# Application of Statistical Analysis In a Health Program

By RUTH R. PUFFER, Dr.P.H.

The statistical program is an integral part of health programs just as are the medical, nursing, and sanitation programs. In fact, the statistical aspects are often so much a part of the administration of a program that it is difficult to separate the statistical from the administrative.

Because of the administrative use of statistics, the statistician works with the health officer, the epidemiologist, the clinician, the nurse, and others in planning and developing programs and in applying statistical analyses for their guidance. This teamwork begins when plans are being made for the initiation of a new program to insure collection of proper data for administrative purposes and for continual evaluation.

Statistical analysis is used here in a broad sense to include records, and collection, processing, and tabulation of data, as well as analysis and interpretation—all essential parts of statistical work. The success of a program may depend on the vision shown when the records are designed. The records must have sufficient data for administration, for evaluation, and sometimes for research. Space must be provided for the data required for analysis. Satisfactory procedures for collection and completion of the records should be developed in the planning stage. The method of processing and tabulating the data is important. If mechanical means are needed, plans for codes for punching and tabulating are part of the initial planning. Selection of the best method of analysis and of correct interpretation of the the results are important phases of statistical work.

In planning the statistical phases of a program, study, or experiment, the specific objectives should be stated and the collection of data directed to fulfilling those aims. The objectives and methods will vary in each program.

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### Presents a Challenge

The application of statistical analysis, used in the broad sense, to planning, operating, and evaluating a health program differs in every field in which services are provided. No single pattern applies to local health department activities, to work in maternal and child hygiene, to cancer control, and to other programs. Statistical analyses vary from descriptive statistics to applying life table methods to data collected for use in studies of cancer and tuberculosis patients.

The wide range in the kinds of statistical analyses and in their application makes the statistician's work one of the most varied and stimulating in the field of public health. It requires imagination and vision to apply the right kind of analysis and to provide services that will really be useful. The statistician must be ready to make suggestions, to adapt new

techniques, and to recommend uses of the results in the improvement of the programs.

In the past, progress in health departments has often been measured by reductions in death rates from communicable diseases and in infant and maternal mortality. However, at present we have only an occasional death from typhoid fever or diphtheria, and deaths from puerperal causes are few. Certainly, we cannot measure the effect of a health department on a population by the reduction in deaths from communicable diseases. New ways of measuring the effect of specific programs on the health of the population are needed. We need morbidity studies to learn the causes of illness and disability in order to develop preventive programs.

All this means a constantly changing and interesting field for the statistician. In Tennessee, for example, our statistical work changes continually, and within a few months we may be involved in new applications that require new approaches. Examples from five fields of current interest will illustrate.

### Birth Registration Test

The recent birth registration test made as part of the 1950 census is a good example of evaluation of statistical work and of the accuracy of birth statistics. However, the contribution of this vital statistics work will depend on use of the results in improvement of birth registration—particularly in States and localities.

For the test, the census enumerators obtained information on each infant born in January, February, and March 1950. These records were matched with birth certificates filed through routine registration procedures in all the State health departments except Massachusetts. Preliminary results released by the Public Health Service showed that 97.8 percent of the births in the United States were registered (*1*). However, there was considerable variation by States. In general, registration was not as complete in southern as in northern States.

All of us from States in which registration is not complete must further define the problem within our States. The percentages of births registered by counties in Tennessee are shown in figure 1. This information has been released in the health department's monthly bulletin, "The Spotlight," and thus each county registrar knows the problem in his county.

The breakdown of registration according to place and attendant in table 1 supplies further information on why births are not registered. While 99.5 percent of the infants delivered in hospitals were registered, only 91.9 percent of those attended by physicians but not delivered in hospitals and 84.8 percent delivered by midwives were registered.

**Table 1. Number and percentage of births registered in Tennessee, by attendant, birth registration test, 1950** [1]

| Attendant | Total births | Births matched | |
|---|---|---|---|
| | | Number | Percent |
| Total | 18, 476 | 17, 863 | 96. 7 |
| Physician, in hospital | 13, 206 | 13, 146 | 99. 5 |
| Physician, not in hospital | 3, 471 | 3, 191 | 91. 9 |
| Midwife, other, not stated | 1, 799 | 1, 526 | 84. 8 |

[1] Preliminary data from Public Health Service.

