

# CHANGE WITH AGE IN SUSCEPTIBILITY TO MINOR RESPIRATORY ILLNESS

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ONE of the striking epidemiological characteristics of the minor respiratory illnesses is the variation of their incidence with age. The attack rate is highest during the early years of life, declines throughout the school ages and until adult life is reached. Then the incidence maintains a fairly constant level. This characteristic, variation in incidence with age, has been noted in all morbidity studies which have

Table 1. Mean number of respiratory illnesses per person in each of the three successive years of observation among persons at specific ages, Pleasantville and Mt. Kisco combined.<sup>1</sup>

AGE AS OF FIRST YEAR	NUMBER OF PERSONS n	YEAR OF OBSERVATION					
		First: 1946-1947		Second: 1947-1948		Third: 1948-1949	
		Mean Number of Respiratory Illnesses	Standard Deviation	Mean Number of Respiratory Illnesses	Standard Deviation	Mean Number of Respiratory Illnesses	Standard Deviation
5 Years	79	3.08±0.23	2.02	2.64±0.19	1.67	2.18±0.19	1.69
6	90	2.79±0.20	1.88	2.28±0.19	1.77	2.17±0.20	1.86
7	80	2.39±0.18	1.61	2.20±0.18	1.61	1.74±0.17	1.49
8	104	2.28±0.15	1.58	1.80±0.13	1.34	1.88±0.16	1.63
9	70	1.93±0.19	1.56	1.77±0.19	1.63	1.67±0.20	1.64
10	75	1.76±0.19	1.65	1.48±0.16	1.35	1.65±0.16	1.38
11	80	1.80±0.15	1.38	1.40±0.16	1.48	1.61±0.17	1.54
12	70	1.53±0.16	1.36	1.64±0.18	1.51	1.51±0.18	1.54
13	77	1.79±0.17	1.49	1.26±0.14	1.24	1.42±0.16	1.44
14	75	1.71±0.16	1.41	1.63±0.17	1.47	1.85±0.18	1.52
15	93	1.40±0.13	1.29	1.24±0.14	1.37	1.13±0.12	1.11
16	33	1.70±0.28	1.60	1.45±0.24	1.40	1.21±0.18	1.01
17	38	0.97±0.18	1.12	1.05±0.20	1.24	0.74±0.15	0.91
18	26	1.15±0.27	1.38	1.00±0.21	1.07	0.77±0.25	1.28
19-29	87	1.28±0.13	1.24	1.14±0.13	1.20	1.14±0.15	1.43
30-34	164	1.21±0.09	1.09	1.17±0.08	1.05	1.27±0.09	1.16
35-39	291	1.22±0.07	1.19	1.14±0.07	1.17	1.21±0.07	1.24
40-44	281	1.09±0.07	1.17	0.94±0.07	1.13	0.98±0.07	1.10
45-49	179	0.87±0.07	0.92	0.85±0.07	0.90	0.67±0.07	0.91
50+	104	0.84±0.09	0.93	0.77±0.10	0.98	0.56±0.08	0.78

<sup>1</sup> School years: September, 1946-May, 1947; September, 1947-May, 1948; and September, 1948-May, 1949.

<sup>1</sup> From the Milbank Memorial Fund. This is the sixth in a series of papers dealing with a study of acute respiratory illness.

included records of the common cold and other minor respiratory illnesses (1, 2, 3, 4).

It seems quite logical to assume that the variation of incidence of respiratory illness with age is due for the most part to change in the susceptibility of the host to the organism or organisms responsible for such illness. Degree of contact with the community appears to be a factor which may have an influence upon change in susceptibility of the host. For example, preschool children have the highest attack rate from respiratory illness but they have considerably less contact with the community than do school-age children or adults. As the environment becomes broader with corresponding greater opportunities for contact with respiratory illness, the incidence of

