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PART IV

SPATIAL VARIATIONS IN MORTALITY RATES

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An Econometric Analysis of Spatial Variations in Mortality Rates by Race and Sex

Morris Silver

1. INTRODUCTION

The wish to measure the effects of income, schooling, and a variety of other variables upon mortality and to isolate their role in explaining the difference in mortality rates of whites and blacks in the United States is the primary factor motivating this study. To accomplish this we have applied multiple regression analysis to 1959–61 age-adjusted mortality rates by race and sex for states and standard metropolitan statistical areas (SMSA's). Questions about the effect of age adjustment on spatial patterns in mortality rates, about differences in the spatial patterns of age-specific mortality rates, and about the stability of mortality rates within and among geographic units over the 1959–61 period are dealt with in Appendix B.

Given the importance of and intrinsic interest in racial differences in mortality rates, it is surprising that attempts to subject them to econometric analysis have been so rare.[1] Brief summaries of the tech-

NOTE: I am indebted to Richard Auster, Michael Grossman, Gene Lewit, Jacob Mincer, Charlotte Muller, Kong-Kyun Ro, Mortimer Spiegelman, and especially to Victor Fuchs for many helpful comments.

[1] There have been many quantitative studies of mortality rates and other measures of health, but most of these are concerned only with the broad question of the influence of "social conditions" on health rather than with tests of specific economic or noneconomic hypotheses or estimation of specific parameters. A study by C. A. Moser and Wolf Scott (*British Towns*, London, 1961) is interesting and sophisticated, but its objectives—the quantification of social and economic differences among British towns—and variables are only slightly related to those of this study.

niques and findings of some of the few related prior studies in the field are presented below.

Adelman ran cross-country multiple regressions of thirty-four developed and underdeveloped countries, utilizing data falling in the period 1947–57.[2] The dependent variables are age-specific mortality rates and the independent variables include per capita income, the percentage rate of growth of per capita income, the percentage of the labor force employed outside agriculture, and the number of physicians per 10,000 inhabitants. Income elasticities are found to be negative in all cases and statistically significant up to age fifty, with values ranging from —0.14 for the forty–forty-four age group to —0.58 for the one–four age group. Higher percentages of the labor force outside agriculture tend to reduce mortality rates. Mortality rates are also found to be negatively correlated with the physician variable.

Fuchs chose states as his unit of observation and ran regressions for the years 1940, 1950, and 1960, utilizing both linear and logarithmic-linear unweighted and weighted forms (each state weighted by its population.)[3] In his first set of regressions the dependent variables are age-adjusted and infant mortality rates, while the independent variables include the number of physicians per capita, the rural percentage of the population, the nonwhite percentage of the population, the median income of families and unrelated individuals, the number of health personnel (including physicians) per capita, the foreign-born percentage of the population, and the median number of school years completed by the adult population. It is found that the percentage of nonwhites is positively correlated with age-adjusted mortality and is statistically significant. The coefficients of income for age-adjusted mortality are always *positive* and statistically significant in the 1960 regressions. On the other hand, they are predominantly *negative* for infant mortality, while also statistically significant. The other variables in the regressions do not exhibit consistent, statistically significant relationships with the dependent variables.

Auster, Leveson, and Sarachek utilized simultaneous equations techniques and the assumption of a Cobb-Douglas production function to estimate the effects of various medical services (e.g., physicians and drug expenditures per capita) on age-adjusted mortality rates across states for the entire population and for whites alone during 1959–61. Their study appears as chapter 8 of this volume.

[2] Irma Adelman, "An Econometric Analysis of Population Growth," *American Economic Review*, 53, June 1963, pp. 314–39.

[3] Victor R. Fuchs, "Some Economic Aspects of Mortality in the United States," New York, NBER, July 1965, pp. 13–27, mimeograph.

It is worth noting that both the Fuchs and the Auster, Leveson, and Sarachek study find strong positive relations across states between income and mortality, though not infant mortality, while Adelman observes the "traditional" inverse relationship across countries. A major objective of my study is to cast additional light on the relationship between income and mortality. In particular, an effort will be made to determine whether the relationship across SMSA's is different from that across states, how the income effect varies with sex and race, what the influence of the multicollinearity between income and schooling consists in, and whether the source of income (labor or nonlabor) is relevant.

In Section 2 the independent variables employed in the multiple regressions of Section 3 are classified and discussed. Race and sex differentials in mortality are examined in Section 4. The main findings are summarized and some concluding observations are offered in Section 5.

2. SOME VARIABLES DETERMINING MORTALITY BEHAVIOR

The factors believed to determine the mortality rate, which is taken as an inverse index of "health," and the corresponding statistical measures are classified as variables in the "consumer demand function for health" and "other" variables. The variables in the demand function are further classified as economic, informational, or taste. "Tastes" are interpreted to include health attitudes, perceptions, and motivations. Primary attention is directed to the roles of the economic and informational variables.

A complete list of all the variables examined in the course of this study is presented below. (Details on their construction and sources are given in Appendix A.) Variables marked by an asterisk were excluded from the final regressions featured in this article for various reasons explained in the text; exploratory regressions using them are available from the author on request.

Variables Explored in the Regression Analysis

A. Variables in the Explanatory Equations

Y(DDR)	Directly age-adjusted death rate (per 1,000 population) for all ages (1959–61, by color and sex)
Y'(IDR)	Indirectly age-adjusted death rate for all ages (1959–61, by race and sex)
X_1(MHWY)	Median income of husband-wife families standardized for the age of the head (1959, by color)

X'_1(MPY)	Median income of persons age fourteen and over with incomes (1959, by race and sex)
X''_1(MHWYD)	MHWY above its third quartile = 0; MHWY below its third quartile = actual MHWY (1959, by color)
X'''_1(%LT3T)	Per cent of husband-wife families with annual cash incomes less than \$3,000, standardized for the age of the head (1959, by color)
X_{1L}(LABY)	Labor income of head of family or his wife (1959, by color)
X_{1NL}(NLABY)	Nonlabor income of head of family or his wife (1959, by color)
X_2(EARNR)	Weekly earnings rate of persons age fourteen and over in the experienced civilian labor force (1959, by color and sex)
X_3(MRTL)	Age-standardized per cent married with spouse present (1960, by race and sex)
X_4(FRTL)	Age-standardized (all ages) number of children ever born per 1,000 women ever married (1960, by color)
X_5(REGN)	South = 1; all other = 0
X_6(FB)	Ratio of foreign-born whites to native-born whites multiplied by 100 (1960, by sex)
X_7(MS)	Median number of years of school completed by persons age twenty and over (1960, by color and sex)
X_8(%RCC)	Per cent of persons in geographic unit residing in central cities (1960, by race)
X_9(%LAB)	Laborers except farm and mine workers as a per cent of all employed persons (1960, by race and sex)
X_{10}(%MWLFPC)	Per cent of married women with husband present and children under six who are in the labor force (1960, by color)
X_{11}(%MFG)	Per cent of employed persons in manufacturing (1960, by race and sex)
X_{12}(%BLK)	Per cent of population black (1960)
X_{13}(SEG)	Index of nonwhite residential segregation in SMSA's (1950)
X_{14}(ULCR)	Measure of psychological tensions: age-standardized death rate of persons age fourteen and over from ulcers of the stomach and duodenum (1959–61, color and sex, SMSA's only)
X'_{14}(ULCRD)	ULCR divided by age-standardized death rate from influenza and pneumonia (1959–61, by color and sex, SMSA's only)
X_{15}(ATMP)	Average annual temperature 1931–60 (SMSA's only)

X'_{15}(ATMP)^2	Square of annual average temperature 1931–60 (SMSA's only)
X_{16}(AHUM)	Average relative humidity in 1960 (SMSA's only)
X'_{16}(AHUM)^2	Square of average relative humidity in 1960 (SMSA's only)
X_{17}(DTMP)	Average daily maximum temperature minus average daily minimum temperature for 1960 (SMSA's only)
X_{18}(DHUM)	Absolute average daily deviation of relative humidity in 1960 (SMSA's only)
X_{19}(GASDR)	Density of automobile emissions (total consumption of gasoline divided by area of SMSA) expressed in rank form (1961–65, SMSA's only)
X'_{19}(GASDD)	GASDR above its median = 1; GASDR below its median = 0
X_{20}(ACSPR)	Arithmetic average concentration of suspended particulates expressed in rank form (1961–65, SMSA's only)
X'_{20}(ACSPD)	ACSPR above its median = 1; ACSPR below its median = 0
X_{21}(SO_2DR)	Density of sulfur dioxide emissions (total emissions of sulfur dioxide divided by area of SMSA) expressed in rank form (1961–65, SMSA's only)
X'_{21}(SO_2DR)	SO_2DR above its median = 1; SO_2DR below its median = 0
X_{22}(PHYS)	Employed physicians in medical practice per 10,000 population (1960)
X_{23}(%HOUS)	Per cent of housing units with 1.5 or more persons per room (1960, by color)
X_{24}(POPD)	Number of persons per square mile of land area in 1960
X_{25}(%FS)	Number residing outside the state and in the South in 1955 as a per cent of those five years old and over (1960, by color and sex, states only)
X_{26}(CIG)	Index of cigarette smoking in 1955 (by color and sex, states only)
X_{27}(WTRH)	Water hardness 1950–51 (states only)
X_{28}(HIGHW)	Per capita state and local expenditures on highways (1962)
X_{29}(WELF)	Per capita state and local expenditures on public welfare (1962)
X_{30}(HOSP)	Per capita state and local expenditures on hospitals (1962)
X_{31}(HLTH)	Per capita state and local expenditures on health services other than hospitals (1962)

X_{32}(POL)	Per capita state and local expenditures on police protection (1962)
X_{33}(FIRE)	Per capita state and local expenditures on fire protection (1962)
X_{34}(SAN)	Per capita state and local expenditures on sanitation including sewerage (1962)
	B. Supplementary Variables
X'_{8}(%RUA)	Per cent of persons in state residing in urbanized areas (1960, by race and sex)
X_{24N}(TPOP)	Total population of geographic unit
X_{28}(UO)	Per cent of state's nonagricultural workers belonging to unions in 1953
X_{29}(RS)	State employment change from 1950 to 1960 due to its regional share

Variables in the Demand for Health

The application of demand (or choice) theory to health and the empirical estimation of income and relative cost elasticities is quite natural. Like the more conventional goods, health provides psychic income to the household and is, in part, acquired through the expenditure of scarce resources—money and time. Further, the "quantity" of health is to some degree subject to "rational" calculation, i.e., it is not rigidly determined by cultural, technical, biological, and genetic factors.[4]

ECONOMIC VARIABLES: COMMAND OVER GOODS AND SERVICES (INCOME).[5] Command over goods and services is represented mainly by a measure of family income (X_1). However, key results are checked by using a measure of individual income (X'_1). The emphasis placed on results for family income and the use of a somewhat unorthodox measure of family income (the age-standardized income of husband-wife families) are explained by a number of considerations. First, most individuals are members of families that pool their economic resources.

[4] See Michael Grossman, "The Demand for Health: A Theoretical and Empirical Investigation," NBER, forthcoming.

[5] Theoretically, it is possible that changes in the earnings rate (X_2) as distinct from changes in income may affect the demand for health. However, in the present sample income and earnings rate are highly correlated and exploratory regressions produced the symptoms of serious multicollinearity. Since income is, at least in principle, the more general measure of command over goods and services, and neither economic theory nor intuition leads to confident predictions about the sign of earnings rate coefficients, it was decided to exclude EARNR from the analysis.

Second, the expected long-run income of young single individuals is measured better by family income and, more specifically, by husband-wife income than by their actual current income. Third, the lifetime realized income of older persons whose marriage partner has died is measured better by husband-wife income than by their actual current individual (or family) income. Fourth, variables not included in the statistical model might increase the mortality rate in a geographic unit, with a consequent increase in the proportion of families in which the husband or wife is deceased. An increase in the proportion of such families would reduce average family income and cause its estimated coefficient to be biased. This, however, would not be the case for husband-wife income. Fifth, the use of an income measure that is based on age-standardized husband-wife income operates to adjust income for what might be termed nondiscretionary variations in family size. To explicitly adjust income for the number of children would introduce a bias if, as I believe, the number of children depends upon the income of the married couple.

It is usually assumed that the income elasticity of demand for health is positive (i.e., that health is a "superior good"), but this would not be the case if certain goods the consumption of which is adverse to health (e.g., automobile usage, cigarettes, and rich foods) have sufficiently high positive income elasticities. Of course, it is proper to speak of an income elasticity of demand for health only if the consumer is aware of the effects (positive or negative) of his consumption decisions upon his health—if the health consequences of consuming certain items are not widely understood or are regarded as unproven,[6] it is conceivable that the magnitude and even the sign of the estimated income elasticity might not accurately reflect the household's health intentions.

Yet another problem in the estimation of income elasticities of demand for health is the existence of a number of nonconsumption factors that are positively correlated with income and that might tend to reduce health status. Such factors include psychological tensions and pressures associated with earning higher incomes, certain ways in which higher incomes are earned (e.g., arduous, sedentary, or risky types of work), aspects of the occupational and industrial distribution, and, perhaps, a higher opportunity cost for time spent by the household in the production of health. This problem is dealt with in two ways: (1) the best available measures of the troublesome factors were included in the multiple regressions, and (2), in addition to regressions including

[6] A possible example is cigarette smoking before the Surgeon General's report.

total family income (X_1) and total individual income (X'_1), special regressions were run utilizing crude estimates of labor income (X_{1L}) and nonlabor income (X_{1NL}) as measures of command over goods and services, and elasticities obtained for each.

HEALTH INFORMATION. The inclusion of a measure of health information is needed to standardize the analysis of other variables and is of independent interest. The cost of realizing a given level of health declines as the amount of health information available to the household increases, hence the "law of demand" predicts a positive relationship between such information and health. The measure employed is schooling (X_7), which is perhaps the best available indicator of spatial differences in the extent and diffusion of information pertaining to health. In addition to being more likely to have received training in such special topics as personal hygiene, sanitation, and nutrition, persons with more schooling know better how to seek out and select appropriate health services. Schooling also reduces the costs of acquiring sources of psychic income other than health, and consequently it is not really clear what happens to the *relative cost* of health. Additional difficulties arise in interpreting the coefficient of schooling because schooling probably increases the taste for health and is itself less arduous and dangerous than market work.[7]

The inclusion of schooling in the regressions substantially increases the difficulty of interpreting the results for income. This is true for a variety of reasons: (1) schooling is an alternative measure of wealth; (2) income is one of the determinants of the level of schooling; (3) holding schooling constant, increases in income might in large part be due to people "working harder" or doing more dangerous work; (4) higher incomes may lead individuals to improve their health status by demanding additional health information (schooling). Thus it is important and useful to pay careful attention to income coefficients derived from estimating equations that exclude schooling.

TASTE VARIABLES:[8] MARITAL STATUS, FERTILITY, AND REGION.

Marital Status. It is widely believed that being unmarried in a society such as our own subjects the individual to psychological stresses that ultimately reduce his health status. However, differences in attitudes associated with marital status may actually affect choices between health and other goods. For example, it seems likely that a married person will

[7] I owe the latter point to Charlotte Muller.

[8] Inconclusive exploratory findings for two additional taste variables—migration from the South (X_{25}) and nativity (X_6)—led to their exclusion from the analysis.

place a higher relative value on his health than a single person because the former has loved ones to consider and, on the average, the welfare of loved ones is more strongly dependent on the married person's health than upon his other sources of satisfaction (including those that have an adverse effect upon health).[9]

While emphasis upon the above line of reasoning leads to the classification of marital status as a taste variable, it might also be classified as an economic variable because being married may lower the relative prices of a number of health-producing items (e.g., nursing services and proper nutrition), with the consequence that the demand for these items and ultimately for health is increased. X_3 is the measure of marital status employed.

