CHAPTER 19

"Difference" Cancers, Females: Relation with Medical Radiation

• Part 1. Introduction

Difference-Cancers are All-Cancers-Minus-Respiratory-System Cancers. Please see Chapter 18, Part 1.

• Part 2. How the Dose-Response Develops, 1921-1940

• - Part 2a.	1921 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	165.11	123.6	Constant	34.7966
New England	142.24	141.2	Std Err of Y Est	14.0275
West North Central	140.93	117.0	R Squared	0.3479
Mid-Atlantic	137.29	138.7	No. of Observations	9
East North Central	136.06	128.2	Degrees of Freedom	7
Mountain	135.38	108.9		
West South Central	125.15	97.4	X Coefficient(s)	0.6157
East South Central	119.76	100.1	Std Err of Coef.	0.3186
South Atlantic	110.32	104.5	Coefficient / S.E.	1.9326

• - Part 2b.	1923 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	163.06	123.6	Constant	36.2380
New England	137.39	141.2	Std Err of Y Est	13.3595
West North Central	138.31	117.0	R Squared	0.4085
Mid-Atlantic	138.92	138.7	No. of Observations	9
East North Central	131.82	128.2	Degrees of Freedom	7
Mountain	130.51	108.9		
West South Central	119.16	97.4	X Coefficient(s)	0.6220
East South Central	113.16	100.1	Std Err of Coef.	0.2829
South Atlantic	106.79	104.5	Coefficient / S.E.	2.1989

• - Part 2c.	1925 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	161.67	123.6	Constant	38.8866
New England	138.31	141.2	Std Err of Y Est	12.5952
West North Central	133.92	117.0	R Squared	0.4743
Mid-Atlantic	134.36	138.7	No. of Observations	9
East North Central	127.54	128.2	Degrees of Freedom	7
Mountain	122.30	108.9		
West South Central	112.83	97.4	X Coefficient(s)	0.6215
East South Central	107.22	100.1	Std Err of Coef.	0.2473
South Atlantic	103.61	104.5	Coefficient / S.E.	2.5130

• - Part 2d.	1927 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	157.83	123.6	Constant	34.8682
New England	137.50	141.2	Std Err of Y Est	11.1182
West North Central	131.54	117.0	R Squared	0.5904
Mid-Atlantic	138.40	138.7	No. of Observations	9
East North Central	126.18	128.2	Degrees of Freedom	7
Mountain	118.75	108.9		
West South Central	108.25	97.4	X Coefficient(s)	0.6643
East South Central	102.07	100.1	Std Err of Coef.	0.2092
South Atlantic	102.13	104.5	Coefficient / S.E.	3.1762

• - Part 2e.	1929 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	156.64	123.6	Constant	35.0373

New England	138.46	141.2	Std Err of Y Est	10.4406
West North Central	128.72	117.0	R Squared	0.6388
Mid-Atlantic	138.49	138.7	No. of Observations	9
East North Central	126.51	128.2	Degrees of Freedom	7
Mountain	118.68	108.9		
West South Central	105.60	97.4	X Coefficient(s)	0.6685
East South Central	99.41	100.1	Std Err of Coef.	0.1900
South Atlantic	100.86	104.5	Coefficient / S.E.	3.5183

● - Part 2f.	1931 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	159.97	123.6	Constant	40.4276
New England	142.35	141.2	Std Err of Y Est	10.0708
West North Central	126.50	117.0	R Squared	0.6639
Mid-Atlantic	140.82	138.7	No. of Observations	9
East North Central	128.59	128.2	Degrees of Freedom	7
Mountain	118.89	108.9		
West South Central	105.95	97.4	X Coefficient(s)	0.6215
East South Central	96.73	100.1	Std Err of Coef.	0.1671
South Atlantic	99.59	104.5	Coefficient / S.E.	3.7185

● - Part 2g.	1934 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	160.09	123.6	Constant	44.6430
New England	148.60	141.2	Std Err of Y Est	8.5632
West North Central	125.96	117.0	R Squared	0.7570
Mid-Atlantic	149.62	138.7	No. of Observations	9
East North Central	129.36	128.2	Degrees of Freedom	7
Mountain	117.16	108.9		
West South Central	104.68	97.4	X Coefficient(s)	0.5843
East South Central	92.00	100.1	Std Err of Coef.	0.1251
South Atlantic	98.41	104.5	Coefficient / S.E.	4.6697

