

New Orleans asthma

II. Relationship of climatologic and seasonal factors to outbreaks

John Salvaggio, M.D., Victor Hasselblad, Ph.D., John Seabury, M.D., and L. T. Heiderscheid, New Orleans, La.

Outbreaks of obstructive pulmonary disease in the city of New Orleans, which occur in epidemic proportions, are generally seasonal, occurring with greater frequency and magnitude during the months of September, October, and November. These fall outbreaks are associated with minimum temperatures and minimum humidities. Involved individuals are not symptomatic exclusively during outbreaks, and previously observed similarities between involved and noninvolved asthmatic subjects are due to the overlap of these groups. In light of previous observations that New Orleans asthma affects a homogeneous group of allergic individuals and is not related to measurable increases in specific chemical pollutants, the observed climatological and seasonal variations suggest that it does not differ from conventional "extrinsic" bronchial asthma.

The city of New Orleans has been the site of periodic outbreaks of obstructive pulmonary disease for more than a decade. The episodes are primarily nocturnal and often involve more than 100 "asthma" admissions to the Charity Hospital emergency room in a single 24 hour period. Previous work¹⁻⁴ has focused on several likely point sources of air pollution, but no single source has been definitely incriminated.

Our initial approach to this problem involved characterization of involved individuals, who were found to represent a homogeneous group with strong personal and family histories of atopic disease and striking immediate skin reactivity to a broad spectrum of local inhalant allergens.⁵ The objectives of the present study were to determine the relationship between certain climatological patterns and outbreaks of obstructive pulmonary disease.

From the Departments of Medicine and Microbiology (Clinical Immunology Division), Louisiana State University School of Medicine, and the United States Public Health Service National Center for Air Pollution Control.

Supported by United States Public Health Service Contract No. PH-22-68-50 and National Institute of Allergy and Infectious Diseases Research Grant AI-05754.

Received for publication May 29, 1969.

METHODS AND MATERIALS

Daily adult and pediatric asthma admissions at the Charity Hospital emergency room, which is in the geographic center of the city, were recorded on a 7 A.M. to 7 A.M. basis.

Some of these patients were under treatment for bronchial asthma in the Charity Hospital Allergy or Medicine Clinics, but the great majority were indigent Negroes whose only medical care consisted of Charity Hospital emergency room visits during intractable episodes of wheezing.

Climatological data, including temperature, barometric pressure, relative humidity, and hourly wind direction and speed, were gathered at New Orleans International Airport 8 miles west of the city limits.

Climatological data and patient admission analysis covered 5 years from January 1, 1963, through December 31, 1967. Contingency tables were computed for various weather factors on a monthly basis because strong seasonal trends were noted for weather factors and asthma admissions. The months of September, October, and November were studied in greatest detail because the majority of outbreaks occurred during these months. An October day was said to be a high-admit day if the number of visits exceeded 50. The cutoff for November was arbitrarily set at 40, and the cutoff for all other months was 35. This was done to allow for the higher daily averages in October and November than in other months. These particular values were chosen so that an adequate number of high- and low-admit days would be obtained.

No attempt was made to evaluate geographic or temporal variations in chemical air pollutants (such as sulfur dioxide, nitrogen dioxide, aldehydes, and benzene-soluble particulate matter) during outbreaks, because no relationship was noted between chemical pollutants and outbreaks in previous studies performed by the United States Department of Health, Education, and Welfare.⁶

RESULTS

Seasonal and epidemiological patterns

Although outbreaks were sporadic, they were greater in frequency and magnitude during September, October, and November. With the use of the previously mentioned cutoff points for high-admit days, 21 epidemic peaks occurred during September, October, and November of 1965, 1966, and 1967 (Fig. 1), and four of these involved more than 100 admissions during a single 24 hour period. Peaks of lesser magnitude occurred regularly during the summer months as illustrated by the 12 episodes involving more than 35 admissions per day for the months June, July, and August, 1966 and 1967 (Fig. 2). Only three such episodes were noted in 1966 and 1967 during the winter and spring months of December 1 through May 30. This has been a consistent finding in other years. This pattern is in keeping with previously reported observations and bears a general similarity to the over-all national seasonal incidence of bronchial asthma.

