CHAPTER 41

IHD in Females: The Dose-Response between Medical Radiation and IHD

• Part 1. Introduction: IHD in Females

This chapter follows the model of Chapter 40, but eliminates the text.

• Part 2. How the Dose-Response Behaves, for Medical Radiation and IHD in Females

	x	y	
• - Part 2a.	1921	1950	IHD, Females
	PhysPop	MortRate	Regression Output:
Pacific	165.11	125.0	Constant 5.8843
New England	142.24	153.2	Std Err of Y Est 27.2707
West North Central	140.93	104.1	R Squared 0.2026
Mid-Atlantic	137.29	169.4	No. of Observations 9
East North Central	136.06	124.2	Degrees of Freedom 7
Mountain	135.38	96.2	
West South Central	125.15	94.0	X Coefficient(s) 0.8259
East South Central	119.76	84.7	Std Err of Coef. 0.6194
South Atlantic	110.32	103.4	Coefficient / S.E. 1.3334
• - Part 2b.	1923	1950	IHD, Females
	PhysPop	MortRate	Regression Output:
Pacific	163.06	125.0	Constant -0.4910
New England	137.39	153.2	Std Err of Y Est 25.9957
West North Central	138.31	104.1	R Squared 0.2754
Mid-Atlantic	138.92	169.4	No. of Observations 9
East North Central	131.82	124.2	Degrees of Freedom 7
Mountain	130.51	96.2	
West South Central	119.16	94.0	X Coefficient(s) 0.8978
East South Central	113.16	84.7	Std Err of Coef. 0.5504
South Atlantic	106.79	103.4	Coefficient / S.E. 1.6310
• - Part 2c.	1925	1950	IHD, Females
	PhysPop	MortRate	Regression Output:
Pacific	161.67	125.0	Constant 1.2851
New England	138.31	153.2	Std Err of Y Est 24.9726
West North Central	133.92	104.1	R Squared 0.3313
Mid-Atlantic	134.36	169.4	No. of Observations 9
East North Central	127.54	124.2	Degrees of Freedom 7
Mountain	122.30	96.2	
West South Central	112.83	94.0	X Coefficient(s) 0.9132
East South Central	107.22	84.7	Std Err of Coef. 0.4904
South Atlantic	103.61	103.4	Coefficient / S.E. 1.8623
• - Part 2d.	1927	1950	IHD, Females
	PhysPop	MortRate	Regression Output:
Pacific	157.83	125.0	Constant -11.2627
New England	137.50	153.2	Std Err of Y Est 22.4700
West North Central	131.54	104.1	R Squared 0.4586
Mid-Atlantic	138.40	169.4	No. of Observations 9
East North Central	126.18	124.2	Degrees of Freedom 7
Mountain	118.75	96.2	
West South Central	108.25	94.0	X Coefficient(s) 1.0293
East South Central	102.07	84.7	Std Err of Coef. 0.4227
South Atlantic	102.13	103.4	Coefficient / S.E. 2.4351
• - Part 2e.	1929	1950	IHD, Females
	PhysPop	MortRate	Regression Output:
Pacific	156.64	125.0	Constant -11.6926
New England	138.46	153.2	Std Err of Y Est 21.5596
West North Central	128.72	104.1	R Squared 0.5016

Mid-Atlantic	138.49	169.4	No. of Observations	9
East North Central	126.51	124.2	Degrees of Freedom	7
Mountain	118.68	96.2		
West South Central	105.60	94.0	X Coefficient(s)	1.0414
East South Central	99.41	84.7	Std Err of Coef.	0.3924
South Atlantic	100.86	103.4	Coefficient / S.E.	2.6542

● - Part 2f.	1931	1950	IHD, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	159.97	125.0	Constant	-5.0973
New England	142.35	153.2	Std Err of Y Est	20.7787
West North Central	126.50	104.1	R Squared	0.5370
Mid-Atlantic	140.82	169.4	No. of Observations	9
East North Central	128.59	124.2	Degrees of Freedom	7
Mountain	118.89	96.2		
West South Central	105.95	94.0	X Coefficient(s)	0.9827
East South Central	96.73	84.7	Std Err of Coef.	0.3449
South Atlantic	99.59	103.4	Coefficient / S.E.	2.8496

● - Part 2g.	1934	1950	IHD, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	160.09	125.0	Constant	-3.0909
New England	148.60	153.2	Std Err of Y Est	17.7357
West North Central	125.96	104.1	R Squared	0.6627
Mid-Atlantic	149.62	169.4	No. of Observations	9
East North Central	129.36	124.2	Degrees of Freedom	7
Mountain	117.16	96.2		
West South Central	104.68	94.0	X Coefficient(s)	0.9610
East South Central	92.00	84.7	Std Err of Coef.	0.2591
South Atlantic	98.41	103.4	Coefficient / S.E.	3.7086

