Respiratory-System Cancers, Males, 1940-1988: Fractional Causation by Medical Radiation

● Table 51-A, Column A, shows the dramatic post-1940 rise in the male National MortRate from Respiratory-System Cancers. The relationship with cigarette smoking is reviewed in Chapter 48. Although male Respiratory Cancer MortRates rose in every Census Division, the observations in Box 1 clearly indicate that smoking-intensity and PhysPop are inversely related (Chapter 48, Part 5b). In order to match the Census Divisions for smoking, an adjustment is obligatory. Box 2 calculates the appropriate adjustment factors.

● Chapter 51 contains a second set of tables (51-AA through 51-FF), located after Table 51-F. In Tables 51-BB through FF, the regressions produce positive Constants — in contrast with the negative Constants produced in Tables 51-B through 51-F. The discussion is located with Table 51-AA.

			Table 51-A				
		Respiratory Cancers, Males: Fractional Causation by Medical Radiation over Time					
Year	Col.A Natl MR	Col.B Frac.C	Col.C R-Sq	Col.D X-Coef	Col.E StdErr	Col.F Coef/SE	Col.G Source
1940	11.0	~100%	0.8673	0.1169	0.0173	6.7640	Chap.16
1950	21.6	84%	0.9007	0.2070	0.0260	7.9692	Tab 51-B
1960	35.2	77%	0.9375	0.3312	0.0323	10.2463	Tab 51-C
1970	47.3	71%	0.9417	0.3997	0.0376	10.6295	Tab 51-D
1980	59.4	67%	0.9447	0.4498	0.0411	10.9368	Tab 51-E
1988	59.7	65%	0.9445	0.4042	0.0370	10.9188	Tab 51-F

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Box 1, Chap. 51
Respiratory-System Cancers, Males: Post-1940 Change in MortRates by Census Trios

1960 vs. 1940, by Trios: Col.D expresses change by ratios. Col.F expresses change by subtraction.
1988 vs. 1940, by Trios: Col.I expresses change by ratios. Col.K expresses change by subtraction.
MRs change inversely with PP. High-PP Trio has lowest growth-factor. Low-PP Trio has highest growth-factor.

	Col.A 1940 MortRate Tab 16-A	Col.B 1960 MortRate Tab 16-A	Col.C Ratio Col.B /Col.A	Col.D Input from Col.C	Col.E Diff: Col.B minus A	Col.F Input from Col.E	Col.G 1988 MortRate Tab 16-A	Col.H Ratio Col.G /Col.A	Col.I Input from Col.H	Col.J Diff: Col.G minus A	Col.K Input from Col.J
Pacif	12.0	34.9	2.908	Avg Chg	22.9	Avg Chg	50.7	4.225	Avg Chg	38.7	Avg Chg
NewE	13.5	38.1	2.822	TopTrio	24.6	TopTrio	56.3	4.170	TopTrio	42.8	TopTrio
MidAtl	17.1	40.6	2.374	2.702	23.5	23.7	57.5	3.363	3.919	40.4	40.6
WNoCen	7.7	28.4	3.688	Avg Chg	20.7	Avg Chg	56.2	7.299	Avg Chg	48.5	Avg Chg
ENoCen	10.6	35.7	3.368	MidTrio	25.1	MidTrio	62.3	5.877	MidTrio	51.7	MidTrio
Mtn	7.8	25.5	3.269	3.442	17.7	21.2	44.2	5.667	6.281	36.4	45.5
WSoCen	7.6	34.9	4.592	Avg Chg	27.3	Avg Chg	67.9	8.934	Avg Chg	60.3	Avg Chg
ESoCen	4.9	29.0	5.918	LowTrio	24.1	LowTrio	79.1	16.143	LowTrio	74.2	LowTrio
SoAtl	8.3	35.7	4.301	4.937	27.4	26.3	68.5	8.253	11.110	60.2	64.9

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                                         Box 2, Chap. 51
                   Respiratory-System Cancers, Males:  Calculation of Adjustment Factor

                        This adjustment is discussed fully in Chapter 49.
  ● Part 1:  Calculate average population-weighted MortRate for the combined TopTrio Census Divs.

