



**Centers for Disease Control and Prevention
Epidemiology Program Office
Case Studies in Applied Epidemiology
No. 751-N99**

An Epidemic of Deaths in the London Fog

Student's Guide

Learning Objectives

After completing this case study, the participant should be able to:

- Construct and interpret graphs of time-related data;
- Calculate and discuss excess mortality;
- Discuss the strengths and limitations of mortality data, and the interpretation of mortality patterns in light of external events; and
- Construct and interpret a scattergram.

This case study was originally developed for the CDC EIS Summer Course by Malcolm Harrington (EIS '75) in the 1970s. An alternative version was developed at the World Health Organization by Todd Kjellström and Nancy Hicks in 1991. The current version contains features from both versions, and was adapted and revised by Richard Dicker in 1999.



**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service**



PART I

On the morning of Friday, December 5, 1952, with the temperature just below freezing, a dense fog settled over Greater London. The fog was notable for its density, its duration, and almost complete absence of remission in either density or temperature for four long days. The fog was generally considered to be the worst in living memory.

The fog had far-reaching effects on city life. Low visibility contributed to numerous traffic accidents. Emergency services were taxed both by increased demand and poor driving

conditions. Ambulance services were kept busy by an apparent increase in people suffering from a variety of illnesses, predominantly respiratory. At the annual Smithfield Show, featuring prized pigs, cows, sheep, and goats, a number of cows died.

London is situated in the valley of the River Thames in southeast England, bounded on the north and south by chalk hills. Greater London covers 720 square miles and is inhabited by 8 million people.

Question 1: What sources of data might you use to collect to determine the potential health impact of the fog on humans?

Question 2: Assuming that at least some of the data you want would be available for the current time period, what might you use for a comparison period?

Tables 1 and 2 show the number and rate of deaths registered (death certificates received) by week for central London and the Outer Ring, which together make up "Greater

London." For comparison, the number of deaths registered in the 160 "Great Towns" outside of London are also shown.

Table 1. Number of deaths registered in Greater London and in the 160 Great Towns Outside London during the weeks ending November 8, 1952 to January 10, 1953

Area	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
Central London	693	747	753	853	945	2,484	1,523	1,029	1,372	1,216
Outer Ring	900	818	946	1,049	1,117	2,219	1,615	1,205	1,605	1,418
Greater London, Total	1,593	1,565	1,699	1,902	2,062	4,703	3,138	2,234	2,977	2,634
160 Great Towns outside of London	3,310	3,410	3,603	4,140	4,585	4,749	4,541	4,238	4,865	4,983

Table 2. Death rates per 100,000 population in Central London and the Outer Ring during the weeks ending November 8, 1952 to January 10, 1953

Area	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
Central London	23.1	24.9	25.1	28.4	31.5	82.8	50.8	34.3	45.7	40.5
Outer Ring	18.0	16.4	18.9	21.0	22.3	44.4	32.3	24.1	32.1	28.4

Question 3: Graph and interpret the data in Tables 1 and 2.

The number of deaths registered in Greater London for the weeks ending Nov. 8, 1952 through Jan. 10, 1953 and for the

corresponding weeks for the previous five years are shown in Table 3.

Table 3. Number of registered deaths, Greater London, weeks ending November 8, 1952 to January 10, 1953, and in the corresponding weeks of the previous five years

Year	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
1947-48	1,616	1,545	1,683	1,566	1,795	1,763	1,749	1,453	2,028	1,740
1948-49	1,688	1,758	1,809	1,637	2,206	2,067	1,810	1,624	2,181	2,170
1949-50	1,907	1,953	2,002	2,086	1,880	1,802	1,858	1,858	1,805	1,958
1950-51	1,792	1,747	1,722	1,881	1,819	1,979	2,320	2,414	3,415	3,297
1951-52	1,725	1,631	1,412	1,513	1,543	1,852	2,021	1,763	1,946	2,029
1952-53	1,593	1,565	1,699	1,902	2,062	4,703	3,138	2,234	2,977	2,634
Average, 1947-51	1,746	1,727	1,726	1,737	1,849	1,893	1,952	1,822	2,275	2,239

Question 4: How does the mortality pattern in 1952/1953 compare with the historical patterns?

Question 5: Estimate the number of excess deaths in 1952/1953.

Question 6: What are some possible explanations for the excess mortality in 1952-1953?

