CHAPTER 23

All Causes of Death Combined: Relation with Medical Radiation

• Part 1. The Purpose of Section Three of This Book

Now we begin Section Three of our inquiry. Our purpose is to learn whether or not the extremely strong positive correlation, observed between 1940 PhyPops and 1940 cancer mortality-rates, also occurred (a) for Non-Malignancies as a group, and (b) for specific types of Non-Malignancies. This inquiry was undertaken as an independent check on the concept set forth in Chapter 3: That we could explore the relationship, between the average per capita accumulated dose of medical radiaton and cancer MortRates, by studying the relationship between PHYSPOP and cancer MortRates.

1a. The Logic: Expectation of a Contrast

Our reasoning begins with the current "general wisdom": The only proven cause of DEATH, inducible by ionizing radiation in irradiated people, is fatal cancer. The established exception is prompt noncancer death in a person who has received an extremely high dose of ionizing radiation all at once (acute exposure) to most or all of the body. The prompt deaths in 1945, among many persons who briefly survived the Hiroshima-Nagasaki bombings, and the prompt deaths in 1986 among some of the firemen who tried to extinguish the fire at the Chernobyl nuclear reactor, are examples. High, acute, whole-body doses are not part of medical practice, without bone-marrow transplantation. One additional exception would be death due to unrecognized and therefore untreated radiation-induced myxedema (severe hypo-thyroidism), resulting in coma and death.

The "general wisdom" above has the following implication, for our study of the role of medical radiation in cancer MortRates:

We would expect the PhysPop-Cancer relationship to DIFFER from the PhysPop-NonCancer relationship, if PhysPop is approximately proportional to accumulated dose from medical radiation. If PhysPop FAILS to produce strong positive correlations with noncancer causes of death, while PhysPop DOES produce strong positive correlations with cancer MortRates, the contrast will be a powerful, independent, confirmatory piece of evidence that the dose-response, between PhysPop and cancer MortRates, is a dose-response between medical radiation and cancer MortRates.

1b. Overview of the Results

Results? During the first four decades after ionizing radiation was introduced into medicine, nearly all Non-Malignancies behaved VERY DIFFERENTLY from Malignancies, with respect to PhysPop --- as already indicated in Chapter 4, Part 1. The numerous chapters in Section Three provide the data which support our earlier statement. For everyone's convenience, the results are tabulated for comparison in Chapter 38, Box 1.

1c. An Important Exception: Ischemic Heart Disease

The big exception to our finding about Non-Malignancies is Ischemic Heart Disease (IHD). We discovered that it behaves VERY SIMILARLY to the Malignancies, with respect to PhysPop. This startling result is not a marginal finding --- it is statistically very strong. It led us to propose

Hypothesis-2: "Medical radiation, received even at very low and moderate doses , is an important cause of Ischemic Heart Disease..."

The data for Ischemic Heart Disease are provided, analyzed, and discussed in their own sections of this book: Section Four.

• Part 2. Parallel Analyses for Malignancies and Non-Malignancies

In Chapters 23 through 37, we have done exactly the same linear regressions of MortRates upon PhysPops as we did for cancers in Chapters 6 through 21. The very same PhysPop values are used from the Universal PhysPop Table 3-A. And the MortRates in Chapters 23 through 37 come from the same sources described in Chapter 4. In short, the results in Section Three can be validly compared with the results in Section Two.

The two sets of chapters look different, however. For Non-Malignancies, we do not show each regression analysis separately. By now, readers must be saturated with the format. We present the regression OUTPUT in Box 1 of each chapter. The INPUT-data are provided by the MortRate table at the end of each chapter, and by the Universal PhysPop Table 3-A, which means that we present all the data which readers need if they wish to verify the work independently. In addition, Box 1 extends the analyses for Non-Malignancies beyond 1940 --- which we will do in Section Five for the Malignancies and Ischemic Heart Disease.

2a. The Tables of Mortality Rates

We begin here in Chapter 23 with All Causes of Death Combined (please see Table 23-A, at the end of this chapter). In Chapter 24, we subtract All-Cancers, to obtain a good approximation for All Non-Malignancies.

