

CHAPTER 8

Breast Cancer, Females: Relation with Medical Radiation

● Part 1. Introduction

We put Breast Cancer early in Section Two of this book, because of the interest in seeing how the 1940 Fractional Causation obtained in this chapter compares with the 1995 Fractional Causation (75%) obtained for this particular cancer in Gofman 1995/1996. The two studies use completely different data and completely different methods.

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

In Part 2, we regress the 1940 MortRates (from Table 8-A) upon the non-interpolated sets of PhysPop values 1921-1940 (from the Universal PhysPop Table 3-A). The summary-results of all the regression analyses are presented in Box 1 nearby.

● - Part 2a.	1921	1940	Breast Cancer, Females
	PhysPop	MortRate	Regression Output:
Pacific	165.11	26.7	Constant -10.9421
New England	142.24	28.8	Std Err of Y Est 4.0114
West North Central	140.93	22.6	R Squared 0.5061
Mid-Atlantic	137.29	27.8	No. of Observations 9
East North Central	136.06	24.3	Degrees of Freedom 7
Mountain	135.38	18.6	
West South Central	125.15	15.1	X Coefficient(s) 0.2440
East South Central	119.76	15.1	Std Err of Coef. 0.0911
South Atlantic	110.32	18.3	Coefficient / S.E. 2.6780
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● - Part 2b.	1923	1940	Breast Cancer, Females
	PhysPop	MortRate	Regression Output:
Pacific	163.06	26.7	Constant -9.9385
New England	137.39	28.8	Std Err of Y Est 3.7059
West North Central	138.31	22.6	R Squared 0.5784
Mid-Atlantic	138.92	27.8	No. of Observations 9
East North Central	131.82	24.3	Degrees of Freedom 7
Mountain	130.51	18.6	
West South Central	119.16	15.1	X Coefficient(s) 0.2432
East South Central	113.16	15.1	Std Err of Coef. 0.0785
South Atlantic	106.79	18.3	Coefficient / S.E. 3.0991
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● - Part 2c.	1925	1940	Breast Cancer, Females
	PhysPop	MortRate	Regression Output:
Pacific	161.67	26.7	Constant -8.6344
New England	138.31	28.8	Std Err of Y Est 3.3288
West North Central	133.92	22.6	R Squared 0.6598
Mid-Atlantic	134.36	27.8	No. of Observations 9
East North Central	127.54	24.3	Degrees of Freedom 7
Mountain	122.30	18.6	
West South Central	112.83	15.1	X Coefficient(s) 0.2409
East South Central	107.22	15.1	Std Err of Coef. 0.0654
South Atlantic	103.61	18.3	Coefficient / S.E. 3.6849
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● - Part 2d.	1927	1940	Breast Cancer, Females
	PhysPop	MortRate	Regression Output:
Pacific	157.83	26.7	Constant -9.1171
New England	137.50	28.8	Std Err of Y Est 2.7534
West North Central	131.54	22.6	R Squared 0.7673
Mid-Atlantic	138.40	27.8	No. of Observations 9
East North Central	126.18	24.3	Degrees of Freedom 7
Mountain	118.75	18.6	
West South Central	108.25	15.1	X Coefficient(s) 0.2488

East South Central	102.07	15.1	Std Err of Coef.	0.0518
South Atlantic	102.13	18.3	Coefficient / S.E.	4.8040

● - Part 2e.	1929	1940	Breast Cancer, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	156.64	26.7	Constant	-8.5821
New England	138.46	28.8	Std Err of Y Est	2.5197
West North Central	128.72	22.6	R Squared	0.8051
Mid-Atlantic	138.49	27.8	No. of Observations	9
East North Central	126.51	24.3	Degrees of Freedom	7
Mountain	118.68	18.6		
West South Central	105.60	15.1	X Coefficient(s)	0.2466
East South Central	99.41	15.1	Std Err of Coef.	0.0459
South Atlantic	100.86	18.3	Coefficient / S.E.	5.3774

● - Part 2f.	1931	1940	Breast Cancer, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	159.97	26.7	Constant	-6.3107
New England	142.35	28.8	Std Err of Y Est	2.4198
West North Central	126.50	22.6	R Squared	0.8203
Mid-Atlantic	140.82	27.8	No. of Observations	9
East North Central	128.59	24.3	Degrees of Freedom	7
Mountain	118.89	18.6		
West South Central	105.95	15.1	X Coefficient(s)	0.2270
East South Central	96.73	15.1	Std Err of Coef.	0.0402
South Atlantic	99.59	18.3	Coefficient / S.E.	5.6519