● - Part 2h.	1936	1950	IHD, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	158.44	125.0	Constant	-3.7018
New England	150.18	153.2	Std Err of Y Est	16.2958
West North Central	126.14	104.1	R Squared	0.7153
Mid-Atlantic	155.05	169.4	No. of Observations	9
East North Central	130.42	124.2	Degrees of Freedom	7
Mountain	119.80	96.2		
West South Central	103.52	94.0	X Coefficient(s)	0.9602
East South Central	89.94	84.7	Std Err of Coef.	0.2290
South Atlantic	99.16	103.4	Coefficient / S.E.	4.1932

● - Part 2i.	1938	1950	IHD, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	157.62	125.0	Constant	-1.6209
New England	154.08	153.2	Std Err of Y Est	14.5088
West North Central	124.95	104.1	R Squared	0.7743
Mid-Atlantic	160.69	169.4	No. of Observations	9
East North Central	131.98	124.2	Degrees of Freedom	7
Mountain	119.88	96.2		
West South Central	102.79	94.0	X Coefficient(s)	0.9380
East South Central	88.21	84.7	Std Err of Coef.	0.1914
South Atlantic	99.26	103.4	Coefficient / S.E.	4.9002

● - Part 2j.	1940	1950	IHD, Females	
	PhysPop	MortRate	Regression Output:	
Pacific	159.72	125.0	Constant	4.4119
New England	161.55	153.2	Std Err of Y Est	12.4544
West North Central	123.14	104.1	R Squared	0.8337
Mid-Atlantic	169.76	169.4	No. of Observations	9
East North Central	133.36	124.2	Degrees of Freedom	7
Mountain	119.89	96.2		
West South Central	103.94	94.0	X Coefficient(s)	0.8761
East South Central	85.83	84.7	Std Err of Coef.	0.1479
South Atlantic	100.74	103.4	Coefficient / S.E.	5.9234

• - Part 2k.	1950 PhysPop	1950 MortRate
Pacific	148.60	125.0
New England	162.51	153.2
West North Central	120.06	104.1
Mid-Atlantic	168.71	169.4
East North Central	123.69	124.2
Mountain	119.38	96.2
West South Central	101.34	94.0
East South Central	83.05	84.7
South Atlantic	99.07	103.4

IHD, Females

Regression Output:

Constant	3.9806
Std Err of Y Est	11.1400
R Squared	0.8669
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.9041
Std Err of Coef.	0.1339
Coefficient / S.E.	6.7531

Box 1 of Chap. 41

Summary: Regression Outputs, Female IHD MortRates Regressed on PhysPop.

We are searching for the maximum correlation between PhysPops of 1921-1950 and the female Ischemic Heart Disease MortRates of 1950. Even the maximum correlation 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	0.2026	5.88	0.8259	0.6194	1.3334
2b	1923	0.2754	-0.49	0.8978	0.5504	1.6310
2c	1925	0.3313	1.29	0.9132	0.4904	1.8623
2d	1927	0.4586	-11.26	1.0293	0.4227	2.4351
2e	1929	0.5016	-11.69	1.0414	0.3924	2.6542
2f	1931	0.5370	-5.10	0.9827	0.3449	2.8496
2g	1934	0.6627	-3.09	0.9610	0.2591	3.7086
2h	1936	0.7153	-3.07	0.9602	0.2290	4.1932
2i	1938	0.7743	-1.62	0.9380	0.1914	4.9002
2j	1940	0.8337	4.41	0.8761	0.1479	5.9234
2k --->	1950 Max	0.8669	3.98	0.9041	0.1339	6.7531

Box 2 of Chap. 41

Input-Data for Figure 41-A. Ischemic Heart Disease. Females.

Part 2k, Best-Fit Equation: Calc. MortRate = (0.9041 * PhysPop) + (3.981)

Census Divisions	1950 Observed PhysPops	1950 Observed MortRates	Best-Fit Calc. MortRates
Pacific	148.60	125.0	138.330
New England	162.51	153.2	150.906
West No. Central	120.06	104.1	112.527
Mid-Atlantic	168.71	169.4	156.512
East No. Central	123.69	124.2	115.809
Mountain	119.38	96.2	111.912
West So. Central	101.34	94.0	95.602
East So. Central	83.05	84.7	79.067
South Atlantic	99.07	103.4	93.550
Additional PhysPops	70.00		67.268
--- not "observed" ---	60.00		58.227
down to zero PhysPop	50.00		49.186
(zero medical radiation).	40.00		40.145
For each, we calculate	30.00		31.104
a best-fit MortRate.	20.00		22.063
These additional x,y pairs	10.00		13.022
are also part of the	0		3.981
best-fit line (Chap 5, Part 5e).			

