

CHAPTER 15

Buccal-Cavity & Pharynx Cancers, Males: Relation with Medical Radiation

● Part 1. Introduction

Buccal-Cavity and Pharynx Cancers include cancers of the lip, tongue, unspecified parts of the buccal cavity, and the pharynx (see Chapter 4, Part 5, Number 5). The MortRates in Table 15-A clearly present a "small numbers problem." The problem is so severe for the females --- as indicated by their lower national MortRate in Table 15-B --- that we did not analyse the female data.

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

● - Part 2a.	1921 PhysPop	1940 MortRate	Buccal + Pharynx Ca, Males Regression Output:
Pacific	165.11	5.3	Constant -0.3152
New England	142.24	6.4	Std Err of Y Est 1.2889
West North Central	140.93	4.6	R Squared 0.1884
Mid-Atlantic	137.29	6.9	No. of Observations 9
East North Central	136.06	4.8	Degrees of Freedom 7
Mountain	135.38	2.8	
West South Central	125.15	4.0	X Coefficient(s) 0.0373
East South Central	119.76	3.3	Std Err of Coef. 0.0293
South Atlantic	110.32	4.3	Coefficient / S.E. 1.2746

● - Part 2b.	1923 PhysPop	1940 MortRate	Buccal + Pharynx Ca, Males Regression Output:
Pacific	163.06	5.3	Constant -0.6198
New England	137.39	6.4	Std Err of Y Est 1.2327
West North Central	138.31	4.6	R Squared 0.2577
Mid-Atlantic	138.92	6.9	No. of Observations 9
East North Central	131.82	4.8	Degrees of Freedom 7
Mountain	130.51	2.8	
West South Central	119.16	4.0	X Coefficient(s) 0.0407
East South Central	113.16	3.3	Std Err of Coef. 0.0261
South Atlantic	106.79	4.3	Coefficient / S.E. 1.5589

● - Part 2c.	1925 PhysPop	1940 MortRate	Buccal + Pharynx Ca, Males Regression Output:
Pacific	161.67	5.3	Constant -0.7436
New England	138.31	6.4	Std Err of Y Est 1.1670
West North Central	133.92	4.6	R Squared 0.3346
Mid-Atlantic	134.36	6.9	No. of Observations 9
East North Central	127.54	4.8	Degrees of Freedom 7
Mountain	122.30	2.8	
West South Central	112.83	4.0	X Coefficient(s) 0.0430
East South Central	107.22	3.3	Std Err of Coef. 0.0229
South Atlantic	103.61	4.3	Coefficient / S.E. 1.8763

● - Part 2d.	1927 PhysPop	1940 MortRate	Buccal + Pharynx Ca, Males Regression Output:
Pacific	157.83	5.3	Constant -1.2380
New England	137.50	6.4	Std Err of Y Est 1.0624
West North Central	131.54	4.6	R Squared 0.4486
Mid-Atlantic	138.40	6.9	No. of Observations 9
East North Central	126.18	4.8	Degrees of Freedom 7
Mountain	118.75	2.8	
West South Central	108.25	4.0	X Coefficient(s) 0.0477
East South Central	102.07	3.3	Std Err of Coef. 0.0200
South Atlantic	102.13	4.3	Coefficient / S.E. 2.3862