Analysis of results from the birth registration test has indicated where registration is incomplete and who fails to register. The next step is to plan and operate a better birth registration program. Many approaches must be used. First, the physicians delivering babies at home and the midwives who failed to register must be shown the value of birth registration so that all births they attend in the future will be reported. All registrars must be aware of the problem and of the ways of checking to insure that all known births are registered. The field agents of the division of vital statistics must aid in the counties where registration is incomplete. If the old tried ways fail, new methods of learning about babies delivered at home must be discovered.

Results indicate that the public does not know the value of birth registration. Therefore, a health education program is needed. A film entitled "A Piece of Paper," referring to the birth certificate, has been developed in Tennessee. This film will be shown to high school

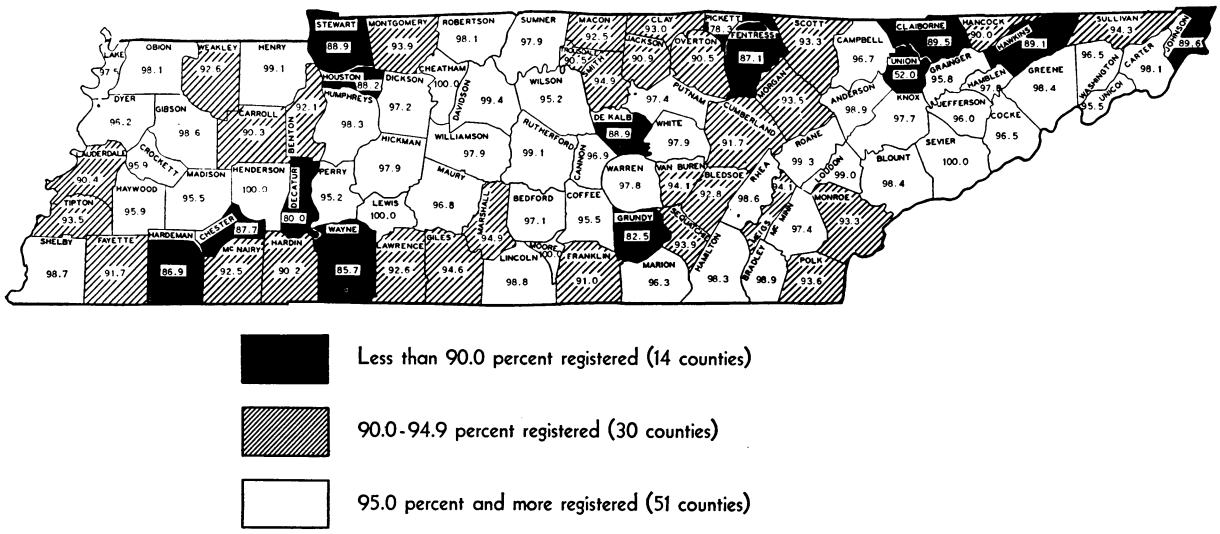


**Figure 1. Percentages of births registered by counties in Tennessee, according to preliminary figures supplied by the Public Health Service from the 1950 birth registration test.**

students, to parent-teacher groups, at State and county fairs, and to other groups in hope that each prospective parent will know the value of the birth certificate and make sure that each infant is properly registered soon after birth. A pamphlet, "Birth Registration in Tennessee," is also in use in the education program.

Thus, the results of this birth registration test are being applied to planning and operating a program to improve birth registration.

### Crippled Children's Service

In Tennessee, statistical assistance is given routinely to the crippled children's service for the administration of that program. A punch card is prepared for each crippled child placed on the register, giving name, date of birth, county, diagnosis, and similar data. A section shows the services and expenditures in a given year. These punch cards are used for preparing the annual reports and for making special tabulations whenever needed by the crippled children's service.

The annual report required by the Children's Bureau of the Federal Security Agency is completed by tabulations from cards of children treated by physicians during the year. In addition, we make tabulations for the director of the crippled children's service to use in evaluating the program. An example is table 2, which shows that 4,782 children (35 percent on the register) received physicians' services. The expenditures per child vary according to type of crippling condition. The expense per child for cleft palate and harelip was $93, for clubfoot $51, for rickets $21, and for burns $325. These figures are quoted when discussing expenditures with families and with county judges.