          Col.A      Col.B      Col.C     Col.D  |          Col.A      Col.B      Col.C     Col.D
  Census  1940 MR    1940 Pop'n 1940 Popn Col.A * | Census  1950 MR    1950 Pop'n 1950 Popn Col.A *
  Div.    Tab 16-A   Tab 3-B    /45,710,039 Col.C | Div.    Tab 16-A   Tab 3-B    /53,964,513 Col.C
                                                  |
  Pacific  12.0      9,733,262   0.2129    2.56  | Pacific  21.1      14,486,527   0.2684    5.66
  NewEng   13.5      8,437,290   0.1846    2.49  | NewEng   23.6       9,314,453   0.1726    4.07
  Mid-Atl  17.1     27,539,487   0.6025   10.30  | Mid-Atl  28.4      30,163,533   0.5590   15.87
                                                  |
   1940           Sum TopTrio      Sum  TopTrio  |  1950           Sum TopTrio      Sum  TopTrio
                  45,710,039    1.0000   15.350  |                 53,964,513    1.0000   25.612  |
  --------------------------------------------------------------------------------------------------
          Col.A      Col.B      Col.C     Col.D  |          Col.A      Col.B      Col.C     Col.D
  Census  1960 MR    1960 Pop'n 1960 Popn Col.A * | Census  1970 MR    1970 Pop'n 1970 Popn Col.A *
  Div.    Tab 16-A   Tab 3-B    /65,875,863 Col.C | Div.    Tab 16-A   Tab 3-B    /75,017,000 Col.C
                                                  |
  Pacific  34.9     21,198,044   0.3218   11.23  | Pacific  44.2      26,087,000   0.3477   15.37
  NewEng   38.1     10,509,367   0.1595    6.08  | NewEng   47.7      11,781,000   0.1570    7.49
  Mid-Atl  40.6     34,168,452   0.5187   21.06  | Mid-Atl  49.5      37,149,000   0.4952   24.51
                                                  |
   1960           Sum TopTrio      Sum  TopTrio  |  1970           Sum TopTrio      Sum  TopTrio
                  65,875,863    1.0000   38.367  |                 75,017,000    1.0000   47.374
  --------------------------------------------------------------------------------------------------
          Col.A      Col.B      Col.C     Col.D  |          Col.A      Col.B      Col.C     Col.D
  Census  1980 MR    1980 Pop'n 1980 Popn Col.A * | Census  1988 MR    1990 Pop'n 1990 Popn Col.A *
  Div.    Tab 16-A   Tab 3-B    /80,615,000 Col.C | Div.    Tab 16-A   Tab 3-B    /88,495,000 Col.C
                                                  |
  Pacific  53.5     31,523,000   0.3910   20.92  | Pacific  50.7      37,837,000   0.4276   21.68
  NewEng   57.3     12,322,000   0.1528    8.76  | NewEng   56.3      12,998,000   0.1469    8.27
  Mid-Atl  58.4     36,770,000   0.4561   26.64  | Mid-Atl  57.5      37,660,000   0.4256   24.47
                                                  |
   1980           Sum TopTrio      Sum  TopTrio  |  1988           Sum TopTrio      Sum  TopTrio
                  80,615,000    1.0000   56.316  |                 88,495,000    1.0000   54.416
  --------------------------------------------------------------------------------------------------
  ● Part 2:  Take ratios of these TopTrio MortRates, with 1940 as the denominator of each ratio.
     Col.D modifies Col.C by separate PhysPop adjustments for MidTrio and LowTrio Census Divisions.

          Col.A       Col.B       Col.C   Col.D      Col.E
          TopTrio  1940 TopTrio  = Col.A  ppAdju   = Col.C                RESPIRATORY CANCERS.
          Mean MR     Mean MR    / Col.B  Tab 47-B  * Col.D                      Males.
                                          MidTrio
  1950    25.612      15.350      1.669    0.99      1.65  = MidTrio Adjustment Factor, 1950
  1960    38.367      15.350      2.500    0.97      2.42  = MidTrio Adjustment Factor, 1960
  1970    47.374      15.350      3.086    0.95      2.93  = MidTrio Adjustment Factor, 1970
  1980    56.316      15.350      3.669    0.94      3.45  = MidTrio Adjustment Factor, 1980
  1988    54.416      15.350      3.545    0.94      3.33  = MidTrio Adjustment Factor, 1988
  -------------------------------------------------  LowTrio  ----------------------------------------
  1950    25.612      15.350      1.669    1.00      1.67  = LowTrio Adjustment Factor, 1950
  1960    38.367      15.350      2.500    1.01      2.52  = LowTrio Adjustment Factor, 1960
  1970    47.374      15.350      3.086    1.02      3.15  = LowTrio Adjustment Factor, 1970
  1980    56.316      15.350      3.669    1.04      3.82  = LowTrio Adjustment Factor, 1980
  1988    54.416      15.350      3.545    1.07      3.79  = LowTrio Adjustment Factor, 1988
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                                   Table 51-B
                  Respiratory Cancers, Males:  Fractional Causation in 1950
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Part 1.

Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1950 PopFrac Tab 3-B	Col.B 1950 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1950 Adju MortRates	Col.G A * F
Pacific	0.0961	21.1	2.028			21.1	2.028
New England	0.0618	23.6	1.458			23.6	1.458
Mid-Atlantic	0.2002	28.4	5.686			28.4	5.686
WestNoCentral	0.0933	16.5	1.539	7.7	1.65	12.705	1.185
EastNoCentral	0.2017	21.8	4.397	10.6	1.65	17.490	3.528
Mountain	0.0337	16.7	0.563	7.8	1.65	12.870	0.434
WestSoCentral	0.0965	19.0	1.834	7.6	1.67	12.692	1.225
EastSoCentral	0.0762	14.7	1.120	4.9	1.67	8.183	0.624
SouthAtlantic	0.1406	19.8	2.784	8.3	1.67	13.861	1.949

```
                                            Sum =    21.4
          1950 Observed Natl MR from Table 16-B =    21.6                    Sum =
                                                        1950 Natl Adjusted MR =   18.1159
```

