from serious heart disease (class *2b* and class 3) and form the group in which occurred our maternal deaths from heart disease. To a large extent cardiac disease accounts for the total uncorrected maternal mortality in a series of 18,207 consecutive obstetric discharges during a four and one-third year period in the Lying-in Hospital.

CONCLUSIONS

1. In 14,157 obstetric patients discharged from the hospital, the incidence of cardiac disease is 3.97 per cent.

2. The maternal mortality is almost three times as high in cardiac patients as in the total hospital patients.

3. Rheumatic heart disease accounts for more than 90 per cent of our pregnant cardiac patients.

4. We are of the definite opinion that the functional classification of the New York Heart Association is of more value as an aid in the treatment of the pregnant patient suffering from heart disease than is the anatomic classification.

5. Only about 41 per cent of the group of 418 cardiac patients studied gave no history of rheumatic fever, scarlet fever, chorea or frequent sore throat.

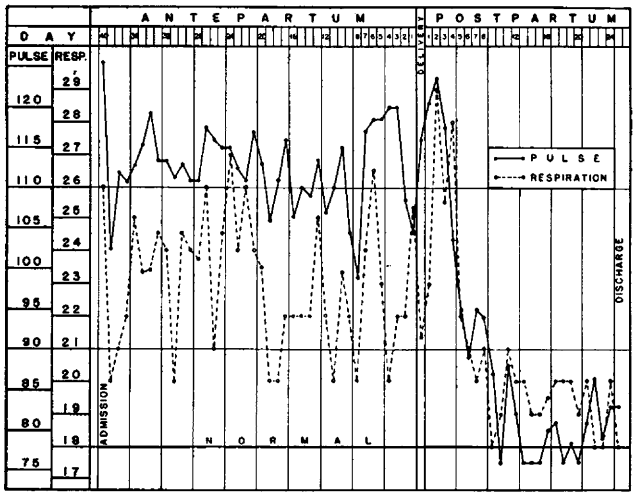

Chart 4.—Cesarean section with sterilization in class 3 cardiac disease.

6. About 50 per cent of the 418 cardiac patients were wholly unaware, at the time they first consulted a physician in their pregnancy, of the existence of a cardiac disease.

7. Hospitalization and complete rest are the greatest aids in the treatment of heart disease in pregnant women.

8. Digitalis and its compounds are of definite help in the severe types of this disease.

9. Increased pulse and respiration rates, dyspnea and cyanosis, undue fatigue, palpitation and chest pains are the outstanding signs and symptoms in the evaluation of the cardiac condition.

10. The treatment in class 1 and class *2a* cardiac patients consists of hospitalization two weeks before term, followed by spontaneous delivery or in a small number forceps delivery at the beginning of the second stage.

11. The severe types, class *2b* and class 3, must be hospitalized earlier in pregnancy in order to decide whether the pregnancy should be allowed to continue, and, if so, delivery should be effected by forceps unless the patient falls in the class 3 category.

12. In those patients who have had a definite break in compensation it is advisable, after adequate hospitalization with digitalis therapy, to perform a cesarean section either at viability or at term, followed by sterilization.

530 East Seventieth Street.

CLIMATE AND RHEUMATIC HEART DISEASE

A SURVEY AMONG AMERICAN INDIAN SCHOOL CHILDREN IN NORTHERN AND SOUTHERN LOCALITIES

JOHN R. PAUL, M.D.
AND
GEORGE L. DIXON, M.D.
TUCSON, ARIZ.

The influence of climate on the prevalence, course and clinical picture of rheumatic fever has been much discussed though seldom accurately measured.[1] Widespread differences in clinical concepts about this disease which exist in different places, difficulties in clinical diagnosis and the absence of specific diagnostic tests have made it practically impossible to determine its prevalence with accuracy in any given locality, much less to compare its prevalence in several localities. Despite the lack of accurate data, however, there is general agreement that the disease is common and severe in temperate zones, that it is less common in warmer and subtropical climates, and that it is rare in the tropics.[2] But comparative prevalence determinations in which identical diagnostic criteria have been used in different geographic or climatologic locations are practically nonexistent. Consequently it has been the major object in this work to make such determinations under conditions that were moderately controlled.