● - Part 2h.	1936 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	158.44	123.6	Constant	45.2814
New England	150.18	141.2	Std Err of Y Est	7.8708
West North Central	126.14	117.0	R Squared	0.7947
Mid-Atlantic	155.05	138.7	No. of Observations	9
East North Central	130.42	128.2	Degrees of Freedom	7
Mountain	119.80	108.9		
West South Central	103.52	97.4	X Coefficient(s)	0.5757
East South Central	89.94	100.1	Std Err of Coef.	0.1106
South Atlantic	99.16	104.5	Coefficient / S.E.	5.2055

● - Part 2i.	1938 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	157.62	123.6	Constant	47.6201
New England	154.08	141.2	Std Err of Y Est	7.0749
West North Central	124.95	117.0	R Squared	0.8341
Mid-Atlantic	160.69	138.7	No. of Observations	9
East North Central	131.98	128.2	Degrees of Freedom	7
Mountain	119.88	108.9		
West South Central	102.79	97.4	X Coefficient(s)	0.5538
East South Central	88.21	100.1	Std Err of Coef.	0.0933
South Atlantic	99.26	104.5	Coefficient / S.E.	5.9331

● - Part 2j.	1940 PhysPop	1940 MortRate	Difference-Cancers, Females Regression Output:	
Pacific	159.72	123.6	Constant	52.8821
New England	161.55	141.2	Std Err of Y Est	6.6648
West North Central	123.14	117.0	R Squared	0.8528
Mid-Atlantic	169.76	138.7	No. of Observations	9
East North Central	133.36	128.2	Degrees of Freedom	7
Mountain	119.89	108.9		
West South Central	103.94	97.4	X Coefficient(s)	0.5041
East South Central	85.83	100.1	Std Err of Coef.	0.0792
South Atlantic	100.74	104.5	Coefficient / S.E.	6.3682

Box 1 of Chap. 19

Summary: Regression Outputs, "Difference" Cancers, Females.

Below are the summary-results from regressing the 1940 cancer MortRates upon the ten sets of PhysPops (1921-1940), as presented in Parts 2a-2j of this chapter.

Part	PhysPop	R-squared	Constant	X-Coef	Std Err	X-Coef/SE
2a	1921	0.3479	34.80	0.6157	0.3186	1.9326
2b	1923	0.4085	36.24	0.6220	0.2829	2.1989
2c	1925	0.4743	38.89	0.6215	0.2473	2.5130
2d	1927	0.5904	34.87	0.6643	0.2092	3.1762
2e	1929	0.6388	35.04	0.6685	0.1900	3.5183
2f	1931	0.6639	40.43	0.6215	0.1671	3.7185
2g	1934	0.7570	44.64	0.5843	0.1251	4.6697
2h	1936	0.7947	45.28	0.5757	0.1106	5.2055
2i	1938	0.8341	47.62	0.5538	0.0933	5.9331
2j --->	1940 Max	0.8528	52.88	0.5041	0.0792	6.3682

Box 2 of Chap. 19

Input-Data for Figure 19-A. "Difference" Cancers. Females.

Part 2j, Best-Fit Equation: Calc. MortRate = (0.5041 * PhysPop) + (52.88)

Census Divisions	1940 Observed PhysPops	1940 Observed MortRates	Best-Fit Calc. MortRates
Pacific	159.72	123.6	133.395
New England	161.55	141.2	134.317
West No. Central	123.14	117.0	114.955
Mid-Atlantic	169.76	138.7	138.456
East No. Central	133.36	128.2	120.107
Mountain	119.89	108.9	113.317
West So. Central	103.94	97.4	105.276
East So. Central	85.83	100.1	96.147
South Atlantic	100.74	104.5	103.663
Additional PhysPops	70.00		88.167
--- not "observed" ---	60.00		83.126
down to zero PhysPop	50.00		78.085
(zero medical radiation).	40.00		73.044
For each, we calculate	30.00		68.003
a best-fit MortRate.	20.00		62.962
These additional x,y pairs	10.00		57.921
are also part of the	0		52.880
best-fit line (Chap 5, Part 5e).			

Box 3 of Chap. 19

Presumptive Fraction of Cancer MortRate Attributable to Medical Radiation.

Please see text in Chapter 6, Parts 4 and 6.

Difference-Cancers. FEMALES.

• FEMALE National MortRate (MR) 1940, from Table 19-B	122.8	National MortRate
• Constant, from regression, Part 2j	52.8821	Constant
• Fractional Causation, Best Est. = (Natl MR - Constant) / Natl MR	56.9%	Frac. Causation

90% Confidence-Limits (C.L.) on Fractional Causation. See text in Chapter 6, Part 4b, please.