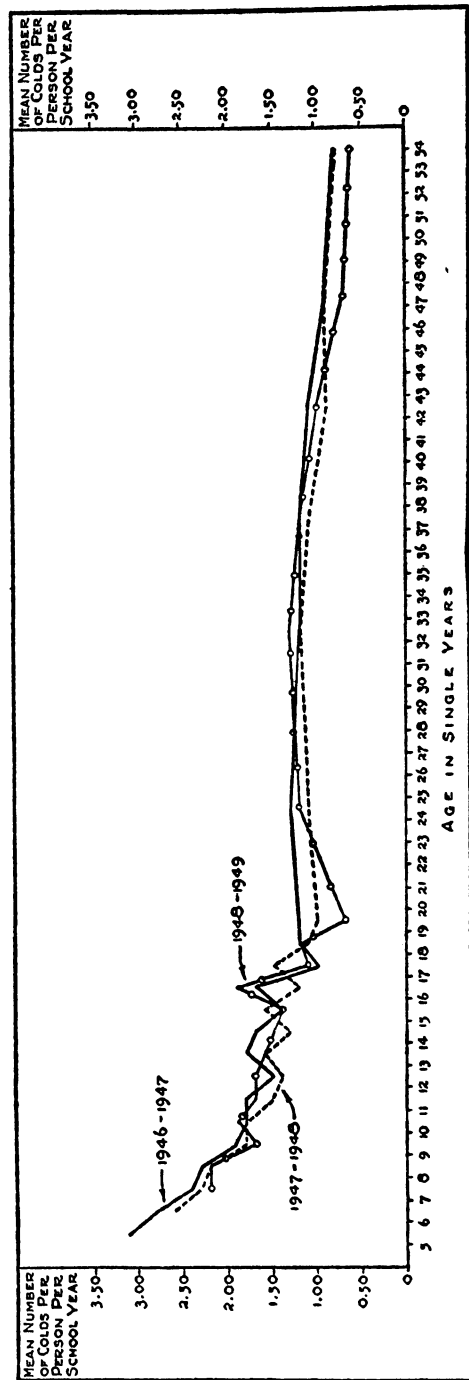


Fig. 1. Mean number of attacks per person at specific ages in each of three successive school years.

such illness declines. On the other hand decline in susceptibility to these diseases may be due also to physiological change in the host which accompanies growth and physical development.

A three-year study of acute respiratory illness in two communities, Pleasantville and Mt. Kisco in Westchester County, New York, provides data which make it possible to describe in detail change or lack of change in susceptibility to minor respiratory illnesses. The purpose of this report is to present these data.

**DATA AND METHOD OF STUDY**

The data and method of the study of respiratory illness in the two communities in Westchester County, New York, have been fully described in previous reports (5, 6, 7). Briefly, the

Table 2. Variance in minor respiratory illness among persons at age of first observation. (Three years of observation.) Pleasantville and Mt. Kisco combined. September, 1946-May, 1949.

SOURCE OF VARIATION	DEGREES OF FREEDOM	VARIATION OR SUM OF SQUARED DEVIATIONS	VARIANCE (MEAN SQUARE)	RATIO OF VARIANCE	P*
<b>5 YEARS</b>					
Between Year Means	2	31.92	15.96	10.04	<.01
Among Person Means	78	527.06	6.76	4.25	<.01
Residual	156	248.08	1.59		
Total		807.06			
<b>6 YEARS</b>					
Between Year Means	2	19.82	9.91	6.93	<.01
Among Person Means	89	659.37	7.41	5.18	<.01
Residual	178	254.18	1.43		
Total		933.37			
<b>7 YEARS</b>					
Between Year Means	2	17.91	8.96	6.95	<.01
Among Person Means	79	391.18	4.95	3.84	<.01
Residual	158	204.09	1.29		
Total		613.18			
<b>8 YEARS</b>					
Between Year Means	2	13.66	6.83	5.46	<.01
Among Person Means	103	463.95	4.50	3.60	<.01
Residual	206	258.34	1.25		
Total		735.95			

Table 2.—(Continued)

SOURCE OF VARIATION	DEGREES OF FREEDOM	VARIATION OR SUM OF SQUARED DEVIATIONS	VARIANCE (MEAN SQUARE)	RATIO OF VARIANCE	P*
9 YEARS					
Between Year Means	2	2.35	1.18		
Among Person Means	69	380.11	5.51	4.63	<.01
Residual	138	164.32	1.19		
Total		546.78			
10 YEARS					
Between Year Means	2	3.00	1.50	1.24	>.05
Among Person Means	74	302.38	4.09	3.38	<.01
Residual	148	179.00	1.21		
Total		484.38			
11 YEARS					
Between Year Means	2	6.41	3.21	3.38	.01—.05
Among Person Means	79	367.40	4.65	4.89	<.01
Residual	158	149.59	0.95		
Total		523.40			
12 YEARS					
Between Year Means	2	0.70	0.35		
Among Person Means	69	299.03	4.33	3.87	<.01
Residual	138	153.97	1.12		
Total		453.70			
13 YEARS					
Between Year Means	2	11.54	5.77	4.93	<.01
Among Person Means	76	273.06	3.59	3.07	<.01
Residual	152	177.12	1.17		
Total		461.72			
14 YEARS					
Between Year Means	2	1.98	0.99		
Among Person Means	74	334.46	4.52	4.39	<.01
Residual	148	152.02	1.03		
Total		488.46			
15 YEARS					
Between Year Means	2	3.41	1.71	1.73	>.05
Among Person Means	92	262.93	2.86	2.89	<.01
Residual	184	182.59	0.99		
Total		448.93			
16 YEARS					
Between Year Means	2	3.88	1.94	1.90	>.05
Among Person Means	32	117.21	3.66	3.59	<.01
Residual	64	65.45	1.02		
Total		186.54			

