FREQUENCY OF IMMUNIZING AND RELATED PROCEDURES IN NINE THOUSAND SURVEYED FAMILIES IN EIGHTEEN STATES[1]

by SELWYN D. COLLINS

THERE are only three or four immunizing procedures that are widely used in the general population as active preventives that are given prior to exposure to disease. Smallpox vaccination is the oldest and most extensively used preventive procedure; Jenner vaccinated the first individual in 1796 or more than eighty years before the beginnings of modern bacteriology and immunology (14). The next of the more frequently used procedures came just one hundred years later when in 1896 the first person was immunized against typhoid fever (19). It was seventeen years later in 1913 that the first individual was injected with diphtheria toxin-antitoxin for active immunization against the disease (18), although diphtheria antitoxin for the treatment of cases and for passive immunization of contacts had been used since 1894. In 1924 the first individual was injected with scarlet fever toxin-antitoxin (15), but immunization against this disease is still in its early if not its experimental stages.

The dates mentioned above in connection with these immunizations refer to their earliest use on human beings. In every instance there was experimental work for a number of years before the procedure was applied to humans and improvement of the process after its first use. Moreover, there is always considerable lag between the first test of the procedure and its general use.

Rabies vaccination and tetanus antitoxin were among the early developments in immunology and are highly successful—they are differentiated here in that they are not used prior to exposure to

[1] From the Division of Public Health Methods of the National Institute of Health, United States Public Health Service. The author is indebted to Dr. Mary Gover for assistance in the preparation of this paper.

conditions which give rise to the disease. Cold vaccine and desensitizing treatments for hay fever and poison ivy are similarly used only for individuals who are definitely susceptible to the diseases. Whooping cough immunization comes in the category of procedures used prior to exposure but it is as yet definitely in the experimental stages.

In the matter of efficacy, ease of application, and general usefulness, smallpox vaccination undoubtedly stands at the head of the list and, as will be seen later, it is also first in frequency. Immunity is developed soon enough after vaccination and is of sufficient duration so that the same procedure is applicable both before and after exposure to the disease.

Active diphtheria immunization is rapidly becoming a contender for first place among immunizations both in efficacy and frequency. However, with the short incubation period of diphtheria, the development of immunity is too much delayed to use the procedure after exposure to the disease, but the earlier method of administering antitoxin to those exposed confers a passive immunity which gives temporary protection.

Typhoid fever immunization has been highly successful and widely used in the Army (19) and Navy (13) but not in the civilian population. The necessity for three injections in each series, and the repetition of the whole process at intervals of not to exceed three years to maintain active immunity, makes the procedure less applicable to populations not under military control.

Scarlet fever immunization has been used less frequently and there are still differences of opinion as to its efficacy and applicability for extensive use.

SOURCE AND CHARACTER OF DATA

In connection with a study of illness and medical care which was made by the United States Public Health Service in cooperation with the Committee on the Costs of Medical Care, information on

the frequency of various immunizing procedures was recorded. The data were collected through periodic calls to the homes by visiting nurses for a sufficient time to obtain a twelve-month record of illness and medical care during the years 1928-1931.

The 8,758 white families surveyed included 39,185 individuals living in 130 localities in eighteen states and represented all geographic sections of the United States. Every size of community was included, from metropolitan districts to small industrial and agricultural towns and rural unincorporated areas. The observed group was fairly similar to the general population with respect to age and sex composition, percentage native-born, and percentage married. With respect to income, the distribution was reasonably similar to the estimated distribution of the general population of the United States at the time of the survey. More details about the canvassed families are given in a preceding report (1).

Information was obtained on the history of artificial immunizations[2] and clinical attacks of smallpox, diphtheria, typhoid, and scarlet fever at any time prior to the study. For the study year a record was made for these four diseases and also for immunizations and related procedures for other diseases, including the injection of material for the prevention of cold, whooping cough, tetanus, rabies, hay fever, and poison ivy or oak. Some of these procedures are not strictly immunizations but they are all used for the prevention of specific diseases, either before exposure, as in active immunization against diphtheria, smallpox, typhoid, scarlet fever, and whooping cough, or after exposure but before the development of symptoms, as in tetanus and rabies. Injections for hay fever and poison ivy or oak are desensitizing rather than immunizing procedures but their purpose is the same. Diphtheria antitoxin administered to contacts of a case is analogous to the administration of

[2] "Immunization" is used in this paper to mean the injection of the usual number of doses of the material that is presumed to produce immunity to the specific disease; no data are available on tests following the injections to indicate whether the process actually produced immunity in the individual.

tetanus antitoxin after an accident in which the victim may have been infected with tetanus.

This paper reports on the frequency of occurrence of the various types of immunizing procedures with no attempt to appraise their effectiveness in preventing disease.

Table 1. History of immunizations and cases of certain diseases among persons of specific ages, canvassed white families in eight states.[1]

Age in Years	Percentage of Persons With History of:								Number of Persons Observed[2]
	Immunization at Any Time but No Case				Case at Any Time				
	Smallpox	Diphtheria	Typhoid Fever	Scarlet Fever	Smallpox	Diphtheria	Typhoid Fever	Scarlet Fever	
All Ages	54.4	15.8	7.53	1.97	3.05	5.30	4.26	8.83	37,859
All Ages Under 15	40.9	31.8	4.95	2.80	1.29	3.27	.61	6.90	15,342
Under 6 Months	2.1	3.6							529
6–11 Months	4.9	7.5	.33	.66	.06	.33	.06	.11	390
1	7.8	14.0	.79					.34	889
2	11.9	20.5	1.25	2.02	.33	1.50	.05	1.25	1,044
3	12.5	22.8	2.31					2.68	1,082
4	20.1	28.5	2.65	2.26	.52	1.87	.17	3.97	1,133
5	27.1	32.8	3.93					4.79	1,171
6	44.9	37.8	4.49	3.09	.95	3.09	.43	5.79	1,159
7	57.7	41.5	5.39					7.95	1,169
8	57.1	42.6	6.22	3.67	1.58	3.76	1.00	7.72	1,204
9	58.8	43.1	7.26					9.85	1,007
10	61.6	40.8		4.05	2.58	5.61		11.73	1,077
11	60.9	38.5							901
12	65.9	35.6	8.17		2.98	6.36	1.20		915
13	63.7	34.0		3.49				12.64	829
14	65.5	31.6			3.34	5.76			843
15	65.0	28.0							686
16	65.7	19.8				5.95			708
17	62.3	17.8	10.04	2.97	3.61		2.43	12.97	585
18	65.8	13.3				5.94			575
19	65.1	11.2							487
20–24	66.5	5.3	7.93	1.23	4.03	6.93	3.70	11.87	2,110
25–29	64.2	3.4	7.99		3.74	6.69	4.99		2,485
30–34	65.6	3.7	12.05	1.42	4.43	6.81	5.70	9.38	3,141
35–44	63.8	2.9	11.95		4.62	6.49	7.73		5,927
45–54	61.6	1.6	7.46		4.65	6.57	9.61		3,353
55–64	61.8	.9	4.30	.59	3.48	7.31	12.15	9.60	1,466
65 and Over	52.7	.6	1.85		4.12	8.11	10.69		994

