

CHAPTER 10

Digestive-System Cancers, Females: Relation with Medical Radiation

● Part 1. Introduction

Digestive-System Cancers include cancers of the esophagus, stomach, small and large intestine, rectum, biliary passages and liver, pancreas, and peritoneum (See Chapter 4, Part 5, Number 6).

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

● - Part 2a.	1921	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	165.11	46.8	Constant	0.3717
New England	142.24	61.3	Std Err of Y Est	8.8662
West North Central	140.93	49.7	R Squared	0.3007
Mid-Atlantic	137.29	60.2	No. of Observations	9
East North Central	136.06	53.1	Degrees of Freedom	7
Mountain	135.38	47.7		
West South Central	125.15	34.5	X Coefficient(s)	0.3494
East South Central	119.76	36.3	Std Err of Coef.	0.2014
South Atlantic	110.32	37.3	Coefficient / S.E.	1.7350

● - Part 2b.	1923	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	163.06	46.8	Constant	1.1696
New England	137.39	61.3	Std Err of Y Est	8.5255
West North Central	138.31	49.7	R Squared	0.3534
Mid-Atlantic	138.92	60.2	No. of Observations	9
East North Central	131.82	53.1	Degrees of Freedom	7
Mountain	130.51	47.7		
West South Central	119.16	34.5	X Coefficient(s)	0.3531
East South Central	113.16	36.3	Std Err of Coef.	0.1805
South Atlantic	106.79	37.3	Coefficient / S.E.	1.9561

● - Part 2c.	1925	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	161.67	46.8	Constant	4.0462
New England	138.31	61.3	Std Err of Y Est	8.3113
West North Central	133.92	49.7	R Squared	0.3855
Mid-Atlantic	134.36	60.2	No. of Observations	9
East North Central	127.54	53.1	Degrees of Freedom	7
Mountain	122.30	47.7		
West South Central	112.83	34.5	X Coefficient(s)	0.3420
East South Central	107.22	36.3	Std Err of Coef.	0.1632
South Atlantic	103.61	37.3	Coefficient / S.E.	2.0956

● - Part 2d.	1927	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	157.83	46.8	Constant	1.2118
New England	137.50	61.3	Std Err of Y Est	7.5490
West North Central	131.54	49.7	R Squared	0.4931
Mid-Atlantic	138.40	60.2	No. of Observations	9
East North Central	126.18	53.1	Degrees of Freedom	7
Mountain	118.75	47.7		
West South Central	108.25	34.5	X Coefficient(s)	0.3705
East South Central	102.07	36.3	Std Err of Coef.	0.1420
South Atlantic	102.13	37.3	Coefficient / S.E.	2.6093

● - Part 2e.	1929	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	156.64	46.8	Constant	0.9492

New England	138.46	61.3	Std Err of Y Est	7.1771
West North Central	128.72	49.7	R Squared	0.5418
Mid-Atlantic	138.49	60.2	No. of Observations	9
East North Central	126.51	53.1	Degrees of Freedom	7
Mountain	118.68	47.7		
West South Central	105.60	34.5	X Coefficient(s)	0.3758
East South Central	99.41	36.3	Std Err of Coef.	0.1306
South Atlantic	100.86	37.3	Coefficient / S.E.	2.8769
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● - Part 2f.	1931	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	159.97	46.8	Constant	4.2282
New England	142.35	61.3	Std Err of Y Est	7.0596
West North Central	126.50	49.7	R Squared	0.5567
Mid-Atlantic	140.82	60.2	No. of Observations	9
East North Central	128.59	53.1	Degrees of Freedom	7
Mountain	118.89	47.7		
West South Central	105.95	34.5	X Coefficient(s)	0.3474
East South Central	96.73	36.3	Std Err of Coef.	0.1172
South Atlantic	99.59	37.3	Coefficient / S.E.	2.9647
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● - Part 2g.	1934	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	160.09	46.8	Constant	6.2062
New England	148.60	61.3	Std Err of Y Est	6.3037
West North Central	125.96	49.7	R Squared	0.6465
Mid-Atlantic	149.62	60.2	No. of Observations	9
East North Central	129.36	53.1	Degrees of Freedom	7
Mountain	117.16	47.7		
West South Central	104.68	34.5	X Coefficient(s)	0.3296
East South Central	92.00	36.3	Std Err of Coef.	0.0921
South Atlantic	98.41	37.3	Coefficient / S.E.	3.5781
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● - Part 2h.	1936	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	158.44	46.8	Constant	5.8518
New England	150.18	61.3	Std Err of Y Est	5.7814
West North Central	126.14	49.7	R Squared	0.7027
Mid-Atlantic	155.05	60.2	No. of Observations	9
East North Central	130.42	53.1	Degrees of Freedom	7
Mountain	119.80	47.7		
West South Central	103.52	34.5	X Coefficient(s)	0.3304
East South Central	89.94	36.3	Std Err of Coef.	0.0812
South Atlantic	99.16	37.3	Coefficient / S.E.	4.0672
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● - Part 2i.	1938	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	157.62	46.8	Constant	7.0152
New England	154.08	61.3	Std Err of Y Est	5.3636
West North Central	124.95	49.7	R Squared	0.7441
Mid-Atlantic	160.69	60.2	No. of Observations	9
East North Central	131.98	53.1	Degrees of Freedom	7
Mountain	119.88	47.7		
West South Central	102.79	34.5	X Coefficient(s)	0.3192
East South Central	88.21	36.3	Std Err of Coef.	0.0708
South Atlantic	99.26	37.3	Coefficient / S.E.	4.5115

