

METHODS OF DETERMINING THE PREVALENCE OF RHEUMATIC FEVER IN CITIES AND SMALL COMMUNITIES¹

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RHEUMATIC FEVER is one of the serious diseases of this country, ranking in importance with tuberculosis and syphilis. That heart disease often results from it has long been known. There is much evidence that rheumatic fever is infectious. Seemingly, also, it is more likely to attack children in the poorer families, particularly those living in damp houses, than the families in better circumstances. Obviously, an important public health problem is involved. However, no one knows the exact nature of the disease or the exact cause of it.

For all these reasons, rheumatic fever is a challenge to the medical profession and science in general. And any systematic study such as the one by Dr. John R. Paul, which he reports on in the following pages, deserves the thoughtful attention of all who are interested in improved protection of the public health.

Dr. Paul, whose work is aided by the Milbank Memorial Fund, is studying the relation between rheumatic fever and living conditions in New Haven, Connecticut, and surrounding regions. The results already obtained indicate the value of the special method of approach which he describes in essential detail.—THE EDITOR

RHEUMATIC FEVER has long been recognized as a major cause of sickness and death among children and young people in many parts of the United States, yet there is little exact knowledge about the prevalence of this disease throughout the country at large, about its relative prevalence in urban as compared with rural communities, and about its relative prevalence in poverty-stricken sections of the population as compared with the well-to-do sections. Obviously, it behooves us to strive toward supplying the much-needed knowledge in the hope that control of the disease may eventually be achieved.

Compulsory reporting of cases of rheumatic fever by physicians has been carried out in a few countries, but many of the attempts have been short-lived. Indeed, it seems questionable whether this disease at present lends itself to reporting. This

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is due not only to an apparent lack of contagiousness (so that reasons for reporting may not be obvious to some practising physicians), but particularly to its insidious clinical character and the difficulties in accurate diagnosis.

Attempts to estimate the frequency of rheumatic fever have been made through such means as the records of hospital admissions or mortality statistics. But these methods have proved unsatisfactory. In our study of the problem in New Haven, Connecticut, therefore, we have developed special methods, the description of which may be worth while.

In pursuing our investigation, we have aimed not merely to gather morbidity statistics, but also to learn more about conditions under which this obscure disease seems to flourish and to analyze these conditions in order to find out whether they can be altered. For example, it has long been suspected that, within certain districts of a given city or small community, groups of houses have existed in which an unusual number of cases of rheumatic fever were found. Almost fifty years ago, observations were made on this point in Germany, where in Kiel and Leipzig as many as five or six cases were found in one house on several occasions. The suggestion was made that rheumatic fever might be termed a "house disease." Such findings may have merely reflected a high familial incidence, but not all the cases from the so-called rheumatic houses represented the same family. There have been relatively few subsequent observations of this type.

Another feature which has been mentioned from time to time, and in which the attempt has been made to relate the presence or absence of rheumatic fever to more or less specific local environmental conditions, has been the association of the disease with damp soil or with rivers. These observations are for the most part casual in nature and have been largely derived from groups of patients attending special schools or a central clinic, without regard to factors of selection or to other factors

which might account for a concentration of cases within certain areas, such as crowding within districts where the rents were low.

Two concerted efforts have been made in England, however, to study the home distribution of rheumatic fever cases more carefully. One of these was begun in 1927 in the Borough of Kensington in London,³ where rheumatic fever was made a reportable disease in children under sixteen years of age for a period of three years. A population and case map of the district, which was constructed, showed the greatest prevalence of the disease to be in poorer and densely crowded areas. The other British survey⁴ was done in three counties in the western part of England from which cases were enrolled on a voluntary basis. The criteria of selection was limited to rheumatic heart disease occurring in children between the ages of five and fifteen. By and large the greatest prevalence of such cases was found among areas in which there was over-crowding, defective lighting, and low-lying housing sites.

Our own methods for gathering information on these points have been employed by the author only in the City of New Haven, Connecticut, and its immediate surroundings. They may be of some value to others interested in this problem, and are presented largely for purposes of comparison with similar future studies which might be initiated in this City or elsewhere.

