same status he had during the first one (SS,

MM, DD, WW). The remaining possibilities are the ones which are changes in marital status, and, consequently, they are the events which must be registered at the time of the second, or a subsequent, visit.

POSSIBLE CHANGES IN MARITAL STATUS BETWEEN TWO VISITS

CLASSIFICATION IN FIRST VISIT	CLASSIFICATION IN VISITS FOLLOWING FIRST ONE			
	Single (S)	Married-United (M)	Separated-Divorced (D)	Widowed (W)
Single	(SS)	(SM)	0	0
Married-united	0	(MM)	(MD)	(MW)
Separated-divorced	0	(DM)	(DD)	(DW)
Widowed	0	(WM)	0	(WW)

Changes in age.—The information about the date of birth, for each person, is obtained on registration at the first visit. With this information, it is possible to identify and record the changes from one age group to another during each interval between visits. For the people over 85 years of age, such a change is out of the question.

III. PROCEDURES FOR OBTAINING DATA AND CALCULATING RATES FOR DEMOGRAPHIC EVENTS

With a system established for identifying demographic events by making repeated visits, it is necessary to face a series of practical problems for collecting the data and calculating the desired rates. It is also necessary to evaluate the precision of the results obtained.

A. *The design of the survey.*—A birth rate of 40 implies, for example, that each year one birth will occur in every five or six households. The events studied (births, deaths, migrations, and changes in marital status) do not occur very frequently. Yet the method requires that the rates must be based exclusively on events recorded during the survey. It therefore becomes necessary to include in the investigation a great number of individuals, that is, to observe a large population, in order to obtain results having an adequate degree of precision. A fixed minimum uniform size to be used in any survey cannot be set, since it will depend on the desired degree of precision of the rates as well as on the level of the rates to be measured. It is sufficient here to point out that the method is applicable only to relatively large populations which can be studied either as a whole or through a sample.

If the survey is to be conducted by the use of sampling, as is usually the case, it is important to stress the convenience of sampling by clusters. Cluster sampling greatly simplifies field work. It is easier to define the areas of observation, thus resulting in fewer errors and higher levels of productivity by interviewers. In the pilot surveys at Guanabara and Cauquenes, designs making use of samples of clusters were used with great advantage.

Another important consideration is the type of form used to collect the information. It is advisable that it be simple and seek limited information—only the information indispensable for the determination of the rates aimed at in the survey; this assures short interviews. Simplicity in the design of the form and short interviews offer the following advantages: (1) They favor the cooperation of the population, indispensable for the success of the survey. (2) Each interviewer can deal with a large number of people and consequently a large population can be under observation. (3) Less skill and educational background are required of interviewers, for which reason the fees for each visit are the same, or only slightly above, the usual ones for censal enumerations. (4) It

simplifies the punching of the cards used in mechanical processing of the data and facilitates rapid preparation of reports.

B. *Procedures for making the survey.*—Once the area to be investigated is defined, the first step is to register all the people residing in it. It is not necessary to complete registration on one given day and not even necessary to refer the information collected to a given day. It can be done over a more or less lengthy period of time—the date of each interview, varying from one person to another is used as the date of registration.

In the pilot surveys of Guanabara and Cauquenes, the period during which a round of visits was completed was approximately two months. (Populations of the order of 12,000 and 20,000 individuals, respectively, were studied.)

On the occasion of the first visit to each dwelling within the area studied, a record is made of the date of the visit, the location of the dwelling, and of the five characteristics which define each person (sex, date of birth, information needed to determine the social status, urban or rural residence, and marital status). Information about the identity of the person is also obtained in order to locate him thereafter in case that, after the first visit, the person should change his residence. Each individual is under observation from the moment he is registered, that is, exposed to the occurrence of the events defined above: death, departure, change in marital status, childbirth (in the case of women), and variation in age. The date of registration is termed the date of entry to observation.

