

INCIDENCE OF PNEUMONIA IN TWO COMMUNITIES IN NEW YORK STATE

DORIS TUCHER¹

PNEUMONIA has always been one of the most serious of the acute infectious diseases. Before the discovery of the antibiotics, for example, the period from 1930–1935, mortality from pneumonia in the United States was approximately 70–80 per 100,000 population. Since the discovery of the antibiotics and their use in the treatment of pneumonia, the severity of the illness has been modified greatly. The mortality has decreased within the last decade; data for 1948 show a mortality rate of 35 per 100,000 population (1, 2).

Certain facts about pneumonia have been established by observations of practicing physicians and by field-method studies. It affects most heavily those at the two extremes of the age span, namely, young children and older adults; it has a seasonal incidence with a peak during late winter and early spring.

Although pneumonia does not cause as many deaths as in the past, there is no indication that the incidence of the disease in the general population has decreased. Statistics on incidence of pneumonia in the general population are not available because it is not one of the "reportable diseases." Observation over a period of time of a population to note the occurrence of illness is one way of obtaining data on the incidence of pneumonia.

Three studies which included reporting of cases of pneumonia are the Hagerstown Study (1921–1924), the study made by the Committee on the Costs of Medical Care (1928–1931), and the study in the Eastern Health District of Baltimore (1938–1943). These studies showed annual rates of 8.7, 8.2, and 8.0 per 1,000 population, respectively (3, 4, 5).

A study of acute respiratory illness in two communities,

¹ From the Milbank Memorial Fund. This is the seventh in a series of papers dealing with a study of respiratory illness.

Pleasantville and Mt. Kisco in Westchester County, New York, was conducted by the Milbank Memorial Fund in cooperation with the Westchester County Department of Health during the three school years, September to June, 1946-1949. Periodic visits were made to certain families for the collection of illness records. This paper presents the data on pneumonia cases which were reported in the two communities.

DATA AND METHOD OF STUDY

The two communities, Pleasantville and Mt. Kisco, were fairly comparable with respect to size. According to the 1940 Census, there were 4,454 persons living in the incorporated village of Pleasantville and 5,941 in the village of Mt. Kisco. Sixteen per cent of the population of Pleasantville were foreign born compared with 21 per cent in Mt. Kisco. In both communities the foreign born were chiefly Italian. Negroes formed a very small proportion of the population in either place; about 1 per cent in Pleasantville and 3 per cent in Mt. Kisco.

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.

The sickness record included the nature of the illness as stated by the informant, usually the mother, date of onset and duration of illness, the onset and duration of disability and the number of days in bed, the amount of medical care, and, if hospitalized, the number of days in the hospital.

The mean number of families visited during the three school years of the special study was 530 in Pleasantville and 570 in Mt. Kisco. The families in Pleasantville included some 2,100 persons and those in Mt. Kisco 2,400. In each group of families there were about 900 school-age children and 180 to 200 pre-school-age children.

CHARACTERISTICS OF THE TWO COMMUNITIES

In the study of acute respiratory illness, data were obtained from each family which reveal certain social characteristics of the family. The data included a census of the household, the age, sex, and marital status of the members, the occupation and place of employment of all employed members, and the highest education attained for all members of the household.

A description of the two communities with respect to these characteristics has been presented in previous reports (6, 7). The two communities were found to be comparable with respect to loss of families due to moving or refusal to cooperate, age distribution of the family members, age of husbands and wives, and size of family. There were, however, marked differences between the two communities in the educational attainment of the husbands and wives, and in the occupation of the head of the household. A higher proportion of the household heads in Pleasantville were in the professional and managerial class than was true of those in Mt. Kisco.

INCIDENCE OF PNEUMONIA

The illnesses reported upon in this study are pneumonia cases which occurred in households in Pleasantville and Mt. Kisco. Only households which were observed at least thirty weeks in one or more of the three school years September to June, 1946-1949 are included. A total of forty-eight cases were reported in Pleasantville and seventy-five in Mt. Kisco. Five cases were excluded for the following reasons: three cases, which were guests in the household, were excluded because the persons affected were nonresidents; two cases were excluded because they occurred in persons who received no medical care for the illness.