A. *The Examination of School Children as a Means of Determining the Prevalence of Rheumatic Heart Disease within a Community.* Difficulties of determining the prevalence of rheumatic fever within a given community of appreciable size are such that in approaching the problem one is immediately forced to seek compromise measures. One of the first and the most

³Fenton, J.: First and Second Annual Reports on the Rheumatism Scheme of the Royal Borough of Kensington, London, 1929 and 1930.

⁴Savage, W. G.: Incidence of Rheumatic Heart Disease in Childhood (1927-1930) in Gloucestershire, Somerset, and Wilts. *Supplement of the British Medical Journal*, July 18, 1931, p. 37; and Coombs, C. F.: *Proceedings of the Royal Society of Medicine (Section on Diseases of Childhood)*, 1931, xxiv, p. 99.

obvious of these is to determine the prevalence of rheumatic heart disease (which can be considered as an end result of certain cases of rheumatic fever). This compromise is not ideal because the development of rheumatic heart disease may perhaps be an indication of the type of therapy to which rheumatic patients are subjected, rather than an expression of the actual frequency of the disease responsible for the cardiac lesion. Nevertheless, it does represent a practical form of approach. Public and private school children below the high-school age offer a satisfactory group for study because generally they are an unselected group, supposedly representing a cross-section of the juvenile population of a given community. There are at least four methods of obtaining from school children data pertinent to this purpose. The first three are dependent upon the fact that certain grades or classes of the public (and private) schools in a community are subjected to an annual physical examination by school physicians.

I. The school physicians may be instructed to list all cases of rheumatic heart disease found among pupils examined. Thus the prevalence among various age groups in different schools may be determined. To our knowledge, this type of survey has been adopted only in a few instances because of the difficulty of actually determining, in the course of a routine school examination, whether a given cardiac "defect" is rheumatic or not. Careful diagnostic tests are not, or cannot often be applied in the usual school examinations of hundreds or thousands of children. The largest single factor of error seems to lie in the interpretation of the systolic murmur. Is it functional, or does it represent an organic heart lesion of rheumatic origin? Another important factor is the differentiation of congenital heart disease from rheumatic heart disease.

II. The school physicians may list all cases of *organic heart disease* found in the course of their examinations and from these figures one may estimate roughly the prevalence of rheumatic heart disease, if one assumes (as has been done)

that 80 per cent of organic heart disease occurring in children under sixteen years of age is due to rheumatic fever. The danger of this procedure again lies in the difficulty of accepting the findings of school examinations done on a large scale. Many estimates of this type have been reviewed in a previous publication.⁵

III. The school physicians may be instructed to list all children thought to have a definite or a suspicious cardiac "defect," and arrangements may be made for the reexamination of these children by an individual or group of individuals specially trained or interested in the diagnosis of rheumatic heart disease. Estimates based on this method include those of the Boston survey;⁶ and of Goodman and Prescott in New York City.⁷

IV. All of the examinations of the original "unselected" group of school children may be performed by an individual who is himself specially trained or interested in the detection of rheumatic heart disease. The school physician may, of course, fulfill these qualifications. The disadvantage of this method lies in the practical impossibility of covering very large groups of children. The advantage lies in the interest and experience of the examiner in this field, the inclusion of certain schools such as private schools which might be missed by other methods, and the application of standard diagnostic criteria to the whole unselected group.

Methods II, III, and IV have been used by us in our attempts to determine the prevalence of rheumatic heart disease among public and private school children of New Haven and its environs.^{5,8} According to Method II (1932), the average rheu-

⁵Paul, J. R.; Harrison, E. R.; Salinger, R.; and DeForest, G. K.: The Social Incidence of Rheumatic Heart Disease. A Statistical Study in New Haven School Children. *American Journal of Medical Sciences*, clxxxviii, September, 1934, p. 301.

⁶A Cardiac Survey of Children in Boston Public Schools. *The Nation's Health*, ix, No. 12, December, 1927, p. 21.

⁷Goodman, M., and Prescott, J. W.: Heart Disease Among Adolescent School Children. *Journal of the American Medical Association*, ciii, July 21, 1934, p. 157.

