

# Journal of Public Health

*This report describes a rapid survey technic designed to obtain data for comparison of polio immunization levels among subpopulation groups in an urban community. The authors discuss how such a survey can be most usefully employed by the health officer and others concerned with polio immunization.*

## **THE CDC QUOTA SAMPLING TECHNIC WITH RESULTS OF 1959 POLIOMYELITIS VACCINATION SURVEYS**

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**S**TUDIES<sup>1-3</sup> of 1958 poliomyelitis outbreaks brought into sharp focus recent major changes in attack rates by race and socioeconomic status. An epidemiological pattern of high concentration of paralytic cases among young children living in poor socioeconomic conditions was observed in Detroit, urban areas of northern New Jersey, and mining camp localities of Virginia and West Virginia.<sup>4</sup> In Detroit, cases were concentrated in the central sections of the city, areas with a large Negro population and much crowding. Prior to 1956, from 10 to 20 per cent of poliomyelitis cases had occurred among the Negro population, but in 1956 and 1957 the percentage increased to approximately 40 per cent and in 1958 to 60 per cent of total cases. Only a small

part of the increase could be associated with the growing Negro population of the city. During the same year similar observations were made of poliomyelitis outbreaks in urban areas of New Jersey and in mining camp areas of Virginia. In the Virginia outbreaks the population was chiefly white, but paralytic cases were concentrated among very young children. A possible explanation of the unusual character of these outbreaks—a concentration of cases in young children living in depressed conditions—was a relatively low rate of artificial immunization in relation to other subpopulations of the epidemic areas. If this hypothesis were correct, it was quite probable that conditions in many urban areas were conducive to explosive outbreaks which could produce high attack

rates among unvaccinated preschool children. At this time, even in areas where outbreaks were occurring, there were no means to determine poliomyelitis vaccination rates according to the necessary classification: age, race, and socioeconomic status.

It was decided therefore to develop an urban survey technic of the following nature:

1. The general approach should be epidemiological with an urban area classified into geographical subareas according to socioeconomic, racial, and cultural characteristics and with estimation of immunization rates for each subgroup as the primary objective of the survey design.

2. Needs for technical assistance should not be extensive, advance planning brief, and analysis prompt and simple.

3. Interviewers would have to be provided from the regular health department staff.

Each population subgroup was to be treated as an independent unit in estimating immunization rates. Estimation of an average rate for the entire urban area was rejected as an important factor. Also, comparison of results from one city with those of another was considered of trivial importance. Therefore, considerable flexibility was permissible in the design of individual surveys to answer questions of importance to a particular city.

A pilot survey was conducted in the city of Atlanta in November, 1958, a manual of operations<sup>5</sup> was prepared, and in January, consultation with the Statistics Section staff of the Communicable Disease Center was made generally available, through the Public Health Service's regional offices, to cities wishing to conduct an immunization survey. The response was immediate. From May through June, consultation was given to 36 cities located in all parts of the country. The method proved adaptable to a broad variety of conditions. To focus attention on specific problems, a survey of one city is described here in some detail.

## The Boston Survey

A survey of the city of Boston was conducted late in March, 1959. In its general plan, it typifies a number of surveys conducted in cities ranging in size from a hundred thousand to a million in population. The city of Boston and the Massachusetts State Health Department provided epidemiological guidance, clerical assistance, interviewers, maps, forms, and other assistance. Technical guidance was provided by the Communicable Disease Center. The schedule of operations was as follows:

Monday, March 23: Planning sessions with local groups

Tuesday, March 24: Final definition of plans

Wednesday, March 25: Location of primary sampling units and preparation of an interviewer's manual of instructions

Thursday, March 26: Field examination of primary sampling units in certain sections of the city

Friday, March 27: Preparation of itinerary with map and listing of sample points for each interview team

Monday, March 30: Assembly of interviewers' kits and general review of plan

Tuesday, March 31: Briefing of interviewers and commencement of field work

Wednesday, April 1: Completion of field work and tabulation of Tuesday's returns

Thursday, April 2: Completion of tabulations and field call backs

Friday, April 3, a. m.: Preparation of report  
p. m.: Review of report with Health Department

In 1950, the city of Boston had a population of approximately 800,000. Originally comprising only a group of small villages surrounding Boston Harbor and the Charles River, the city limits now also include a considerable adjacent area.