METHODS

For measuring the geographic prevalence of rheumatic heart disease we have determined the rates (or percentage) of such cases as could be found among three groups of Indian school children in northwestern and southwestern sections of this country. The choice of these Indian populations has rested on the fact that there is a general similarity from the standpoint of race among some North American Indian tribes which is not found among other groups of Americans, and also that, regardless of their geographic locality, there is a general similarity of their living conditions. Furthermore, within certain Indian reservations in this country many of the adults and almost all of the younger children have spent their lives within a few miles of the place of their birth. Their illnesses, therefore, should be truly representative of local, living and climatic conditions. In fact, several such groups of Indians may furnish more valuable information about

The expenses of this work have been defrayed by the Milbank Memorial Fund.

From the Department of Internal Medicine, Yale University School of Medicine, New Haven, Conn., and the Desert Sanatorium, Tucson, Ariz.

1. Accurate determinations on the prevalence of a disease which is not reportable are difficult enough to obtain but particularly difficult in a disease in which there is no diagnostic test, such as rheumatic fever or its sequelae. Data from hospital admission lists throughout this country or from private practice are of some value, though admittedly inaccurate. See discussion of Nichol's [2a] paper and Climate and Rheumatic Fever, editorial, J. A. M. A. **108**: 210 (Jan. 16) 1937.

2. Most of the recent literature on this subject has been summarized by (*a*) Nichol, E. S.: Geographic Distribution of Rheumatic Fever and Rheumatic Heart Disease in the United States, J. Lab. & Clin. Med. **21**: 588 (March) 1936. See also (*b*) Coburn, A. F.: The Factor of Infection in the Rheumatic State, Baltimore, Williams & Wilkins Company, 1931.

the geography of disease than do most school populations in this country. Particularly is this true of the Southwest, a region which has been included in this survey, where the white school population contains a large percentage of recent immigrants from other regions.

A final controlled condition used in this study is that the same methods of gathering data and the same diagnostic criteria have been applied by the same two examiners in the different locations studied.

In planning the study, a section of the West was first outlined and a number of Indian reservations within this section were chosen (fig. 1). Permission for the privilege of proceeding with this work was first obtained from the Office of Indian Affairs, U. S. Department of the Interior.[3] The reservations were then divided into a northern, a middle and a southern division, from which comparable groups of children could be examined. As will be seen from the map in figure 1, the two northern reservations (representing Crow, Shoshone and Arapahoe Indians) were located in Montana and Wyoming; the middle reservations (largely representing Navajo Indians) were located in northern New Mexico and northern Arizona, and the southern reservations (representing Pima and Papago Indians) were located in southern Arizona. It will also be seen that the middle group is not separated from the southern one by nearly as great a distance as it is from the northern one. But in spite of their proximity to one another the isothermal lines show a difference of 20 degrees F. in the average temperature (which is largely the result of a difference in altitude) between the southern and the middle group, and this is considerably greater than the temperature difference of 5 degrees F. existing between the middle and the northern group.

Another climatic condition that concerns the areas under surveillance appears in figure 2. Here the degree of moisture (precipitation) is shown on the sectional map. It will be seen that all the Indian reservations surveyed were in fairly dry areas but that the southernmost group is in a region with precipitation figures ranging from only 3 to 10 inches a year.

It was our object to examine about 1,000 children of the same age distribution from each of these three (northern, middle and southern) groups.

DIAGNOSTIC CRITERIA

Obviously the diagnosis of clear-cut rheumatic heart disease offers little difficulty, but mild cases offer considerable difficulty. Most of the cases encountered in a survey of this type are mild, and of course inactive, and unfortunately the diagnosis of just such forms as these requires a large element of personal judgment. It has been our effort throughout, however, to include only the more definite cases.

In approaching the problem we have assumed from the onset that the great majority of children showing rheumatic carditis will present evidence of mitral insufficiency or stenosis and that in such cases systolic or presystolic murmurs will probably be present in the region of the cardiac apex. In justification of this approach it should be emphasized that we have followed the rule that most systolic murmurs do not indicate the presence of any organic heart disease. Nevertheless a search for such murmurs generally represented the starting point of our cardiac examinations.

