An Inexpensive Methodology
for Immunization Surveys

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AN INEXPENSIVE methodology for performing accurate immunization surveys has been developed by the Tennessee Department of Public Health. It is described here in sufficient detail to enable public health agencies to perform such surveys even if they have limited personnel and limited access to consultants and libraries.

Approximately half of Tennessee's population of 4 million lives in 4 metropolitan areas; the

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other half is distributed throughout the State. All 95 county health departments in the State provide some scheduled clinic time for immunizations. In the past, however, the information that we collected from these county health departments provided only the age and race distribution of the children given immunizations by each local health department. Although this distribution is helpful, it can be misleading because each department gives immunizations to nonresidents, and children in each geographic area receive some immunizations from providers other than the local health departments. Thus, we still needed to know what the immunization levels were in any given county.

Therefore, we in the Tennessee Department of Public Health decided to conduct county-specific immunization surveys of 2-year-olds. We knew that by applying sound sampling techniques and by accounting for all children in the sample, the survey could provide the information we needed. Once a survey was completed, we wanted to be able to state with predefined accuracy the immunization levels and sources of immunizations of 2-year-olds. We also wanted to see if it was possible to preselect from birth certificate information those children likely to be unimmunized by certain characteristics of their mothers and to see if we could spot clusters of unimmunized children in geographic areas so that we could focus our immunization resources in those areas.

We hoped that when the data collected showed an unacceptable percentage of unimmunized children, we could implement special immunization programs in those areas that had refused us permission to carry out such programs in the past. The basis for the refusal had often been a disagreement over what the immunization levels in the county actually were, since we were unable to accurately estimate the activity of private physicians. The disagreement would no longer hold, we believed, when we had accurate information about the extent of the participation of the private medical community.

We decided to conduct our surveys on a county-by-county basis for two major reasons. The first reason was that, after the surveys were completed, the health officer would not be able to argue that his county was not well represented by a multicounty survey showing poor immunization levels. The second reason was that the counties differ widely in (a) number of immunizations

given per private physician per year (table 1), (b) number of public health clinic hours per population per week, and (c) percentage of target population reported immunized by county health departments (table 1).

Methodology

We developed a methodology that could be carried out by one or two persons. Our agency has limited resources and could not assign a large number of persons to this project.

The method of performing surveys of 2-year-old children in Tennessee is divided into two sections: (a) drawing the sample and preparing for the survey and (b) using the sample to obtain the immunization data.

The steps that we take to draw the sample and make it ready for use in conducting the survey are as follows:

1. The immunization section obtains from the data processing section a line listing of birth certificate information printed at random on children who will be 2 years old when we will be conducting the survey in the county. For example, we would obtain a listing of children born from January 1, 1970, through December 31, 1970, if we were going to begin our survey on January 1, 1973. These printouts contain all the identifying data we need except mothers' addresses.

2. Once we know how many children will be 2 years old at the time of the survey, we are ready to determine the size of our sample. We decided beforehand that we wanted our surveys to generate a 7½ percent precision factor at 95 percent confidence levels, assuming that the children were as likely to be immunized as they were to be unimmunized. If we were sampling the whole universe of 2-year-olds, our sample size would need to be only 178. This sample size is obtained

by applying the forumla $n = \dfrac{T^2 \times P \times (1-P)}{D^2}$

where n equals the number in the sample size, T equals the variable associated with the confidence level (designated by the investigator, usually 95 percent), P equals the expected proportion of children immunized, $(1-P)$ equals the expected proportion of children not immunized, and D equals the acceptable proportion of error. As intriguing as it might be to assess the statewide

Table 1. Immunizations given 2-year-olds by private physicians and by county health departments per year, Tennessee

County	Number of 2-year-olds	Number of private physicians	Immunizations given by—			
			Private physicians[1]		Health departments[2]	
			Number	Percent	Number	Percent
Montgomery	962	11	452	47	318	33
Greene	853	17	358	42	401	47
Rutherford	1,256	14	502	40	653	52
Putnam	657	6	223	34	263	40
Maury	692	15	194	28	415	60
Blount	1,104	17	298	27	640	58
Obion	531	15	122	23	361	68
Stewart	93	3	21	22	48	52
Madison	1,198	15	252	21	719	60
Union	162	1	28	17	104	64
Bedford	482	13	72	15	395	82
Claiborne	330	6	43	13	257	78
Macon	183	3	24	13	134	73
Robertson	496	11	55	11	397	80
Scott	329	4	33	10	227	69

[1] Includes only children who received all their immunizations from private physicians.
[2] Includes only children who received all their immunizations from the health department.