Table 2.—(Continued)

SOURCE OF VARIATION	DEGREES OF FREEDOM	VARIATION OR SUM OF SQUARED DEVIATIONS	VARIANCE (MEAN SQUARE)	RATIO OF VARIANCE	P*
17 YEARS					
Between Year Means	2	2.05	1.03	1.49	> .05
Among Person Means	37	84.96	2.30	3.33	< .01
Residual	74	51.28	0.69		
Total		138.29			
18 YEARS					
Between Year Means	2	1.95	0.98		
Among Person Means	25	69.28	2.77	2.64	< .01
Residual	50	52.72	1.05		
Total		123.95			
19-29 YEARS					
Between Year Means	2	1.02	0.51		
Among Person Means	86	305.80	3.56	4.62	< .01
Residual	172	132.98	0.77		
Total		439.80			
30-34 YEARS					
Between Year Means	2	0.78	0.39		
Among Person Means	163	337.06	2.07	2.62	< .01
Residual	326	257.89	0.79		
Total		595.73			
35-39 YEARS					
Between Year Means	2	1.14	0.57		
Among Person Means	290	765.72	2.64	3.11	< .01
Residual	580	490.19	0.85		
Total		1,257.05			
40-44 YEARS					
Between Year Means	2	3.21	1.61	2.30	> .05
Among Person Means	280	689.67	2.46	3.51	< .01
Residual	560	392.12	0.70		
Total		1,085.00			
45-49 YEARS					
Between Year Means	2	4.32	2.16	3.86	.01— .05
Among Person Means	178	245.54	1.38	2.46	< .01
Residual	356	199.02	0.56		
Total		448.88			
50+ YEARS					
Between Year Means	2	4.40	2.20	4.68	.01— .05
Among Person Means	103	157.41	1.53	3.26	< .01
Residual	206	96.93	0.47		
Total		258.74			

\* P Gives the probability with which differences equal to or exceeding those observed might arise through chance.

epidemiological field investigation of respiratory illness was based upon the periodic survey of families for the purpose of collection of illness records. All families in which there were one or more children attending grade school or high school in each of the two communities were included in the study. These families were visited every twenty-eight days during the three school years, September to June, 1946-1949. On each visit to the family, inquiry was made about acute respiratory illnesses which had occurred among their members during the past four weeks.

Acute respiratory illness presented in this report includes all reported illnesses except attacks of asthma, intestinal influenza or grippe, tonsillectomies, and mastoidectomies. Previous analyses have shown that the two communities were similar with respect to age distribution of the study population and median size of family. However, there was a definite difference between the two with respect to education and occupational class of the head of the household. For the purposes of this particular analysis it is believed that any differences between the two communities can be ignored. Therefore, the data presented represent the combined experience of both.

This is a study based upon 564 families, all of which were observed for illness in each of the three school years. A further restriction upon the data was imposed. Only families described as simple biological units are included. These units were composed of a husband, wife, and their children.<sup>2</sup> This results in a homogeneous group in which the risk of exposure within the family and of community exposure to respiratory disease may be considered to be held relatively constant. It is true that husbands, wives, and children may all have different opportunities for community exposure to respiratory illness. However, the families because of their constitution are generally similar in this respect.

#### STABILITY OF RESISTANCE TO RESPIRATORY ILLNESS

The study of either susceptibility or resistance to respiratory

<sup>2</sup> In thirty-six families there was only one parent present, that is, the parent was a widow or a widower.

illness requires data of a particular kind. Records of such illness must be collected with great care for the same persons over a period of time. Care is needed in the collection of these records to insure that any differences in number of illnesses in time are not due to some variation in the method of obtaining reports of such illness, or due to variations caused by unusual epidemics of respiratory disease. Consequently, very few studies of respiratory illness can meet the rigorous standards for critical study of host susceptibility or resistance.