[1] Dates of interviews varied from 1928 to 1931. Data refer to histories at the beginning of the twelve-month morbidity study.

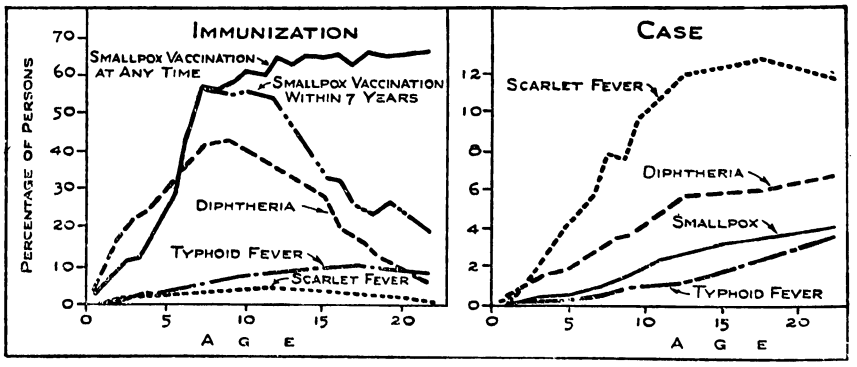
[2] The numbers observed are those known as to history of smallpox; for the other diseases there were from thirteen to fifty-two fewer persons (all ages) because of unknown histories, but in every case the percentages here shown are based on those known as to the history of the disease in question.

HISTORY OF IMMUNIZATIONS AND CASES AT BEGINNING OF STUDY

Table 1 and Figure 1 show the percentages of persons of specific ages who, prior to the study, had been immunized against smallpox, diphtheria, typhoid, and scarlet fever, together with the percentages who had suffered clinical attacks of these diseases. With the exception of smallpox vaccination within seven years, these percentages represent reports of immunizations or cases at any time in the life of the individual. The curves are therefore cumulative in nature, for a person who was attacked at two, five, or ten years is still in the attacked group at twenty years of age. The curve for diphtheria immunizations does not appear to be cumulative, but the reason for the sharp drop after ten years of age is that active immunization against diphtheria has not been widely used for more than fifteen or twenty years; since artificial immunization is rarely administered to persons over twenty years of age, those individuals who were above that age before the procedure became common have never received the injections. With the continuation of the present rates of injection, the diphtheria immunization curve will approximate the appearance of the smallpox curve when the children who were ten years old at the time of this study become twenty-five years of age.

The curve for scarlet fever immunizations declines for similar

Fig. 1. Percentage of persons of specific ages (a) who had been artificially immunized, and (b) who had suffered clinical attacks of certain diseases—8,758 canvassed white families in eighteen states, 1928-1931.



reasons to those discussed for diphtheria. The proportion of persons who had been vaccinated against smallpox within seven years also declines as age increases; most children are vaccinated at school entrance and as there are few revaccinations this curve declines rather rapidly after 12-14 years of age.

Because immunizations are largely done in childhood, the curves in this paper have been confined to the ages under twenty-five years. Table 1 includes data for the older age groups.

For the preschool ages more children had been immunized against diphtheria than vaccinated against smallpox. This is in agreement with the findings of the White House Conference study (17). However, this was true only in the preschool ages; after the age of school entrance the percentage vaccinated against smallpox was considerably greater than the percentage immunized against diphtheria.

The curves in Figure 1 cannot be taken as representing active immunity at the time of the survey, particularly in the adult ages, because: (a) Many of the vaccinations were done in childhood and never repeated; at 20-24 years of age, only 19 per cent and at 35-44 years only 11 per cent of the persons had been vaccinated within seven years. (b) Schick and Dick tests indicate that a large percentage of adults have acquired immunity to diphtheria and scarlet fever without an artificial immunization or recognized attack of the disease. (c) The immunization curves represent histories of artificial immunizing procedures only; histories of clinical attacks are shown separately in the right half of the figure.

In the older ages, histories of typhoid fever attacks are as frequent as histories of artificial immunizations. Among persons 35-44 years, 8 per cent gave a history of a case of typhoid and 12 per cent gave a history of an artificial immunization without a case; above forty-five years, 11 per cent gave a history of a case and 5 per cent a history of an artificial immunization. For smallpox, only about 5 per cent of adults gave a history of the disease as compared with 66 per cent

who had been vaccinated but had not had the disease. In diphtheria the percentage with histories of recognized attacks is also small as compared with the percentage artificially immunized and the percentage who show immunity by the Schick test. At nine years when the history of active diphtheria immunizations was at the maximum of 43 per cent, 4 per cent of the children gave a history of a recognized attack. Among adults, about 7 per cent gave a history of an attack of diphtheria. The percentage with a history of a recognized attack of scarlet fever is small as compared with the percentage who show immunity by the Dick test but is large as compared with the percentage with a history of artificial immunization. At 10-14 years of age, 12 per cent of the children gave a history of scarlet fever attacks as compared with 4 per cent for artificial immunizations.

Figure 1 represents percentages for the whole group of surveyed persons. It will be of interest to examine the percentages with a history of artificial immunization in various subgroups of the total. In Figure 2 immunizations and case histories have been plotted for cities of different sizes and for rural unincorporated areas. There is a vast difference between large cities and rural areas in the matter of smallpox vaccination, the percentage of adults who had been vaccinated being twice as high in large cities as in rural areas. The curves for small cities and towns under 5,000 fall logically between the two extremes. The history of cases shows the reverse situation, the percentage for large cities being the lowest and for towns and rural areas the highest, with no difference between the two latter categories.