In addition to the program evaluation, analyses are made of specific problems and used in many different ways. One example is in the field of accident prevention. When the director of the crippled children's service discussed accident prevention at the Governor's Safety Conference, he stressed the prevention of crippling from accidents. More than 1,000 of the children on the register in 1951 (1,041, or 7.6 percent) had been crippled by accidents. Three hundred and seventy-four children had received severe burns. The expenditures per child were greater for treatment of burns ($325) than for any other type of crippling.

The number of crippled children on the register per 100,000 population has been studied by counties according to causes of crippling. These case rates are shown by counties for cleft palate and harelip (fig. 2). The higher rates for this condition and for rickets in east Tennessee counties are of special interest to the director of the program, and he hopes to find

the causes of the higher rates in order to develop a preventive program in conjunction with the treatment program.

### Speech and Hearing Program

At the request of the director of the speech and hearing program recently established in Tennessee, statistical assistance was given in the design of records, and plans were developed for coding and punching data for children with serious defects. Since the director wished to evaluate case finding by several different methods, tabulations and analyses have been made according to method of case finding (*2*). Figure 3 shows the results of examination of all elementary school children through mass surveys, and of cases obtained through referral by teachers using symptom sheets and by teachers without preparation.

The mass survey revealed that 8.9 percent of the children had speech defects and 13.8 percent, hearing defects. The percentages were much smaller by the other two methods of case finding. By knowing how successful these various methods of case finding are, the director can decide how best to operate a satisfactory program. Analyses of the work by counties have also been useful in the operational phases. Many decisions have had to be made regarding defects. The need for consistency in order to develop satisfactory statistical data for analyses has meant review of records and procedures. In a new field such as this, the statistical phases are closely interwoven with the administrative, and continual analyses and

**Table 2. Total expenditures and cost per child in each diagnostic group of children receiving physicians' services, crippled children's service, Tennessee, 1951**

| Diagnostic group | Number of cases | Expenditures | |
|---|---|---|---|
| | | Total | Per child |
| Total | 4, 782 | $275, 518. 04 | $57. 62 |
| Tuberculosis of bones and joints | 123 | 11, 889. 55 | 96. 66 |
| Poliomyelitis | 1, 366 | [1] 23, 494. 28 | [1] 17. 20 |
| Rickets | 114 | 2, 450. 14 | 21. 49 |
| Cerebral palsy | 451 | 38, 183. 20 | 84. 66 |
| Arthritis and rheumatism | 77 | 15, 073. 71 | 195. 76 |
| Osteomyelitis and periostitis | 109 | 10, 562. 41 | 96. 90 |
| Other diseases of bones and joints | 639 | 22, 312. 30 | 34. 92 |
| Cleft palate and harelip | 228 | 21, 255. 65 | 93. 23 |
| Clubfoot | 411 | 20, 971. 87 | 51. 03 |
| Other congenital malformations | 428 | 32, 095. 63 | 74. 99 |
| Birth injuries | 93 | 2, 185. 05 | 23. 50 |
| Burns | 106 | 34, 468. 43 | 325. 17 |
| Other accidents | 212 | 20, 697. 66 | 97. 63 |
| Other | 425 | 19, 878. 16 | 46. 77 |

[1] Some expenditures paid by the National Foundation for Infantile Paralysis are not included.

