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VII. Air Pollution and Disease Symptoms in a "Normal" Population

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The effect of each of several pollutants on the health of urban families on the lower East Side of New York city has been assessed. Prevalence of certain symptoms on one day of the week (Monday) was assessed according to level of each pollutant (low, medium, or high). Prevalence was treated as a binomial variable (number of "yes" responses/number of "yes" and "no" responses) whereas pollutant level was a continuous variable (but ordered, by thirds), according to the method of Armitage.

In summer, in children under 8 years of age, prevalence of respiratory symptoms was directly related to increasing levels of particulate matter and of carbon monoxide.

In heavy smokers, prevalence of eye irritation and headache was directly related to increasing levels of carbon monoxide.

DURING various episodes of excessive atmospheric pollution, the occurrence of an unusually high number of severe illnesses, some terminating in death, has been recognized repeatedly. However, the effect of exposure to daily fluctuating levels of pollutants in the environment on the health of urban families is more difficult to pinpoint. No one doubts that people feel miserable during days of high pollution, but how can we assess the toll, and evaluate critical levels of prime offenders in the atmosphere?

Families living in lower- and middle-income housing on the lower East Side of New York city have been observed for a period of nearly three years. These "normal" individuals lived within a 2,000-foot radius of the monitoring station where concentrations of various air pollutants were being measured concurrently. The relationship between the prevalence of certain symptoms and the level of the pollutants has been subjected to statistical analysis. The applicability of the method used, and the outcome of the analysis will be discussed in this paper. The analysis so far deals with "single symptom-single pollutant" pairs, although we recognize that the problem is in fact multivariate. We present this analysis as a first-step approach to solution of an admittedly complex problem.

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Definition of Population

Population.—Three groups of people living in the lower East Side of New York city were studied. The nature of the groups and their selection have already been described.[1,2] Briefly, following a preliminary survey, a stratified sample was selected, representing a cross section of lower- and middle-income groups, living within an area of one-half square mile, considered relatively homogenous in its air environment. Altogether, 1,820 individuals participated, representing 469 family units.

Subpopulations.—*Under 8 Years of Age.*—This group consisted of those children who were born on or after Feb 12, 1956, and thus had not reached their eighth birthday by mid-February 1964, the approximate midpoint of the study. This age break provided a contrast between young children known to have unusually high prevalence of respiratory disease and all older individuals. Limitations of the extent of the analysis precluded other age breaks.

Eight Years of Age and Over.—In this group are all those individuals whose birth date was before Feb 12, 1956, and thus had passed their eighth birthday by the midpoint of the study. In regard to smoking habits, the extremes were selected among adolescents and adults: those individuals 12 years or older at time of entry to study were divided among the following categories.

HEAVY CIGARETTE SMOKERS.—These individuals smoked 20 or more cigarettes per day.

NONCIGARETTE SMOKERS.—These people had never smoked cigarettes.

The highest and lowest groups offered the greatest contrast in smoking habits. Inclusion of intermediate groups was desirable but not feasible.

Duration of Study.—Interviews were carried out over a period of nearly three years, less six weeks. The average stay of an individual in the study was 46 weeks.

Definition of Symptoms

Symptom-Days.—Interviewers trained by our staff visited each family once a week. He, or she, filled in a structured questionnaire according to answers given by one responsible adult, usually the mother, who responded for herself and for other members of the family. The precoded questions concerned the daily presence or absence of 21 symptoms of disease. The present analysis is concerned with only four of these symptoms: cough, eye irritation, "common cold," and headache, which were defined as follows.

Cough.—The question "Did you cough on this day?" was asked about all individuals except those who on first entering the study stated that they coughed regularly (called "chronic coughers"). The presence or absence of a cough was recorded for each day of the study.

Eye Irritation.—A positive answer to the question "Did you have itching, burning, or tearing of your eyes on this day?" is considered equivalent to eye irritation. This question was asked of the entire study population.

Common Cold.—A positive answer to the question "Did you have a cold any day this week?" was used. We have found that a "cold" is almost synonymous with rhinitis (or "runny nose"). The question was asked of the entire study population.

Headache.—The statement that a person had a headache on each day was used. The headache question was not asked for children 4 years old and under.

Prevalence.—A symptom-day consisted of one day on which one person answered "Yes" about a symptom. A person-day consisted of one day on which one person answered definitely "Yes" or "No," omitting indefinite or unknown answers. Thus the prevalence of a symptom is the ratio of symptom-days to person-days.

In this analysis, the association of combinations of each of these four symptoms with each of four air pollutants was studied.

Measurement of Pollutants

Air Pollution.—The concentration of each pollutant was measured at a monitoring station in the center of the half square mile in which the three groups lived. The pollutants analyzed consisted of particulate matter, carbon monoxide, total hydrocarbons, and sulfur dioxide. Hourly averages of continuous readings of each were recorded (except particulate matter which was averaged each two hours). They were measured as follows.

Particulate Matter.—This was measured in coefficient of haze (COH) units at roof level (189 feet) by smoke sampler—optical density of the spot produced by collecting the filtrate of a given volume of air. The source is chiefly burning of fossil fuels. Particles under 100μ in diameter only are collected; almost all of these are less than 10μ, and are relatively evenly dispersed. Particles in this size range are known to be capable of reaching the alveoli of the lung.

Total Hydrocarbons.—Total hydrocarbons, reported as parts per million of methane measured at third floor level (30 feet) consist almost entirely of methane. The source is principally from automobiles.

Carbon Monoxide.—Carbon monoxide (CO), measured in parts per million at third floor level comes from a combined source of furnaces and automobiles.

Sulfur Dioxide.—Sulfur dioxide (SO_2), measured in parts per million at third floor level, was determined by an SO_2 conductivity meter which is known to measure more than SO_2 alone, including reducing substances and sulfates. Any ionizing substances, a sulfur compound, or carbon dioxide present in the sample may alter the measurement.

The meter employs a conductivity method for the measurement of SO_2. On July 28, 1964 the electrical bridge in the meter was changed from selenium to germanium in an effort to improve the functioning of the machine. Subsequently it was discovered that the SO_2 values recorded after the change in the electrical bridge were different from those recorded before the alteration. Although initially a source of concern, it was possible to make the data obtained from the beginning of August 1964 comparable to the earlier data by the application of a carefully calibrated linear transformation.

The daily average of the 12 or 24 averages within the 24-hour period of each pollutant was the function used throughout this analysis.

Statistical Analysis

The method of statistical analysis was selected as one applicable to the nature of the variables under study: (1) a proportion