After a short period, say, three or four months, a second visit to the area under study takes place, and inquiries are made about what has happened with regard to the events studied to each of the individuals registered at the first visit. Only the events which have affected the people registered and which occurred during the period of time between the first and the second visit are recorded. On account of the proximity of the date of occurrence of the events (after the first visit) to that of the second interview, it is assumed that errors of recall by the respondents will be few and will not lead to omissions in the reporting of the events that are investigated. This procedure assures accuracy in establishing the dates of occurrence of events. In case that there should exist doubts about the date of occurrence of an event, an estimation of the date can be made with an acceptably small error (less than the time between the two visits which define the period studied the second visit).

Wherever the event of *death* or *departure* is encountered, its date of occurrence and the cause are recorded, be it a death or a departure (one of the three categories defined for departures). The individual affected is out of observation as of that date, which is termed the date of exit from observation. This date must necessarily be a date subsequent to the date of entry to observation. The difference between the former and the latter defines a period of time which is termed exposure time and is expressed in years.

If the event affecting the individual is a change in *marital status*, the date of occurrence, as well as the type of change, is recorded. It happens, in this case, that the individual changes his status but, unlike what happens in the case of death or departure, he remains under observation in his new status. In other words, he moves from one cell of the classification to another. He is regarded as exiting from observation with respect to his former cell, at the date of the change in marital status (the cause being marriage-union, separation-divorce, becoming widowed), and simultaneously, with the same date, he is registered as entering observation in the cell of his new marital status. For all operational purposes the individual is considered as if he were two different people—one who was under observation in the original marital status and exited from observation owing to change in marital status at the date of occurrence and another who came under observation

on that same date, in the new marital status, and who is exposed thereafter to the events studied. The exposure times of these fictitious individuals exclude each other. With regard to the first, the study is completed; with regard to the second, it continues.

It may happen that an individual is affected on the same day by two of the events studied, for instance, a change in marital status and a departure. For reasons related to the mechanical processing of the data, it is convenient to consider these two events as having occurred one after the other. Two successive events affecting the same person are dealt with, as in the case of change in marital status, as if they affected two different people studied in periods of time which exclude each other. This procedure gives rise to a rule which is useful in practice: each person who comes under observation must exit from observation owing to one, and only one, cause.

When a woman under observation bears a child in the time between two visits of the survey, both the date of occurrence and the number of children born alive are recorded. The mother, under such circumstances, remains under observation, there being no change in her status. In the processing of the information there are, however, advantages in treating this case in a way similar to the treatment given to a change in marital status. It is convenient to consider the exposure time previous to childbirth and the time after (which begins at that same date) as if it were the one corresponding to a different person, having identical characteristics to the previous one, who comes under observation at the time of delivery and becomes exposed thereafter to the events studied. The advantage of recording the birth of a child as if it were a cause of exit simplifies mechanical processing of the data.

The children born alive to women under observation are recorded in the survey. Their characteristics (sex, date of birth, social status of the mother, as well as mother's place of residence—urban or rural) are entered in the form. The date of birth is taken to be the date of entry to observation; as of that moment they are considered to be exposed to the events studied. In the second interview, it is established whether they are still alive and residing at the mother's dwelling. In other words, the procedure is exactly the same as if the children had been previously registered, not at the time of the first visit but on the day of their birth.

The *changes in age* which occur during the period of time between the first and the second visit are determined mechanically through the information about the date of birth of the people, which is obtained on registration at the first visit, and there is no need for special questions about this point. It is necessary at the second and subsequent visits to collect information about arrivals, that is, persons who have become residents in the area studied. The people who at the time of the first visit were not living in the area and who thereafter, and before the second one, established their residence in the area must be entered into the study. For each of these individuals the second visit has the nature of the first one, in which the characteristics of each person are recorded. In addition, the condition of entrance is established; it must be determined to which of the three categories of arrival, previously defined on the basis of the place of origin, he belongs. The date of entry to the observation of the people arriving in the area studied can be considered as the one declared by them as the date on which they moved into the area studied. In the pilot surveys of Guanabara and Cauquenes, however, it was thought preferable to adopt the date of registration (i.e., of the second visit, not of arrival) as the date of entry into observation, in order not to violate the principle that the events recorded in the investigation are those which affect the people already registered.