After these exclusions were made there remained a total of forty-five cases in forty-one households in Pleasantville and seventy-three cases in sixty households in Mt. Kisco. All of these illnesses had medical care. Of these, 29 per cent in Pleasantville and 41 per cent in Mt. Kisco were hospitalized.

Seasonal Incidence. Figure 1 shows the weekly incidence of

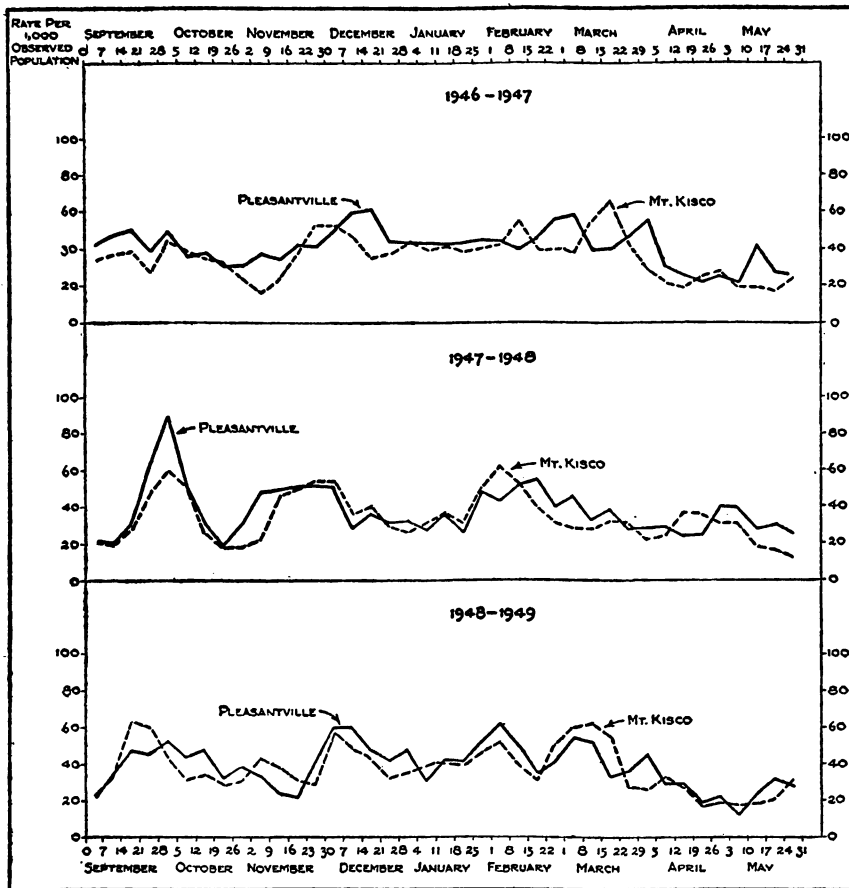


Fig. 1. Weekly incidence of acute respiratory illness in Pleasantville and Mt. Kisco, September to May, 1946-1947, 1947-1948, and 1948-1949.

acute minor respiratory illness for all ages in Pleasantville and Mt. Kisco for the three school years, September to June, 1946-1949. The solid line indicates data for Pleasantville and the broken line indicates data for Mt. Kisco. This chart shows the remarkable similarity in seasonal incidence between the two communities in each year. The data indicate that there are four periods of high incidence, namely, September, November, January and February, and April or May.

Figure 2 shows the number of pneumonia cases by week of onset in each school year for Pleasantville and Mt. Kisco. The data for Pleasantville are shown by the solid bar and for Mt.

