

THE PREVALENCE OF TUBERCULOUS INFECTION IN A RURAL COMMUNITY IN NEW YORK STATE¹

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THE significance of the tuberculin test as a technique for revealing, with a fair degree of precision, the presence or absence of infection with tubercle, is generally recognized. Early experimentation with the use of the Von Pirquet tuberculin test in the clinics and dispensaries of the larger cities, such as Vienna, Berlin, Lille, New York, and later with the Mantoux test in Philadelphia, led to the conclusion that about 90 per cent of all children are infected with tubercle by the time age 19 is reached. From these findings and from the results of autopsy studies it has been assumed that practically every adult has a little bit of tuberculosis. Slater in 1924 questioned the representativeness of the data from which this conclusion was drawn and called attention to the fact that in a rural community in Minnesota only 10 per cent of 1,654 children, 5-19 years of age, showed tuberculous infection as revealed by the Pirquet test.² Since 1924, experiments with the Mantoux tuberculin test among a representative sample of school children in Cattaraugus County in New York State has afforded further evidence that the prevalence of tuberculous infection in another rural area is low, namely, from 7 per cent for farm children to 13 per cent for village children.³ This low infection rate is due, no doubt, to the fact that there are

¹From the Division of Research, Milbank Memorial Fund.

²Slater, S. A.: The Results of Pirquet Tuberculin Tests on 1,654 Children in a Rural Community in Minnesota. *The American Review of Tuberculosis*, November, 1924, x, No. 3, pp. 299-305.

³Korns, J. H.: Tuberculous Infection Among School Children in a Rural Area in New York State. *The American Review of Tuberculosis*, November, 1931, xxiv, No. 5, pp. 532-536.

relatively few sources of tuberculous infection in a given rural area and consequently less chance of contact, casual or close, for the majority of the population.

A low infection rate among children of school age leads naturally to the following question: *Does this low rate of infection persist into adult life in a rural population?* Records of tuberculin testing for a sample of a rural population are now available which may throw some light upon this question.

As a part of an epidemiological investigation of tuberculosis in a rural area, Cattaraugus County, which is being made through the cooperation of the Department of Health of that County, the Milbank Memorial Fund, and the United States Public Health Service, a complete health examination was made available to farm and village families in five townships, beginning in April, 1931, and continuing to the present time. One of the purposes of the examination was to discover the prevalence of tuberculous infection in a random sample drawn from a rural population; consequently, as a part of the health examination, each individual in the family was given the Mantoux tuberculin test and had an X-ray of the chest.

Certain environmental conditions within a population group, which may be factors determining to a large degree the chances of exposure to tuberculosis and the acquisition of infection, should be considered. Among these are: (1) the number of foci, the cases of open tuberculosis within the area; (2) the density of the population, particularly its distribution in population centers of various sizes, the frequency with which persons living in the open country mingle with more urban populations in or out of the area, and economic status as influencing household congestion, and other conditions affecting the opportunity for contact with foci of infection; and (3) the extent to which such conditions as the fore-

going are modified by procedures for the control of the disease. As a background for the data of this study, a brief description of the five townships, with respect to some of these factors, is pertinent.

It is difficult to secure accurate information as to the frequency of occurrence of open tuberculosis in any area. All evidence points to a low prevalence of the disease in Cattaraugus County for at least thirty-odd years. The median annual death rate since 1900 was 67.2, and the highest recorded rate in the period was 92.5.⁴ The results of intensive case-finding work since 1923 have corroborated the indications given by the mortality record. Since the population of the five townships has been under close observation for a number of years, it is reasonable to assume that practically all cases of active tuberculosis are known. Early in 1931 there were four families known to have an active case of tuberculosis with positive sputum. In addition, eighteen families were being carried for supervision by the County Bureau of Tuberculosis, in each of which there was either an arrested case of adult pulmonary or latent childhood type tuberculosis.