An initial classification of the city into subpopulations was based on a rank index constructed from 1950 census data which provided measures of crowding, sanitation, and education by census tract. After the tracts had been ranked by these criteria, they were classified

into three groups, "upper socioeconomic" including the 25 per cent of the tracts with highest ranks, "middle socioeconomic," including the central 50 per cent of the ranks, and "lower socioeconomic" including the 25 per cent of the tracts with lowest ranks.

Within these broad groupings two subpopulations, considered as possibly differing from the general population with respect to their acceptance of the poliomyelitis immunization program, were distinguished. These were (1) a central area populated by a predominantly Negro population and (2) the "North End," the oldest part of the city in which the dominant culture of recent generations has been Italian. To the casual observer the latter area appears to be a typical slum. It was believed, however, that many families of the area remained there for sentimental rather than economic reasons and were probably of quite different character from inhabitants of other census tracts classified as lower socioeconomic.

Thus, five subpopulations with distinctive characteristics were defined. Collectively, these included the entire area of the city of Boston as shown in Figure 1.

The number of subpopulations was determined in part from the factors mentioned but also with some consideration of the number of available interviewers. These included eight nurses and eight sanitary inspectors who were to be available for two days of field work. Working in pairs, they formed eight teams. Both members of one team spoke Italian and were assigned to the North End. Itineraries for the seven teams assigned to the other four subpopulations were arranged so that each team took an approximately equal number of interviews in each subpopulation. Through this device, differences in interviewing skill were eliminated when subpopulations were compared.

Within subpopulations, primary sam-

pling units were first distributed to census tracts in proportion to the 1950 population of each tract. Within census tracts, they were located by a process of randomization. The procedure used permitted any geographic point within the census tract to have approximately the same chance of selection as any other point. When a point was thus determined, the nearest street intersection was taken as the focal point of a primary sampling unit.

The primary sampling unit itself consisted of the "arms" of an intersection, each extending a distance of one block. Four interviews, two by each member of a team, were taken at each intersection. To determine a particular dwelling unit for interview, the total number of dwelling units on both sides of the street within a one-block interval was estimated by the interviewer and then a particular dwelling unit was selected by use of a table of random numbers. Substitutes were not permitted. When no one was at home, a special call-back form was left by the interviewer. Call backs were completed by telephone when possible. If not, one field call back was made.

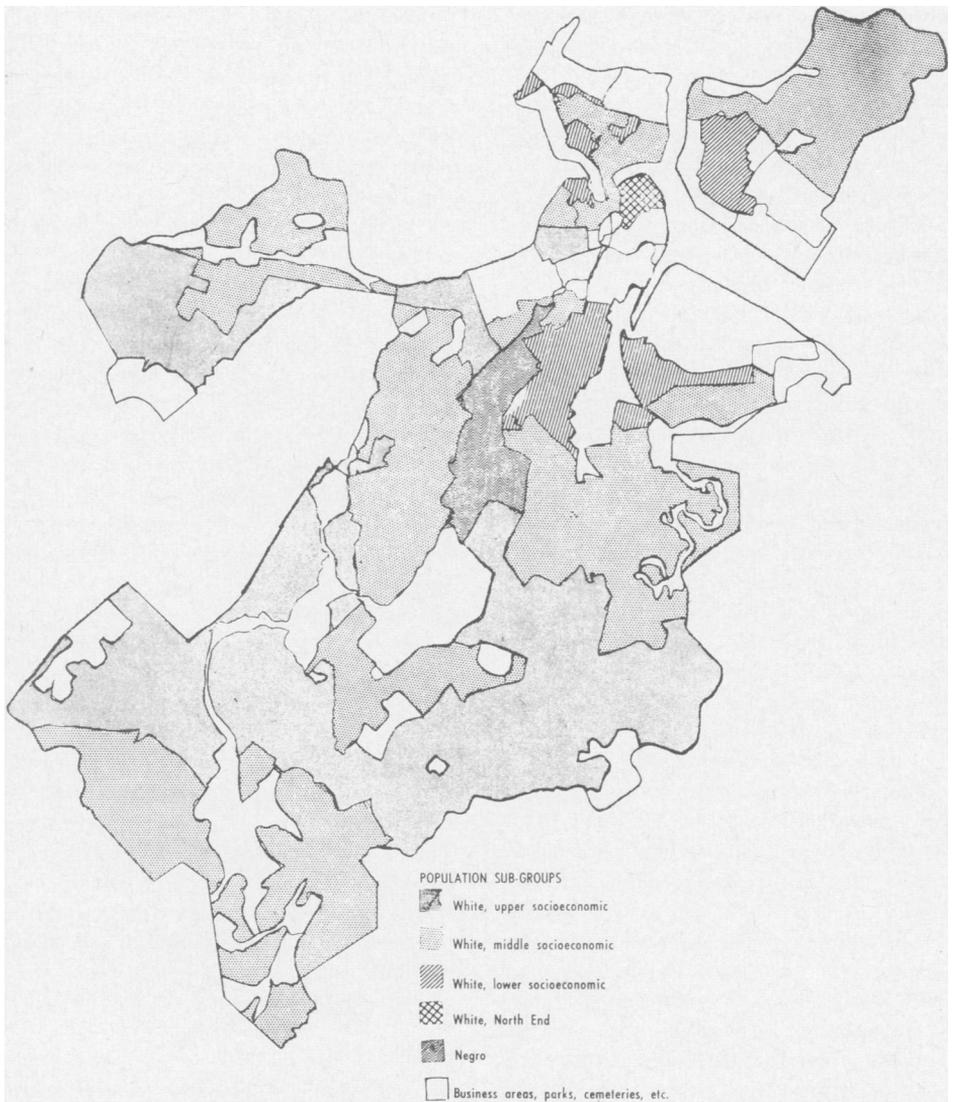
A standard interview form provided information on the number of poliomyelitis inoculations which each member of the household had received.

