Factors That Affect Casefinding in the Liberian Fertility Survey

Enumeration, enumerator, and vital events characteristics

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RESULTS from fertility surveys being conducted in many developing countries are appearing more frequently in periodicals and government publications throughout the world (*1–14*). Although these surveys are no longer looked upon as statistical oddities, all are viewed as experiments because many attributes associated with enumeration techniques, enumerator performances, and with some of the characteristics surrounding the occurrence of given events have had unpredictable yet pronounced effects on casefinding. These gaps in knowledge are both unfortunate and perhaps unnecessary. Unfortunate because the information would be of great benefit to present and future fertility surveys (*8–10*) and unnecessary because much of the data that could resolve many casefinding problems have been available in one form or another in the history of any survey but rarely have been abstracted.

In this paper I present some basic components and characteristics of enumeration techniques, enumerator attributes, and vital events characteristics that have affected the chances of recording or not recording a vital event in the Liberian fertility survey.

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General Design of Survey

To understand these data, it is necessary to summarize briefly the basic methodology underlying

the Liberian survey and to explain the enumeration techniques used in collecting the data.

The Liberian Population Growth Survey was started in May 1969. It is being conducted by the Department of Planning and Economic Affairs, Republic of Liberia, with technical and financial support from the U.S. Agency for International Development. The design of the survey is based on the methods developed by Chandrasekar and Deming (*15*), the principle of which is that two independent data-collection methods are used to record the number of vital events that have occurred in a specific population in a particular period. The results obtained from the two systems are compared, and any differences found are reconciled through a combination of field verification and logic. After reconcilation is completed, the manner in which each event was recorded is classified into three groups: (*a*) those events recorded by both enumeration systems, *C;* (*b*) those recorded by one system only, N_1; and (*c*) those recorded by the other system only, N_2. The total number of events recorded (N) is determined by adding the three groups. Moreover, the number of events missed by both systems can be estimated by applying the probability formula $N = N_1 \times N_2 \div C$ and adding the result to the former sum to get the total number of events that probably occurred in the area during the specified time period.

In the Liberian survey the dual enumeration system used is patterned after the Turkish model (*9,10*). With this model, one system is based on a monthly household enumeration and the other on a semiannual enumeration, using recall periods of 6 and 12 months. The first period covers events occurring from May through October 1969 and the second from November 1969 through April 1970.

With this method, the enumeration procedure, and the Chandrasekar-Deming (C–D) correction factor to determine the probable number of births, deaths, and infant deaths, three types of analyses were made. The first gave the distribution of recorded and unrecorded events in relation to the size of the enumeration unit and to the two different enumeration time periods. The second compared the proportion of missed events by the various attributes of the individual enumerators. The third investigated the relationship of recorded and unrecorded events by selected characteristics of the events themselves and of persons associated with their occurrence. In making these analyses, two- and three-way analyses of variance were used to determine the statistical significance of the data. These analyses are available on request.

Essentially, the outcome of this work suggested that the recording of a vital event in Liberia was not a random occurrence but was associated with selected demographic characteristics of the persons involved in the event, and in some instances with a particular enumeration system, type of enumerator, and enumeration location.

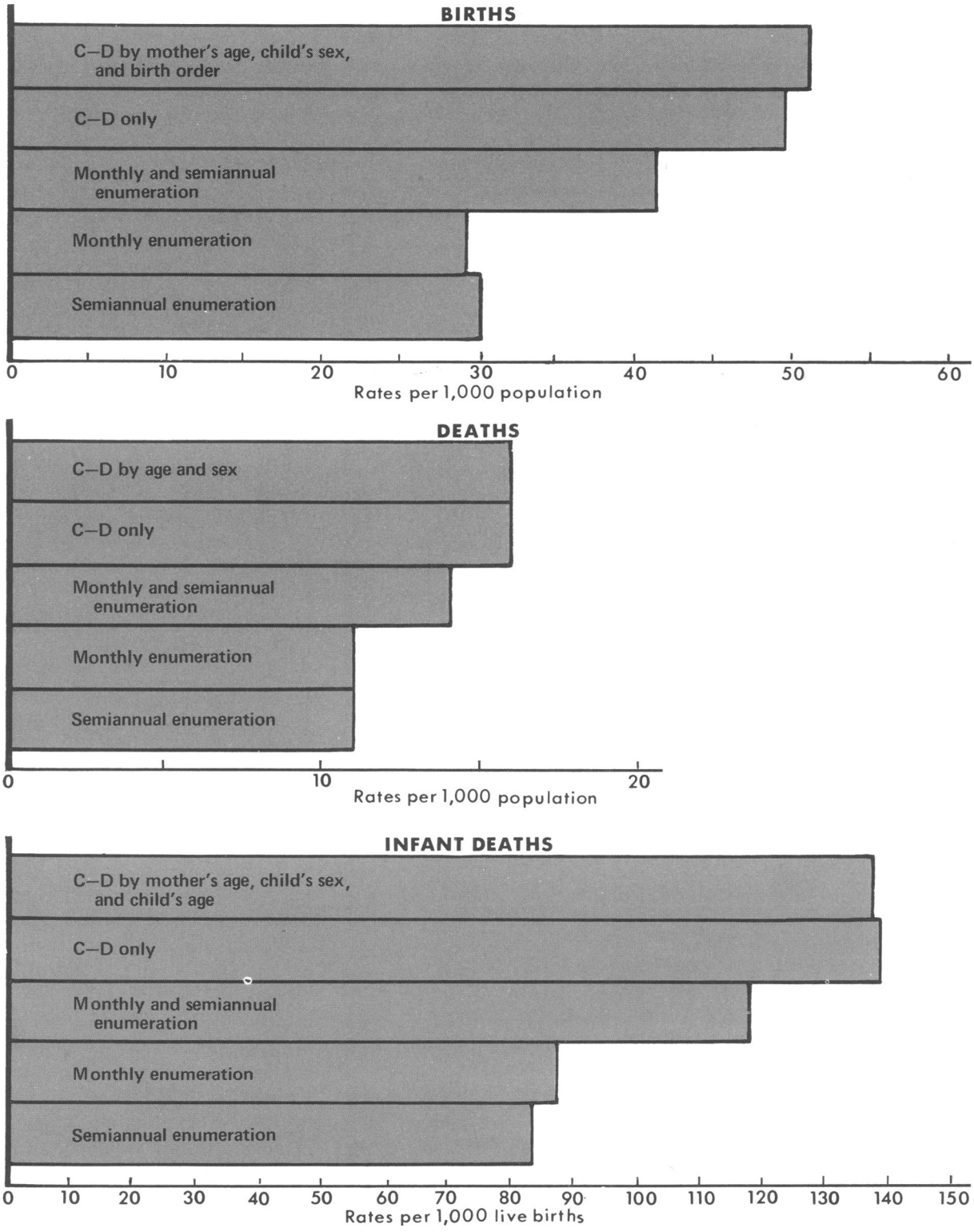
The events analyzed occurred from May 1969 through April 1970 and included 3,691 births and 1,030 deaths, of which 422 were infant deaths. The sample population was 70,000 persons, enumerated on a probability basis, throughout the rural areas (2,000 persons or less) and urban areas (2,001 persons or more) of the country. The sample size is roughly 5 percent of the current estimated population of Liberia.

