SOME SKELETAL PLANS FOR STUDYING HEALTH EFFECTS OF AIR POLLUTION

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1. Filtered air studies on populations at risk

One of the difficulties in evaluating the health effects of photochemical pollution lies in the fact that these tend to be long term effects, in contrast to immediate air pollution disasters, such as the London "Killer fog" of 1952. A method of obtaining short term photochemical pollution effects consists of considering the results of lung function tests obtained under different pollution conditions on subjects suffering from respiratory diseases.

In Ury and Hexter [5], a number of univariate and multivariate statistical procedures are discussed for a study in which a series of lung function tests and other physiological measurements were obtained for 15 emphysematous subjects, both under ambient and under filtered air conditions, in a Los Angeles hospital room with controllable air supply. A significant association was found to exist between airway resistance and oxidant levels. (Subsequently, a lesser but still significant association was found to exist between airway resistance and NO_2.)

This type of study can obviously be extended to subjects suffering from any respiratory or circulatory disease or to any other population at risk, and to any pollutant which can be effectively filtered out. In order to isolate the effects of specific pollutants, partial correlation or step-wise regression should presumably be used.

2. Simple and robust "preliminary" methods, after blocking

In Ury [3] and Ury *et al.* [4], a statistically significant association is shown to exist between the frequency of automobile accidents and oxidant levels in Los Angeles, while no association is found between such accidents and CO levels.

The statistical method used in these reports is extremely simple. Accident frequencies and pollutant levels are compared for the same hour of the day on the same day of the week at time intervals of exactly one week, in order to equalize as many covariables as possible. If the hour with the higher pollutant level has the higher accident frequency, this is scored $+1$, and the opposite case, -1. Ties in either variable are scored 0. Thus, a concordance sign test,

or Kendall's tau with $n = 2$, is used to investigate the possible association between accidents and pollutant levels.

This almost embarrassingly naive method has all the earmarks of a preliminary look-in. Before proceeding to more sophisticated techniques one should, however, note the following. (a) Even nine pollutant monitoring stations can scarcely cover every area of Los Angeles County precisely. (b) Pollutant measurements are far from reliable; errors of 50 per cent or more are quite common. (c) For the many other potential pitfalls see [4]. In short, any study dealing with area wide pollution rather than with pollutants measured at a specific place is likely to run into a number of problems, and the unreliability of pollutant measurements can affect even studies of the type given in Section 1.

While the concordance sign test procedure is not especially applicable to health studies (since such factors as hospital admissions are not too meaningful on an hourly basis), it is applicable to crime studies, for example, in any area that has monitoring stations that provide hourly averages, or maximum values, for various pollutants.

3. Simple follow-up methods for daily mortality studies

A skeletal plan for a study of daily mortality is given elsewhere by Hexter, using the multiple regression technique outlined in Hexter and Goldsmith [1]. After making allowance for cyclic variation, trend and temperature, one can obtain at least a preliminary idea of the effects of various pollutants during short periods of heavy "smog" by subjecting the residuals to simple sign tests of the type outlined in Section 2. This is covered in detail in [2].

4. Multiple location studies of physiological measurements with different pollutant levels

As a specific example, consider the residence effect on blood lead level in four locations: a rural town or village in California, the Los Angeles beach area, the Oakland area, and downtown Los Angeles. A randomly chosen sample of n subjects from each area, matched with regard to sex, age, socioeconomic status, occupational exposure and length of residence, can presumably give a fair idea of the pollution effect on blood lead levels. If an *a priori* ordering of the locations with regard to pollutant levels is feasible, regression or trend tests can be used.

This type of study can be applied to any pollutant and physiological measurement and to any set of communities sufficiently close to monitoring stations that measure this pollutant. Once again, simple and robust procedures should be used, in view of measurement unreliability.

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