Part 2. --

Trio-Seq.	Col.A Mean1940 thru1950 PPs from Tab 47-A x'	Col.B 1950 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1950 Adjusted MortRates regressed on Mean 1940 thru 1950 PPs		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1950 Adjusted MortRates regressed on 1940 PhysPops	
Pac	154.16	21.1	Regression Output:		159.72	Regression Output:	
NewEng	162.03	23.6	Constant	-9.5039	161.55	Constant	-9.4898
MidAtl	169.24	28.4	Std Err of Y Est	2.1691	169.76	Std Err of Y Est	2.2817
WNoCen	121.60	12.705	R Squared	0.9007	123.14	R Squared	0.8901
ENoCen	128.53	17.490	No. of Observation	9	133.36	No. of Observation	9
Mtn	119.64	12.870	Degrees of Freedom	7	119.89	Degrees of Freedom	7
WSoCen	102.64	12.692			103.94		
ESoCen	84.44	8.183	X Coefficient(s)	0.2070	85.83	X Coefficient(s)	0.2041
SoAtl	99.91	13.861	Std Err of Coef.	0.0260	100.74	Std Err of Coef.	0.0271
			XCoef / S.E. =	7.9692		XCoef / S.E.	7.5313

Part 3-A.
Calculation of Fractional Causation
from Averaged PhysPops

1. Nonradiation rate is Adjusted
   Constant (Part 2, Col.C) = NEG =   0.0

2. Radiation rate is Natl Adjusted
   MortRate (Part 1, Col.G = 18.1159)
   minus Nonradiation rate (0.0) =   18.1159

3. 1950 Fractional Causation is radiation
   rate (18.1159) divided by OBSERVED
   Natl MR Part 1,Col.C=   21.6   =   0.84

Part 3-B.
Calculation of Fractional Causation
from 1940 PhysPops

1. Nonradiation rate is Adjusted
   Constant (Part 2, Col.E) = NEG =   0.0

2. Radiation rate is Natl Adjusted
   MortRate (Part 1, Col.G = 18.1159)
   minus Nonradiation rate (0.0) =   18.1159

3. 1950 Fractional Causation is radiation
   rate (18.1159) divided by OBSERVED
   Natl MR Part 1, Col.C=   21.6   =   0.84

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                                       Table 51-C
                     Respiratory Cancers, Males:  Fractional Causation in 1960
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```

Part 1.
Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1960 PopFrac Tab 3-B	Col.B 1960 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1960 Adju MortRates	Col.G A * F
Pacific	0.1182	34.9	4.125			34.9	4.125
New England	0.0586	38.1	2.233			38.1	2.233
Mid-Atlantic	0.1905	40.6	7.734			40.6	7.734
WestNoCentral	0.0858	28.4	2.437	7.7	2.42	18.634	1.599
EastNoCentral	0.2020	35.7	7.211	10.6	2.42	25.652	5.182
Mountain	0.0382	25.5	0.974	7.8	2.42	18.876	0.721
WestSoCentral	0.0945	34.9	3.298	7.6	2.52	19.152	1.810
EastSoCentral	0.0672	29.0	1.949	4.9	2.52	12.348	0.830
SouthAtlantic	0.1448	35.7	5.169	8.3	2.52	20.916	3.029

Sum = 35.1

1960 Observed Natl MR from Table 16-B = 35.2

Sum =
1960 Natl Adjusted MR =   27.2620

Part 2.

Trio-Seq.	Col.A Mean1940 thru1960 PPs from Tab 47-A x'	Col.B 1960 Adju MRs from Col.F Part 1	Col.D 1940 PPs from Table 3-A (TrioSeq) x''
Pac	155.69	34.9	159.72
NewEng	162.81	38.1	161.55
MidAtl	167.04	40.6	169.76
WNoCen	118.15	18.634	123.14
ENoCen	123.87	25.652	133.36
Mtn	117.40	18.876	119.89
WSoCen	102.31	19.152	103.94
ESoCen	85.63	12.348	85.83
SoAtl	101.72	20.916	100.74

Col.C
Respiratory Ca, Males:
1960 Adjusted MortRates
regressed on
Mean 1940 thru 1960 PPs
Regression Output:

Constant	-16.2889
Std Err of Y Est	2.6735
R Squared	0.9375
No. of Observation	9
Degrees of Freedom	7
X Coefficient(s)	0.3312
Std Err of Coef.	0.0323
XCoef / S.E. =	10.2463

Col.E
Respiratory Ca, Males:
1960 Adjusted MortRates
regressed on
1940 PhysPops
Regression Output:

Constant	-15.7619
Std Err of Y Est	3.2174
R Squared	0.9095
No. of Observation	9
Degrees of Freedom	7
X Coefficient(s)	0.3204
Std Err of Coef.	0.0382
XCoef / S.E.	8.3861

Part 3-A.
Calculation of Fractional Causation
from Averaged PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.C) = NEG =   0.0

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 27.2620)
    minus Nonradiation rate (0.0) =   27.2620

3. 1960 Fractional Causation is radiation
    rate (27.2620) divided by OBSERVED
    Natl MR Part 1,Col.C=   35.2   =   0.77

Part 3-B.
Calculation of Fractional Causation
from 1940 PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.E) = NEG =   0.0

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 27.2620)
    minus Nonradiation rate (0.0) =   27.2620

3. 1960 Fractional Causation is radiation
    rate (27.2620) divided by OBSERVED
    Natl MR Part 1, Col.C=   35.2   =   0.77

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                                      Table 51-E
                     Respiratory Cancers, Males:  Fractional Causation in 1980
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```

Part 1.

Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1980 PopFrac Tab 3-B	Col.B 1980 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1980 Adju MortRates	Col.G A * F
Pacific	0.1398	53.5	7.479			53.5	7.479
New England	0.0546	57.3	3.129			57.3	3.129
Mid-Atlantic	0.1630	58.4	9.519			58.4	9.519
WestNoCentral	0.0759	53.7	4.076	7.7	3.45	26.565	2.016
EastNoCentral	0.1846	61.4	11.334	10.6	3.45	36.570	6.751
Mountain	0.0502	43.6	2.189	7.8	3.45	26.910	1.351
WestSoCentral	0.1049	62.8	6.588	7.6	3.82	29.032	3.045
EastSoCentral	0.0646	70.8	4.574	4.9	3.82	18.718	1.209
SouthAtlantic	0.1624	65.2	10.588	8.3	3.82	31.706	5.149

```
                                              Sum =    59.5                          Sum =
          1980 Observed Natl MR from Table 16-B =      59.4      1980 Natl Adjusted MR =      39.6488
```

Part 2.

Trio-Seq.	Col.A Mean1940 thru1980 PPs from Tab 47-A x'	Col.B 1980 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1980 Adjusted MortRates regressed on Mean 1940 thru 1980 PPs Regression Output:		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1980 Adjusted MortRates regressed on 1940 PhysPops Regression Output:	
Pac	177.35	53.5	Constant	-26.5400	159.72	Constant	-22.8215
NewEng	185.86	57.3	Std Err of Y Est	3.7445	161.55	Std Err of Y Est	5.4754
MidAtl	186.11	58.4	R Squared	0.9447	169.76	R Squared	0.8818
WNoCen	128.82	26.565	No. of Observation	9	123.14	No. of Observation	9
ENoCen	133.71	36.570	Degrees of Freedom	7	133.36	Degrees of Freedom	7
Mtn	133.45	26.910			119.89		
WSoCen	114.66	29.032	X Coefficient(s)	0.4498	103.94	X Coefficient(s)	0.4699
ESoCen	99.46	18.718	Std Err of Coef.	0.0411	85.83	Std Err of Coef.	0.0650
SoAtl	124.62	31.706	XCoef / S.E. =	10.9368	100.74	XCoef / S.E.	7.2261

Part 3-A.
Calculation of Fractional Causation
from Averaged PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.C) = NEG =   0.0

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 39.6488)
    minus Nonradiation rate (0.0) =   39.6488

3. 1980 Fractional Causation is radiation
    rate (39.6488) divided by OBSERVED
    Natl MR Part 1,Col.C=   59.4   =   0.67

Part 3-B.
Calculation of Fractional Causation
from 1940 PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.E) = NEG =   0.0

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 39.6488)
    minus Nonradiation rate (0.0) =   39.6488

3. 1980 Fractional Causation is radiation
    rate (39.6488) divided by OBSERVED
    Natl MR Part 1, Col.C=   59.4   =   0.67

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================================================================================================
                                        Table 51-F
                    Respiratory Cancers, Males:  Fractional Causation in 1988
================================================================================================
```

Part 1.
Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1990 PopFrac Tab 3-B	Col.B 1988 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1988 Adju MortRates	Col.G A * F
Pacific	0.1535	50.7	7.782			50.7	7.782
New England	0.0527	56.3	2.967			56.3	2.967
Mid-Atlantic	0.1527	57.5	8.780			57.5	8.780
WestNoCentral	0.0721	56.2	4.052	7.7	3.33	25.641	1.849
EastNoCentral	0.1713	62.3	10.672	10.6	3.33	35.298	6.047
Mountain	0.0543	44.2	2.400	7.8	3.33	25.974	1.410
WestSoCentral	0.1087	67.9	7.381	7.6	3.79	28.804	3.131
EastSoCentral	0.0621	79.1	4.912	4.9	3.79	18.571	1.153
SouthAtlantic	0.1725	68.5	11.816	8.3	3.79	31.457	5.426

