Respiratory-System Cancers, Males: Relation with Medical Radiation

● Part 1. Introduction

Respiratory-System Cancers include cancers of the larynx, bronchus and trachea, of lung specified as primary, of lung unspecified as to whether primary or secondary, and of other parts of the respiratory-system (see Chapter 4, Part 5, Number 7).

This study produces negative Constants for the central estimate and for both of the confidence-limits on the X-Coefficient --- as shown in Box 3. In this situation, we hesitate to use any value for Fractional Causation in Figure 16-A. Instead, we will say that the true Fractional Causation is far more likely to be near 100% than to be a low percentage. The dose-response in Part 2j is highly significant.

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

● - Part 2a.

	1921 PhysPop	1940 MortRate
Pacific	165.11	12.0
New England	142.24	13.5
West North Central	140.93	7.7
Mid-Atlantic	137.29	17.1
East North Central	136.06	10.6
Mountain	135.38	7.8
West South Central	125.15	7.6
East South Central	119.76	4.9
South Atlantic	110.32	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-6.1174
Std Err of Y Est	3.4686
R Squared	0.2466
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1192
Std Err of Coef.	0.0788
Coefficient / S.E.	1.5136

● - Part 2b.

	1923 PhysPop	1940 MortRate
Pacific	163.06	12.0
New England	137.39	13.5
West North Central	138.31	7.7
Mid-Atlantic	138.92	17.1
East North Central	131.82	10.6
Mountain	130.51	7.8
West South Central	119.16	7.6
East South Central	113.16	4.9
South Atlantic	106.79	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-6.9754
Std Err of Y Est	3.2642
R Squared	0.3328
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1291
Std Err of Coef.	0.0691
Coefficient / S.E.	1.8685

● - Part 2c.

	1925 PhysPop	1940 MortRate
Pacific	161.67	12.0
New England	138.31	13.5
West North Central	133.92	7.7
Mid-Atlantic	134.36	17.1
East North Central	127.54	10.6
Mountain	122.30	7.8
West South Central	112.83	7.6
East South Central	107.22	4.9
South Atlantic	103.61	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-6.2251
Std Err of Y Est	3.1543
R Squared	0.3769
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1275
Std Err of Coef.	0.0619
Coefficient / S.E.	2.0578

● - Part 2d.

	1927 PhysPop	1940 MortRate
Pacific	157.83	12.0
New England	137.50	13.5
West North Central	131.54	7.7
Mid-Atlantic	138.40	17.1
East North Central	126.18	10.6

Respiratory-System Ca, Males
Regression Output:

Constant	-7.7067
Std Err of Y Est	2.8082
R Squared	0.5062
No. of Observations	9
Degrees of Freedom	7

Mountain	118.75	7.8
West South Central	108.25	7.6
East South Central	102.07	4.9
South Atlantic	102.13	8.3

X Coefficient(s)	0.1415	
Std Err of Coef.	0.0528	
Coefficient / S.E.	2.6786	

● - Part 2e.

	1929 PhysPop	1940 MortRate
Pacific	156.64	12.0
New England	138.46	13.5
West North Central	128.72	7.7
Mid-Atlantic	138.49	17.1
East North Central	126.51	10.6
Mountain	118.68	7.8
West South Central	105.60	7.6
East South Central	99.41	4.9
South Atlantic	100.86	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-7.6693
Std Err of Y Est	2.6878
R Squared	0.5476
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1424
Std Err of Coef.	0.0489
Coefficient / S.E.	2.9109

● - Part 2f.

	1931 PhysPop	1940 MortRate
Pacific	159.97	12.0
New England	142.35	13.5
West North Central	126.50	7.7
Mid-Atlantic	140.82	17.1
East North Central	128.59	10.6
Mountain	118.89	7.8
West South Central	105.95	7.6
East South Central	96.73	4.9
South Atlantic	99.59	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-6.7703
Std Err of Y Est	2.5697
R Squared	0.5865
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1344
Std Err of Coef.	0.0426
Coefficient / S.E.	3.1510

● - Part 2g.

