Elaborate: What does the six cities study tell us about particulate air pollution exposure and mortality rates?

Name_____ Class_____ Date_____

Background: Six Cities Study

In 1974 a group of scientists from Harvard conducted the Six U.S. Cities Study. This study followed 8,111 randomly selected people living in six cities within the U.S. - Harriman, TN, Watertown, MA, Steubenville, OH, Portage, WA, Topeka, KS, and St. Louis, MO. This study was the first of its kind linking premature mortality with fine particulate pollution.
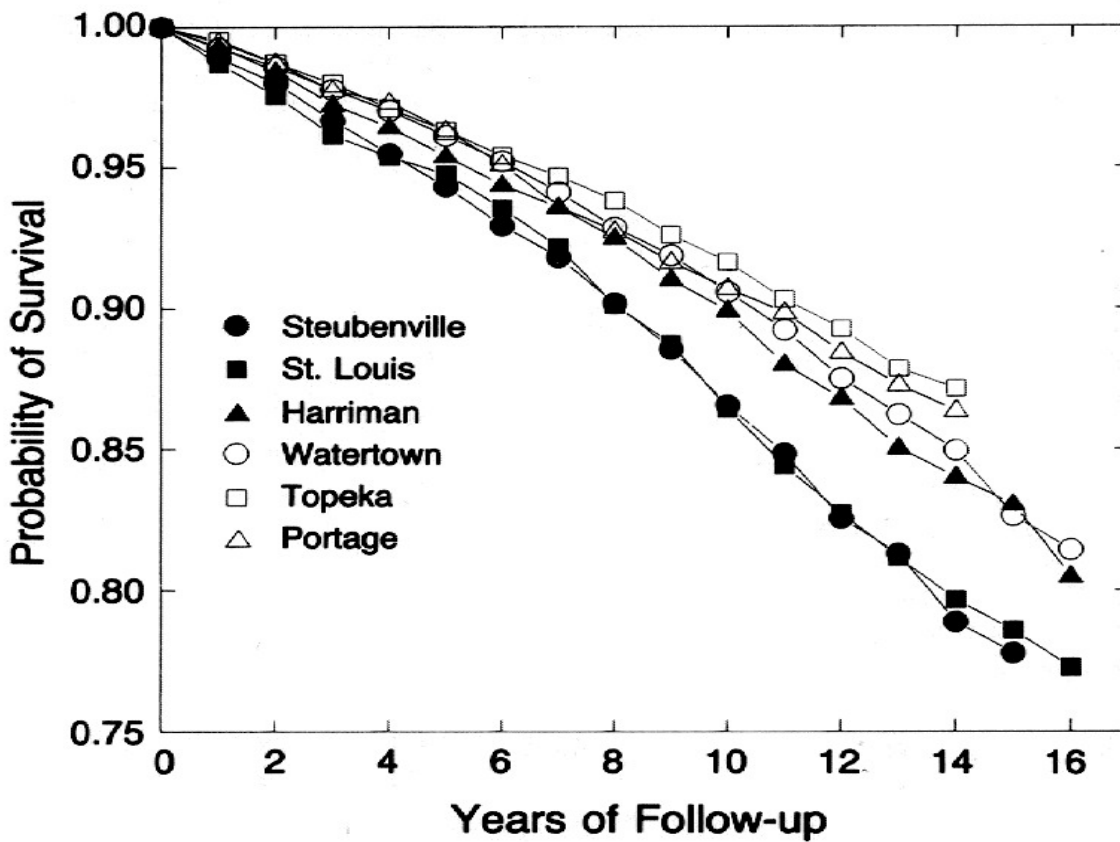
U.S Cities in the Six Cities Study

The Six Cities researchers investigated the effects of air pollution on mortality. Data was collected from each city's outdoor air monitoring station. After adjusting for other risk factors, city specific mortality rates correlated with fine particulate air pollution concentrations. As the concentration of fine particulate air pollution increased, the mortality rate also increased. During the study, there were 646 deaths due to cardiovascular disease and 98 deaths due to nonmalignant respiratory disease. Utilizing data from the six cities, the city with the least air pollution and the city with the most air pollution were also used to determine the range of particulate air pollution concentrations. The data included: inhalable particles (range 18.2-46.5 $\mu g/m^3$), fine particles (range 11-29.6 $\mu g/m^3$, and sulfate particles (range 4.8-12.8 $\mu g/m^3$).

Fine particles and sulfates are so small they end up indoors, resulting in a strong association between indoor and outdoor particulate air pollution concentrations. Elevated levels of particulate air pollution have been associated with decreases in lung function and increases in respiratory symptoms such as cough, wheezing, shortness of breath, and asthma attacks. Over the course of the Six U.S. Cities Study's follow-up period, 1,196 deaths were positively associated with average $PM_{2.5}$ levels, 226 deaths were associated with lung cancer, and 195 deaths were associated with non-malignant respiratory disease.