Unit Size and Period

Events missed by size of unit. When designing a fertility survey, the question of how large to make the enumeration unit often arises. Usually the size is dictated by such things as sampling error, budget, transportation facilities, how much a given enumerator or supervisor can adequately control, and the actual size of localities in a country. In Liberia, more than half of the people live in localities of about 200 persons. Moreover, these localities are not usually served by roads, but rather are more or less connected by footpaths. In designing the survey it therefore was decided to enumerate every household in each sampling unit so as to minimize traveling expenses and time. Most localities in the sample, then, had about 200 persons and, on the average, one part-time monthly enumerator was needed for each unit. If the unit was larger, additional enumerators were hired on the ratio of one to every 200 or 300 persons. Because the definition of a rural area included localities of up to 2,000 persons, some units were quite large.

The urban units were of more uniform size, but some variation was experienced because of changes in the urban population postdating the sample frame. Because of the variation in unit size, the proportion of events missed by both enumeration systems in each of six sizes of sampling units could be compared to see if any differences were apparent. The sizes selected were as follows: (*a*) localities with less than 200 persons, (*b*) 200 to 399, (*c*) 400 to 599, (*d*) 600 to

Vital rates, by selected homogeneous groups and enumeration methods, using the Chandrasekar-Deming method



799, (*e*) 800 to 999, and (*f*) units with more than 1,000 persons.

The total number of births, deaths, and infant deaths that occurred in each class size was tabulated separately by the enumeration method. The C–D correction factor was computed, and the missing events were added to find the probable number of events that occurred. The percentage of events missed in each size class and for each enumeration system was then computed. These results are shown in table 1.

Table 1. Percentage of events missed, by size of enumeration unit and enumeration system

Events missed and enumeration system	Population of sampling units					
	199 or less	200–399	400–599	600–799	800–999	1,000 or more
Births:						
Monthly	40	33	42	57	49	49
Semiannual	40	35	41	54	41	52
Deaths:						
Monthly	28	30	34	46	36	49
Semiannual	30	39	40	63	47	53
Infant deaths:						
Monthly	21	29	50	27	35	48
Semiannual	21	34	47	73	35	55

Although inconsistencies are apparent, the general trend of the data suggested that the larger the sampling unit the higher the percentage of missed events. Specifically, in units of less than 200 persons, an average of 30 percent of all events was missed by the monthly and semiannual system; in units of 200 to 399, 33 percent were missed; in units of 400 to 599, 42 percent; in units of 800 to 999, 41 percent; and in units of more than 1,000 persons, 51 percent were missed.

No significant differences were observed in number of misses by type of event, with each being missed an average of 40 percent. In comparing the proportion of events missed by the monthly and semiannual systems individually, no significant differences were found although the semiannual system missed a few more events (44 percent) than the monthly system (39 percent).

Regardless of some internal inconsistencies, the data suggest that the optimum size of an enumeration unit, as far as the recording of an event is concerned, would be less than 400 persons, and units larger than 400 should be avoided.

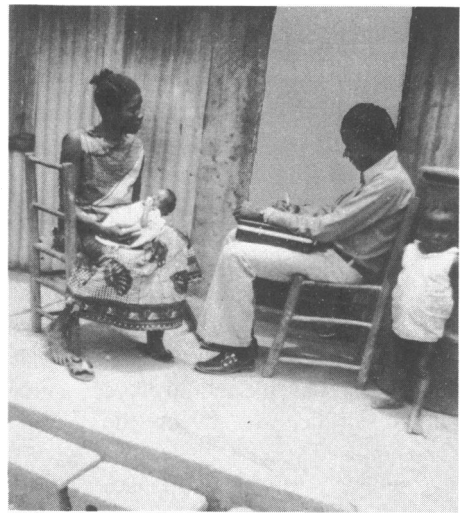
This result does not constitute a recommendation nor is it possible to say that larger units might not be possible in other countries or with some other type of enumeration design. It suggests, however, that there is something about the larger units in Liberia that makes the recording of a birth or death more difficult. Since the workload of any monthly enumerator is approximately the same, about 40 households each, this explanation does not appear to be reasonable. More than likely it has something to do with population mobility. The larger the unit the more its attributes are associated with urbanization; the strongest of these is migration, with all the unstable characteristics associated with it.

When people are moving in and out, an event is likely to be missed by both enumeration systems, or it is more likely to be recorded by one system than another. If this occurs, the proportion of events recorded by both systems is smaller in proportion to that recorded by each; this is reflected by a higher C–D correction factor.

Undoubtedly, this explanation is not the entire answer. Such things as a more affluent society, a more impersonal attitude toward the enumerators, and lack of identity or aloofness—all characteristics of persons in large localities—are probably at work also. Whatever these reasons, they apparently exist in Liberia, and perhaps should be considered when designing a fertility survey in other countries.