The following visits, after the second, have no special characteristics as com-

pared to the second visit. The one considered as the last visit does not have any special characteristics in this sense either. The last visit could be the fourth if the study lasts a year, and the interval between the visits is, then, four months. In it, as in the other visits subsequent to the first one, not only the occurrence of the events studied but also the non-occurrence of them is recorded, so that for each individual studied there exists not only a date of entry to but also a date of exit from observation. For each person—even for those not affected by an event studied—it is possible to compute an exposure time as the difference between the date of exit—in these cases the date of the last visit in which it was ascertained that nothing had occurred—and the date of entry to observation.

It is worth mentioning that, during the last visit, if the criterion of registering the arrivals in terms of the date of registration (and not in terms of the date in which it took place) is adopted, it happens that these people have nil exposure time, as the date of entry to observation coincides with the date of the last interview, that is, the date regarded as that of exit. They do not, in consequence, contribute exposure time to the study. The cause of exit in these cases is to be assimilated to that of the individuals who are not affected by any of the events studied, so as to maintain, without any exception, the principle that each person registered has a date of exit from observation and a cause.

C. *Mechanical processing of the data.*—A punched card is prepared for each person, in which his five characteristics are recorded; this fits him within one of the cells into which the population has been divided (1,056 in all, in the hypothetical survey). The date of entry to observation, the date of exit from observation, as well as the cause of it, are also recorded. As was stated above, several procedures are adopted to simplify mechanical processing of the data collected. Thus, *the date of entry to observation* is, in most cases, the date when the person is registered. In some other cases, however, it is the occasion on which a change in his marital status takes place, the occasion when a living child is born, or the occasion when there is a change in age group. Thus it is seen that a previously registered person when affected by the above-mentioned events is re-entered into observation. For the same reason, the *date of exit from observation* will, as a rule, be the date of death, of departure, or of the last visit in which it was ascertained that an individual had not been affected by any of the events studied. In some cases, however, this date will be of a change in marital status, of childbirth, or of some change in age group. That is to say, these events (changes in marital status, childbirth, or changes in age) are dealt with as if they were causes of exit from observation, though the person affected by the events is still actually being studied. Consequently, each person studied gives rise to at least one punched card and to as many other punched cards as changes in marital status, childbirth, or changes in age affect him while under observation. Each of these cards is referred to an exposure time which excludes each of the others. When added together, all these exposure times furnish the total exposure time of the person considered throughout the interval of the investigation. These individuals, affected by the events mentioned above, are dealt with as if they were different individuals observed at different periods of time, each of them exiting from observation due only to one cause. Likewise, two punched cards are prepared, instead of only one, in the cases in which a person is simultaneously affected by two of the events studied. One of them has no special characteristics of any kind, while the other shows the same date of entry as the date of exit, that is, it defines nil exposure time. The causes of exit in each of the two cards are different and correspond to each of the events which have affected the individual.

All the individual cards which belong

to the same cell (people of the same sex, age group, social status, urban-rural status, and marital status) may be abstracted to one single summary card through the mechanical operation of tabulation. In the summary card are recorded (*a*) the characteristics which define the cell, (*b*) the sum of the dates of entry to observation in the individual cards, (*c*) the sum of the dates of exit from observation in the individual cards, and (*d*) the sum of the different events which have affected the members of the cell. In order to compute the sums of the dates of the individual cards, the days of entry and exit are previously expressed in decimal values, using the year as a unit. The sum of events in the process of tabulation of the individual cards is performed through selectors which sum the events of each kind which have affected the individuals studied separately, that is to say, the total number of deaths, births, and so forth. The exposure time is not reckoned separately for each individual card but is computed only in the summary card, which collects all the experience affecting the people who belong to the same cell.

There are practical advantages in this course of action, because the number of summary cards is only 1,056 in the hypothetical survey, regardless of the number of people in the population studied. The exposure time of each summary card, that is, of each cell, is computed by subtracting the sum of the dates of entry from the sum of the dates of exit. Once the individual cards have been tabulated in order to elaborate the summary cards and the exposure time for each of them has been computed, a new set of summary cards is prepared in which are computed the specific rates aimed at in the survey. These new summary cards are derived from the original summary cards without any need to process the individual cards again.