```
                                        Sum =    60.8                           Sum =
            1988 Observed Natl MR from Table 16-B =    59.7       1988 Natl Adjusted MR =    38.5459
```

Part 2.

Trio-Seq.	Col.A Mean1940 thru1990 PPs from Tab 47-A x'	Col.B 1988 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1988 Adjusted MortRates regressed on Mean 1940 thru 1990 PPs Regression Output:		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1988 Adjusted MortRates regressed on 1940 PhysPops Regression Output:	
Pac	191.97	50.7	Constant	-27.1037	159.72	Constant	-21.3904
NewEng	208.20	56.3	Std Err of Y Est	3.6381	161.55	Std Err of Y Est	5.6760
MidAtl	204.72	57.5	R Squared	0.9445	169.76	R Squared	0.8650
WNoCen	141.14	25.641	No. of Observation	9	123.14	No. of Observation	9
ENoCen	146.19	35.298	Degrees of Freedom	7	133.36	Degrees of Freedom	7
Mtn	145.91	25.974			119.89		
WSoCen	126.28	28.804	X Coefficient(s)	0.4042	103.94	X Coefficient(s)	0.4515
ESoCen	113.28	18.571	Std Err of Coef.	0.0370	85.83	Std Err of Coef.	0.0674
SoAtl	142.93	31.457	XCoef / S.E. =	10.9188	100.74	XCoef / S.E.	6.6973

Part 3-A.
Calculation of Fractional Causation
from Averaged PhysPops

1. Nonradiation rate is Adjusted
   Constant (Part 2, Col.C) = NEG =   0.0

2. Radiation rate is Natl Adjusted
   MortRate (Part 1, Col.G = 38.5459)
   minus Nonradiation rate (0.0) =   38.5459

3. 1988 Fractional Causation is radiation
   rate (38.5459) divided by OBSERVED
   Natl MR Part 1,Col.C=   59.7   =   0.65

Part 3-B.
Calculation of Fractional Causation
from 1940 PhysPops

1. Nonradiation rate is Adjusted
   Constant (Part 2, Col.E) = NEG =   0.0

2. Radiation rate is Natl Adjusted
   MortRate (Part 1, Col.G = 38.5459)
   minus Nonradiation rate (0.0) =   38.5459

3. 1988 Fractional Causation is radiation
   rate (38.5459) divided by OBSERVED
   Natl MR Part 1, Col.C=   59.7   =   0.65

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● **Special Section: Tables 51-AA through 51-FF**

       At the outset of this chapter, we mentioned the negative Constants produced by the regressions in Tables 51-B through 51-F. Their production is not surprising, because (a) the 1940 PhysPop-MortRate dose-response for male Respiratory-System Cancers also produces a negative Constant of appreciable magnitude relative to the 1940 National MortRate, and (b) the 1940 dose-response is the foundation for the Smoking Adjustment which precedes the post-1940 regressions.

       Biologically, MortRates below zero do not exist, as we stressed in Chapter 22 (Part 3). Nonetheless, we must expect that some negative Constants will show up when we subdivide the 1940 All-Cancer MortRates to make 16 separate examinations (Chapters 8 through 21). A negative Constant reflects a best-fit slope which is too steep to be biologically realistic. Such a slope may well be the result of a few 'outliers' --- datapoints which are 'way out of line' in a series of observations. In epidemiology, a few outliers are no justification for disbelieving the bigger picture.

Two Questions Answered by the Special Tabulation (Next Page)

       We asked, "Which analyses of 1940 MortRates produced negative Constants which exceeded about 20% of the corresponding National Cancer MortRate?" There were only two: Male Respiratory-System Cancers and male Urinary-System Cancers, as shown in Column E of the Special Tabulation on the next page. It is notable that the corresponding female MortRates did NOT produce the aberration --- so there is no reason to suspect that there is something special about Respiratory-System Cancers or Urinary-System Cancers. Moreover, from Column D of the tabulation, we note that these two Cancers account for only (11.0 + 7.4) / (115.0), or 16% of the male All-Cancer MortRate in 1940. In other words, appreciable negative Constants do NOT characterize the "bigger picture" in 1940 for either males or females.

       Also we asked: "Is the too-steep slope in 1940, for male Respiratory-System and male Urinary-System Cancers, predictable from their 1940 High-5/Low-4 MortRate Ratios?" The answer is yes, as demonstrated by Column B of the tabulation. Those two entities, having Hi5/Lo4 ratios of 1.70 and 1.77 respectively, are the ones having values far above the center of the distribution of such ratios (approximateley 1.45). Their large Hi5/Lo4 ratios, for their 1940 MortRates, identify them as the outliers.