● - Part 2e.	1929	1940	Buccal + Pharynx Ca, Males
	PhysPop	MortRate	Regression Output:
Pacific	156.64	5.3	Constant
New England	138.46	6.4	Std Err of Y Est
West North Central	128.72	4.6	R Squared
Mid-Atlantic	138.49	6.9	No. of Observations
East North Central	126.51	4.8	Degrees of Freedom
Mountain	118.68	2.8	
West South Central	105.60	4.0	X Coefficient(s)
East South Central	99.41	3.3	Std Err of Coef.
South Atlantic	100.86	4.3	Coefficient / S.E.
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● - Part 2f.	1931	1940	Buccal + Pharynx Ca, Males
	PhysPop	MortRate	Regression Output:
Pacific	159.97	5.3	Constant
New England	142.35	6.4	Std Err of Y Est
West North Central	126.50	4.6	R Squared
Mid-Atlantic	140.82	6.9	No. of Observations
East North Central	128.59	4.8	Degrees of Freedom
Mountain	118.89	2.8	
West South Central	105.95	4.0	X Coefficient(s)
East South Central	96.73	3.3	Std Err of Coef.
South Atlantic	99.59	4.3	Coefficient / S.E.
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● - Part 2g.	1934	1940	Buccal + Pharynx Ca, Males
	PhysPop	MortRate	Regression Output:
Pacific	160.09	5.3	Constant
New England	148.60	6.4	Std Err of Y Est
West North Central	125.96	4.6	R Squared
Mid-Atlantic	149.62	6.9	No. of Observations
East North Central	129.36	4.8	Degrees of Freedom
Mountain	117.16	2.8	
West South Central	104.68	4.0	X Coefficient(s)
East South Central	92.00	3.3	Std Err of Coef.
South Atlantic	98.41	4.3	Coefficient / S.E.
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● - Part 2h.	1936	1940	Buccal + Pharynx Ca, Males
	PhysPop	MortRate	Regression Output:
Pacific	158.44	5.3	Constant
New England	150.18	6.4	Std Err of Y Est
West North Central	126.14	4.6	R Squared
Mid-Atlantic	155.05	6.9	No. of Observations
East North Central	130.42	4.8	Degrees of Freedom
Mountain	119.80	2.8	
West South Central	103.52	4.0	X Coefficient(s)
East South Central	89.94	3.3	Std Err of Coef.
South Atlantic	99.16	4.3	Coefficient / S.E.
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● - Part 2i.	1938	1940	Buccal + Pharynx Ca, Males
	PhysPop	MortRate	Regression Output:
Pacific	157.62	5.3	Constant
New England	154.08	6.4	Std Err of Y Est
West North Central	124.95	4.6	R Squared
Mid-Atlantic	160.69	6.9	No. of Observations
East North Central	131.98	4.8	Degrees of Freedom
Mountain	119.88	2.8	
West South Central	102.79	4.0	X Coefficient(s)
East South Central	88.21	3.3	Std Err of Coef.
South Atlantic	99.26	4.3	Coefficient / S.E.
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● - Part 2j.	1940	1940	Buccal + Pharynx Ca, Males
	PhysPop	MortRate	Regression Output:
Pacific	159.72	5.3	Constant
New England	161.55	6.4	Std Err of Y Est
West North Central	123.14	4.6	R Squared
Mid-Atlantic	169.76	6.9	No. of Observations
East North Central	133.36	4.8	Degrees of Freedom

Mountain	119.89	2.8		
West South Central	103.94	4.0		
East South Central	85.83	3.3	X Coefficient(s)	0.0382
South Atlantic	100.74	4.3	Std Err of Coef.	0.0089
			Coefficient / S.E.	4.2782

**Box 1 of Chap. 15****Summary: Regression Outputs, Buccal Cav. & Pharynx 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	0.1884	-0.32	0.0373	0.0293	1.2746
2b	1923	0.2577	-0.62	0.0407	0.0261	1.5589
2c	1925	0.3346	-0.74	0.0430	0.0229	1.8763
2d	1927	0.4486	-1.24	0.0477	0.0200	2.3862
2e	1929	0.4695	-1.13	0.0472	0.0190	2.4891
2f	1931	0.4935	-0.78	0.0441	0.0169	2.6115
2g	1934	0.6056	-0.67	0.0430	0.0131	3.2784
2h	1936	0.6290	-0.60	0.0422	0.0122	3.4453
2i	1938	0.6718	-0.47	0.0409	0.0108	3.7853
2j --->	1940 Max	0.7234	-0.21	0.0382	0.0089	4.2782

**Box 2 of Chap. 15****Input-Data for Figure 15-A. Buccal Cav. & Pharynx Cancers, Males.**

Part 2j, Best-Fit Equation: Calc. MortRate = (0.0382 \* PhysPop) + (-0.21)

Census Divisions	1940 Observed PhysPops	1940 Observed MortRates	Best-Fit Calc. MortRates
Pacific	159.72	5.3	5.891
New England	161.55	6.4	5.961
West No. Central	123.14	4.6	4.494
Mid-Atlantic	169.76	6.9	6.275
East No. Central	133.36	4.8	4.884
Mountain	119.89	2.8	4.370
West So. Central	103.94	4.0	3.761
East So. Central	85.83	3.3	3.069
South Atlantic	100.74	4.3	3.638
Additional PhysPops	70.00		2.464
--- not "observed" ---	60.00		2.082
down to zero PhysPop	50.00		1.700
(zero medical radiation).	40.00		1.318
For each, we calculate	30.00		0.936
a best-fit MortRate.	20.00		0.554
These additional x,y pairs	10.00		0.172
are also part of the	0		-0.210
best-fit line (Chap 5, Part 5e).			