Further analysis of emergency room records revealed a likely explanation for our previous finding that individuals involved in outbreaks strongly resembled uninvolved patients with bronchial asthma in degree of skin reactivity to local inhalant allergens, eosinophilia, and personal and family history of

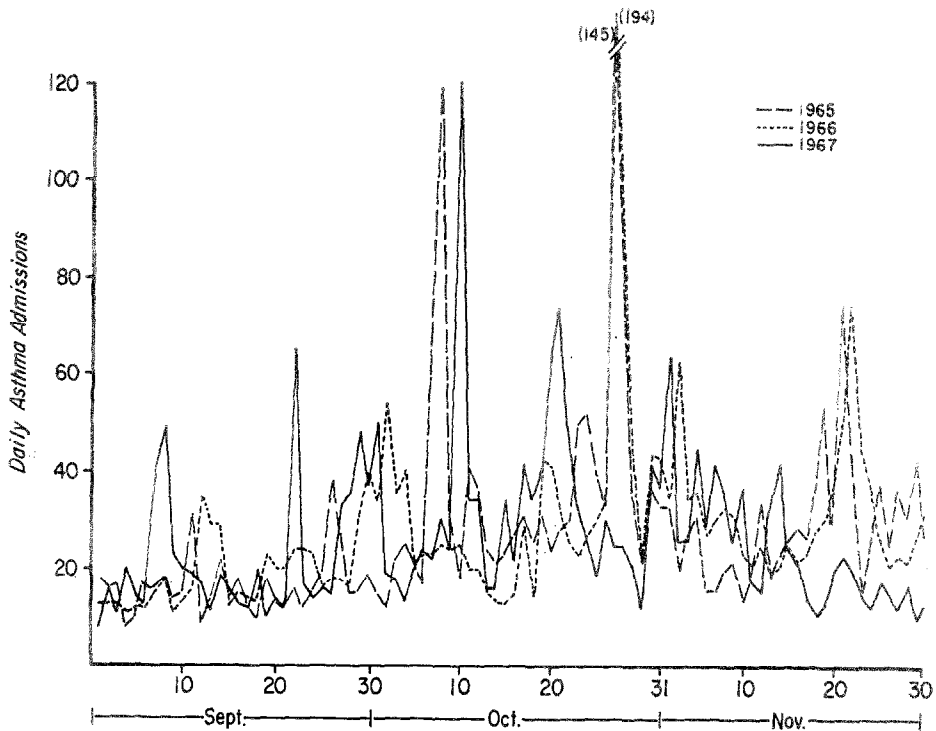
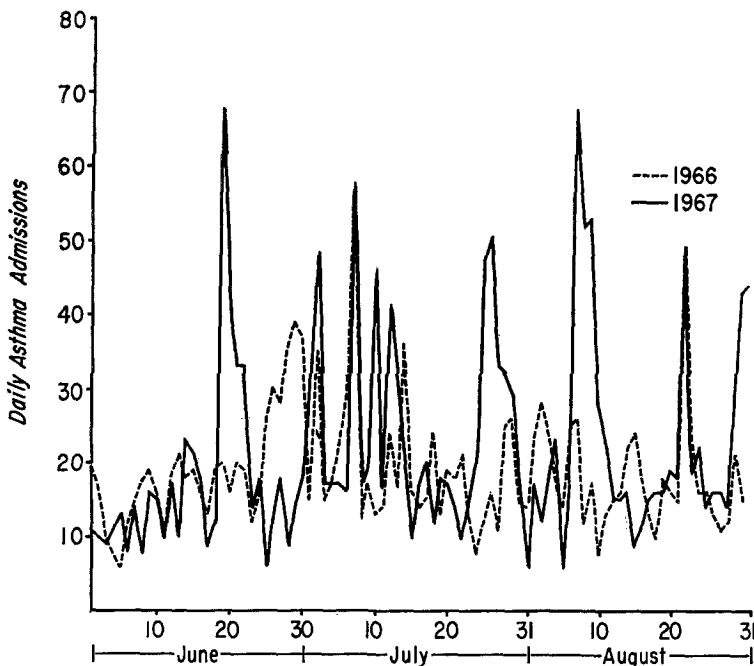


Fig. 1

Daily asthma admissions to Charity Hospital (1965, 1966, 1967).

atopic disease.⁵ Seventy-nine per cent of the 145 individuals involved in one randomly chosen outbreak on October 27, 1966, were also treated in the Charity Hospital emergency room for bronchial asthma on multiple occasions during "nonepidemic" days of the preceding 6 month period, indicating that involved individuals are not symptomatic exclusively during outbreaks. In addition, 100 names of subjects admitted to the Charity Hospital emergency room for treatment of bronchial asthma on "nonepidemic days" during the fall months of 1966 were randomly chosen from the emergency room files. These names were checked against a list of individuals involved in 25 preceding outbreaks. Fifty-one per cent were found to be involved in one or more of these 25 outbreaks, the percentage increasing in proportion to the number of outbreaks analyzed. This finding suggests that previously observed similarities between involved and noninvolved asthmatic subjects⁵ were due to overlap among these groups.