The order of the typhoid fever immunization curves is the opposite of those for smallpox vaccination; rural areas show the highest and large cities the lowest percentages immunized against typhoid. In the matter of histories of attacks, towns and small cities show higher percentages than rural unincorporated areas and large cities. This situation is in agreement with the findings of

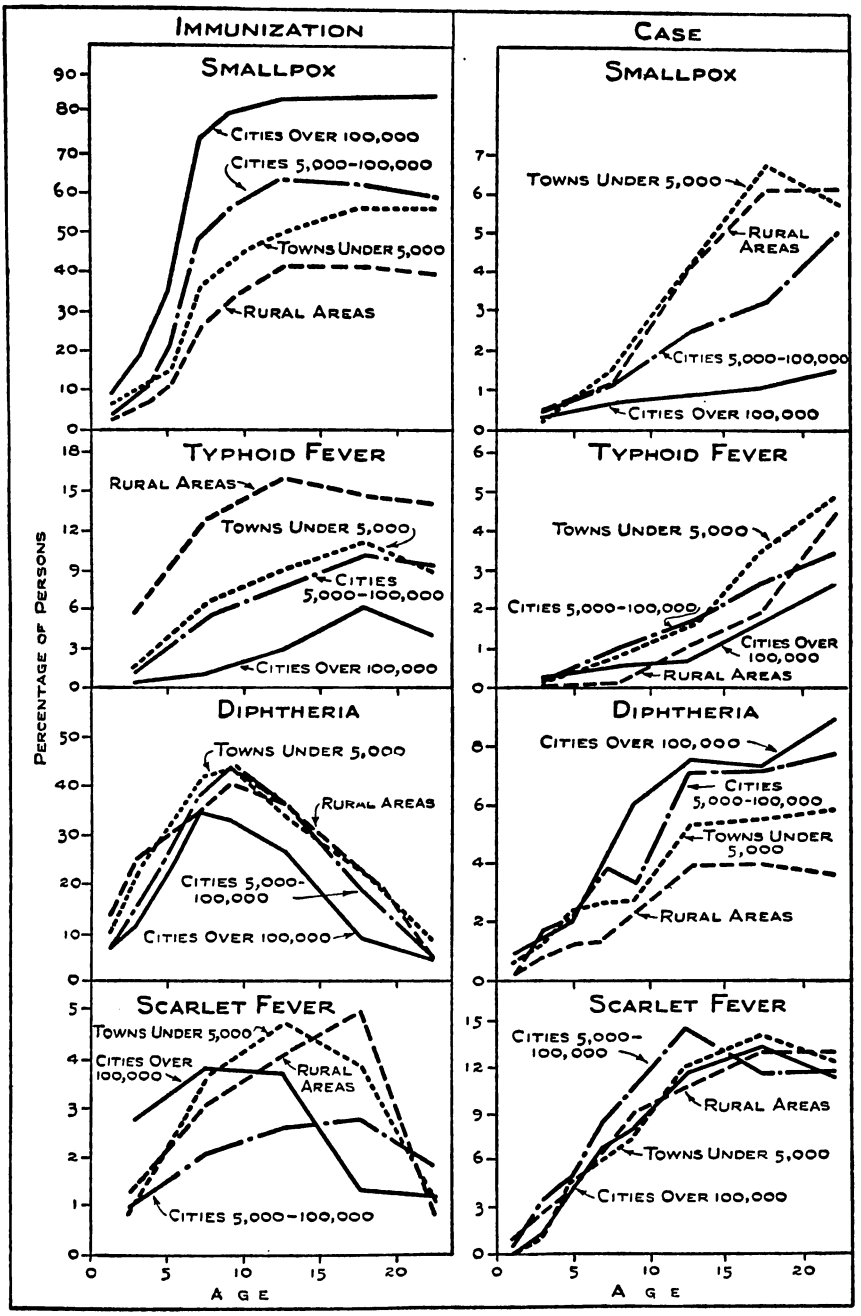


Fig. 2. Percentage of persons of specific ages in cities and rural areas (a) who had been artificially immunized, and (b) who had suffered clinical attacks of certain diseases—8,758 canvassed white families in eighteen states, 1928-1931. (New York State omitted in the diphtheria curves to obtain more comparable groups of cities and rural areas (9).

Leach and Maxcy (16) that in Alabama the lowest typhoid rates occur in rural areas and large cities.

There is not much variation with size of city in the percentage with a history of diphtheria immunization. Figure 2 shows that the large cities have low percentages, but it must be remembered that all rural areas and small towns included in the study had a health department or some other organization employing a visiting nurse. Therefore areas which are most rural and have no health work or nursing service are not represented. Referring to histories of clinical attacks of diphtheria, the large cities show the highest percentages and the smaller towns follow in logical sequence, with the lowest percentages in rural areas. However, these data were collected in the period 1928-1931 and the situations with respect to diphtheria immunizations and cases may have changed considerably since those years. Diphtheria mortality in the registration states in the years 1929-1930 was higher in large cities than in either small cities or rural areas (9). An examination of diphtheria mortality since 1915 in the states of the expanding registration area indicates that in every one of the sixteen years from 1915 to 1930 the rate in urban places (10,000 or more population) was higher than in rural areas, but in all four years from 1931 to 1934 (last available data on this point), the urban rate was below the rural. There appears to be much variation in the different states with respect to the relation of urban to rural diphtheria mortality. In general, rates for rural parts of the South seem to be higher than those for southern cities and in general rates for rural parts of the North seem to be lower than those for northern cities, but in both sections there are numerous exceptions. The situation is changing so rapidly that any generalization must be considered as more or less tentative.

Scarlet fever immunization and case histories seem to show no logical relationship to size of city.

Figure 3 shows immunizations and case histories in the four geographic areas into which the eighteen states have been divided.