In the MortRate tables of Section Three, as in Section Two, the MortRate entries for the Nine Census Divisions are population-weighted, whereas the averages below them are not. "High-5" continues to refer to the first five Census Divisions in the list (Pacific, New England, West North Central, Mid-Atlantic, East North Central). "Low-4" refers to the last four (Mountain, West South Central, East South Central, South Atlantic).

2b. Some Approximations in Table 23-A

Although it is convenient to label Table 23-A as "All Causes of Death Combined," in reality, it seems that not quite every cause of death is included. The MortRates available in Table 67 of Grove 1968, for the years 1940, 1950, and 1960 by Census Divisions, cover "32 Selected Causes of Death." These causes are listed with their ICD numbers (7th Revision) in our Chapter 4, Part 5. Nearly every cause of death is included: Major illnesses (cancer included), accidents, suicide, homicide, miscellaneous, and cause unknown.

By contrast with Grove's Table 67 (which consumes over 100 pages), Grove's Table 54 reports consolidated national "Age-Adjusted Death Rates" for those same years in just a single page (Grove p.317). Because Table 54 provides no information by Census Divisions or by states, it is useless for our studies.

Nonetheless, we mention Table 54 here because its consolidated national rates (total death-rates) for 1950 and 1960 show up in recent government publications such as "Health United States, 1995" (PHS 1995, Table 36, p.122) --- and neither the PHS entries nor their sources in Grove's Table 54 are identical with the consolidated national rates in Grove's Table 67, which we use in our Table 23-A. The disparity between Grove's Table 54 and Grove's Table 67, with respect to the TOTAL death-rates in 1940, 1950, and 1960, causes us to infer that the entries for "All Causes" in Grove's Table 67 are for the combination of All 32 Selected Causes, and not for absolutely every cause.

Fortunately, a "first approximation" of the TOTAL death rates is all that we need to execute the inquiry which we described above in Part 1a. For this purpose, our Table 23-A uses the "All Causes" entries from Grove's Table 67 for the years 1940, 1950, 1960. For the year 1980, our Table 23-A uses the "All Causes" entries from reference NatCtrHS 1980. In that document, the 1980 All-Cause

rates --- though labeled "All Causes" --- may be a first approximation which does not provide exact continuity for Grove's "All Causes." However, the nature of our Section Three does not demand a perfect match.

• Part 3. Regression-Outputs: The Remarkable X-Coefficients in Box 1

Box 1 presents the output from all the linear regressions. The first ten lines of each group (male, female) are the outputs from regressing the 1940 MortRates of Table 23-A upon the PhysPops of 1921-1940, in parallel with our analyses for cancer. The remaining lines in each group regress the 1950 MortRates upon the 1950 PhysPops, the 1960 MortRates upon the 1960 PhysPops, etc.

3a. Inverse Relationships: X-Coefficients with Negative Signs

In great contrast to the cancer chapters, there are no statistically significant values for R-squared or for the X-Coefficient/SE ratio, when the 1940 MortRates for All-Causes-Combined are regressed upon 1940 PhysPops.

However, in the FULL female set of regression output (Box 1), there are some statistically significant relationships, as indicated by X-Coef/SE ratios above $\sim$ 2.0.

And what else is remarkable? These significant relationships are INVERSE relationships between PhysPop and MortRates, as revealed by the negative sign on the X-Coefficient. The higher is the physician-density, the lower is the MortRate. Moreover, we should not ignore the statistically "non-significant" output when we are pondering positive versus negative correlations. In a "sign" test, the totality of information is to be considered. All ten correlations for the males, and all ten correlations for the females, produce X-Coefficients with a negative sign. The constancy of direction is itself a test of significance --- in this case, for an INVERSE relationship between All Causes of Death Combined, and PhysPop. And this occurs even though All-Causes-Combined includes cancer, which produces a consistently POSITIVE X-Coefficient.

The inverse correlations suggested in Box 1 are consistent with the finding in Table 23-A that the Hi5/Lo4 MortRate ratios are consistently below 1.0, whereas the Hi5/Lo4 PhysPop ratios in Table 3-A are consistently above 1.0.