⁸Paul, J. R.: The Epidemiology of Rheumatic Fever. A Preliminary Report with Special Reference to Environmental Factors in Rheumatic Heart Disease

(continued on page 57)

matic heart disease rate among public school children of the City of New Haven proved to be 13.4 per 1,000; according to Method III (1930), 11.4 per 1,000; and to Method IV (male pupils only, 1932), 38.5 per 1,000.

Inasmuch as we believe that Method IV is the most accurate one which we have employed, it seems worth while to mention some of its details. Sample public and private schools were selected and permission for examination of the pupils was obtained from the Board of Education (or the headmaster in the case of private schools) as well as from the physicians in charge of the health of the school population. Only male pupils were examined in order to obviate certain problems with regard to the removal of clothing prior to the examination. An average of eight to ten minutes was spent on each boy. By this method, 958 pupils from six public and private schools were examined in the course of four months. A major task was that of finding the opportune moment in which time could be spared from routine activities of the school for these examinations.

While the diagnosis of clear-cut rheumatic heart disease offers little difficulty, the element of clinical judgment is particularly important in border-line cases. Criteria employed by us for the diagnosis of doubtful cases of rheumatic heart disease were as follows:

1. A history of rheumatic fever, if present, was regarded as of positive importance in the presence of questionable cardiac signs.
2. Some of the signs which have been regarded as of positive significance are given in the order of their importance. The presence of: (1) Apical systolic and pre-systolic thrills, or a systolic thrill transmitted to the vessels of the neck. (2) Pre-systolic murmurs, aortic diastolic and other mid-diastolic murmurs. (3) Cardiac enlargement which could not be explained on any other basis. (4) Loud or harsh systolic murmurs best heard at the apex and transmitted outwards.

and Recommendations for Future Investigation. New York, Metropolitan Life Insurance Company Press, 1930.

The diagnosis of congenital heart disease usually rested upon the history, the cardiac findings, the presence of cyanosis, and clubbing of the fingers.

The diagnosis or the interpretation of functional murmurs, of course, offered considerable difficulty. We have followed the view that more definite functional murmurs are generally present at the base of the heart and can best be heard when the patient is prone.

It should be emphasized that under the conditions in which our data were obtained, the application of these diagnostic criteria proved difficult. The majority of cases of rheumatic heart disease encountered among the school populations represented mild forms, and unfortunately the diagnosis of just such forms as these requires an appreciable element of personal judgment. It was our effort throughout, however, to include only the more definite cases.

Before attempting an analysis of the results obtained by any of the four methods, it is important to know whether the school population of children, routinely or specially examined, actually represents an unselected cross-section of the juvenile population of the City. If Methods I, II, or III are followed, it is important to know whether or not all parochial schools are included; and whether special schools exist in certain districts of the City for physically or mentally defective children. It is also obvious in the use of any of the methods that a small percentage of the severe cases of active or even old rheumatic heart disease may be completely missed because children suffering from those conditions may not attend school.

When the various known factors of error have been evaluated, the results obtained from any of these methods can be analyzed in a number of ways. Primarily, one may determine from the total number of school children examined the prevalence according to different age groups in the whole city. Of equal importance, to us at least, has been determination of the prevalence

in individual schools or groups of schools. Since public school children are generally drawn from a given district of the city, it is possible, if the population of that district is fairly stable, to relate the local prevalence of rheumatic heart disease to the local population density as well as to racial factors and general living conditions in that district. In the Boston survey, for instance, it was found that in the two most congested districts of the City the organic heart disease rate averaged 7 per 1,000, while in four less congested districts it was 4 per 1,000. Similar findings have been reported in New Haven.⁵ With the exception of these two studies, however, and another carried out in three counties in the western part of England,⁴ we are not aware of other school surveys in which the attempt has been made to relate the prevalence of rheumatic carditis to social, economic, or racial conditions.

B. Community Studies. Whether or not it is possible to select a small community and to determine by an intensive survey what the prevalence of rheumatic fever is, or has been, in that community, is the next question which we have attempted to answer. Primarily, we have had four objectives: (1) The determination of the actual number and ages of individuals who lived in selected communities within the City of New Haven; (2) the number of those who had contracted rheumatic fever in these communities; (3) whether or not the prevalence of rheumatic fever as determined by this method was higher in "damp" communities than in dry ones; and (4) whether or not the prevalence of rheumatic fever could be related to anything else.