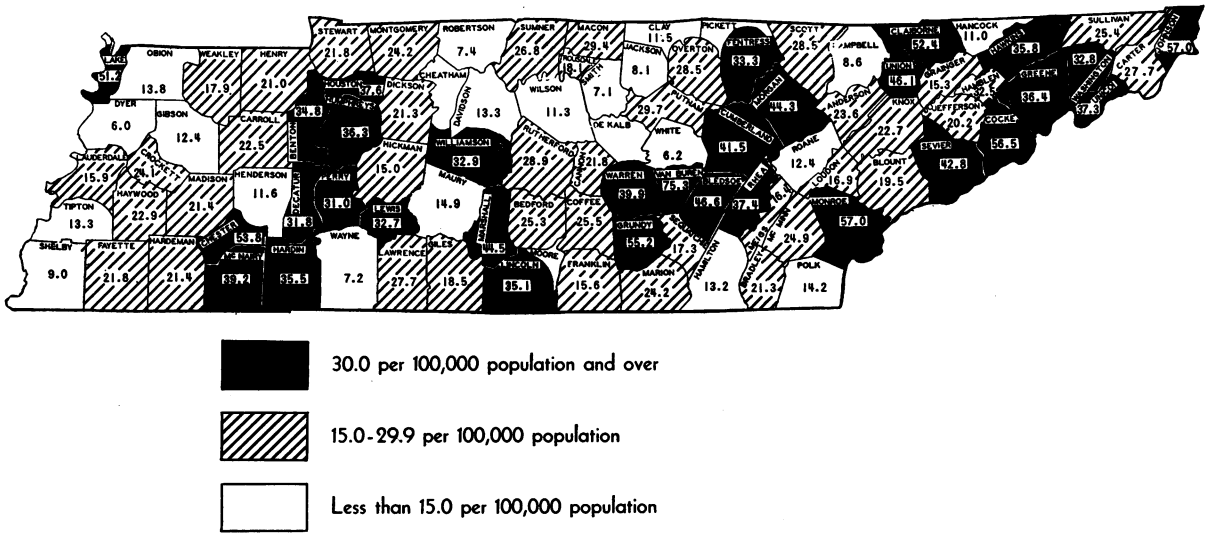


**Figure 2. Number of children with cleft palate or harelip, or both, per 100,000 population on crippled children's register for Tennessee counties, January 1, 1952.**

evaluation of results have a constructive influence on the program.

## Statistics for Industrial Hygiene

The director of the Tennessee industrial hygiene program wished to know the health problems in industrial groups. Three types of data have been developed and used in that program: (*a*) mortality statistics by occupation and industry; (*b*) morbidity statistics through the study of absenteeism of workers; and (*c*) survey data.

### *Mortality by Occupation and Industry*

Beginning with death certificates for 1944, the occupation and industry given for persons 15 years and over have been coded, using the classifications of the United States Bureau of the Census. The early work we did in this field pointed the way to the improvement and extension of such mortality studies. Many of the difficulties encountered were pointed out in a previous paper (*3*). Defective though the data were, differences were noted in tuberculosis death rates according to socioeconomic class. The rate for white men in professional work was 26.3 per 100,000 and for laborers 91.7. The National Office of Vital Statistics of the Public Health Service has contributed to the improvement of data on death certificates by release of the booklet, "Guide for Reporting Occupation and Industry on Death Certificates" (*4*).

### *Morbidity Statistics*

As in all fields of health, morbidity statistics are preferable to mortality statistics for knowledge of health problems. In order to study the health problems of industrial workers, a study of illnesses of 1 day or longer causing absence from work has been carried on in Tennessee. Participating plants report absences to us monthly, giving data on age, sex, color, and cause of illness. Detailed annual reports, prepared for the plants, show frequency, disability, and severity rates according to age, sex, color, and causes of illness. By comparing the rates of a plant with rates of other participating plants and with those of a public utility, the health problems of the plant can be determined. Directors of industrial hygiene and of the statistical service can then discuss the problems with plant managers, and steps can be taken to improve the health program of the plant.

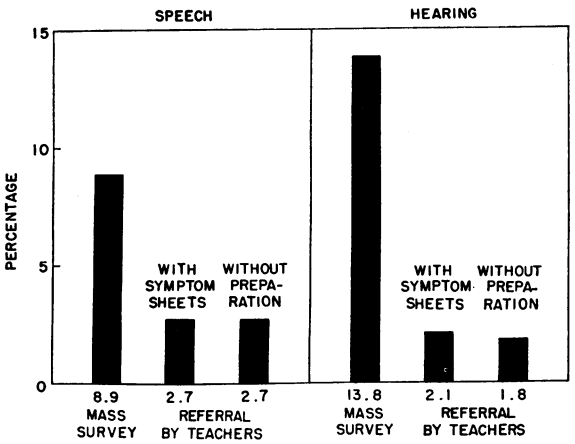


**Figure 3. Percentage of elementary school children with speech and hearing defects, according to method of case finding in 19 counties of Tennessee, 1951–52.**

Marked progress in the reduction of absences due to illness has occurred in participating plants. One plant has given permission for use of its data in discussing industrial absenteeism. The absence rates from illness and injury and from other causes in this plant during 8 years of participation are shown in figure 4. During the first few years of participation, the absence rates were high—especially for causes of absence other than illness and injury. More accurate data have since been obtained. The high absence rates are due to epidemics of influenza. The statistical analyses have been revealing and have been used continually in evaluating and operating the medical program of the plant.