Fertility. There are two reasons for including a measure of the fertility of women (X_4) in the analysis. First, since higher fertility rates increase maternal (and related) mortality rates, they may reflect a desire to substitute a larger number of children or more frequent coition for health. Second, the fertility rate might be an inverse index of "rational behavior"—that is, a high fertility rate might be indicative of the fact that an individual weights present satisfactions highly relative to future ones. Such a weighting system would tend to impair health and raise mortality rates (e.g., through a lesser inclination to take preventive measures or through longer delays in seeking medical care). However, in view of the possibility that higher incomes lead married couples to demand smaller families in order to improve their health status it is wise to examine income coefficients derived from estimating equations which exclude fertility.

Region. A regional dummy variable might reflect a variety of cultural factors affecting choices between health and other goods. The South–non-South dichotomy reflected in X_5 is probably the most relevant.

Other Variables[10]

RESIDENCE. Our cities are no longer the "graveyard of countrymen," but, as Peterson points out, while epidemics no longer decimate the

[9] On the other hand, Charlotte Muller reminds me that marriage may sometimes induce persons, in the interest of loved ones, to "work harder" and make other choices with adverse health effects.

[10] The following additional variables were excluded from the analysis because exploratory regressions failed to convincingly demonstrate their importance: per cent in manufacturing (X_{11}), per cent of laborers excluding farm and mine

cities, "air pollution, traffic, overcrowding, and the stress of urban life still present special hazards."[11] However, these negative factors may be partially or wholly offset by medical care that is of higher quality and is more readily available in emergency cases. While a priori considerations do not dictate the expected sign, it seems worthwhile to include the per cent residing in central cities (X_8) as an independent variable.

PER CENT OF BLACK POPULATION. The per cent of the geographic unit's population that is black (X_{16}) may be relevant for at least two reasons: (1) this percentage may be positively correlated with the extent of racial discrimination against blacks[12] and may also reflect preferential treatment of whites in the areas of education and public health services; and (2) it may be positively correlated with the mortality rate of whites (and of blacks) because it represents greater "exposure" to blacks who, for example, suffer higher rates of various communicable diseases.

PSYCHOLOGICAL PRESSURES. It is commonly believed that the types of activities and circumstances causing significant increases in average incomes give rise to or are accompanied by psychological tensions and pressures that, in a variety of ways, tend to reduce health and shorten life. The regression coefficient of a measure of these tensions would be of independent interest and the inclusion of such a variable would make the coefficient of income a purer measure of the consumption aspect of health.

Perhaps the best available index of such pressures are death rates from ulcers of the stomach and duodenum (X_{14}).[13] Unlike other diseases that are believed to be caused or aggravated by tension, ulcers are responsible for only a small fraction of all deaths. Unfortunately, spatial variations in the death rate from ulcers may reflect factors such as the quality and quantity of medical care and attitudes toward

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workers (X_9), labor force participation of women with young children (X_{10}), residential segregation of blacks (X_{13}), overcrowded housing conditions (X_{23}), population density (X_{24}), and water hardness (X_{27}).

[11] William Peterson, *Population*, New York, 1961, p. 266.

[12] For references to the literature and some empirical evidence, see Gary S. Becker, *The Economics of Discrimination*, Chicago, 1957, pp. 98–99 and 104–107.

[13] See Gene Kaufman and Theodore D. Woolsey, "Sex Differences in the Trend of Mortality from Certain Chronic Diseases," *Public Health Reports*, 68, August 1953, pp. 761–68. The ulcer death rate was found to be positively correlated with family income for each of the four race-sex groups included in the study.

such care as well as differences in psychological tensions. A crude attempt is made to purge the ulcer death rate of its nontension dimensions by dividing X_{14} by the death rate from influenza and pneumonia. The resulting measure of tension is X'_{14}.

PHYSICIANS PER CAPITA. Employed physicians in medical practice per 10,000 population in 1960 (X_{22}) is taken to represent public health conditions and the availability of medical care in an area. However, in view of the fact that the level of income in an area plays an important role in determining both public health conditions and the availability of medical care, it is of the utmost importance to examine income coefficients derived from estimating equations that exclude physicians per capita.

CIGARETTE CONSUMPTION. There is some justification for classifying cigarette consumption as a variable in the demand for health because, as is well known, many individuals consciously substitute the pleasures of smoking for those flowing from better health. However, cigarette smoking has been classified as an "other" variable because its health consequences were not widely understood until recently. The measure employed is an index of cigarette smoking for 1955 (X_{26}).

CLIMATE. It has long been argued that climatic conditions have important effects on health.[14] Among the factors mentioned most frequently are average levels of temperature and relative humidity and their variability. Accordingly, measures of average temperature (X_{15}, X'_{15}), average relative humility (X_{16}, X'_{16}), the variability of temperature (X_{17}), and the variation of relative humidity (X_{18}) are included in the regressions.

AIR POLLUTION. Recently published data on various pollutants for sixty-five SMSA's with more than 40,000 manufacturing employees make possible an examination of the effects of air pollution in the context of a multivariate analysis for SMSA's. The published air pollution variables, in the form of ranks for 1961 (65 indicates the most severe pollution), refer to density of automobile emissions (X_{19}), concentration of suspended particulates (X_{20}, representing pollution from fuel burning, including motor vehicles, open burning, incinerators, manufacturing, etc.), and density of sulfur dioxide emissions (X_{21}). The ranked data are supplemented by the dummy pollution variables (X'_{19}–X'_{21}).

[14] For an elaborate discussion on this question and some empirical evidence, see Ellsworth Huntington, *Civilization and Climate*, New Haven, 1948, chapters 7–9.

3. REGRESSION ANALYSIS

Organization of the Regressions

The relationships discussed in Section 2 are investigated for each race-sex group by means of both ordinary least squares and two-stage least squares for states and SMSA's.[15] In the first stage, each of the independent variables considered "endogenous" is regressed upon the "exogenous" independent variables plus a number of "supplementary" variables intended to increase statistical efficiency. The second stage consists of replacing the actual values of the endogenous variables with their predicted values and estimating the desired parameters.

The use of two-stage least squares is justified by the possibility that it may mitigate problems like the following: (1) High mortality rates may lower family income and earnings if they are accompanied by or associated with high rates of work loss due to illness or injury and declines in productivity. (2) Payments made to persons *because* they are ill (e.g., certain veterans and public assistance payments) may dominate geographic variations in nonlabor income and at the same time reduce the variance in total income. (3) The coefficients of schooling and earnings would be biased if (a) high mortality rates, by reducing the period over which economic returns are expected to be earned, lowered the incentive to invest in formal education and in other activities that improve skills and move persons up the occupational ladder;[16] and (b) poor health reduced years of schooling by causing individuals to drop out of schools, or to be dropped, because of poor attendance or academic performance. (4) The coefficient of physicians per capita may be biased because "where health is poor, ceteris paribus, the demand for doctors [and other health-producing resources] will tend to be high."[17] (5) The coefficients of marital status and fertility may be biased because healthy persons are more likely to get married and have children than unhealthy ones. In addition, high fertility rates may be a deliberate response to high rates of child mortality which, in turn, are positively correlated with the mortality rate at all ages. (6) The coefficient of the ulcer death rate would be biased if a higher ulcer death rate merely reflected a generally unsatisfactory health situation.

[15] See J. Johnston, *Econometric Methods*, New York, 1963, chap. 9.

[16] The relationship between mortality rates and the incentive to invest in human capital is explored by Gary S. Becker in his *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, New York, NBER, 1964, pp. 49–50.

[17] See essay by Auster, Leveson, and Sarachek in this volume.

In addition to mitigating simultaneous equation problems, the use of two-stage least squares may improve estimates of coefficients by compensating for measurement errors in a more weakly measured endogenous variable like family income, which is based upon recall during an interview and does not take account of differences in price levels among geographic units. However, because of numerous statistical difficulties, the two-stage least squares results are utilized as a check, while conclusions are based primarily on the results for ordinary least squares.

The dependent variables utilized in the regressions are 1959–61 directly age-adjusted mortality rates for all ages (DDR, Y).[18] It is well known that deficiencies in the census coverage of the black population introduce errors into their mortality rates.[19] However, the important question for the regression analysis that follows is whether the degree of underreporting varies systematically with our independent variables. According to Siegel,

> There is evidence from the reinterview studies of 1960 of poorer enumeration of housing units in very large cities and in rural areas than in small and moderate-size cities and in suburbs. No specific evidence from these studies is available by race relating city-size variations in coverage, whether of housing units or of persons in enumerated housing units; so we cannot say definitely whether the Negroes in the very large cities are more or less completely counted than Negroes in small or moderate-size cities or rural areas. There is a basis for suggesting that Negroes are counted most poorly in the very large cities in the fact that the 1960 enumeration in urban slums was more difficult and took longer than in other urban segments and in rural areas.[20]

To some extent, bias problems caused by underreporting may be mitigated by the inclusion in the regressions of the residence variable (X_8), the per cent of black population (X_{12}), and population density (X_{24}). Furthermore, a special regression for blacks including the absolute size of the black population as an independent variable did not perceptibly alter regression coefficients.

Since many of the variables included in the "black" regressions in actuality refer to nonwhites, these regressions are restricted to states and SMSA's in which at least 70 per cent of the nonwhites are blacks.

[18] Where possible, key results are checked by means of indirectly age-adjusted mortality rates for all ages (IDR, Y').

[19] See Appendix B.

[20] Jacob S. Siegel, "Completeness of Coverage of the Nonwhite Population in the 1960 Census and Current Estimates, and Some Implications," in *Social Statistics and the City,* Cambridge, Mass., 1968, p. 56.

The "full sample" regressions for SMSA's include fifty-nine SMSA's for blacks and ninety-nine for whites,[21] while the corresponding sample sizes for states are thirty-two and forty-eight. Differences in the specifications of state and SMSA regressions are due to the unavailability of certain independent variables for a given type of geographic unit and the statistical requirements of the two-stage least squares analysis.

The natural value weighted regressions (the weights being the square roots of the numbers of persons in a race-sex group) shown in Table 9-1 are the outcome of extensive experimentation. Key results have been checked by means of unweighted regressions and logarithmic regressions. In order to conserve space and avoid burdening the general reader with excessive detail, the exploratory regressions are omitted here and are available from the author upon request.

Results for Ordinary Least Squares

INCOME. Regression 1 provides little or no evidence of a negative relationship between family income (MHWY) and mortality. In the case of black males the income coefficients are negative but statistically insignificant, while the coefficients are *positive* and usually significant for the other race-sex groups. However, excellent reasons for stressing income coefficients derived from estimating equations that exclude schooling (MS), physicians per capita (PHYS), and fertility (FRTL) are provided by the a priori arguments of Section 2 and some relatively high observed intercorrelations between the variables. For example, (a) the simple correlation coefficients between MHWY and FRTL are —0.54 (whites) and —0.76 (blacks) for SMSA's, while the corresponding values for states are —0.80 and —0.94; (b) for SMSA's the simple correlation coefficients between MHWY and MS range from 0.25 (white females) to 0.85 (black males), with the corresponding range for states at 0.46 to 0.94; (c) the simple correlations between MHWY and PHYS are 0.49 (whites) and 0.46 (blacks) for SMSA's, while the corresponding state values are 0.73 and 0.83; (d) the correlations between FRTL and MS are negative and reach values of —0.74 (SMSA's) and —0.92 (states) for black females;[22] (e) the correlations between MS and PHYS range from 0.31 (white females) to 0.66

[21] In some SMSA's certain white independent variables actually refer to the total population, but this is only the case where nonwhites represent a trivial fraction of the total population.

[22] These correlations may reflect the fact that both schooling and fertility are indexes of the level of contraceptive knowledge.

(black males) for SMSA's, while the corresponding range for states is 0.27 to 0.80.[23]

When MS, PHYS, and FRTL are excluded (see regression 1*) the results tend to support the existence of a *negative* relationship.[24] While the state income coefficients for whites are positive (significant for white males), the remaining income coefficients are negative and approach or achieve statistical significance at conventional levels.[25] The income coefficients for black males are significantly lower (taking account of signs) than those for white males.[26] The observed differences in state and SMSA results for income, and certain other variables, probably cannot be attributed to differences in the regional coverage of the regressions.[27] However, while the exact cause of this difference remains unclear,[28] serious problems of interpretation are forestalled by the fact that, with the application of two-stage least squares analysis (white females) and the replacement of total income by labor and nonlabor income (white males), the income results for states and SMSA's bear

[23] Exploratory regressions for SMSA's reveal that the inclusion of PHYS raises the adjusted coefficient of determination for each of the race-sex groups while it substantially reduces the magnitudes of the MS regression coefficients and computed t values.

[24] There are reasons for believing that the effect of income varies with its level—for example, it may decline because technical considerations bring about a state of affairs in which the expenditure of an extra dollar will bring no increase in length of life. (In such a situation individuals might be expected to turn increasingly to "close" substitutes for length of life such as goods and services promoting physiological well-being within a fixed length of life.) In order to take account of this possibility experiments were carried out with a dummy income variable (X''_1) and the per cent of families below the "poverty line" of $3,000 ($X'''_1$). The results are tainted by multicollinearity problems and do not convincingly demonstrate the existence of differences in effect over the income ranges considered in the race-sex regressions.

[25] Comparisons reveal that when family income (MHWY) is replaced by individual income (MPY), the results often vary perceptibly but rarely dramatically.

[26] But see the white male results for nonlabor income. A complete set of significance tests is available from the author.

[27] The results of a state regression excluding states not represented in the SMSA regressions differ in detail but not in substance from those noted in the text.

