

## CHAPTER 9

### Digestive System Cancers, Males: 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, Males	
	PhysPop	MortRate		Regression Output:	
Pacific	165.11	63.4	Constant	-21.7593	
New England	142.24	71.7	Std Err of Y Est	10.4249	
West North Central	140.93	59.9	R Squared	0.4639	
Mid-Atlantic	137.29	74.7	No. of Observations	9	
East North Central	136.06	64.9	Degrees of Freedom	7	
Mountain	135.38	52.1	X Coefficient(s)	0.5827	
West South Central	125.15	42.3	Std Err of Coef.	0.2368	
East South Central	119.76	38.2	Coefficient / S.E.	2.4611	
South Atlantic	110.32	43.4			
.....					
● - Part 2b.		1923	1940	Digestive Cancers, Males	
	PhysPop	MortRate		Regression Output:	
Pacific	163.06	63.4	Constant	-20.1073	
New England	137.39	71.7	Std Err of Y Est	9.6496	
West North Central	138.31	59.9	R Squared	0.5407	
Mid-Atlantic	138.92	74.7	No. of Observations	9	
East North Central	131.82	64.9	Degrees of Freedom	7	
Mountain	130.51	52.1	X Coefficient(s)	0.5865	
West South Central	119.16	42.3	Std Err of Coef.	0.2043	
East South Central	113.16	38.2	Coefficient / S.E.	2.8705	
South Atlantic	106.79	43.4			
.....					
● - Part 2c.		1925	1940	Digestive Cancers, Males	
	PhysPop	MortRate		Regression Output:	
Pacific	161.67	63.4	Constant	-14.8748	
New England	138.31	71.7	Std Err of Y Est	9.2016	
West North Central	133.92	59.9	R Squared	0.5823	
Mid-Atlantic	134.36	74.7	No. of Observations	9	
East North Central	127.54	64.9	Degrees of Freedom	7	
Mountain	122.30	52.1	X Coefficient(s)	0.5645	
West South Central	112.83	42.3	Std Err of Coef.	0.1807	
East South Central	107.22	38.2	Coefficient / S.E.	3.1240	
South Atlantic	103.61	43.4			
.....					
● - Part 2d.		1927	1940	Digestive Cancers, Males	
	PhysPop	MortRate		Regression Output:	
Pacific	157.83	63.4	Constant	-17.3245	
New England	137.50	71.7	Std Err of Y Est	7.7735	
West North Central	131.54	59.9	R Squared	0.7019	
Mid-Atlantic	138.40	74.7	No. of Observations	9	
East North Central	126.18	64.9	Degrees of Freedom	7	
Mountain	118.75	52.1	X Coefficient(s)	0.5937	Page 2
West South Central	108.25	42.3	Std Err of Coef.	0.1462	
East South Central	102.07	38.2	Coefficient / S.E.	4.0599	
South Atlantic	102.13	43.4			
.....					
● - Part 2e.		1929	1940	Digestive Cancers, Males	
	PhysPop	MortRate		Regression Output:	
Pacific	156.64	63.4	Constant	-16.3714	
New England	138.46	71.7	Std Err of Y Est	7.2168	

West North Central	128.72	59.9	R Squared	0.7431
Mid-Atlantic	138.49	74.7	No. of Observations	9
East North Central	126.51	64.9	Degrees of Freedom	7
Mountain	118.68	52.1		
West South Central	105.60	42.3	X Coefficient(s)	0.5909
East South Central	99.41	38.2	Std Err of Coef.	0.1313
South Atlantic	100.86	43.4	Coefficient / S.E.	4.4995

## ● - Part 2f.

	1931	1940	Digestive Cancers, Males	
	PhysPop	MortRate	Regression Output:	
Pacific	159.97	63.4	Constant	-10.9999
New England	142.35	71.7	Std Err of Y Est	6.9944
West North Central	126.50	59.9	R Squared	0.7587
Mid-Atlantic	140.82	74.7	No. of Observations	9
East North Central	128.59	64.9	Degrees of Freedom	7
Mountain	118.89	52.1		
West South Central	105.95	42.3	X Coefficient(s)	0.5446
East South Central	96.73	38.2	Std Err of Coef.	0.1161
South Atlantic	99.59	43.4	Coefficient / S.E.	4.6911