       We have demonstrated to ourselves (the work is not included here) that the too-steep slopes and resulting negative Constants, in 1940, account for the too-steep slopes and negative Constants which show up in our post-1940 Smoking Adjusted MortRates. If the highest 1940 MortRate is reduced somewhat and the lowest 1940 MortRate is raised somewhat, not only does the negative Constant in 1940 become positive, but also the post-1940 Constants become positive.

Obtaining Positive Constants in Tables 51-BB through 51-FF

       Because we know that the slopes are unrealistically steep for male Respiratory-System Cancers in Tables 51-B through 51-F, we have produced more realistic slopes in Tables 51-BB through 51-FF. How? Here, we do NOT disturb the Observed 1940 MortRates in Column D of Table 51-BB. Instead, we change the adjustment factor in Column E. For Table 51-BB, we multiplied the adjustment factors from Column E of Table 51-B by 1.4. Thus, the adjustment factors used in Column E of Table 51-BB are 2.31 (which is 1.65 * 1.4) and 2.338 (which is 1.67 * 1.4). As a result, the six adjusted MortRates and the National Adjusted MortRate are higher in Table 51-BB than in Table 51-B. With these y-values in the new regression, the slope (X-Coefficient) is lower in Table 51-BB than in Table 51-B, and the Constant becomes positive.

       We followed the same procedure for Tables 51-CC, 51-DD (not shown), 51-EE, and 51-FF: We multiplied the adjustment factors in Column E of the first set of tables by 1.4. As a result, all the Constants become positive --- an outcome which suggests that the second set of adjustment factors is more realistic. We also note that the R-squared values in this second set of tables are lower (although still very strong) than they were in the first set. Table 51-AA (next page) summarizes the results. Readers can make their own comparison of Table 51-AA with Table 51-A.

Table 51-AA
Respiratory Cancers, Males: Fractional Causation by Medical Radiation over Time

Year	Col.A Natl MR	Col.B Frac.C	Col.C R-Sq	Col.D X-Coef	Col.E StdErr	Col.F Coef/SE	Col.G Source
1940	11.0	~100%	0.8673	0.1169	0.0173	6.7640	Chap.16
1950	21.6	89%	0.7168	0.1403	0.0333	4.2087	Tab 51-BB
1960	35.2	86%	0.7917	0.2241	0.0435	5.1581	Tab 51-CC
1970	47.3	79%	0.7951	0.2677	0.0514	5.2118	Tab 51 DD
1980	59.4	71%	0.7948	0.2984	0.0573	5.2076	Tab 51-EE
1988	59.7	74%	0.7816	0.2652	0.0530	5.0050	Tab 51-FF

Special Tabulation for Chap. 51

Col.A		Col.B: 1940 MortRate Hi5/Lo4 Ratio	Col.C: 1940 Constant	Col.D 1940 Natl MortRate	Col.E: Ratio of ColC/ColD
All Cancers Combined	Male	1.44	11.6	115.0	0.10
Chaps. 6+7	Fem	1.27	53.0	126.1	0.42
Breast Cancer, Chap.8	Fem	1.55	-2.2	23.3	-0.09
Digestive-Syst. Cancer	Male	1.52	1.9	60.4	0.03
Chaps. 9+10	Fem	1.39	10.2	50.1	0.20
Urinary-Syst. Cancers	Male	1.77	-2.8	7.4	-0.38
Chaps. 11+12	Fem	1.40	0.6	4.0	0.15
Genital Cancers	Male	1.32	3.2	15.2	0.21
Chaps. 13+14	Fem	1.04	29.1	32.1	0.91
Buccal-Pharynx, Ch15	Male	1.56	-0.2	5.1	-0.04
Respiratory-Syst. Canc	Male	1.70	-5.1	11.0	-0.46
Chaps. 16+17	Fem	1.46	0.1	3.3	0.03
"Difference" Cancers	Male	1.42	16.7	104.0	0.16
Chaps. 18+19	Fem	1.42	52.9	122.8	0.43
All-Except-Genital Ca	Male	1.46	6.4	99.8	0.06
Chap. 20	Fem	1.36	23.9	94.0	0.25
All-Exc-Gen+Resp Ca	Male	1.44	11.5	88.8	0.13
Chap. 21	Fem	1.36	23.8	90.7	0.26

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                                         Table 51-BB
                    Respiratory Cancers, Males:  Fractional Causation in 1950
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Part 1.
Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1950 PopFrac Tab 3-B	Col.B 1950 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1950 Adju MortRates	Col.G A * F
Pacific	0.0961	21.1	2.028			21.1	2.028
New England	0.0618	23.6	1.458			23.6	1.458
Mid-Atlantic	0.2002	28.4	5.686			28.4	5.686
WestNoCentral	0.0933	16.5	1.539	7.7	2.31	17.787	1.660
EastNoCentral	0.2017	21.8	4.397	10.6	2.31	24.486	4.939
Mountain	0.0337	16.7	0.563	7.8	2.31	18.018	0.607
WestSoCentral	0.0965	19.0	1.834	7.6	2.338	17.769	1.715
EastSoCentral	0.0762	14.7	1.120	4.9	2.338	11.456	0.873
SouthAtlantic	0.1406	19.8	2.784	8.3	2.338	19.405	2.728

