

# Epidemiological ASPECTS OF Air Pollution\*

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**E**pidemiology of acute diseases has led to effective prevention of such diseases as cholera and smallpox. These achievements allow us to live together in great metropolitan complexes like Los Angeles, free from the very great toll formerly taken by premature death.

Life in a modern city brings with it new health challenges. These new health problems, including mental health, alcoholism, chronic disease, air pollution, and exposure to the by-products of newly harnessed energy forms, such as radiation, have brought forth a new emphasis in public health, and a new concern with air, comfort, and enjoyment of our longer life span. In these areas as in traditional ones also, epidemiology is the basic fact-finding tool of public health.

If it were feasible to expose people experimentally to all kinds and concentrations of air pollutants, there would be less need for air pollution epidemiology. This is not possible, so investigation must be made of naturally occurring human exposures to air pollution. Natural air pollution exposures are the raw data of the air pollution epidemiologist; the meticulous classification, analysis, and comparison of these data is his operating procedure. Finally air pollution epidemiology is concerned with groups of persons, and their reaction to air pollution exposures; it is not so greatly concerned with reactions of single individuals.

Just as epidemiology led to methods for control of water-borne disease before bacteriology permitted the accurate diagnosis of them, so it is hoped that epidemiology may assist in the control of the health effects of air pollution even before it is possible to diagnose a disease caused by air pollution.

The studies to be described are concerned with how air pollutants damage the health of groups of people. Several basic problems recur in all of these

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studies, the accurate description of the groups of people to be studied, the definition and measurement of air pollution, the detection and measurement of effects possibly related to air pollution and the clarification of any relationship between these effects and air pollution.

The importance of air to health may easily be overlooked. Each day we bring into our lungs for equilibration with the blood, some 30 pounds of air, compared with our daily exchange of five pounds of water and less than four of food. Man can survive about five weeks without food, about five days without water, but only about five minutes without air.

A start was made in California by reviewing what was known about air pollution effects and listing the types of effects which could be looked for, measured, and hopefully prevented. Five potentially measurable health effects of air pollution are now of concern:

Air pollution may cause acute sickness and death such as occurred in the Muese Valley, at Donora, and during the several London episodes.

Air pollution may cause or aggravate chronic diseases such as chronic bronchitis, emphysema, or lung cancer.

Air pollution may cause interference with important bodily functions such as the exchange of gases in the lung or gas transport by the blood.

Air pollution may cause adverse bodily symptoms such as eye irritation and difficulty in breathing.

Air pollution, because it is unpleasant in many ways, may cause groups of persons to be dissatisfied with or leave their places of residence or work.

In studies on the health effects of air pollution in California data has been collected about each of these possible effects, acute sickness or death, chronic or insidious disease, interference with bodily function, production of adverse symptoms, and instability of residential or work communities.