## ● - Part 2g.

	1934	1940	Digestive Cancers, Males	
	PhysPop	MortRate	Regression Output:	
Pacific	160.09	63.4	Constant	-6.3946
New England	148.60	71.7	Std Err of Y Est	5.6845
West North Central	125.96	59.9	R Squared	0.8406
Mid-Atlantic	149.62	74.7	No. of Observations	9
East North Central	129.36	64.9	Degrees of Freedom	7
Mountain	117.16	52.1		
West South Central	104.68	42.3	X Coefficient(s)	0.5046
East South Central	92.00	38.2	Std Err of Coef.	0.0831
South Atlantic	98.41	43.4	Coefficient / S.E.	6.0756

## ● - Part 2h.

	1936	1940	Digestive Cancers, Males	
	PhysPop	MortRate	Regression Output:	
Pacific	158.44	63.4	Constant	-5.7821
New England	150.18	71.7	Std Err of Y Est	4.9168
West North Central	126.14	59.9	R Squared	0.8807
Mid-Atlantic	155.05	74.7	No. of Observations	9
East North Central	130.42	64.9	Degrees of Freedom	7
Mountain	119.80	52.1		
West South Central	103.52	42.3	X Coefficient(s)	0.4968
East South Central	89.94	38.2	Std Err of Coef.	0.0691
South Atlantic	99.16	43.4	Coefficient / S.E.	7.1902

## ● - Part 2i.

	1938	1940	Digestive Cancers, Males	
	PhysPop	MortRate	Regression Output:	
Pacific	157.62	63.4	Constant	-3.2139
New England	154.08	71.7	Std Err of Y Est	4.3256
West North Central	124.95	59.9	R Squared	0.9077
Mid-Atlantic	160.69	74.7	No. of Observations	9
East North Central	131.98	64.9	Degrees of Freedom	7
Mountain	119.88	52.1		
West South Central	102.79	42.3	X Coefficient(s)	0.4735
East South Central	88.21	38.2	Std Err of Coef.	0.0571
South Atlantic	99.26	43.4	Coefficient / S.E.	8.2970

## ● - Part 2j.

	1940	1940	Digestive Cancers, Males	
	PhysPop	MortRate	Regression Output:	
Pacific	159.72	63.4	Constant	1.8931
New England	161.55	71.7	Std Err of Y Est	4.3237
West North Central	123.14	59.9	R Squared	0.9078
Mid-Atlantic	169.76	74.7	No. of Observations	9
East North Central	133.36	64.9	Degrees of Freedom	7
Mountain	119.89	52.1		
West South Central	103.94	42.3	X Coefficient(s)	0.4262
East South Central	85.83	38.2	Std Err of Coef.	0.0513
South Atlantic	100.74	43.4	Coefficient / S.E.	8.3009

*Box 1 of Chap. 9**Summary: Regression Outputs, for Digestive-System Cancers, Males.*

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-Coeff	Std Err	X-Coeff/SE
2a	1921	0.4639	-21.76	0.5827	0.2368	2.4611
2b	1923	0.5407	-20.11	0.5865	0.2043	2.8705
2c	1925	0.5823	-14.87	0.5645	0.1807	3.1240
2d	1927	0.7019	-17.32	0.5937	0.1462	4.0599
2e	1929	0.7431	-16.37	0.5909	0.1313	4.4995
2f	1931	0.7587	-11.00	0.5446	0.1161	4.6911
2g	1934	0.8406	-6.39	0.5046	0.0831	6.0756
2h	1936	0.8807	-5.78	0.4968	0.0691	7.1902
2i	1938	0.9077	-3.21	0.4735	0.0571	8.2970
2j --->	1940 Max	0.9078	1.89	0.4262	0.0513	8.3009

*Box 2 of Chap. 9**Input-Data for Figure 9-A. Digestive-System Cancers. Males.*

Part 2j, Best-Fit Equation:  $\text{Calc. MortRate} = (0.4262 * \text{PhysPop}) + (1.89)$