## Cancer Statistics

In order to obtain cancer statistics which would aid our program, a study of patients admitted to the cancer clinics in Tennessee is in progress. A summary sheet is prepared in the participating tumor clinics for each patient found to have a malignant neoplasm. The summary sheets are sent to the Tennessee Department of Public Health, where they are coded and punched and tabulations made for an annual report of the clinic. These annual reports give the clinic directors an evaluation of their

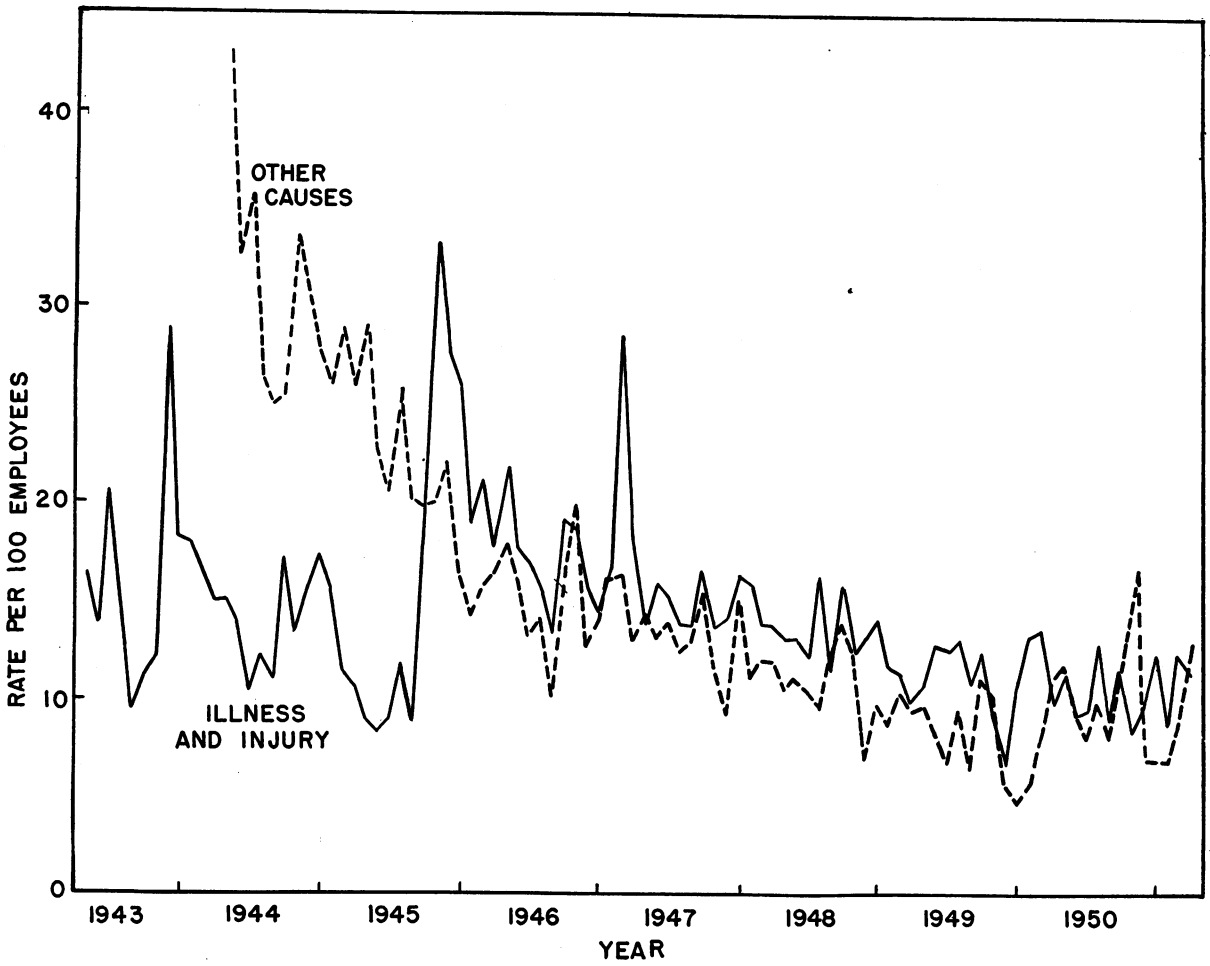


**Figure 4. Absence rates per 100 employees from illness and injury, and from other causes, in a Tennessee plant, by months, May 1943 through April 1951.**

programs through a careful analysis of the findings. They contain data regarding the number and distribution of cases by site, age, race, and sex, by extent of the lesion (localized, with regional involvement, or with remote metastasis), by period from onset of symptoms to diagnosis, and by type of treatment.