NOTE: For this table "private physicians" include both pediatricians and general practitioners.

immunization status of 2-year-olds with the sample size of 178, we would have no use for such a statewide assessment because of the wide variation among geographic areas. We obtain the needed sample size for any specific county by applying

the formula $S = \dfrac{n}{1 + \dfrac{n}{N}}$ where S equals the

sample size for the county, n equals the number needed if the universe were to be sampled, and N equals the number of resident births in the county during the year that the 2-year-olds were born.

3. Once the sample size has been determined, we adjust that number upward to allow for those that we expect to have moved. Our experience and the experience of school systems allow us to make this adjustment.

The children in the sample are selected by dividing the sample size into the number of 2-year-olds in the county; this gives us the number of records skipped between those picked from the line listing. For example, in a county having 1,500 age 2 children where it is determined that a sample of 150 is needed, every 10th record would be taken. For the first record, a number from 1 through 10 would be drawn at random, and then every 10th record after the first one would be

taken. An Immunization Survey Data Form is then completed on each child selected from the line listing for the survey.

The information on the data form includes the birth certificate number, date of birth, and the county of birth if it is different from the county of residence. The sample is then placed in numerical order, based on the birth certificate number, to make it ready for the next step. At this point, one person has spent 2 full hours on the survey.

4. The sample forms are then taken to the vault containing original birth records, where the following information is obtained: mother's name, including her maiden name; father's name; address; race; mother's educational level; number of other siblings in the family; the month prenatal care began; and the number of prenatal visits.

The sample is then screened against the infant death register and the infant adoption register for the county to be surveyed, and those found on either register are removed from the sample. If the number of forms removed from the sample as a result of death or adoption is larger than anticipated, the child following the one originally selected from the line listing is included in the sample. We check the quality of samples by comparing the percentages of white and nonwhite children in the sample with 1970 census data. So

far we have never drawn a sample which varied more than 2 or 3 percent from the census data.

5. The survey forms are then taken by our secretarial staff to the South Central Bell Telephone Company offices in Nashville, where telephone numbers are checked. The company's offices in Nashville maintain listings for all of their districts in the State and make them available for our staff's use. The secretaries first check for a listing at the address given on the birth certificate under the father's name, and, if none is found, the mother's maiden name is checked. This procedure provides us with telephone numbers for about one-half of the families before we go into the county.

6. The last action required before conducting the survey is obtaining detailed maps from the Tennessee Department of Highways of the area to be surveyed. These detailed maps make finding the houses where the children live both easy and fast.

In advance of actually collecting the data, local newspapers and television and radio stations are notified that the county is to be surveyed, and a picture of the person conducting the survey appears in the local newspapers. We feel that this helps to prepare the citizens for strangers knocking on their doors. At least to this date no one has refused to give us information.

The following are the steps in actual data collection:

1. The person conducting the survey arrives at the health department early on a morning when the immunization records are not going to be in heavy use. Each sample form is checked against the health department records, and when a record is found, the immunization status of that child is recorded on the form. Only forms containing current information are labeled complete. The proportion of 2-year-olds who have current immunization records at the health department has ranged from a low of 40 percent to a high of 77 percent. This check of health department records usually requires about 3 hours for one person to do.

2. Incomplete forms are separated into those with and those without telephone numbers.

3. The surveyor then calls the mothers of 2-year-olds for whom telephone numbers have been obtained. Immunization information is noted on the form during each telephone interview, and the form is then labeled compete. When the sur-

veyor cannot reach a mother by telephone during the day, he calls again after 7 pm. The evening calls are more often successful than not.