The five rural townships have a total population of approximately 5,000 in some 1,400 families, predominately native-white families of the older native stock. There are three small villages, varying in size from a total population of 250 to approximately 900 in the largest village. Some contact is maintained more or less frequently with more urban centers nearby—the cities of Salamanca (population 9,000) and Olean (population 23,000), and infrequently with Buffalo (about 60 miles distant)—but the population of the five

⁴Exclusive of deaths of Indian residents and of nonresidents in the J. N. Adam Memorial Hospital at Perrysburg. Even as early as 1880 and 1890, according to the United States Census enumerations, the death rates from "consumption" were only 132 and 108 respectively, and since 1924 all of the annual rates have been under 47 per 100,000 population.

townships may be considered as essentially rural in the ordinary meaning of the term. The economic status of 22 per cent of the families from which our sample was drawn was graded as "comfortable," of 41 per cent as "upper moderate," of 20 per cent as "lower moderate," and of 17 per cent as "poor or very poor."⁵ Thus this community may be regarded as neither excessively poor nor very prosperous.

Since 1923, the Cattaraugus County Department of Health has employed throughout the County the following measures for tuberculosis control: an intensive program of case-finding, free diagnostic and consultation services, improved sanatorium facilities, nursing supervision and instruction to prevent the spread of infection in tuberculous households, and a definite program for the eradication of bovine tuberculosis.⁶ Consequently, we are considering a population which has had a relatively intensive antituberculosis program for at least eight years.

The data on tuberculin reactions were obtained in a series of general health examinations offered free to families through United States Public Health Service investigators engaged in morbidity and other studies in the area. The examinations were made at a County Department of Health clinic located

⁵The economic status used is that given by the United States Public Health Service investigators who have been conducting a study of illness among these families for a period of three years. The classification given to each family is based upon the general impression formed after the family had been visited several times.

⁶A Note on the Extent of Tuberculin Testing and Tuberculous Infection in Cows in a Rural Area of Cattaraugus County. *Milbank Memorial Fund Quarterly Bulletin*, April, 1931, ix, No. 2, pp. 46-51. In the summer of 1930, the results of tuberculin testing of cattle belonging to 720 households in the five rural townships were checked. Fourteen per cent of the herds and 10 per cent of 7,489 cows were not tested. Of the cows tested 1.6 per cent were stated to have been positive reactors. This rate is nearly double the 0.85 per cent for the entire County as shown by the records of the state veterinarian.

in the largest village in the five townships. Transportation to and from the clinic was made available for families needing it so that distance or lack of transportation facilities would not make the health examination impossible for any family. It was desired to secure, as nearly as possible, a random sample of the families living in this particular area. None of the four families with active tuberculosis, however, was asked to have this special examination; otherwise, it is believed that the bases of selection for the families which constitute our sample were the general interest of the family in health and a willingness to have a health examination which included the tuberculin test.⁷ Of the 250 families which availed themselves of the special health examination, 246 were regarded as constituting a fairly random sample of this rural area.

Five hundred and eighty-nine individuals of all ages in the 246 families were given the intracutaneous tuberculin test, beginning with .01 or 0.1 mgm. followed at a 48-hour

⁷It should be pointed out that a scrutiny of the 250 families examined revealed the fact that among them there were eight families known to have arrested tuberculosis. As was stated above, a total of eighteen families in the five townships were being carried for supervision by the Bureau of Tuberculosis because of arrested tuberculosis. If we assume these eighteen families to be evenly distributed among the 1,400, in any sample of 250 families drawn at random, we should expect to have three or four such families. Statistically it is unlikely that the inclusion of eight families came about purely through chance, and, in fact, it is known that the examination of some of them was influenced by the knowledge of arrested tuberculosis. Moreover, families supervised by the Bureau of Tuberculosis are accustomed to clinic examinations and have received some health teaching, and, as a consequence, are probably more easily available for a health examination than are those unaccustomed to clinic attendance. Since the infection rate among members of households with cases of the disease is high, it seems proper to exclude four of the eight families in order to present for purposes of strict accuracy the prevalence of tuberculous infection in a random sample population from a rural area, although their inclusion or exclusion makes little difference in the general results here presented. In all other respects the sample was found to be in close agreement with the population from which it was drawn.

interval by 1.0 mgm. in case no reaction from the previous dose was noted.⁸ Two hundred and eight, or 35 per cent, of the total group were found to be positive to tuberculin. It seems entirely fitting to add to this group the records for 435 children, aged 5-19, from the five townships who were given the tuberculin test during 1930 by Dr. John H. Korns as a part of the study of tuberculous infection in school children.³ As Dr. Korns has stated in his report, the children tested

Table 1. Per cent of individuals at different ages with a positive reaction to the Mantoux test among a random sample population and 435 apparently healthy school children drawn from five rural townships in Cattaraugus County, New York, 1930—April, 1933.