Events missed, by periods. As stated, the enumeration design of the survey is divided into two 6-month periods. At the end of each period an independent enumerator completed a semiannual enumeration, and the monthly and semiannual results were matched, verified, and all differences reconciled. To determine if there were any differences in the pattern of missed events between the two periods, the proportions of births, deaths, and infant deaths missed for a given period were computed for the rural and urban areas and for each enumeration system. The underlying purpose of this comparison was to determine if there was a significant loss or weakening of independence in the two systems through conditioning of respondents by repeated visits to the household, straight collusion between the two enumerators, or perhaps a combination of the two. Repeated visits are perhaps of greater theoretical importance since one major prerequisite of the C–D method is that both systems remain independent throughout the enumeration pe-

Left. Accurate reporting of number of children ever born in "Smell No Taste," Liberia, is difficult because mothers tend to report only surviving children. **Right.** Enumerators must be of the same tribal and linguistic group as respondents in Logantown, Liberia.



riod. If the respondents are conditioned, one enumeration is dependent on the other. In the Liberian context, this would have been the semiannual enumeration. Collusion would destroy independence automatically because both systems would pick up and lose the same events and thus become, in a sense, one system only.

To compare the periods, data were standardized by computing the number of events missed in each period and by expressing the result as a percentage of all events that occurred, as determined by the C–D method. This procedure was followed for each type of event, rural and urban location, and enumeration system. The results of the process are shown in table 2.

As indicated by the data, no significant differences were noted between periods in the proportion of events missed. This observation apparently was true regardless of the type of event, rural or urban location, or who made the enumeration.

Although none of the differences obtained were statistically significant, some of the results are worth noting in the event a future pattern emerges. The data suggested that, on the average, 17 percent of all events were missed during the first half of the survey and 14 percent during the second half. The pattern of missed events, however, was somewhat inconsistent. For individual events, during the first period about 20 percent of the births and 15 percent of all deaths and infant deaths were missed. During the second period the corresponding averages were 16 percent for births, 17 percent for all deaths, and 11 percent for infant deaths. The monthly enumerators improved slightly in the second half, whereas the semiannual enumerators obtained approximately the same results in each period.

For all events, the monthly casefinders missed 40 percent during the first half and 34 percent during the second half. The semiannual enumerator-supervisors missed about 39 percent during the first half and 41 percent during the second half.

The rural enumerators missed approximately 14 percent of all events during the first half and 13 percent during the second half. The urban enumerators missed 22 percent during the first period and improved slightly to 15 percent during the second half of their survey.

Table 2. Percentage of events missed, by enumeration period, rural and urban locations, and enumeration system

Enumeration period and events missed	Location		Enumeration system	
	Rural	Urban	Monthly	Semiannual
May–October:				
Births	19	21	47	42
Deaths	12	18	35	36
Infant deaths	12	28	37	40
November–April:				
Births	12	19	34	40
Deaths	14	20	32	46
Infant deaths	14	7	35	37

The data are far from conclusive, and many of the slight differences noted may be attributed to experience in enumerator techniques and quality control procedures in the field, but it is reasonable to conclude that the independence of the dual enumeration system has been preserved in Liberia and has remained so over time. If the respondents were conditioned or if collusion occurred, it follows that the proportion of missed events would have declined significantly during the second half. There is little evidence that this happened. Whether this result would remain over a longer period or be true in another country or for some other enumeration system cannot be stated at this time. Perhaps similar data will be obtained from other fertility surveys that can be added to this isolated result.

Enumerators and Casefinding

Events missed by resident and nonresident monthly enumerators. In nearly all developing countries, the recruitment of qualified enumerators in remote villages and even in cities has posed a problem because literacy usually is low. In Liberia the literacy rate for persons over 10 years old is 22 percent. The demand for mature literate people is usually so great that it is often difficult to attract persons who are willing to perform door-to-door enumeration work. The problem is further complicated by a diversity of cultures and languages and strong tribal or group affiliations. Consequently, it is necessary to recruit enumerators locally who can both communicate with the respondents and have a cultural affinity with them.

In Liberia, it was virtually impossible to find a resident in every sampling unit who could both read and write, who was related to the tribe or clan, and who was willing to become a part-time monthly enumerator. In the rural sampling areas where resident enumerators could not be found, it was necessary to recruit someone in a nearby village who was a member of the same clan and language group and pay him a small travel allowance to make his monthly rounds. In the rural units, 66 percent of the enumerators were of the nonresident type.

For the urban sampling units the problem was not as acute because the residents were culturally diversified, but even in these areas, 44 percent of the enumerators were not residents of their respective enumeration areas.

To determine the effect of hiring nonresident enumerators on the number of missed events, the sampling units were divided into two groups; those with and those without resident enumerators. The number of events missed in each area was computed separately by the C–D method for each type of event and rural or urban area and converted into percentages. The results are shown in table 3.

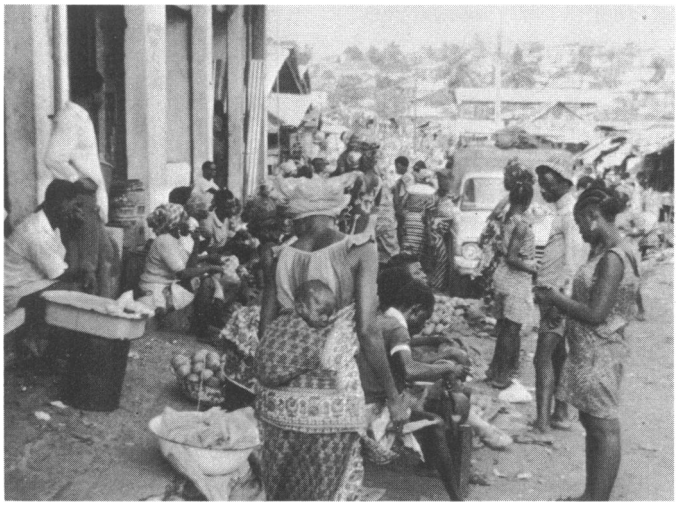
No significant differences were found between resident and nonresident enumerators in the percentage of missed events. The resident workers did slightly better, missing 14 percent of all events, than the nonresident's 19 percent, but the differences were inconsistent. The resident enumerators missed about the same number of births—resident 19 percent and nonresident 18 percent; for all deaths, however, the residents did slightly better (12 percent) than their nonresident counterparts (14 percent). For infant deaths the nonresidents missed 22 percent and the residents, 17 percent. The rural resident and nonresident enumerators missed about the same number of events (residents 13 percent and nonresidents 14 percent). In the urban areas, the residents did slightly better (16 percent) than the nonresidents (23 percent). For all events, the urban enumerators missed more than the rural enumerators.