**Box 3 of Chap. 15**  
**Presumptive Fraction of Cancer MortRate Attributable to Medical Radiation.**

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

Buccal-Cavity + Pharynx Cancers. MALES.

● MALE National MortRate (MR) 1940, from Table 15-B	5.1 National MortRate
● Constant, from regression, Part 2j	-0.2081 Constant
● Fractional Causation, Best Est. = (Natl MR - Constant) / Natl MR	104.1% # 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	0.0382 X-Coef., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2j	0.0089 Standard Error
Upper 90% C.L. on X-Coef. = (Coef) + (1.645 * SE) =	0.0528 New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1940 Natl PhysPop) =	-1.8771 New Constant
Frac. Causation, High-Limit = (Natl MR - New Constant) / Natl MR =	136.8% # 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) =	0.0236 New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1940 Natl PhysPop) =	1.9892 New Constant
Frac. Causation, Low-Limit = (Natl MR - New Constant) / Natl MR =	61.0% New Frac. Caus'n.

**Box 4 of Chap. 15**  
**Error-Check on Our Own Work: Buccal-Cav. & Pharynx Cancers, Males.**

Please see text in Chapter 6, Part 5.

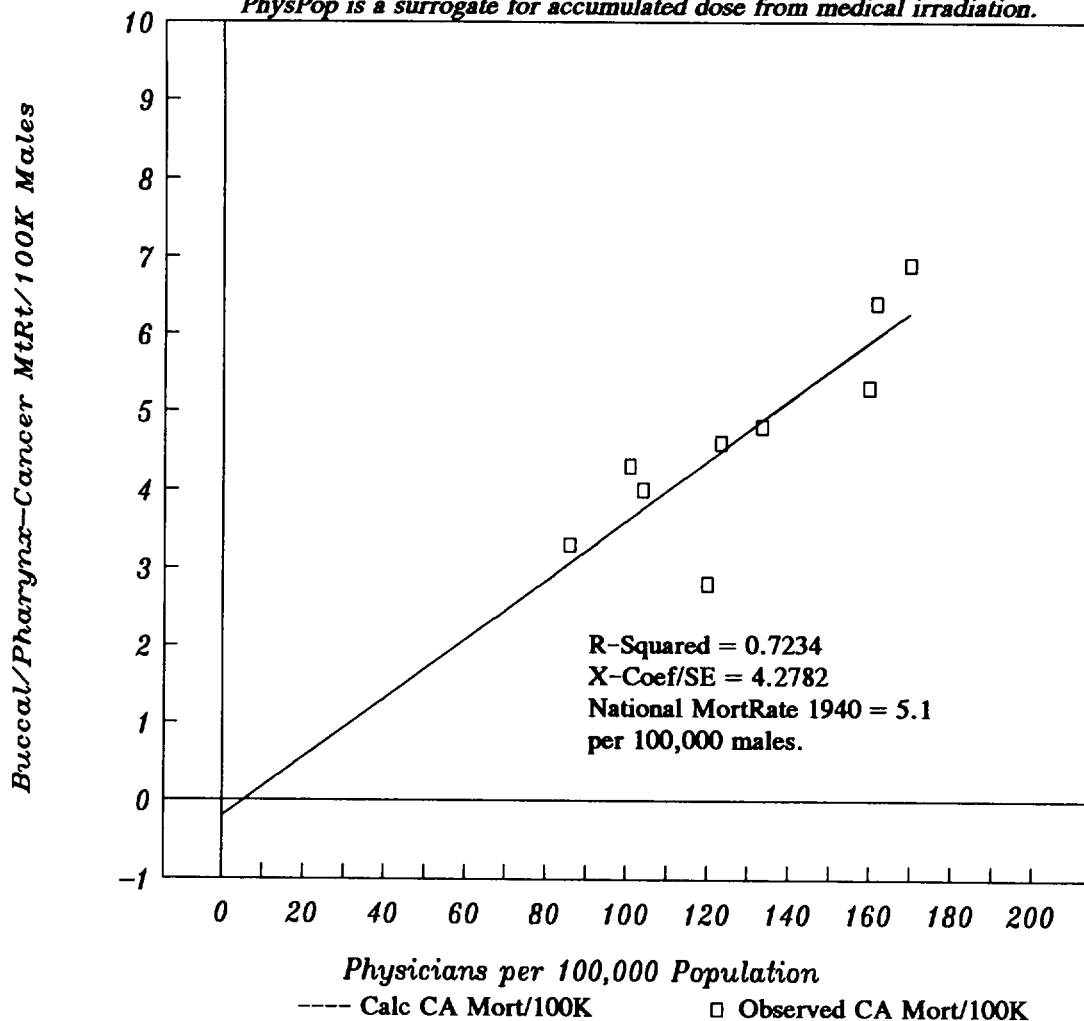
Below, Columns A, C, and E come directly from the regression input in Part 2j. Column B, the fraction of the whole 1940 population in each Census Division, comes from Table 3-B in Chapter 3. Each Column-D entry is the product of (B-entry times C-entry). Each Column-F entry is the product of (B-entry 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 =	5.03
The Nat'l Male MortRate is also (X-Coef * Nat'l PhysPop) + Constant =	4.84
Comparison: The Nat'l Male MortRate, 1940, in Table 15-B =	5.10