Gafafer and Doull had data which met the requirements for study of resistance to the common cold (8). Their study included a number of groups. The ones cited here are one student group numbering 111 who reported their respiratory illnesses for three years and forty-five who reported for four years. Their conclusion concerning the study of the two stu-

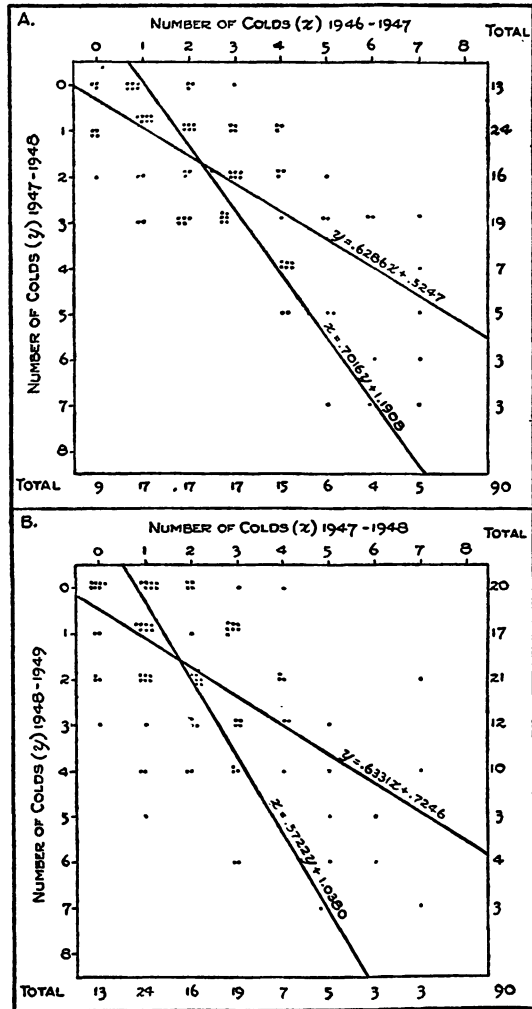
Table 3. Correlation coefficients for minor respiratory illnesses among persons of both sexes by single years of age and broad age groups for adults. Pleasantville and Mt. Kisco combined. School years September, 1946-May, 1947; September, 1947-May, 1948; September, 1948-May, 1949.

AGE AS OF FIRST YEAR	NUMBER OF PERSONS N	1ST VERSUS 2ND YEAR		2ND VERSUS 3RD YEAR		1ST VERSUS 3RD YEAR	
		Correlation Coefficient $r$	Standard Error $\sigma r$	Correlation Coefficient $r$	Standard Error $\sigma r$	Correlation Coefficient $r$	Standard Error $\sigma r$
5 Years	79	.53	.081	.50	.085	.54	.080
6	90	.66	.059	.60	.067	.49	.081
7	80	.61	.071	.43	.092	.41	.094
8	104	.47	.077	.47	.077	.47	.076
9	70	.55	.084	.59	.079	.51	.090
10	75	.47	.091	.42	.096	.45	.092
11	80	.53	.081	.64	.066	.53	.081
12	70	.50	.091	.41	.099	.57	.081
13	77	.47	.089	.45	.092	.34	.102
14	75	.44	.090	.59	.076	.53	.083
15	93	.43	.085	.42	.086	.32	.094
16	33	.43	.145	.66	.099	.41	.146
17	38	.56	.113	.34	.145	.41	.137
18	26	.52	.146	.50	.149	.11	.198
19-29	87	.53	.077	.60	.069	.51	.077
30-34	164	.30	.071	.41	.065	.34	.069
35-39	291	.43	.048	.49	.045	.33	.052
40-44	281	.45	.048	.52	.043	.41	.050
45-49	179	.44	.060	.32	.067	.23	.071
50+	104	.48	.075	.39	.083	.42	.081

dent groups was "that stability of resistance or susceptibility to colds was not a characteristic of either population."

In the present analysis it is postulated that susceptibility to minor respiratory illness changes with age. To test this assumption it is necessary to study the illness experience over a period of years of persons in well-defined or narrow age classes until adult life is reached. Consequently, the data are presented for children by single years of age, starting at age 5 and up to age 18, and thereafter for adults by broad age groups. It seems reasonable to assume that children at specific ages have generally similar risks of exposure to respiratory illness in the community and that adults, whose environment is not so circumscribed as that of children, have among themselves similar opportunities of contact with respiratory illness.

