

Rheumatic Fever in School Children of Denver, Colorado

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FOR MANY YEARS, COLORADO was among the States having the highest death rates from rheumatic heart disease. The high prevalence of rheumatic fever in the Rocky Mountain areas from the 1940s to the 1960s has been well documented (1-5). In 1945, a Rheumatic Fever Diagnostic Service was established at the University of Colorado School of Medicine at Denver, to which any child in the area who was thought to have rheumatic fever could be referred for examination.

During the first 3 years of the operation of this service, 2,639 children were referred from the greater metropolitan area of Denver (6, 7). The records of 1,971 children seen during the first 2 years were analyzed in detail, and they are the basis of this report. Since the most frequent reason for referral was the discovery of a functional

heart murmur in the course of a routine physical examination, many of the referred children were found to be entirely healthy. This finding provided an opportunity to study the characteristics of rheumatic children in a high-prevalence area and to use a large group of healthy children as controls.

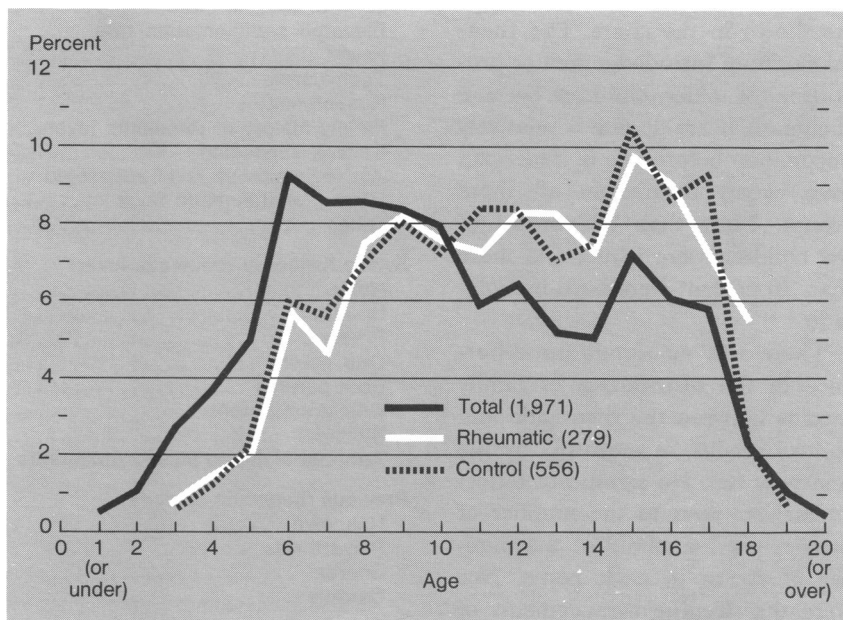
Methods

Each child had a history taken, a physical examination, an electrocardiogram, a fluoroscopy, an interview with a social worker and a dietitian, and laboratory studies including urinalysis, hematocrit, leukocyte count, and sedimentation rate. All findings on each child

were punched on IBM cards. Of the total 1,971 children, 1,236 were found to have no heart disease and 604 were classed as rheumatic, including those with a history of rheumatic fever or chorea and with possible rheumatic fever or rheumatic heart disease. Of the remaining 131 children, 118 had definite or possible congenital heart disease and 14 (1 duplicate) had miscellaneous cardiac conditions including hypertension.

Of the 604 children classed as rheumatic, only those who had unquestionable rheumatic fever, chorea, carditis, or inactive rheumatic heart disease at the time they were seen in the clinic were included in the study. All 325

Age distribution of total clinic population and rheumatic and control groups



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children with only a history of a rheumatic episode or possible active rheumatic fever and rheumatic heart disease were excluded. The remainder, a total of 279 children—hereafter referred to as “the rheumatic group”—included 242 with rheumatic heart disease or active carditis, or both, 22 with chorea (3 of these also had rheumatic heart disease), and 18 with acute rheumatic fever. At the time they were seen in the clinic, 12 of the children in the rheumatic group had pericarditis, and 6 had subcutaneous nodules.

From the group of 1,236 children with no heart disease, all those with other conditions such as acute or chronic respiratory infections were excluded. Enough children remained so that control children could be selected from each age group to match the age distribution of the rheumatic children. Thus, the control group consisted of 556 children who were entirely healthy at the time they were examined.

Results

The results of the study are detailed in table 1. The age distributions of the total clinic population, the rheumatic group, and the control group are shown in the chart. The rheumatic group included a greater proportion of older children because rheumatic heart disease is relatively uncommon before age 6. The sexes were evenly divided in all three groups. More than 90 percent of the children were white, and more than 70 percent were born in Colorado.