Before starting our surveys, we obtained the approval of the City Health Officer. An outline of the proposed survey was then presented before the local medical society of the practitioners of the City. It was explained that if we should enter a house in which any member was under the care of a physician, that physician would be consulted before questioning or examining his patient. A favorable answer to the project was obtained.

Two "damp" communities were first selected on the following bases: (1) That the community did not contain more than twenty-five families; (2) that from our case map of the City which marked the home sites of New Haven Dispensary or Hospital cases of rheumatic fever there was at least one case listed in the district selected, and that we were not aware of the health of other members of the community; and (4) that the community was "damp," in that it was situated on the banks of a stream or river and that the cellars of many of the houses frequently became flooded with water. As controls for studying the "damp" communities, two communities of the same size were chosen on the bases: (1) That we did not know of any cases of rheumatic fever in the community; (2) that they were relatively dry; and (3) that the residents represented essentially the same social plane as that of the "damp" communities.

The limits of the community were first defined. A house-to-house survey was then made which involved a visit to every family and available individual. A surprising degree of cooperation was encountered, due, perhaps, to the fact that in many of the homes visited one or more members had at some time attended the New Haven Dispensary or Hospital and were familiar with follow-up methods. Histories were obtained from each individual with special reference to the occurrence of rheumatism, heart disease, sore throats and tonsillitis, scarlet fever, growing pains, frequent nose bleeds, St. Vitus' dance, and "malarial fever."⁹ An examination of the throat and chest was also performed. This was done not only because many cases of rheumatic heart disease develop in the absence of clinical signs of rheumatic fever, but that an examination at this time seems to support and aid in obtaining a history. As we have repeatedly found from previous experience, it is not enough to question an

⁹It has been our experience that when children or adults who are not actively sick have been found from time to time to run an otherwise unexplained temperature, a favorite term applied in the past by the parents or family physician has been *malarial fever*.

apparently well individual, or his parents, with regard to his past health, particularly when the reason for the doctor's visit or his questions is not very apparent. A reply in the negative to most of the questions is the easiest and safest answer. But while the physical examination is being performed, and the tonsils, or perhaps the appendix, are found to have been removed, the individuals being examined (or their parents) are apt to give more thoughtful answers.

At the outset of the work it became apparent that the original idea of determining the prevalence of rheumatic fever among *all* the community residents would have to be qualified. As we were primarily anxious to know the relationship between the local environment and the presence or absence of rheumatic fever, we excluded from the survey those families which had not been in residence in the community for more than two years. We also excluded all individuals over fifty years of age. Reasons for excluding the older individuals concern the increased difficulties of making a diagnosis of rheumatic heart disease in an elderly individual. Memory with regard to juvenile illness is apt to be poor, and certain elements exist which cloud the diagnostic problem, such as the increased incidence of osteoarthritis, hypertension, cardiac enlargement, and other cardiac signs, most of which are associated with arteriosclerosis.

Criteria for the identification of a case of rheumatic fever in these communities were: (1) A definite history of one of the manifestations of rheumatic fever; (2) evidences of the active disease; and (3) evidences of rheumatic heart disease with or without a history of rheumatic fever. Other symptoms obtained from the history which might or might not have been related to rheumatic fever were listed, such as growing pains and arthritis of various types. Some of these latter symptoms have been marked in the charts shown in Figures 1 and 2 describing the findings, but have not been considered in determining the prevalence of rheumatic fever.

A brief description of the four communities studied may be given as follows, the "damp" communities being designated as P and Q, the controls L and V:

Community P. This community consisted of a somewhat isolated group of twenty-nine wooden, one-family houses, situated in a sparsely populated district of the City. It was roughly about seventy-five feet above sea level. On one side was a swamp and a hill and on the other side a fairly large stream. The presence of a number of springs in the hillside resulted in the cellars of most of the houses being partially filled with water, or at least very damp, for the greater part of the year. Most of the residents were native-born Americans. A few were Polish or Italian. Ten of the twenty-nine houses proved to be either vacant or occupied by families who had lived there for less than two years. The remaining nineteen houses were visited, and from them a group of eighty individuals under fifty years of age was studied. Fifteen residents (18 per cent of the group) had at one time or another been patients in the New Haven Hospital or Dispensary and their medical records were available to supplement data obtained in the field.