The data from all the clinics are combined annually into one report (*5*). Data taken from the 1950 annual report are given to show how the work is evaluated. The percentage distribution of cancer by site found in patients admitted to the Tennessee clinics in 1950 has been compared with the similar distribution of newly diagnosed cases found in Atlanta, Ga., through the survey (*6*) of the National Cancer Institute, Public Health Service (fig. 5). The Atlanta study recorded all cases of cancer found by physicians, hospitals, or by death certificates, which probably gives a good distribution of new cases in a southern community. Of the patients admitted to Tennessee clinics, 30.1 percent had cancer of the female genital organs, and 13.3 percent had cancer of the female breast (accessible sites). In Atlanta, the comparable percentages were lower, 16.3 and 10.3, while cancer cases of the digestive organs constituted 17.8 percent of the group. Thus in Tennessee clinics, cancer of the accessible sites is being discovered. Improvement has been noted, however, in detecting cancer of inaccessible sites, and more cancers of the digestive system and of the respiratory system are being diagnosed. The data show the need for health education and for finding cases in the localized stage. This material is being used by the cancer spe-

cialists, and one of the clinic directors uses the material in teaching medical students.

Each one of these cancer patients is being placed under observation, and his status is obtained at annual intervals from the date of diagnosis. An important part of this study program is to follow each patient and to analyze the results by calculating death and survival rates. Slips are sent to the clinics for the status of patients at annual intervals. If the clinic is unable to locate the patient, the slip is sent to the health department and a field visit is made. Careful follow-up of each patient is essential for analyses.

The method of analysis is the same as that used in the study of the life experience of tuberculosis patients (*7*). The probability of dying or of surviving is obtained for each year by an adaptation of life-table methods. By this method each patient is considered to be at risk of death for the year, except those for whom the status was unknown. Each of the persons of unknown status is counted as being exposed to one-half year of experience. The cumulative probability of dying during the period of observation is obtained.

Using this method, the probabilities of dying have been calculated for the different clinics by site, race, sex, and other distributions (*8*).

Figure 6 shows the percentage of the patients diagnosed in 1947 as having malignant neoplasms of the skin, of the female genital organs and breast, and of other sites, who were dead at the end of the first 3 years of observation. During the first 3 years, 19.4 percent of the patients admitted in 1947 with malignant neoplasms of the skin died. The percentages were much larger for the other sites—60.6 percent of those with malignant neoplasms of the female genital organs and 54.8 percent of those with malignant neoplasms of the breast died during the first 3 years of observation. The percentage dying during the first 3 years of cancer of all other sites combined was 69.1.

As we obtain more data, analyses will be made according to site, extent of the lesion on diagnosis, type of treatment, and other variables. However, in order to have satisfactory data for analysis, it is advisable to build slowly and soundly. Procedures had to be established and follow-up has to be well done.

In the field of cancer statistics, the application of statistical analyses to the development and guidance of the program is especially important. The annual reports have been useful in showing the limitations of the Tennessee program and the need of service to patients with malignant neoplasms of inaccessible sites.