There was no significant difference in the distribution of family income between the rheumatic and control groups, as measured by the Smirnow test. No significant differences were seen in the number of persons per household or the number of rooms in each home. Nor were the sleeping arrangements of

Table 1. Characteristics of children referred to Rheumatic Fever Diagnostic Service, Denver, in percentages

Characteristics	Total clinic population (N = 1,971)	Rheumatics (N = 279)	Controls (N = 556)
Sex:			
Male	50.68	49.46	50.71
Female	49.21	50.17	49.28
Birthplace:			
Denver	54.66	51.25	52.15
Colorado	17.90	20.43	18.16
Other	25.67	26.16	29.87
Race:			
White	91.73	94.26	91.90
Black	1.93	1.43	1.97
Mexican-American or Spanish-American	5.02	2.85	4.31
Asian-American .....	.66	.72	1.08
Income:¹			
Under \$2,500	51.69	50.17	48.90
Over \$2,500	34.09	36.90	36.01
No answer	14.91	17.56	15.46
Family owns home	51.49	55.19	53.41
Crowding:			
Rooms alone	33.23	38.70	35.97
Rooms with sibling, sleeps alone	28.36	25.44	27.50
Sleeps with sibling	38.84	32.25	31.29
Sources of referral:			
Patient has private physician	72.09	72.75	68.88
Referred by private physician	46.82	49.46	38.84
Referred by schools with permission of private physician	22.47	21.50	27.51
Other sources	6.80	5.02	5.26
Reason for referral:			
Heart murmur, private physician	26.07	21.50	35.61
Heart murmur, school physician	17.75	12.18	15.46
Joint or muscle pains	22.57	15.77	23.74
Elevated sedimentation rate .....	.86	.71	1.07
Fever	4.01	1.79	3.05
Tachycardia	1.93	.71	2.69
Nosebleeds	4.16	1.79	4.13
Family history of rheumatic fever .....	.96	.35	1.25
Chorea suspected	1.57	5.37	.71
Active rheumatic fever suspected	5.89	12.18	3.95
History of rheumatic fever	13.24	29.39	4.67
Other	11.41	6.09	11.69
Family history of rheumatic fever:			
None	56.57	48.03	61.33
Doubtful	11.47	12.90	10.25
Present	29.02	35.84	26.97
One parent	11.51	13.62	8.27
Both parents .....	.71	1.07	.35
One grandparent	3.20	3.94	3.59
Sibling	7.31	12.90	6.83
Adopted child, no history obtainable .....	.86	.35	.53
Previous rheumatic episode:			
Unknown	9.03	8.24	9.90
Polyarthritis	9.80	22.93	.36
Chorea	3.09	14.33	
Carditis .....	.30	1.80	

Table 1. Characteristics of children referred to Rheumatic Fever Diagnostic Service, Denver, in percentages—continued

Characteristics	Total clinic population (N = 1,971)	Rheumatics (N = 279)	Controls (N = 556)
Two or more attacks:			
Polyarthritis	1.73	6.45	
Rheumatic episodes			
Type not determined	2.44	9.00	
Two attacks of chorea .....	.20	1.43	
Three or more attacks of chorea .....	.25	1.43	
Decompensation .....	.15	.72	
Birth history:			
Abnormal	7.66	3.58	11.15
Prematurity	4.10	2.86	5.93
Regular pediatric supervision	39.52	38.35	36.69
Immunization history:			
Smallpox	86.91	89.60	87.41
Diphtheria	83.46	84.58	82.55
Pertussis	36.52	25.44	34.53
Other history:			
Sore throat	49.77	46.59	46.76
Tonsillitis	42.16	41.21	37.58
Scarlet fever	15.57	19.71	18.52
Diphtheria	2.28	1.79	1.97
Influenza	30.69	37.99	32.55
Otitis	27.49	24.73	28.59
Sinusitis	10.14	11.11	11.51
Pneumonia	16.99	21.14	13.84
Measles	77.37	84.94	82.01
Mumps	43.12	52.32	45.32
Pertussis	49.67	55.19	53.41
Chickenpox	66.56	65.94	70.68
German measles	39.21	44.08	36.33
Poliomyelitis	2.48	1.63	1.07
Exposure to tuberculosis	7.45	6.09	6.65
Brucellosis .....	.41	.35	.71
Eczema, hay fever, or asthma	22.07	14.33	22.79
Tonsillectomy	60.27	62.36	63.48
Accidents	15.93	18.27	17.98
Appendectomy	3.85	4.65	3.95
Other operation	3.90	3.94	4.49
Jaundice	4.06	5.38	3.23
Kidney trouble	6.29	6.45	4.49
Constipation	14.35	13.97	13.66
Hearing problem	6.24	6.81	5.03
Cough	13.85	13.62	10.07
Headache	29.27	34.40	27.69
Fainting	5.78	9.67	6.11
Menses started	13.69	18.27	19.06
Convulsions	3.75	2.15	3.23
Night terrors	14.86	11.82	13.84
Temper tantrums	14.71	10.75	12.76
Nailbiting	25.26	25.08	26.25
Enuresis	14.91	13.62	11.69
Family history of diseases:			
Tuberculosis	21.05	20.07	21.40
Cancer	26.48	25.80	22.48

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the children in the rheumatic group more crowded than those of the control group. More than 50 percent of the families in both groups owned their homes. About 70 percent of the total clinic population and the rheumatic group had been referred either directly by their physicians or by the schools with the permission of their physicians. A slightly lower percentage of the control group were referred by their physicians or with their physicians' permission. The remainder were referred directly by the schools or by community agencies, such as the Visiting Nurse Association, or public health nurses.

The children in both groups represented a cross-section of the school population of the city. In most categories, the two groups did not differ. The categories in which there were differences are shown in table 2. The rheumatic group had a higher incidence of family histories of rheumatic fever and a lower incidence of family histories of allergies. The higher percentage of abnormal births recorded for the control group seemed to be due primarily to a higher incidence of prematurity. Although there was no difference in numbers of children immunized against diphtheria and smallpox, a smaller number of the rheumatic group had been immunized against pertussis. There was a higher incidence of a history of pneumonia and rubella in the rheumatic group and of rheumatic children with either enlarged or infected tonsils and a lower incidence of hay fever, asthma, and eczema.

Because Denver is a mile above sea level, the hematocrits of both groups were relatively high. Approximately 3 times as many children in the rheumatic group had hematocrits of <40 percent, and 38 percent of the rheumatic group had a sedimentation rate of >.45 mm compared to 7.33 percent of the con-

trols. Leucocyte counts of $>10,000$ mm^3 were present in 8.60 percent of the rheumatic group compared to 1.79 percent of the control group. These laboratory data indicate that many of the rheumatic children were in the active rheumatic state.

There were some differences between the two groups that were of borderline significance—more rheumatic children with a history of mumps, influenza, headache, and red cells or casts in the urine. The elevated blood pressure observed in the rheumatic group probably reflects the fact that 15 percent of these children had aortic regurgitation.

Although a family history of rheumatic fever was significantly higher in the rheumatic group, more than 25 percent of the control group also had this history. We refined this group of control children further by excluding all those with either a positive or a doubtful family history. The resultant "no family history group" of 357 children was again compared to the rheumatic group with respect to past illnesses. The differences for pneumonia and allergy widened slightly, and for rubella the difference increased in significance from $P < .05$ to $P < .001$ (table 3). From the findings of this analysis, it seems that not only children with a personal history of rheumatic fever but also those with only a family history of the disease were more susceptible to rubella.

Discussion

The results of this study confirm the theory that rheumatic fever tends to aggregate in families. This finding has been documented by other investigators, notably Wilson (8). The lower rates of personal and family histories of allergies among the rheumatic children suggest that they are not unusually hypersensitive.

Table 1. Characteristics of children referred to Rheumatic Fever Diagnostic Service, Denver, in percentages—continued