Age Groups	Number		Per Cent Positive
	Total Tested	Positive	
0-4	53	0	0.0
5-9	255	17	6.7
10-14	258	21	8.1
15-19	127	25	19.7
20-29	60	20	33.3
30-39	77	42	54.5
40-49	93	59	63.4
50-59	60	41	68.3
60+	41	25	61.0

may be considered as a representative sample of apparently healthy school children, since the consent of the parents was the only selective factor.

The prevalence of tuberculous infection at different ages is indicated by the proportion of positive reactors among the individuals tested (Table 1 and Figure 1). In the age period

⁸The tuberculin tests were given and interpreted by a specially trained nurse, Miss Muriel V. Lowry, R.N., under the supervision of Dr. John H. Korns, director of the Bureau of Tuberculosis, Cattaraugus County, during the period April, 1931-February 15, 1933. Dr. J. H. Wylie assisted in the supervision of the tuberculin tests from April, 1931 to February 15, 1932. Since February 15, 1933, the tests have been given and interpreted by Mrs. Alcesta R. Owen, R.N., who was instructed by Miss Lowry and under the supervision of Dr. Ralph E. Wheeler, epidemiologist, Milbank Memorial Fund and consultant, United States Public Health Service. The tuberculin used was Old Tuberculin (human) prepared and standardized by the New York State Department of Health, and most of the tuberculin used in this study was further standardized on guinea pigs by Dr. J. D. Aronson of the Henry Phipps Institute, Philadelphia.

0-14 years only a gradual increase in the prevalence rate appears from 0 for children under five to 8 per cent for those 10-14 years of age. For the age period 15-19 years the rate more than doubles,

rising to 19 per cent.

From 20 to 39 years of age the increase in positive reactors is still more rapid, rising from 19 per cent to approximately 55 per cent for the age group 30-39. From age 40 the increase is

less rapid with the highest proportion of reactors, 68 per cent, among individuals 50-

59 years of age. For persons over 59 the rate instead of increasing or remaining constant, is less than that for the earlier decade. This discrepancy for the older ages may be accidental or it may be interpreted as indicating a loss of sensitivity to tuberculin among older people.

So far as the authors are aware, no data are available in the literature on the prevalence of tuberculous infection among a random sample of white adults with which strict comparisons could be made with these presented for the rural townships in Cattaraugus County. Two or three other reports may be referred to, however. Aronson,⁹ reported the results of the intracutaneous tuberculin test among a group of white farm families living on an isolated country road in

⁹Aronson, J. D.: Incidence of Tuberculous Infection in Some Communities of the South. *The American Journal of Hygiene*, September, 1931, xiv, No. 2, pp. 374-393.

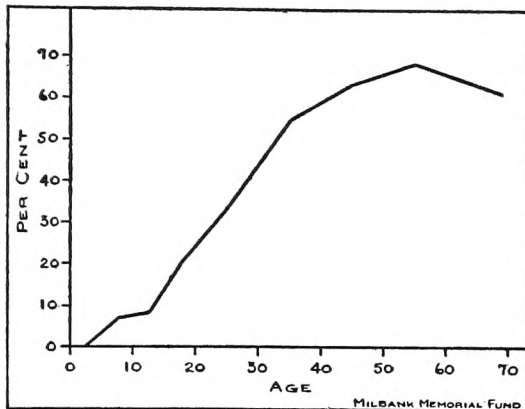


Fig. 1. Prevalence of tuberculous infection at different ages among a random sample population and 435 apparently healthy school children drawn from five rural townships in Cattaraugus County, New York, 1930-April, 1933.