Table 3. Percentage of events missed, by resident and nonresident monthly enumerators and rural and urban locations

Type of monthly enumerator and events missed	Rural	Urban
Resident:		
Births	15	21
Deaths	11	13
Infant deaths	13	15
Nonresident:		
Births	15	20
Deaths	14	29
Infant deaths	13	21

The results of this compilation may have important implications for nations that are considering the use of resident enumerators in a fertility survey. The data in my paper suggest that if local enumerators are not available, enumerators who have some cultural affinity with the respondents but who may live outside the immediate sampling unit can be hired without any significant adverse effect on the casefinding of births and only a slight penalty on the casefinding of deaths, specifically in the urban areas. Thus, even in those countries where manpower is scarce, qualified nonresident enumerators can do a satisfactory job.

Events missed by selected attributes of the enumerators. Most important to any survey, or in fact to any data-collecting enterprise, is the skill, diligence, and self-discipline of its enumerators or casefinders. Unfortun-



Enumeration is difficult in the urban area of Monrovia, and many events are missed by both enumeration systems

ately, however, the screening and ultimate employment of these people still remain hit or miss. The usual method of selecting an enumerator is to interview the candidate, consider his age, educational attainment, past experience, general appearance, and poise, and then perhaps test him. Successful candidates are then trained and started in fieldwork. Essentially, the same type of process is used to select supervisory personnel although the procedures are somewhat more stringent. Regardless of how carefully these steps are followed, enumerator and supervisory failures have plagued every survey.

To determine some attributes associated with the successful selection of enumerators, each of the 199 monthly and 30 semiannual enumerators employed in the Liberian survey was asked for a simple biographical sketch including age, educational background, and length of service. Since each enumerator was permanently assigned to a particular sampling unit or group of units, computing the number of births, deaths, and infant deaths missed by each one was relatively easy. First, the sampling units were compiled by age, educational attainment, and length of service of the enumerator; second, it was ascertained how many events were recorded by the monthly system and by the semiannual system in these units; third, the number of events missed by both systems was computed by using the C–D method; and then the percentage missed by a given enumerator group, by age, education, and length of service was determined. Variation in these attributes for a particular type of enumerator was limited because only persons with at least a primary school education were selected for enumerators; moreover, all the monthly and semiannual enumerators had worked for the survey for at least 6 months, but enough contrast existed in age, education, and service to make limited comparisons.

The age groups of the monthly enumerators were 24 years or less, 25 to 29 years, 30 to 34 years, and 35 or over. Since all the semiannual enumerators were over age 25, the lower age group was dropped from the analysis of these fieldworkers. Two educational groups were used, 12 years or less and 13 years or more. The two length-of-service groups included enumerators with less than 12 months and those with 13 months or more. The results are discussed for each type of enumerator.

The sampling units were compiled for rural and urban monthly enumerators in the four age groups, two educational groups, and the two length-of-service categories cited. The proportion of events missed by each group was computed separately. The percentage of missed events, by age and rural or urban location, is shown in table 4.

The results suggested that monthly enumerators ages 30 to 34 years missed significantly fewer events (27 percent) than the enumerators aged 29 and under (46 percent) or the enumerators aged 35 or over (38 percent). Births were missed (46 percent) more frequently than

total deaths or infant deaths (36 percent each). More events were missed in the urban than the rural areas, but the differences were inconsistent.

The analysis of missed events by educational attainment (table 5) suggested that although enumerators with more than high school education, mostly school teachers, missed fewer events than those with high school or less education (38 compared with 43 percent), the difference was inconsistent from event to event. No consistent differences were obtained in the percentage of misses by event or rural or urban location, although the pattern for birth and urban location was repeated.

Table 4. Percentage of events missed, by monthly enumerators' age groups and rural and urban locations

Monthly enumerators' age groups (years) and events missed	Rural	Urban
24 or under:		
Births	40	52
Deaths	39	53
Infant deaths	45	47
25–29:		
Births	30	82
Deaths	37	49
Infant deaths	26	53
30–34:		
Births	36	38
Deaths	25	17
Infant deaths	30	18
35 or over:		
Births	44	45
Deaths	30	36
Infant deaths	26	44

Table 5. Percentage of events missed, by monthly enumerators' educational attainment and rural and urban locations

Monthly enumerators' education and events missed	Rural	Urban
Grades 1–12:		
Births	32	63
Deaths	34	44
Infant deaths	40	45
Grades 13 and over:		
Births	47	45
Deaths	34	38
Infant deaths	25	40

Table 6. Percentage of events missed, by monthly enumerators' length of service and rural and urban locations

Monthly enumerators' length of service and events missed	Rural	Urban
12 months or less:		
Births	41	64
Deaths	32	55
Infant deaths	29	59
13 months or more:		
Births	40	53
Deaths	34	39
Infant deaths	36	47

The results concerning events missed by enumerators working 12 months or less and those working more than 12 months (table 6) suggested that no significant differences in the proportion of missed events were associated with length of field service. The least experienced men missed slightly more events (47 percent) than the more experienced men (42 percent), but inconsistencies were apparent from event to event. Again urban enumerators missed significantly more events, particularly births, than the rural workers.

This experience suggests that monthly enumerators 30 to 35 years old miss fewer events than the younger and older enumerators and that enumerators with higher educational attainment and more experience do not necessarily miss fewer events than their less fortunate or experienced counterparts. No particular reason can be or is offered concerning the age differential. Perhaps another factor associated with the age group 30 to 35 years is at work or, conversely, something about being younger or older than this age group is associated with missing an event. Until this result is duplicated elsewhere, it should be viewed as perhaps an artifact of the arithmetic.