	1934 PhysPop	1940 MortRate
Pacific	160.09	12.0
New England	148.60	13.5
West North Central	125.96	7.7
Mid-Atlantic	149.62	17.1
East North Central	129.36	10.6
Mountain	117.16	7.8
West South Central	104.68	7.6
East South Central	92.00	4.9
South Atlantic	98.41	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-6.2805
Std Err of Y Est	2.1708
R Squared	0.7049
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1297
Std Err of Coef.	0.0317
Coefficient / S.E.	4.0891

● - Part 2h.

	1936 PhysPop	1940 MortRate
Pacific	158.44	12.0
New England	150.18	13.5
West North Central	126.14	7.7
Mid-Atlantic	155.05	17.1
East North Central	130.42	10.6
Mountain	119.80	7.8
West South Central	103.52	7.6
East South Central	89.94	4.9
South Atlantic	99.16	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-6.3345
Std Err of Y Est	1.9653
R Squared	0.7581
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1294
Std Err of Coef.	0.0276
Coefficient / S.E.	4.6842

● - Part 2i.

	1938 PhysPop	1940 MortRate
Pacific	157.62	12.0
New England	154.08	13.5
West North Central	124.95	7.7
Mid-Atlantic	160.69	17.1
East North Central	131.98	10.6
Mountain	119.88	7.8
West South Central	102.79	7.6
East South Central	88.21	4.9
South Atlantic	99.26	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-5.9557
Std Err of Y Est	1.7390
R Squared	0.8106
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1256
Std Err of Coef.	0.0229
Coefficient / S.E.	5.4740

● - Part 2j.

	1940 PhysPop	1940 MortRate
Pacific	159.72	12.0
New England	161.55	13.5
West North Central	123.14	7.7
Mid-Atlantic	169.76	17.1
East North Central	133.36	10.6
Mountain	119.89	7.8
West South Central	103.94	7.6
East South Central	85.83	4.9
South Atlantic	100.74	8.3

Respiratory-System Ca, Males
Regression Output:

Constant	-5.1002
Std Err of Y Est	1.4558
R Squared	0.8673
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.1169
Std Err of Coef.	0.0173
Coefficient / S.E.	6.7636

Box 1 of Chap. 16
Summary: Regression Outputs, Respiratory-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-Coef	Std Err	X-Coef/SE
2a	1921	0.2466	-6.12	0.1192	0.0788	1.5136
2b	1923	0.3328	-6.98	0.1291	0.0691	1.8685
2c	1925	0.3769	-6.23	0.1275	0.0619	2.0578
2d	1927	0.5062	-7.71	0.1415	0.0528	2.6786
2e	1929	0.5476	-7.67	0.1424	0.0489	2.9109
2f	1931	0.5865	-6.77	0.1344	0.0426	3.1510
2g	1934	0.7049	-6.28	0.1297	0.0317	4.0891
2h	1936	0.7581	-6.33	0.1294	0.0276	4.6842
2i	1938	0.8106	-5.96	0.1256	0.0229	5.4740
2j --->	1940 Max	0.8673	-5.10	0.1169	0.0173	6.7636

Box 2 of Chap. 16
Input-Data for Figure 16-A. Respiratory-System Cancers. Males.

Part 2j, Best-Fit Equation: Calc. MortRate = (0.1169 * PhysPop) + (-5.10)

Census Divisions	1940 Observed PhysPops	1940 Observed MortRates	Best-Fit Calc. MortRates
Pacific	159.72	12.0	13.571
New England	161.55	13.5	13.785
West No. Central	123.14	7.7	9.295
Mid-Atlantic	169.76	17.1	14.745
East No. Central	133.36	10.6	10.490
Mountain	119.89	7.8	8.915
West So. Central	103.94	7.6	7.051
East So. Central	85.83	4.9	4.934
South Atlantic	100.74	8.3	6.677
Additional PhysPops	70.00		3.083
--- not "observed" ---	60.00		1.914
down to zero PhysPop	50.00		0.745
(zero medical radiation).	40.00		-0.424
For each, we calculate	30.00		-1.593
a best-fit MortRate.	20.00		-2.762
These additional x,y pairs	10.00		-3.931
are also part of the	0		-5.100
best-fit line (Chap 5, Part 5e).			