Pediatric admissions (below age 12) generally did not parallel adult admissions even when cases of "bronchiolitis and bronchitis" were tabulated together with "asthma" admissions, although a weak trend toward parallelism was noted during certain outbreaks in October and November. The number of pediatric admissions was always small in comparison to that of adult admissions, although several deaths were noted in severely affected children. Among reasons that might account for this discrepancy are lack of sufficient exposure of children for sensitization to airborne allergens and the readiness of indigent

**Fig. 2**

Daily summer admissions to Charity Hospital (1966, 1967).

parents to seek early preventive care for their children in pediatric clinics through child welfare services.

Climatological data

A significant relationship between minimum daily temperature and number of "asthma" admissions was noted as illustrated in the two-by-two contingency tables for the months October through January (Table I). Numbers in each cell represent number of days satisfying the given conditions for temperature and patient admissions during the 5 year period, 1963 through 1967. Note the increase in total number of "epidemic" days in October when compared to that of January, despite the fact that the daily cutoff point for October is 15 admissions above that of January. A similar relationship was noted between minimum humidity and high-admit days during fall months, as illustrated in Table II for October and November, 1963 through 1967. Maximum temperature showed no significant relationship to number of "asthma" admissions for the 5 year period of analysis, although "epidemics" of relatively low magnitude during the summer months of June, July, and August occurred on days of maximum temperature.

Relative humidity in New Orleans is high with recorded 12 midnight and 6 A.M. means generally above 85 per cent. Outbreaks were rarely noted, however, on excessively humid nights and never on nights associated with overt precipitation. Patches of dense fog are also common in the surrounding marshes and

Table 1. *Asthma admissions, 1963 through 1967*

<i>Minimum temperature</i>	<i>October</i>		<i>November</i>	
	<i>Days with more than 50 admits</i>	<i>Days with 50 admits or less</i>	<i>Days with more than 40 admits</i>	<i>Days with 40 admits or less</i>
Greater than 45° F.	12	101	11	93
Less than or equal to 45° F.	17	25	14	32
	p = 0.000065		p = 0.00358	

<i>Minimum temperature</i>	<i>December</i>		<i>January</i>	
	<i>Days with more than 35 admits</i>	<i>Days with 35 admits or less</i>	<i>Days with more than 35 admits</i>	<i>Days with 35 admits or less</i>
Greater than 40° F.	8	78	2	79
Less than or equal to 40° F.	16	53	8	66
	p = 0.0157		p = 0.0356	

suburbs, but most outbreaks have been reported on clear nights under "ideal" weather conditions.

Previous reports have strongly suggested that low-speed winds from the southwest were associated with outbreaks.⁷ Wind direction, however, showed a relationship to high rate of asthma admissions only in the month of October for the years 1963 through 1967 (chi square = 31.231; $p = < 0.001$). In particular, large outbreaks during October appeared to be associated with southwest winds (Table III).

Six p.m. wind speed did not show as strong a relationship to high asthma admission rates as was expected, although a relationship was noted during the months of October ($p = 0.0019$) and January ($p = 0.0074$) (Table IV).

With the use of the cutoff point of 29.80 inches (1.009.1 millibars), high barometric pressure showed a relationship to asthma admissions only during the month of September ($p = 0.0420$). No relationship was noted for the other months analyzed (October through March) during the 5 year period. Contingency tables for the months of September, October, and November are illustrated in Table V.

The p values are reported for all two-by-two tables. These represent exact probability of a given combination plus all combinations more unusual than the given one. Thus, they are comparable to the p values associated with the chi square test but have the advantage that no approximations are involved.

DISCUSSION

The primary findings in this study were as follows:

High "asthma admission" days at New Orleans Charity Hospital were associated with minimum temperature and minimum humidity during the months of September, October, and November.

Low wind speed and southwest wind direction were related to high "asthma

Table II. *Asthma admissions, 1963 through 1967*

Minimum relative humidity	September		October	
	Days with more than 35 admits	Days with 35 admits or less	Days with more than 50 admits	Days with 50 admits or less
Greater than 45%	10	123	6	89
45% or less	3	14	23	37
	p = 0.1682		p = 0.000001	

Table III. *Asthma admissions, 1963 through 1967*

6 P.M. wind direction	October	
	Days with more than 50 admits	Days with 50 admits or less
Calm	11	16
NE	3	46
SE	1	24
SW	10	10
NW	4	30

Chi square = 31.231; p = 0.000003.