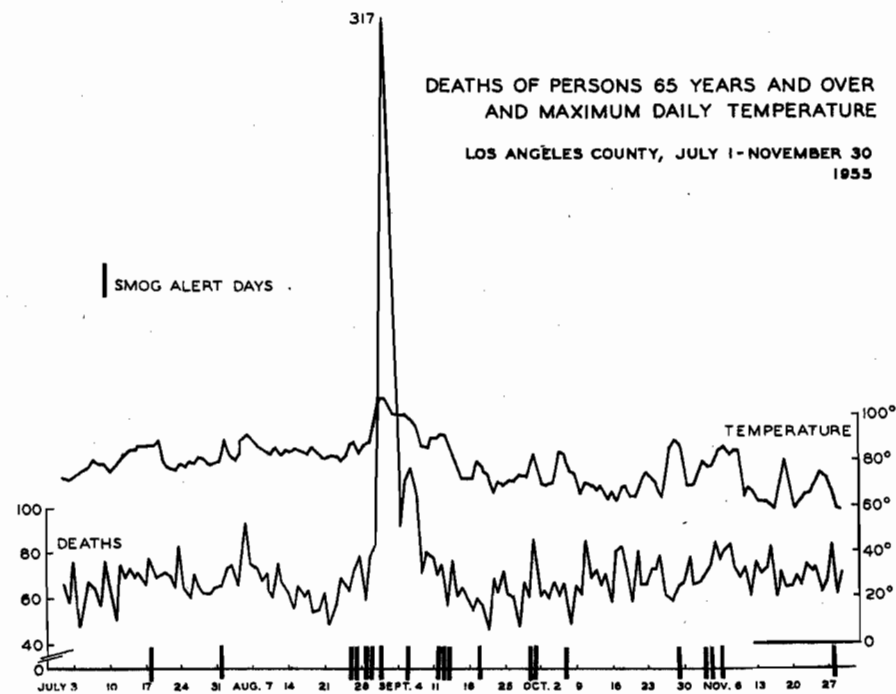


Fig. 1

The work commenced in the fall of 1954 at which time a series of air pollution episodes in Los Angeles led people to ask whether "can this air pollution kill people?" That summer and fall three distinct smog episodes occurred. The daily number of deaths among persons over 65 did not appear to fluctuate in response to these episodes, nor did the total daily deaths, or the deaths due to cardiac or respiratory causes.

In late August and early September, 1955 there was a period of very high temperature both preceded and followed by smog. During the high temperature, the number of deaths rose, but with falling temperatures the number of deaths dropped despite continued high air pollution levels (Fig. 1).

In a further attempt to assess the immediate mortality effect of air pollution, the California State Department of Public Health has been obtaining since 1954 reports on daily deaths and transfers to hospitals among the 4000 or so residents of nursing homes in Los Angeles with 25 or more beds. These persons are for the most part elderly and often in frail health. Except for the heat wave mentioned above, there has been no increase in mortality from this group which could be associated with air pollution (Fig. 2). In consultation with biostatistical experts we are working out methods for the separation of the effects of high temperature from the possible effects of air pollution.

During the smog episodes in 1954 a probability sample of Californians were being interviewed about their health. There was no evidence that they experienced more sicknesses or hospitalizations during the smog episodes.

Acting on reports of physicians that patients with asthma were adversely affected by air pollution, our staff undertook a study of the possible relation of asthma attacks to air pollution levels in Pasadena in the fall of 1956. Investigation of 137 private patients of a cooperating group of physicians for a period of 10 weeks, disclosed a very low positive association between asthma attacks and air pollution levels.

Increasing frequency of two chronic diseases of the lung, lung cancer and emphysema of the lung, leads to questions concerning the possible effect on them of air pollution.

Lung cancer has a clear-cut causal relationship with cigarette smoking. Less well known is the fact that nationwide the disease is more frequent in urban counties than in rural ones (Fig. 3). Urban air pollution provides a possible explanation. There are also a number of occupations which appear to be associated with lung cancer (Fig. 4).

In California there are no important differences in lung cancer rates between



† = Days of official alerts (ozone 0.50 ppm or higher).  
Source: State of California, Department of Public Health.

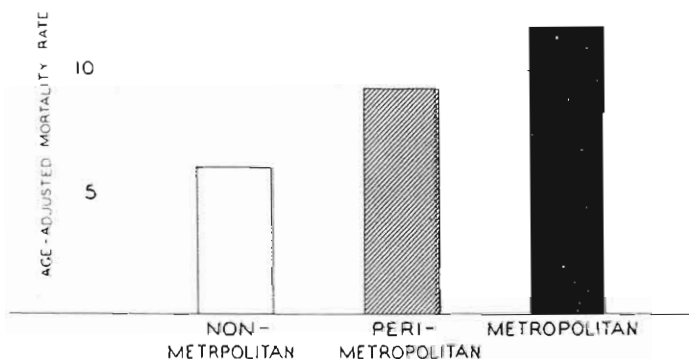
Fig. 2

cities and rural areas, but we feel this may be due to the fact that so many Californians have migrated here from other states and from one part of the state to another. With the support of the American Cancer Society and the co-operation of the California Department of the American Legion, data on present and past residence, occupation, and smoking have been obtained on about 75,000 Legionnaires and 50,000 of their wives. A search is planned among the death certificates for all persons dying of lung cancer in California over the next five to 10 years to see how many people in various portions of this study group die of the disease. Thus one may find out what effect living in air polluted areas of the state may have on the lung cancer death rate.

In the case of pulmonary emphysema the death rate in California increased fourfold in the period 1950 to 1957 (Fig.