Table 1 shows the mean number of respiratory illnesses per person in three successive years of observation for persons at specific ages. The data are arrayed according to age as of the first year. For example, the mean number of illnesses for those





who were age 5 in the first year was 3.08 per person; in the second year when they were age 6 the mean was 2.64; and in the third year when they had reached age 7, the mean was 2.18.

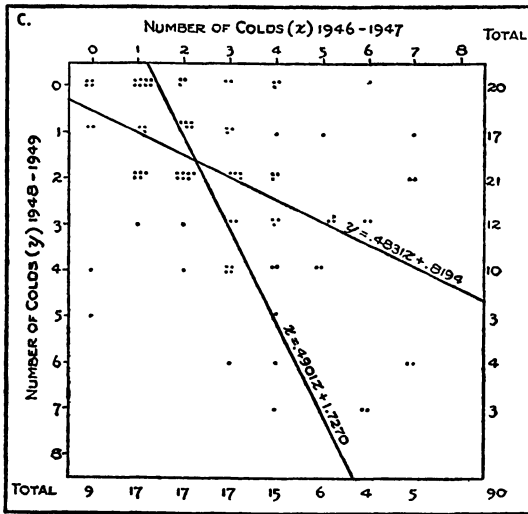


Fig. 2, A, B, and C. Scatter diagram showing the relationship between the number of respiratory illnesses observed in children aged 6 in successive school years: A, 1946-1947 and 1947-1948; B, 1947-1948 and 1948-1949; and C, with an interval of one year, 1946-1947 and 1948-1949.

The decline in incidence of respiratory illness with age can be seen most clearly in Figure 1 which shows the mean number of attacks per person at specific ages in each of the three successive school years. After age 5 there was a rapid decline in the mean incidence per person until age 12. During the adolescent ages there was an increase, though somewhat irregular, in the mean number of illnesses per person.

During the late teen ages there was a fairly sharp decrease in the incidence of respiratory illness. After adult life was reached the mean number of illnesses per person maintained a fairly constant level, about 1 to 1.2 per person; after age 40 there was a slight decline in the mean number of illnesses.

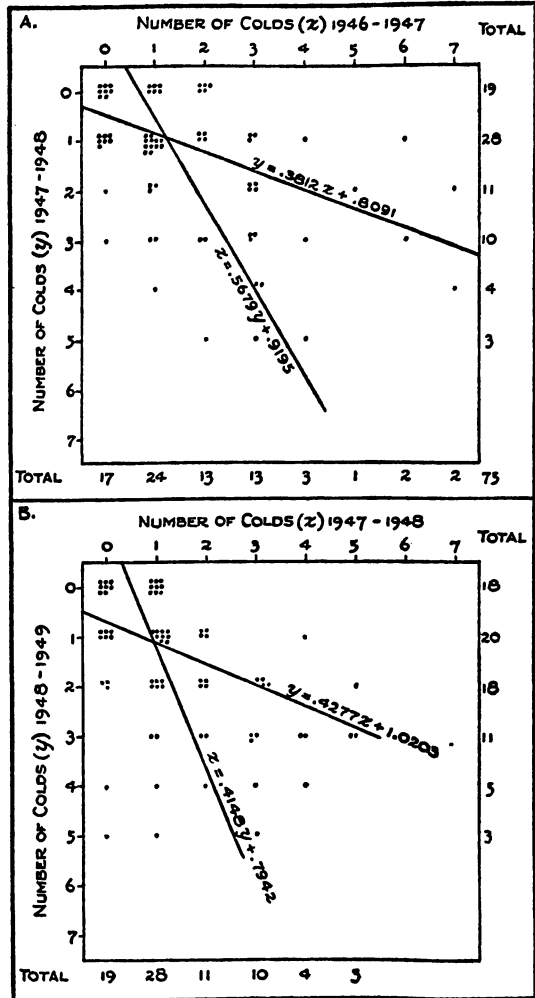
A point of considerable interest brought out by Figure 1 is that the period of adolescence, a period of physiological change or stress, shows an increase in susceptibility to respiratory illness. This may be interpreted to mean that susceptibility to infection is not determined solely by familiarity of the host with infecting organisms in the environment which results in an increase in resistance, or natural immunity. Change in the internal environment of the host is also a factor of importance.