All the examinations recorded in this study were performed by one of us, and most of the doubtful cases were seen by both of us. In the actual performance of the cardiac examinations the following procedure was used:

The children were stripped to the waist and unless abnormal conditions were present were examined only in the erect position. A few features besides those referable to the heart were included; namely, the degree of nutrition, evidences of infection of the upper respiratory tract and the size of cervical lymph nodes. For the cardiac examination the hand was placed on the precordium and the point of maximum impulse located.

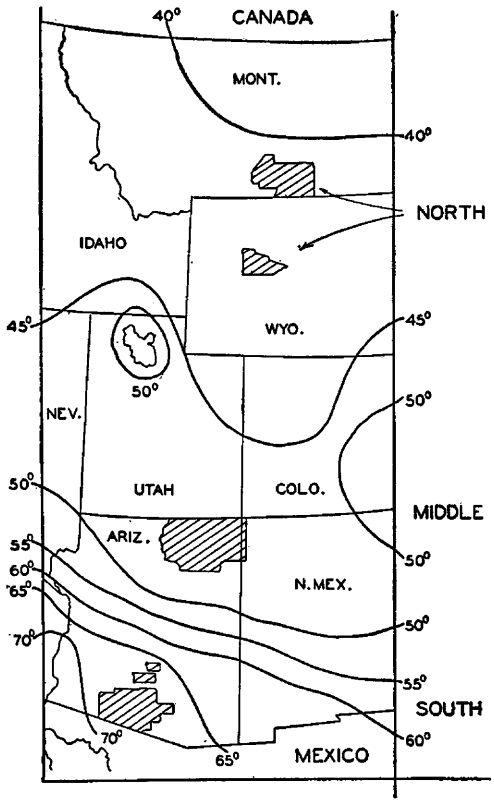

Fig. 1.—Sectional map of the United States showing (by shaded areas) the locations of the three groups of Indian reservations included in this study. The series of curved lines (isotherms) indicate average annual temperatures.

The stethoscope was then placed on the apical region, the midprecordium and the base of the heart. If no abnormalities were found on palpation and auscultation, the child's heart was considered normal. No attempt was made to determine the size of the heart by percussion, unless abnormalities detected either by palpation or auscultation were found. The usual time consumed in the examination of children with normal hearts was about two minutes per child.

As a rule we paid little or no attention to soft systolic murmurs heard only at the pulmonic area and have not included them in the recorded results. All murmurs heard in the midprecordium were, however, recorded. Of these, systolic murmurs were the most frequently heard, and we have classified them arbitrarily, i. e., regardless as to where they seemed to arise, into three types, according to the diagram in figure 3.

Type I systolic murmurs represent a loud murmur, usually maximal in the general region of the apex,

3. Dr. J. G. Townsend, Director of Health, Office of Indian Affairs, Washington, D. C., gave this permission, and many medical officers in the Indian Service, whose names are too numerous to mention here, were generous in their cooperation and support of this work.

which can be heard in the area indicated; that is, besides covering the midprecordium it extends laterally beyond the left nipple line and often downward. Such murmurs were present in the majority of cases that we have listed as definite rheumatic heart disease.

Type II represents a systolic murmur which is not as loud as type I and can be heard laterally as far as the left nipple line but not beyond. It is in the interpretation of these type II murmurs as to whether they