```
                                        Sum =    21.4                             Sum =
         1950 Observed Natl MR from Table 16-B =  21.6      1950 Natl Adjusted MR =    21.6935
```

Part 2. --

Trio-Seq.	Col.A Mean1940 thru1950 PPs from Tab 47-A x'	Col.B 1950 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1950 Adjusted MortRates regressed on Mean 1940 thru 1950 PPs Regression Output:		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1950 Adjusted MortRates regressed on 1940 PhysPops Regression Output:	
Pac	154.16	21.1	Constant	2.4168	159.72	Constant	2.3293
NewEng	162.03	23.6	Std Err of Y Est	2.7841	161.55	Std Err of Y Est	2.7873
MidAtl	169.24	28.4	R Squared	0.7168	169.76	R Squared	0.7161
WNoCen	121.60	17.787	No. of Observation	9	123.14	No. of Observation	9
ENoCen	128.53	24.486	Degrees of Freedom	7	133.36	Degrees of Freedom	7
Mtn	119.64	18.018			119.89		
WSoCen	102.64	17.769	X Coefficient(s)	0.1403	103.94	X Coefficient(s)	0.1391
ESoCen	84.44	11.456	Std Err of Coef.	0.0333	85.83	Std Err of Coef.	0.0331
SoAtl	99.91	19.405	XCoef / S.E. =	4.2087	100.74	XCoef / S.E.	4.2018

Part 3-A. | Part 3-B.
Calculation of Fractional Causation | Calculation of Fractional Causation
from Averaged PhysPops | from 1940 PhysPops

1. Nonradiation rate is Adjusted | 1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.C) =   2.4168 | Constant (Part 2, Col.E) =   2.3293

2. Radiation rate is Natl Adjusted | 2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 21.6935) | MortRate (Part 1, Col.G = 21.6935)
    minus Nonradiation rate (2.4168) =   19.2766 | minus Nonradiation rate (2.3293) =   19.3642

3. 1950 Fractional Causation is radiation | 3. 1950 Fractional Causation is radiation
    rate (19.2766) divided by OBSERVED | rate (19.3642) divided by OBSERVED
    Natl MR Part 1,Col.C=   21.6   =   0.89 | Natl MR Part 1, Col.C=   21.6   =   0.90

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                                    Table 51-CC
               Respiratory Cancers, Males:  Fractional Causation in 1960
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```

Part 1.
Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1960 PopFrac Tab 3-B	Col.B 1960 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1960 Adju MortRates	Col.G A * F
Pacific	0.1182	34.9	4.125			34.9	4.125
New England	0.0586	38.1	2.233			38.1	2.233
Mid-Atlantic	0.1905	40.6	7.734			40.6	7.734
WestNoCentral	0.0858	28.4	2.437	7.7	3.388	26.088	2.238
EastNoCentral	0.2020	35.7	7.211	10.6	3.388	35.913	7.254
Mountain	0.0382	25.5	0.974	7.8	3.388	26.426	1.009
WestSoCentral	0.0945	34.9	3.298	7.6	3.528	26.813	2.534
EastSoCentral	0.0672	29.0	1.949	4.9	3.528	17.287	1.162
SouthAtlantic	0.1448	35.7	5.169	8.3	3.528	29.282	4.240