Sunflower County, Mississippi. One hundred and thirteen individuals were tested, only 52 of whom were over 20 years of age. The per cent of persons found positive at different ages is shown in Table 2. The rates for each age group are much higher for the farm families in Mississippi than those for the five townships in New York State, but the increase in prevalence with age is similar in both groups. The prevalence of tuberculous

Table 2. Per cent of individuals at different ages with a positive reaction to the Mantoux test in a group of isolated farm families, Sunflower County, Mississippi.⁹

Age Groups	Number		Per Cent Positive
	Total Tested	Positive	
All Ages	113	62	54.9
0-9	32	10	31.3
10-19	29	12	41.4
20-29	14	9	64.3
30-39	13	11	84.6
40-49	11	9	81.8
50+	14	11	78.6

infection among children 5-14 years of age in various groups drawn from metropolitan areas indicates a rate as high or higher than the rate among adults 40 years or older in our sample of a rural population. Among 1,000 children 13 and 14 years of age in the Bellevue-Yorkville district of New York City, 67.3 per cent reacted to the intracutaneous test.¹⁰ In Philadelphia, 79.7 per cent of white school children reacted to tuberculin at age fifteen.¹¹ These rates contrasted with rates of 63 or 68 reached at ages 40-59 in the five townships indicate a very much slower rate of infection in a sparsely settled rural area.

The lag in the cumulative curve of tuberculous infection in the five townships as compared with curves for urban

¹⁰Barnard, M. W.; Amberson, J. B.; and Loew, M. F.: Tuberculosis in Adolescents. *The American Review of Tuberculosis*, May, 1931, xxiii, No. 5, pp. 593-641.

¹¹Hetherington, H. W.; McPhedran, F. M.; Landis, H. R. M.; and Opie, E. L.: A Survey to Determine the Prevalence of Tuberculous Infection in School Children. *The American Review of Tuberculosis*, October, 1929, xx, No. 4, pp. 421-510.

AGE GROUPS	PER CENT INFECTED (1)	PER CENT NONINFECTED (2)	PER CENT ACQUIRING INFECTION ¹ (3)	INCIDENCE AMONG NONINFECTED ² (4)
0-4	0.0	100.0	0.0	0.0
5-9	6.7	93.3	6.7	6.7
10-14	8.1	91.9	1.4	1.5
15-19	19.7	80.3	11.6	12.6
20-29	33.3	66.7	13.6	16.9
30-39	54.5	45.5	21.2	31.8
40-49	63.4	36.6	8.9	19.6
50-59	68.3	31.7	4.9	13.4
60+	61.0	39.0		

¹Estimated from the difference between cumulative percentages at different age groups in column (1).

²Calculated by relating the per cent acquiring infection in a specific age group to the per cent noninfected in the preceding age group.

Table 3. Calculated incidence of tuberculous infection at different ages among a random sample population drawn from five rural townships in Cattaraugus County, New York, 1930—April, 1933.

areas is in general accord with a conclusion drawn from the results of a study of other infectious diseases in this same area,¹² namely, "The more rural the population . . . the higher are the ages at which each of these diseases (measles, scarlet fever, and whooping cough) occur."

The frequency with which infection was acquired at various age groups in this sample population can be estimated by computing the differences between the cumulative percentages for successive age groups (Table 3, column 3). Approximately 7 per cent of the children over four years of age acquired infection at ages 5-9 and only 1.4 per cent at ages 10-14. The proportion of individuals who acquired infection during the age period 15-19, is somewhat higher than for those in the younger ages. Thirteen per cent acquired infection between 20 and 29 years of age and the incidence of infection reaches its peak (21 per cent) during the age period 30-39. After age 40 the proportion of the population acquiring infection declines.

¹²Sydenstricker, Edgar, and Collins, Selwyn D.: Age Incidence of Communicable Diseases in a Rural Population. United States *Public Health Reports*, January 16, 1931, xlvii, No. 3, pp. 100-113.

The cumulative percentages also afford a basis for estimating the incidence of infection among persons of different ages not previously infected (Table 3, column 4, and Figure 2).