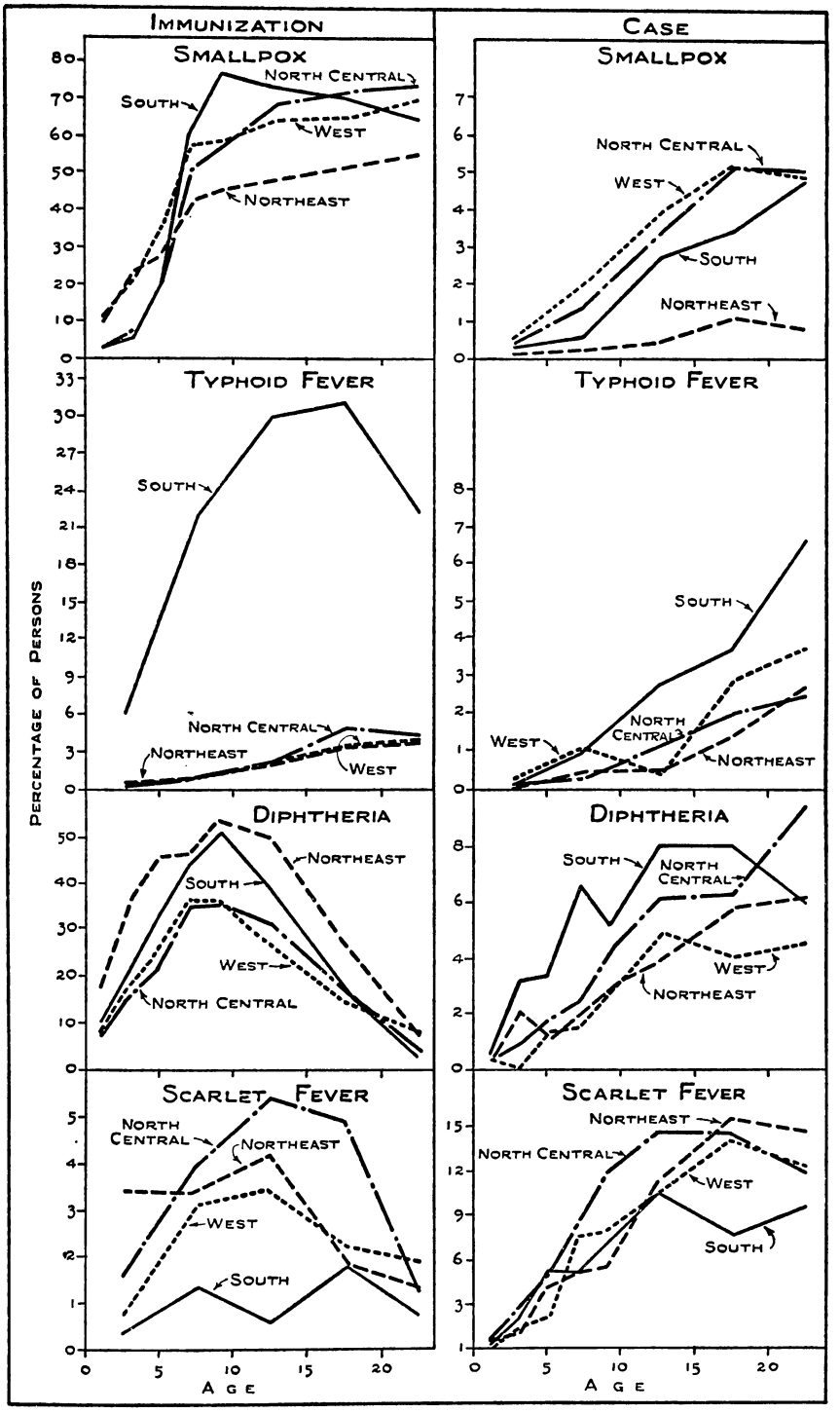


Fig. 3. Percentage of persons of specific ages in four geographic sections (a) who had been artificially immunized, and (b) who had suffered clinical attacks of certain diseases—8,758 canvassed white families in eighteen states, 1928-1931. Surveyed states in each area were:

Northeast: New York, Massachusetts, Connecticut.

North Central: Illinois, Ohio, Michigan, Indiana, Wisconsin, Minnesota, Kansas.

South: District of Columbia, Virginia, West Virginia, Tennessee, Georgia.

West: Washington, California, Colorado.

The Northeast area includes data from three New England and Middle Atlantic states, the North Central data from seven East and West North Central states, the South data from five South Atlantic and South Central states, and the West area includes data from three Mountain and Pacific states. Although there are only 18 states they appear to represent these four areas fairly well (1).

In the matter of smallpox vaccination the only striking variation is the low percentage for the Northeast area where there is very little smallpox and where one usually thinks of well-vaccinated populations. The explanation, however, is obvious when the surveyed population of the Northeast is classified according to size of city. The cities in this region are better vaccinated than those of any other section, but in the rural districts the percentages vaccinated are low. However, the well-vaccinated cities appear to protect the rural districts from the invasion of smallpox, for the percentage with a history of an attack is low in these rural areas. The highest percentage with a history of a smallpox attack occurs in the Western and North Central states with the South intermediate.

The most striking geographic difference shown in Figure 3 is the extremely high history of typhoid immunizations in the South. The South is also high in the history of typhoid cases; immunization was apparently resorted to in an attempt to control a bad typhoid situation. In the matter of case histories, the West comes next to the South but immunization has not been used extensively in that section.

The Northeast and South are high in diphtheria immunization histories and the South is also high in diphtheria case histories. Immunizations in the preschool ages are definitely higher in the Northeast than in any other section.

In scarlet fever immunizations the South is low and the North Central is high. No significant variation appears in case histories except that in several age groups the North Central is slightly above the other regions.

IMMUNIZATIONS AND CASES DURING THE TWELVE-MONTH STUDY

The record of medical care for illness and preventive service affords data on the frequency of immunizations during the twelve-month morbidity study. These data for the one year, although more accurate than the history records, may represent more frequent or less frequent immunizations than the average for a period of years.

This record for the one year of the study includes a number of

Table 2. Current immunizations and related procedures among persons of specific ages in canvassed white families in eighteen states during twelve consecutive months, 1928-1931.