#### Results of the Survey

In Boston, 448 interviews were scheduled for the general population survey. Of these, 431 were completed; the remainder included 12 refusals and five incomplete interviews.

In the North End, only 54 of the 80 scheduled interviews were completed. The low completion rate was due in part to interviewer fatigue brought on by successive climbs to fourth floor flats and in part to interviews requiring more time than usual because of the sociable habits of this subpopulation.

Characteristic differences in age dis-



**Figure 1—Classification of the City of Boston into Subpopulations**

tribution of the subpopulations are evident in the larger percentage (Tables 1 and 2) of older persons in the upper socioeconomic group and the large percentage of young children in the Negro population. The North End group included a relatively large proportion of older persons and a somewhat smaller proportion of young children. Figure

2 and Table 3 present the immunization status of the sample populations. Distinct differences in immunization rates by subpopulations may be observed. The distinctly higher proportion of children under five years with three or more inoculations in the North End sample is notable when compared with other groups initially classified as lower socio-

economic. The 5-to-14-age-group showed relatively high immunization rates in all samples.

In the age-group 15 to 39 the upper socioeconomic white subpopulations appeared to be somewhat better immunized than other groups, but at ages 40 and over relatively few persons had been immunized in any of the subpopulations.

**Results of Other Surveys**

It has been previously mentioned that the Communicable Disease Center provided technical assistance on poliomyelitis immunization surveys to 36 cities during the early months of 1959. A majority of these have been reported in the weekly CDC Poliomyelitis Surveillance Unit Report. In Table 4 the cities surveyed are listed with a reference to the issue of the PSU Report containing a description of the findings. A number of additional surveys were made by State Health Department personnel who had participated in an initial survey in the state.

The general plan of the Boston survey was followed in other surveys but with appropriate local modifications. Only urban areas were surveyed, although many county-wide health departments desired to include the rural area within their jurisdiction and many rural health departments wished to conduct surveys. A modified technic adapted to this purpose has now been developed and two pilot rural surveys, one in Halifax County, N. C., and one in Jefferson County, Mo., have been completed.

For the reasons mentioned, comparison of immunization status from one city to another depends on a number of variables: modifications in local procedures, different methods for classification of subpopulations, and analysis by age in accordance with groupings of special interest to the local health departments. All these factors make intercity comparisons difficult, if not invalid.