The results of education and experience are perhaps more important, particularly in developing countries where highly educated and experienced enumerators are scarce. Apparently neither attribute is particularly mandatory in producing good enumerators. What may be more important are good motivation, proper training, and tight supervision.

The semiannual enumerators, who supervise the monthly enumerators, were grouped into three age categories, as indicated previously. The number of events missed by each was computed and converted into a percentage. The same educational and length-of-service groups used for the monthly enumerators were compiled, and the appropriate percentage of events missed for each was computed. The results for age are shown in table 7.

Unlike the experience of the monthly enumerators, the percentage of missed events varied significantly in each age group, with the semiannual enumerators

Table 7. Percentage of events missed, by semiannual enumerators' age groups and rural and urban locations

Semiannual enumerators' age groups (years) and events missed	Rural	Urban
29 and under:		
Births	60	46
Deaths	45	47
Infant deaths	42	47
30–34:		
Births	32	43
Deaths	31	53
Infant deaths	29	41
35 and over:		
Births	29	38
Deaths	17	12
Infant deaths	20	12

Keeping track of migrations causes many problems for the survey enumerators of Monrovia

in the younger age groups missing more events than the older enumerators. The semiannual enumerators under age 29 missed about 48 percent of all events, those 30 to 34 years missed 38 percent, and those over age 35 missed 21 percent. No significant or consistent differences were noted for individual events or locations.

The number of events missed by the more highly educated semiannual enumerators (40 percent) was not significantly lower than the number missed by the less educated enumerators (45 percent). No significant differences were observed for events or rural and urban locations (table 8).

The percentage of events missed by length of service (table 9) did not differ between enumerators working 1 year or less and those working more than 1 year (43 percent each). A significant difference was obtained for events, however; deaths were missed at an average rate of 51 percent, infant deaths at 40 percent, and births at 36 percent. No differences were obtained for rural and urban locations.

In summarizing the results from an operational point of view, it is apparent that the older semiannual enumerator-supervisors were somewhat more thorough in covering events than their younger co-workers. In all probability this result had something to do with the functions of the semiannual supervisors. Perhaps the older supervisors obtained more respect from the monthly enumerators than did the younger supervisors. The possibility also exists that the respondents were more at ease with the older than with the younger men. Whatever the reason, the data suggested that in the recruitment of supervisory personnel, the age of the candidate should be considered.

Aside from the age of the semiannual enumerator-supervisors, educational attainment and length of service did not seem to be an important factor in the success of casefinding. Like their monthly counterparts, such factors as motivation, thoroughness,

Table 8. Percentage of events missed, by semiannual enumerators' educational attainment and rural and urban locations

Semiannual enumerators' education and events missed	Rural	Urban
Grades 1–12:		
Births	54	43
Deaths	42	45
Infant deaths	41	46
Grades 13 and over:		
Births	35	50
Deaths	44	47
Infant deaths	25	41

Table 9. Percentage of events missed, by semiannual enumerators' length of service and rural and urban locations

Semiannual enumerators' length of service and events missed	Rural	Urban
12 months or less:		
Births	46	22
Deaths	38	66
Infant deaths	23	58
13 months or more:		
Births	39	37
Deaths	60	41
Infant deaths	38	41

and ability to command apparently played a more important role than extensive education and simple seniority.

Events Characteristics

Comparison of crude birth and death rates with events categorized into selected homogeneous groups. Chandrasekar and Deming in their original work in India (*15*) suggested that one of the better ways to apply their method was to prepare separate estimates for groups of events that had relatively similar coverage rates and then to sum these individual estimates to obtain the total number of events that occurred. This procedure has been tried in Thailand and Pakistan, with the result that little difference was found in the estimates yielded between the homogeneous-group procedures and the global method (*16*). Outside these studies, however, little work has been done on the homogeneous-group recommendation, and little documentation is available. The procedure unfortunately has certain logistical disadvantages for nations without access to sophisticated data-processing capabilities. To follow the homogeneous-group recommendation, it is necessary to first determine which categories should be used that may affect the recording or missing of an event, code and compile the events into these categories by the three casefinding methods (that is, both systems, monthly system only, and semiannual system only), and then tabulate the C–D correction factor for each. To do this, one needs a highly motivated editing and coding crew, a computer,

Table 10. Comparison of vital rates by selected homogeneous groups and enumeration systems, using the Chandrasekar-Deming method

Homogeneous group and enumeration system	Crude rates			Index of coverage		
	Liberia	Rural	Urban	Liberia	Rural	Urban
Births [1]						
C–D method:						
Mother's age, sex of child, birth order	51	50	53	[2] 100	[2] 100	[2] 100
Mother's age, sex of child	49	48	52	98	97	98
Mother's age, birth order	50	49	54	99	98	102
Sex of child, birth order	49	48	52	97	96	98
Mother's age only	49	48	52	97	97	97
Sex of child only	49	48	52	97	97	97
Birth order only	49	48	52	97	97	98
Without homogeneous groups	49	48	52	97	97	97
Enumeration system:						
Monthly and semiannual	41	41	42	81	82	78
Monthly only	29	29	29	57	57	55
Semiannual only	30	30	28	58	60	53
Deaths [3]						
C–D method:						
Age and sex	16	18	12	[2] 100	[2] 100	[2] 100
Age only	16	18	11	99	99	99
Sex only	16	18	12	98	97	99
Without homogeneous groups	16	18	12	98	97	99
Enumeration system:						
Monthly and semiannual	14	16	10	86	87	83
Monthly only	11	12	7	65	66	63
Semiannual only	11	12	6	64	66	55
Infant deaths [4]						
C–D method:						
Mother's age, sex of child, age of child	137	155	88	[2] 100	[2] 100	[2] 100
Mother's age, sex of child	138	159	81	101	102	93
Mother's age, age of child	140	161	83	102	104	95
Sex and age of child	137	158	83	100	102	95
Mother's age only	139	159	83	102	103	96
Sex of child only	134	154	83	98	99	94
Age of child only	134	153	82	98	98	95
Without homogeneous groups	138	159	83	101	102	94
Enumeration system:						
Monthly and semiannual	117	137	67	86	88	76
Monthly only	87	101	50	63	65	57
Semiannual only	83	98	42	60	63	48

[1] Number of births per 1,000 population.
[2] Assumed standard.
[3] Number of deaths per 1,000 population.
[4] Number of deaths among children under 1 year per 1,000 live births.

and skilled auxiliary data-processing personnel.