[28] The simple correlations between MHWY and DDR, by race-sex groups, are shown below:

	WM	*WF*	*BM*	*BF*
State	.24	.50	−.39	−.59
SMSA	.07	.19	−.30	−.39

TABLE 9-1

Natural Value Weighted[a] Regressions of Age-adjusted Mortality Rates for All Ages on Various Independent Variables (SMSA's and States, 1959–61): Second Stage of Two-Stage Least Squares and Corresponding Results for Ordinary Least Squares Analysis

Independent Variable	99 Observations		48 Observations		99 Observations		48 Observations	
	(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)	(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)
	WHITE MALES							
	← *Regression 1* →				← *Regression 1** →			
MHWY X_1	0.0001	0.0001	0.0003	0.0004	−0.0000	−0.0002	0.0003	0.0002
	[0.059]	[0.059]	[0.201]	[0.268]	[−0.000]	[−0.119]	[0.201]	[0.134]
	(0.60)	(0.94)	(1.37)	(2.82)[d]	(−0.22)	(−2.54)[c]	(2.31)[c]	(2.43)[c]
NLABY X_{1NL}	—	—	—	—	—	—	—	—
LABY X_{1L}	—	—	—	—	—	—	—	—
MRTL X_3	−0.111	−0.091	0.026	−0.028	−0.054	−0.093	0.042	−0.034
	[−0.641]	[−0.527]	[0.192]	[−0.209]	[−0.313]	[−0.538]	[0.312]	[−0.254]
	(−2.02)[c]	(−5.22)[d]	(0.38)	(−0.80)	(−1.68)	(−5.46)[d]	(0.92)	(−1.08)
FRTL X_4	0.006	0.0009	−0.0006	0.0002	—	—	—	—
	[1.066]	[0.174]	[−0.164]	[0.055]				
	(2.57)[c]	(2.95)[d]	(−0.58)	(0.69)				
MS X_7	−0.095	−0.204	−0.203	−0.175	—	—	—	—
	[−0.091]	[−0.196]	[−0.238]	[−0.205]				
	(−0.48)	(−3.05)[d]	(−1.60)	(−2.07)[c]				

(continued)

TABLE 9-1 (continued)

% RCC[b]	X_8	—	—	0.279 [0.009] (0.35)	−0.251 [−0.008] (−0.45)	—	—	−0.324 [−0.011] (−0.59)	−0.471 [−0.015] (−0.89)
% BLK[b]	X_{12}	0.093 [0.084] (4.08)[d]	0.047 [0.042] (6.56)[d]	0.009 [0.009] (0.98)	0.017 [0.018] (2.25)[c]	0.032 [0.029] (2.89)[d]	0.042 [0.038] (5.35)[d]	0.012 [0.013] (1.49)	0.018 [0.019] (2.36)[c]
ULCR	X_{14}	0.256 [0.248] (2.44)[c]	0.093 [0.090] (3.31)[d]	—	—	−0.016 [−0.015] (−0.18)	0.089 [0.086] (2.71)[d]	—	—
PHYS	X_{22}	0.041 [0.061] (1.13)	−0.015 [−0.021] (−1.42)	−0.052 [−0.074] (−0.68)	−0.014 [−0.020] (−0.43)	—	—	—	—
CIG[b]	X_{26}	—	—	0.012 [0.226] (2.25)[c]	0.011 [0.200] (2.57)[c]	—	—	0.014 [0.265] (3.21)[d]	0.011 [0.193] (2.67)[c]
Constant		2.46	16.03	7.31	8.21	15.31	17.90	2.29	8.66
R^2		0.280	0.584	0.445	0.511	0.139	0.396	0.397	0.433
$\bar{R}^2$		0.224	0.552	0.331	0.410	0.102	0.370	0.325	0.365

(continued)

TABLE 9-1 (continued)

Independent Variable		99 Observations (2-SLS, SMSA) (OLS, SMSA)		48 Observations (2-SLS, State) (OLS, State)		99 Observations (2-SLS, SMSA) (OLS, SMSA)		48 Observations (2-SLS, State) (OLS, State)	
		WHITE MALES							
		← Regression 2 →				← Regression 2* →			
MHWY	X_1	—	—	—	—	—	—	—	—
NLABY	X_{1NL}	0.002 [0.336] (0.60)	−0.0002 [−0.034] (−0.75)	−0.002 [−0.298] (−1.53)	−0.0003 [−0.056] (−0.47)	−0.002 [−0.370] (−3.53)[d]	−0.0008 [−0.135] (−3.64)[d]	−0.002 [−0.280] (−2.14)[c]	−0.0007 [−0.131] (−1.72)
LABY	X_{1L}	−0.0001 [−0.043] (−0.26)	0.0001 [0.043] (1.43)	0.0007 [0.338] (2.31)[d]	0.0005 [0.241] (3.07)[d]	0.0004 [0.170] (2.01)[c]	−0.0000 [−0.000] (−0.06)	0.0007 [0.338] (3.41)[d]	0.0004 [0.193] (2.79)[d]
MRTL	X_3	−0.122 [−0.705] (−2.09)[c]	−0.099 [−0.570] (−5.33)[d]	−0.111 [−0.832] (−1.13)	−0.056 [−0.421] (−1.34)	−0.147 [−0.846] (−3.69)[d]	−0.119 [−0.684] (−6.34)[d]	−0.056 [−0.423] (−0.98)	−0.079 [−0.593] (−2.14)[c]
FRTL	X_4	0.010 [1.976] (1.18)	0.0008 [0.155] (2.58)[d]	−0.0004 [−0.109] (−0.48)	0.0001 [0.027] (0.26)	—	—	—	—
MS	X_7	0.075 [0.072] (0.21)	−0.206 [−0.199] (−3.10)[d]	0.005 [0.006] (0.03)	−0.147 [−0.172] (−1.67)	—	—	—	—

(continued)

TABLE 9-1 (continued)

% RCC[b]	X_8	—	—	−0.480	−0.489	—	—	−0.981	−0.792
				[−0.016]	[−0.016]			[−0.032]	[−0.026]
				(−0.54)	(−0.59)			(−1.69)	(−1.50)
% BLK[b]	X_{12}	0.133	0.046	0.020	0.020	0.045	0.043	0.023	0.022
		[0.121]	[0.042]	[0.021]	[0.021]	[0.041]	[0.039]	[0.024]	[0.024]
		(1.79)	(6.48)[d]	(1.90)	(2.51)[c]	(4.05)[d]	(5.60)[d]	(2.59)[c]	(2.92)[d]
ULCR	X_{14}	0.259	0.100	—	—	0.170	0.104	—	—
		[0.251]	[0.097]			[0.164]	[0.101]		
		(2.45)[c]	(3.49)[d]			(1.74)	(3.24)[d]		
PHYS	X_{22}	0.067	−0.012	−0.076	−0.010	—	—	—	—
		[0.099]	[−0.018]	[−0.107]	[−0.014]				
		(1.14)	(−1.12)	(−1.01)	(−0.30)				
CIG[b]	X_{26}	—	—	0.018	0.012	—	—	0.018	0.013
				[0.333]	[0.222]			[0.334]	[0.246]
				(2.95)[d]	(2.80)[d]			(4.07)[d]	(3.34)[d]
Constant		−12.82	16.82	15.14	10.69	21.12	19.50	9.28	11.80
R^2		0.282	0.591	0.492	0.528	0.245	0.444	0.478	0.489
$\bar{R}^2$		0.218	0.555	0.372	0.416	0.204	0.414	0.402	0.414

(continued)

TABLE 9-1 (continued)

Independent Variable		99 Observations (2-SLS, SMSA)	99 Observations (OLS, SMSA)	48 Observations (2-SLS, State)	48 Observations (OLS, State)	99 Observations (2-SLS, SMSA)	99 Observations (OLS, SMSA)	48 Observations (2-SLS, State)	48 Observations (OLS, State)
		WHITE FEMALES							
		← *Regression 1*			→	← *Regression 1**			→
MHWY	X_1	−0.002 [−1.782] (−0.77)	0.0003 [0.281] (3.48)[d]	−0.0000 [−0.000] (−0.03)	0.0003 [0.332] (4.54)[d]	−0.001 [−1.219] (−3.12)[d]	−0.0002 [−0.188] (−1.99)	−0.0001 [−0.111] (−0.93)	0.0001 [0.111] (0.73)
NLABY	X_{1NL}	—	—	—	—	—	—	—	—
LABY	X_{1L}	—	—	—	—	—	—	—	—
MRTL	X_3	−0.116 [−0.978] (−1.50)	−0.097 [−0.820] (−7.47)[d]	−0.019 [−0.223] (−0.33)	−0.055 [−0.639] (−3.18)[d]	−0.147 [−1.238] (−5.25)[d]	−0.084 [−0.710] (−6.52)[d]	−0.088 [−1.025] (−4.51)[d]	−0.080 [0.938] (−5.05)[d]
FRTL	X_4	−0.004 [−1.224] (−0.58)	0.0009 [0.275] (3.98)[d]	−0.0005 [−0.226] (−0.55)	0.0008 [0.361] (3.80)[d]	—	—	—	—
REGN[b]	X_5	−2.635 [−0.061] (−0.95)	−0.349 [−0.008] (−2.86)[d]	−0.519 [−0.026] (−2.88)[d]	−0.346 [−0.017] (−3.36)[d]	−1.934 [−0.045] (−4.46)[d]	−0.666 [−0.015] (−3.75)[d]	−0.436 [−0.022] (−2.64)[c]	−0.334 [−0.004] (−2.24)[c]
MS	X_7	−0.037 [−0.056] (−0.09)	−0.262 [−0.402] (−5.07)[d]	−0.356 [−0.721] (−2.32)[c]	−0.251 [−0.508] (−4.95)[d]	—	—	—	—

(continued)

TABLE 9-1 (continued)

% RCC[b]	X_8	—	—	0.161 [0.009] (0.30)	−0.278 [−0.016] (−0.95)	—	—	−0.232 [−0.013] (−0.55)	−0.205 [−0.011] (−0.52)
% BLK[b]	X_{12}	0.068 [0.097] (1.56)	0.023 [0.033] (3.71)[d]	0.009 [0.015] (1.19)	0.012 [0.021] (2.44)[c]	0.080 [0.115] (3.63)[d]	0.031 [0.044] (3.47)[d]	0.014 [0.024] (1.88)	0.011 [0.019] (1.58)
ULCR	X_{14}	−0.381 [−0.172] (−0.35)	0.103 [0.047] (2.19)[c]	—	—	−0.007 [−0.003] (−0.02)	0.148 [0.067] (2.16)[c]	—	—
PHYS	X_{22}	−0.046 [−0.109] (−0.83)	−0.027 [−0.063] (−3.15)[d]	−0.018 [−0.041] (−0.28)	0.001 [0.002] (0.05)	—	—	—	—
CIG[b]	X_{26}	—	—	0.014 [0.111] (1.88)	0.012 [0.097] (2.22)[c]	—	—	0.007 [0.053] (0.83)	−0.0004 [−0.003] (−0.05)
WELF[b]	X_{29}	—	—	−0.005 [−0.023] (−1.00)	−0.010 [−0.050] (−3.19)[d]	—	—	−0.005 [−0.023] (0.99)	−0.010 [−0.049] (−2.24)[c]
Constant		38.89	12.56	11.65	7.79	24.59	13.06	11.56	10.62
R^2		0.472	0.798	0.746	0.860	0.457	0.526	0.647	0.675
$\bar{R}^2$		0.425	0.780	0.677	0.823	0.428	0.501	0.585	0.618

(continued)

TABLE 9-1 (continued)

Independent Variable		99 Observations		48 Observations		99 Observations		48 Observations	
		(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)	(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)
		WHITE FEMALES							
		← Regression 2 →				← Regression 2* →			
MHWY	X_1	—	—	—	—	—	—	—	—
NLABY	X_{1NL}	−0.0006	0.0004	0.0001	0.0004	−0.003	0.0002	−0.0000	0.0002
		[−0.479]	[0.319]	[0.094]	[0.377]	[−1.996]	[0.160]	[−0.000]	[0.188]
		(−0.55)	(6.26)[d]	(0.20)	(4.82)[d]	(−2.44)[c]	(1.81)	(−0.09)	(1.84)
LABY	X_{1L}	0.012	−0.0001	−0.0003	−0.0000	0.0000	−0.001	−0.0005	−0.0005
		[1.617]	[0.014]	[−0.049]	[−0.000]	[0.000]	[−0.195]	[−0.082]	[−0.082]
		(0.99)	(−0.38)	(−0.57)	(−0.11)	(0.03)	(−5.17)[d]	(−1.29)	(−1.69)
MRTL	X_3	−0.454	−0.096	0.016	−0.053	−0.190	−0.083	−0.088	−0.081
		[−3.836]	[−0.813]	[−0.190]	[−0.613]	[−1.602]	[−0.704]	[−1.031]	[−0.942]
		(−1.11)	(−7.16)[d]	(−0.28)	(−3.10)[d]	(−4.41)[d]	(−7.17)[d]	(−4.55)[d]	(−5.24)[c]
FRTL	X_4	0.022	0.0007	−0.0004	0.0007	—	—	—	—
		[6.699]	[0.214]	[−0.180]	[0.316]				
		(1.06)	(3.03)[d]	(−0.42)	(3.53)[d]				
REGN[b]	X_5	—	—	−0.522	−0.342	−2.987	−0.455	−0.443	−0.329
				[−0.026]	[−0.017]	[−0.069]	[−0.011]	[−0.022]	[−0.016]
				(−2.88)[d]	(−3.44)[d]	(−3.29)[d]	(−2.74)[d]	(−2.67)[c]	(−2.28)[c]
MS	X_7	−0.213	−0.276	−0.360	−0.249	—	—	—	—
		[−0.327]	[−0.423]	[−0.729]	[−0.505]				
		(−0.86)	(−5.25)[d]	(−2.33)[c]	(−5.01)[d]				

(continued)

TABLE 9-1 (continued)

% RCC[b]	X_8	—	—	0.033	−0.366	—	—	−0.299	−0.334
				[0.002]	[−0.021]			[−0.017]	[−0.019]
				(0.06)	(−1.25)			(−0.70)	(−0.80)
% BLK[b]	X_{12}	0.207	0.011	0.012	0.014	0.117	0.025	0.017	0.015
		[0.296]	[0.016]	[0.020]	[0.025]	[0.168]	[0.355]	[0.030]	[0.027]
		(1.12)	(2.25)[c]	(1.36)	(2.85)[d]	(3.27)[d]	(3.08)[d]	(2.17)[c]	(2.17)[c]
ULCR	X_{14}	2.008	0.109	—	—	−0.082	0.135	—	—
		[0.909]	[0.049]			[−0.037]	[0.061]		
		(1.29)	(2.28)[c]			(−0.27)	(2.18)[c]		
PHYS	X_{22}	0.096	−0.024	−0.006	0.005	—	—	—	—
		[0.226]	[−0.056]	[−0.014]	[0.012]				
		(0.85)	(−2.74)[d]	(−0.09)	(0.25)				
CIG[b]	X_{26}	—	—	0.015	0.013	—	—	0.008	0.001
				[0.118]	[0.100]			[0.065]	[0.009]
				(1.96)	(2.33)[c]			(1.01)	(0.16)
WELF[b]	X_{29}	—	—	−0.005	−0.009	—	—	−0.005	−0.009
				[−0.025]	[−0.047]			[−0.024]	[−0.043]
				(−1.07)	(−2.99)[d]			(−1.01)	(−2.99)[d]
Constant		−30.05	12.19	11.03	7.74	33.26	12.04	11.49	10.44
R^2		0.472	0.788	0.749	0.869	0.467	0.619	0.656	0.703
$\bar{R}^2$		0.425	0.770	0.672	0.829	0.432	0.594	0.588	0.642

(continued)

TABLE 9-1 (continued)

Independent Variable		59 Observations		32 Observations		59 Observations		32 Observations	
		(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)	(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)
		BLACK MALES							
		← *Regression 1* →				← *Regression 1** →			
MHWY	X_1	−0.0005 [−0.153] (−0.55)	−0.0001 [−0.031] (−0.16)	−0.0002 [−0.058] (−0.23)	−0.0000 [−0.000] (−0.03)	−0.001 [−0.307] (−3.50)[d]	−0.0009 [−0.276] (−4.49)[d]	−0.001 [−0.347] (−2.45)[c]	−0.001 [−0.318] (−2.92)[d]
NLABY	X_{1NL}	—	—	—	—	—	—	—	—
LABY	X_{1L}	—	—	—	—	—	—	—	—
MRTL	X_3	−0.070 [−0.262] (−0.32)	−0.154 [−0.580] (−3.22)[d]	−0.189 [−0.857] (−1.22)	−0.281 [−1.277] (−3.71)[d]	0.065 [0.247] (0.45)	−0.181 [−0.683] (−3.72)[d]	−0.243 [−1.104] (−1.76)	−0.289 [−1.312] (−3.98)[d]

(continued)

TABLE 9-1 (continued)