● - Part 2g.	1934	1940	Breast Cancer, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	160.09	26.7	Constant	-4.0298
New England	148.60	28.8	Std Err of Y Est	1.9436
West North Central	125.96	22.6	R Squared	0.8840
Mid-Atlantic	149.62	27.8	No. of Observations	9
East North Central	129.36	24.3	Degrees of Freedom	7
Mountain	117.16	18.6		
West South Central	104.68	15.1	X Coefficient(s)	0.2075
East South Central	92.00	15.1	Std Err of Coef.	0.0284
South Atlantic	98.41	18.3	Coefficient / S.E.	7.3052

● - Part 2h.	1936	1940	Breast Cancer, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	158.44	26.7	Constant	-3.4183
New England	150.18	28.8	Std Err of Y Est	1.8002
West North Central	126.14	22.6	R Squared	0.9005
Mid-Atlantic	155.05	27.8	No. of Observations	9
East North Central	130.42	24.3	Degrees of Freedom	7
Mountain	119.80	18.6		
West South Central	103.52	15.1	X Coefficient(s)	0.2014
East South Central	89.94	15.1	Std Err of Coef.	0.0253
South Atlantic	99.16	18.3	Coefficient / S.E.	7.9604

● - Part 2i.	1938	1940	Breast Cancer, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	157.62	26.7	Constant	-2.2092
New England	154.08	28.8	Std Err of Y Est	1.6613
West North Central	124.95	22.6	R Squared	0.9153
Mid-Atlantic	160.69	27.8	No. of Observations	9
East North Central	131.98	24.3	Degrees of Freedom	7
Mountain	119.88	18.6		
West South Central	102.79	15.1	X Coefficient(s)	0.1906
East South Central	88.21	15.1	Std Err of Coef.	0.0219
South Atlantic	99.26	18.3	Coefficient / S.E.	8.6965

● - Part 2j.	1940	1940	Breast Cancer, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	159.72	26.7	Constant	-0.1205
New England	161.55	28.8	Std Err of Y Est	1.6870
West North Central	123.14	22.6	R Squared	0.9126

Mid-Atlantic	169.76	27.8	No. of Observations	9
East North Central	133.36	24.3	Degrees of Freedom	7
Mountain	119.89	18.6		
West South Central	103.94	15.1	X Coefficient(s)	0.1713
East South Central	85.83	15.1	Std Err of Coef.	0.0200
South Atlantic	100.74	18.3	Coefficient / S.E.	8.5512

Box 1 of Chap. 8

Summary: Regression Outputs for Breast Cancer, 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. We are searching for the maximum correlation. Even the maximum will tend to understate the true correlation (Chapter 5, Part 8b).

Part	PhysPop	R-squared	Constant	X-Coef	Std Err	X-Coef/SE
2a	1921	0.5061	-10.94	0.2440	0.0911	2.6780
2b	1923	0.5784	-9.94	0.2432	0.0785	3.0991
2c	1925	0.6598	-8.63	0.2409	0.0654	3.6849
2d	1927	0.7673	-9.12	0.2488	0.0518	4.8040
2e	1929	0.8051	-8.58	0.2466	0.0459	5.3774
2f	1931	0.8203	-6.31	0.2270	0.0402	5.6519
2g	1934	0.8840	-4.03	0.2075	0.0284	7.3052
2h	1936	0.9005	-3.42	0.2014	0.0253	7.9604
2i --->	1938 Max	0.9153	-2.21	0.1906	0.0219	8.6965
2j	1940	0.9126	-0.12	0.1713	0.0200	8.5512

Box 2 of Chap. 8

Input-Data for Figure 8-A. Breast Cancer. Females.

Part 2i, Best-Fit Equation: Calc. MortRate = (0.1906 * PhysPop) + (-2.21)

Census Divisions	1938 Observed PhysPops	1940 Observed MortRates	Best-Fit Calc. MortRates
Pacific	157.62	26.7	27.832
New England	154.08	28.8	27.158
West No. Central	124.95	22.6	21.605
Mid-Atlantic	160.69	27.8	28.418
East No. Central	131.98	24.3	22.945
Mountain	119.88	18.6	20.639
West So. Central	102.79	15.1	17.382
East So. Central	88.21	15.1	14.603
South Atlantic	99.26	18.3	16.709
Additional PhysPops	70.00		11.132
--- not "observed" ---	60.00		9.226
down to zero PhysPop	50.00		7.320
(zero medical radiation).	40.00		5.414
For each, we calculate	30.00		3.508
a best-fit MortRate.	20.00		1.602
These additional x,y pairs	10.00		-0.304
are also part of the	0		-2.210
best-fit line (Chap 5, Part 5e).			

Box 3 of Chap. 8
Presumptive Fraction of Cancer MortRate Attributable to Medical Radiation.