The results in Box 1 are extremely different from the results for cancer alone. We remind readers that the cancer regressions (both statistically significant ones, and non-significant ones) produce only positive X-Coefficients in Chapters 6 through 21.

3b. The Graphs of 1940 MortRates Regressed on 1940 PhysPops

For our graphs, we pick the 1940-1940 combination of variables, so that these graphs can be compared with the graphs for cancer. The graphs are prepared in the way demonstrated repeatedly in Box 2 of the cancer chapters. In all the graphs, PhysPop is a surrogate for average accumulated dose from medical radiation.

Figures 23-A+B (males, females) depict the best-fit lines when the 1940 MortRates are regressed upon the 1940 PhysPops. Readers can appreciate the scatter of the boxy symbols, which represent the nine real-world datapoints, and can note the direction of the best-fit line (up, flat, or down).

When the sign of the X-Coefficient in Box 1 is negative for the 1940-1940 combination, the direction of the best-fit line is downward. When the sign is positive (in some other chapters), the direction is upward. We remind readers (from Chapter 6, Part 3) that the visual steepness of the best-fit line --- but not its direction --- is tied to the scales for the y-axis and x-axis. A flat line of best-fit indicates that the y-variable (MortRate) does not respond to increases in the x-variable (PhysPop).

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Box 1 of Chap.23

Summary: Regression Outputs, All Causes of Death Combined.

Below are the summary-results from all the regressions of MortRates upon PhysPops. MortRates are from Table 23-A, and PhysPops are from Table 3-A.

MALES

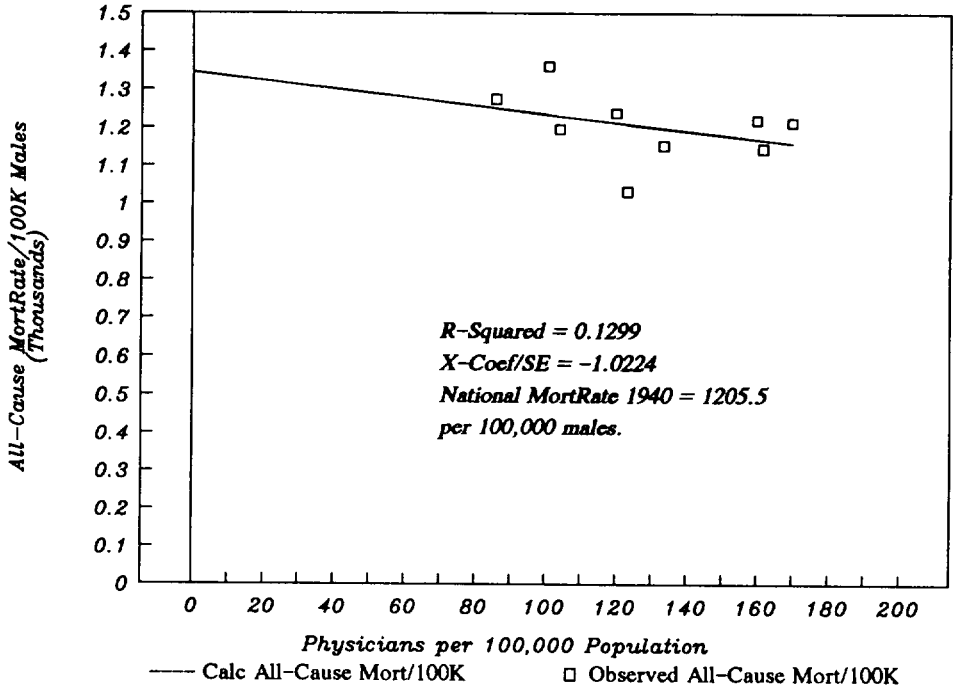
Year MortRate	Year PhysPop	R-squared	Constant	X-Coef	Std Err	X-Coef/SE
1940	1921	0.2634	1609.61	-3.0177	1.9073	-1.5822
1940	1923	0.2459	1559.28	-2.7183	1.7991	-1.5110
1940	1925	0.2338	1514.92	-2.4576	1.6818	-1.4613
1940	1927	0.2271	1492.64	-2.3208	1.6181	-1.4343
1940	1929	0.2112	1470.96	-2.1649	1.5815	-1.3689
1940	1931	0.1900	1436.09	-1.8729	1.4615	-1.2815
1940	1934	0.1839	1406.03	-1.6218	1.2915	-1.2558
1940	1936	0.1736	1393.86	-1.5154	1.2498	-1.2125
1940	1938	0.1596	1375.91	-1.3646	1.1833	-1.1532
1940	1940	0.1299	1345.73	-1.1082	1.0839	-1.0224
1950	1950	0.0997	1085.78	-0.4912	0.5580	-0.8803
1960	1960	0.0650	1032.23	-0.3759	0.5388	-0.6977
1970	1970	0.1437	947.88	-0.5112	0.4717	-1.0838
1980	1980	0.2343	882.58	-0.6247	0.4269	-1.4636
1990	1990	--	--	--	--	--