MS	X_7	−0.470 [−0.280] (−0.66)	−0.550 [−0.328] (−1.81)	−0.894 [−0.541] (−2.05)[c]	−0.841 [−0.509] (−2.86)[d]	—	—	—	—
% RCC[b]	X_8	—	—	1.911 [0.078] (1.06)	1.567 [0.064] (1.15)	—	—	1.629 [0.066] (0.87)	0.729 [0.029] (0.49)
ULCR	X_{14}	0.408 [0.285] (2.95)[d]	0.135 [0.095] (2.99)[d]	—	—	0.369 [0.258] (2.74)[e]	0.130 [0.091] (2.61)[e]	—	—
PHYS	X_{22}	−0.074 [−0.087] (−0.62)	−0.056 [−0.067] (−1.49)	0.065 [0.061] (0.47)	−0.059 [−0.056] (−0.65)	—	—	—	—
Constant		21.27	27.15	27.91	33.65	11.60	26.71	28.91	31.38
R^2		0.246	0.505	0.380	0.607	0.218	0.376	0.280	0.461
$\bar{R}^2$		0.175	0.458	0.261	0.531	0.175	0.342	0.203	0.404

(continued)

TABLE 9-1 (continued)

Independent Variable		59 Observations		32 Observations		59 Observations		32 Observations	
		(2-SLS, SMSA) (OLS, SMSA)		(2-SLS, State) (OLS, State)		(2-SLS, SMSA) (OLS, SMSA)		(2-SLS, State) (OLS, State)	
		BLACK MALES							
		Regression 2				*Regression 2**			
MHWY	X_1	—	—	—	—	—	—	—	—
NLABY	X_{1NL}	−0.004 [−0.333] (−0.45)	0.002 [0.180] (2.40)[e]	0.002 [0.140] (0.50)	0.002 [0.196] (1.46)	−0.003 [−0.306] (−1.92)	−0.0005 [−0.045] (−0.62)	−0.0006 [−0.056] (−0.31)	−0.0004 [−0.037] (−0.30)
LABY	X_{1L}	−0.0002 [−0.043] (−0.20)	−0.0006 [−0.130] (−1.52)	−0.0004 [−0.078] (−0.48)	−0.0004 [−0.078] (−0.82)	−0.0007 [−0.152] (−1.76)	−0.001 [−0.022] (−3.56)[d]	−0.001 [−0.275] (−2.01)	−0.001 [−0.255] (−2.39)[e]
MRTL	X_3	−0.021 [−0.078] (−0.08)	−0.107 [−0.405] (−2.24)[e]	−0.169 [−0.768] (−1.06)	−0.254 [−1.153] (−3.35)[d]	−0.076 [−0.286] (−0.43)	−0.169 [−0.639] (−3.20)[d]	−0.217 [−0.986] (−1.35)	−0.272 [−1.232] (−3.31)[d]

(continued)

TABLE 9-1(continued)

MS	X_7	−0.351 [−0.209] (−0.45)	−0.422 [−0.251] (−1.45)	−0.912 [−0.552] (−2.06)[c]	−0.876 [−0.530] (−3.05)[d]	—	—	—	—
% RCC[b]	X_8	—	—	2.486 [0.101] (1.20)	2.426 [0.099] (1.69)	—	—	1.842 [0.075] (0.92)	0.961 [0.392] (0.60)
ULCR	X_{14}	0.461 [0.322] (2.40)[c]	0.117 [0.082] (2.72)[d]	—	—	0.450 [0.315] (3.08)[d]	0.125 [0.087] (2.46)[c]	—	—
PHYS	X_{22}	0.078 [0.092] (0.20)	−0.116 [−0.138] (−2.77)[d]	−0.014 [−0.014] (−0.07)	−0.129 [−0.123] (−1.31)	—	—	—	—
Constant		17.90	23.84	26.32	31.38	20.36	25.94	27.04	29.99
R^2		0.248	0.566	0.389	0.642	0.244	0.380	0.283	0.466
$\bar{R}^2$		0.161	0.516	0.242	0.556	0.188	0.334	0.177	0.387

(continued)

TABLE 9-1 (continued)

Independent Variable		59 Observations		32 Observations		59 Observations		32 Observations	
		(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)	(2-SLS, SMSA)	(OLS, SMSA)	(2-SLS, State)	(OLS, State)
		BLACK FEMALES							
		Regression 1				*Regression 1**			
MHWY	X_1	0.0008 [0.330] (1.49)	0.0005 [0.206] (2.29)[c]	0.001 [0.470] (1.36)	0.0007 [0.274] (2.79)[d]	−0.0007 [−0.289] (−3.23)[d]	−0.0006 [−0.248] (−3.90)[d]	−0.0006 [−0.235] (−1.57)	−0.0004 [−0.159] (−1.28)
NLABY	X_{1NL}	—	—	—	—	—	—	—	—
LABY	X_{1L}	—	—	—	—	—	—	—	—
MRTL	X_3	0.125 [0.556] (0.53)	−0.078 [−0.344] (−2.87)[d]	−0.151 [−0.815] (−1.82)	−0.140 [−0.757] (−4.24)[d]	−0.031 [−0.136] (−0.82)	−0.075 [−0.331] (−2.89)[d]	−0.085 [−0.459] (−1.76)	−0.113 [−0.609] (−3.21)[d]
FRTL	X_4	−0.004 [−0.830] (−1.13)	−0.0001 [−0.023] (−0.16)	0.0008 [0.267] (0.45)	0.0002 [0.067] (0.35)	—	—	—	—

(continued)

TABLE 9-1 (continued)

REGN[b]	X_5	—	—	0.899 [0.060] (0.85)	0.457 [0.031] (1.25)	—	—	−0.034 [−0.002] (−0.05)	0.256 [0.017] (0.49)
MS	X_7	−2.465 [−2.142] (−1.65)	−0.861 [−0.748] (−3.87)[d]	−0.744 [−0.687] (−1.80)	−0.728 [−0.672] (−4.00)[d]	—	—	—	—
% RCC[b]	X_8	—	—	1.908 [0.109] (1.36)	1.447 [0.083] (1.98)	—	—	1.082 [0.062] (0.94)	0.523 [0.030] (0.55)
ULCR	X_{14}	0.093 [0.028] (0.40)	0.081 [0.024] (1.28)	—	—	0.374 [0.111] (1.71)	0.140 [0.042] (1.61)	—	—
PHYS	X_{22}	0.044 [0.071] (0.20)	−0.075 [−0.121] (−3.17)[d]	−0.194 [−0.249] (−1.83)	−0.144 [−0.185] (−3.01)[d]	—	—	—	—
WELF[b]	X_{29}	—	—	−0.032 [−0.094] (−3.25)[d]	−0.036 [−0.104] (−5.31)[d]	—	—	−0.032 [−0.092] (−2.68)[c]	−0.031 [−0.090] (−2.94)[d]
Constant		31.69	21.44	17.30	20.40	13.81	16.26	15.39	16.00
R^2		0.350	0.676	0.723	0.870	0.160	0.293	0.472	0.570
$\bar{R}^2$		0.275	0.639	0.626	0.825	0.114	0.254	0.370	0.487

(continued)

TABLE 9-1 (continued)

Independent Variable		59 Observations (2-SLS, SMSA) (OLS, SMSA)		32 Observations (2-SLS, State) (OLS, State)		59 Observations (2-SLS, SMSA) (OLS, SMSA)		32 Observations (2-SLS, State) (OLS, State)	
		BLACK FEMALES							
		← *Regression 2* →				← *Regression 2** →			
MHWY	X_1	—	—	—	—	—	—	—	—
NLABY	X_{1NL}	0.007 [2.219] (1.33)	0.0008 [0.269] (2.99)[d]	0.001 [0.354] (1.26)	0.0008 [0.258] (2.89)[d]	0.002 [0.773] (2.82)[d]	0.0003 [0.101] (1.04)	0.0002 [0.064] (0.32)	0.0002 [0.064] (0.70)
LABY	X_{1L}	−0.039 [−2.960] (−1.15)	−0.0006 [−0.046] (−0.96)	0.002 [0.161] (0.88)	0.0000 [0.000] (0.05)	0.010 [−0.742] (−4.00)[d]	−0.003 [−0.214] (−4.41)[d]	−0.003 [−0.218] (−2.24)[c]	−0.003 [−0.176] (−2.82)[d]
MRTL	X_3	−0.075 [−0.331] (−1.00)	−0.095 [−0.422] (−3.39)[d]	−0.153 [−0.827] (−1.81)	−0.147 [−0.793] (−4.30)[d]	−0.386 [−1.717] (−3.83)[d]	−0.133 [−0.589] (−4.65)[d]	−0.176 [−0.952] (−2.63)[c]	−0.168 [−0.908] (−4.34)[d]
FRTL	X_4	−0.006 [−1.267] (−1.55)	−0.0001 [−0.023] (−0.22)	0.0008 [0.267] (0.45)	0.0002 [−0.067] (0.43)	—	—	—	—
REGN[b]	X_5	—	—	1.239 [0.083] (0.95)	0.324 [0.022] (0.81)	—	—	−0.356 [−0.024] (−0.56)	−0.067 [−0.005] (−0.14)

(continued)

TABLE 9-1 (concluded)

MS	X_7	1.362	−0.874	−0.719	−0.711	—	—	—	—
		[1.183]	[−0.760]	[−0.664]	[−0.656]				
		(0.38)	(−4.01)[d]	(−1.70)	(−3.86)[d]				
% RCC[b]	X_8	—	—	2.293	1.264	—	—	−0.008	−0.264
				[0.131]	[0.072]			[−0.005]	[−0.015]
				(1.38)	(1.65)			(−0.01)	(−0.29)
ULCR	X_{14}	4.387	0.110	—	—	1.334	0.196	—	—
		[1.306]	[0.033]			[0.397]	[0.058]		
		(1.19)	(1.72)			(4.12)[d]	(2.44)[c]		
PHYS	X_{22}	0.500	−0.055	−0.263	−0.121	—	—	—	—
		[0.799]	[−0.089]	[−0.339]	[−0.156]				
		(1.12)	(−2.18)[c]	(−1.40)	(−2.20)[c]				
WELF[b]	X_{29}	—	—	−0.031	−0.036	—	—	−0.032	−0.030
				[−0.090]	[−0.104]			[−0.094]	[−0.086]
				(−2.96)[d]	(−5.29)[d]			(−2.86)[d]	(−3.08)[d]
Constant		41.34	21.69	16.97	20.52	24.29	17.49	19.91	18.85
R^2		0.367	0.697	0.725	0.874	0.332	0.428	0.537	0.657
$\bar{R}^2$		0.280	0.655	0.613	0.823	0.283	0.385	0.426	0.575

Note: Two sets of regressions are shown, with the second identified by an asterisk to indicate omission of MS, PHYS, and FRTL. 2-SLS indicates results from the second stage of a two-stage least squares analysis. OLS indicates results from an ordinary least squares analysis. The regression coefficient appears first, followed by the elasticity at means, in brackets, and the computed t values, in parentheses.

[a] The weights are the square roots of the populations of the race-sex groups.

[b] Exogenous variable.

[c] The coefficient is statistically significant at the .05 level of significance.

[d] The coefficient is statistically significant at the .01 level of significance.

a closer resemblance.[29] The MHWY elasticities of the mortality rate derived from regression 1* range from —0.12 (white males) to —0.28 (black males) for SMSA's, while the range for states is 0.13 (white males) to —0.32 (black males).

The fact that health-producing goods and services consumed by less affluent households are sometimes paid for directly (by charity) or indirectly (by taxes) by more affluent households might produce a positive correlation between income and the "cost" of health. Such a correlation would cause underestimation of income regression coefficients that might be especially severe for blacks. In order to quantify this type of bias, I ran experimental black regressions that included white family income as well as other regressions that included a variety of public expenditure variables. The coefficients of white income have the expected negative signs (not significant), but the inclusion of white family income does not materially alter the coefficients of black income. The coefficients of the public expenditure variables are usually negative, but their inclusion has little or no systematic impact upon the black MHWY coefficients.

Bias in the estimated coefficients, especially the income coefficient, may have resulted from the failure to adjust the income figures for price level differences among geographic units at a given time. Unfortunately, the 1959 crude price data are available for only fifteen of the SMSA's included in the white and black regressions.[30] The reader may wish to use the results of regressions (excluding MS, PHYS, and FRTL) for these fifteen SMSA's to roughly gauge the magnitude of bias in the full sample income coefficients. In the case of white males the coefficient of "money" MHWY is —0.0003, while that of "real" MHWY is —0.0005; for white females the comparable figures are —0.0005 and —0.0007, for black males, —0.0017 and —0.0023, and for black females, —0.0009 and —0.0015.

Certain nonconsumption factors cause the "pure" income effect to be underestimated by simultaneously being correlated positively with income and tending to reduce health status, as pointed out in Section 2. To some extent the analysis has already been standardized for such factors by including ULCR, %MFG, %LAB, EARNR, %RCC, and

[29] It should be noted that the state income results already resemble those for SMSA's in that the exclusion of MS, PHYS, and FRTL reduces the algebraic values of the regression coefficients.

[30] The source of the price data is Helen H. Lamale and Margaret S. Stotz, "The Interim City Worker's Family Budget," *Monthly Labor Review*, August 1960, Table 2.

POPD in the regressions. However, at this point an attempt is made to obtain direct evidence on this question by replacing total family income (MHWY) by crude estimates of its labor (LABY) and nonlabor (NLABY) components. In regressions 2 and 2* for white males the coefficients of NLABY are negative in every case (approaching or achieving significance when MS, FRTL, and PHYS are excluded), while the coefficients of LABY are either positive (significant for states) or negative, but smaller in magnitude than the coefficient of NLABY.

These results are consistent with the view that for white males the observed coefficients of total family income represent a compromise between the favorable health effects of a "pure" increase in income and the unfavorable (or less favorable) health effects of increases in earnings resulting from "working harder" and doing more dangerous or sedentary types of work. On the other hand, for reasons that are uncertain, the results for the other race-sex groups tend to be unstable and the differences in labor and nonlabor coefficients do not lend themselves to meaningful interpretations.[31] It is important to note that when the comparison is between the white male coefficient for NLABY and the black male coefficient for MHWY, the observed racial income differential is considerably narrowed.

SCHOOLING (MS). There are difficulties in disentangling the health effects of schooling and income, but the regression coefficients of schooling consistently have the expected negative sign and often achieve statistical significance. The schooling elasticities derived from regression 1 are among the largest for each race-sex group, ranging from —0.20 (white males) to —0.75 (black females) for SMSA's.

Exploratory regressions reveal that even after account has been taken of MHWY, FRTL (a measure of contraceptive knowledge), and PHYS (reflecting the availability of medical care), the inclusion of MS increases (sometimes materially) the adjusted coefficients of determination. Tentatively, it may be concluded that health information plays an important role in determining mortality. Further, while increases in the demand for medical services and in the level of contraceptive knowledge may be important channels through which schooling exerts its influence, they are not the only channels.

MARITAL STATUS (MRTL). The regression coefficients of MRTL

[31] In this connection it must be noted that not only is our NLABY variable a crude estimate of "nonlabor income" but nonlabor income is itself a crude estimate of "pure" income. Capital gains, for example, may be achieved by means of difficult and anxiety-provoking work.

have the expected negative sign and typically are statistically significant. The marital status elasticities derived from regression 1 are among the largest for each race-sex group, ranging from —0.34 (black females) to —0.82 (white females).

FERTILITY (FRTL). The coefficients of FRTL have the expected positive sign, but consistent statistical significance is achieved only for white females.[32] The elasticities for white females are relatively high: 0.28 (SMSA's) and 0.36 (states). The failure of FRTL for black females is probably explained by its high correlation with schooling (—0.74 for SMSA's)[33]—exploratory regressions reveal that when MS is excluded the coefficient for black females is positive and significant.