```
                                     Sum =    35.1                         Sum =
            1960 Observed Natl MR from Table 16-B =    35.2    1960 Natl Adjusted MR =    32.5299
```

Part 2. --

Trio-Seq.	Col.A Mean1940 thru1960 PPs from Tab 47-A x'	Col.B 1960 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1960 Adjusted MortRates regressed on Mean 1940 thru 1960 PPs Regression Output:		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1960 Adjusted MortRates regressed on 1940 PhysPops Regression Output:	
Pac	155.69	34.9	Constant	2.3462	159.72	Constant	1.9609
NewEng	162.81	38.1	Std Err of Y Est	3.5939	161.55	Std Err of Y Est	3.4375
MidAtl	167.04	40.6	R Squared	0.7917	169.76	R Squared	0.8094
WNoCen	118.15	26.088	No. of Observation	9	123.14	No. of Observation	9
ENoCen	123.87	35.913	Degrees of Freedom	7	133.36	Degrees of Freedom	7
Mtn	117.40	26.426			119.89		
WSoCen	102.31	26.813	X Coefficient(s)	0.2241	103.94	X Coefficient(s)	0.2226
ESoCen	85.63	17.287	Std Err of Coef.	0.0435	85.83	Std Err of Coef.	0.0408
SoAtl	101.72	29.282	XCoef / S.E. =	5.1581	100.74	XCoef / S.E.	5.4528

Part 3-A.
Calculation of Fractional Causation
from Averaged PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.C) =   2.3462

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 32.5299)
    minus Nonradiation rate (2.3462) =   30.1838

3. 1960 Fractional Causation is radiation
    rate (30.1838) divided by OBSERVED
    Natl MR Part 1,Col.C=   35.2   =   0.86

Part 3-B.
Calculation of Fractional Causation
from 1940 PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.E) =   1.9609

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 32.5299)
    minus Nonradiation rate (1.9609) =   30.5690

3. 1960 Fractional Causation is radiation
    rate (30.5690) divided by OBSERVED
    Natl MR Part 1, Col.C=   35.2   =   0.87

==

Table 51-EE

Respiratory Cancers, Males: Fractional Causation in 1980

==

Part 1.

Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).

The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1980 PopFrac Tab 3-B	Col.B 1980 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1980 Adju MortRates	Col.G A * F
Pacific	0.1398	53.5	7.479			53.5	7.479
New England	0.0546	57.3	3.129			57.3	3.129
Mid-Atlantic	0.1630	58.4	9.519			58.4	9.519
WestNoCentral	0.0759	53.7	4.076	7.7	4.83	37.191	2.823
EastNoCentral	0.1846	61.4	11.334	10.6	4.83	51.198	9.451
Mountain	0.0502	43.6	2.189	7.8	4.83	37.674	1.891
WestSoCentral	0.1049	62.8	6.588	7.6	5.348	40.645	4.264
EastSoCentral	0.0646	70.8	4.574	4.9	5.348	26.205	1.693
SouthAtlantic	0.1624	65.2	10.588	8.3	5.348	44.388	7.209

Sum = 59.5

1980 Observed Natl MR from Table 16-B = 59.4

Sum =

1980 Natl Adjusted MR = 47.4574

Part 2. --

Trio-Seq.	Col.A Mean1940 thru1980 PPs from Tab 47-A x'	Col.B 1980 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1980 Adjusted MortRates regressed on Mean 1940 thru 1980 PPs		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1980 Adjusted MortRates regressed on 1940 PhysPops	
Pac	177.35	53.5	Regression Output:		159.72	Regression Output:	
NewEng	185.86	57.3	Constant	2.5975	161.55	Constant	3.6939
MidAtl	186.11	58.4	Std Err of Y Est	5.2167	169.76	Std Err of Y Est	5.2342
WNoCen	128.82	37.191	R Squared	0.7948	123.14	R Squared	0.7935
ENoCen	133.71	51.198	No. of Observation	9	133.36	No. of Observation	9
Mtn	133.45	37.674	Degrees of Freedom	7	119.89	Degrees of Freedom	7
WSoCen	114.66	40.645			103.94		
ESoCen	99.46	26.205	X Coefficient(s)	0.2984	85.83	X Coefficient(s)	0.3223
SoAtl	124.62	44.388	Std Err of Coef.	0.0573	100.74	Std Err of Coef.	0.0622
			XCoef / S.E. =	5.2076		XCoef / S.E.	5.1857

Part 3-A.

Calculation of Fractional Causation from Averaged PhysPops

1. Nonradiation rate is Adjusted Constant (Part 2, Col.C) = 2.5975

2. Radiation rate is Natl Adjusted MortRate (Part 1, Col.G = 47.4574) minus Nonradiation rate (2.5975) = 44.8600

3. 1980 Fractional Causation is radiation rate (44.8600) divided by OBSERVED Natl MR Part 1,Col.C= 59.4 = 0.71

Part 3-B.

Calculation of Fractional Causation from 1940 PhysPops

1. Nonradiation rate is Adjusted Constant (Part 2, Col.E) = 3.6939

2. Radiation rate is Natl Adjusted MortRate (Part 1, Col.G = 47.4574) minus Nonradiation rate (3.6939) = 43.7635

3. 1980 Fractional Causation is radiation rate (43.7635) divided by OBSERVED Natl MR Part 1, Col.C= 59.4 = 0.74

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Table 51-FF
Respiratory Cancers, Males: Fractional Causation in 1988

===

Part 1.
Calculation of the 6 Adjusted MortRates (Col.F) and the National Adjusted MortRate (Col.G).
The last six entries in Part 1, Col.F, are the products of (Col.D * Col.E), as discussed in Chap. 49.

Trio-Sequence	Col.A 1990 PopFrac Tab 3-B	Col.B 1988 Obs MR Tab 16-A	Col.C A * B	Col.D 1940 MR Mid,Low Tab 16-A	Col.E AdjuFact Bx2,Pt2 Col.E	Col.F 1988 Adju MortRates	Col.G A * F
Pacific	0.1535	50.7	7.782			50.7	7.782
New England	0.0527	56.3	2.967			56.3	2.967
Mid-Atlantic	0.1527	57.5	8.780			57.5	8.780
WestNoCentral	0.0721	56.2	4.052	7.7	4.662	35.897	2.588
EastNoCentral	0.1713	62.3	10.672	10.6	4.662	49.417	8.465
Mountain	0.0543	44.2	2.400	7.8	4.662	36.364	1.975
WestSoCentral	0.1087	67.9	7.381	7.6	5.306	40.326	4.383
EastSoCentral	0.0621	79.1	4.912	4.9	5.306	25.999	1.615
SouthAtlantic	0.1725	68.5	11.816	8.3	5.306	44.040	7.597

Sum =   60.8

1988 Observed Natl MR from Table 16-B =   59.7

Sum =
1988 Natl Adjusted MR =   46.1524

Part 2.

Trio-Seq.	Col.A Mean1940 thru1990 PPs from Tab 47-A x'	Col.B 1988 Adju MRs from Col.F Part 1	Col.C Respiratory Ca, Males: 1988 Adjusted MortRates regressed on Mean 1940 thru 1990 PPs Regression Output:		Col.D 1940 PPs from Table 3-A (TrioSeq) x''	Col.E Respiratory Ca, Males: 1988 Adjusted MortRates regressed on 1940 PhysPops Regression Output:	
Pac	191.97	50.7	Constant	2.1988	159.72	Constant	4.7678
NewEng	208.20	56.3	Std Err of Y Est	5.2078	161.55	Std Err of Y Est	5.4503
MidAtl	204.72	57.5	R Squared	0.7816	169.76	R Squared	0.7608
WNoCen	141.14	35.897	No. of Observation	9	123.14	No. of Observation	9
ENoCen	146.19	49.417	Degrees of Freedom	7	133.36	Degrees of Freedom	7
Mtn	145.91	36.364			119.89		
WSoCen	126.28	40.326	X Coefficient(s)	0.2652	103.94	X Coefficient(s)	0.3054
ESoCen	113.28	25.999	Std Err of Coef.	0.0530	85.83	Std Err of Coef.	0.0647
SoAtl	142.93	44.040	XCoef / S.E. =	5.0050	100.74	XCoef / S.E.	4.7183

Part 3-A.
Calculation of Fractional Causation
from Averaged PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.C) =   2.1988

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 46.1524)
    minus Nonradiation rate (2.1988) =   43.9536

3. 1988 Fractional Causation is radiation
    rate (43.9536) divided by OBSERVED
    Natl MR Part 1,Col.C=   59.7   =   0.74

Part 3-B.
Calculation of Fractional Causation
from 1940 PhysPops

1. Nonradiation rate is Adjusted
    Constant (Part 2, Col.E) =   4.7678

2. Radiation rate is Natl Adjusted
    MortRate (Part 1, Col.G = 46.1524)
    minus Nonradiation rate 4.7678 =   41.3846

3. 1988 Fractional Causation is radiation
    rate (41.3846) divided by OBSERVED
    Natl MR Part 1, Col.C=   59.7   =   0.69