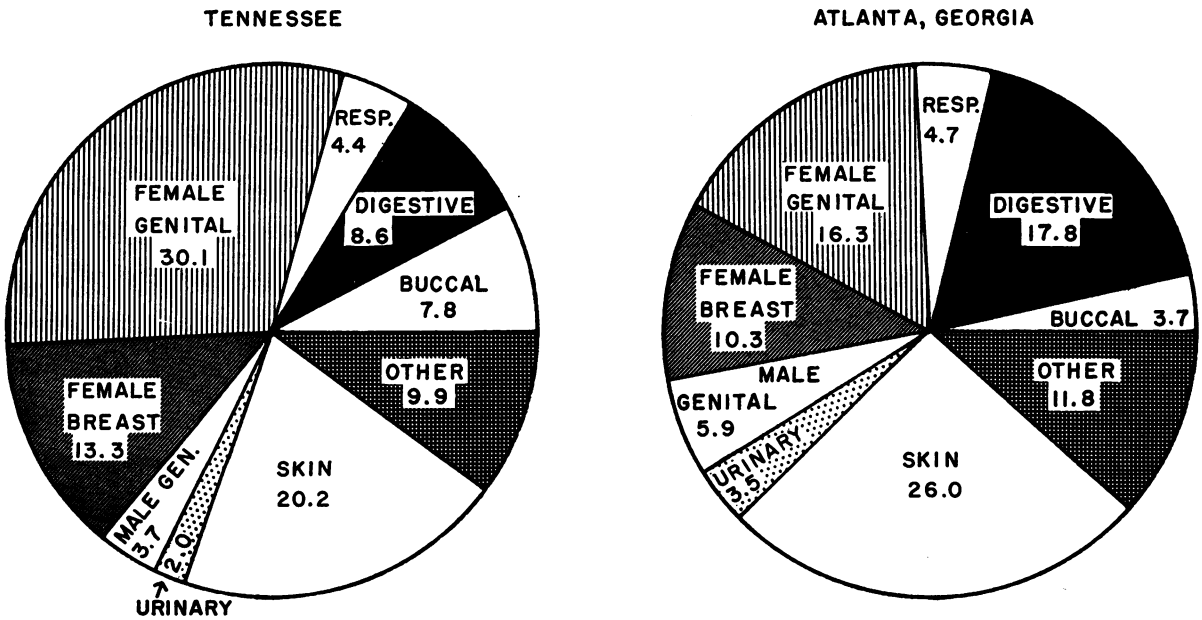


**Figure 5. Percentage of cases of malignant neoplasms according to site for six tumor clinics in Tennessee, 1950, and for the Atlanta, Ga., area 1947.**

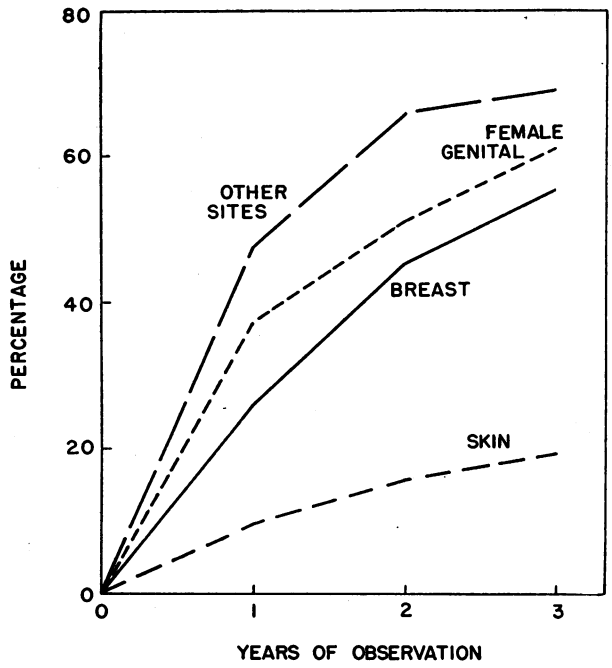


**Figure 6. Mortality during 3 years of observation of patients with malignant neoplasms admitted in 1947 to five tumor clinics in Tennessee, by site.**

Health education is also needed to get patients to clinics when lesions are localized. The analysis of the life experience provides a method of studying the treatment and behavior of malignant neoplasms of the different types and sites. Combining the experience of different cancer clinics with careful follow-up of patients through clinics and health departments will provide the medical profession, as well as health officials, with accurate data regarding survival of patients.

## Summary

Several examples have been given of the application of statistical analyses to planning, operating, and evaluating different types of health services. Applications in five fields—birth registration, crippled children's service, speech and hearing program, industrial hygiene, and cancer statistics—show various ways statistical analyses serve in health programs. The statistical program is an integral part of all health programs for we need data for definition of problems and guidance of programs. Since the programs vary, each health department must decide how statistical analyses can be applied to specific problems. Because of the variety in the applications and the continually changing problems, statistical work provides an unusually challenging field of work.

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