5). There are several possible explanations for this. Physicians may be giving this diagnosis on death certificates rather than asthma or bronchitis, which are related disorders. Figure 5 suggests that this is not the case since there is no long-term fall in asthma and bronchitis. The people who died may have come here because they had the disease and wanted to live in a warm, dry, climate. They may be persons who survived other formerly fatal conditions such as tuberculosis or pneumonia. These questions are now being explored by interviewing both physicians who cared for patients dying of these sicknesses, and the next-of-kin of the patients. It is necessary to know how the physician chose the diagnosis, what previous illnesses, occupations and residences the person had, how much smoking they did, and for those who moved here, whether they moved for

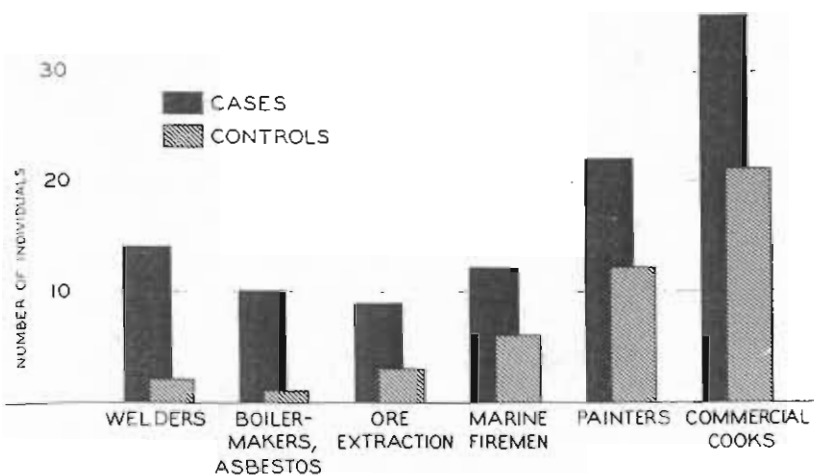
### THE ASSOCIATION OF LUNG CANCER WITH URBANIZATION OF COUNTY OF RESIDENCE



Source: Monos

Fig. 3

## OCCUPATIONS WITH A HIGH LUNG CANCER DEATH RATE



Source: Breslow, et al.

Fig. 4

health or medical reasons. This information may shed some light on the possible relationship of air pollution to the epidemiology of pulmonary emphysema. It is important to state here, too, that urban-rural differences exist nationwide for emphysema but do not so exist in California.

Only recently has exploration begun in the study of the possible epidemiological use of measurements of lung function as they relate to the air pollution problem. It is assumed that irritating air pollutants on being breathed will alter the airways in such a way as to increase the resistance to airflow. Several instruments for estimating maximal rate of airflow are being compared in the effort to measure this property of lung function.

Over a period of days we tested a large number of persons once, also obtaining the age, sex, smoking, and occupational history necessary for their classification. For analysis of such a study it is necessary to assume that, but for air pollution exposure, all persons of same age, sex, smoking and occupational groups should have the same test results. The study was undertaken last summer (1958) in Vernon, an industrial area in central Los Angeles County, at the time of an x-ray survey. About 6500 persons were tested, during a time which was fixed in advance. Unfortunately there was little air pollution during the days our equipment and team were available, the maximum value being 0.18 ppm of oxidant (KI Method). We were unable to detect an effect of air pollution on lung function by the method used at that time.

A second method used was to study the same group of men repeatedly on days with varying air pollution. During the late summer and fall of 1958, Dr.

Charles Schoettlin studied at weekly intervals two groups of men at the Veteran's Administration Hospital, West Los Angeles, one group had chronic lung disease, the second did not. The men in these two groups were matched for age and smoking history. The data are still being analyzed.

In 1956 a portion of the California Health Survey was devoted to questions about air pollution. A probability sample one adult in each 2000 households in California, was asked a number of questions about health and about the extent that air pollution affected them. The respondents were questioned con-