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

Breast Cancer. FEMALES.

- FEMALE National MortRate (MR) 1940, from Table 8-B 23.3 National MortRate
- Constant, from regression, Part 2i -2.2092 Constant
- Fractional Causation, Best Est. = (Natl MR - Constant) / Natl MR 109.5% Frac. Causation
- # The Upper-Limit is 100%. Negative Constants produce values > 100%. See Chapter 22, Part 3.

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

X-Coefficient, from Part 2i	0.1906	X-Coeff., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2i	0.0219	Standard Error
Upper 90% C.L. on X-Coeff. = (Coef) + (1.645 * SE) =	0.2266	New X-Coefficient
New Constant = (Natl MR) - (New X-Coeff * 1938 Natl PhysPop) =	-5.9994	New Constant
Frac. Causation, High-Limit = (Natl MR - New Constant) / Natl MR =	126%	New Frac. Caus'n.
# The Upper-Limit is 100%. Negative Constants produce values > 100%. See Chapter 22, Part 3.		
Lower 90% C.L. on X-Coeff. = (Coef) - (1.645 * SE) =	0.1546	New X-Coefficient
New Constant = (Natl MR) - (New X-Coeff * 1938 Natl PhysPop) =	3.3102	New Constant
Frac. Causation, Low-Limit = (Natl MR - New Constant) / Natl MR =	85.8%	New Frac. Caus'n.

Box 4 of Chap. 8
Error-Check on Our Own Work: Breast Cancer, Females.

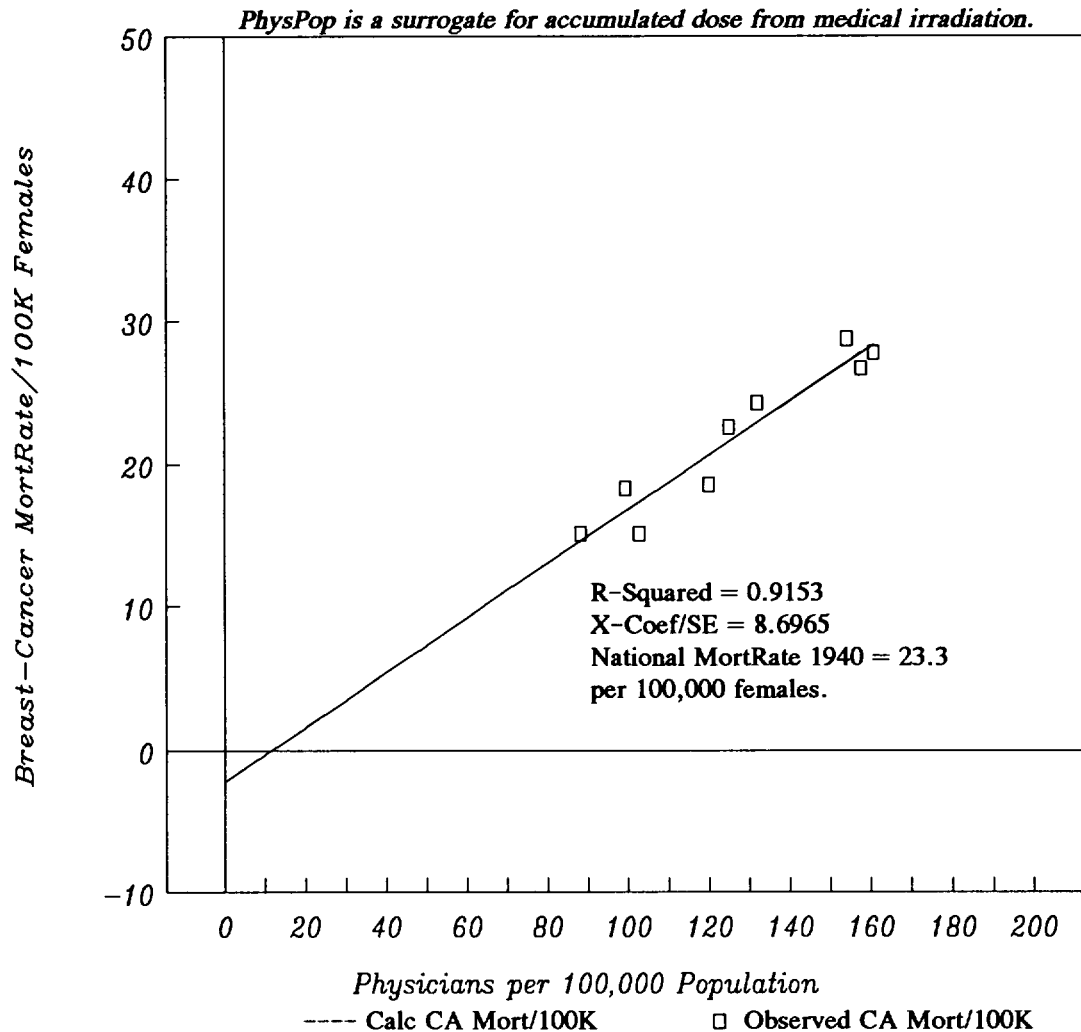
Please see text in Chapter 6, Part 5.