FEMALES

Year MortRate	Year PhysPop	R-squared	Constant	X-Coef	Std Err	X-Coef/SE
1940	1921	0.7010	1514.19	-4.3050	1.0626	-4.0514
1940	1923	0.6674	1447.39	-3.9161	1.0448	-3.7482
1940	1925	0.6377	1384.66	-3.5497	1.0112	-3.5103
1940	1927	0.5753	1337.23	-3.2299	1.0490	-3.0790
1940	1929	0.5443	1310.32	-3.0393	1.0511	-2.8915
1940	1931	0.5122	1268.79	-2.6890	0.9918	-2.7113
1940	1934	0.4390	1208.49	-2.1916	0.9364	-2.3405
1940	1936	0.4000	1187.51	-2.0117	0.9313	-2.1602
1940	1938	0.3468	1157.01	-1.7588	0.9123	-1.9278
1940	1940	0.2823	1118.10	-1.4283	0.8609	-1.6592
1950	1950	0.0654	768.18	-0.4147	0.5927	-0.6997
1960	1960	0.0072	651.92	-0.1041	0.4624	-0.2251
1970	1970	0.0118	542.80	-0.0912	0.3152	-0.2894
1980	1980	0.0346	441.82	-0.1122	0.2240	-0.5009
1990	1990	--	--	--	--	--

1940 MortRate, Males, All-Causes Combined, versus 1940 PhysPop Values for the 9 Census Divisions, USA. No provable relationship.

PhysPop is a surrogate for accumulated dose from medical irradiation.



1940 MortRate, Females, All-Causes Combined, versus 1940 PhysPop Values for the 9 Census Divisions, USA. No Provable Relationship