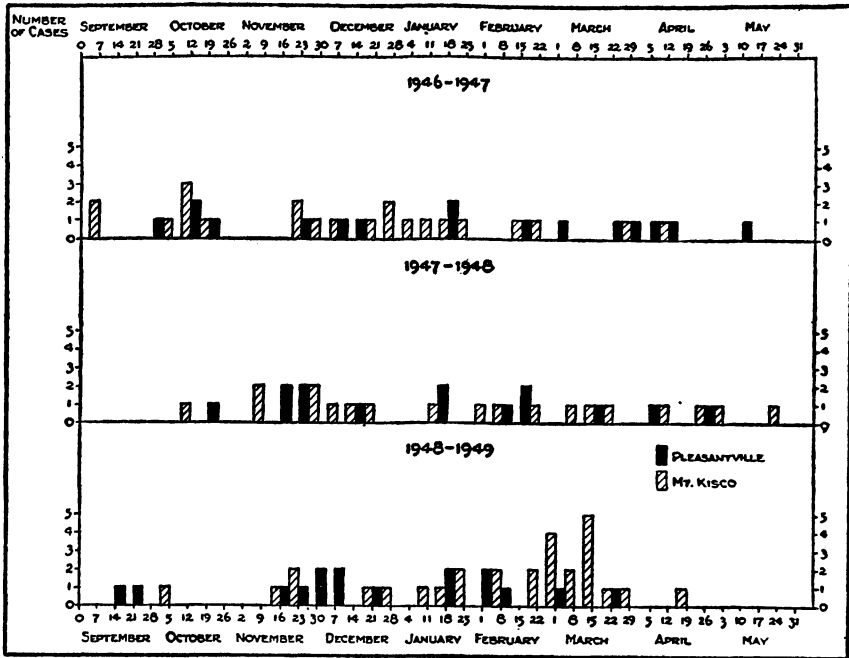


Fig. 2. Number of cases of pneumonia by week of onset in Pleasantville and Mt. Kisco, September to May, 1946-1947, 1947-1948, and 1948-1949.

Kisco by the cross-hatched bar. The interesting feature of this chart is the fact that pneumonia occurred throughout the year and was not restricted to one particular season. This was true of all three study years. The period February through March in 1949 in Mt. Kisco is of interest because there was a greater concentration of pneumonia cases at that time than at any other period.

Table 1. Annual incidence of pneumonia by age in Pleasantville and Mt. Kisco. Data for the three school years, September, 1946 to May, 1949 are combined.

AGE GROUP	PLEASANTVILLE	MT. KISCO
	Rate Per 1,000 Population	
ALL AGES	6.6	9.7
0-4	15.5	20.4
5-9	9.2	21.0
10-18	2.0	6.1
19-34	4.8	6.1
35-54	6.4	5.3
55+	9.7	15.5

In that period there were 15 cases in Mt. Kisco compared with 2 in Pleasantville.

Incidence by Age. The annual incidence of pneumonia by

age in Pleasantville and Mt. Kisco is shown in Table 1. The population is composed of persons counted in each year in which they were observed. The rate is a mean annual rate. Pleasantville had a rate for all ages of 6.6 per 1,000 population and Mt. Kisco a rate of 9.7.

The highest incidence in both communities was in the younger age group, those 9 years and younger. In Pleasantville, the group aged 0-4 had more pneumonia than any other age group. The rate for this group was 15.5 per 1,000 population. Those aged 55 and over had the next highest rate, 9.7. In Mt. Kisco, the groups aged 0-4 and 5-9 had similar rates, 20.4 per 1,000 population for children aged 0-4 and 21.0 for children aged 5-9. The rate for those aged 55 and over was the next highest. The rate for all ages in Mt. Kisco is significantly higher than that for Pleasantville.²

Figure 3 gives the incidence of pneumonia by age as noted in three studies, namely, the study in the Eastern Health District of Baltimore, the study made by the Committee on the Costs of Medical Care, and the study in the two communities being reported upon. The data for all three studies show a similar age variation in the incidence of pneumonia. All of them show the highest incidence in the younger age groups with a rapid decline until the adult ages are reached. After age 55+, all show a rise in the rates. It is interesting to note that Mt. Kisco had consistently higher rates of pneumonia than was noted in any of the other studies with the exception of the groups aged 0-4 and 35-54. Pleasantville, on the other hand, had the lowest rates for the age groups 0-4, 5-9, and 10-18.