Before our survey was started, three cases of rheumatic fever or heart disease were known to exist among the residents of this community. They were excluded from our subsequent determinations.

Community Q. This consisted of a street but a few feet above sea level, which followed the bank of the Quinnipiac River. A section of the street, a quarter of a mile in length, was selected. Many of the cellars of the houses on the river side of the street were flooded whenever the river was high. Sixteen families were studied and seventy-seven individuals were examined, the group including native-born American, Italian, Polish, Irish, and one Negro family. Nearly all lived in one- or two-family houses, half of which were situated on the river side of the street. Of the individuals examined, 14 per cent had at one time been admitted to the New Haven Dispensary or Hospital. Three cases of rheumatic fever from this district were listed in our Dispensary files. They were excluded from our subsequent determinations.

Control Communities. Community L consisted of a street, one block in length, located in a crowded but dry district, about sixty feet above sea level. Sixteen families were visited, and fifty-nine individuals were examined. They were largely of American and Irish extraction. A third of these had at some time visited the New Haven Hospital and Dispensary. Here we used the same type of survey as that used in the "damp" districts.

Community V consisted of a street one-half block in length, situated about thirty feet above sea level, in a densely crowded area close to the hospital. The district was poor but by no means one of the poorest in the City. Sixteen families were visited, and seventy-five individuals were examined. They included Russian and Polish Jews, but there were also Italian, Greek, and Spanish families in the group. Sixty-five per cent of these individuals had at one time visited the New Haven Hospital or Dispensary.

It is not the purpose of this paper to describe or analyze the results obtained from these surveys, for the work is in its infancy. Enough progress has been made, however, to show that the method is practical and that the criteria of community selection can be made on a number of bases other than dampness or dryness. It may suffice to say that in the two "damp" communities P and Q, five new cases of rheumatic heart disease were discovered in which primary symptoms had presumably developed while the patient resided in the community. In the "dry" communities no such cases of rheumatic heart disease were discovered. Two cases of "pre-existing" rheumatic heart disease were discovered in the "dry" communities, and two were also found in the "damp" communities. The prevalence of chronic arthritis was, or had been, a little higher in the "damp" communities, but the story was usually so indefinite that it was difficult to determine (particularly in individuals over twenty years of age) just what type of arthritis had been sustained. Some of the preliminary results have been charted in Figures 1