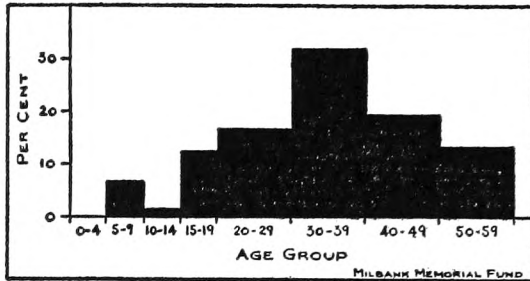


Fig. 2. Calculated incidence of tuberculous infection at different ages among a random sample population drawn from five rural townships in Cattaraugus County, 1930-April, 1933.

Without attempting to attach too much significance to the exact percentages, it is interesting to note that the incidence of infection increases rapidly after age 14 to its peak in the age group 30-39, and after age 40 declines with almost equal rapidity.

These variations in the incidence of infection may be regarded as a crude indication of variations in the opportunity for exposure to tuberculosis at different ages under rural conditions.

Without attempting too broad conclusions from the findings in one rural area two observations may be ventured as hypotheses: (1) that the late acquisition of infection is closely associated with delay in the widening of environment for the individual and, as a consequence, delay in the chances of contact with tuberculosis outside the home; and (2) a considerable proportion of the population escapes infection until adult life when, since tuberculosis for the most part is a chronic disease of adults, opportunities for contact with tuberculosis increase. The data here presented do not throw any direct light on the question of tuberculous infection among a population as a protection against reinfection. As Opie¹³ says:

¹³Opie, E. L.: Recognition and Control of Tuberculosis of Childhood. *American Journal of Public Health*, April, 1933, xxiii, No. 4, pp. 305-315.

"All we know about immunity against tuberculosis indicates that infection confers some, but limited, resistance to the disease. We have very little direct information about the fate of those who are exposed for the first time during adolescence or early adult life to infection. Anatomical observations demonstrate that such first infection often pursues a rapidly fatal course."

Myers,¹⁴ in discussing the experience of the Lymanhurst School with tuberculosis in children, makes the following statement:

"From our own observations and the findings of others the fact is becoming quite clear that the potential future tuberculosis load of any community is found among the apparently healthy children and adults of that community who react positively to the tuberculin test. In other words, we cannot subscribe to the view that a positive tuberculin reaction is a favorable sign."

Though we cannot regard a positive reaction to tuberculin in childhood and early adult life as an indication of immunity to further infection and tuberculous disease, neither can we use it, even in a rural area, to identify with certainty those who will develop clinically manifest tuberculosis.

SUMMARY

A low rate of infection, 35 per cent of 589 individuals of all ages, is indicated by the results of the intracutaneous tuberculin test among a sample population drawn from five rural townships in Cattaraugus County, an area where all available evidence (mortality and morbidity records) points to a low prevalence of tuberculous disease. The age specific rates of tuberculous infection indicate a gradual increase for individuals under 15 years of age, 0 for children under five, to

¹⁴Myers, J. A.: The Experience of the Lymanhurst School with Tuberculosis in Children. *Tubercle*, February, 1933, xiv, No. 5.

8 per cent for those aged 10-14; after 15 years of age the increase is much more rapid rising from 19 per cent (age 15-19) to 55 per cent for the age group 30-39; from age 40 the increase is less rapid with the highest rate of infection, 68 per cent, among individuals 50-59 years of age. This increase in the prevalence of tuberculous infection with age is much slower than that found for groups drawn from metropolitan areas; for example, rates of 67 to 79.7 for children aged 13-15 in New York City and Philadelphia were not attained in the rural population until ages 40-59. The estimated incidence of infection among persons of different ages not previously infected, increases rapidly after age 14 to its peak in the age group 30-39, then declines with almost equal rapidity. The data for the sample population in this rural area suggest: (1) that the late acquisition of infection is closely associated with delay in the widening of environment for the individual and, as a consequence, delay in the chances of contact with tuberculosis outside the home; and (2) a considerable proportion of the population escapes infection until adult life when, since tuberculosis for the most part is a chronic disease of adults, opportunities for contact with tuberculosis increase.