X-Coefficient, from Part 2j	0.5041	X-Coef., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2j	0.0792	Standard Error
Upper 90% C.L. on X-Coef. = (Coef) + (1.645 * SE) =	0.6344	New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1940 Natl PhysPop) =	39.0359	New Constant
Frac. Causation, High-Limit = (Natl MR - New Constant) / Natl MR =	68.2%	New Frac. Caus'n.
Lower 90% C.L. on X-Coef. = (Coef) - (1.645 * SE) =	0.3738	New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1940 Natl PhysPop) =	73.4413	New Constant
Frac. Causation, Low-Limit = (Natl MR - New Constant) / Natl MR =	40.2%	New Frac. Caus'n.

Box 4 of Chap. 19

Error-Check on Our Own Work: "Difference" Cancers, Females.

Below, Columns A, C, and E come directly from the regression input in Part 2j. Column B, the fraction of the whole 1940 population in each Census Division, comes from Table 3-B in Chapter 3. Each Column-D entry is the product of (B-entry times C-entry). Each Column-F entry is the product of (B-entry times E-entry). PhysPops and MortRates are each "per 100,000."

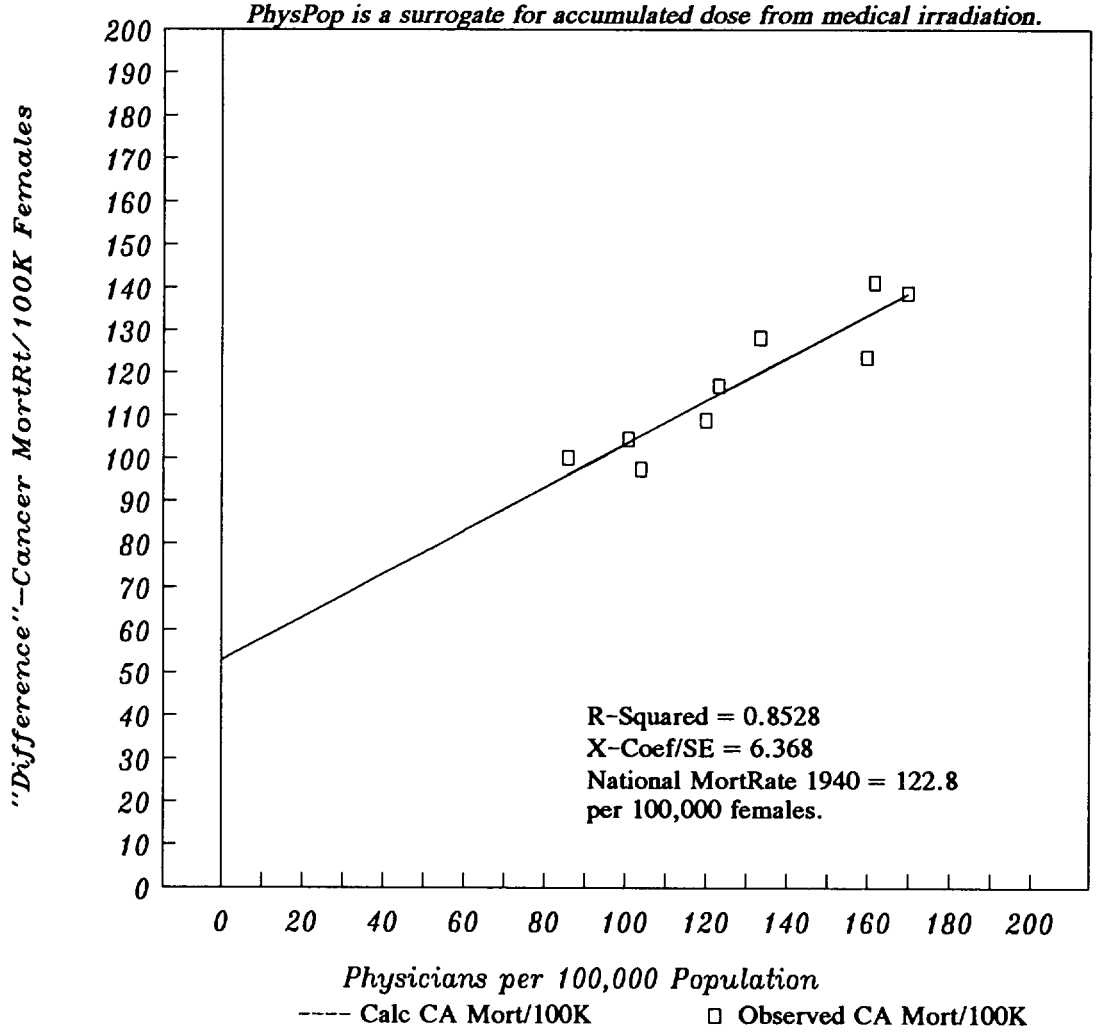
The Weighted-Avg. Nat'l PhysPop, 1940, is the sum of Column-D entries =	132.04
The Weighted-Avg. Nat'l Female MortRate, 1940, is sum of Col.F entries =	120.58
The Nat'l Female MortRate is also (X-Coef * Nat'l PhysPop) + Constant =	119.44
Comparison: The Nat'l Female MortRate, 1940, in Table 19-B =	122.80