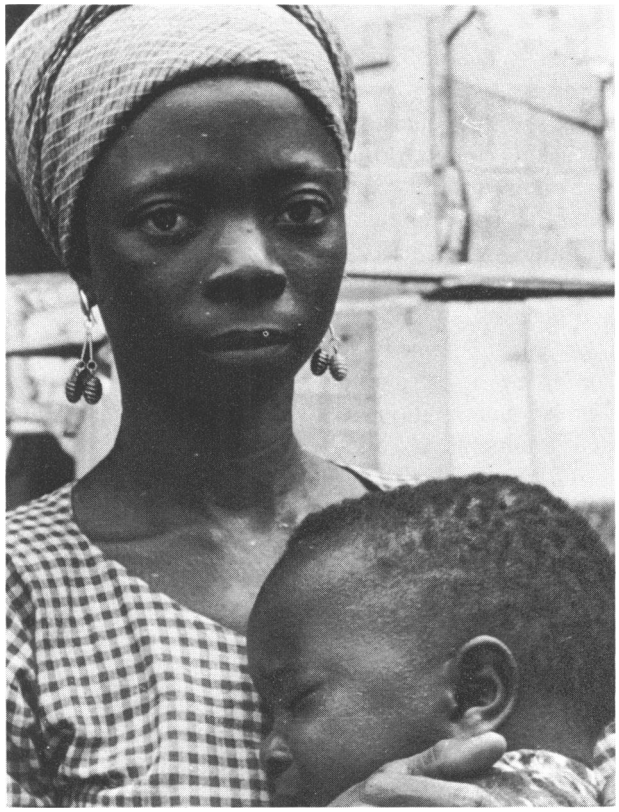
Fortunately, in Liberia the personnel and equipment were available, and the design of the Liberian survey, from the beginning, provided for the division of events into homogeneous groups. The choice of categories to use in forming the groups was dependent on information asked in the questionnaire. Unfortunately, no "canned set" of variables was available. Those arbitrarily chosen that were considered pertinent to recording or not recording an event, and which appeared to be homogeneous, were as follows: for births, age of mother and sex and birth order of the child; for deaths of infants under age 1 year, age of mother and sex and neonatal-postneonatal survival of child; for deaths of persons over 1 year old, age and sex of the deceased. Rates were then tabulated for each of these homogeneous groups and individual enumeration systems, and a coverage index was computed for each group or system. This index is simply the number of events covered by a particular homogeneous group or enumeration system, divided by the number of events covered by the most detailed category of homogeneous group. The result was then multiplied by 100. The index numbers are shown in table 10.

The data suggested that for births, deaths, and infant deaths no significant differences were obtained among the various combinations of homogeneous groups and the straight C–D global method. The coverage indices ranged above 95 for all combinations of homogeneous groupings and the regular C–D estimates.

In contrast to this result, however, the use of the C–D method either alone or in the various categories of homogeneous groups yielded significantly higher index coverage numbers than the monthly and the semiannual systems in combination or either enumeration system alone. The two enumeration systems combined, with index numbers ranging from 78 to 87, covered significantly more events than either the monthly or semiannual enumeration systems alone. There were no differences in coverage of events between either the monthly or semiannual systems.

For rural or urban areas, no significant differences were noted in births and total deaths regardless of the homogeneous combinations or enumeration system used. For infant deaths, however, the urban enumerators missed significantly more events than their rural counterparts.

Essentially then, this exercise confirms work in Thailand and Pakistan which suggested that categorizing the events into homogeneous groups makes little difference in the resulting estimates. Had the sample size been larger or if different categories had been chosen, however, these conclusions may not have held true. Caution should therefore be exercised before dropping the homo-



Estimating age of mother is difficult in tropical Africa; 44 percent of all ages were estimated by the enumerators

geneous-group recommendation of Chandrasekar and Deming until further data become available.

Regardless of the decision to categorize or not to categorize, as demonstrated in the chart, one firm conclusion can be drawn from these data on the experience in Liberia. The dual system of enumeration with the C–D method yields much higher estimates than the monthly and semiannual systems combined; one system only, be it a monthly house-to-house enumeration or a semiannual enumeration, misses many events. Since this experience has been reported in every like survey undertaken thus far (*16*), it would seem that in developing countries, with all their inherent problems of low literacy, shortages of trained manpower, statistically unsophisticated and oftentimes unsympathetic respondents, and challenging geographic and transportation factors, a multiple cross-checking enumeration system would be more satisfactory than a single system with no means to verify the results.

Comparison of the type of event missed by both enumeration systems. Although the categorizing of events into homogeneous groups apparently makes no significant difference in C–D estimates, it does provide an opportunity to determine if any particular characteristic of a given event increases or decreases its chances of being missed by both enumeration systems. The estimated number of events missed in each homogeneous group category was computed and expressed as a percentage of the total number of events which occurred in that particular category. Because the homogeneous categories used varied from event to event, each event was analyzed separately. Moreover, since all the categories did not have an equal opportunity to occur in every instance (for example, birth order nine for females of 10 to 14 years) and some categories were naturally correlated (that is, high-parity women are usually older), it was necessary in some instances to analyze specific groups of categories separately. Furthermore, since few events occurred in some categories, several groups were combined to provide meaningful numbers and minimize distortions in ratios. The results of this work, by event, follow.

The percentages of live births missed by both systems for the rural and urban areas were computed for the following groups: birth order one and two combined, three and four, five and six, seven and eight, and nine and over: mothers' ages under 19 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, and 35 years and over. The results are presented in table 11.