Twenty years after the Six Cities study was published another research group reanalyzed the data and found that the risk of mortality was strongly associated with fine particulate air pollution. Life expectancy was 2-3 years shorter in the most polluted cities. The participants in the most polluted city (Steubenville, Ohio) had a 31% increased risk of mortality. At the time, the most polluted cities were well within air pollution standards. Because of these new findings, the EPA established new air quality standards. The Clean Air Act was implemented in 1970 and amended in 1977 and 1980. Since the new standards were enacted, $PM_{2.5}$ concentrations have consistently decreased and average life expectancy has gone up by 2.7 years. The EPA estimates that the control of particulate air pollution saved 160,000 lives in 2010 alone by reduc-

Examine and analyze the following graphs then use your analysis and information from the Background materials to answer questions 1 -5.

The Probability of Survival, per City, of the Six Cities Participants during Years of Follow-up

Amount of Total Particles, Fine Particles, and Sulfate Particles Concentrations per City, per Year
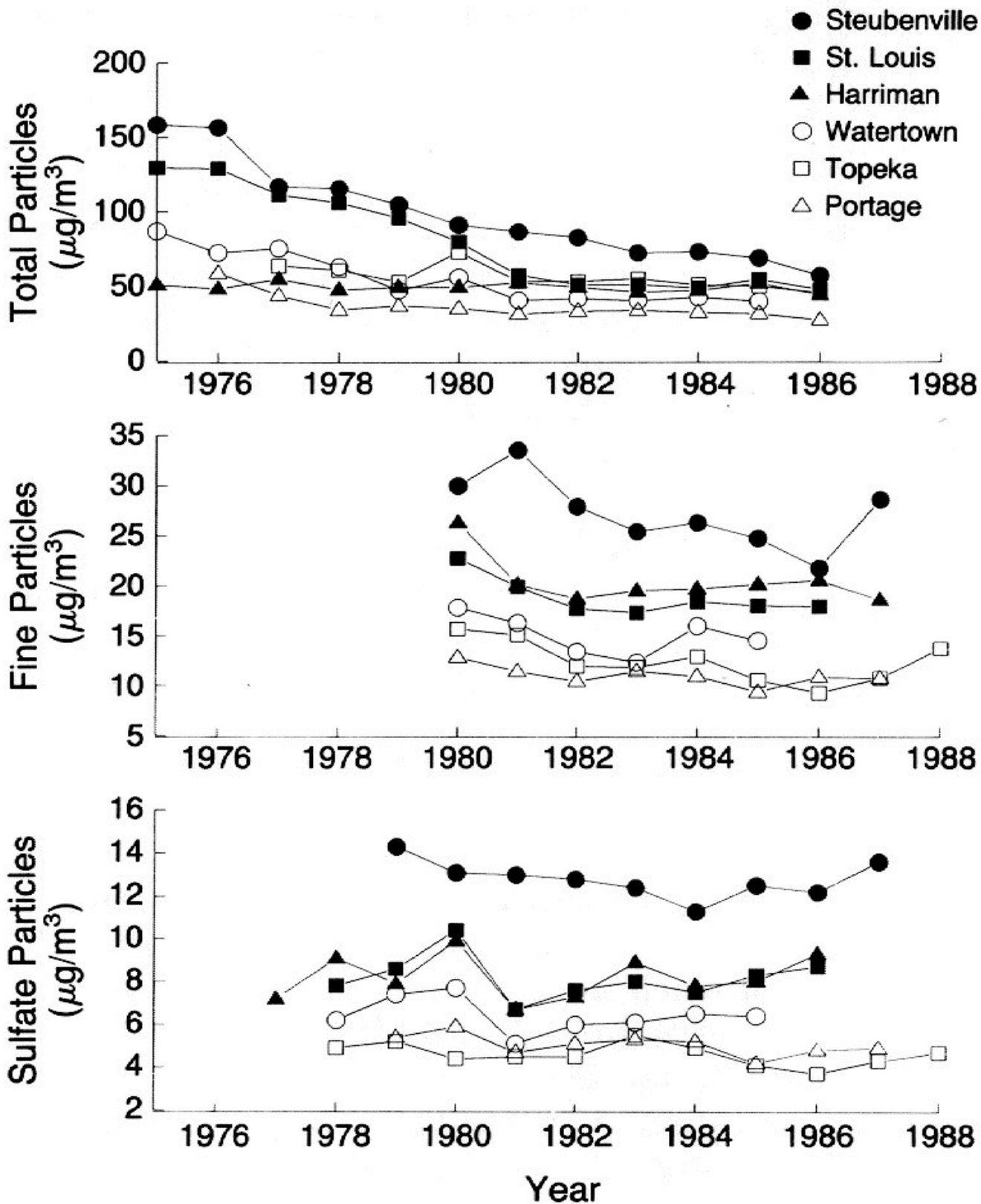
Answer the following questions completely and concisely.

1. How did the Six Cities Study influence future air quality regulations? Summarize the effects of the updated regulations.

2. According to the Probability of Survival Graph, residents of which city had the lowest probability of survival 14 years after follow-up? Which city had the highest probability of survival 14 years after follow-up? Explain how the probability of survival in these two cities is related to fine particulate air pollution concentrations.

3. When looking at the three graphs showing the amounts of total particles, fine particles, and sulfate particles per year, which graph shows the most obvious trend? Describe the trend?

4. Why is the Six Cities Study considered a landmark study on air pollution?

5. Why is the Six Cities Study an example of a population health study?

Teacher Comments: