

# Chapter Seven

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## Exercise One

### Question

The number of deaths from leukemia and other cancers among survivors of the Hiroshima atom bomb are shown in Table 7.12 (below), classified by the radiation dose received. The data refers to deaths during the period 1950-1959 among survivors who were aged 25 to 64 years in 1950 (from data set 13 of Cox and Snell 1981, attributed to Otake 1979).

Deaths	Radiation Dose (rads)					
	0	1-9	10-49	50-99	100-199	200+
Leukemia	13	5	5	3	4	18
Other Cancers	378	200	151	47	31	33
Total Cancers	391	205	156	50	35	51

### Solution

(a): Obtain a suitable model to describe the dose-response relationship between radiation and the proportional cancer mortality rates for leukemia.

(b): Examine how well the model describes the data.

(c): Interpret the results.

## Exercise Two

### Question

**Odds ratios.** Consider a  $2 \times 2$  contingency table from a prospective study in which people who were or were not exposed to some pollutants are followed up and, after several years, categorized according to the presence or absence of a disease. Table 7.13 (below) shows the probabilities for each cell. The odds of disease for either exposure group is  $O_i = \pi_i / (1 - \pi_i)$ , for  $i = 1, 2$ , and so the odds ratio

$$\phi = \frac{O_1}{O_2} = \frac{\pi_1(1 - \pi_2)}{\pi_2(1 - \pi_1)}$$

is a measure of the relative likelihood of disease for the exposed and not exposed groups.

	Diseased	Not diseased
Exposed	$\pi_1$	$1 - \pi_1$
Not exposed	$\pi_2$	$1 - \pi_2$

### Solution

(a): For the simple logistic model  $\pi_i = e^{\beta_i} / (1 + e^{\beta_i})$ , show that if there is no difference between the exposed and not exposed groups (i.e.  $\beta_1 = \beta_2$ ), then  $\phi = 1$ .

(b): Consider  $J$   $2 \times 2$  tables like Table 7.13, one for each level  $x_j$  of a factor, such as age group, with  $j = 1, \dots, J$ . For the logistic model

$$\pi_{ij} = \frac{\exp(\alpha_i + \beta_i x_j)}{1 + \exp(\alpha_i + \beta_i x_j)}, \quad i = 1, 2, \quad j = 1, \dots, J.$$

Show that  $\log \phi$  is constant over all table if  $\beta_1 = \beta_2$  (McKinlay 1979).

## Exercise Three

### Question

Tables 7.14 and 7.15 (both below) show the survival 50 years after graduation of men and women who graduated each year from 1938 and 1947 from various Faculties of the University of Adelaide (data compiled by J.A. Keats). The columns labeled  $S$  contain the number of graduates who survived and the columns labeled  $T$  contain the total number of graduates. There were insufficient women graduates from the Faculties of Medicine and Engineering to warrant analysis.

Year of Graduation	Faculty							
	Medicine		Arts		Science		Engineering	
	S	T	S	T	S	T	S	T
1938	18	22	16	30	9	14	10	16
1939	16	23	13	22	9	12	7	11
1940	7	17	11	25	12	19	12	15
1941	12	25	12	14	12	15	8	9
1942	24	50	8	12	20	28	5	7
1943	16	21	11	20	16	21	1	2
1944	22	32	4	10	25	31	16	22
1945	12	14	4	12	32	38	19	25
1946	22	34			4	5		
1947	28	37	13	23	25	31	25	35
Total	177	275	92	168	164	214	103	142

Year of Graduation	Faculty			
	Arts		Science	
	S	T	S	T
1938	14	19	1	1
1939	11	16	4	4
1940	15	18	6	7
1941	15	21	3	3
1942	8	9	4	4
1943	13	13	8	9
1944	18	22	5	5
1945	18	22	16	17
1946	1	1	1	1
1947	13	16	10	10
Total	126	157	58	61

### Solution

(a): Are the proportions of graduates who survived for 50 years after graduation the same all years of graduation?

(b): Are the proportions of male graduates who survived for 50 years after graduation the same for all Faculties?

(c): Are the proportions of female graduates who survived for 50 years after graduation the same for Arts and Science?

(d): Is the difference between men and women in the proportion of graduates who survived for 50 years after graduation the same for Arts and Science?