Age in Years	Smallpox Vaccination	Typhoid Immunization	Diphtheria Active Immunization by Toxin–Antitoxin or Toxoid	Scarlet Fever Immunization	Whooping Cough Immunization	Cold, Influenza or Pneumonia Vaccine	Tetanus Antitoxin	Hay Fever Desensitization Injections	Diphtheria Antitoxin for Contacts	Schick Test For Diphtheria Without Immunization	Population (Years of Life)
	ANNUAL IMMUNIZATIONS PER 1,000 POPULATION PER YEAR										
All Ages[1]	31.4	4.41	12.6	.73	1.69	3.06	1.17	.65	1.56	1.22	38,544
All Ages Under 15	52.7	4.81	30.5	1.65	3.93	1.96	2.22	.51	3.17	2.91	15,796
Under 5	42.1	2.2	48.1	1.6	7.3	.5	1.8	.2	2.0	2.7	5,513
5– 9	70.3	5.1	29.2	1.7	2.1	3.0	2.3	.3	3.7	3.8	5,715
10–14	43.6	7.7	10.7	1.5	2.2	2.4	2.6	1.1	3.9	2.0	4,568
15–19	29.5	8.5	1.3			2.3	1.3	.3	1.3		3,050
20–24	15.1	3.3	.9			1.9	.5	—	.5		2,119
25–34	19.9	3.5	—	.1	.1	4.4	.3	1.2	.2	.04	5,640
35–44	12.1	4.6	—			3.9		1.0			5,930
45–54	15.5	2.7	—			4.8	.2	.5	.3		3,351
55 and Over	6.5	2.0	—			4.9					2,471
	NUMBER OF IMMUNIZATIONS										
All Ages[1]	1,209	170	487	28	65	118	45	25	60	47	

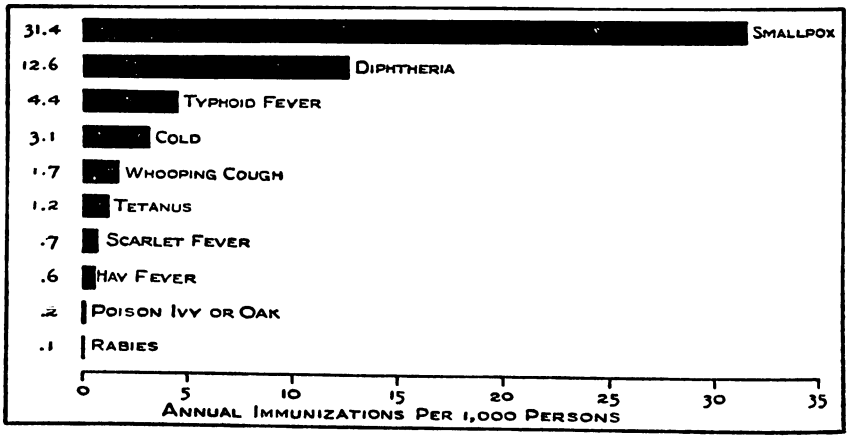
In addition to those shown in the table there were eight series of injections for poison ivy or oak which is 0.21 per 1,000 persons, and five series of injections against rabies or 0.13 per 1,000 persons.

[1] "All ages" includes a few of unknown age.

immunizing procedures not included in the data on histories. As already mentioned, procedures are here included without distinction as to their effectiveness in preventing disease—the purpose of this study was to measure their frequency and not their usefulness. Table 2 and Figure 4 show the frequency of occurrence of the various kinds of immunizations and related procedures during one year in this surveyed group of nearly 40,000 people. Considering persons of all ages, there were 2.5 times as many smallpox vaccinations as diphtheria immunizations, but among children under fifteen years the corresponding ratio was only 1.7. The frequencies of other immunizations were relatively small; it is significant that the use of cold vaccine is fourth in frequency although its efficacy is doubted by many authorities.

Figure 5 shows smallpox vaccination and diphtheria immunization rates in detailed ages to twenty years. In current injections as in histories (Figure 1), diphtheria immunizations are more frequent in the preschool ages than are smallpox vaccinations. However, smallpox vaccination rates rise sharply at the age of school entrance and thereafter continue well above diphtheria immunization rates. There are small numbers of smallpox vaccinations through-

Fig. 4. Annual rates of occurrence of various kinds of artificial immunizations and related procedures per 1,000 population under observation—8,758 canvassed white families in eighteen states during twelve consecutive months, 1928-1931.



out the adult ages but practically no diphtheria immunizations.

Figure 6 shows similar age curves in five and ten-year age groups for the less frequent types of immunization. Scarlet fever and whooping cough immunizations are confined almost entirely to children and are shown only up to twenty years. The other types are more frequent in the adult ages and the entire curves are shown. The highest typhoid immunization rates occur between ten and twenty years with a small secondary peak at forty years of age. The curve for cold vaccine rises definitely as age increases.

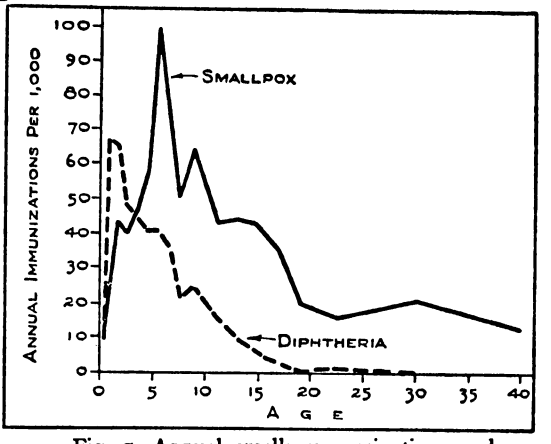


Fig. 5. Annual smallpox vaccinations and diphtheria immunizations per 1,000 persons of specific ages—8,758 canvassed white families in eighteen states during twelve consecutive months, 1928-1931. (Ages used are under 6 months; 6-11 months; single years to 8; two-year age-groups to 20; and five and ten-year age-groups thereafter.)

The use of tetanus antitoxin is confined largely to children; the maximum rate at 10-14 years is five to thirteen times the rates for the age groups above twenty years. In the morbidity study for the same period in this surveyed population there were 2,667 accidents (exclusive of poisoning) and in forty-five of them, or 1.7 per cent, the administration of tetanus antitoxin was reported. The use of tetanus antitoxin was more frequent in injuries by cutting and piercing instruments; a total of 293 such injuries were reported and twenty of them, or 6.8 per cent, were followed by tetanus antitoxin. The maximum percentage occurred for the age group 5-9 years in which 11.8 per cent of the seventy-six cutting and piercing accidents were followed by tetanus antitoxin.[3] Among the eighty-

[3] The percentage of cutting and piercing accidents that were followed by tetanus antitoxin were: under 5 years, 9.8; 5-9, 11.8; 10-14, 8.8; 15-24, 2.8; 25 and over, 1.2 per cent.