In order to prepare the summary cards to be used in calculating the rates, it will suffice to group the original summary cards—1,056 in the hypothetical survey—conveniently together, in order to reach the degree of specification required for the rates. In the new summary cards are recorded the characteristics of the rate, the sum of the exposure times, and the sum of events recorded in the original summary cards. The annual rates aimed at are obtained by dividing—mechanically, in the new summary cards—the number of events observed by the exposure time. For instance, if it is a question of computing the annual mortality rate of a given social status and ten-year age group, say, 20–29, it will be enough to (1) group the summary cards which belong to the given social status and to the two five-year age groups which constitute the ten-year age group to be studied, that is, 20–24 and 25–29; (2) prepare a tabulation of those summary cards, from which will result the new summary card containing an indication of the given social status and the selected ten-year age group, that is, 20–29, the sum of the exposure times of the original summary card and the total number of recorded deaths in each of them; and (3) divide mechanically the total number of deaths by the total exposure time. This quotient is the annual mortality rate aimed at.

The mechanical process of tabulating the individual cards, of computing the exposure times in the 1,056 original summary cards, and of grouping and tabulating the latter in order to produce new summary cards in which the rates are calculated can be completed in only a few hours. With the exception of the first tabulation, the duration of which depends on the total number of individuals observed, the other steps are performed with a number of summary cards which is independent of the size of the population studied. Once the cards have been punched and the operation verified, the results are obtained quickly.

D. *Significance of the rates obtained.*—In the previous sections the steps necessary to obtain rates resulting from the quotient of the number of events observed and the exposure time of individu-

als registered with similar characteristics were described. It is a question of examining now the significance to be attached to those results, that is, the reason for which the value obtained can be considered an annual rate. An annual rate, which measures the relative frequency of a given event, is defined as the quotient between the number of events occurring in a year (for instance, annual number of births, deaths, and so forth) and the mean population. The mean population of the year studied is a concept which must be precisely defined. By mean population is meant the total time lived in the year in question by the population from which the rate is obtained. Thus, for instance, when a person has remained in the population during the whole year, the time lived which that individual contributes to the computation of the mean population is 1; if a person has entered the population (an immigrant or a newborn child, for instance) in the middle of the year and remains in the population thereafter, the time lived contributed to the mean population is $\frac{1}{2}$; and so on. The mean population is the total time lived by the people who at some time of the year have belonged to the population. It is also called exposure time, and it is expressed in years, that is, the unit of measure is the year.

If the time during which the population is observed is less (or more) than a year, it must be borne in mind that the number of events observed and the total exposure time are affected by that circumstance. It is possible, however, to express them in terms of years by dividing by the length of the interval of time of observation. In the case of the events recorded, the result could be called "the mean annual number of events," and in the case of the exposure time it is termed "the mean population." The rate which is obtained as the quotient between the number of events and the exposure time is identical to the one which would be obtained by dividing "the mean annual number of events" by "the mean population." It is seen, therefore, that the result is conceptually *an annual rate* which measures the relative frequency of the event studied with respect to the time unit, that is, the year.

Consider now each individual who is recorded in the survey as a population under observation. Each person defines, with regard to each of the events studied (arrivals excluded), an annual rate. Moreover, the same can be said in what respects the exposure time of each person insofar as that individual belongs to the same cell. According to these assumptions, the events in the population-individual take the value 1 when they occur, and 0 when they do not take place. The exposure time, in turn, is nothing but the time elapsed between the date of exit from and the date of entry to observation and is expressed in years. An average of the annual rates of the individuals observed, which belongs to a given category defined by the specification of the rate aimed at and formed by the union of various cells, produces a rate which expresses the relative frequency of the event in the population under study. This mean rate is computed by adding, on the one hand, the numerators of the individual rates—the exposure times of the individuals—and then dividing the former by the latter.