Box 3 of Chap. 16
Presumptive Fraction of Cancer MortRate Attributable to Medical Radiation.

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

Respiratory-System Cancers. MALES.

- MALE National MortRate (MR) 1940, from Table 16-B   11.0   National MortRate
- Constant, from regression, Part 2j   -5.1002   Constant
- Fractional Causation, Best Est. = (Natl MR - Constant) / Natl MR   146.4% # 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 2j   0.1169   X-Coef., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2j   0.0173   Standard Error

Upper 90% C.L. on X-Coef. = (Coef) + (1.645 * SE) =   0.1454   New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1940 Natl PhysPop) =   -8.1931   New Constant
Frac. Causation, High-Limit = (Natl MR - New Constant) / Natl MR =   174.5% # 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-Coef. = (Coef) - (1.645 * SE) =   0.0884   New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1940 Natl PhysPop) =   -0.6778   New Constant
Frac. Causation, Low-Limit = (Natl MR - New Constant) / Natl MR =   106.2% # New Frac. Caus'n.
  # The Upper-Limit is 100%. Negative Constants produce values > 100%. See Chapter 22, Part 3.

Box 4 of Chap. 16
Error-Check on Our Own Work: Respiratory-System Cancer, 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 =   10.79
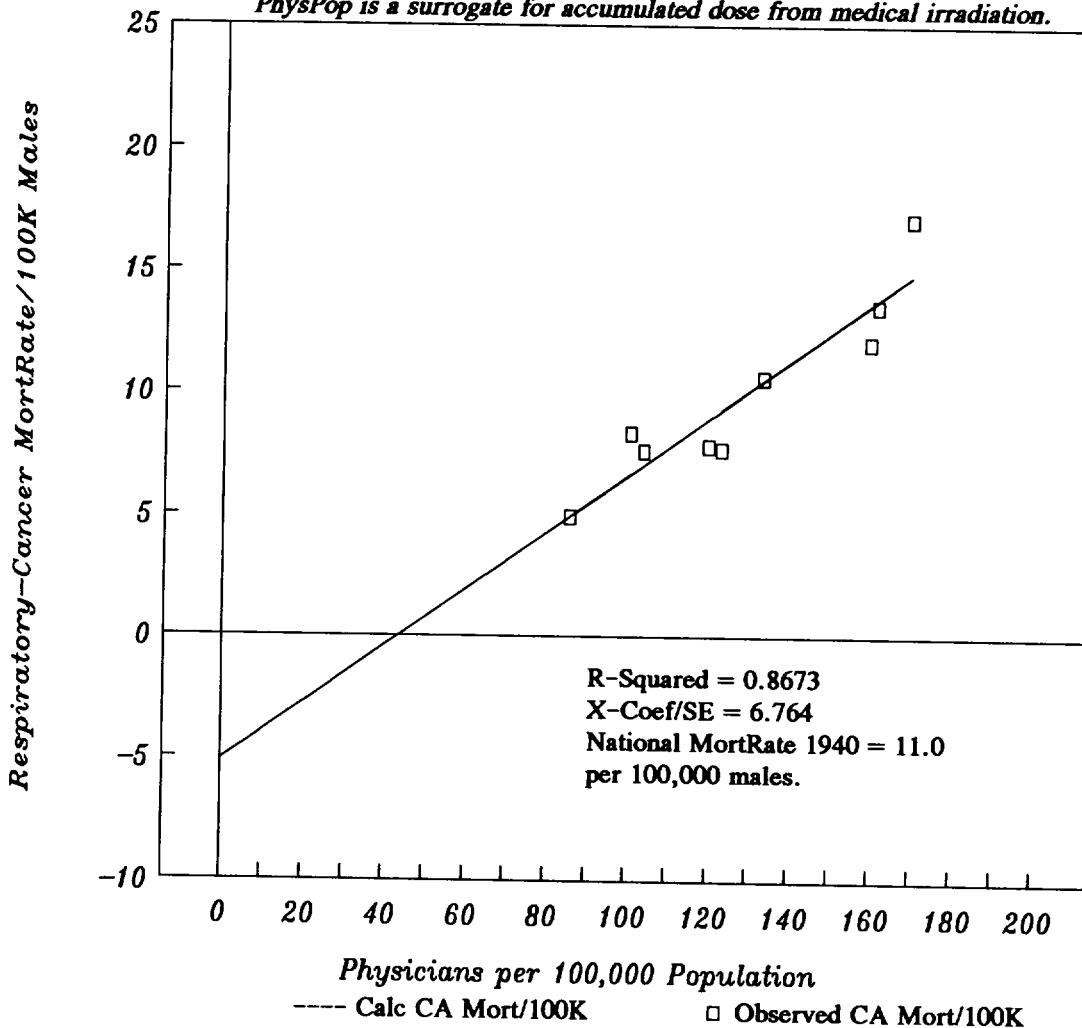The Nat'l Male MortRate is also (X-Coef * Nat'l PhysPop) + Constant =   10.34
Comparison: The Nat'l Male MortRate, 1940, in Table 16-B =   11.00