Box 3 of Chap. 41

Percent of IHD MortRate Attributable to Medical Radiation.

Please see text in Chapter 40, Parts 4 and 5.

IHD. FEMALES. * denotes multiplication.

• FEMALE National MortRate (MR) 1950, from Table 41-B	126.5	National MortRate
• Constant, from regression, Part 2k	3.9806	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, Parts 4b-d, please.

X-Coefficient, from Part 2k	0.9041	X-Coef., Best Est.
Standard Error (SE) of X-Coefficient, from Part 2j	0.1339	Standard Error
Upper 90% C.L. on X-Coef. = (Coef) + (1.645 * SE) =	1.1244	New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1950 Natl PhysPop) =	-17.7673	New Constant
Frac. Caus'n, High-Limit = (Natl MR - New Constant) / Natl MR =	114.0%	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) =	0.6838	New X-Coefficient
New Constant = (Natl MR) - (New X-Coef * 1950 Natl PhysPop) =	38.7572	New Constant
Frac. Caus'n, Low-Limit = (Natl MR - New Constant) / Natl MR =	69.4%	New Frac. Caus'n.

Box 4 of Chap. 41

Error-Check on Our Own Work: Ischemic Heart Disease, Females.

Please see text in Chapter 6, Part 5.

Below, Columns A, C, and E come directly from the regression input in Part 2k. Column B, the fraction of the whole 1950 population in each Census Division, comes from Table 3-B in Chapter 3. Each Column-D entry = (B * C). Each Column-F entry = (B * E). MortRates are each "per 100,000."

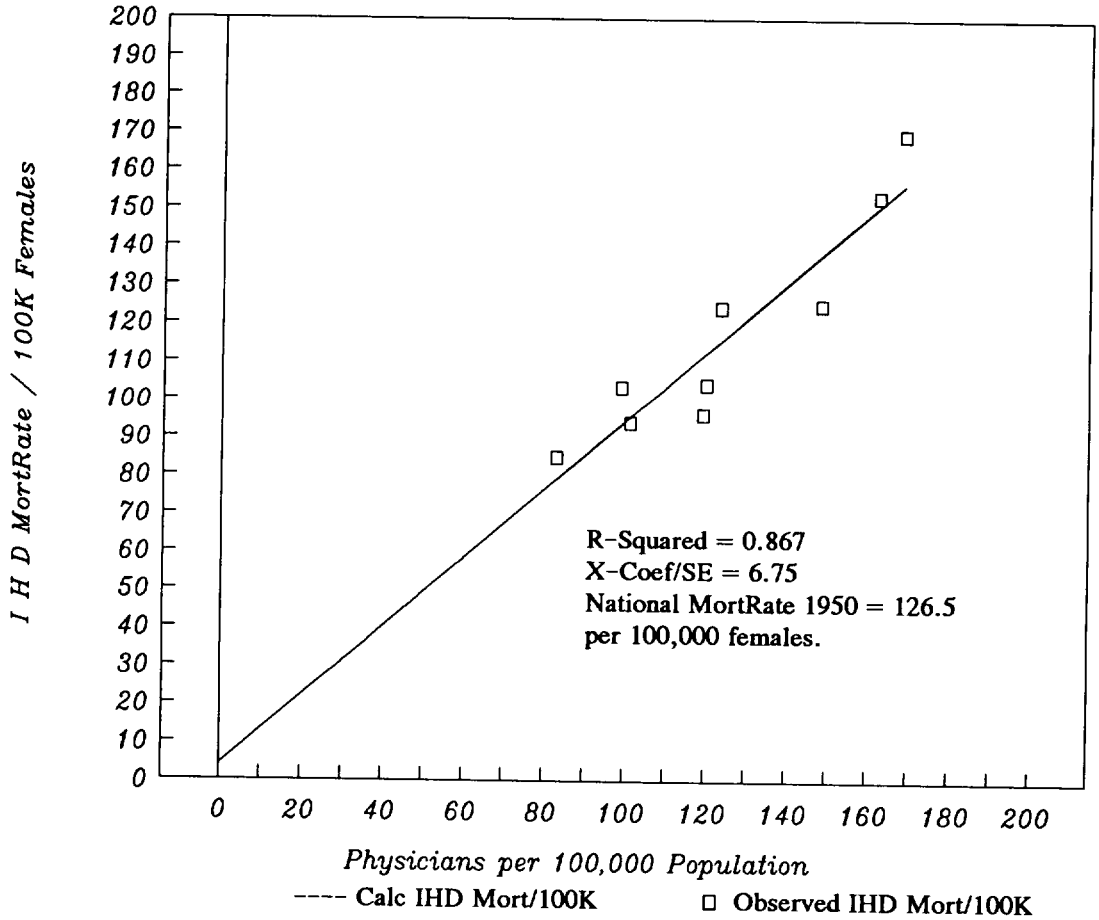
The Weighted-Avg. Nat'l PhysPop, 1950, is the sum of Column-D entries =	128.31
Weighted-Avg. Nat'l Female MortRate, 1950, is sum of Col.F entries =	123.46
Nat'l Female MortRate is also (X-Coef * 1950 Nat'l PhysPop) + Constant =	119.99
Comparison: The Nat'l Female MortRate, 1950, in Table 41-B =	126.50