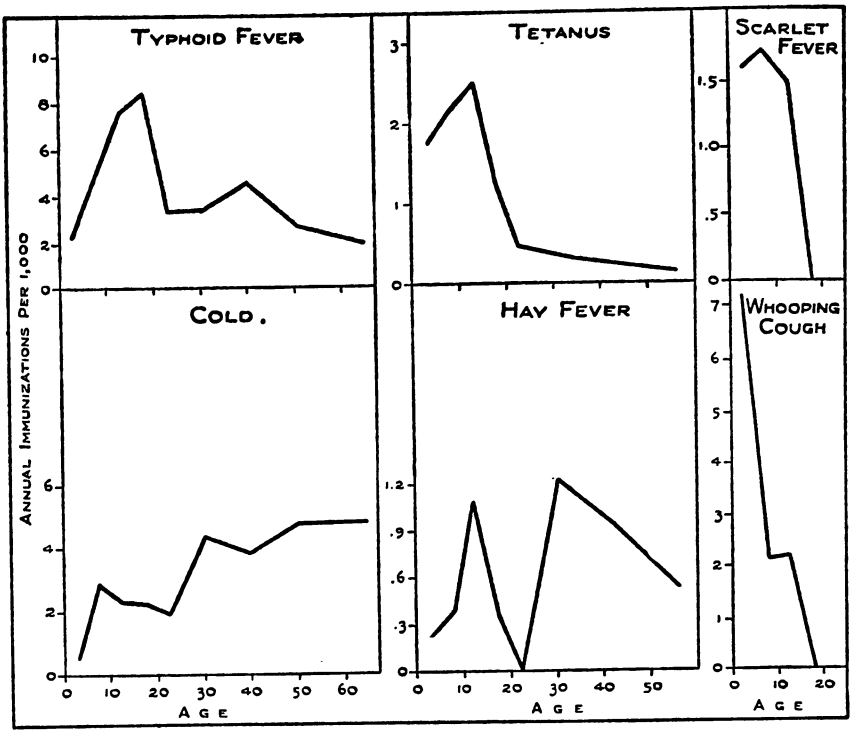


Fig. 6. Annual artificial immunizations and related procedures of certain kinds per 1,000 persons of specific ages—8,758 canvassed white families in eighteen states during twelve consecutive months, 1928-1931.

three accidents of this type for persons over twenty-five years of age, 1.2 per cent were followed by tetanus antitoxin. Many more such cutting and piercing accidents occurred among boys than girls but the percentages followed by tetanus antitoxin were not significantly different.

Hay fever desensitizing injections showed peaks of approximately equal size at ten to fourteen and twenty-five to forty-four years of age; although the numbers are small, the curve seems to be fairly correct since these two peaks correspond roughly in age to peaks in the incidence of hay fever as reported in these families during the same year (6). Desensitizing injections are given for both hay fever and asthma; 25 per cent of the seventy-six cases reported as hay fever were taking the injections, but only 4 per cent of

the 150 cases reported as asthma. Among the twenty cases designated as hay fever that were less than twenty years of age, 40 per cent were taking the injections as compared with 20 per cent among the fifty-six cases over twenty years of age. It seems doubtful whether 25 per cent of hay fever victims actually take desensitizing injections; it is probable that the enumerators who canvassed the families were more likely to receive a report of hay fever if the patient were taking injections than if no such treatments were being given.

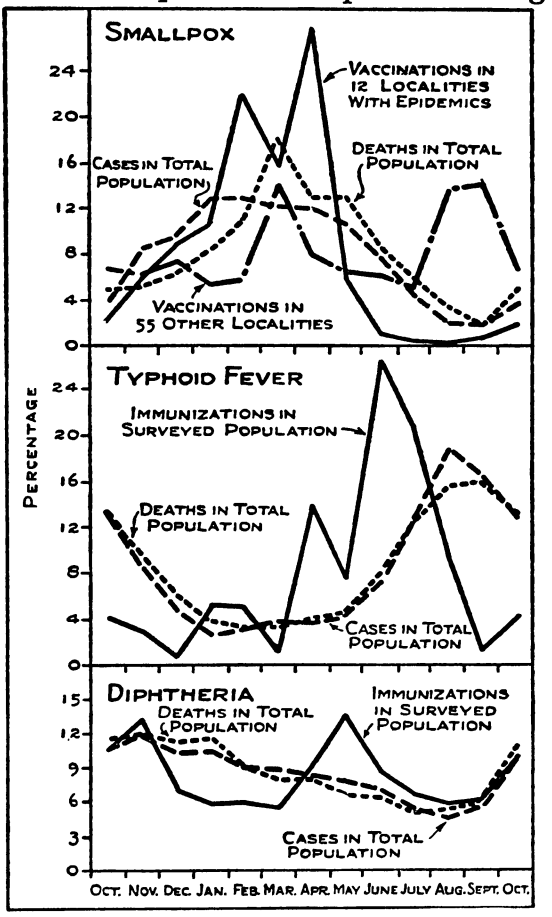


Fig. 7. Percentage of artificial immunizations, of clinical cases, and of deaths for smallpox, typhoid, and diphtheria in each month (thirty-day basis)—immunizations in the surveyed families in eighteen states, 1928-1931; cases and deaths in the total population of the eighteen surveyed states, 1929-1930.

Figure 7 shows from data for the general population of the eighteen surveyed states (11, 12) the seasonal curve of smallpox, diphtheria, and typhoid fever cases and deaths in terms of the percentage occurring in each month, with adjustment to a thirty-day basis. Along with these curves are similar ones for immunizations in the surveyed population. For smallpox vaccinations there is a curve for twelve localities which reported a large number of vaccinations in the face of actual or threatened epidemics, and an-

other for fifty-five localities which reported few vaccinations. Smallpox vaccinations were greatly concentrated in those localities that had actual or threatened epidemics, 74 per cent of them occurring in twelve such localities. In Figure 7 it is seen that the great majority of vaccinations in these communities came at the high season of smallpox cases and deaths. In the fifty-five localities with few vaccinations there was also a peak of vaccinations at the season when smallpox was prevalent but equally high percentages for August and September which must represent preparation for school entrance. The season of high incidence of smallpox cases and deaths is January to April.

There is little or no evidence of the extensive use of typhoid fever immunization in the face of epidemics. However, there is a definite peak in the frequency of immunizations in June which may be in preparation for the vacation season but more probably represents the time when health departments urge the use of the procedure. The high typhoid season comes in August and September.