In the first comparison—the percentage of live births missed in both enumeration systems by birth order, sex, and rural or urban location—the data suggest that the lower the birth order the greater the chance of missing a birth. Also, a female live birth is more likely to be missed than a male live birth. Specifically, the proportion of births missed for first and second orders averaged 22 percent; for third and fourth orders, 21 percent; for fifth and sixth orders, 17 percent; for seventh and eighth orders, 16 percent; and for ninth orders or higher, 10 percent. Essentially, no significant differences were yielded between orders one through four and orders five through eight, but each group was different from another, and all were higher than order nine or over.

Both systems missed an average 15 percent of the live male births and 19 percent of the female live births. Urban enumerators missed more births (20 percent) than their rural counterparts (15 percent). The difference was not consistent for both sexes, however, and may only be considered indicative.

For the second analysis birth order was held constant, and a comparison was made between births missed by age of mother, sex of infant, and rural or urban location. The results suggested that no significant or consistent differences were obtained in the

Table 11. Percentage of births missed by both enumeration systems, by birth order, age of mother, sex, and rural and urban locations

Characteristics	Rural		Urban	
	Male	Female	Male	Female
Birth order:				
1st and 2d	16	27	27	19
3d and 4th	13	21	27	21
5th and 6th	12	14	17	25
7th and 8th	14	12	14	25
9th and over	11	7	3	19
Mother's age group (years):				
Under 20	19	19	25	21
20–24	12	12	26	19
25–29	10	17	22	19
30–34	19	37	27	24
35 or over	15	19	11	27

number of births missed by age of mother, sex, or location. On the average, births among women under 19 years were missed 21 percent of the time; among women 20 through 29 years, 17 percent; among women 30 to 34 years, 28 percent; and among women over 35 years, 18 percent. Female births were missed more frequently (21 percent) than male births (19 percent), and urban births more frequently (22 percent) than rural (18 percent). Inconsistencies were prevalent in both distributions, however, and the differences were not significant.

Only a guess is possible concerning the apparent reason for the relationships found. Perhaps pride in fertility, the inherent geographic stability of a mother with a large number of children, and the embarrassment of illegitimacy combined to produce an inverse relationship between birth order and proportion of missed births. As to the greater percentage of missed female births, perhaps the greater desirability of having a male birth in Liberia is as good a guess as any.

The percentages of deaths missed by both systems for the rural and urban areas were computed for males and females for the following age groups: under 1 year, 1 to 4 years, 5 to 9 years, and the conventional 10-year groups thereafter. The resulting percentages are shown in table 12.

As indicated by the data, no significant or consistent differences were suggested in the percentage of deaths missed by age of the deceased. Variation by sex from age to age and from rural to urban was prevalent throughout the distribution. The data suggested, however, that a male death was significantly more difficult to record than a female death. On the average, male deaths were missed 18 percent of the time and female deaths 11 percent in both the rural and urban areas. Why a male death was more difficult to locate is not known. The relative geographic instability of a male may play a part. Moreover, males are usually heads of households, and when they die the household dissolves through migration, which might make recording of the event more difficult.

The percentages of infant deaths missed by both systems were computed for the urban and rural areas in the following categories: mothers under 19 years, 20 to 24 years, 25 to 29 years, and 30 years and over; sex of child; and survival during the neonatal or postneonatal period. The percentage distributions are shown in table 13.

Differences were noted for age of mother and survival period. The percentage of missed infant deaths was significantly higher for women in the mid-childbearing period, ages 25 to 29, than in any other age group. No differences were found in the proportion of infant deaths missed for ages under 25 or over age 29. On the average, 30 percent of the infant deaths were missed by both systems among mothers aged 25 to 29 as compared with 7 to 11 percent for mothers in the other age groups. No differences were found in the number of infant deaths missed by sex, with each being missed about 15 percent of the time. Significantly more infant deaths were missed during the neonatal period than during

Table 12. Percentage of deaths missed by both enumeration systems, by age and sex of deceased and rural and urban locations

Age group of deceased (years)	Rural		Urban	
	Male	Female	Male	Female
Under 1 year	14	15	18	16
1–4	5	10	15	14
5–9	18	11	21	0
10–19	0	25	13	0
20–29	29	0	15	12
30–39	14	0	13	14
40–49	40	14	27	22
50–59	19	0	0	0
60 and over	2	10	24	9

Table 13. Percentage of infant deaths missed by both enumeration systems, by age of mother, sex of child, survival period, and rural and urban locations

Mother's age group (years) and sex of child	Location		Survival period	
	Rural	Urban	Neonatal	Postneonatal
19 or under:				
Male	9	14	14	0
Female	15	12	16	10
20–24:				
Male	8	19	19	0
Female	0	13	4	6
25–29:				
Male	19	41	32	28
Female	30	32	35	25
30 and over:				
Male	14	16	15	15
Female	8	14	14	0

the postneonatal period. About 19 percent of the infant deaths occurring during the first month of life were missed as compared with 11 percent during the remaining 11 months.

In the second analysis the survival period was held constant, and the percentage of infant deaths missed by age of mother, sex of child, and rural or urban location was studied. Significant differences were found by age of mother and location but not by sex. Again the highest proportion of missed events (about 31 percent) occurred in the central childbearing ages of 25 to 29 years, averaging 10 to 13 percent higher than in any other age group. More male events were missed (18 percent) than female events (15 percent), but not consistently. Significantly more infant deaths were missed by urban enumerators (20 percent) than by rural enumerators (13 percent).

Again, the reasons for these differences are difficult to demonstrate. Why the mid-childbearing ages should be associated with a missed event is not known. The higher proportion of neonatal deaths in all probability is related to the fact that most infants died shortly after birth (during the first week); consequently, most occurred between enumerations. Moreover, since the infants were not in the family long enough to be considered family members, neither the births nor the ensuing deaths were reported to the monthly or the semiannual enumerators. The higher porportion of urban infant deaths missed is probably associated with the simple fact that the mothers were not found by the enumerators because of the high mobility of the urban population. Whatever the reasons, in Liberia, age of mother, neonatal survival, and urban location apparently are associated with failure to record an infant death.

Conclusions

Many factors associated with enumeration techniques, enumerator performance, and characteristics of the vital events themselves affect the success or failure of casefinding in fertility surveys. Some factors that contributed to recording or not recording a vital event in the Liberian fertility survey were as follows:

The proportion of births, deaths, and infant deaths that were missed by enumerators increased directly with the size of the enumeration unit. The optimum size suggested was less than 400 persons.