(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	5.3	0.39
New England	0.0641	161.55	10.36	6.4	0.41
West No. Central	0.1027	123.14	12.65	4.6	0.47
Mid-Atlantic	0.2092	169.76	35.51	6.9	1.44
East No. Central	0.2022	133.36	26.97	4.8	0.97
Mountain	0.0315	119.89	3.78	2.8	0.09
West So. Central	0.0992	103.94	10.31	4.0	0.40
East So. Central	0.0819	85.83	7.03	3.3	0.27
South Atlantic	0.1354	100.74	13.64	4.3	0.58
Sums	1.0000		132.04		5.03

**1940 Buccal/Pharynx 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, Buccal/Pharynx 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 is (Natl MortRate minus the Y-intercept) / (Natl MortRate).

**Fractional Causation of Buccal/Pharynx Cancer Mortality-Rate in Males  
by Medical Radiation = ~100 % from Best Estimate (Box 3).  
61 % at Lower 90% Conf. Limit (Box 3). ~100 % at Upper 90 % Conf. Limit (Box 3).**

**Table 15-A.**  
***Buccal-Cav. & Pharynx 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 15-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	5.3	4.7	4.6	4.4	4.2	--
New England	6.4	6.5	6.6	6.2	5.7	--
West North Central	4.6	4.5	4.0	3.8	3.5	--
Mid-Atlantic	6.9	5.9	5.4	5.3	5.1	--
East North Central	4.8	4.9	4.9	4.8	4.6	--
Mountain	2.8	3.2	2.6	2.8	2.9	--
West South Central	4.0	4.3	3.9	4.1	4.2	--
East South Central	3.3	4.2	4.2	4.3	4.4	--
South Atlantic	4.3	4.7	4.5	4.8	5.0	--
Average, ALL	4.7	4.8	4.5	4.5	4.4	--
Average, High-5	5.6	5.3	5.1	4.9	4.6	--
Average, Low-4	3.6	4.1	3.8	4.0	4.1	--
Ratio, Hi5/Lo4	1.56	1.29	1.34	1.23	1.12	--

**Table 15-B.**  
***Buccal-Cavity & Pharynx 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	3.1	5.1	1.1
1950	3.0	5.0	1.2
1960	3.0	4.7	1.3
1970	--	4.65	1.4
1979-81	2.9	4.6	1.5
1989-91	--	--	--

- - 1940, 1950, 1960: All rates come from Grove 1968, Table 67, p.679, "Malignant neoplasm of buccal cavity and pharynx (140-148)," ICD/7.
- - 1970: All rates are interpolations (Chap. 4, Parts 2b, 2c).
- - 1980: All rates (ICD/9, 140-149) come from the reference NatCtrHS 1980.
- - 1990: No data obtained. Please see Chap. 4, Part 2c.