Characteristics	Total clinic population (N = 1,971)	Rheumatics (N = 279)	Controls (N = 556)
Family history of diseases (continued):			
Rheumatoid arthritis	18.92	17.20	16.17
Allergy	34.14	28.31	35.79
Heart disease other than rheumatic heart disease	28.71	30.10	27.69
Hyperthyroidism	14.71	15.41	12.94
Nephritis	11.36	13.62	9.71
Epilepsy	3.30	3.22	3.05
Diabetes	11.82	9.31	13.48
Hypothyroidism	.76	1.79	.17
Pounds under expected weight:			
20 or more	2.33	3.22	2.87
15-19	3.75	6.09	5.57
10-14	8.12	9.67	9.35
5-9	14.81	15.77	14.38
1-4	22.67	19.71	20.14
Exact expected weight	7.51	6.81	4.85
Pounds over expected weight:			
1-4	17.40	12.18	16.72
5-9	9.79	7.16	8.09
10-14	5.53	8.96	5.93
15-19	1.93	2.50	3.59
20 or more	4.77	6.45	6.47
Tonsils:			
Out	58.85	60.59	61.15
In and normal	21.10	16.12	21.76
Enlarged	13.34	14.33	8.45
Infected	5.86	8.96	3.77
Blood pressure, systolic (mm Hg):			
150 or more	.82	1.07	.89
140	1.62	3.94	1.97
130	4.21	8.24	4.31
120	14.40	20.78	15.28
110	24.15	26.52	28.95
100	24.15	20.78	20.32
90	13.64	6.81	12.76
80	2.99	1.43	1.25
70	.36	.35	.17
60	.05		
110 or more	45.20	61.29	52.33
100 or less	41.20	29.39	34.53
Not taken	13.65	10.03	13.84
Laboratory findings:			
Red cells or casts in urine	3.09	4.65	2.51
Hematocrit 39 or below	9.43	12.54	4.49
Sedimentation rate .45 or above	18.71	37.99	7.33
Leucocyte count more than 10,000	4.31	8.60	1.79
Diet and medications:			
Diet low in iron	56.06	55.55	56.29
Diet low in calcium	27.90	31.18	27.33
Diet low in vitamin C	28.66	26.16	28.77
Vitamin medication	32.47	22.93	26.97
Iodized salt	73.16	74.19	72.48
Iron and liver	6.95	7.88	4.85
Raw milk	6.80	8.24	5.76

¹ Median Income, United States, in 1945 was \$2,621 (U.S. Census Bureau, Current Population Report No. 2, p. 60).

Table 2. Categories of significant differences between rheumatic and control groups, in percentages

Category	Total clinic population (N = 1,971)	Rheumatics (N = 279)	Controls (N = 556)	P
Family history:				
Rheumatic fever	29.02	35.84	26.97	<.05
Allergy	34.14	28.31	35.79	<.05
Birth history: abnormal	7.66	3.58	11.15	<.005
Immunization: pertussis	36.52	25.44	34.53	<.01
Personal history:				
Pneumonia	16.99	21.24	13.84	<.01
Rubella	39.21	44.08	36.33	<.05
Hay fever, asthma, or eczema	22.07	14.33	22.79	<.01
Tonsils:				
Normal	21.10	16.12	21.76	
Enlarged	13.34	14.33	8.45	
Infected	5.86	8.96	3.77	<.005
Laboratory findings:				
Hematocrit 39 or below	9.44	12.54	4.49	<.005
Sedimentation rate .45 or above	18.71	37.99	7.33	<.005
Leucocyte count more than 10,000	4.31	8.60	1.79	<.005

The rheumatic children clearly tended to be anemic, although the distribution of body weight was the same for the two groups and dietary histories revealed no differences in iron intake.

More rheumatic than control children had a history of pneumonia and had enlarged and infected tonsils. About 60 percent of both groups had had tonsillectomies. However, since all children

with acute and chronic respiratory infections had been eliminated from the control group, no conclusion can be drawn concerning the significance of these findings. It is not clear why the control children had higher rates of abnormal births and pertussis immunization than the rheumatic children.

Not previously documented is the greater susceptibility of rheumatic children to rubella. At the time

that these results were first analyzed, this difference seemed unimportant because rubella was considered a mild childhood exanthem. However, since that time it has been found that rubella virus causes a variety of conditions, including heart disease in the fetus and persistent abnormalities of lymphocytes in the infant as well as exanthem in children and polyarthritis in adults. Over the years it has become apparent that the rheumatic fever and rubella syndromes have several features in common. The finding that the rheumatic child is more susceptible to the rubella virus remains unexplained.

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Table 3. History of illness in rheumatic and control groups, in percentages

Illness	Total clinic population (N = 1,971)	Rheumatics (N = 279)	Controls (N = 556)	Controls with no family history of rheumatic heart disease (N = 337)	P
Scarlet fever	15.57	19.71	18.52	18.10	
Diphtheria	2.28	1.79	1.97	1.78	
Influenza	30.69	37.99	32.55	31.75	
Otitis media	27.49	24.73	28.59	27.89	
Pneumonia	16.99	21.14	13.84	11.57	<.01
Measles	77.37	84.94	82.01	81.89	
Mumps	43.12	52.32	45.32	45.99	
Pertussis	49.67	55.19	53.41	48.96	
Chickenpox	66.56	65.94	70.68	70.91	
Rubella	39.21	44.08	36.33	30.25	<.001
Poliomyelitis	2.48	1.63	1.07	1.48	
Eczema, hay fever, or asthma	22.07	14.33	22.79	24.33	<.01