The high season for diphtheria cases and deaths is October to January. There is a peak in diphtheria immunizations in November but it is largely due to a single community, whereas the peak in May is the result of immunizations in many communities. Apparently the seasonal incidence of the disease has little to do with the month of immunization against diphtheria; the late spring seems to be the favorite time selected by health departments for diphtheria immunization work.

The high season for scarlet fever cases and deaths is January to April. There were only twenty-eight scarlet fever immunizations during the study year so no attempt was made to determine the usual seasonal distribution of the procedure.

Figure 8 shows the percentage of immunizations of different kinds that were done in public clinics. Diphtheria stands at the top with 57 per cent, typhoid next with 52 per cent, smallpox with 42, and scarlet fever with 36 per cent. Few of the other types of im-

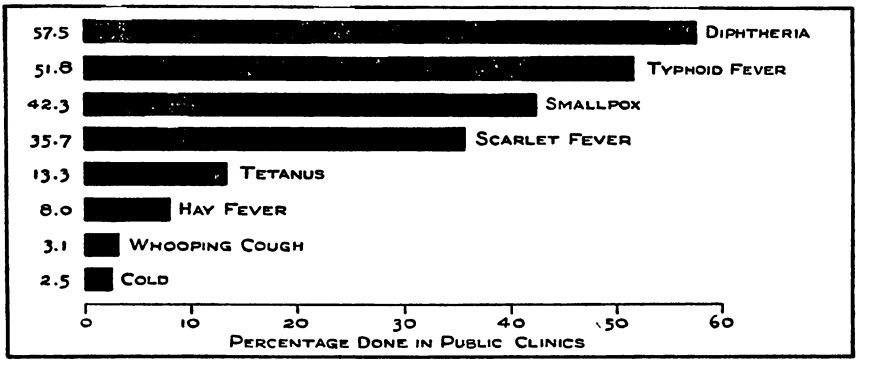
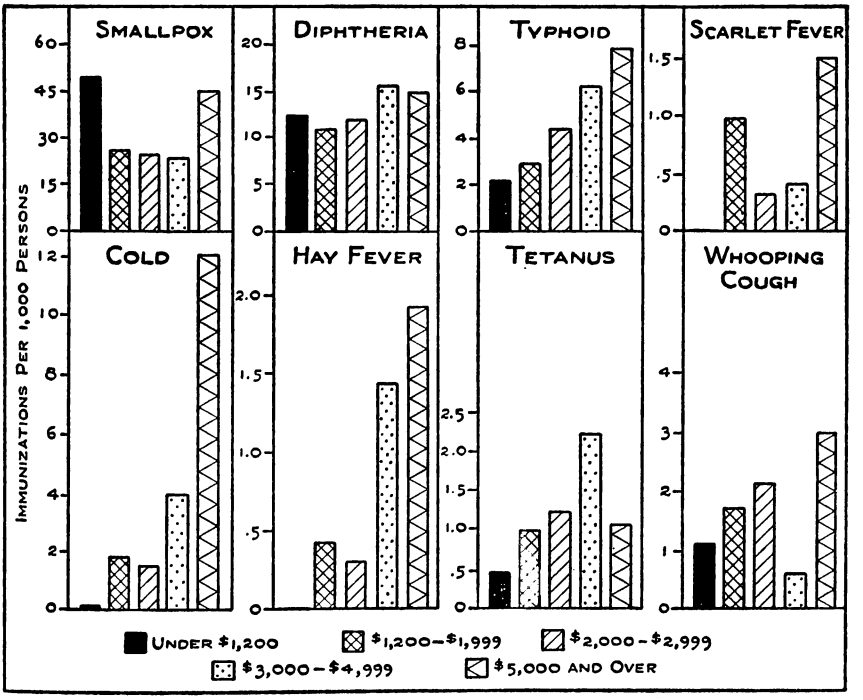


Fig. 8. Percentages of various kinds of artificial immunizations and related procedures that were done in public clinics—8,758 canvassed white families in eighteen states, 1928-1931.

munization are done in public clinics. The maximum percentage of immunizations that were done in public clinics occurs in the school ages but in the case of typhoid fever the percentage was

Fig. 9. Annual rates of occurrence of various kinds of artificial immunizations and related procedures per 1,000 persons of all ages in families of different income levels in eighteen states during twelve consecutive months, 1928-1931.

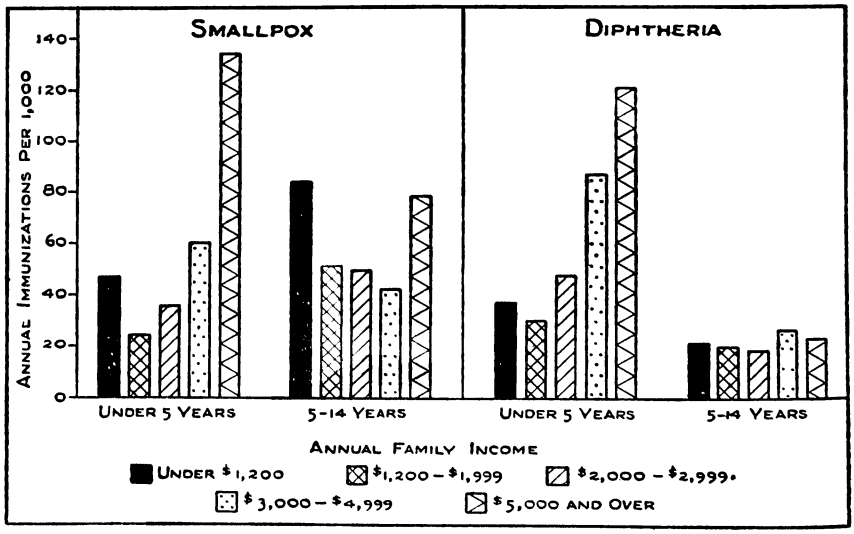


almost as high for adults. This may represent a greater use of clinics by adults in the South where most of the typhoid immunizations occurred. About 90 per cent of the immunizations of all types in public clinics were reported as free with the other 10 per cent paying either a nominal or a full charge.