The relative weakness of the FRTL results for males[34] casts doubt on the view that fertility can be regarded as an inverse index of "rational behavior" (see Section 2).

REGION (REGN). The coefficients for white females are negative and significant while those for black females are positive and sometimes significant in exploratory regressions for SMSA's.[35] The results suggest that residence in the South reduces the mortality rate of white women while it increases the rate for black women.

RESIDENCE (%RCC). The results for %RCC weakly suggest that for blacks the negative health aspects of residence in the central cities of SMSA's outweigh the positive aspects.[36]

PER CENT OF BLACK POPULATION (%BLK). The coefficients of %BLK are positive and significant for whites, but this variable is ex-

[32] The finding for white females is consistent with a recent study making use of data on deaths and various socioeconomic characteristics of individuals. The study found a positive association between mortality ratios, standardized for age and education, and fertility for white females. See Evelyn M. Kitagawa, "Social and Economic Differentials in Mortality in the United States, 1960," paper prepared for a session on socioeconomic differentials in mortality of the General Assembly and Conference of International Union for Scientific Study of Population, London, September 3–11, 1969.

[33] The corresponding correlation for white females is only − 0.17. The basis for the racial difference in the correlation between fertility and schooling is uncertain, but a racial difference in the correlation between the levels of schooling and contraceptive knowledge and practice is suspected.

[34] FRTL is excluded from the estimating equation for black males because exploratory regressions show that its coefficient is negative and very insignificant even when MS is excluded.

[35] The REGN variable is excluded from the male regressions because exploratory regressions reveal that the coefficients for white males fluctuate in sign and are insignificant, while those for black males are positive but never significant.

[36] The results for whites are mixed. While the state coefficients are *negative*, those observed in exploratory regressions for SMSA's are *positive*.

cluded from the black regressions because exploratory regressions reveal that its coefficients, while positive, are extremely insignificant. The basis for the racial difference in the impact of %BLK is uncertain, but it should be noted that in the case of blacks %BLK is highly correlated across SMSA's with MHWY (−0.67) and MS (−0.70).[37]

PSYCHOLOGICAL TENSION (ULCR). The coefficients of ULCR take the expected positive sign and are highly significant for males.[38] The estimated ULCR elasticities derived from regression 1 are relatively high: 0.09 (for both white and black males).

PHYSICIANS PER CAPITA (PHYS). The coefficients of PHYS have the expected negative sign, except for state data on white females.[39] That statistical significance is achieved only for females may indicate that geographic variations in the availability of medical care during childbirth significantly affect female health.

CIGARETTE SMOKING (CIG). The results for the cigarette variable provide additional evidence of a positive relationship between smoking and mortality. The elasticity of 0.20 for white males is among the highest in the study.[40]

PUBLIC WELFARE (WELF). The coefficients of WELF have the ex-

[37] The corresponding correlation coefficients for whites are 0.14 for MHWY and −0.01 (males) and −0.04 (females) for MS.

[38] ULCR rather than ULCRD (the ratio of the ulcer death rate to the death rate from influenza and pneumonia) is chosen to measure psychological tensions because exploratory regressions for SMSA's reveal that (1) the coefficient of ULCR always has the expected positive sign while the coefficient of the "deflated" ulcer variable is negative for black males, (2) computed *t* values are larger for the undeflated ulcer variable, and (3) the coefficients of multiple determination are somewhat larger when ULCR is utilized. Further, a tension variable is needed mainly to standardize the results for income, and in this respect the undeflated variable seems to have the advantage—the income coefficients are consistently negative and, with the exception of black females, the negative computed *t* values are greater in magnitude.

[39] The fact that the results for PHYS are much weaker for states than for SMSA's is probably due to much higher correlations between PHYS and other independent variables in states.

[40] In the case of blacks the regression coefficients of CIG, in exploratory regressions, are positive and insignificant for males but negative and respectable for females. Given the crude nature of the black CIG estimates (see Appendix A), it was decided to exclude this variable from the black regressions. For reasons that are unclear the regression coefficient of CIG for white females is negative and insignificant when MS, PHYS, and FRTL are excluded (regression 1*). Charlotte Muller has suggested that race and sex differences in the effect of smoking might be due to differences in the time at which smoking became commonplace in the various groups.

pected negative sign and achieve statistical significance.[41] The elasticity of —0.05 for white females is relatively high.

TEMPERATURE (ATMP) AND SULFUR DIOXIDE AIR POLLUTION (SO_2D). The regressions for climate and air pollution variables are not presented in Table 9-3 because they differ somewhat in specification and because the relevant measures are unavailable for large numbers of SMSA's.[42] The results are summarized below.

The findings for average temperature (ATMP) are reasonably strong: (1) The regression coefficients are consistently negative and with the exception of black males achieve or approach statistical significance. (2) The inclusion of ATMP increases the adjusted coefficients of determination for each of the race-sex groups. That the coefficients of ATMP are negative suggests that, over the range considered, increases in average temperature reduce mortality rates.

The most promising of the available air pollution variables is SO_2D, but the results are mixed. While the coefficients of the dummy variable are usually *negative* but insignificant, the coefficients of the more sensitive rank variable always have the expected positive sign and are significant for whites.

Results for Two-Stage Least Squares

After some experimentation estimating equations were obtained for the endogenous variables. The coefficients of determination are shown in Table 9-2, while the second-stage equations are shown, with the ordinary least squares results, in Table 9-1. It should be noted that in order to satisfy the order condition for identifiability—i.e., "that the number of predetermined variables excluded from the relation must be at least as great as the number of endogenous variables included less one," [43] it was necessary to exclude some exogenous variables from the SMSA regressions. The decision of which exogenous variables to exclude is not very difficult. First, REGN is sometimes excluded from the regressions for white females and is excluded from all the black female regressions because of extremely high correlations with total family income and its components (in the range of 0.9). Secondly, %RCC is excluded because it is not of the greatest interest and the ordinary least

[41] The male regression coefficients of WELF are also negative but they do not achieve significance. Since females are more likely to be strongly dependent upon public welfare payments than males, this result is not unreasonable, and it was considered appropriate to exclude WELF from the male regressions.

[42] Detailed tables are available from the author.

[43] Johnston, *Econometric Methods*, p. 251.

TABLE 9-2
Coefficients of Multiple Determination (R^2) for the First-Stage Natural Weighted Regressions for States and SMSA's

Endogenous Variables		White Males		White Females		Black Males		Black Females	
		SMSA's (99 Observations)	States (48 Observations)	SMSA's (99 Observations)	States (48 Observations)	SMSA's (59 Observations)	States (32 Observations)	SMSA's (99 Observations)	States (32 Observations)
MHWY	X_1	.564	.888	.492	.869	.220	.628	.842	.969
NLABY	X_{1NL}	.606	.851	.511	.878	.794	.973	.788	.959
LABY	X_{1L}	.465	.854	.293	.757	.743	.976	.818	.959
MRTL	X_3	.606	.790	.588	.811	.821	.971	.614	.657
FRTL	X_4	.446	.764	.450	.767	.602	.914	.793	.977
MS	X_7	.359	.745	.433	.706	.840	.974	.822	.956
ULCR	X_{14}	.463		.298		.278		.494	
PHYS	X_{22}	.420	.835	.447	.829	.427	.896	.636	.893

Source: Available from the author on request.

squares findings are relatively weak and unstable. Assessments of the validity of the two-stage least squares results should take account of the fact that (a) the coefficients of determination for the first-stage regressions are sometimes quite low, which reduces the chances of obtaining significant regression coefficients for the endogenous variables, and (b) the simple correlations between some of the independent variables are quite high (above 0.8), which leads one to expect multicollinearity problems.[44]

With the exception of white females, where the evidence for a negative relationship between mortality and MHWY is sharply strengthened, the two-stage least squares results for income are like those for ordinary least squares. Turning to the other endogenous variables, the ordinary least squares results receive reasonably convincing support in the cases of schooling and the ulcer death rate, somewhat weaker support for marital status and physicians per capita, and little or none for fertility.

4. ANALYSIS OF RACE AND SEX DIFFERENTIALS IN MORTALITY RATES

In this section, the previous findings are applied to the problem of "explaining" race and sex differentials in age-adjusted mortality rates. After careful consideration of the preceding regressions it was decided to rely on three variants of the ordinary least squares regressions for SMSA's. In order to focus more clearly upon the role of income, variants I and II exclude the measures of schooling, fertility, and physicians per capita. Variant I utilizes total family income to measure command over goods and services. Variant II, however, represents an attempt to distinguish between the roles of labor and nonlabor income. In the case of white males, the coefficients of labor and nonlabor income are estimated separately, while for the other race-sex groups the coefficients of the latter variables are assumed to be equal to the estimated coefficients of total family income.[45] Variant III focuses on

[44] Such problems are, in fact, evidenced by sharp fluctuations in the coefficients and computed *t* values for some of the variables. In comparing the Auster, Leveson, and Sarachek results with those of this essay it should be remembered that they take income, schooling, the birth rate, and labor force participation rates for females to be *exogenous* variables.

[45] This procedure is considered appropriate because, in the regressions of Section 3, the white male coefficients of labor and nonlabor income not only differ sharply but behave in a stable and meaningful manner, which is not the case for the other race-sex groups.

the role of schooling and hence excludes the income measures as well as the measures of fertility and physicians per capita.

All variants differ from the regressions of Section 3 in that the white regressions are restricted to the fifty-nine SMSA's included in the black regressions in order to facilitate racial comparisons. The parameters of the regression equations are shown in Table 9-3.

The first step in the analysis is an over-all comparison between the mortality differentials predicted by each variant of the regression equation and the actual differentials. The procedure employed is as follows: The constant terms of the regression equations relevant for a given race or sex comparison are averaged, utilizing as weights the number in the appropriate race-sex groups (see Table 9-4); the appropriate values of the independent variable are then entered in the equations yielding predicted mortality rates for each SMSA; by subtraction, predicted mortality differentials are obtained for each SMSA; finally, the arithmetic mean of the predicted differentials is calculated and compared with the corresponding arithmetic mean of the actual, uncorrected[46] differentials. The constant terms are averaged in the first step because an observed difference in constant terms is unconvincing as an *explanation* of a race or sex mortality differential.

Line (2) of Table 9-5 reveals that the predicted and actual differentials being compared often have opposite signs (i.e., if the difference in the constant terms is put aside, the equations often predict that whites and females will have higher mortality rates than blacks and males). This finding may be indicative of substantive deficiencies in the specification of the equations, such as the omission or poor measurement of important independent variables. However, this is not necessarily the case. The predicted differentials are the result of differences between race-sex groups in *both* the levels and regression coefficients of the independent variables. It is of some interest to examine the differentials that can be attributed to differences in levels alone. First, the a priori arguments of Section 2 do not typically dictate differences in regression coefficients. Second, even though some differences in regression coefficients are significant, taken as a whole the formal tests must be regarded as inconclusive because of inconsistencies in the results.[47] In this connection it is well to remember that in certain

[46] It should be remembered that population underreporting is especially severe for blacks. The use of more accurate population figures, if available, might considerably reduce racial differentials in mortality rates.

[47] The tests are available upon request. The over-all inconsistency of the significance tests suggests the use of pooled regressions. Would the increase in

TABLE 9-3

Parameters of the Natural Weighted Variants I–III Regression Equations by Race-Sex Group for 59 SMSA's, 1959–61

Independent Variable		Variant I				Variant II	Variant III			
		WM	WF	BM	BF	WM	WM	WF	BM	BF
MHWY	X_1	−0.0000 (−0.35)	−0.0001 (−0.52)	−0.001 (−5.02)[b]	−0.0004 (−1.36)	—	—	—	—	—
NLABY	X_{1NL}	—	—	—	—	−0.001 (−3.64)[b]	—	—	—	—
LABY	X_{1L}	—	—	—	—	0.0003 (1.98)	—	—	—	—
MRTL	X_3	−0.084 (−3.82)[b]	−0.074 (−3.82)[b]	−0.196 (−4.09)[b]	−0.077 (−3.02)[b]	−0.122 (−5.56)[b]	−0.060 (−3.07)[b]	−0.047 (−3.19)[b]	−0.150 (−3.61)[b]	−0.050 (−2.56)[a]
REGN	X_5	—	−0.638 (−2.59)[a]	—	0.478 (1.01)	—	—	−0.473 (−3.43)[b]	—	−0.255 (−0.95)
MS	X_7	—	—	—	—	—	−0.312 (−4.21)[b]	−0.418 (−6.41)[b]	−0.838 (−6.61)[b]	−0.958 (−6.57)[b]

(continued)

TABLE 9-3 (concluded)

% RCC	X_8	−0.020	0.235	2.590	1.568	0.119	−0.044	0.146	2.628	2.211
		(−0.05)	(0.64)	(2.01)[a]	(1.56)	(0.31)	(−0.12)	(0.54)	(2.30)[a]	(2.98)[b]
% BLK	X_{12}	0.049	0.030	—	—	0.047	0.046	0.020	—	—
		(4.29)[b]	(2.53)[a]			(4.63)[b]	(4.74)[b]	(2.38)[a]		
ULCR	X_{14}	0.078	0.190	0.102	0.138	0.117	0.096	0.168	0.103	0.120
		(1.46)	(1.77)	(2.03)[a]	(1.62)	(2.41)[a]	(2.40)[a]	(2.13)[a]	(2.27)[a]	(1.88)
Constant		16.07	11.46	26.32	14.21	18.33	17.47	14.18	26.39	19.76
R^2		0.415	0.543	0.419	0.341	0.544	0.561	0.754	0.529	0.624
$\bar{R}^2$		0.360	0.490	0.376	0.279	0.491	0.519	0.725	0.494	0.589

Note: The computed t values are in parentheses. The unweighted arithmetic mean values of the variables, by race-sex group, are as follows:

Variable		WM	WF	BM	BF
MHWY	X_1	6603.17	6603.17	4156.37	4156.37
NLABY	X_{1NL}	1822.27	5615.27	1228.01	3435.57
LABY	X_{1L}	4780.90	987.90	2932.69	725.12
MRTL	X_3	68.62	63.48	54.93	49.34
REGN	X_5	0.47	0.47	0.47	0.47
MS	X_7	11.16	11.37	8.31	9.08
% RCC	X_8	0.47	0.47	0.80	0.80
% BLK	X_{12}	14.30	14.30	14.30	14.30
ULCR	X_{14}	10.36	3.05	9.15	3.15

Source: Text.

[a] Indicates coefficient is significant at the .05 level of significance.

[b] Indicates coefficient is significant at the .01 level of significance.

TABLE 9-4

Weighted Averages of Parameters for the Variants I–III Regression Equations, by Race-Sex Groups, 59 SMSA's, 1959–61

		Variant I				Variant II		Variant III			
		Male	Female	White	Black	Male	White	Male	Female	White	Black
MHWY	X_1	−0.0001	−0.0001	−0.00005	−0.0007	—	—	—	—	—	—
NLABY	X_{1NL}	—	—	—	—	−0.001	−0.0005	—	—	—	—
LABY	X_{1L}	—	—	—	—	0.0001	0.0001	—	—	—	—
MRTL	X_3	−0.098	−0.075	−0.079	−0.134	−0.131	−0.098	−0.071	−0.047	−0.053	−0.098
REGN	X_6	—	−0.497	−0.327	0.250	—	−0.327	—	−0.446	−0.242	−0.134
MS	X_7	—	—	—	—	—	—	−0.376	−0.487	−0.367	−0.901
% RCC	X_8	0.298	0.404	0.111	2.055	0.420	0.179	0.281	0.407	0.053	2.410
% BLK	X_{12}	0.043	0.026	0.036	—	0.042	0.039	0.041	0.017	0.033	—
ULCR	X_{14}	0.081	0.184	0.136	0.121	0.116	0.155	0.097	0.162	0.133	0.111
Constant		17.32	11.81	13.71	19.98	19.30	14.81	18.56	14.89	15.78	22.92

Source: Table 9-3.

instances formal tests may, in effect, overstate the case of race and sex differentials. For example, differences in income coefficients might actually reflect the fact that black incomes are more strongly dependent upon health status than those of whites.[48] Finally, focusing on levels is desirable because even significant differences in parameters are often difficult to interpret and hence difficult to apply to policy problems. As an illustration, does an observed difference in regression coefficients reflect an intrinsic difference between the two race-sex groups being compared or does it merely reflect the fact that these groups differ in the level of the variable, with the coefficient varying systematically with level in both?