4. When forms are incomplete, home visits must be made to collect the data. The surveyor (who is usually a field representative, a position which requires a bachelor's degree and 4 years of experience) usually takes one of the detailed maps and plots the sample having incomplete forms with the help of the public health nurse or sanitarian, or both. When the sanitarian or nurse does not know a location on the map, the surveyor requests assistance from post office stations. This assistance has been valuable to us in all surveys and has reduced considerably the time it would take to do the surveys. By having the sample previously plotted on the detailed maps, the surveyor is able to keep the time spent in the field getting from place to place to an absolute minimum.

When a surveyor visits a mother, he inquires about the immunization status of the child in the sample and tries to verify the data collected from the mother by looking at any records she has. If the surveyor discovers that the child is not adequately immunized, he informs the mother about the county health department's next immunization clinic.

When the surveyor fails to find someone at the address shown on the form, it is his responsibility to determine if the family has moved elsewhere in the county or is no longer living in the county. Surveyors check for addresses with agencies such as the electric, water, and gas companies, or refuse collection organizations. When the field investigation part of the survey has been completed, the records on the whole sample are complete. For the surveyor to leave the county at the end of the survey, each child in the sample must fall into one of three categories: (a) known immunization status, (b) known to have moved outside the county, or (c) known to be dead.

In summary, by carefully planning the work and making total use of all available time, two persons can conduct a survey in a county by working 2 full days and 1 night. This means that the whole survey, drawing the sample and gathering the data, can be done by two people in 3 days, or by one person in 5 days. The 5 man-days cost $165. Getting the survey done quickly, with no loose ends remaining, has impressed the health officers whose counties we are surveying. The

process itself seems to make them realize that we know what we are doing. As a result, they readily accept the data that we get from the surveys.

Results

The surveys have provided all the information that we had originally hoped for. We have been able to (a) determine accurately the immunization levels of 2-year-olds, (b) determine the sources of the immunizations, (c) spot clusters of unimmunized children in a defined geographic area, and (d) conduct special immunization programs as a result of the surveys.

Since we did not know the immunization status of those 2-year-olds who migrated into a county, we could assume that all of them were not immunized, that they were immunized the same as the rest of the county, that their immunization levels were the same as those achieved by the health department throughout the State, that they were the same as those found in the county surveyed that had the worst immunization levels, or that they were fully immunized.

After testing the foregoing assumptions, as shown in the following example for Rutherford County, we chose the assumption that in-migrant children were immunized the same as the rest of the county.

Assuming that in-migrants' immunization status was—	Percent immune to measles
Same as survey sample	82
Not immunized	70
Same as State average	78
Same as worst county surveyed	78
Fully immunized	84

We discovered that immunization status makes little difference unless one assumes a fully immunized or a fully unimmunized status of children moving into a county.

After the survey data are tabulated, they are sent to the county health officer with our recommednations for special programing. Additionally, the unimmunized and inadequately immunized are plotted on a map of the county, and this information is used in locating clinic sites for special immunization programs as well as for helping us make decisions on where to focus our surveillance efforts.

The sample data are also tabulated in such a way that we can relate immune status to certain characteristics of a mother, such as her educational level, the number of other siblings in the family, the month prenatal care began, and the number of prenatal visits, as shown in table 2. The data from Rutherford County do not show the expected large difference in education or prenatal care level between immunized and nonimmunized children.

Conclusion

Immunization surveys can be completed for an entire county of any size during 5 man-days. The prevalent myth that surveys require an army of statisticians and surveyors is discredited. Data obtained from the immunization surveys have identified unmet immunization needs and stimulated action to meet the needs. The methodology described in this article can be adapted to most geographic areas where birth registration is nearly complete.

Table 2. Rutherford County immunization survey of 2-year-olds, October 1972

Immunization status	Educational level of mother (years)	Number of other siblings	Mean month prenatal care began	Mean number of prenatal visits
Completed all immunizations	11.73	0.73	3.76	8.84
Immunized by private physician	13.08	.48	3.61	8.80
Immunized by private physician and health department	11.20	1.60	3.10	9.40
Immunized by health department	10.47	.81	4.04	8.77
Did not complete all immunizations	11.16	1.75	4.47	7.34
Incomplete DTP and oral poliomyelitis, no measles or rubella	10.86	1.71	4.50	7.07