PhysPop is a surrogate for accumulated dose from medical irradiation

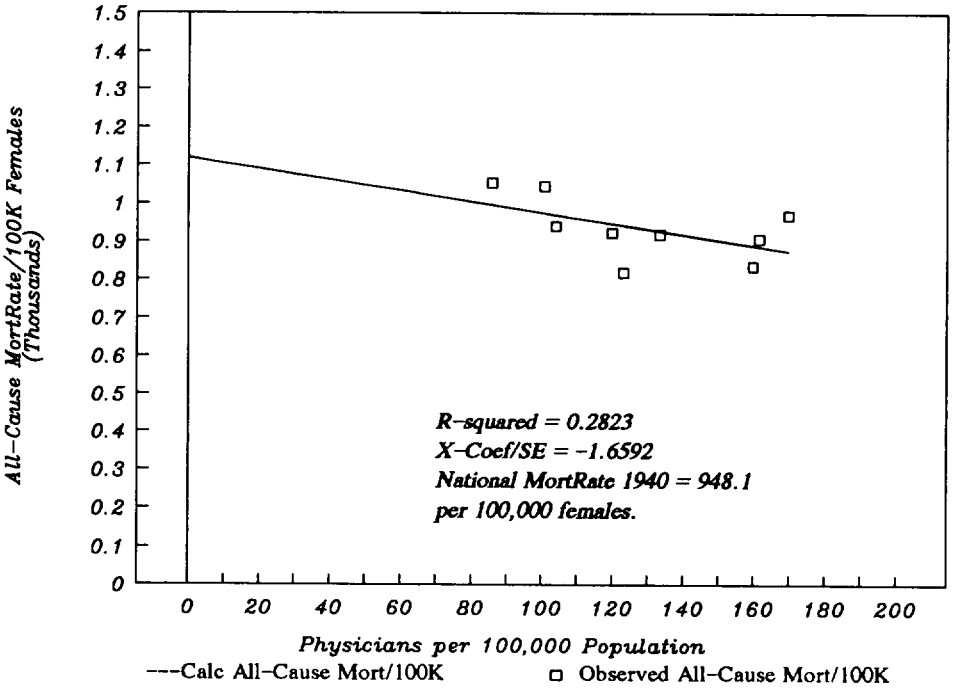


Table 23-A

All Causes of Death Combined: Rates by Census Divisions and National.

The term "All Causes of Death Combined" is an approximation (text, Part 2b). Annual rates per 100,000 are age-adjusted to the 1940 reference year. There are no exclusions by color or "race." Entries for the Nine Census-Divisions are population-weighted; the averages below them are not. "National Rates" for both sexes: Deaths per 100,000 population (males + females). Males: Deaths per 100,000 male population. Females: Deaths per 100,000 female population. Sources and omissions are discussed in Chapter 4, Part 2.

MALES

Census Division	1940	1950	1960	1970	1980	1990
Pacific	1219.8	1002.7	934.2	820.7	707.1	--
New England	1144.3	983.6	991.1	856.6	722.0	--
West North Central	1031.3	957.1	923.7	815.1	706.5	--
Mid-Atlantic	1213.0	1056.9	1007.2	893.5	779.8	--
East North Central	1151.4	1032.4	986.9	882.3	777.7	--
Mountain	1238.2	1021.0	957.6	833.9	710.2	--
West South Central	1196.2	994.7	979.6	891.0	802.4	--
East South Central	1273.8	1066.4	1035.8	940.6	845.4	--
South Atlantic	1360.3	1103.9	1053.2	935.1	817.0	--
Average, ALL	1203.1	1024.3	985.5	874.3	763.1	--
Average, High-5	1152.0	1006.5	968.6	853.6	738.6	--
Average, Low-4	1267.1	1046.5	1006.5	900.1	793.8	--
Ratio, Hi5/Lo4	0.91	0.96	0.96	0.95	0.93	--

FEMALES

Census Division	1940	1950	1960	1970	1980	1990
Pacific	835.3	647.4	593.7	501.2	408.6	--
New England	907.1	702.6	648.7	524.6	400.5	--
West North Central	818.8	672.2	601.3	490.5	379.7	--
Mid-Atlantic	968.9	767.6	678.1	561.3	444.5	--
East North Central	919.5	733.0	652.5	544.6	436.6	--
Mountain	923.9	691.4	600.1	497.2	394.3	--
West South Central	939.9	684.6	619.8	526.3	432.8	--
East South Central	1052.5	783.6	684.6	565.4	446.2	--
South Atlantic	1043.1	764.0	671.9	556.0	440.1	--
Average, ALL	934.3	716.3	639.0	529.7	420.4	--
Average, High-5	889.9	704.6	634.9	524.4	414.0	--
Average, Low-4	989.9	730.9	644.1	536.2	428.4	--
Ratio, Hi5/Lo4	0.90	0.96	0.99	0.98	0.97	--

NATIONAL RATES

	1940	1950	1960	1970	1980	1990
Both Sexes	1077.2	881.5	811.5	694.9	578.3	520
Males	1205.5	1037.1	990.4	879.3	768.1	--
Females	948.1	731.7	648.2	537.3	426.4	--

- 1940, 1950, 1960: All rates come from Grove 1968, Table 67, Page 663, "All Causes." No ICD numbers were given. Please see Chap. 23, Part 2b; also Chap. 4, Part 5.
- 1970 rates are interpolations (Chap. 4, Parts 2b, 2c).
- 1980: All rates come from the reference NatCtrHS 1980. No IDC numbers were given. Please see Chap. 23, Part 2b.
- 1990: "Both sexes" national rate is from PHS 1995, Table 36, p.122. No other data were obtained. Please see Chap. 4, Part 2c.