(A) Census Division	(B) 1950 Pop'n Fraction	(C) PhysPop 1950	(D) 1950 Weighted PhysPop	(E) MortRate 1950	(F) Weighted MortRate
Pacific	0.0961	148.60	14.28	125.0	12.01
New England	0.0618	162.51	10.04	153.2	9.47
West No. Central	0.0933	120.06	11.20	104.1	9.71
Mid-Atlantic	0.2002	168.71	33.78	169.4	33.91
East No. Central	0.2017	123.69	24.95	124.2	25.05
Mountain	0.0337	119.38	4.02	96.2	3.24
West So. Central	0.0965	101.34	9.78	94.0	9.07
East So. Central	0.0762	83.05	6.33	84.7	6.45
South Atlantic	0.1406	99.07	13.93	103.4	14.54
Sums	1.0001		128.31		123.46

1950 Ischemic Heart Disease Mortality-Rates versus 1950 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 1950. 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, Ischemic Heart Disease Mortality-Rate per 100,000 females = the reported rates in USA Vital Statistics for the Nine Census Divisions, Year 1950.

Shown above is the strongest relationship between these two variables (Part 2k). 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 Ischemic Heart Disease Mortality-Rate (Females) by Medical Radiation = 97 % from Best Estimate (Box 3).

69 % at lower 90 % Conf. Limit (Box 3). ~100 % at Upper 90 % Conf. Limit (Box 3).

Table 41-A.

Ischemic Heart Disease: Female Mortality Rates by Census Divisions

Rates are annual deaths per 100,000 female population, USA, age-adjusted to the 1940 reference year. No exclusions by color or "race." The MortRate for each Census Division is population-weighted, whereas the averages in Table 41-A are not. Chapter 4 defines "High-5" and "Low-4." Sources: See Table 41-B.

Census Division	1940	1950	1960	1970	1980	1993
Pacific	--	125.0	133.4	107.4	81.4	57.7
New England	--	153.2	176.3	138.0	99.6	55.7
West North Central	--	104.1	135.8	111.0	86.1	58.3
Mid-Atlantic	--	169.4	189.7	154.9	120.1	78.8
East North Central	--	124.2	162.2	134.5	106.8	70.2
Mountain	--	96.2	118.9	96.6	74.2	46.3
West South Central	--	94.0	123.9	105.5	87.1	66.5
East South Central	--	84.7	126.2	110.7	95.2	67.7
South Atlantic	--	103.4	132.4	111.6	90.8	61.6
Average, ALL	--	117.1	144.3	118.9	93.5	62.5
Average, High-5	--	135.2	159.5	129.1	98.8	64.1
Average, Low-4	--	94.6	125.4	106.1	86.8	60.5
Ratio, Hi5/Lo4	--	1.43	1.27	1.22	1.14	1.06

Table 41-B.

Ischemic Heart Disease: National Mortality Rates, USA.

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	--	--	--
1950	190.0	256.4	126.5
1960	225.5 #	306.5	152.5
1970	186.8	259.7	124.9
1979-81	148.1	212.8	97.2
1992-94	94.9	131.0	64.7

The peak rate occurred in 1963 (AHA 1995).

• - 1950, 1960: All rates are from Grove 1968, Table 67, Pages 720-722, "Arteriosclerotic Heart Disease, including coronary disease (420)" ICD/7.

• - 1970: Rates are interpolations between 1960 and 1980 (Chap. 4, Parts 2b, 2c).

• - 1980: All rates (ICD/9, 410-414) come from the reference NatCtrHS 1980.

• - 1990: The 1993 rates (ICD/9, 410-414.9) come from the reference NatCtrHS 1993; please see Chap.4, Part 2b. Exception: The 1993 Rate for both sexes (combined) comes from AHA 1996, p.8.