The procedure used to obtain predicted differentials attributable to differences in the levels of the independent variables is the same as that used for the over-all comparisons, with one major exception—the regression coefficients are averaged as well as the constant terms.[49] The results shown in lines (3) and (4) of Table 9-5 suggest the following conclusions.

1. The equations do quite well in explaining racial differentials in mortality rates. There is agreement between the signs of the mean predicted differentials and the signs of the mean actual differentials. The predicted differentials can be expressed as 31 per cent or more of the actual differentials. In conformity with the views of many students of this problem, income (or, alternatively, schooling) and the per cent married with spouse present are the variables whose level differences are most strongly associated with the excess of black over white mortality rates.

2. Utilizing variant II, mortality differentials predicted on the basis of differences in the levels of the independent variables represent

statistical efficiency resulting from a duplication of the analysis by means of pooled regressions justify the additional research effort? I think not, for the following reasons. First, there appear to be real race and sex differences in the constant terms, a consequence of which would be severe multicollinearity problems. Second, the technique used in the text is flexible enough to allow considering what seems to be a real sex difference in the regression coefficient of labor income. Finally, the technique utilized in the text produces results for race and sex differentials that are, generally speaking, strong and reasonable.

[48] I owe this point to William Landes.

[49] In this connection, when an independent variable is not included in the regression for one of the groups being compared, the regression coefficient is assumed to have a zero value. The predicted mortality rate that can be attributed to the level of a *given* independent variable is ascertained by inserting its values in the average equation while holding all other independent variables constant.

TABLE 9-5

Comparison of Arithmetic Mean Predicted and Actual Mortality Rate Differentials by Sex and Race Groups, SMSA's, 1959–61

Differentials (M-F *or* B-W)	Males I	Males II	Males III	Females I	Females II	Whites I	Whites II	Whites III	Blacks I	Blacks III
(1) Uncorrected mean actual differential	2.78	2.78	2.78	3.56	3.56	4.43	4.43	4.43	3.65	3.65
(2) Mean predicted differential due to levels and coefficients	−7.66	−5.13	−6.21	1.03	−2.07	0.29	−2.24	1.13	−8.40	−3.02
(3) Mean predicted differential due to levels	1.63	2.13	2.02	1.55	1.11	0.59	3.06	0.77	−0.02	0.82
as % of (1)	59	77	73	44	31	13	69	17	−0.5	22
(4) Mean predicted differential due to levels of individual variables:										
MHWY (X_1)	0.29	—	—	0.34	—	—	—	—	—	—
as % of (1)	10			10						
NLABY (X_{1NL})	—	0.60	—	—	—	—	2.05	—	—	—
as % of (1)		22					46			
LABY (X_{1L})	−0.26	—	—	—	—	—	0.38	—	—	—
as % of (1)	−9						9			
MRTL (X_3)	1.34	1.79	0.97	1.06	0.67	−0.41	−0.50	−0.27	−0.75	−0.55
as % of (1)	48	64	35	30	19	−9	−11	−6	−20	−16
MS (X_7)	—	—	1.07	—	1.11	—	—	0.08	—	0.70
as % of (1)			39		31			2		19
% RCC (X_8)	0.10	0.14	0.09	0.13	0.13	—	—	—	—	—
as % of (1)	3	5	3	4	4					
ULCR (X_{14})	−0.10	−0.14	−0.12	0.02	0.02	0.99	1.13	0.97	0.73	0.67
as % of (1)	−4	−5	−4	0.5	0.5	22	26	22	20	18

Source: Text and Table 9-4.

about 70 per cent of the excess of white male over white female mortality rates. The key differences in levels are that the ulcer death rate (a measure of psychological tension) is higher for males than for females,[50] while the ratio of nonlabor to total family income is higher for females than for males.

3. Utilizing variant III, differentials predicted on the basis of differences in the levels of the independent variables represent 24 per cent of the excess of black male over black female mortality rates. The key differences are that black females have more schooling than black males and that, as in the case of whites, females have lower ulcer death rates than males.

5. SUMMARY OF MAIN FINDINGS AND SUGGESTIONS FOR FUTURE RESEARCH

The most interesting and important findings, based on regressions run across states and standard metropolitan statistical areas, with age-adjusted mortality as the dependent variable, are listed below.

1. In multiple regressions excluding schooling, the coefficients of family income are typically negative. This relationship is much stronger for black than for white males and is much more evident across SMSA's than across states. For white males across states the relationship is positive.

2. When family income is crudely decomposed into labor and nonlabor components, the results suggest that for white males the observed coefficient of family income represents a compromise between the favorable health effects of a "pure" increase in income and the unfavorable (or less favorable) health effects of increases in earnings. When the total family income of white males is replaced by their nonlabor income, the observed racial differential in income effects is considerably narrowed.

3. The ordinary least-squares regression coefficients for schooling are strongly negative and usually achieve statistical significance.

4. An inverse relationship that seems especially strong for black males is observed between the mortality rate and the per cent married with spouse present.

5. The mortality rate is positively correlated with a measure of psychological tension (the death rate from ulcers of the stomach).

[50] The psychological tension interpretation would have to be modified in the case of the sex differences to the extent that the male-female differential in susceptibility to ulcers is due to physiological (hormonal) differences.

6. Nontrivial shares of the excess of black over white mortality rates can be attributed to differences in income (or schooling) levels and, even more importantly, in percentages married with spouse present.

7. The ratio of nonlabor to total family income may account for a major share of the excess of white male over white female mortality. Differences in the ulcer death rate also work in this direction.

8. The excess of black male over black female mortality may be related to the greater schooling of black females. Sex differences in ulcer death rates are also noted.

Meanwhile, the limitations of the study must be kept in mind, notably the following: (1) The regression analysis is confined to spatial (or "ecological") data for the period 1959–61. Lagged values of the independent variables are not included in the regressions and results are not checked by means of time series data or data for individuals. (2) Health is measured by age-adjusted mortality rates for all ages. Alternative measures of health (e.g., "disability days") are not considered and little or no attention is paid to age-specific and specific-cause mortality rates. One of the major conclusions of Appendix B is that the "probability" is quite low (0.28 to 0.49) that a geographic unit having a high mortality rate for one age group will have relatively high rates for other age groups. (3) Attempts to increase knowledge concerning the health effects of air pollution are seriously hampered by the use of published pollution data which are expressed only in rank form. (4) Collinearity problems make it difficult to disentangle the effects of certain variables (most importantly, family income versus schooling or the earnings rate). (5) The income measures employed in the study are undeflated, which, according to pilot regressions, imparts a bias to the income coefficients. (6) The regression analysis does not include direct measures of the relative prices of medical care and other health-producing (or health-inhibiting) goods and services. There is great need for such price measures.

There is also need for new studies utilizing different methodologies and types of data. In my opinion, first priority should be given to further study of the roles of income, schooling, and marital status. The latter variables appear to be crucial in explaining the excess of black over white mortality, but the exact causal mechanisms are still uncertain.

We need more definitive answers to a number of questions. For example, "pure" increases in income are spent in ways that improve health status, but exactly which purchased goods and services are primarily responsible? How important is medical care as compared to health-related items like proper nutrition and adequate recreation?

Exactly which labor force activities are responsible for the observed positive correlation between earnings and the mortality rate of white males? To what extent should the observed beneficial health effects of schooling be attributed to an increased use of medical services? How important is training in such topics as personal hygiene and nutrition? Should increased use of medical and health-related goods and services be attributed to the fact that persons with more schooling know better how to seek out and select the appropriate items? Or does schooling, perhaps, reflect or increase the "taste" for good health and consequently the demand? Is it the real answer that schooling is an excellent proxy for wealth and certain occupational factors and has little or no independent effect upon health? Which of the possible lines of explanation of the role of marital status is most relevant—that married persons place a higher relative value on their health than single persons or that being married lowers the relative prices of a number of health-producing items? Until we have the answers to these related questions both policy and theory will suffer.

APPENDIX A: DETAILS ON VARIABLES INCLUDED IN THE REGRESSION ANALYSIS[51]

Y **(DDR)**: See Edward A. Duffy and Robert E. Carroll, *United States Metropolitan Mortality, 1959–61,* U.S. Department of Health, Education, and Welfare, Public Health Service, Cincinnati, Bureau of Disease Prevention and Environmental Control, 1967, Table 4.

Age adjustment is by the direct method (see note to Table 9–B-4).

Y' **(IDR)**: See note to Table 9–B-1 and footnote 53.

X_1 **(MHWY)**: See *Census of Population, 1960,* State Tables 133 and 139 and National Summary Table 224.

In the 1960 census, "total income" is the sum of wage and salary income, self-employment income, and other income. "Other income" includes net receipts from rents, royalties, interest, dividends, periodic income from estates and trust funds, social security benefits, pensions,

[51] See definitions of all variables included in the regressions on pp. 163–166.

veterans payments, military allotments for dependents, unemployment insurance, public assistance or other governmental payments, periodic contributions from persons who are not members of the household, alimony, and periodic receipts from insurance policies or annuities. The figures represent the amount of income received before deductions for personal income taxes, social security, bond purchases, union dues, et cetera. Not included as income are the following: money received from the sale of property; the value of income "in kind," such as food produced or consumed in the home or free living quarters; withdrawals of bank deposits; money borrowed; tax refunds; gifts and lump-sum inheritance or insurance benefits. Measures of median income are readily available in the census data and the median has the advantage of holding transitory components to a minimum.

X'_1 (MPY): See source for X_1.

X'''_1 (%LT3T): See source for X_1.

The percentage of husband-wife families in each age group with annual cash incomes of less than $3,000 (using this as the "poverty line") is computed and then averaged, with the national percentage of husband-wife families in each age group used as weights.

X_{1L} (LABY): See source for X_1 and *Census of Population, 1960,* State Table 144.

In accordance with a decision to focus attention on sources of the income of the head of the family or his wife, (a) the estimate of the labor component of income for a given race-sex group is the median annual earnings of that group (for persons with earnings) multiplied, in the case of males, by the fraction of husband-wife families in which the head worked in 1959 and, in the case of females, by the fraction in which the wife worked in 1959 (X_{1L}); and (b) the estimate of nonlabor income (X_{1NL}) for a given race-sex group is obtained as a residual by subtracting X_{1L} of the sex group whose mortality is being studied from the MHWY (X_1) of the corresponding race group—e.g., the nonlabor income of white females is obtained by subtracting the median (weighted) earnings of white females from white husband-wife income.

X_{1NL} **(NLABY):** See notes for X_1, X_2, and LABY.

X_2 **(EARNR):** *Census of Population, 1960,* State Tables 124 and 118.

Weekly earnings rates are obtained by dividing median annual earnings for persons with earnings in 1959 by the median number of weeks worked by those working in that year. In general, the weekly earnings rate resulting from the above division will not be equal to the (unavailable) median weekly earnings rate of the individuals in an area. However, while random errors in an independent variable cause underestimates of the regression coefficient, I can see no reason for believing that our proxy measure will be systematically biased.

X_3 **(MRTL):** *Census of Population, 1960,* State Tables 109 and 96 and National Summary Table 46.

The number of husband-wife families in each group is used as the number of married males or females. The percentage married in each age group is obtained by dividing the above numbers by the number of males or females in each age group (fourteen to twenty-four was used for the youngest age group). The national percentages of those age fourteen and over in each age group are used as weights.

X_4 **(FRTL):** *Census of Population, 1960,* State Table 113 and National Summary Table 190.

The children-ever-born measure is superior to the birth rate, which might be considered an index of the rationality of current behavior, because current health is dependent not only on present behavior but on the extent to which past decisions were rational.

X_6 **(FB):** *Census of Population, 1960,* State Table 96.

X_7 **(MS):** *Census of Population, 1960,* State Table 103.

X_8 **(%RC):** *Census of Population, 1960,* State Tables 14 and 15, Final Report.

Pc (3)–10, Selected Area Reports, *Standard Metropolitan Statistical Areas,* Table 1.

X'_8 **(RUA)**: See sources for X_8.

X_9 **(%LAB)**: *Census of Population, 1960,* State Table 122.

X_{10} **(%MWLFPC)**: *Census of Population, 1960,* State Table 116.

X_{11} **(%MFG)**: *Census of Population, 1960,* State Table 129.

X_{12} **(%BLK)**: *Census of Population, 1960,* State Table 90.

X_{13} **(SEG)**: Wendell Bell and Ernest W. Willis, "The Segregation of Negroes in American Cities: A Comparative Analysis," *Social and Economic Studies,* March 1957, Appendix.

X_{13} is based upon data for census tracts: if the percentage of blacks residing on a block is equal to the percentage of blacks in the tract, the index takes a value of 0; at the other extreme, if the percentage of blacks residing on the block is 0 or 100, the index takes the value of 100.

X_{14} **(ULCR)**: See source for Y.

X'_{14} **(ULCRD)**: See source for Y.

X_{15} **(ATMP)**, X_{16} **(AHUM)**, X_{17} **(DTMP)**, X_{18} **(DHUM)** : U.S. Department of Commerce, Weather Bureau, Environmental Services Administration, *Climatological Data: National Summary for 1960, 1961.*

The data are averages for weather stations in the standard metropolitan statistical area. X_{18} is based upon relative humidity measures for 1 A.M. and 1 P.M., E.S.T.

X_{19} **(GASDR)**, X_{20} **(ACSPR)**, X_{21} **(SO_2DR)**: U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Air Pollution Control, HEW-R43, August 4, 1967.

X_{22} **(PHYS)**: *Census of Population, 1960,* State Tables 120 and 133.

X_{23} **(%HOUS)**: *U.S. Census of Housing, 1960,* U.S. Summary, States and Small Areas, Tables 6 and 25 and Series HC(1), States and Small Areas, Tables 15, 37, 38.

The housing data are for owner-occupied and renter-occupied rooms.

X_{24} **(POPD)**: U.S. Department of Commerce, Bureau of the Census, *County and City Data Book: 1962,* Table 1, item 4 and Table 3, item 4.

X_{25} **(%FS)**: *Census of Population, 1960,* State Table 100.

X_{26} **(CIG)**: *Tobacco Smoking Patterns in the United States,* Public Health Monograph No. 45, 1956, Tables 146 and 15a.

