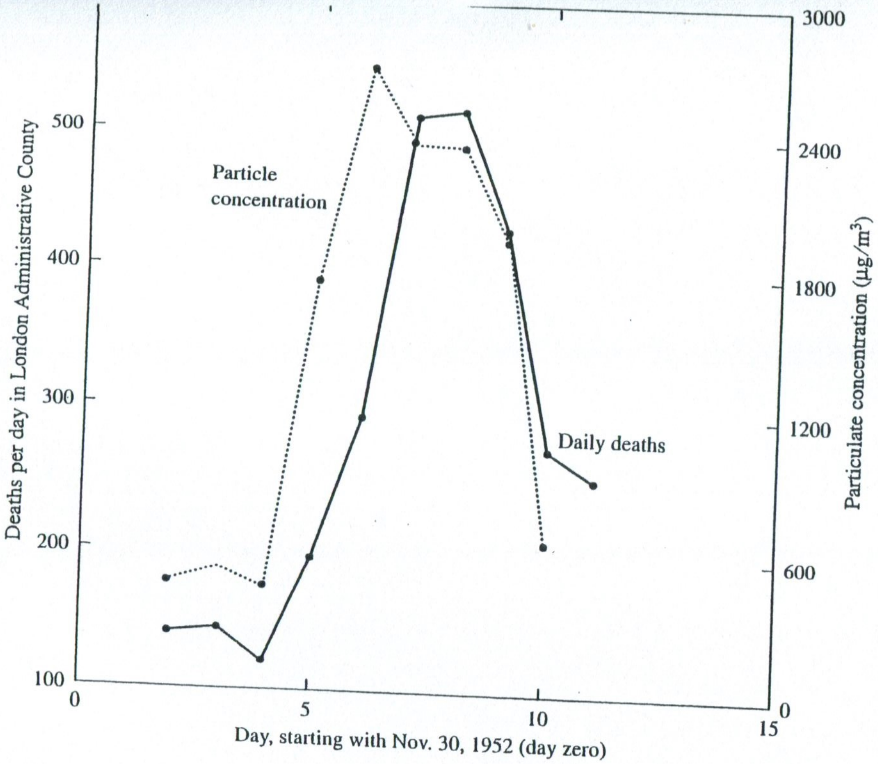

FIGURE 2.6
Daily death rates and particle concentrations for the December 1952 London pollution episode, after Schwartz [20].

problems. The air pollution episode did not kill them, but rather hastened their deaths or shortened their lives.

Figure 2.7 shows the results of a prospective study of mortality [21]. Large groups (1200 to 1600) or participants were selected in six cities. For 14 to 16 years their health and survival were measured, along with concentrations of pollutants in the six cities. The survival rate (fraction of the original study population still living) was highest in the least polluted cities. Figure 2.7 plots the ratio of the annual death rate in each of the cities to that in the cleanest city (Portage, WI). This ratio is obviously 1.00 for Portage, increasing to 1.26 for Steubenville. This study, by the highly respected air pollution group at the Harvard School of Public Health, was one of the major bases for the change in U.S. particulate standards in 1997 [22]. From the study we see:

1. The death rate, adjusted for smoking and some other factors, seems to be linearly proportional to the fine particle concentration (particles with diameters $< 2.5\ \mu$).

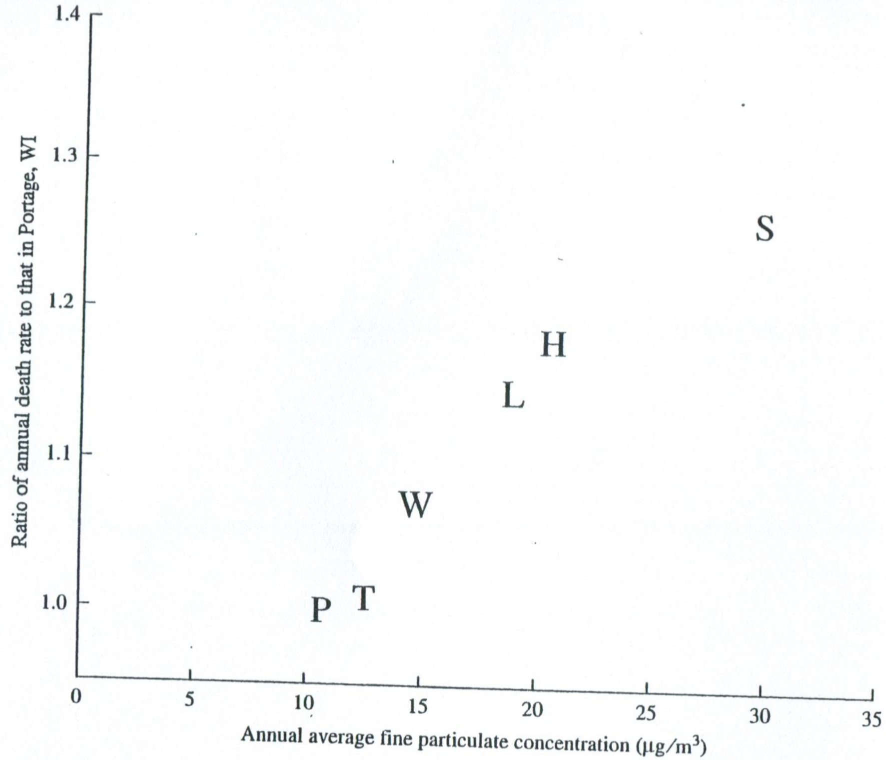

FIGURE 2.7
Ratio of death rates to that in Portage, WI, as a function of fine particle concentration. Here P = Portage, WI; T = Topeka, KA; W = Watertown, MA; L = St. Louis, MO; H = Harriman, TN; and S = Steubenville, OH. After Dockery et al., "An Association between Air Pollution and Mortality in Six U.S. Cities," *New England J. of Medicine*, Vol. 329, pp. 1753–1759, 1993. *Copyright ©1993 Massachusetts Medical Society, All rights reserved.* [21]

Other air pollutant concentrations or combinations of them did not correlate the mortality data as well.

2. There does not appear to be any threshold.
3. The concentrations are quite low. The values are not directly comparable to those in Fig. 2.6 because of different measuring methods, but using the best estimates of the correspondence of those methods [23], one concludes the peak value of $\approx 2500\ \mu g/m^3$ on Fig. 2.6 would correspond to about $1500\ \mu g/m^3$ on Fig. 2.7. However, the value on Fig. 2.7 is an annual average, and those are typically about one-third of the highest-day value, so the proper ratio between the highest values on the two figures is roughly $[1500/(30 \cdot 3)] \approx 17$. → 약 17배 정도 낮음
4. Figure 2.7 is a comparison of annual death rates as a function of particle concentration whereas Fig. 2.6 is of daily death rates. Various statistical studies have shown that the effect is similar over most studies, both prospective and retrospective.