Class Exercise: Fog in Lcity, Ccountry

This exercise provides with practice in:

- *Deriving well-designed plan of action to be executed under "pressure" circumstances*
- *Consideration of use of routinely collected data as a time- and cost-saving strategy*
- *Presentation of data in a graphical format*
- *Interpretation of graphical data*
- *Consideration of the limitation of certain sources of data*
- *Consideration of the necessity of calculating rates to compare localities or the same locality over time*
- *Integrating multiple sources of data*
- *Differentiating a "close" relationship and a "causal" association*
- *Formulating remedial measures to prevent a similar episode from occurring in the futu*re

Problem:

You are responsible for public health in the Greater Lcity area in 1992. On 5 December a thick layer of fog develops at a temperature close to 0^0C. The fog persists without remission for several days and the daily newspapers carry stories about the fog. There is general agreement that this fog is unprecedented and unusually severe.

There is a heavy demand for hospital beds and on 8 December the Central Lcity hospitals issue an Emergency Bed Warning that they have sufficient beds for fewer than 85% of applicants.

In addition, the Veterinary Public Health section of the Ministry of Health has reported that many cattle at the Lcity cattle show became ill during the fog and had to be slaughtered.

On 8 December the newspapers report that people are dying due to the fog, and that the fog contains dangerous chemical pollutants. Due to the community concern also expressed directly to the politicians, the Ministry of Health appoints you to investigate all health aspects of the fog, to propose remedial measures and to prepare information for the community about the fog.

Question 1: This is a monumental task to be achieved under condition of pressure from the Minister of Health, who is responding to pressure from politicians, who are responding to pressure from voting constituents. Trying to remain cool, what immediate steps might you want to recommend?

Question 2: What kind of information would you want your staff to begin to collect?

Question 3: The use of routinely collected data (if appropriate and available) will result in quicker and less expensive results.

What sources might provide data on mortality?
What sources might provide data on morbidity?
What sources might provide data on air pollution?
What sources might provide demographic data?

Table 1: Number of deaths registered in the inner and outer part of Greater Lcity and the 160 Great Towns outside in the weeks ending 8 November 1992 to 10 January 1993

Weeks ending	08-Nov	15-Nov	22-Nov	29-Nov	06-Dec	13-Dec	20-Dec	27-Dec	03-Jan	10-Jan
LAC	693	747	753	853	945	2482	1523	1029	1372	1216
OR	900	818	946	1049	1117	2219	1615	1205	1605	1418
LAC+OR	1593	1565	1699	1902	2062	4701	3138	2234	2977	2634
160 Great Towns	3310	3410	3603	4140	4585	4749	4541	4238	4865	4983

LAC = Lcity Administrative County; OR = Outer Ring

Question 4: Using the data of Table 1, construct a graph to compare mortality tendencies in the Lcity Administrative County (LAC), the Outer ring (OR), and the 160 Great Towns (not including Lcity). What information does the graph provide?

The population of LAC was 3 million and that of the outer ring (OR) 5 million.

Question 5: What are the death rates per 100,000 population? Calculate the table (call it Table 2). Plot the graph. What do you observe?

Question 6: In this situation, registered deaths routinely collected were used, saving time and money, and providing a rapid ("quick and dirty") assessment of the situation. But as usual, for speed, one pays a penalty. What are the potential limitations of death data collected this way?

In this situation the actual limitations were:

1. The available dates were the dates that the death was registered, not the actual date of death.
2. Irregular time lags in registering deaths were possible.
3. Deaths were registered by county of residence rather than by place of death.
4. Death rates calculated assume no population change.

Question 7: Summarize what you know so far.

Question 8: At this point you have only been working with total numbers of deaths. What additional information should you have regarding the death rates?

To have more information on the groups that were at greatest risk, it is useful to derive the age-specific mortality data. They are shown in Table 3.

Table 3. Age-specific mortality data for deaths registered, LAC, weeks from 6 November 1992 to 10 January 1993.

Weeks ending	08-Nov	15-Nov	22-Nov	29-Nov	06-Dec	13-Dec	20-Dec	27-Dec	03-Jan	10-Jan
0-<4 weeks	19	25	13	22	16	28	19	12	22	21
4 weeks < 1 yr	12	2	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	12	138	118	152	157	448	521	167	236	204
65-74 yrs	177	210	225	226	254	717	444	258	368	334
75+ yrs	237	243	242	343	355	949	619	437	548	474
All ages	582	742	749	853	945	2484	1793	1029	1372	1216

Question 9: What do you observe? What age groups were at greatest risks? It would be helpful to visualize the data if time allows.

Table 4 shows the age-specific deaths per 100,000 population in LAC.

Weeks ending	08-Nov	15-Nov	22-Nov	29-Nov	06-Dec	13-Dec	20-Dec	27-Dec	03-Jan	10-Jan
0-1 yrs	55.0	65.2	36.7	63.2	57.1	110.3	69.3	46.9	95.8	79.5
1-4 yrs	5.0	5.0	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	0.0	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	1.0	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	123.1
75+ yrs	197.6	202.6	201.8	286.0	296.0	791.2	516.0	364.0	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 5 shows the cause-specific mortality data

Cause-specific mortality data

Weeks ending	08-Nov	15-Nov	22-Nov	29-Nov	06-Dec	13-Dec	20-Dec	27-Dec	03-Jan	10-Jan
CAUSE										
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
Vascular lesions of CNS	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	-	-	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 diseases 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	2484	1523	1029	1372	1216

Question 10: Table 5 presents the cause-specific mortality data. What specific diseases/conditions are responsible for the increase in mortality?