● - Part 2j.	1940	1940	Digestive Cancers, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	159.72	46.8	Constant	10.1907
New England	161.55	61.3	Std Err of Y Est	5.2483
West North Central	123.14	49.7	R Squared	0.7550
Mid-Atlantic	169.76	60.2	No. of Observations	9
East North Central	133.36	53.1	Degrees of Freedom	7
Mountain	119.89	47.7		
West South Central	103.94	34.5	X Coefficient(s)	0.2895
East South Central	85.83	36.3	Std Err of Coef.	0.0623
South Atlantic	100.74	37.3	Coefficient / S.E.	4.6442

Box 1 of Chap. 10
Summary: Regression Outputs, Digestive-System Cancers, Females.

Below are the summary-results from all the calculations of Part 2, for the 1940 MortRates regressed on PhysPop.

Part	PhysPop	R-squared	Constant	X-Coef	Std Err	X-Coef/SE
2a	1921	0.3007	0.37	0.3494	0.2014	1.7350
2b	1923	0.3534	1.17	0.3531	0.1805	1.9561
2c	1925	0.3855	4.05	0.3420	0.1632	2.0956
2d	1927	0.4931	1.21	0.3705	0.1420	2.6093
2e	1929	0.5418	0.95	0.3758	0.1306	2.8769
2f	1931	0.5567	4.23	0.3474	0.1172	2.9647
2g	1934	0.6465	6.21	0.3296	0.0921	3.5781
2h	1936	0.7027	5.85	0.3304	0.0812	4.0672
2i	1938	0.7441	7.02	0.3192	0.0708	4.5115
2j ---->	1940 Max	0.7550	10.19	0.2895	0.0623	4.6442

Box 2 of Chap. 10
Input-Data for Figure 10-A. Digestive-System Cancers. Females.

Part 2j, Best-Fit Equation: Calc. MortRate = (0.2895 * PhysPop) + (10.19)

Census Divisions	1940 Observed PhysPops	1940 Observed MortRates	Best-Fit Calc. MortRates
Pacific	159.72	46.8	56.429
New England	161.55	61.3	56.959
West No. Central	123.14	49.7	45.839
Mid-Atlantic	169.76	60.2	59.336
East No. Central	133.36	53.1	48.798
Mountain	119.89	47.7	44.898
West So. Central	103.94	34.5	40.281
East So. Central	85.83	36.3	35.038
South Atlantic	100.74	37.3	39.354
Additional PhysPops	70.00		30.455
--- not "observed" ---	60.00		27.560
down to zero PhysPop	50.00		24.665
(zero medical radiation).	40.00		21.770
For each, we calculate	30.00		18.875
a best-fit MortRate.	20.00		15.980
These additional x,y pairs	10.00		13.085
are also part of the	0		10.190
best-fit line (Chap 5, Part 5e).			