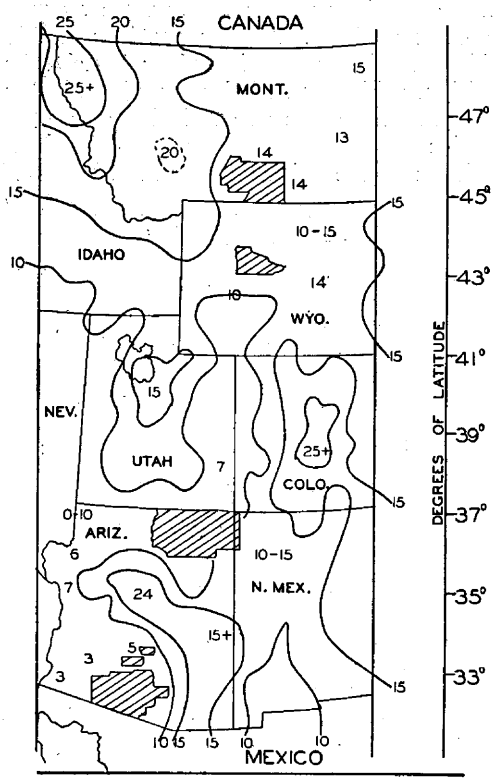

Fig. 2.—Sectional map, similar to that in figure 1, showing by isohyetal lines or scattered figures the normal annual precipitation (expressed in inches). Degrees of north latitude appear on the right of this map.

were "functional" or "organic" that we have met our greatest difficulty, and in their presence we have examined the heart as carefully as the circumstances would permit, and with the subject lying on his back and also on his left side.

Type III is represented by a soft systolic murmur which is heard in the midprecordium but is also heard in the pulmonic area and is not transmitted laterally. It is our impression that the great majority of these murmurs are transmitted from the base downward. From the onset of this survey we did not consider them as of much significance as far as the diagnosis of rheumatic heart disease is concerned, and evidence accumulated in the course of the study substantiated this belief.

In interpreting our type II and III systolic murmurs as a starting point in the diagnosis of rheumatic heart disease, the following other aids to diagnosis were occasionally used:

A history of rheumatic fever, if present, was regarded as of positive importance in the presence of questionable cardiac signs. Such histories were obtained, however, in a very small number of questionable cases.

Some of the other signs, which have been regarded as aids to a positive diagnosis, were the presence of cardiac enlargement that could not be explained on any other basis, an increase in the area of impulse to the left, accentuation of the first sound at the apex, accentuation of the pulmonic second sound, and accentuation of the murmur when the patient was lying on his left side.

The diagnosis of congenital heart disease rested on the cardiac manifestations, the presence of cyanosis, clubbing of the fingers and the history.

RESULTS

Rheumatic heart disease rates found in the school children within the three areas covered by this survey appear in table 1. For their proper interpretation they should be compared with similar rates determined in school children from other sections of this or other countries, but unfortunately few such comparisons can be made. For, although there are many statistics on the observed prevalence of heart disease in school children, they have been largely compiled from data obtained in the course of routine physical examinations in which the diagnostic criteria for either heart disease or rheumatic heart disease have not been defined and the methods of examination of the heart have of necessity been more cursory than those employed here. This question has been discussed in a previous publication in which juvenile, organic heart disease rates ranging from 0.1 to 2.1 per cent have been collected from the literature (up to 1934) and tabulated geographically.[4] It is our impression that such crude rates, so far as they concern rheumatic heart disease, are considerably lower than those which would have been found in this survey. This impression has been strengthened by the fact that, using the identical methods outlined in the present report, one of us (J. R. P.) has previously determined the prevalence of rheumatic heart disease in a group of school children within the city of New Haven, Conn., and found it to be considerably higher than that obtained the previous year by the school physicians.[4]

But to return to the figures in table 1. Here it appears that Indian children from certain of the northwestern reservations show a high rate of rheumatic heart disease. It happens to be twice as high as that (2.2 per cent) determined by the same method among urban New England school children living at a somewhat more southern latitude, although in a climate far more damp. Among the thirty-one children found to have rheumatic heart disease in the northwestern Indian

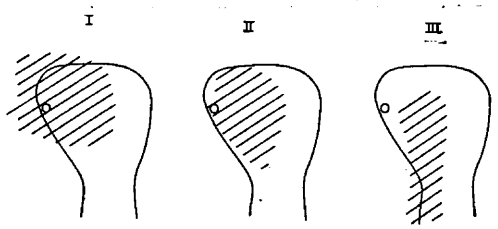

Fig. 3.—Diagrammatic cardiac outlines on which are indicated the sites (shaded areas) where the three types of systolic murmurs recorded in this study were heard. The small circle roughly marks the site of the left nipple.

