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A group of Manhattan residents was questioned weekly on the occurrence of acute respiratory symptoms. Incidence and prevalence rates of "common colds" were related to environmental variables. Findings are discussed.

HEALTH AND THE URBAN ENVIRONMENT

VIII—AIR POLLUTION, WEATHER, AND THE COMMON COLD

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Introduction

ALTHOUGH the ubiquitous air pollution to which urban residents are constantly exposed has been widely condemned as a community health hazard, solid evidence of such an effect has been difficult to demonstrate. The notorious, but rare, acute air pollution episodes (Donora, 1948; London, 1952) took their greatest toll from the elderly—largely those with pre-existing cardiorespiratory disabilities. The two principal questions posed by such evidence are: (1) Does air pollution, at its usually prevailing lower levels, also affect health? (2) If so, are ordinary urban populations involved?

Studies on the behavior of airborne respiratory disease agents suggest that one mechanism through which air pollution may produce such an effect could be by altering susceptibility to, or transmission of, such agents in a population. Complicating any analysis of the relationship of levels of air pollution to incidence or prevalence of such infections are the intricate interrelationships between various meteorological factors and pollution levels. To assess the relative importance of meteorological and pollution factors in common upper respiratory illness, the following analysis was performed.

Materials and Methods

The study providing the data on which the analyses reported here are based has been described fully elsewhere (McCarroll, 1965; McCarroll, 1966). Briefly, the data on the "common cold" were obtained from a panel of families residing in the lower east side area of New York City through weekly interviews. The meteorology data came from the official U.S. weather station located in Central Park, about 4.5 miles from the center of the study area. The air pollution data were obtained from special monitoring equipment installed in the study area specifically for the study. The variables included in these analyses are:

"Common Cold"

1. Incidence rate/1,000/day
2. Prevalence rate/1,000/day

Environmental Variables

1. Pollutant indexes
   a. Particulate matter (COH units)
   b. Carbon monoxide (CO/ppm)
   c. Sulfur dioxide (SO_2/ppm)

2. Meteorological variables (24 hour averages)
   a. Temperature (°F)
   b. Relative humidity (%)
   c. Wind velocity (mph)
   d. Barometric pressure (inches Hg.)
   e. Solar radiation (gram cal./cm^2/sec)

In earlier analyses of these materials, various periodicities have been demonstrated; these may have been due either to the periodic nature of the interrogation regarding the health status of panel members (a weekly questionnaire), or to the variation introduced into meteorological and air pollution measurements by season of year and day of week (e.g., traffic patterns, industrial activity, and the like). The influence of season on these variables, and the levels recorded for New York City during this period, may be examined in Table 1. To eliminate these sources of variation from our analyses, aimed at studying the relation between the common cold and meteorological and pollutant variables, we have made each analysis specific for the consecutive nine seasons (winter, spring, summer, fall) during the study period for which panel membership and pollution data are sufficiently complete to warrant analysis. Within each season we have removed the variability attributable to the day of the week, by taking deviations from the day average and standardizing these deviations by division by the standard deviation. Thus, for the prevalence of common cold on a particular Wednesday during the spring of 1963, we have as a basic unit for analysis

$$C=\frac{x-\bar{x}}{s}$$

where x is the prevalence rate for the Wednesday in question, $\bar{x}$ is the average prevalence rate for all Wednesdays in the spring of 1963, and s is the standard deviation of these prevalence rates. (For another example of the use of this technique, see Sterling, 1966.)

Previous analyses of health data from this study have been restricted to the prevalence of a symptom or health-related condition on a given day. Since the role of meteorological and pollutant variables in influencing the common cold is poorly understood, we wished to be able to make separate analyses of the influence of these variables on the onset of the common cold (incidence), as well as the duration of the common cold once acquired (prevalence). Moreover, provision was made for examining the effect of these influences on the onset of a common cold for time lags up to 72 hours. In defining incidence, we have required only that an onset be preceded by one or more days, when the question concerning common cold was answered "no" (McCarroll, 1965). Some notion of the symptoms prompting a report of common cold may be gained by noting that such a report involved rhinitis 90 per cent of the time, cough 41 per cent, sore throat 34 per cent, feverishness 13 per cent, and gastrointestinal symptoms in 8 per cent of reported common colds.

All the findings reported here are based on stepwise multiple regression analyses of the standardized variables described above. If the incidence (or prevalence) of the common cold were linearly related to the total set of available meteorological and pollutant variables, the stepwise procedure would generate the coefficients a_i in the following linear equation:

$$C=a_o+a_1x_1+a_2x_2+\cdots+a_8x_8$$

In this equation, C is the standardized common cold incidence (or prevalence) measurement and x_1 to x_8 are the standardized measurements of the eight pollutant and meteorological variables. The stepwise procedure has the property that it enters the pollutant and meteorological variables one at a time in order of their ability to "explain" the variability in the common cold incidence,