Table 4 shows the number of registered deaths by age group. Table 5 shows the corresponding

rates. Table 6 shows the number of registered death by cause of death.

Table 4. Number of registered deaths by age group, Central London, during the weeks ending November 8, 1952 to January 10, 1953

Age group	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
0 - 4 weeks	19	25	13	22	16	28	19	12	22	21
4 wks. - 1 yr	12	7	5	9	12	26	15	11	25	18
1 - 4 yrs.	5	5	11	5	6	7	13	7	7	5
5 - 14 yrs.	5	4	4	3	4	6	6	2	3	4
15 - 24 yrs.	7	12	4	3	9	7	14	7	9	4
25 - 34 yrs.	8	16	14	7	16	28	17	11	21	15
35 - 44 yrs.	33	21	28	22	36	64	29	34	28	39
45 - 54 yrs.	67	66	85	61	80	204	96	83	105	98
55 - 64 yrs.	123	138	118	152	157	448	251	167	236	204
65 - 74 yrs.	177	210	229	226	254	717	444	258	368	334
75+ years	237	243	242	343	355	949	619	437	548	474
All Ages	693	747	753	853	945	2,484	1,523	1,029	1,372	1,216

Table 5. Death rates per 100,000 population by age group, Central London, during the weeks ending November 8, 1952 to January 10, 1953

Age group	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
0 - 1 yrs.	55.0	65.2	36.7	63.2	57.1	110.0	69.3	46.9	95.8	79.5
1 - 4 yrs.	2.3	2.3	5.0	2.3	2.7	3.2	5.9	3.2	3.2	2.3
5 - 14 yrs.	1.3	1.0	1.0	0.8	1.0	1.6	1.6	0.5	0.8	1.0
15 - 24 yrs.	1.7	2.9	1.0	0.7	2.2	1.7	3.4	1.7	2.2	1.0
25 - 34 yrs.	1.4	2.9	2.5	1.3	2.9	5.0	3.0	2.0	3.7	2.7
35 - 44 yrs.	6.1	3.9	5.2	4.1	6.7	11.9	5.4	6.3	5.2	7.2
45 - 54 yrs.	15.0	14.8	19.0	13.7	17.9	45.7	21.5	18.6	23.5	22.0
55 - 64 yrs.	34.8	39.1	33.4	43.0	44.4	126.8	71.1	47.3	66.8	57.8
65 - 74 yrs.	70.0	83.1	90.6	89.4	100.5	283.6	175.6	102.0	145.5	132.1
75+ years	197.6	202.6	201.8	286.0	296.0	791.2	516.0	364.3	456.9	395.2
All Ages	20.7	22.3	22.5	25.5	28.2	74.2	45.5	30.7	41.0	36.3

Table 6. Number of registered deaths by cause, Central London, during the weeks ending November 8, 1952 to January 10, 1953

Cause of death	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
Respiratory tuberculosis	10	20	18	19	14	77	37	21	24	22
Cancer of stomach	20	31	22	20	30	21	18	23	30	30
Cancer of lung	41	30	38	27	45	69	32	36	48	36
Other malignant and lymphatic neoplasms	112	114	110	113	116	167	118	91	133	109
CNS vascular lesions	49	84	73	98	102	128	119	91	131	105
Chronic rheumatic heart disease	18	10	17	20	18	57	27	15	22	28
Coronary disease	93	108	113	131	118	281	152	109	150	128
Myocardial degeneration	59	65	65	79	88	244	131	108	136	115
Other diseases of heart	28	28	30	42	49	126	80	40	50	44
Influenza	0	0	1	7	2	24	9	6	4	7
Pneumonia	35	29	31	28	45	168	125	91	104	87
Bronchitis	39	45	46	73	76	704	396	184	215	222
Other disease of respiratory system	2	5	10	8	9	52	21	13	10	14
Motor vehicle accidents	6	8	6	1	8	4	10	4	5	7
Suicide	5	5	5	5	10	10	7	5	12	15
Other and ill-defined causes	176	165	168	182	215	352	241	192	298	247
TOTAL (All causes)	693	747	753	853	945	2,484	1,523	1,029	1,372	1,216

Question 7: Describe the age-specific mortality data shown in Tables 4 and 5.

Question 8: Describe the cause-specific mortality data shown in Table 6.

Question 9: How might you evaluate the hypothesis that the increase in deaths is associated with the fog?