Box 3 of Chap. 10
Presumptive Fraction of Cancer MortRate Attributable to Medical Radiation.

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

Digestive-System Cancers. FEMALES.

- FEMALE National MortRate (MR) 1940, from Table 10-B 50.1 National MortRate
- Constant, from regression, Part 2j 10.1907 Constant
- Fractional Causation, Best Est. = (Natl MR - Constant) / Natl MR 79.7% Frac. Causation

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

X-Coefficient, from Part 2j	0.2895	X-Coeff., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2j	0.0623	Standard Error
Upper 90% C.L. on X-Coeff. = (Coef) + (1.645 * SE) =	0.3920	New X-Coefficient
New Constant = (Natl MR) - (New X-Coeff * 1940 Natl PhysPop) =	-1.6575	New Constant
Frac. Causation, High-Limit = (Natl MR - New Constant) / Natl MR =	#103.31%	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) =	0.1870	New X-Coefficient
New Constant = (Natl MR) - (New X-Coeff * 1940 Natl PhysPop) =	25.4085	New Constant
Frac. Causation, Low-Limit = (Natl MR - New Constant) / Natl MR =	49.3%	New Frac. Caus'n.

Box 4 of Chap. 10
Error-Check on Our Own Work: Digestive-System Cancers, Females.

Please see text in Chapter 6, Part 5.

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 = 48.77

The Nat'l Female MortRate is also (X-Coeff * Nat'l PhysPop) + Constant = 48.42

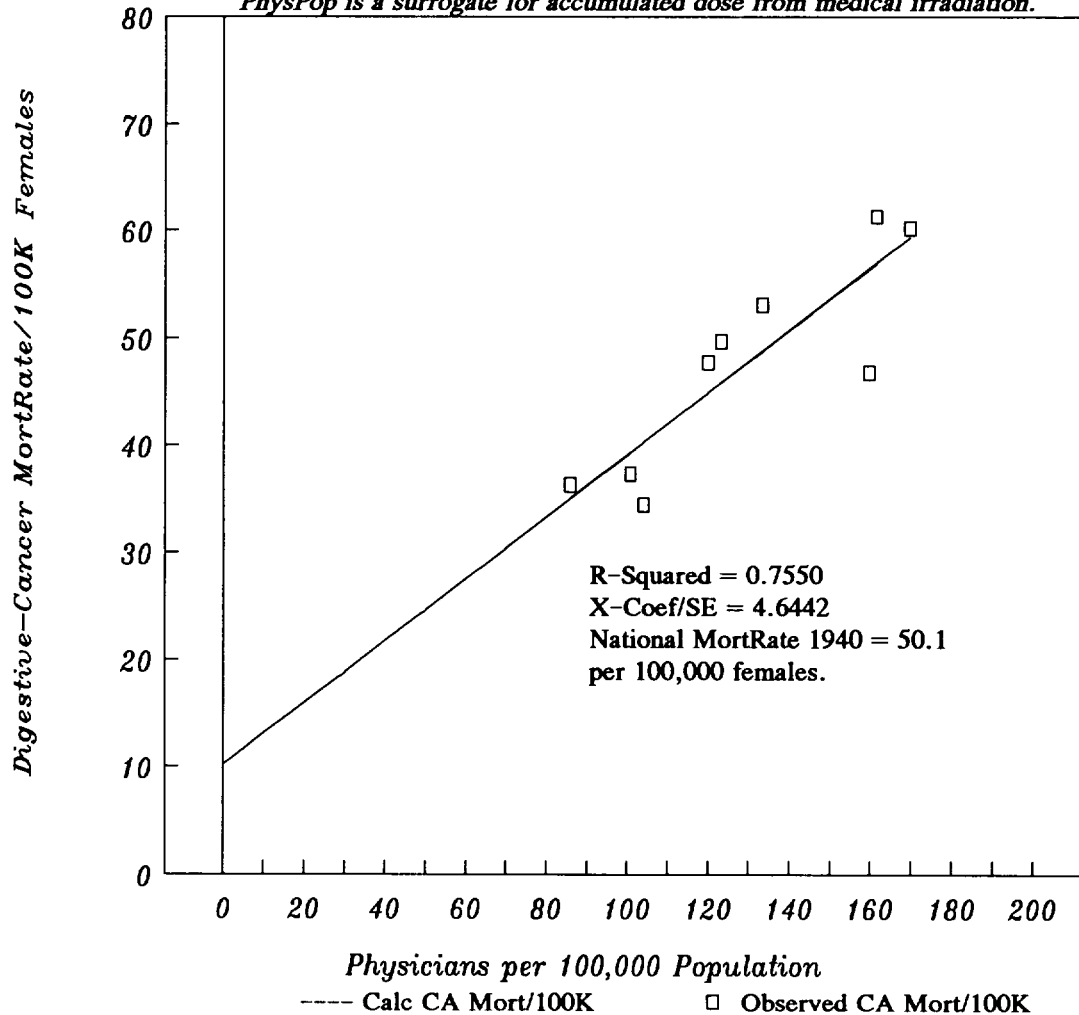
Comparison: The Nat'l Female MortRate, 1940, in Table 10-B = 50.10