Census Divisions	1940 Observed PhysPops	1940 Observed MortRates	Best-Fit Calc. MortRates
Pacific	159.72	63.4	69.963
New England	161.55	71.7	70.743
West No. Central	123.14	59.9	54.372
Mid-Atlantic	169.76	74.7	74.242
East No. Central	133.36	64.9	58.728
Mountain	119.89	52.1	52.987
West So. Central	103.94	42.3	46.189
East So. Central	85.83	38.2	38.471
South Atlantic	100.74	43.4	44.825
Additional PhysPops	70.00		31.724
--- not "observed" ---	60.00		27.462
down to zero PhysPop	50.00		23.200
(zero medical radiation).	40.00		18.938
For each, we calculate	30.00		14.676
a best-fit MortRate.	20.00		10.414
These additional x,y pairs	10.00		6.152
are also part of the	0		1.890
best-fit line (Chap 5, Part 5e).			

**Box 3 of Chap. 9**  
**Presumptive Fraction of Cancer MortRate Attributable to Medical Radiation.**

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

Digestive-System Cancers. MALES.

- MALE National MortRate (MR) 1940, from Table 9-B 60.4 National MortRate
- Constant, from regression, Part 2j 1.8931 Constant
- Fractional Causation, Best Est. = (Natl MR - Constant) / Natl MR 96.9% Frac. Causation

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

X-Coefficient, from Part 2j	0.4262	X-Coeff., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2j	0.0513	Standard Error
Upper 90% C.L. on X-Coeff. = (Coef) + (1.645 * SE) =	0.5106	New X-Coefficient
New Constant = (Natl MR) - (New X-Coeff * 1940 Natl PhysPop) =	-7.0196	New Constant
Frac. Causation, High-Limit = (Natl MR - New Constant) / Natl MR =	111.6%	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) =	0.3418	New X-Coefficient
New Constant = (Natl MR) - (New X-Coeff * 1940 Natl PhysPop) =	15.2672	New Constant
Frac. Causation, Low-Limit = (Natl MR - New Constant) / Natl MR =	74.7%	New Frac. Caus'n.

**Box 4 of Chap. 9**

**Error-Check on Our Own Work: Digestive-System Cancers, Males.**

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."

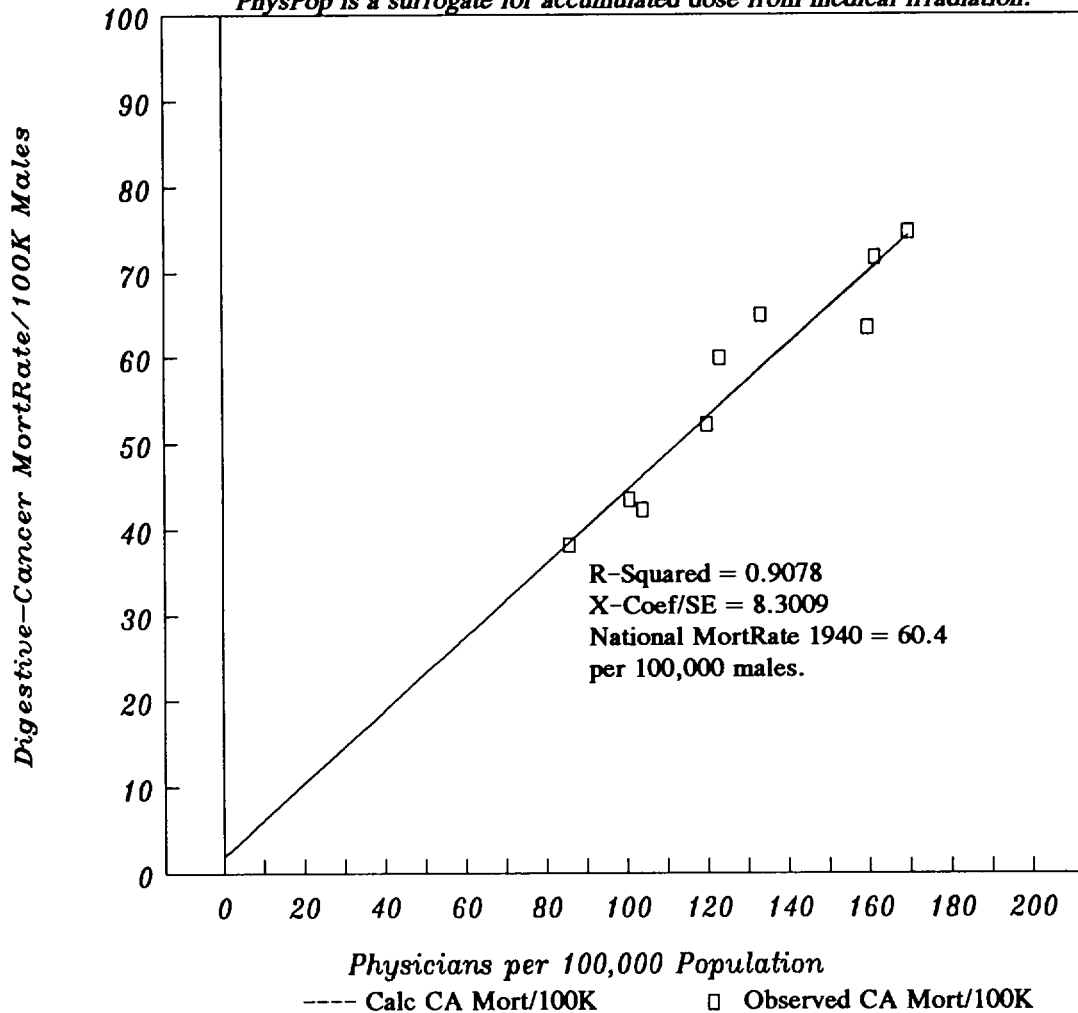
The Weighted-Avg. Nat'l PhysPop, 1940, is the sum of Column-D entries =	132.04
The Weighted-Avg. Nat'l Male MortRate, 1940, is sum of Col.F entries =	59.03
The Nat'l Male MortRate is also (X-Coeff * Nat'l PhysPop) + Constant =	58.17
Comparison: The Nat'l Male MortRate, 1940, in Table 9-B =	60.40