(A) Census Division	(B) Pop'n Fraction	(C) PhysPop 1940	(D) Weighted PhysPop	(E) MortRate 1940	(F) Weighted MortRate
Pacific	0.0739	159.72	11.80	123.6	9.13
New England	0.0641	161.55	10.36	141.2	9.05
West No. Central	0.1027	123.14	12.65	117.0	12.02
Mid-Atlantic	0.2092	169.76	35.51	138.7	29.02
East No. Central	0.2022	133.36	26.97	128.2	25.92
Mountain	0.0315	119.89	3.78	108.9	3.43
West So. Central	0.0992	103.94	10.31	97.4	9.66
East So. Central	0.0819	85.83	7.03	100.1	8.20
South Atlantic	0.1354	100.74	13.64	104.5	14.15
Sums	1.0000		132.04		120.58

1940 "Difference" Cancer Mortality-Rates versus 1940 PhysPop Values for the 9 Census Divisions, USA.

Dose-Response Relationship

PhysPop is a surrogate for accumulated dose from medical irradiation.



On the X-axis, PhysPop values = Physicians per 100,000 Population in the Nine Census Divisions of the USA Population, Year 1940. This variable is a surrogate for accumulated radiation dose --- the more physicians per 100,000 people, the more radiation procedures are done per 100,000 people.

On the Y-axis, "Difference" Cancer Mortality-Rate per 100,000 females = the reported rates in USA Vital Statistics for the Nine Census Divisions, Year 1940.

Shown above is the relationship between these two variables (Part 2j). The nine datapoints (boxy symbols) were collected long ago for other purposes, and are free from potential bias with respect to this dose-response study. Fractional causation is (Natl MortRate minus the Y-intercept) / (Natl MortRate).

Fractional Causation of "Difference" Cancer Mort-Rate (Female) by Medical Rad'n 57 % from Best Estimate (Box 3).

40 % at lower 90 % confidence limit (Box 3). ~68 % at upper 90 % confidence limit (Box 3).

Table 19-A.
"Difference" Cancer MortRates by Census Divisions: Females.

"Difference" Cancers are (All-Cancers minus Respiratory-System Cancers). The entries below are the corresponding entries in Table 7-A (All-Cancers, Female) minus the corresponding entries in Table 17-A (Respiratory-System Cancers, Female). Rates are annual deaths per 100,000 female population, USA, age-adjusted to the 1940 reference year. There are no exclusions by color or "race."

Census Division	1940	1950	1960	1970	1980	1988
Pacific	123.6	113.3	104.2	96.7	89.2	83.7
New England	141.2	128.0	116.8	107.4	97.9	89.5
West North Central	117.0	112.3	104.9	95.4	86.0	83.7
Mid-Atlantic	138.7	132.0	121.4	110.2	99.0	92.8
East North Central	128.2	123.0	114.7	104.3	93.9	90.1
Mountain	108.9	101.8	96.9	88.4	80.0	78.2
West South Central	97.4	105.0	97.7	90.3	82.8	83.2
East South Central	100.1	105.6	100.1	93.2	86.2	86.1
South Atlantic	104.5	108.6	102.4	94.8	87.1	85.0
Average, ALL	117.7	114.4	106.6	97.8	89.1	85.8
Average, High-5	113.8	117.6	115.6	111.1	106.6	105.6
Average, Low-4	80.2	92.9	97.4	98.8	100.2	104.1
Ratio, Hi5/Lo4	1.42	1.27	1.19	1.12	1.06	1.01

Table 19-B.
"Difference" Cancer Mortality Rates, USA National.

Annual MortRates in Table 19-B are obtained by subtracting Table 17-B from Table 7-B.

Rates are age-adjusted to the 1940 reference year. Both sexes: Deaths per 100,000 population (males + females). Males: Deaths per 100,000 male population. Females: Deaths per 100,000 female population. No exclusions by color or "race."

	Both Sexes	Male	Female
1940	113.1	104.0	122.8
1950	114.7	111.2	118.6
1960	109.6	110.5	109.6
1970	101.4	107.8	100.1
1979-81	95.8	105.1	90.5
1987-89	--	103.0	86.8

• - Sources are stated in Table 17-B and Table 7-B.