When using a dual enumeration system based on a continuing monthly enumeration with two independent semiannual enumerations, the data indicated that no significant differences were found between events missed during each of the separate 6-month periods, suggesting that respondent conditioning and enumerator collusion did not occur.

Where local personnel were not available, it was possible to recruit enumerators who had some cultural affinity with the respondents but who lived outside the immediate sampling unit without any significant adverse effect on the casefinding of a given vital event.

Monthly enumerators aged 30 to 35 years missed fewer vital events than the younger or older enumerators; however, educational attainment and experience did not significantly affect the successful casefinding of a vital event.

Older semiannual enumerator-supervisors missed fewer vital events than younger enumerators, but educational attainment and more experience had no effect on casefinding.

The categorizing of births, deaths, and infant deaths into homogeneous groups and computing the Chandrasekar-Deming estimate did not produce estimates significantly different from the C–D estimate not categorized into groups; however, the use of the C–D estimate alone or in the various homogeneous groups yielded significantly higher estimates than the monthly and semiannual systems in combination or either enumeration system alone. Combination of the monthly and semiannual enumeration estimates were significantly higher than estimates by either system individually, but no significant differences were apparent between the monthly and semiannual systems in the coverage of events.

The percentages of births missed by both enumeration systems were significantly related to the birth order of the child, with the lower orders being missed more frequently than the higher. Moreover, a female birth was significantly more difficult to record than a male birth. No significant differences were found in the percentages of births missed by age of mother. Male deaths were missed significantly more times than female deaths, but no differences in coverage were found by age of deceased.

Infant deaths were missed significantly more times among women aged 25 to 29 years than among any other age group. Furthermore, infant deaths occurring in the neonatal period were missed significantly more times than those occurring in the remaining 11 months of life. Infant deaths in the urban areas were

missed significantly more times than those in the rural areas.

REFERENCES

(1) Ahmed, N., and Krotki, K.: Simultaneous estimations of the population growth: The Pakistan experiment. Pakistan Development Rev 3: 37–65 (1963).

(2) Cantrelle, P.: Repeated demographic observation in a rural area in Senegal: Method and first results. Document No. B.6/V/F/207. World Population Conference, Belgrade, 1965.

(3) Demographic sample survey. University of Ghana, Accra, 1968. Mimeographed.

(4) Lauriat, P.: Field experiences in estimating population growth. Demography 4: 228–243 (1967).

(5) Majundar, M.: Estimation of vital rates in the Indian National Sample Survey. Document No. B.6/I/E/312. World Population Conference, Belgrade, 1965.

(6) Turkish Ministry of Health and Social Welfare: Vital statistics from the Turkish Demographic Survey. School of Public Health, Ankara, 1967.

(7) Turkish Ministry of Health and Social Welfare: Vital statistics from the Turkish Demographic Survey. School of Public Health, Ankara, 1970.

(8) Malawi population change survey: Sample design, mapping of segments, and instructions. National Statistical Office, Zomba, 1969. Mimeographed.

(9) Rumford, J. C., Heperkan, Y., and Fincancioğlu, N.: The principles and preliminary results of the Turkish Demographic Survey. Public Health Rep 83: 573–582, July 1968.

(10) Rumford, J. C.: Use of the Chandrasekar-Deming technique in the Liberian fertility survey. Public Health Rep 85: 965–974, November 1970.

(11) Sabagh, G., and Scott, C.: An evaluation of the use of retrospective questionnaires for obtaining vital data: The experience of the Moroccan multipurpose sample survey of 1961-1963. Document No. B.6/V/E/56. World Population Conference, Belgrade, 1965.

(12) Guanabara demographic pilot survey. ST/SOA/Series A.35. United Nations, New York, 1964.

(13) The Mysore population study. ST/SOA/Series A.34. United Nations, New York, 1961.

(14) Vukovich, G.: The U.A.R. project for measuring vital rates in rural areas. Document No. B.6/1/E/68. World Population Conference, Belgrade, 1965.

(15) Chandrasekar, C., and Deming, W. E.: On a method of estimating birth and death rates and the extent of registration. J Am Stat Assoc 44: 101–115, March 1949.

(16) Seltzer, W.: Some results from Asian population growth studies. Population Studies 23: 395–406, November 1969.

RUMFORD, JOHN C. (U.S. Bureau of the Census, USAID, Liberia):

Factors that affect casefinding in the Liberian fertility survey. Enumeration, enumerator, and vital events characteristics. Health Services Reports, Vol. 87, March 1972, pp. 247–261.

Lack of adequate information on what effect enumeration and vital events characteristics have on casefinding has hindered the development and design of fertility surveys throughout the world. The purpose of this paper was to study some of these effects in a fertility survey conducted in Liberia from May 1969 to April 1970.

The proportion of births, deaths, and infant deaths missed by enumerators generally increased directly with the size of the enumeration unit. When using a dual enumeration system based on a continuing monthly enumeration with two independent semiannual enumerations, the data indicated that no significant differences were found between events missing during each of the 6-month periods, indicating that respondent conditioning and enumerator collusion did not occur. The number of missed events was related to the enumerators' age group but not to their residence or nonresidence in the sampling unit or to their education or length of tenure in the survey.

Categorizing births, deaths, and infant deaths into homogeneous groups and computing the Chandrasekar-Deming estimates did not produce estimates significantly different from those obtained when the events were not categorized into groups. Combination of the monthly and semiannual enumeration systems produced higher results than those from either system alone, but no differences were noted between the monthly and semiannual systems results individually.

The percentages of births missed by both enumeration systems were inversely related to the birth order of the child, and a female birth was more difficult to record than a male birth. No differences were noted in the percentage of births missed by age of mother. Male deaths were missed more times than female deaths, but no differences were found by age.

Infant deaths among children of women aged 25 to 29 were missed more times than among mothers of any other age group, and deaths occurring in the neonatal period were missed significantly more times than those occurring in the remaining 11 months of life. Infant deaths in the urban areas were missed more often than those occurring in the rural areas.