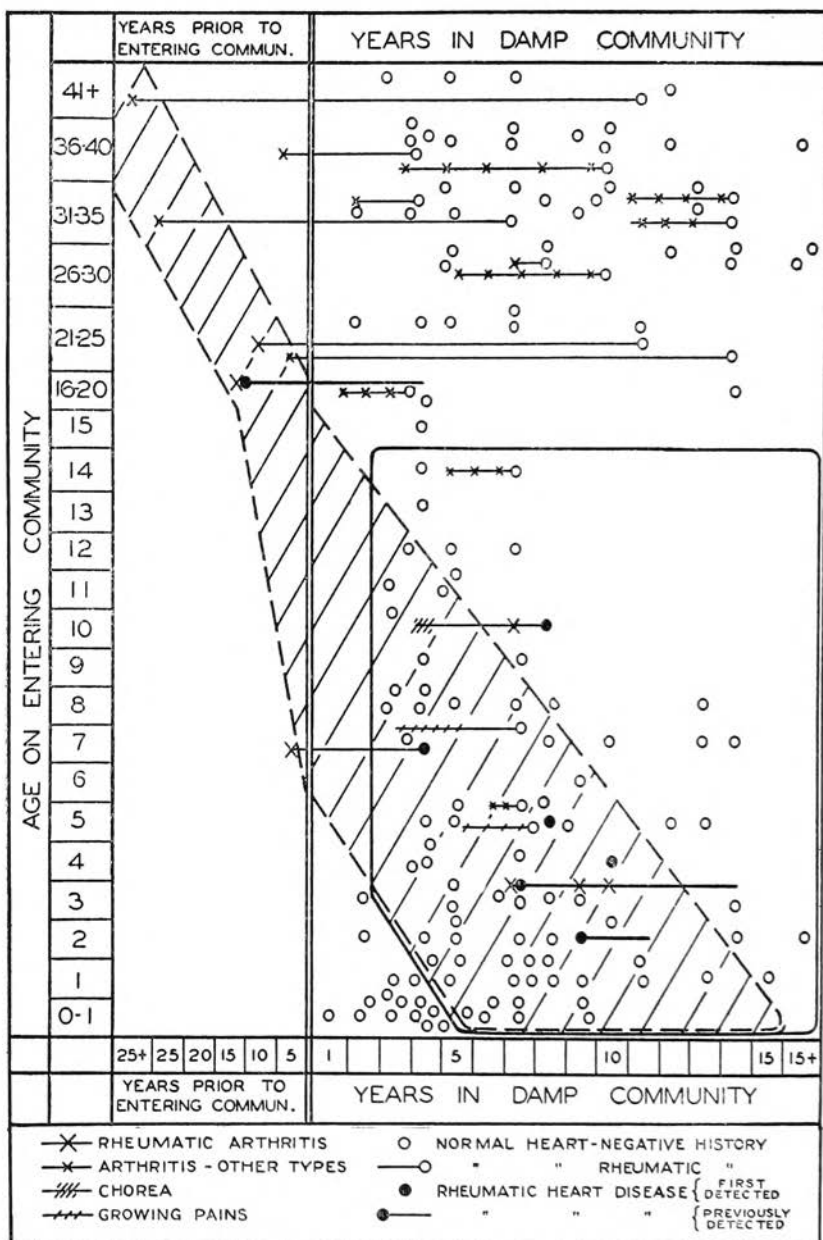


Fig. 1. Schematic diagram of the two "damp" communities P and Q.

These charts have been devised to show certain data with regard to normal and rheumatic individuals, exclusive of the six individuals who represented the basis on which these "damp" communities were chosen. These data include: (1) The number of individuals below fifty years of age (designated as circles and dots) who had lived in