The decline in incidence of respiratory illness with age is due

no doubt to a decline in susceptibility to such illness as age increases. It is a striking fact that the decline is most rapid during the period of deceleration of growth; at the adolescent ages it is halted and the incidence shows some increase during this period of acceleration of growth. When full maturity is reached the incidence tends to maintain a level with no marked fluctuations.

Figure 1 also illustrates the fact that there was essentially no real difference between the years studied, that is, no evidence of unusual epidemics of respiratory illness in one year as compared with another. Therefore, the data are entirely suitable for comparison of a person's experience of respiratory illness in the three successive years.

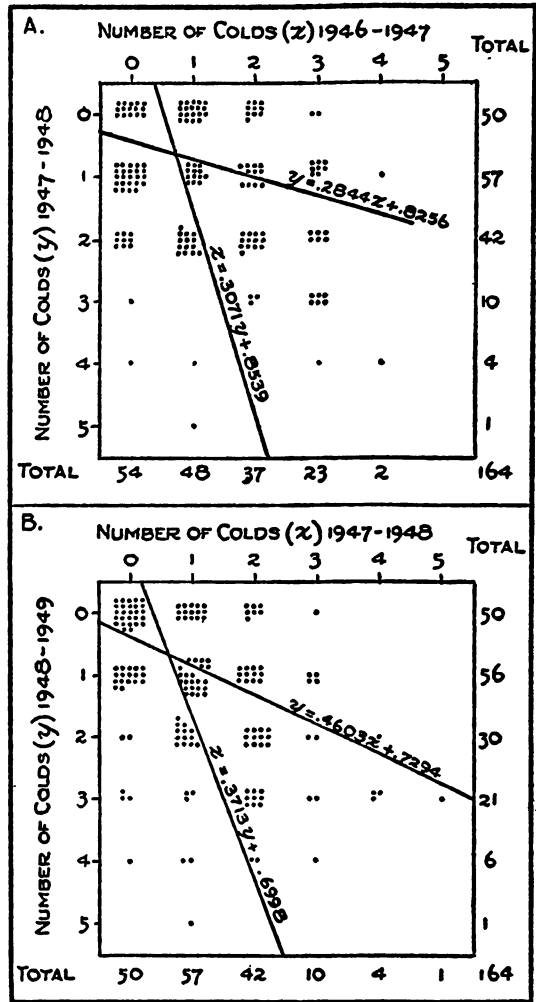
A comparison of a person's experience in the three successive years may be examined by application of the method of analysis of variance to the data. Table 2 shows these data. Here again the data are arrayed according to single years of age at first observation, from age 5 to age 18 and by broad age groups thereafter. It is noteworthy that up to age 9 there is a signifi-





Figures 2, 3, and 4 show scatter diagrams with regression lines for persons at three different ages: children aged 6, children aged 10, and adults aged 30-34. The coefficient of correlation was highest for those aged 6, somewhat lower for children aged 10, and lowest for adults aged 30-34.

It seems reasonable to conclude from these data that stability of resistance or change in susceptibility to respiratory illness is different for young children compared with adults. During the early school ages, resistance to respiratory illness is in the process of being established. When adult life is reached there is a tendency for persons who suffer frequent attacks of respiratory illness to remain over a period of time in that class.



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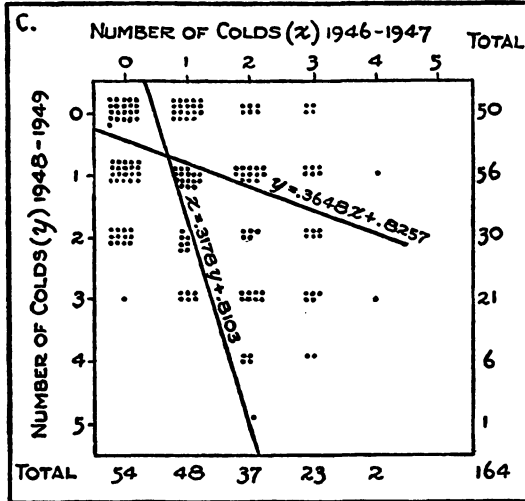


Fig. 4, A, B, and C. Scatter diagram showing the relationship between the number of respiratory illnesses observed in adults aged 30-34 in successive school years: A, 1946-1947 and 1947-1948; B, 1947-1948 and 1948-1949; and C, with an interval of one year, 1946-1947 and 1948-1949.

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