Nevertheless, a general impression of the nationwide experience is of interest and for this purpose Figure 3 has been

**Table 1—Subpopulations and Sample Composition\***

Area	1950 Population	Scheduled Interviews	Completed Interviews			All Ages	Total Persons†			
			Total	White	Nonwhite		<5	5-14	15-39	40+
1. White, upper	252,200	104	99	92	7	355	50	63	108	134
2. White, middle	344,500	104	98	98		397	56	97	142	102
3. White, lower	73,200	104	102	95	7	368	55	104	119	90
4. North End	16,000	80	54	54		180	22	31	57	70
5. Negro	62,900	136	132	27	105	440	92	109	160	79
Subtotal	748,800	528	485	366	119	1,740	Totals by age have no valid interpretation			
6. Not included in survey	52,644									
7. Grand total	801,444									

\* Line 6, areas not surveyed, includes the central business district and the population of areas eliminated since 1950 by the urban-renewal problem.

† "Total persons" includes only white for areas 1, 2, 3, and 4 and only nonwhite for area 5.

**Table 2—Special Characteristics of the Sample Populations**

Area	Persons	Per cent Under 5	Per cent Over 40
	Per Household		
White, upper	3.9	14.1	37.7
White, middle	4.1	14.1	25.7
White, lower	3.9	14.9	24.5
North End	3.3	12.2	38.9
Negro	4.2	20.9	18.0

prepared. This shows results for the white population classified by socioeconomic level and age-group according to the proportion of persons having received three or more poliomyelitis inoculations. Findings are given for 26 cities which used the same age-grouping as the Boston survey. The cities included are marked with an asterisk in Table 4.

In general, results followed a pattern similar to that shown by the Boston survey. This is emphasized by the horizontal dashed line in Figure 3 indicating the median value for each age and socioeconomic group.

The age-group under five is of smallest sample size in all cities and hence exhibits the greatest degree of inherent sample variation. However, it is of interest to note that the highest immunization rates in lower socioeconomic groups rarely approached the lowest rates for upper socioeconomic levels.

In the age-group 5 to 14 a considerable difference in variability by socioeconomic level may be observed. This is believed to reflect differences in school immunization programs.

In the age-group 15 to 39 the general pattern is similar to that in the group under age five. In the 15 to 39 group, sample sizes were considerably larger than in the under-five group, and, hence, a greater portion of the variability may be attributed to differences among cities

in availability of clinics, prevailing medical practices, and recognition of a need for immunization by older persons.

### Practical Results of the Surveys

In Boston the survey findings were considered a major factor in winning support of the three local medical societies for mass immunization through dollar clinics. Some 30 such clinics were established at strategic points easily accessible to those populations found to be poorly immunized. Over 30,000 inoculations were given in a first series of clinics and approximately the same number in a similar group of clinics held a month later for second inoculations. The governor of Massachusetts designated May as poliomyelitis vaccination month and appeared on both radio and television to urge everyone to be immunized.

In other cities, community interest and activity were manifested in a variety of ways. In St. Paul, Minn., during the summer months, clinics were established in community centers and neighborhood libraries. In Columbus, Ohio, a door-to-door campaign was conducted by a "Mothers' March" with a goal of 40,000 inoculations by July.

In Providence, R. I., the activity following the survey gave rise to the establishment of immunization clinics in satellite towns and communities not included in the survey.

In Dallas, Tex., nine new clinics were inaugurated, seven in local church buildings. In Houston, an "Operation-Polio-Mobile" was conducted by the Junior Chamber of Commerce which enrolled 17 civic organizations and 19 commercial establishments as participants in the project.

In the small town of Casper, Wyo., where no local health department existed, clinics were set up by the local medical society following a survey conducted by the State Health Department

in cooperation with the local chapter of the National Foundation.

In general, radio and television stations as well as local newspapers contributed time and space generously to the local poliomyelitis immunization programs.

**Discussion**

In reviewing the field experience, it may be said that the objectives of swift initial planning, simplicity in field procedures, and rapid analysis have been shown feasible.

The general validity of the results have met the test of careful scrutiny by seasoned health officers and epidemiologists. In this practical sense no important biases have been found in the method. Nevertheless, it should be stressed that there are two inherent biases in the procedure which, although apparently not serious in the present application, might be of concern if the method were applied indiscriminately.