Incidence by Occupational Class. In a previous report of the studies in Pleasantville and Mt. Kisco the relation of occupational class to the incidence of acute respiratory illness was con-

² The statistical test used in this study is that which derives a value "t" from the ratio of the difference between the two rates to be tested to the standard error of the difference between the rates. The standard error of the difference between rates σd is derived from the following formula:

$$\sigma d = \sqrt{P Q \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}$$

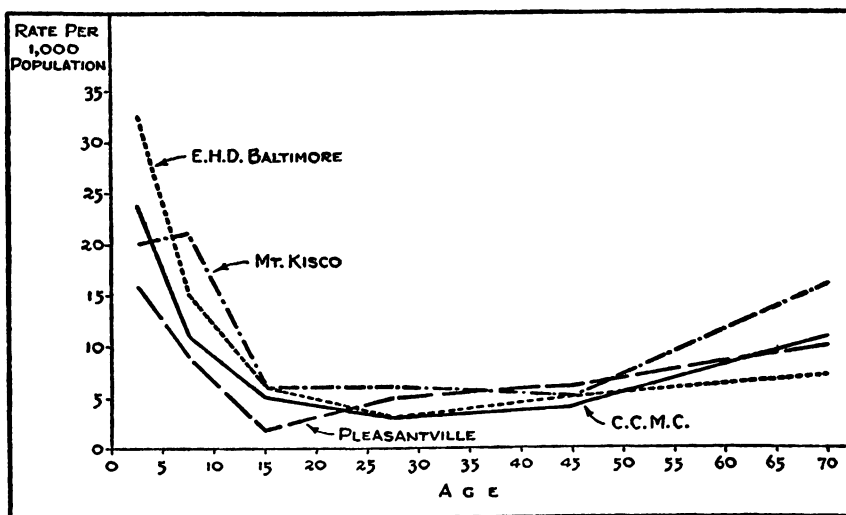


Fig. 3. Age-specific incidence of pneumonia in the population studied by the Committee on the Costs of Medical Care, 1928-1931, in the sample population of the Eastern Health District of Baltimore, 1938-1943, and in the sample populations in Pleasantville and Mt. Kisco, 1946-1949.

sidered (6, 7). The observed population in each community was classified according to the occupational class of the head of the household and delegated to one of three classes: (1) professional and managerial; (2) clerks, salesmen, and skilled workers; and (3) semi-skilled workers, unskilled, and domestics. The data showed that "the higher the occupational class, the higher was the incidence of acute respiratory illness."

Table 2 gives the incidence of pneumonia cases by occupational class in the two communities combined for the three

Table 2. Annual incidence of pneumonia by occupational class of the head of the household. Data for the three school years, September, 1946 to May, 1949 and for both communities are combined.

OCCUPATIONAL CLASS	RATE PER 1,000 POPULATION	NUMBER OF CASES ¹	POPULATION
Professional and Managerial	9.0	52	5,808
Clerical and Skilled Workers	8.7	35	4,036
Semiskilled and Unskilled Workers	7.5	27	3,594

¹Three cases which occurred in boarders were excluded. One case in a member of a household in which there was no employed member was also excluded.

school years. The incidence of pneumonia for each of the three occupational classes is fairly similar. Since pneumonia has a relatively low frequency of occurrence, the experience of the two communities was combined.

PNEUMONIA AS IT OCCURS IN HOUSEHOLDS

It has been known for some time that healthy persons harbor pneumococci (8). Because pneumonia appears in a population in isolated instances with no known source of infection, it was believed that such cases arose spontaneously when the pneumococci which a person normally harbored reached a specific virulence in relation to the person's susceptibility. In one article, Smillie contradicted this theory (9). He concluded that "the patient with pneumonia does not, as a rule, infect the family with his specific strain. On the contrary, the family infects the patient."

Smillie's investigations indicate that the household is an important unit for study of the epidemiology of pneumonia. It is possible to describe the pneumonia households in Pleasantville and Mt. Kisco with respect to (1) the position of the case in the household; (2) the tendency for households to be repeaters in various school years; (3) the occurrence of multiple cases in the household; and (4) the illness record of the pneumonia household and of the persons who suffered an attack of the disease.

The distribution of pneumonia cases according to the position of the patient in the household is shown in Table 3. In both communities cases among children formed the highest proportion of the total, namely, from 51 to 64 per cent. Cases among mothers and fathers formed the next highest proportions of the total. The one case in Pleasantville in a domestic was in a servant who lived in the home. There were three cases of pneumonia in boarders, one in Pleasantville and two in Mt. Kisco. The households in which these three cases occurred are excluded from all further analysis because it was believed that contact with the family was less intimate than that among family members.