PART II

For four days in 1952, from December 5 to December 8, England experienced rare atmospheric conditions. Absence of wind was coupled with a thermal inversion -- a cold layer of air at ground level was overlaid by a zone of warmer temperature. This inversion prevented dispersal of the fog into the upper atmosphere and supported a build-up of high concentrations of smoke and other atmospheric pollutants. Suspended matter, higher in the urban areas of London, provided nuclei on which particles of moisture were deposited, resulting in denser fog than in the rural areas around London.

Burning of fossil fuel (coal) in open hearth fires in homes and in industrial generation of electricity, along with automobile and lorry emissions, contributed to the atmospheric pollution. Measurements for total suspended matter (TSM) and sulfur dioxide were routinely made in London during this time.

Environmental data collected during this period are summarized in Table 6. Note that the maximum smoke levels at County Hall are probably underestimates, since the filters became clogged!

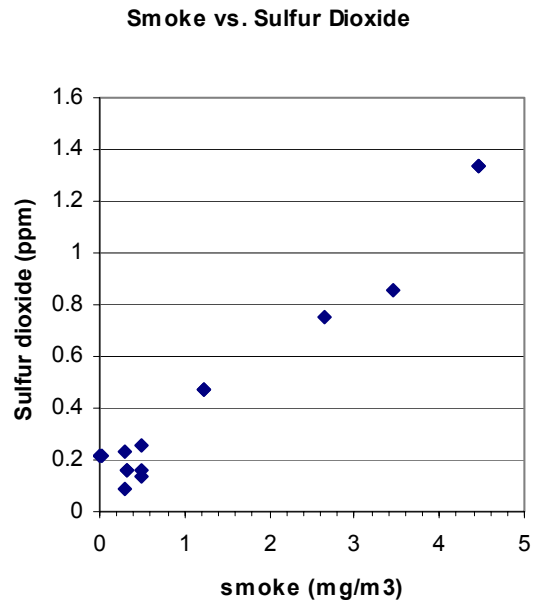
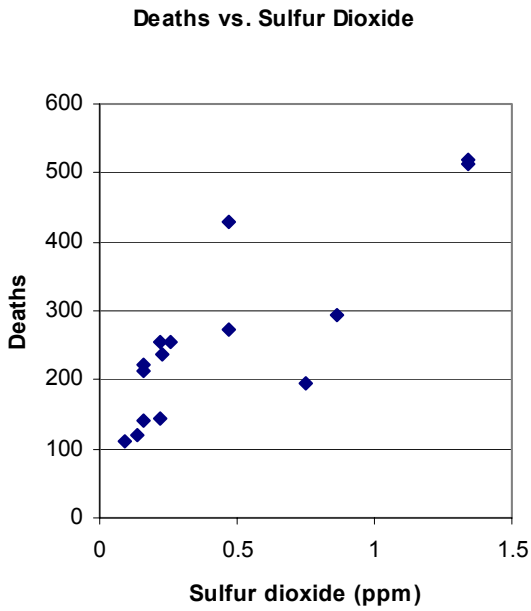
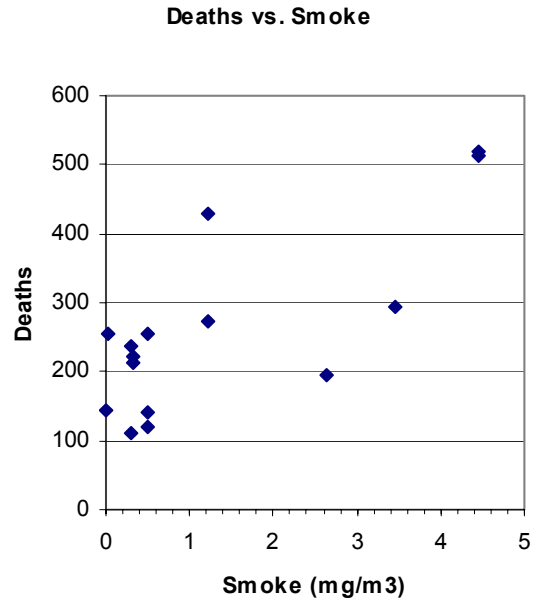
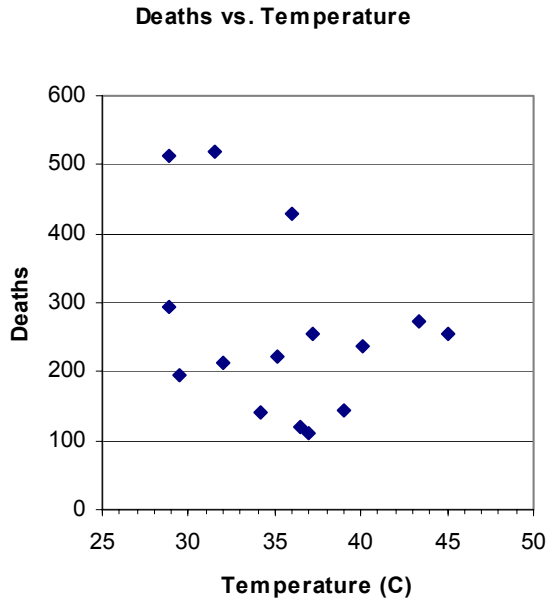
Question 10: What graphical devices could be used to characterize the relationships in Table 6? What statistical techniques?