Figure 9 shows current immunization rates per 1,000 for persons of all ages in each of five income groups. There is not much variation with income in the frequency of diphtheria immunizations; smallpox vaccinations occur more frequently in the lowest and highest income groups with little variation among the three intervening classes. Since these standard types of immunization are so largely obtainable through clinics and health departments, no large variation with income would be expected. The frequency of typhoid immunizations shows considerable rise as income increases, but the use of cold vaccine and hay fever desensitizing injections increases greatly with income, thus indicating that they are considered as luxuries in the field of preventive medicine.

In Figure 10, smallpox vaccination and diphtheria immunization

Fig. 10. Annual smallpox vaccinations and diphtheria immunizations per 1,000 children of specific ages in families of different income levels in eighteen states during twelve consecutive months, 1928-1931.



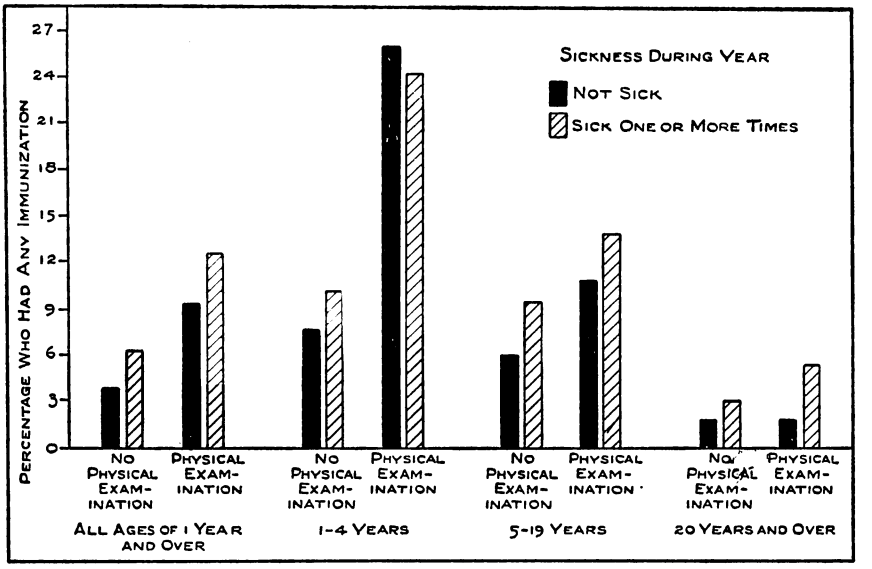


Fig. 11. Percentage of persons of specific ages who had an immunization of some kind during the study year among persons classified according to whether they had a physical examination and whether they were sick during the year—8,758 canvassed white families in eighteen states during twelve consecutive months, 1928-1931.

rates are shown by income for the preschool and the school ages. In the preschool ages when these preventive services are not readily available through the schools, vaccinations and immunizations are more frequent in the higher income groups. In the school ages, when school clinics are available, there is not much variation with income except that the lowest and highest groups have more smallpox vaccinations.

Physical examination and sickness records are available for the surveyed population for the same period as the immunization records. In Figure 11, individuals of different age groups have been classified according to whether they received a physical examination and whether they were sick during the study year. For each of these classes the bars represent the percentage of persons who had one or more immunizations during the study year. Considering persons of all ages who were not sick, immunizations were more than twice as frequent among those who had a physical exam-

ination as among those who had no examination. Similarly among those who were sick, the immunization rate was about twice as high for those who had a physical examination as for those who did not have this service. Comparing the sick with those who were not sick during the year, in the class with no physical examination the immunization rate was somewhat higher in the sick group. Similarly among those who had a physical examination, the rate was higher among those who were sick. Physical examinations must have stimulated immunizations but contact with the doctor through illness appears also to have resulted in some immunizations.[4]

In the preschool age immunizations were two to three times as frequent among those who had physical examinations as among those who did not, but sickness had little relation to the immunization rate.

SUMMARY

Information on the history of artificial immunizations and clinical attacks of smallpox, diphtheria, typhoid, and scarlet fever, and more detailed records of immunizations of all kinds during a twelve-month period between 1928 and 1931 were obtained on 8,758 white families in 130 localities in eighteen states. Each family was visited at intervals of two to four months to secure the data.

At the age of the maximum for histories of artificial immunizations, there were the following percentages with an immunization prior to the study: smallpox, 66 per cent at 20-24 years; diphtheria, 43 per cent at 9 years; typhoid, 10 per cent at 15-19 years, and 12 per cent at 30-34 years; scarlet fever, 4 per cent at 10-11 years. At the age of the maximum for case histories there were the following percentages with a history of a prior attack of the disease: scarlet fever, 13 per cent at 15-19 years; diphtheria, 7 per cent at 20-24 years;

[4] Some procedures, such as the administration of preventive doses of tetanus antitoxin and hay fever desensitizing injections would always be accompanied by the illness or accident for which the injections were given, and in a small percentage of cases there would be reactions following smallpox vaccinations and diphtheria, typhoid, and scarlet fever immunizations. However, both of these types of cases are rare and probably do not account for all of the excess of immunizations among those who were sick during the study year.

smallpox, 4 per cent at 20-24 years, and 5 per cent at 45-54 years; typhoid, 4 per cent at 20-24, and 12 per cent at 55-64 years (Figure 1).

Large cities show twice as many smallpox vaccinations as rural unincorporated areas but fewer histories of smallpox attacks. Rural unincorporated areas show more than twice as many typhoid immunizations as large cities (Figure 2).

Typhoid immunization histories were many times more frequent in the South than in other geographic sections. Histories of clinical attacks of typhoid fever were also frequent in the South (Figure 3).

In the preschool ages diphtheria immunizations were more frequent than smallpox vaccinations, but above five years the reverse was true (Figure 5).

The seasonal variation in the frequency of smallpox vaccinations and typhoid immunizations seems to be related to the seasonal prevalence of the disease, but this is not true of diphtheria (Figure 7).

A higher percentage of diphtheria immunizations were done in public clinics than of any other type of immunization (Figure 8).

The use of immunizing procedures other than those for smallpox and diphtheria tends to increase with income, particularly for cold vaccine and hay fever desensitizing injections (Figure 9). Smallpox and diphtheria immunizations done in the preschool ages increase with income but in the school ages there is not much relation to income (Figure 10).

More immunizations occurred among persons who had a physical examination during the year than among those who did not. In adult ages immunizations were more frequent among those who were sick than among those who were not sick during the year (Figure 11).

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