Below, Columns A, C, and E come directly from the regression input in Part 2i. 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, 1938, is the sum of Column-D entries = 129.30
 The 1938 PhysPop approximation is weighted by the 1940 population-fractions.
 The Weighted-Avg. Nat'l Female MortRate, 1940, is sum of Col.F entries = 22.67
 The Nat'l Female MortRate is also (X-Coeff * Nat'l PhysPop) + Constant = 22.44
 Comparison: The Nat'l Female MortRate, 1940, in Table 8-B = 23.30

(A) Census Division	(B) Pop'n Fraction	(C) PhysPop 1938	(D) 1938 Weighted PhysPop	(E) MortRate 1940	(F) Weighted MortRate
Pacific	0.0739	157.62	11.65	26.7	1.97
New England	0.0641	154.08	9.88	28.8	1.85
West No. Central	0.1027	124.95	12.83	22.6	2.32
Mid-Atlantic	0.2092	160.69	33.62	27.8	5.82
East No. Central	0.2022	131.98	26.69	24.3	4.91
Mountain	0.0315	119.88	3.78	18.6	0.59
West So. Central	0.0992	102.79	10.20	15.1	1.50
East So. Central	0.0819	88.21	7.22	15.1	1.24
South Atlantic	0.1354	99.26	13.44	18.3	2.48
Sums	1.0000		129.30		22.67

**1940 Breast-Cancer Mortality-Rates versus
1938 PhysPop Values for the 9 Census Divisions, USA.**
Dose-Response Relationship



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, Breast-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 strongest relationship between these two variables (Part 2i). 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 Breast-Cancer Mortality-Rate in Females
by Medical Radiation = ~100 % from Best Estimate (Box 3).
85.8 % at Lower 90% Conf. Limit (Box 3). ~100 % at Upper 90 % Conf. Limit (Box 3).**

Table 8-A.
Breast-Cancer Mortality Rates by Census Divisions: Females.

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." Sources are stated in Table 8-B, and described in Chap. 4, Part 2. The Nine Census-Division MortRates are population-weighted (Chap. 4, Part 2b). The averages below them are not.

Census Division	1940	1950	1960	1970	1980	1990
Pacific	26.7	23.8	23.3	22.3	21.2	22.7
New England	28.8	25.8	25.9	25.3	24.7	24.3
West North Central	22.6	22.6	22.8	22.2	21.7	22.6
Mid-Atlantic	27.8	26.5	26.8	26.4	25.9	25.8
East North Central	24.3	23.5	24.3	24.2	24.0	24.1
Mountain	18.6	18.8	20.3	20.3	20.3	21.0
West South Central	15.1	16.6	17.8	18.4	18.9	20.8
East South Central	15.1	16.6	17.6	18.6	19.6	21.4
South Atlantic	18.3	18.4	19.4	20.2	21.0	22.6
Average, ALL	21.9	21.4	22.0	22.0	21.9	22.8
Average, High-5	26.0	24.4	24.6	24.1	23.5	23.9
Average, Low-4	16.8	17.6	18.8	19.4	20.0	21.5
Ratio, Hi5/Lo4	1.55	1.39	1.31	1.24	1.18	1.11

Table 8-B.
Breast-Cancer Mortality Rates, USA National.

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	11.7	0.2	23.3
1950	11.6	0.2	22.5
1960	12.1	0.2	22.9
1970	--	--	23.1
1979-81	12.4	0.2	22.6
1989-91	--	--	23.1

● - 1940, 1950, 1960: All rates come from Grove 1968, Table 67, p.690, "Malignant neoplasms of the breast (170)" ICD/7.

● - 1970: All rates by Divisions are interpolations (Chap. 4, Parts 2b, 2c), except that the 1970 National rate for Females comes from PHS 1995, Table 41, p.138.

● - 1980: All rates (ICD/9, 174-175) come from the reference NatCtrHS 1980.

● - 1990 rates by Divisions and National come from Monthly Vital Statistics Vol.43, No.8, January 31, 1995 (MVS in our Reference List).

● - In Chapter 4, Box 3, age-SPECIFIC Breast-Cancer MortRates are shown (as an illustration of age-specific rates), by decades for the 1950-1990 period.