The underlying data are percentages of persons age eighteen and over in two smoking categories: ½ to 1 and 1 or more packs of cigarettes per day. The percentages are cross-classified by region, sex, residence (urban, rural nonfarm, and rural farm), and, in the South, by race (white or nonwhite). For Southern states the percentage of a sex-race-residence group in a given smoking category is estimated by the corresponding percentage for the entire region, and for each state the percentage of a sex-race group in a given smoking category is obtained by averaging the appropriate regional percentages using as weights the state's 1960 residence distribution of the race-sex group. Next, the estimated fractions for a state are divided by the corresponding percentages for the entire United States (both races and sexes). Finally, the indexes for the ½–1 and 1 or more pack smoking categories are averaged, with the 1 or more pack category receiving twice the weight of the ½–1 pack category. The procedure for non-Southern states is the same as for the Southern states, with the exception that, since a race breakdown is not available for each of the non-Southern regions, it is assumed that the percentage of a sex-residence group in a given smoking category does not vary with race. Available data for the North and West combined reveal some sharp differences in the cigarette consumption of whites and nonwhites, but nonwhites who reside outside the South are concentrated in urban areas, and in such areas color differences in consumption are fairly small. For the ½ to 1 pack category, the ratio of the percentage for white males to that for nonwhite males is 0.85, while that for the 1 or more pack category is 1.63; the corresponding values for females are 1.09 and 0.97.

X_{27} **(WTRH):** Henry A. Schroeder, "Relation Between Mortality from Cardiovascular Disease and Treated Water Supplies," *Journal of the American Medical Association,* 172, April 23, 1960, pp. 1902–08, Table 1.

X_{27} is obtained by weighting the average hardness of each type of water supply (surface or ground) by the population served by that supply; the data refer to 1950–51.

X_{28} **(HIGHW),** X_{29} **(WELF),** X_{30} **(HOSP),** X_{31} **(HLTH),** X_{32} **(POL),** X_{33} **(FIRE),** X_{34} **(SAN):** U.S. Department of Commerce, *Census of Government, 1962,* IV, Table 37.

Total public welfare includes support of and assistance to needy persons contingent on their need. Excluded are pensions to former employees and other benefits not contingent on need. Expenditures include: (a) cash assistance payments made directly to needy persons under categorical and other welfare programs; (b) vendor payments made to private purveyors for medical care, burials, and other services provided under welfare programs; (c) welfare institutions (includes other unspecified items and intergovernmental expenditures). Any services provided directly by the government through its own *Hospitals* and *Health* agencies are classed under those headings.

Supplementary Variables

X'_8 **(%RUA)**: *Census of Population, 1960,* State Tables 14 and 15.

X_{24N} **(TPOP)**: U.S. Bureau of the Census, *Statistical Abstract of the United States, 1969,* Section 33, Table 1 and Section 1, Table 13.

X_{28} **(UO)**: Leo Troy, *Distribution of Union Membership Among the States, 1939 and 1953,* New York, NBER, 1957, p. 18, Table 4.

X_{29} **(RS)**: Calculated from data in Lowell D. Ashby, "The Geographical Redistribution of Employment," *Survey of Current Business,* October 1964, p. 15, Table 3.

X_{29} depends on whether rate of growth of each state's industry was rapid or slow compared with the national growth rates of these industries.

APPENDIX B: A DESCRIPTIVE ANALYSIS OF MORTALITY RATES FOR CENSUS DIVISIONS[52]

Purpose and Main Conclusions

The objective of this appendix is to ascertain the magnitudes and patterns of spatial differences in mortality and to make comparisons of such differences by race and sex. The analysis is designed to provide a useful background for the multivariate analysis of mortality rates presented in the text and to suggest new hypotheses or questions. The data employed are for the nine geographic divisions of the United States in 1959–61. Data for census divisions should make apparent any interesting spatial patterns without burdening the reader with excessive detail. Generally, when measures of association are needed both Spearman rank and product-moment correlation coefficients (unweighted) are utilized. For present purposes, the major advantage of the coefficient of rank correlation is that it reduces the weight given to extreme observations, which can be important when the number of observations is small (as in the present case) or when relationships are nonlinear. Mortality data for all ages are examined in the second part of this appendix; age-specific mortality rates are explored in the third part.

[52] I wish to thank Mortimer Spiegelman for his helpful comments on an earlier draft of this appendix.

The major findings of the descriptive analysis are as follows:

1. When attention is shifted from unadjusted mortality rates to age- and sex-adjusted mortality ratios, it becomes evident that the black rates are substantially higher than their white counterparts in every census division.

2. Age and sex adjustments sharply alter spatial patterns in mortality rates. The simple correlations between the unadjusted and adjusted rates are only 0.61 for whites and 0.34 for blacks.

3. Age and sex adjustments substantially reduce the magnitudes of spatial variations in mortality—from 10.2 to 4.1 per cent for whites and from 14.0 to 5.6 per cent for blacks. In the case of whites, the female coefficient of variation exceeds the male coefficient, and variability is smallest in the fifteen–sixty-four age group. Just the opposite is true for nonwhites.

4. For both races, age-adjusted mortality rates are higher for males than for females in every census division; spatial patterns are quite similar for males and females—the simple correlations are 0.84 for whites and 0.79 for blacks. These high correlations result from strong relationships in the under-fifteen and sixty-five-and-over age group.

5. Of interest in reference to the possible "reversal" of socioeconomic male-female roles within the black subculture is the fact that the spatial pattern of mortality rates for black females resembles that of white males as much as or more strongly than it resembles the pattern for white females.

6. Year-to-year variation in mortality rates for 1959–61 is not large for any census division, but spatial variability in the amount of year-to-year variation is appreciable. The latter type of variation is greater for females and blacks than for males and whites. Evidence of racial differences within divisions in the character of the forces determining year-to-year variability is provided by rather low correlations between the divisional measures of year-to-year variation.

7. There exists, especially in the case of females, an inverse relationship between levels and year-to-year variability in mortality.

8. The probability that a census division having a high mortality rate for one age group will have relatively high rates for the other ages is somewhat higher for females and nonwhites than for males and whites. However, the probabilities are quite low, ranging from 0.28 to 0.49.

Analysis of Mortality Data for All Ages

Table 9—B-1 is designed to facilitate comparisons of spatial levels and

TABLE 9–B-1

Unadjusted and Age- and Sex-adjusted Mortality Rates by Race for U.S. Census Divisions in the Period 1959–61

Census Division	Whites		Blacks	
	Deaths per 1,000 Population	Age- and Sex-adjusted Mortality Ratio	Deaths per 1,000 Population	Age- and Sex-adjusted Mortality Ratio
Northeast	10.54	0.99	9.01	1.38
Middle Atlantic	10.54	1.03	9.82	1.48
East North Central	9.54	0.98	9.20	1.40
West North Central	9.92	0.90	11.90	1.39
South Atlantic	8.37	0.94	10.53	1.51
East South Central	8.73	0.95	11.54	1.36
West South Central	8.16	0.91	10.50	1.26
Mountain	7.95	0.95	9.12	1.40
Pacific	8.84	0.93	7.18	1.23
Coefficient of variation (%)	10.21	4.13	13.83	6.16
Percentage point differential in coefficients of variation	6.08		7.67	
Percentage reduction in coefficient of variation	84.80		76.74	
Rank coefficient of correlation	0.42		0.23	
Product moment coefficient of correlation	0.61		0.34	

Note: Age-sex adjusted by the "indirect" method. For each state, 1959–61 national (excluding Alaska, Hawaii, and Washington, D.C.) age-specific death rates for whites and blacks, both sexes combined, were multiplied by the actual population distributions by race and sex in 1960 to obtain "expected" deaths. The "expected" deaths of males and females of a given race were summed and the result was divided into the sum of the actual deaths to obtain a mortality ratio, i.e., the age- and sex-adjusted death rate in index number form (U.S. whites and blacks equal 1). By using national age-specific rates for both races and sexes as a single standard it is possible to make comparisons of levels of mortality among sexes and races as well as geographic areas.

Sources: *Mortality:* U.S. Department of Health, Education and Welfare, Public Health Service, National Vital Statistics Division, *Vital Statistics of the United States*, 1959—Tables 62 and 71, 1960 and 1961—Tables 5-4 and 5-9. *Population:* U.S. Bureau of the Census, *Census of Population*, 1960, Volume I, Characteristics of the Population, Part 1, United States Summary, Table 158 and Parts 2–52 (State Volumes), Table 96.

variations in the unadjusted and age- and sex-adjusted[53] mortality rates of whites and blacks. Perhaps the most striking fact exhibited by the table is that once we turn from unadjusted to adjusted mortality rates the black rate is substantially higher than the white in every division.[54] Turning to detailed comparisons of the adjusted and unadjusted data, it is observed that for whites the unadjusted rates for Northern divisions, especially the Northeast and Middle Atlantic, are relatively high. In the adjusted data, the Northern disadvantage is retained but is clearly reduced, while the rates for Southern and Western divisions remain quite similar. For blacks the unadjusted rates are especially high in the Southern divisions and low in the Pacific division. However, with age and sex adjustments, the Southern rates are found not to differ greatly from Northern ones and the Pacific advantage is substantially reduced. That age and sex adjustment significantly alters spatial patterns in mortality is most conveniently summarized by the relatively low correlations between the adjusted and unadjusted mortality rates. For whites the product-moment correlation is 0.61 and the rank correlation is 0.42, while the corresponding values for blacks are 0.34 and 0.23.

Age and sex adjustment also reduces substantially the magnitude of spatial variation in mortality—from 10.2 to 4.1 per cent for whites and from 14.0 to 5.6 per cent for blacks. It is worth noting that in relative terms the mortality of blacks varies substantially more than that of whites. The residual variation in mortality is not very large for either race, but it is believed to be large enough to make the more formal analysis presented in the text meaningful.

[53] Mortality is adjusted by the "indirect" method, the major advantage of which is that, unlike "direct" standardization, it does not require the allocation of scarce research resources to the tabulation of age-specific mortality rates by race and sex for each geographic unit. A defect of the indirect technique is that differences among geographic units (or races or sexes) are affected by differences in age distributions, unless the ratios of the (unknown) age-specific mortality rates for the geographic units (or races or sexes) being compared are invariant with respect to age. In this connection it should be noted that differences in directly standardized mortality rates are sensitive to changes in the standard population utilized. For details of the indirect age-sex adjustment, see note to Table 9–B-1.

[54] The relative underenumeration of the black population does not explain these differentials. According to Siegel, if there were no underregistration of deaths, and "if corrected population data are employed, life expectancy of nonwhites at birth in 1959–61 would be increased by about 1-1/2 years and most of the large white-nonwhite difference would remain" (J. Siegel, "Completeness of Coverage of the Nonwhite Population," 1968, p. 24).

Table 9–B-2 presents age-adjusted[55] mortality rates by sex, permitting a more refined analysis of spatial levels and patterns than is possible in Table 9–B-1. It is seen that for each race the male mortality rate is higher than the female one within each geographic division.[56] As expected, the patterns of spatial variation are very similar to those observed in Table 9–B-1. For whites of each sex the Northeast and Middle Atlantic are relatively high and the West South Central is relatively low, while the rates for the other divisions do not differ appreciably; for blacks the rates for the Middle Atlantic and South Atlantic are relatively high, while the Pacific rate is relatively low, especially in the case of females. The similarity of the spatial patterns for males and females is indicated by rather high coefficients of correlation: for whites the product-moment correlation is 0.84 and the rank correlation is 0.88, while for blacks the values are 0.79 and 0.72. However, it is clear from these coefficients that there are nontrivial sex differences in mortality patterns.

Turning to comparisons by race, the evidence lends some credence to current discussions suggesting the existence of a "reversal" of the socioeconomic roles of males and females within the black subculture. First, while the spatial patterns for white and black males are reasonably similar (the product-moment correlation is 0.62 and the rank correlation is 0.65), there is much less similarity between the patterns for females (the product-moment correlation is 0.39 and the rank correlation is 0.30). More significant for the reversal of roles argument is the fact that the spatial pattern for the black females resembles that of the white males about as much or more strongly (the product-moment correlation is 0.35, while the rank correlation is 0.53) than it resembles the pattern for white females. Along the same line, the correlations between black males and white females are surprisingly high (0.56 for the product-moment method and 0.45 for the rank correlation). Another point to be noted is the striking race difference in the relative magnitudes of spatial variations in mortality. For whites the female coefficient of variation is much higher than the very low male coefficient, while for blacks the male coefficient of variation is somewhat higher than that for females.

[55] For details of the method of age adjustment, see note to Table 9–B-2.

[56] The male population is subject to greater underenumeration than the female population (see Siegel, "Completeness of Coverage"), but it is unlikely that sex differentials in the accuracy of enumeration would completely explain the observed sex differentials in mortality.

TABLE 9-B-2

Age-adjusted Mortality Ratios for Males and Females by Race for U.S. Census Divisions in the Period 1959-61

Census Division	Whites: Age-adjusted Mortality Ratio for Males	Whites: Age-adjusted Mortality Ratio for Females	Blacks: Age-adjusted Mortality Ratio for Males	Blacks: Age-adjusted Mortality Ratio for Females
Northeast	1.23	0.81	1.64	1.15
Middle Atlantic	1.27	0.84	1.78	1.23
East North Central	1.20	0.79	1.62	1.20
West North Central	1.12	0.72	1.60	1.19
South Atlantic	1.20	0.72	1.79	1.27
East South Central	1.19	0.74	1.55	1.19
West South Central	1.16	0.69	1.45	1.08
Mountain	1.18	0.73	1.66	1.13
Pacific	1.17	0.72	1.49	1.01
Coefficient of variation (%)	3.38	6.17	6.80	6.41
Percentage point differential in coefficients of variation (male minus female)	−2.79		0.39	
Percentage of difference in coefficients of variation	−58.43		5.74	

Summary of Mortality Rate Correlations

Race-Sex Group	Rank Correlation Coefficient	Product-Moment Correlation Coefficient
White male-white female	.88	.84
Negro male-Negro female	.72	.79
White male-Negro male	.65	.62
White female-Negro female	.30	.39
White male-Negro female	.53	.35
White female-Negro male	.45	.56

Note: Age adjustment is by the "indirect" method. For each state, 1959-61 national (excluding Alaska, Hawaii, and Washington D.C.) age-specific death rates for whites and Negroes of both sexes combined were multiplied by the actual population distributions by race and sex in 1960 to obtain "expected" deaths. The "expected" deaths for a given race and sex were divided into the corresponding number of actual deaths to obtain a mortality ratio, i.e., the age-adjusted death rate in index number form (U.S. whites and Negroes equals 1). By using national age-specific rates for both races and sexes as a single standard it is possible to make comparisons of levels of mortality among races and sexes as well as geographically.

Source: See Table 9-B-1.

TABLE 9–B-3
Year-to-Year Variability in Deaths by Sex and Race for U.S. Census Divisions in the Period 1959–61
(coefficients of variation of deaths, per cent)

	Whites			Blacks		
	Total	Male	Female	Total	Male	Female
Northeast	1.07	1.51	0.71	1.65	1.64	2.05
Middle Atlantic	0.64	0.84	0.45	3.20	3.47	2.90
East North Central	0.77	0.75	0.80	1.84	2.21	1.40
West North Central	1.21	0.83	1.76	0.28	0.76	0.70
South Atlantic	2.64	2.56	2.80	1.91	2.27	1.59
East South Central	1.80	1.93	1.77	1.96	2.28	1.63
West South Central	2.11	2.15	2.06	2.47	2.46	2.52
Mountain	1.55	1.31	1.96	1.26	2.77	4.95
Pacific	2.13	1.90	2.44	4.57	5.08	3.89
Coefficient of variation	41.5	39.9	46.6	53.8	44.6	52.3

Summary of Coefficient of Variation Correlations

Race-Sex Group	Rank Correlation Coefficient	Product-Moment Correlation Coefficient
White male-white female	.72	.74
Black male-black female	.85	.69
White male-black male	.25	.21
White female-black female	.15	.16
White male-black female	.20	.08
White female-black male	.28	.20

Source: See Table 9–B-1.