group, about a third of them proved to have mitral stenosis, and also in about a third of them a history of an illness compatible with rheumatic fever was obtained. In about half of the latter group (with a story of illness) hospital records were available. These results indicate that the Crow, Shoshone and Arapahoe Indians, which were the northern tribes observed, are

4. Paul, J. R.; Harrison, E. R.; Salinger, Robert, and DeForest, G. K.: The Social Incidence of Rheumatic Heart Disease: A Statistical Study in New Haven School Children, Am. J. M. Sc. **188**: 301 (Sept.) 1934.

quite susceptible to rheumatic fever and that they often suffer from its most serious complication.[5] No difference in the rheumatic heart disease rates was found among these three different northern tribes and no apparent difference between those of mixed blood as compared with those of pure blood.[6]

In the middle division of Indian reservations (from northern Arizona and New Mexico—largely representing Navajos) the rheumatic heart rate was found to be 1.9 per cent, or less than half that found among the tribes farther north. Here again a third of the twenty-one Indians proved to have mitral stenosis and in about the same percentage a history compatible with that of rheumatic fever was obtained.

In the southernmost group (southern Arizona—largely representing Pimas and Papagos) rheumatic heart disease was found to be rare. Only five cases were found in about 1,000 children examined, and there was only one case of mitral stenosis.

TABLE 1.—*Rheumatic Heart Disease Rates in Three Different Locations* *

Location of Reservations	Latitude North	Climatic Conditions: Temperature†	Climatic Conditions: Precipitation‡	No. of Indian Children Examined	No. with Definite Rheumatic Heart Disease	Per Cent with Rheumatic Heart Disease
North	44°-46°	42.5°	10-14	688	31	4.5
Middle	26°-37°	47.5°	7-10+	1,106	21	1.9
South	32°-33°	67.5°	3-10	1,019	5	0.5

* For purposes of comparison, attention is called to the fact that the prevalence of rheumatic heart disease has been found to be 2.2 per cent among 2,624 urban and rural school children similarly examined in 1934 in and about the city of New Haven, Conn.[4]
† Approximate average normal temperature for the year in degrees Fahrenheit.
‡ Normal annual precipitation in inches.

OTHER HEART ABNORMALITIES

Mention has been made that the presence of various (three) types of systolic murmurs (fig. 3) was recorded in the course of this survey. Actual prevalence figures for each type are not listed in this report but it is of significance that our type III, midprecordial systolic murmurs (heard also at the base, rather than laterally) were found with equal prevalence in all three (northern, middle and southern) groups. This is in sharp contrast to the geographic prevalence of our type I murmurs (transmitted laterally) and is a finding having some bearing on the clinical interpretation of systolic murmurs.

Examples of congenital heart disease (or congenital cardiac abnormalities) are limited to those types which are most apt to be detected by auscultation alone. Seven such cases (about 0.2 per cent) were found in the entire number (2,813) of children examined. Included among these seven was one case of dextrocardia and two definite cases of patent ductus arteriosus. The remaining four were probably examples of interventricular septal defects.

Other cardiac conditions included one case of old tuberculous pericarditis, five cases of unexplained cardiac enlargement, three of unexplained tachycardia and three of extrasystoles.

Extracardiac abnormalities noted in the course of our examinations which are worth mentioning include the high and more or less equal prevalence of mild infections of the upper respiratory tract—largely colds, present in all three groups (northern, middle and southern), the high and almost equal frequency with which enlargement of the posterior cervical lymph glands was encountered, and the high prevalence of infestations of the scalp with pediculus capitis.

POSSIBLE SOURCES OF ERROR

Obviously the rheumatic heart disease rates listed in table 1 cannot be satisfactorily compared with one another without a consideration of the factors that may influence them. For instance, unless the children from each major geographic division are of comparable age, the carditis rates are not comparable.[7] The age distribution of the children in these three divisions is not identical, but their degree of similarity is sufficient to allow a comparison of several of the different age groups. This appears in table 2. The three age groups of 7 to 9, 10 to 12, and 13 to 15 years offer the most significant figures.