(A) Census Division	(B) Pop'n Fraction	(C) PhysPop 1940	(D) 1940 Weighted PhysPop	(E) MortRate 1940	(F) Weighted MortRate
Pacific	0.0739	159.72	11.80	46.8	3.46
New England	0.0641	161.55	10.36	61.3	3.93
West No. Central	0.1027	123.14	12.65	49.7	5.10
Mid-Atlantic	0.2092	169.76	35.51	60.2	12.59
East No. Central	0.2022	133.36	26.97	53.1	10.74
Mountain	0.0315	119.89	3.78	47.7	1.50
West So. Central	0.0992	103.94	10.31	34.5	3.42
East So. Central	0.0819	85.83	7.03	36.3	2.97
South Atlantic	0.1354	100.74	13.64	37.3	5.05
Sums	1.0000		132.04		48.77

1940 Digestive-System 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, Digestive-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 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 Digest.-Cancer Mortality (Females) by Medical Radiation
80 % from Best Estimate (Box 3).

49 % at Lower 90% Conf. Limit (Box 3). ~100 % at Upper 90 % Conf. Limit (Box 3).

Table 10-A.

Digestive-System 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 10-B, and described in Chap. 4, Part 2. The Nine Census-Division Mortality Rates are population-weighted (Chap. 4, Part 2b). The averages below them are not.

Census Division	1940	1950	1960	1970	1980	1988
Pacific	46.8	37.3	32.5	28.9	25.4	22.8
New England	61.3	48.9	40.7	34.7	28.7	24.7
West North Central	49.7	40.4	34.1	29.3	24.6	21.8
Mid-Atlantic	60.2	51.1	42.9	36.5	30.1	26.0
East North Central	53.1	44.7	38.5	32.8	27.1	24.2
Mountain	47.7	34.8	30.5	26.3	22.2	21.1
West South Central	34.5	33.3	29.6	26.6	23.6	21.5
East South Central	36.3	34.5	29.9	27.2	24.4	23.3
South Atlantic	37.3	34.9	30.6	27.5	24.4	22.8
Average, ALL	47.4	40.0	34.4	30.0	25.6	23.1
Average, High-5	54.2	44.5	37.7	32.4	27.2	23.9
Average, Low-4	39.0	34.4	30.2	26.9	23.7	22.2
Ratio, Hi5/Lo4	1.39	1.29	1.25	1.21	1.15	1.08

Table 10-B.

Digestive-System 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	55.3	60.4	50.1
1950	48.7	55.4	42.4
1960	42.4	49.7	35.8
1970	37.7	45.7	31.0
1979-1981	32.9	41.7	26.2
1987-1989	--	38.8	23.5

● - 1940, 1950, 1960: All rates come from Grove 1968, Table 67, p.684, "Malignant neoplasm of digestive organs and peritoneum, not specified as secondary (150-156A, 157-159)" ICD/7.

● - 1970: All rates are interpolations (Chap. 4, Parts 2b, 2c).

● - 1980: All rates (ICD/9, 150-159) come from the reference NatCtrHS 1980.

● - 1988 rates by Divisions and National come from Monthly Vital Statistics Vol.41, No.9, February 16, 1993.