In all the rates defined as the objective of the survey, with the exception of those which have bearing on the arrival of people, the events which occur and which are indicated in the numerator affect individuals who contribute exposure time to the denominator. In other words, the events occur among individuals exposed to those events. The immigration rates and any other which takes into account the arrival of people have another characteristic. The quotient which defines the rate relates the number of people who have arrived—who enter into the population studied—to the exposure time of the individuals already under observation. It is seen that, in this case, the event (arrival) affects individuals who are not registered at the time of occurrence and

that the denominator—the exposure time—is made up by people who are not exposed to the risk of arrival. This difference between the rates of arrival and the others is inherent to the nature of the events studied. The rate, in this case, does not have the same structure as the other rates. On account of the operational analogy that exists with respect to the way in which the rates are computed, it can be accepted by extension that the quotient mentioned be considered a rate.

IV. ADVANTAGES AND LIMITATIONS OF THE PROCEDURE

This presentation is concluded by offering a brief summary both of the advantages that are ascribed to the survey method of measuring demographic rates and its limitations. The most important objection which can probably be raised is that, because of the fact that field work consists in repeated visits to a great number of people, it will demand too high a cost—perhaps excessive for underdeveloped countries—with limited resources allocated to meet statistical needs. The experiences obtained from the pilot surveys of Guanabara and Cauquenes, however, prove that the cost of operation of this type of survey is within reasonable limits. It is not necessary to pay high fees to interviewers, as would be required in an investigation using elaborate questionnaires. In fact, the cost per interview is of an order of magnitude only slightly higher than that paid to census enumerators. An idea of the simplicity of the task of collecting the data is given by the fact that in the studies in Guanabara and Cauquenes the length of an interview was ten or fifteen minutes. Owing to its brevity and simplicity, the information collected in the questionnaire is easily transferred to punched cards. Since the processing of the data is done almost completely mechanically, the cost of compilation is low.

It has been estimated that U.S. $5,000 would be enough to meet the cost of the field work which a research covering 20,000 people would require throughout a whole year (four interviews to each person) in an underdeveloped country. This hypothetical estimation is based again on the experience of the pilot survey already mentioned.

Another objection which can be made is that the population studied may not cooperate after a few visits. This drawback, which is to be recognized in surveys which require periodical interviews, can be overcome by using a design of sample which provides for the rotation of the sampling areas studied, in such a way that a person is not under study for more than an appropriate period of time. It must also be pointed out that, despite the simplicity of field work, it is not easy to organize and conduct strictly according to plan—problems arise because of the dominantly rural nature of the population in underdeveloped countries, the low level of education of the population, lack of adequate cartographic material, and so forth. In order to obtain satisfactory results, it is mandatory that these obstacles be overcome, that is, that field work be conducted with great rigor. This condition, of course, is not inherent only in this type of survey but must be fulfilled in all surveys, in the registration of vital events, and in taking a population census.

As opposed to the limitations, some advantages considered of great importance can be mentioned:

1. Presumably, the rates obtained satisfactorily measure the relative frequency of the events studied, owing to the fact that special steps are taken in order to overcome errors due to omission.

2. The elaboration of the rates vouchsafes the correspondence which must exist between the events observed and the individuals exposed to them. For instance, there is no danger that the death of an individual is considered within one category and the exposure time of that same individual in another category, as could happen when calculating rates using information obtained from vital statistics and population censuses.

3. The possibility of further extending the scope of the survey to the investigation of different topics has become evident, as well as the possibility of increasing the depth of the study by computing specific rates with an increasing degree of specification.

4. Its great flexibility is another important advantage underlying this method; it admits the inclusion, on occasion of each round of visits, of special questions eliciting valuable information. As an example of this possibility, it can be mentioned that in the Cauquenes pilot survey, on the occasion of the second round of visits, attendance or non-attendance to school of the school-age population was investigated, as well as the cause for non-attendance.

5. Another relevant advantage of the method is that the results are obtained practically immediately after field work has been completed. This is due to the fact that, as has been mentioned already, the processing of the data is performed through a simple mechanical process.