Specifically, both the procedure for selection of primary sampling units within census tracts and the procedure for selection of a dwelling unit within primary sampling units have the effect of giving a dwelling unit in a sparsely populated area a greater probability of entering the sample than one in a densely populated area.

Since census tracts are laid out with the purpose of obtaining reasonably homogeneous units, the socioeconomic characteristics of dwelling units within them tend to be somewhat independent of variation in dwelling unit density. Similarly, at a street intersection, there is commonly a similarity in the pertinent characteristics of nearby families.

However, particularly in large cities, extreme exceptions may occur. In certain transition areas high-rental apartment dwellings may be found cheek-by-jowl with dilapidated dwellings inhabited by a depressed population. Likewise, newly constructed housing projects may have a quite different population

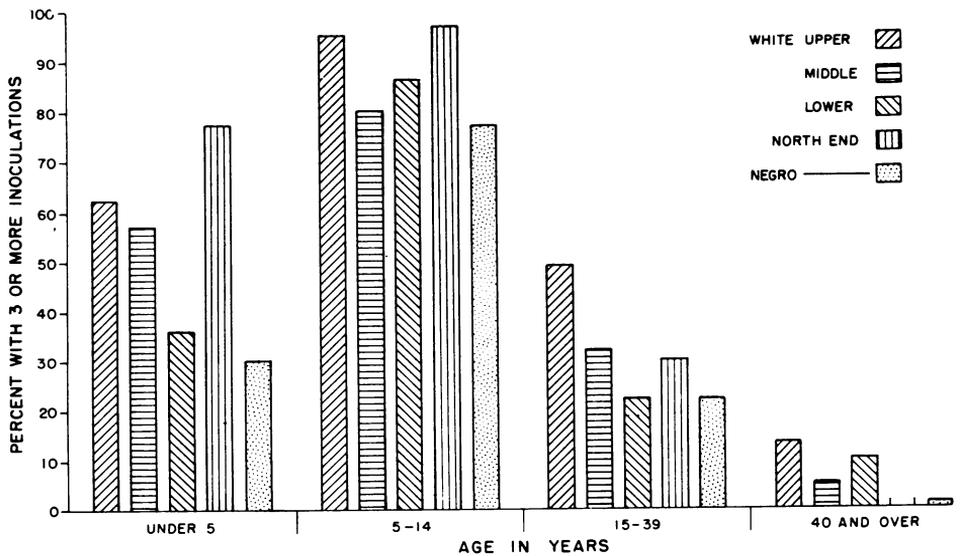


Figure 2—Results of the Boston Poliomyelitis Immunization Survey, by Age and Sub-population

**Table 3—Sample Findings on Poliomyelitis Immunization Status in Boston, April, 1959**

Age Group	Sub-population	Total Persons	Number of Persons by Number of Inoculations						Per cent Reporting:	
			0	1	2	3	4	Unknown	3+	0
Under 5	White, upper	50	6	3	10	31	—	—	62	12
	White, middle	56	14	1	9	30	2	—	57	25
	White, lower	55	25	4	6	20	—	—	36	45
	North End	22	3	1	1	17	—	—	77	21
	Negro	92	47	4	13	28	—	—	30	51
5-14	White, upper	63	—	1	1	56	4	1	95	0
	White, middle	97	5	4	7	75	3	3	80	5
	White, lower	104	1	2	9	89	—	3	86	1
	North End	31	1	—	—	30	—	—	97	3
	Negro	109	7	3	8	83	1	7	77	6
15-39	White, upper	108	31	1	13	52	1	10	49	29
	White, middle	142	56	10	14	45	1	16	32	39
	White, lower	119	61	8	11	26	—	13	22	51
	North End	57	33	2	4	17	—	1	30	58
	Negro	160	91	10	13	35	—	11	22	57
40 and over	White, upper	134	106	4	4	16	1	3	13	79
	White, middle	102	89	1	1	5	—	6	5	87
	White, lower	90	73	2	—	9	—	6	10	81
	North End	70	69	—	1	—	—	—	0	99
	Negro	79	66	1	2	1	—	9	1	84

than in nearby areas. In the present surveys, such problems have been met by field inspection of primary sampling units in questionable areas with appropriate adjustment when necessary.

In conclusion, a few remarks on the usefulness of local surveys may be worthy of brief mention. A question may be asked whether a local immunization survey should be conducted at all. Certain figures on immunization are available from national surveys. These indicate a socioeconomic gradation in the extent of immunization.<sup>6</sup> Furthermore, a consistent pattern of immunization deficiencies has been shown repeatedly in city after city through the present surveys. Cannot a health officer assume that the same pattern prevails in his own community and initiate an immunization program on this assumption?

This is certainly possible, but, even

though a health officer may suspect that his local problem is similar to that of other cities, most of the evidence he can readily obtain is likely to point in a different direction. His sources of information are his own program activities and the experience of local physicians. If he inquires, his child health centers will correctly inform him that it is standard practice to immunize all children in families availing themselves of the clinic resources. Pediatricians will tell him that they routinely immunize all children in their practice and parents as well, when it is indicated. School surveys may indicate a fairly high immunization rate.

Health officers are of course aware of the defects in the sources of information mentioned and usually suspect quite accurately where their problems lie. The real problem is to convince other local

groups to expend time and money in situations where the health officer lacks data to demonstrate the accuracy of his conclusions.

A local survey of the type described yields data which makes the problem apparent to all and provides a base from

which the community momentum necessary for a vigorous program develops rapidly. The impact of information specifying a community's particular problem greatly exceeds the force of argument based on analogy with other areas.

Table 4—Poliomyelitis Immunization Surveys in 1959<sup>1</sup>

State	City	Date of Survey	Poliomyelitis Surveillance Report Number	Publication Date	Surveys Included in Figure 3
Calif.	Long Beach	March	167	May 1	*
	Los Angeles	April	174	July 13	*
	Oakland	March	168	May 15	*
Colo.	Denver	February	163	March 6	*
District of Columbia		March	167	May 1	*
Ga.	Atlanta	(November, 1958)	160	(December 5, 1958)	*
Ill.	Chicago	May	175	July 17	*
Iowa	Des Moines	July	178	August 7	*
Kan.	Wichita	June	171	June 19	*
Ky.	Lexington	March	165	April 3	*
La.	Monroe-				
	W. Monroe.	May	170	June 12	*
	Lafayette	May	170	June 12	*
Mass.	Boston	April	168	May 15	*
Mo.	St. Louis County	September	Unpublished		
	Jefferson County	October	Unpublished		
Minn.	St. Paul	April	169	May 29	*
N. M.	Albuquerque	May	182	September 4	
N. C.	Halifax County	September	188	October 16	
N. Y.	New York	January	176	July 24	
	Rochester	April	181	August 28	
	Syracuse	April	181	August 28	
Ohio	Columbus	February	166	April 20	*
Okla.	Oklahoma City	May	177	July 31	*
	Tulsa	May	183	September 11	*
R. I.	Providence	June	179	August 14	*
Tex.	Dallas	June	180	August 21	*
	Ft. Worth	May	180	August 21	*
	Houston	May	Unpublished		*
Utah	Salt Lake City	March	168	May 15	
Va.	Richmond	March	172	June 26	*
	Danville	March	Unpublished		*
	Fredericksburg	April	Unpublished		*
	Harrisonburg	April	Unpublished		*
	Radford	April	Unpublished		*
	Hampton	April	Unpublished		*
	Casper	April	173	July 6	*

<sup>1</sup> The surveys listed were conducted with technical assistance from Statistics Section, Epidemiology Branch, Communicable Disease Center. Additional surveys have been conducted by state and local health departments.