Question 11: At this point, the assumption in the press and among the general public is that the excess deaths are in some way related to the fog, but you do not know this to be true, therefore you should consider all possibilities. Speculate on the other possible causes for this excess mortality.

Question 12: Considering the general assumption that the fog is related (and further suggested by the increase in respiratory deaths), how would you attempt to validate this assumption? What data do you need? Where might you obtain the data?

The morning of 5 December and for four consecutive days, Lcity province experiences rare atmospheric conditions. The absence of any pressure gradient resulted in a persistent fog, an almost complete absence of wind currents, and a temperature inversion. The temperature inversion prevented dispersal of the fog and allowed the concentration of smoke and other atmospheric pollutants. Suspended particulate matter, higher in urban areas of Lcity, provided nuclei on which particles of moisture were deposited, resulting in denser fog than in the rural areas around Lcity.

Minimal temperatures in central Lcity hovered around freezing.

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 of total suspended particulate matter (TSP) and sulphur oxide were routinely made in Lcity during this time. In comparison, the mean December 1997 concentration of TSP was in the range of 120 to 440 $\mu g/m^3$ in both central and peripheral Lcity. During December 6-8 1992, daily averages from all monitoring stations increased about 5-fold to 1,600 $\mu g/m^3$. Peak values ranges between 3 to 10 times the normal values, and were highest in central Lcity.

For sulphur dioxide, December 1991 concentrations ranged between 70 and 230 ppb. During 6-8 December 1992 peak values were 1,340 ppb, about 3 to 12 times the normal value.

In addition, although not routinely measured, other contaminants were detected during this period, namely: sulphur trioxide, carbon monoxide, and carbon dioxide.

Table 6 presents mortality data along with meteorological data for 1-15 December 1992.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Deaths															
LAC	112	140	143	120	196	294	513	518	430	274	255	236	256	222	213
OR	147	161	178	168	210	287	381	392	362	269	273	248	245	227	212
LAC+OR	259	301	321	288	406	581	894	910	792	543	528	484	501	449	425
Temperature (site 1) [^{0}F]															
Daily mean	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 trend	-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
Atmospheric pollution															
Smoke [mg/m^3]															
Mean (site 1)	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 (site 2)	0.30	0.49	0.61	0.49	2.64	3.45	4.46	4.46	1.22	1.22	0.32	0.29	0.50	0.32	0.32
SO2 [ppm] Mean (site 2)	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

Question 13: Construct a graphic presentation of these data to determine if there is an association.

Question 14: Is the increase in mortality in Lcity related to variations in temperature, smoke or sulphur dioxide?

Question 15: What sources of routinely collected data might be useful to assess morbidity during the fog period?

In the present situation, data were available for applications and admissions in hospitals through the Emergency Bed Service Bureau. Table 7 presents these data.

Table 7: Applications and admissions to hospitals of acute care during the period 1st to 21st December 1992

Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Applications for beds	243	227	221	205	248	321	252	423	489	413	318	317	299	173	300	264	248	219	247	232	164
Admissions	203	197	194	176	207	253	191	299	390	329	270	275	266	158	269	223	215	192	213	211	150
Cases for whom beds were not found	40	30	27	29	41	68	61	124	99	84	48	42	33	15	31	41	33	27	34	21	14
Classifications of admissions in LAC																					
Respiratory disease	52	41	57	39	51	93	92	135	165	123	84	82	96	47	60	63	50	49	51	51	39
Cardiac disease	13	15	12	19	22	45	39	43	40	33	27	30	19	6	13	6	12	15	17	15	17
Cerebral haemorrhoids	10	5	5	5	9	8	6	7	10	6	9	7	6	5	8	9	4	7	6	10	7
Other acute medical conditions	37	29	33	29	33	34	20	35	37	37	44	37	34	14	30	42	44	24	31	27	26
Acute surgical conditions	31	30	19	25	29	15	17	38	32	17	40	29	25	38	33	28	25	28	25	18	18

Question 16: Do the data in Table 7 support the hypothesis of an air pollution effect?

In addition, morbidity information was available from the Ministry of Pensions and National Insurance. These sickness claims cover the working population. Table 8 summarizes these data.

Table 8: New claims to sickness benefit under the national insurance (thousands) in the weeks ending 4 November 1992 to 6 January 1993

Weeks ending	04-Nov	11-Nov	18-Nov	25-Nov	02-Dec	09-Dec	16-Dec	23-Dec	30-Dec	06-Jan
Lcity & Dcity	15.4	15.1	15.0	17.1	19.0	20.3	28.9	16.3	11.4	28.7
Remainder of Lcity County	10.7	10.1	10.3	11.9	13.1	14.4	17.1	17.7	8.7	19.9
Adjacent provinces	88.1	85.8	88.3	97.7	107.9	112.4	102.6	90.0	74.0	139.0

Question 17: Do the data in Table 8 support the hypothesis of an air pollution effect?

Question 18: Is the fog causally responsible for the increased mortality and morbidity?

Question 19: What remedial measures would you suggest to prevent another "fog disease" episode due to smoke and SO_2 in the future?