Another point that may have some bearing on our observations is the difference in physical types and degree of nutrition existent between Indians of some of the different tribes. This has been well illustrated by the difference between the Arapahoe children of the North and the Pima children of the South. Arapahoes are plains Indians, for the most part "meat eaters," and the children, at least as they were brought in from their homes at the opening of the schools, often appeared undernourished. Pima Indians are agricultural and subsist largely on a carbohydrate diet, and the children under similar circumstances were often greatly overnourished. In comparing the weights of Indian children from these two tribes with the average normal weights of white American children of comparable ages and heights, we found that about 45 per cent of the Pima children were "overweight" (10 per cent being as much as 35 pounds [16 Kg.] or more "overweight") and but 8 per cent were "underweight," whereas among the Arapahoe children 15 per cent were "overweight" and 41 per cent were "underweight." Consequently in determining the rheumatic heart disease rates in

TABLE 2.—*Rheumatic Heart Disease Rates in Different Age Groups*

		Age Groups* 5-6	7-9	10-12	13-15	16-19	19+
North division	Number of children in age group	80	204	209	142	49	4
	Per cent with rheumatic heart disease	0	3.9	8.1	4.2	..	..
Middle division	Number of children in age group	61	158	203	312	297	75
	Per cent with rheumatic heart disease	0	4.4	2.0	1.5	1.3	1.3
South division	Number of children in age group	114	296	299	227	77	6
	Per cent with rheumatic heart disease	0	1.0	0.3	0	1.3	..

* Rates have not been determined unless the age groups contain more than fifty children.

5. A high prevalence of rheumatic heart disease has been previously recorded among another Northern American Indian tribe; namely, the Menominees in northeastern Wisconsin. Hrdlička, Aleš: Tuberculosis Among Certain Indian Tribes of the United States, Bull. 42, Smithsonian Institution, Bureau of American Ethnology, Washington, D. C., Government Printing Office, 1909.

6. This is in contrast to the results found in tuberculosis among some of these same Indian tribes in which a relationship between the degree of Indian blood and the incidence of tuberculous infection was found. Aronson, J. D.: Personal communication to the authors.

7. A serious source of error may exist in data concerning the age of North American Indians. In some tribes the parents do not seem to know the ages of their children. Under these circumstances "ages" have been assigned to many of the children in this series by school teachers. Some appreciation of their accuracy can be obtained from height-weight tables. It is our impression that about two thirds of the ages recorded in our series are reasonably correct. In the other third (and this applies mainly to the middle division) there is a probable error in many of the children of about ± 1 year.

these two particular groups of Indian children the difference lies not only in their geographic separation but also in their physical type. In one group there is a large percentage of apparently undernourished children with thin chest walls and easily heard heart sounds, and in the other there are many fat children with thick chest walls. What effect this difference in degree of nutrition may have on the actual prevalence of rheumatic heart disease is, of course, unknown, but what effect it may have on the detection of mild cases of rheumatic heart disease should be considered. Some cases of rheumatic heart disease may have been overlooked in the Pima children, owing to the poor audibility of heart sounds and perhaps to the difficulty in determining the size of the heart. This may have influenced our results, but it is our belief that such a source of error has been slight. Even if the error in this group were as great as the omission of one case of rheumatic heart disease in every 100 children examined, our results would still point to an appreciable decrease in the rheumatic heart disease rates in the Southwest as compared with the Northwest.

COMMENT

It has been intimated earlier in this article that the influence of climate on the prevalence of rheumatic fever is a subject much discussed but less frequently defined and that there has been a dearth of accurate data on the subject. Despite this lack of accurate data there has been, however, general agreement that the disease is common and severe in the temperate zones, that it is less prevalent in warmer (subtropical) climates, and that it is rare in tropical climates. With this impression the results presented in this paper in general agree, and certain figures are presented which we believe are significant because of the moderately controlled conditions under which they have been obtained.