Question 11: How do the changes in mortality correspond to changes in temperature, atmospheric pollution, and sulphur dioxide content?

Table 7. Number of deaths and meteorologic measures by date of occurrence, Greater London, December 1-15, 1952

	Date in December														
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>
<u>Deaths</u>															
Central London	112	140	143	120	196	294	513	518	430	274	255	236	256	222	213
Outer Ring	147	161	178	168	210	287	381	392	362	269	273	248	245	227	212
Greater London, Total	259	301	321	288	406	581	894	910	792	543	528	484	501	449	445
<u>Temperature (EC)</u>															
Daily Mean (Kew)	36.9	34.2	39.0	36.5	29.5	28.9	28.9	31.5	36.0	43.3	45.1	40.1	37.2	35.2	32.0
Departure from average of 80 years	-5.2	-7.7	-3.5	-5.4	-12.1	-12.8	-12.3	-10.0	-1.5	+2.7	+5.0	-0.1	-4.2	-6.0	-8.8
<u>Atmospheric Pollution - Smoke (mg/m³)</u>															
Mean (Kew)	0.34	0.34	0.19	0.42	1.47	1.75	0.87	1.19	0.47	0.17	0.19	0.24	0.32	0.29	0.18
Mean (County Hall)	0.30	0.49	0.01	0.49	2.64	3.45	4.46	4.46	1.22	1.22	.032	0.29	0.50	0.32	0.32
<u>Sulfur Dioxide (ppm)</u>															
County Hall	0.09	0.16	0.22	0.14	0.75	0.86	1.34	1.34	0.47	0.47	0.22	0.23	0.26	0.16	0.16

Figure. Number of deaths by meteorologic measures, Greater London, December 1-15, 1952



To this point, we have used mortality data to characterize the health impact on humans.

Question 12: What are some of the advantages and disadvantages of using mortality data to characterize health effects?

Question 13: What other health data would be helpful in more accurately assessing the impact of the fog on the health of Londoners?

PART III

The only readily available and comprehensive morbidity data were collected by the Ministry of Pensions and National Insurance (now part

of the Department of Health and Social Security).

Table 8. New claims (in thousands) to sickness benefit under the national insurance act, weeks ending November 4, 1952 to January 6, 1953

Area	Week Ending									
	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27	1/3	1/10
London and Middlesex	15.4	15.1	15.0	17.1	19.0	20.3	28.9	16.3	11.4	28.7
Remainder of S.E. Region	10.7	10.1	10.3	11.9	13.1	14.4	17.1	11.7	8.7	19.9
England and Wales excluding S.E. Region	88.1	85.8	88.3	97.7	107.9	112.4	102.6	90.0	74.0	139.0

Question 14: How do the patterns of new claims for sickness absence for London, southeast England, and the rest of England and Wales differ from the mortality patterns of the study period?

Question 15: Given the data you have and the inferences you've made, has an association between exposure to fog and an effect on health been clearly demonstrated? If the answer is "yes", is this association likely to be causal, i.e., that exposure to fog resulted directly in damage to health?

The political, emotional, and medical impact of this fog played a major part in the drafting of the Clean Air Act of 1956.

References

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3. McFarlane A. Daily mortality and environment in English onurbations. I. Air pollution, low temperature, and influenza in Greater London. *Br J Prev Soc Med* 1977;*31*:54-61.