Table IV. *Asthma admissions, 1963 through 1967*

6 P.M. wind speed	October		November	
	Days with more than 50 admits	Days with 50 admits or less	Days with more than 40 admits	Days with 40 admits or less
Greater than 4 m.p.h.	6	74	15	71
4 m.p.h. or less	23	52	10	54
	p = 0.00019		p = 0.4735	

Table V. *Asthma admissions, 1963 through 1967*

Barometric pressure (inches)	September		October		November	
	Days with more than 35 admits	Days with 35 admits or less	Days with more than 50 admits	Days with 50 admits or less	Days with more than 40 admits	Days with 40 admits or less
29.80 or below	6	101	25	96	20	95
Above 29.80	7	36	4	30	5	30
	p = 0.0420		p = 0.1783		p = 0.7492	

admission" days only in October, the month in which most local outbreaks occurred during the 5 years studied.

Local outbreaks were generally seasonal, occurring with greater frequency and magnitude during the months of September, October, and November.

Individuals involved in outbreaks were not symptomatic exclusively on epidemic days or during the fall season. Conversely, those not involved in any given outbreak were frequently involved in other "epidemics."

November		December	
<i>Days with more than 40 admits</i>	<i>Days with 40 admits or less</i>	<i>Days with more than 35 admits</i>	<i>Days with 35 admits or less</i>
14	96	16	107
11	29	8	24
p = 0.0321		p = 0.0851	

Pediatric asthma admissions did not parallel adult admissions during outbreaks.

Several of these findings are worthy of comment. High relative humidity in the absence of a pronounced temperature change is generally thought to favor induction of bronchial asthma in susceptible individuals^{8, 9} as opposed to low humidities noted in the current study. Preliminary evidence, however, suggests that airborne natural allergens and related particulate matter are associated with New Orleans asthma,^{6, 10} and low relative humidity favors dispersion of such substances. It is well known that physical factors such as cold air, citric

December		January	
<i>Days with more than 35 admits</i>	<i>Days with 35 admits or less</i>	<i>Days with more than 35 admits</i>	<i>Days with 35 admits or less</i>
12	91	3	106
12	40	7	39
p = 0.0547		p = 0.0074	

acid, and inert dusts can induce reflex bronchospasm in atopic and normal individuals.¹¹⁻¹⁴ The association between outbreaks of New Orleans asthma and minimal temperature during the fall months can be reasonably explained as intensification by cold fronts of pre-existing bronchospasm in atopic individuals. Although cold fronts have only shown a weak relationship to asthma admissions in a well-studied epidemiological survey in Philadelphia,¹⁵ they have been related to an increased incidence of bronchial asthma in certain low-lying seaport areas of the Netherlands, which closely resemble the flat, sea-level geography of New Orleans.¹⁶ It is not unusual for cold masses of air moving into the semitropical New Orleans fall climate to cause sudden drops of temperature of 15 to 20° F. during late September and October. This is the period during which Ambrosia pollination is at its height, and a combination of physical and allergic factors might reasonably be expected to suddenly precipitate bronchospasm in the "predisposed," atopic population. In addition, relationships of cold fronts to asthma admissions have been noted in New York City.²⁰

The weakness of the relationship between peak asthma admissions and days of high barometric pressure in this study was unexpected in view of the sig-

nificant increase in admissions reported in the city of Philadelphia on such days. These discrepancies, however, might be explained by differences in environmental factors. The combination of chemical air pollution and high barometric pressure is especially important in provoking high asthma-admission rates in Philadelphia,¹⁵ and conditions promoting stagnant air have been prominent factors in precipitating outbreaks of obstructive pulmonary disease in the Meuse Valley of Belgium, in the Tokyo-Yokohama area of Japan, in Los Angeles, and in Donora, Pennsylvania.^{17, 18} New Orleans asthma, however, has not been associated with significant chemical air pollution or low-level fall thermal inversions,⁶ and unlike outbreaks such as those noted in Donora and Los Angeles it exclusively involves a restricted segment of the population, namely, atopic individuals.⁵

In view of the fact that New Orleans asthma affects a homogeneous group of allergic individuals, is associated with climatological variables that adversely affect such individuals, and is generally a seasonal phenomenon, it probably does not differ from conventional "extrinsic" bronchial asthma. Indeed, an increased asthma admission rate during and immediately following the Ambrosia pollination season (postragweed asthma),¹⁹ as is observed with New Orleans asthma, has long been a common clinical observation.