RELATIONSHIP IN HOUSEHOLD	PER CENT		NUMBER	
	Pleasantville	Mt. Kisco	Pleasantville	Mt. Kisco
TOTAL	100.0	100.0	45	73
Father	11.1	8.2	5	6
Mother	24.5	17.8	11	13
Preschool Child	20.0	16.5	9	12
School Child	26.7	45.2	12	33
Adult Child	4.4	2.7	2	2
Grandparent	6.7	6.9	3	5
Other Relatives	2.2	0.0	1	0
Boarder	2.2	2.7	1	2
Servant	2.2	0.0	1	0

Table 3. Distribution of pneumonia cases according to their position in the household in Pleasantville and Mt. Kisco. Data for the three school years, September, 1946 to May, 1949 are combined.

During the three school years a total of 1,401 households were observed in Pleasantville. This number is obtained by counting each household in each year in which it was observed. Forty-three, or 3 per 100, of these households had one or more pneumonia cases in them during their observation. It should be pointed out that a household which had a case in it in one year could also appear as a pneumonia household in other years. Therefore, the rate, 3 per 100, represents the annual risk of becoming a pneumonia household. The annual rate for Mt. Kisco was slightly higher, 4 per 100, that is, there were sixty-eight out of 1,544 households.

The data concerning households indicate that there are certain households which appear to be especially susceptible to attacks of pneumonia. Table 4 shows the pneumonia households arrayed according to the number of cases

Table 4. Distribution of households according to number of pneumonia cases in them during three school years, September to June, 1946-1949 in Pleasantville and Mt. Kisco.

NUMBER OF CASES	PLEASANTVILLE	Mt. KISCO
	Number of Households	
TOTAL	40	58
1 Case	37	48
2 Cases	2	8
3 Cases	1	1
4 Cases	0	1

which occurred in them during the three school years of the study. In Pleasantville, three households, or 7 per cent of the total, contributed 16 per cent of the total pneumonia cases. In Mt. Kisco, 17 per cent of the pneumonia households contributed 32 per cent of the total cases in that community. These data are not influenced by spread within the household. Those with multiple cases are counted only once in this particular analysis.

In Pleasantville there was only one instance of what appeared to be a spread of infection in the household unit, that is, one or more persons who had pneumonia within two to fifteen days subsequent to the first case in the household. In Mt. Kisco there were only two such instances.

In one of the investigations made by Smillie, it was noted that during the period that a pneumonia case was present in the family, one or more other family members may develop some form of respiratory illness, and some may even develop pneumonia (9).

The studies of respiratory disease in Pleasantville and Mt. Kisco were based on monthly reports of illness given to the family visitor by a responsible household member. Laboratory tests to detect any type of infection in the family were not made. Therefore, there was no attempt to establish the presence of a healthy carrier of any type of respiratory illness. It is possible, however, to study the household in order to see how much overt illness of an acute respiratory nature was present in household members immediately preceding and subsequent to an attack of pneumonia in one of its members. For purposes of comparison, a group of control households was selected from the non-pneumonia families in order to compare their illness experience with that of the pneumonia families.

The procedure of selecting control families was as follows: The pneumonia households were arrayed according to age and relationship of persons in the household, occupational class of the head of the household, and the month and year of onset of the index case, a case of pneumonia. Control households

were chosen which most closely matched the pneumonia households as to these characteristics. One member of the control family, the index case, had to have had an attack of acute respiratory illness within fifteen days prior or subsequently to the time of the onset of the pneumonia case in the household to which it was matched. The index case in the control household was either the case with the most severe symptoms if there were more than one case with onset in the time period, or it may have been the only case of acute respiratory illness which occurred in the household within the specified time period, fifteen days prior or fifteen days subsequent to the onset of the matched pneumonia case. Because of the strictness of the matching qualifications, it was found that it was impossible to find control households for pneumonia households with six or more members. Consequently, this part of the study was confined to households not larger than five persons.

In Pleasantville a total of twenty-four pneumonia households with ninety-nine persons in them was matched with forty-six control households containing 190 persons. In Mt. Kisco, thirty-eight pneumonia households with 153 persons were matched with seventy-one control households containing 275 persons. Whenever possible two control households were matched with one pneumonia household.