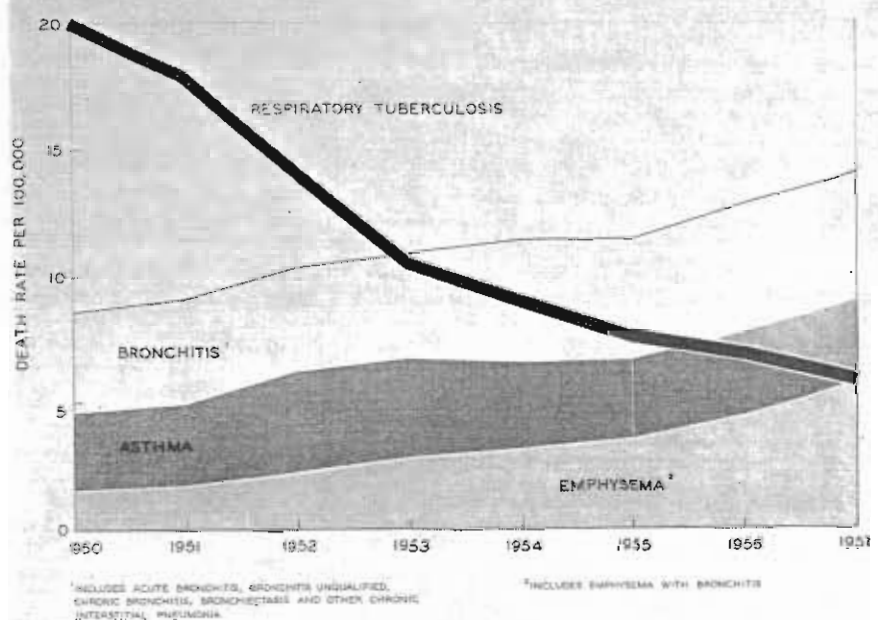
cerning the presence of selected chronic diseases and conditions and what things they felt made them worse. They were also asked about their satisfaction with their home community and with their job. Those who said they were dissatisfied were asked the reasons for being dissatisfied. All these questions were put to the person interviewed before there was any mention of interest in smog or air pollution by the interviewer.

In Los Angeles County, air pollution was spontaneously reported to make eye complaints worse by three persons out of four who had such complaints; asthma and nose and throat complaints were reported to be made worse by air pollution in half, followed by sinus in two out of five, hay fever in three out of ten, bronchitis, shortness of breath and bad headaches each in about one person in five who had the condition.

In answer to the question in the California Health Survey—"Taking everything into consideration, how satisfied are you now with living in \_\_\_\_\_ (community), are you very satisfied, somewhat satisfied or not satisfied at all?" One person out of five in Los Angeles answered that they were only somewhat or not at all satisfied, and when asked, "What don't you like about it?" One person out of four reported air pollution as the reason compared to one person in five reporting personal reasons, and one person out of eight reporting community dissatisfaction because of financial reasons. Of the dissatisfied group almost half reported that they were thinking of moving.

## DEATH RATES DUE TO SELECTED RESPIRATORY DISEASES

CALIFORNIA 1950-57



Source: State of California, Department of Public Health, Death Records.

Fig. 5

Remember that these questions about health effects and community satisfaction were asked before the interviewer had mentioned air pollution as such. The answers therefore represent spontaneous reactions to air pollution, not stimulated by direct questions about air pollution.

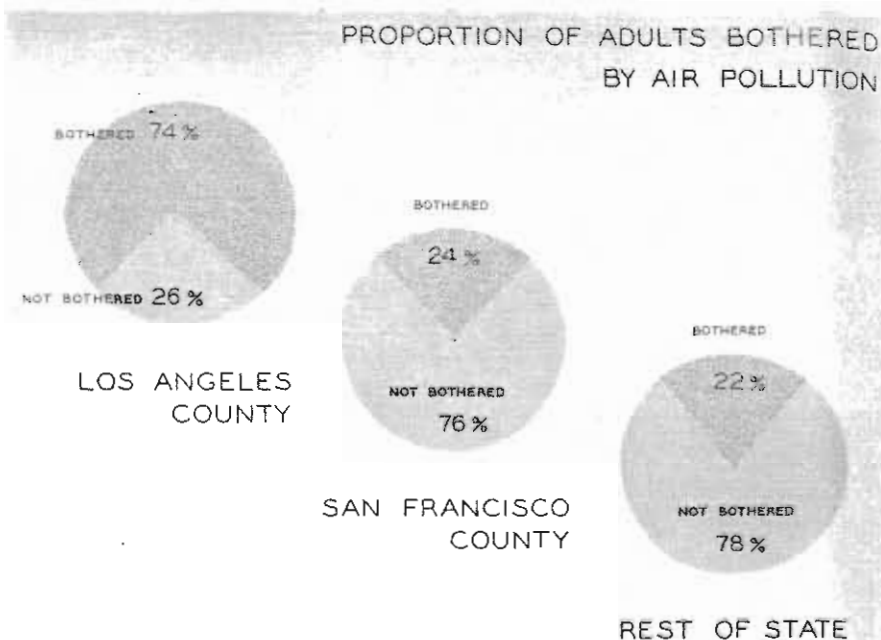
When finally the question—"Lately, there has been a lot of talk about air pollution, such as dust, smog, smoke, etc.; in your community does air pollution (smog) bother you *very much, some, or not at all?*" Two out of three of those interviewed in Los Angeles County reported being bothered (Fig. 6).