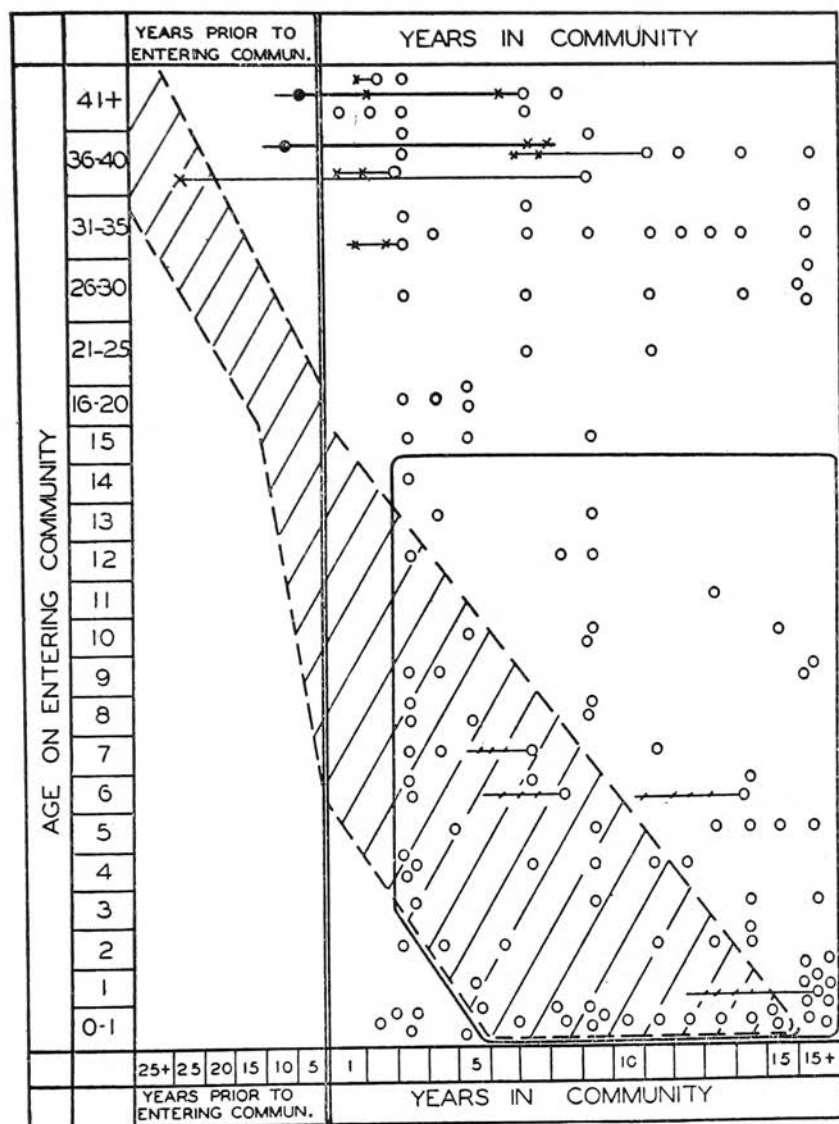


Fig. 2. Schematic diagram of the two control communities L and V.

these communities for more than two years; (2) the period of their life in which they were residents of the community; and (3) whether or not they had signs or symptoms of rheumatic fever. Each individual has been placed in the chart in relation to his or her age on entering the community (cf. vertical column of figures on left) and to the subsequent number of years spent in the community (cf. figures at the base of chart). The shaded area which crosses the chart diagonally represents the age period of greatest susceptibility to first attacks of rheumatic fever, namely, 5-15 years. Enclosed within the roughly oblong figure in the lower right hand side of the chart, therefore, are all the individuals who had spent part or all of their period of greatest susceptibility in the community.

and 2 to show the method of analysis rather than to emphasize any interpretation.

Obviously, a number of intricate problems arose when the attempt was made to relate the active or old cases of rheumatic illness to the size of these populations and to their years of residence in the community. These problems become more or less apparent from a study of the charts (Figs. 1 and 2) and the accompanying explanation of the manner in which our results have been expressed. A major element of difficulty was that the populations within these communities were far from fixed. In fact the number of individuals over ten years of age who had lived in the communities all their lives represented but a small fraction of each group. As a few cases of rheumatic heart disease were discovered in individuals who had not been born in the community, and who gave no history to show when they contracted their heart disease, this offered an annoying variable with which to contend.

In an effort to reduce the variables we believe that perhaps the most accurate estimate of the prevalence of rheumatic fever in these communities can be derived from the sub-groups of individuals (see lower right-hand corners of Figs. 1 and 2) who had passed one or more years of their period of greatest susceptibility (five to fifteen years of age) in the community. When computed on this plan, and excluding the cases on the basis of which the "damp" communities were selected, rheumatic heart disease was found to exist in 10.5 and 2.3 per cent respectively of those who had passed one or more years of their period of greatest susceptibility in the "damp" communities P and Q. No cases of rheumatic heart disease were found in the control communities. However, the problem is still not as simple as these statistics might suggest, for a glance at Figures 1 and 2 will also reveal another feature that may have some bearing, namely, that of the children who entered the "damp" communities below the age of three, their average stay was about five or

six years, whereas in the "dry" communities it was much longer. Possibly the element of "dampness" or "unhealthfulness" may have caused certain families to move out as quickly as possible, resulting in a more rapid turnover in the juvenile population, and this in turn would indirectly influence our determinations. Certainly it will not be until these and perhaps other factors have been analyzed that one may or may not be able to actually incriminate dampness as an important factor which in some way, whether directly or indirectly, may predispose to the prevalence of rheumatic fever. No data have as yet been collected from these communities with regard to crowding, poverty, malnutrition, and the question of streptococcus infections. But it is our hope that by this method information on these other factors may be obtained and analyzed with a view towards gaining more information correlating living conditions and the prevalence of rheumatic fever.