Table 5. Rate of illness in persons in households within a period of ten days prior to and a period of ten days subsequent to an index case in pneumonia and in control households in Pleasantville and Mt. Kisco. Data for the three school years, September, 1946 to May, 1949 are combined.¹

COMMUNITY	RATE PER 100 PERSON DAYS		NUMBER OF ILLNESSES		PERSON DAYS AT RISK	
	Pneumonia Households	Control Households	Pneumonia Households	Control Households	Pneumonia Households	Control Households
Pleasantville	1.4	0.8	20	23	1,381	2,776
Mt. Kisco	1.7	0.7	33	29	1,989	3,978

¹ Index cases were excluded from both groups of families.

In both groups of households, pneumonia and control, a count of illnesses which occurred in their populations was made for the period of ten days prior to and subsequent to the day of onset of the index case. Rates were computed on the total person-days at risk of such illness. A person was considered at risk until he developed an acute respiratory illness; then he was withdrawn from the population.

Table 5 shows the incidence of acute respiratory illness in the population of the pneumonia and control households in Pleasantville and Mt. Kisco. Index cases are excluded. In both communities the pneumonia households had a higher rate of illness at the time of the attack of pneumonia than did the control households. In Pleasantville the illness rate in the population of the pneumonia families was 75 per cent above that in the control families. In Mt. Kisco the pneumonia families had a rate twice as high as was noted for the control families. When the differences between the illness rates in the families selected because of a case of pneumonia and those selected as controls were tested, it was found that the probability of a difference such as was found in Pleasantville might be expected to occur seven times out of one hundred chances. The probability of such a difference occurring by chance in Mt. Kisco was calculated at less than once in a hundred.^{2,3}

There is a known predisposition for persons once attacked by pneumonia to have subsequent attacks. Are these persons who were attacked by pneumonia during the period of the special study also more prone to suffer other acute respiratory infections than was true of the general population? This may be learned by a comparison of their illnesses.

The total respiratory illness experience for the three years is available for persons who had an attack of pneumonia during that time. Table 6 shows in Column 1 the number of illnesses experienced by these persons at specific ages. The expected number, based upon the experience of the total population, is

³ The test was applied on the assumption that no one person in either population was apt to be attacked by acute respiratory illness more than once within the specified twenty-one-day period.

AGE GROUP	PLEASANTVILLE			MT. KISCO		
	Actual Number	Expected Number	Ratio of Actual to Expected	Actual Number	Expected Number	Ratio of Actual to Expected
ALL AGES	264	171.07	1.54	397	293.72	1.35
0-4	66	42.23	1.56	92	73.18	1.26
5-9	92	59.13	1.56	135	120.74	1.12
10-18	26	15.99	1.63	62	39.34	1.58
19+	80	53.72	1.49	108	60.46	1.79

Table 6. Ratio of the actual number of acute respiratory illnesses to the expected number of illnesses among 118 persons who had pneumonia in the three school years, September, 1946 to May, 1949 in Pleasantville and Mt. Kisco.¹

¹ A person was counted for each of the three years that he was observed. His illness experience for these years is combined.

shown in Column 2. The ratio of the observed number of illnesses to the expected is shown in Column 3. In both communities in each age group the observed number of illnesses exceeds the expected number. The consistency of this pattern is most striking. It may be concluded that persons who had pneumonia do constitute a group who are susceptible to acute respiratory illness as judged by a comparison of their illness experience with that of the general population.

SUMMARY

This paper presents data on pneumonia cases which were reported in two communities, Pleasantville and Mt. Kisco in the three school years, September to June, 1946-1949. The findings of this study may be summarized briefly as follows:

1. Cases of pneumonia occurred throughout the year and were not restricted to one particular season.

2. The highest incidence in both communities was in children aged 9 years and younger. Adults aged 55 years and older had the next highest incidence.

3. The incidence of pneumonia in the three occupational classes: professional and managerial; clerks, salesmen, and skilled workers; and semi-skilled workers, unskilled, and domestics was fairly similar.