When asked, "How does it bother you?" Nine out of 10 persons bothered in Los Angeles reported eye irritation with or without some other symptom. In 1958 these same questions were again asked of a statewide sample, with no important differences from 1956 in the proportion bothered by air pollution in any area. About 10 per cent of those bothered by air pollution reported that it gave them difficulty in breathing. Although this proportion may seem low it represents close to 300,000 adult persons in the state's population.

When asked in the 1956 survey "Have you been thinking recently of changing your job?" "All in all, how satisfied are you with your job, very satisfied, somewhat satisfied or not at all satisfied?" About one person out of 15 in Los Angeles indicated they were thinking about a job shift even though satisfied and one person in five indicated they were not very satisfied, of whom almost half were thinking of changing jobs. But of those two-thirds of respondents in Los Angeles who reported being bothered by air pollution about twice as many were thinking about changing jobs as among the one-third not bothered.

Our philosophy is well expressed by the following quotation: "It should seem possible, by a set of well adapted experiments, accurately made, to discover what are usually called the occult qualities of the air, and render them manifest to the senses. And if by this means, we could come at a tolerable knowledge of the effluvia, salts, and other heterogenous matters, wherewith the air at different times, and in different countries is replete, it might give us almost a complete knowledge of the nature of all epidemic diseases that

\*The entire works of Dr. Thomas Sydenham, newly made english from the originals to which are added explanatory and practical notes from the best medicinal writers; with others by the translator: by John Swan, M.D., London—R. Cave, 1763, pp. 9-10. (The quotation is from a note by the translator).



Source: State of California, Department of Public Health, California Health Survey.

Fig. 6

may arise for the future, provided due attention be given at the same time to the age, sex, constitution, manner of living, and so forth of the patient; all which circumstances being carefully considered and compared together, might probably direct to rational, fixed, and effectual methods of cure."\*

The newest aspect of California's program in air pollution will draw heavily on epidemiology. The California State Department of Public Health has been given one of its most difficult tasks, the establishment of standards for air quality. The statute says in part "The standards shall be so developed as to reflect the relationship between the intensity and composition of air pollution and the health, illness, including irritation of the senses, and death of human beings, as well as damage to vegetation and interference with visibility."

Almost the first problem in this task is to determine which group of persons is to be protected. To protect every *last person* from sensory irritation, his crops from damage, or his wife's wash from any soiling might prove unreasonably expensive.

One basis now being considered for the standards is that they will be designed to protect the most sensitive group of persons in the community, and that these groups are to be defined according to age and medical criteria. This means that standards will be more strict than needed to protect the healthy adult male, (the responsibility of industrial hygiene standards) and perhaps

less strict than needed to protect a desperately ill person, (the responsibility of the individual physician). Much of the work in air pollution epidemiology will in the future be based on detecting the most sensitive groups of persons in the population, and on determining their reactivity to various levels of air pollution.

In summary epidemiological studies permit the following conclusions:

1. There has been no convincing evidence that acute sickness or death has resulted from air pollution in California.
2. Lung cancer, chronic bronchitis, and emphysema are chronic diseases whose relationship to air pollution is being studied.
3. Studies concerning the effect of air pollution on important bodily functions are getting underway; they are expected to provide a sensitive method of studying air pollution effects.
4. Population surveys reveal that air pollution causes widespread and disturbing symptoms.
5. Air pollution in Los Angeles has been the commonest cause of community dissatisfaction, and is given as a frequent reason for moving or change of employment.

Air pollution is a threat to health including social health. Epidemiologic studies can provide a well rounded picture of all of these effects, and thus a basis for their prevention through sound community planning and rational controls.