On the other hand, there has been little general agreement as to whether the clinical picture of rheumatic fever is the same in the North as in the South. It has even been suggested that the southern form of the disease may be characterized by the absence of joint symptoms and, without these warning signals of acute arthritis and chronic muscle pain, rheumatic carditis may develop in the south more insidiously and with greater frequency than is generally supposed.[8] From our own results the notion that rheumatic carditis may develop with considerable unsuspected frequency in the Southwest finds no support, for regardless of the fact that the northern rate used for comparison was found to be unusually high (4.5 per cent) the southern rate (0.5 per cent) seems unusually low.

The high rate (4.5 per cent) found among the northern Indian tribes raises a question of some interest because the element of cold, or more particularly dry cold, has not usually been regarded as the sole climatic feature that favors a high prevalence of the disease. On the other hand the element of cold coupled with dampness has long been incriminated as one of the primary conditions favoring the spread of rheumatic fever, as has also the influence of crowding, such as urban as opposed to rural life. Consequently, it is remarkable to find a higher prevalence in relatively dry Montana and Wyoming (normal annual precipitation from 10 to 15 inches) among rural Indian children than that found among urban children in the vicinity of New York City (normal annual precipitation 45 inches). This suggests that either a high susceptibility exists for the disease on the part of some Indians or that something is present in their living conditions that is particularly conducive to the spread of the disease. Whatever such factors may be, they remain to be analyzed. Attention may be called, however, to the fact that although the Indians included in this survey represent a rural (as opposed to an urban) population, the degree of crowding that must occur during the winter months among their family groups probably rivals or even exceeds that found within tenement houses in city slums; for the Indian family group often includes three generations, their winter dwelling is generally a one room affair, and Montana winters are long.

SUMMARY

The different rates with which rheumatic heart disease may be found in school children in different sections of this country is a valuable method for determining the geographic prevalence of rheumatic fever. Groups of Indian school children are particularly favorable for such determinations because of their homogeneity from the standpoint of race and of living conditions and because of the stability of the populations within many of the Indian reservations of the West.

From a survey of Indian children it has been shown that in the cold though relatively dry climate of Wyoming and Montana the prevalence of rheumatic heart disease (4.5 per cent) is high, in comparison with rates determined in New England (2.2 per cent), whereas in the warm though dry climate of southern Arizona it is correspondingly low (0.5 per cent). In other words, rheumatic heart disease is almost ten times as frequent among western Indians living in regions close to the Canadian border as it is among similar groups living close to the Mexican border.

It is probable that the clinical course of rheumatic fever in the Southwest may be milder than that usually encountered in the North, but no evidence was found in this survey suggesting that the apparent mildness of the clinical picture of rheumatic fever in the Southwest may allow rheumatic heart disease to develop with an unsuspected frequency comparable to that seen in more northern climates.

8. McLean, C. C.: The Age Incidence and Climatic Variations in the Manifestations of So-Called Rheumatic Fever in White Children, J. Pediat. **2**: 320 (March) 1933. See also discussion of paper by Bitzer, E. W., and Cook, G. L.: A Clinical Investigation of Incidence of Rheumatic Heart Disease in a Subtropical Climate, South. M. J. **27**: 503 (June) 1934. Also editorial opinion expressed by Hench, P. S.; Bauer, Walter; Fletcher, A. A.; Ghrist, David; Hall, Francis, and White, Preston: The Present Status of the Problem of "Rheumatism"; a Review of Recent American and English Literature on "Rheumatism" and Arthritis, Ann. Int. Med. **8**: 1315 (April) 1935.

Theory of Cause of Allergy.—Studying a large number of allergic families and comparing them with normal controls, Haag has come to the conclusion that there is no evidence that allergic diseases may be considered psychoneuroses or that mental conflict is of any major significance in their etiology. Since a hereditary predisposition is the basis of allergic diseases, all positions in the family circle should show equal incidence of such disease. Since first-born children in all families and youngest children in large families showed the greatest frequency of allergic diseases, some special factor must be present there. The author finds an explanation in the type of nutrition. First-born children, and the youngest children, where older brothers and sisters spoil them, receive special care and are frequently overfed. He regards overfeeding in childhood of significance in producing allergic diseases.—Feinberg, S. M.: Progress in Asthma and Hay Fever, *J. Allergy* **8**: 280 (March) 1937.