Because preliminary data indicate that certain local "epidemics" occur in association with high concentrations of natural airborne allergens¹⁰ and because outbreaks are not related to measurable increases in specific chemical pollutants,⁶ it is likely that they involve sensitization of a segment of the local population by the usual spectrum of natural, seasonal allergens with aggravation by non-specific climatological factors.

Perhaps the unusual peaks of asthma admissions are peculiarly related to local socioeconomic factors and the presence of a large indigent population dependent upon one centrally located charity hospital for medical care. This affords a unique opportunity to study the epidemiology of bronchial asthma in the community at large.

REFERENCES

1. Weill, H., Ziskind, M. M., Dickerson, R. C., and Derbes, V. J.: Epidemic asthma in New Orleans, *J. A. M. A.* **190**: 811, 1964.
2. Lewis, R., Gilkeson, M. M., Jr., and Robison, R. W.: Air pollution and New Orleans asthma, vol. 2, New Orleans, 1962, Tulane University.
3. Weill, H., Ziskind, M. M., Derbes, V., Lewis, R., Horton, R. J., and McCaldin, R. O.: Further observation on New Orleans asthma, *Arch. Environ. Health* **8**: 184, 1964.
4. Weill, H., Ziskind, M. M., Derbes, V. J., Horton, R. J., and Dickerson, R. C.: Recent developments in New Orleans asthma, *Arch. Environ. Health* **10**: 148, 1965.
5. Salvaggio, J. E., and Klein, R. C.: New Orleans asthma. I. Characterization of individuals involved in epidemics, *J. ALLERG.* **39**: 227, 1967.
6. Kenline, P. A.: October 1963 New Orleans asthma study, *Arch. Environ. Health* **12**: 295, 1966.
7. Lewis, R., Gilkeson, M. M., Jr., and McCaldin, R. O.: Air pollution and New Orleans asthma, *Public Health Rep.* **77**: 947, 1962.
8. Samter, M., and Markowitz, A. S.: Nonspecific factors in allergic disease, in Samter, M., editor: *Immunologic diseases*, Boston, 1965, Little, Brown & Company, p. 559.
9. Ordman, D.: The "climate" group of respiratory allergy patients, *Int. Arch. Allerg.* **12**: 162, 1958.
10. Salvaggio, J. E., and Kundur, V. G.: New Orleans epidemic asthma: Relationship between outbreaks and influx of ragweed pollen, *J. ALLERG.* **41**: 90, 1968. (Abst.)
11. Burch, G. E., and Miller, G. C.: The influence of extremes and changes in climate on bronchial asthma, *Arch. Int. Med.* **120**: 389, 1967.

12. Sly, R. M., and Heimlich, E. M.: Physiologic abnormalities in the atopic state: A review, *Ann. Allerg.* 25: 192, 1967.
13. Wells, R. E., Jr., Walker, J., and Hickler, R. B.: Effects of cold air on respiratory air-flow resistance in patients with respiratory-tract disease, *New Eng. J. Med.* 263: 268, 1960.
14. Widdicombe, J. G., Kent, D. C., and Nadel, J. A.: Mechanism of broncho-constriction during inhalation of dust, *J. Appl. Physiol.* 17: 613, 1962.
15. Girsh, L. S., Shubin, E., Dick, C., and Schulaner, F. A.: A study on the epidemiology of asthma in children in Philadelphia, *J. ALLERG.* 39: 347, 1967.
16. Tromp, S. W.: Biometeorological analysis of the frequency and degree of asthma attacks in the Western part of the Netherlands. *Biometeorology, Proceedings of Second International Bioclimatological Conference, 1962, Oxford, 1963*, Pergamon Press, Inc., p. 477.
17. Schrenk, H., Heimann, H., Clayton, G. D., Gafarer, W. M., and Wexler, H.: Air pollution in Donora, Pennsylvania: Epidemiology of the unusual smog episode of October 1948, *Public Health Service Bulletin* 306: 1949.
18. Schoettlin, C. E., and Landau, E.: Air pollution and asthmatic attacks in the Los Angeles area, *Public Health Rep.* 76: 545, 1961.
19. Rebhun, J., Feinberg, S. M., and Malkiel, S.: The antigenic relationship of the pollen, seed, and leaves of giant ragweed, *J. ALLERG.* 25: 407, 1954.
20. Greenburg, L., Field, F., Reed, J. I., and Erhardt, C. L.: Asthma and temperature change, *Arch. Environ. Health* 8: 642, 1964.