(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	63.4	4.69
New England	0.0641	161.55	10.36	71.7	4.60
West No. Central	0.1027	123.14	12.65	59.9	6.15
Mid-Atlantic	0.2092	169.76	35.51	74.7	15.63
East No. Central	0.2022	133.36	26.97	64.9	13.12
Mountain	0.0315	119.89	3.78	52.1	1.64
West So. Central	0.0992	103.94	10.31	42.3	4.20
East So. Central	0.0819	85.83	7.03	38.2	3.13
South Atlantic	0.1354	100.74	13.64	43.4	5.88
Sums	1.0000		132.04		59.03

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 males = 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 Digestive-Cancer Mortality (Males) by Medical Radiation***

***97 % from Best Estimate (Box 3).***

***74.7 % at Lower 90% Conf. Limit (Box 3). ~100 % at Upper 90 % Conf. Limit (Box 3).***

**Table 9-A.**  
***Digestive-System Cancer Mortality Rates by Census Divisions: Males.***

Rates are annual deaths per 100,000 male population, USA, age-adjusted to the 1940 reference year. There are no exclusions by color or "race." Sources are stated in Table 9-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	1988
Pacific	63.4	50.8	46.4	42.9	39.3	36.3
New England	71.7	66.3	58.9	52.5	46.0	42.1
West North Central	59.9	51.9	46.3	42.4	38.5	35.8
Mid-Atlantic	74.7	67.7	60.1	54.2	48.3	43.3
East North Central	64.9	60.0	53.0	48.4	43.7	40.2
Mountain	52.1	43.7	38.9	36.3	33.7	33.0
West South Central	42.3	42.9	40.6	38.8	37.0	36.5
East South Central	38.2	41.3	39.4	38.9	38.4	38.0
South Atlantic	43.4	45.2	43.1	41.6	40.1	38.5
Average, ALL	56.7	52.2	47.4	44.0	40.6	38.2
Average, High-5	66.9	59.3	52.9	48.1	43.2	39.5
Average, Low-4	44.0	43.3	40.5	38.9	37.3	36.5
Ratio, Hi5/Lo4	1.52	1.37	1.31	1.24	1.16	1.08

**Table 9-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
1979-81	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 by Divisions 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.