(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	12.0	0.89
New England	0.0641	161.55	10.36	13.5	0.87
West No. Central	0.1027	123.14	12.65	7.7	0.79
Mid-Atlantic	0.2092	169.76	35.51	17.1	3.58
East No. Central	0.2022	133.36	26.97	10.6	2.14
Mountain	0.0315	119.89	3.78	7.8	0.25
West So. Central	0.0992	103.94	10.31	7.6	0.75
East So. Central	0.0819	85.83	7.03	4.9	0.40
South Atlantic	0.1354	100.74	13.64	8.3	1.12
Sums	1.0000		132.04		10.79

1940 Respiratory 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.

R-Squared = 0.8673
X-Coef/SE = 6.764
National MortRate 1940 = 11.0
per 100,000 males.

Physicians per 100,000 Population

‒‒‒‒ Calc CA Mort/100K   □ Observed CA Mort/100K

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, Respiratory 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 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 of Respiratory Cancer Mortality-Rate (Male) by Medical Radiation: ~100 % *is far more likely than a low percent. See Text, Part 1.*

Table 16-A.
Respiratory-System Cancer MortRates 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 16-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	12.0	21.1	34.9	44.2	53.5	50.7
New England	13.5	23.6	38.1	47.7	57.3	56.3
West North Central	7.7	16.5	28.4	41.1	53.7	56.2
Mid-Atlantic	17.1	28.4	40.6	49.5	58.4	57.5
East North Central	10.6	21.8	35.7	48.6	61.4	62.3
Mountain	7.8	16.7	25.5	34.6	43.6	44.2
West South Central	7.6	19.0	34.9	48.9	62.8	67.9
East South Central	4.9	14.7	29.0	49.9	70.8	79.1
South Atlantic	8.3	19.8	35.7	50.5	65.2	68.5
Average, ALL	9.9	20.2	33.6	46.1	58.5	60.3
Average, High-5	12.2	22.3	35.5	46.2	56.9	56.6
Average, Low-4	7.2	17.6	31.3	45.9	60.6	64.9
Ratio, Hi5/Lo4	1.70	1.27	1.14	1.01	0.94	0.87

Table 16-B.
Respiratory-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	7.2	11.0	3.3
1950	13.0	21.6	4.6
1960	19.5	35.2	5.3
1970	28.4	47.3	11.7
1979-81	36.1	59.4	18.0
1987-89	--	59.7	24.5

● - 1940, 1950, 1960: All rates come from Grove 1968, Table 67, p.686, "Malignant neoplasm of respiratory system, not specified as secondary (160-164)," ICD/7.

● - 1970: All rates by Divisions are interpolations (Chap. 4, Parts 2b, 2c), except that the 1970 National "Both Sexes" rate comes from PHS 1995, Table 30, p.110.

● - 1980: All rates (ICD/9, 160-165) come from the reference NatCtrHS 1980.

● - 1990: All rates for 1987-1989 come from Monthly Vital Statistics Vol.41, No.7, December 1992. The 1988 rates are an acceptable approximation for 1990 (Chap.4, Part 2b.)