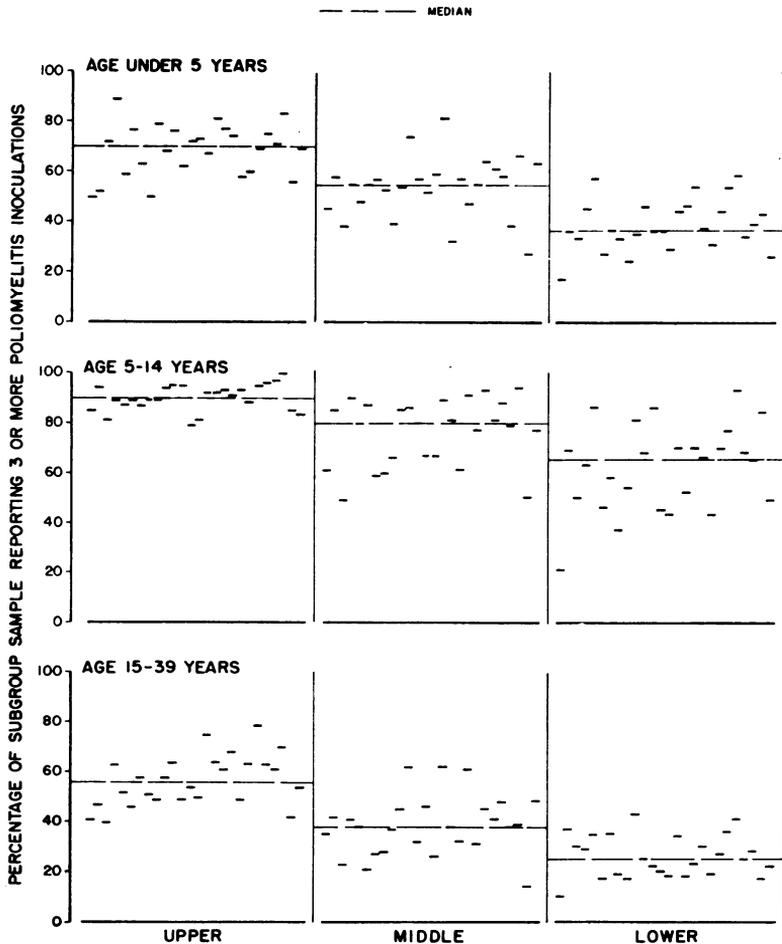


Figure 3—Poliomyelitis Immunization, by Age and Socioeconomic Subgroup: 26 U. S. Cities, January-June, 1959

### Summary

A poliomyelitis immunization survey technic designed for rapid execution and analysis, simplicity of field procedures, and minimal training of interviewers is described. The objective is comparison of appropriate subgroups within the population of a given city. It is not recommended for estimation of city-wide averages or for comparison of results for one city with those of another.

Certain biases are encountered in allocation of primary sampling units

to census tracts and in selection of households within primary sampling units. When conditions of extreme heterogeneity in distribution of dwelling units occur within census tracts and within primary sampling units, careful study and exercise of sound judgment must modify routine application of the methodology.

A survey conducted in Boston in March, 1959, was described to illustrate the procedure and analysis. Similar surveys were conducted in 36 cities located in various parts of the country.

Summary results, given for 26 surveys, indicate that the problem of low immunization rates in young children in lower socioeconomic groups has been widespread.

**ACKNOWLEDGMENTS**—The writers express their appreciation to Dr. John H. Cauley, health commissioner of Boston, and to Dr. F. Randolph Philbrook, Massachusetts State Health Department, for permission to reproduce results of the Boston immunization survey. Dr. J. F. Hackney, commissioner of health of Fulton County, Ga., has been most helpful in enabling field studies of methods in Atlanta. Acknowledgment is also made to the many state and county health department officials who have made useful contributions and in particular to the nurses, sanitarians, and public health representatives who collected data from households. Mr. Walt R. Simmons, statistical advisor, National Health Survey, contributed a number of helpful comments in review of the survey plan in its early stages and CDC consultant Dr. W. J. Hall, University of North Carolina, Chapel Hill, carried out various field studies of methods in the summer of 1959. Development of a rapid survey technic was stimulated by Dr. A. D. Langmuir, chief, Epidemiology Branch, CDC.

Dr. Serfling is chief and Miss Sherman is assistant chief, Statistics Section, Epidemiology Branch; Dr. Cornell is chief of the Laboratory and Field Station Statistics Unit, Communicable Disease Center, Public Health Service, Department of Health, Education, and Welfare, Atlanta, Ga.

This paper was presented before a Joint Session of the Epidemiology, Health Officers, and Statistics Sections of the American Public Health Association at the Eighty-Seventh Annual Meeting in Atlantic City, N. J., October 21, 1959.

Other members of the CDC Statistics Section staff who provided technical guidance in field surveys include Arthur Cohen, Elmer C. Hall, Paul E. Leaverton, William S. Mallios, and Sarah F. Welch. Ernestine Tomlinson and Sarah Wingo provided assistance in many ways.

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