4. It was concluded that the household is an important unit for the study of the epidemiology of pneumonia. The following observations were made:

5. The annual risk of becoming a pneumonia household, that is, of any household member acquiring pneumonia, was 3 per 100 households in Pleasantville and 4 per 100 in Mt. Kisco.

6. Pneumonia cases were more frequent in certain families than in others. In Pleasantville three households, or 7 per cent of the total, contributed 16 per cent of the total pneumonia cases. In Mt. Kisco 17 per cent of the pneumonia households contributed 32 per cent of the total cases.

7. The incidence of acute respiratory illness in the populations of pneumonia and control families was shown for the period of ten days prior to and ten days subsequent to the pneumonia case. In both communities persons in the pneumonia households had a higher rate of illness at the time of the attack of pneumonia than did those in the control families.

8. The total respiratory illness experience for three years for persons who had an attack of pneumonia during that time was shown by age. The expected number of illnesses, based upon the experience of the total population was also shown for these persons. When the observed and expected number of illnesses were compared, those people who had pneumonia constituted a group who were most susceptible to acute respiratory illness.

Acknowledgments are made to Dr. Mildred W. Wells and to the Westchester County Department of Health for generous assistance and cooperation which greatly facilitated the study of acute respiratory illness.

An especial acknowledgment is made to the families in Pleasantville and Mt. Kisco who participated in the study.

REFERENCES

1. Mortality Statistics: United States Department of Commerce, Bureau of the Census, 1930, 1931, 1932, 1933, 1934, and 1935.
2. Vital Statistics of the United States, Part I—Natality and Mortality Data for

the United States Tabulated by Place of Occurrence with Supplemental Tables for Hawaii, Puerto Rico, Virgin Islands, and Alaska. Federal Security Agency, Public Health Service, 1948.

3. Sydenstricker, Edgar: A Study of Illness in a General Population Group. Hagerstown Morbidity Studies No. I—The Method of Study and General Results. *Public Health Reports*, September 24, 1926, pp. 2069–2088.

4. Collins, Selwyn D.: The Incidence of Illness and the Volume of Medical Services Among 9,000 Canvassed Families. United States Public Health Service and the Committee on the Costs of Medical Care. Age Incidence of Specific Causes of Illness. *Public Health Reports*, October 11, 1935, 50: No. 41, pp. 1404–1427.

5. Downes, Jean: Cause of Illness Among Males and Females. The Milbank Memorial Fund *Quarterly*, October, 1950, xxviii, No. 4, pp. 407–428.

6. Downes, Jean: Control of Acute Respiratory Illness by Ultra-Violet Lights. *American Journal of Public Health*, December, 1950, 40: No. 12, pp. 1512–1520.

7. Downes, Jean: Control of Acute Respiratory Illness by Ultra-Violet Lights. Study No. 2. The Milbank Memorial Fund *Quarterly*, April, 1951, xxix, No. 2, pp. 186–217.

8. Smillie, Wilson G.: Epidemiology of Lobar Pneumonia. A Study of the Prevalence of Specific Strains of Pneumococci in the Nasopharynx of Immediate Family Contacts. *Journal of the American Medical Association*, October 21, 1933, pp. 1281–1286.

9. Smillie, Wilson G. and Jewett, Olga F.: The Relationship of Immediate Family Contact to the Transmission of Type-Specific Pneumococci. *The American Journal of Hygiene*, November, 1940, Vol. 32, No. 3, pp. 79–88 (Section A).

Appendix Table 1. Number of cases of pneumonia by age in Pleasantville and Mt. Kisco. Data for the three school years, September, 1946 to May, 1949, are combined.

AGE GROUP	PLEASANTVILLE	MT. KISCO
ALL AGES	45	73
0- 4	9	13
5- 9	9	22
10-18	3	11
19-34	5	8
35-54	14	12
55+	5	7

Appendix Table 2. Population by age in Pleasantville and Mt. Kisco. Data for the three school years, September, 1946 to May, 1949 are combined.

AGE GROUP	PLEASANTVILLE	MT. KISCO
ALL AGES	6,869	7,552
0- 4	581	638
5- 9	975	1,047
10-18	1,537	1,808
19-34	1,039	1,313
35-54	2,177	2,282
55+	515	453
Unknown Age	45	11