Table 9–B-3 provides information on the stability of mortality within the various geographic sex-race cells during the period with which we are concerned (1959–61), and also permits comparison of stability according to the previously utilized principles of classification. It should be noted that year-to-year variability is not very great; the highest coefficient of variation is 5.1 (for black males in the Pacific) and most of the values in the table are substantially lower than this. However, when we turn to spatial variability in the amount of year-to-year variation, it is observed that for both sexes and races it is substantial—in the range of 40–50 per cent. Clearly, the factors responsible for year-to-year variability in mortality are more constant within than among census divisions.

Among blacks there is a tendency for year-to-year variability to be greater for males than for females; this tendency also appears among whites but in a much weaker form. By contrast, for both races the spatial variability in the coefficients of variation is greater among females than males. It seems that males are more susceptible to year-to-year changes in the forces influencing mortality, but that spatially they have more in common with respect to these forces than females. An explanation might be based on the fact that males play a greater and more spatially constant role in the economy than females and are more strongly affected by fluctuations in business conditions. While substantial variation remains "unexplained," the patterns of spatial variability are similar for males and females of a given race: for whites the product-moment correlation is 0.74 and the rank correlation, 0.72, and for blacks the corresponding values are 0.69 and 0.85.

Levels of year-to-year variability are greater for blacks than for whites, with the exception of the West North Central, South Atlantic, and East South Central divisions. In addition, the spatial variability in the divisional coefficients of variation is greater for blacks than for whites. In view of factors like greater reporting errors for blacks and their greater susceptibility to infectious diseases, it is not surprising that black mortality should vary more than white. However, the basis for the exceptions noted above is not apparent.

The coefficients of correlation between the divisional coefficients of variation are quite low. The product-moment correlation for males is 0.21 and the rank correlation is 0.25, while the corresponding values for females are 0.16 and 0.15. Obviously, there are sharp racial differences within divisions in the character of the forces determining year-to-year variability in mortality. Again there is some evidence of a reversal of the male-female roles among blacks. In terms of the spatial pattern in year-to-year variability, black males are as much or more closely related to white females (the product-moment correlation is 0.20 and the rank correlation is 0.28) than they are to white males; and according to the rank correlations, black females are more closely related to white males (0.20) than they are to white females. However, the above conclusion is weakened by the fact that the product-moment correlation between white males and black females is only 0.08.

The data presented in Tables 9–B-2 and 9–B-3 hint that there may exist a positive relationship between the level of mortality and the magnitude of year-to-year variability. For a given sex, black age-adjusted mortality rates are always higher than white rates and there is also a tendency for their levels of year-to-year variability to be greater; for a given race, female age-adjusted mortality rates are always lower than male rates and there is a weak tendency for their levels of year-to-year variability to be lower. A possible explanation for the black-white finding is that, since the white population is larger, its mortality is less subject to random variations (including measurement errors) than black mortality.

In order to obtain better evidence bearing on the existence of such a relationship, product-moment correlations between divisional age-adjusted mortality rates and coefficients of year-to-year variations were run for each race-sex group. The coefficients are as follows: −0.13 for white males, −0.87 for white females, −0.15 for black males, and −0.57 for black females. Thus, the more refined evidence suggests, especially for females, an *inverse* relationship between levels and year-to-year variability in mortality. It would seem that the underlying factors distinguishing relatively high and low mortality areas are rather stable, at least over periods as short as three years. A possible example of such a factor might be high birth rates and the associated large family sizes, which raise female mortality rates, directly or indirectly.

Analysis of Mortality Data by Age

In an attempt to obtain new insights concerning the magnitudes and patterns of spatial differences in mortality, data for census divisions were broken down according to age. In the interest of clarity—and to restrict our problem to manageable proportions—a limited number of meaningful and readily available age categories are employed: under fifteen, fifteen–sixty-four, and sixty-five and over. Because of the unavailability of black age-adjusted mortality rates by age, reliance is placed upon data for nonwhites adjusted by the direct method.[57] The rates are explored in Table 9–B-4. First, it is evident that within each

[57] The evidence presented in the note to Table 9–B-4 indicates that (1) there are nontrivial differences in the spatial mortality patterns of blacks and nonwhites (this is probably because the rates for nonwhites in the Mountain States are influenced by Indians and those on the Pacific Coast by Orientals) and (2) patterns may differ appreciably according to the method of age-adjustment. Nevertheless, it is felt that the data utilized in this appendix are adequate for its limited purposes. In the text. the use of nonwhite data is restricted to states and SMSA's in which nonwhites are overwhelmingly blacks and the multivariate analysis utilizes both directly and indirectly standardized mortality ratios.

TABLE 9-B-4

Age-adjusted Mortality Rates for Three Age Groups by Sex and Color for U.S. Census Divisions in the Period 1959-61

Census Division	White Males Persons Under 15 Years Old	White Males Persons Age 15–64	White Males Persons Age 65 and Over	White Females Persons Under 15 Years Old	White Females Persons Age 15–64	White Females Persons Age 65 and Over
N.E.	216.5	553.4	7141.2	158.7	284.0	4908.8
M.A.	212.3	571.7	7349.6	158.8	303.8	5225.3
E.N.C.	218.7	548.8	7001.0	161.8	281.8	4826.6
W.N.C.	218.5	508.8	6392.3	158.6	246.0	4311.3
S.A.	238.2	601.7	6514.4	172.7	265.5	4395.8
E.S.C.	243.9	579.9	6493.2	193.9	257.4	4504.6
W.S.C.	246.4	555.1	6385.6	184.8	248.1	4079.6
M.	262.6	576.6	6417.0	191.9	281.3	4234.0
P.	225.3	557.1	6592.5	165.7	279.5	4264.5
Coefficient of variation (%)	6.99	4.34	5.15	8.03	6.60	7.87
Coefficient of concordance		0.28			0.32	

(continued)

age-race group the male mortality rate is higher than the female,[58] while in a number of census divisions the nonwhite mortality rate for a given age-sex group, with the exception of the sixty-five and over age group, is higher than the white.[59]

[58] See footnote 54.

[59] The fact that blacks in the older groups have lower mortality rates than whites is well known and is usually explained by the exceptional health characteristics of those blacks able to attain old age and discrepancies in population age reporting for blacks. For discussions of these issues, see Robert D. Grove, "Vital Statistics for the Negro, Puerto Rican, and Mexican Population: Present Quality and Plans for Improvement," *Social Statistics and the City*, a report of a conference sponsored by the Joint Center for Urban Studies of the Massachusetts Institute of Technology and Harvard University (held in Washington, D.C., June 22–23, 1967), Cambridge, Mass., 1968; and Melvin Zelnik, "Age Patterns of Mortality of American Negroes: 1900–02 to 1959–61," *Journal of the American Statistical Association*, 64, June 1969, pp. 443–51. Zelnik concludes (p. 446): "It appears to be quite likely, if not certain, that the low rates of mortality recorded in the official life tables for Negroes above age sixty-five are the result of age misreporting, which thereby also spuriously heightens somewhat the rates of mortality in the immediately prior age groups. However, the bulk of the available evidence suggests that the difference is real

TABLE 9-B-4 (continued)

Nonwhite Males			Nonwhite Females		
Persons Under 15 Years Old	Persons Age 15–64	Persons Age 65 and Over	Persons Under 15 Years Old	Persons Age 15–64	Persons Age 65 and Over
365.0	780.6	7368.7	268.7	540.9	5373.7
427.0	944.8	7036.1	328.6	633.3	5233.5
365.5	855.1	6980.4	291.0	648.4	5222.6
408.0	935.1	7134.0	332.3	678.5	5320.4
450.7	1099.6	6746.6	351.3	783.6	4911.6
443.8	939.3	6763.8	355.7	713.7	5226.7
410.4	866.9	6207.2	330.4	651.8	4596.2
502.7	876.3	5438.1	406.9	564.9	4230.1
313.4	587.1	5739.5	238.8	409.8	4171.7
12.87	14.99	9.45	14.66	16.35	9.06
	0.44			0.49	

Summary of Mortality Rate Correlations

Color-Sex Groups	Age	Rank Correlation Coefficient	Product-Moment Correlation Coefficient
White male-white female	Under 15	.88	.94
White male-white female	15–64	.05	.30
White male-white female	65 and over	.85	.96
Nonwhite male-nonwhite female	Under 15	.92	.98
Nonwhite male-nonwhite female	15–64	.75	.94
Nonwhite male-nonwhite female	65 and over	.97	.97
White male-nonwhite male	Under 15	.53	.67
White male-nonwhite male	15–64	.57	.35
White male-nonwhite male	65 and over	.43	.54
White female-nonwhite female	Under 15	.58	.66
White female-nonwhite female	15–64	−.60	−.43
White female-nonwhite female	65 and over	.72	.65
White male-nonwhite female	Under 15	.62	.70
White male-nonwhite female	15–64	.28	.24
White male-nonwhite female	65 and over	.33	.50
White female-nonwhite male	Under 15	.60	.62
White female-nonwhite male	15–64	−.17	−.24
White female-nonwhite male	65 and over	.75	.66

(continued)

NOTES TO TABLE 9-B-4

Note: Unlike the previous rates, the mortality data utilized in the table are age-adjusted by the *direct method*, using as the standard population the age distribution of the total population of the United States as enumerated in 1940. The change in the method of age adjustment was dictated by the time at which data became available and a desire to economize research resources rather than substantive considerations.

In order to ascertain whether the method of age adjustment and the use of data for nonwhites have important effects on spatial patterns in mortality rates, logarithmic regressions were run in which the dependent variables are the directly adjusted mortality rates for all ages while the independent variables are the previously utilized indirectly adjusted mortality rates for all ages. The results are shown below:

Group	*Intercept*	*Elasticity*	*Coefficient of Correlation*
White males	2.88	0.92	0.98
White females	2.85	0.97	0.98
Nonwhite males-black males	2.84	1.03	0.63
Nonwhite females-black females	2.82	1.64	0.89

The results suggest that the method of age adjustment does not make a great deal of difference for whites: the coefficients of correlation are very high and the elasticities are close to unity. As expected, the correlations between nonwhites and blacks are lower than those for whites but they are still fairly high, while the elasticity for males is close to unity and that for females between 1 and 2.

Source: *Mortality Data*: Mortimer Spiegelman, *Transactions of the Society of Actuaries*, 19, pp. D453–54, from tabulations made for the American Public Health Association under a grant from the United States Public Health Service (CH-00075).

Turning to spatial variability in mortality rates, coefficients of variation are observed to be greater for nonwhites than for whites within each age-sex group. For whites, female coefficients of variation are always higher than male coefficients; the same pattern exists with smaller relative differentials in the under-fifteen and fifteen to sixty-four age groups for nonwhites. However, in the sixty-five and over age group the direction of the sex differential is reversed—i.e., for nonwhites the male coefficient of variation is higher than the female coefficient. It is the above differences in magnitudes and directions which underlie the prior observation (Table 9–B-2) that for whites of all ages the female coefficient of variation is greater than that for males, while for blacks of all ages the male coefficient is slightly higher than that for females.[60] Patterns of spatial variability by age differ substantially

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and that the age patterns of mortality of American Negroes . . . differ from the mortality patterns of the white population of the United States."

[60] For some historical comparisons of male and female coefficients of variation,

according to race. For whites, the coefficient of variation is largest in the under-fifteen age group and smallest in the fifteen to sixty-four age groups; for nonwhites, variability is greatest in the fifteen to sixty-four group and smallest in the sixty-five and over group. It would seem that spatial differences in the factors affecting white mortality are smallest at working ages, while for nonwhites such differences are largest in this age group.

If a census division has a relatively high mortality rate for one age group, is it likely to have relatively high rates for the other age groups? Do the races and sexes differ in this respect? The most convenient way to deal with these questions is to convert the data into ranks and calculate the coefficients of concordance for each sex-race group. The latter statistic is a measure of agreement varying from 0 to 1 (representing perfect agreement among the ranks); its numerical value approximates the result which would be obtained by averaging all the relevant rank order correlations.[61] It is found that the probability that a census division having a high mortality rate for one age group will have relatively high rates for the other ages is somewhat greater for females and nonwhites than for males and whites. More importantly, the coefficients of concordance are quite low, ranging from 0.28 to 0.49. This strongly suggests that in future multivariate studies the results in the text that utilize mortality rates for all ages as the dependent variable should be checked by regressions utilizing age-specific mortality rates.

A visual examination of the ranked data reveals the following.[62] In the under-fifteen age group, the Mountain division is relatively high and the Northeast is relatively low for both sexes and races, while the Pacific is relatively low for nonwhites and the Mountain and East South Central divisions are relatively high for females. In the fifteen–sixty-four age group, the West North Central is relatively low for whites, the South Atlantic relatively high and the Pacific and Northeast relatively low for nonwhites, and the South Atlantic is relatively high for males. In the sixty-five and over age group, the Northeast is rela-

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see Mortimer Spiegelman in the *Transactions of the Society of Actuaries*, 19, March 1968, p. D456. Spiegelman's evidence suggests that a reversal in the direction of the sex differential may have occurred.

[61] For a discussion of the coefficient of concordance, see Helen M. Walker and Joseph Lev, *Statistical Inference*, New York, Holt, Rinehart and Winston, Inc., 1953, pp. 282–86.

[62] In interpreting the results for nonwhites it must be remembered that there is a large Japanese population in the Pacific division.

tively high for both sexes and races, the Middle Atlantic is relatively high[63] and the West South Central relatively low for whites, while the West North Central is relatively high and the Mountain and Pacific divisions are relatively low for nonwhites, with the Mountain division relatively low for females. Perhaps the most interesting of the above findings is that the Northeast is especially favorable for the very young and especially unfavorable for the aged.

The data were next analyzed by means of the correlation techniques utilized for all ages; the results are collected in Table 9–B-4. The analysis of Table 9–B-2 reveals high positive correlations between the divisional mortality rates of males and females within both races. It is now seen that for whites the correlations in the fifteen–sixty-four age group are positive but quite low, which means that the high correlation for all ages is derived from the relationships in the youngest and oldest age groups. A similar pattern, although in a very much weaker form, appears for nonwhites. These results are not very surprising as sex differences in socioeconomic variables affecting mortality would be more pronounced in the fifteen–sixty-four group than in the younger and older groups. The correlation coefficients of Table 9–B-4 show that the previous finding of males of all ages being more highly correlated than females of all ages stems from a *negative* correlation between white females and nonwhite females in the fifteen–sixty-four age groups; the correlations for the other age groups are about the same for males and females. The inverse relationship for the fifteen–sixty-four age group is based on the fact that the mortality of nonwhite women is quite low in the Northeast and Middle Atlantic and high in the Southern divisions, while the reverse is true for white women. The unfavorable situation for nonwhite women in the South might be connected with childbearing, i.e., higher birth rates combined with less medical care, while Southern white women might be freer of pressures relating to work and earnings than Northern white women.

Returning to the question of a possible "reversal" of the socioeconomic roles of males and females in the black subculture, it is found that the evidence is inconclusive. If such a reversal actually occurred, it would be strongest in the fifteen–sixty-four age group, and, indeed, the correlation between white males and nonwhite females in this age group is positive while, as previously noted, the correlation between nonwhite females and white females is negative. At the same

[63] Mortimer Spiegelman has pointed out that in the Middle Atlantic the sixty-five and over age group contains a high proportion of the foreign-born.

time, the white male-nonwhite female and white female-nonwhite female correlations do not differ appreciably for the other two age groups. However, the reverse argument also suggests that nonwhite males, age fifteen–sixty-four, will have more in common with white females age fifteen–sixty-four than with white males of the same age, and this is not the case. The former correlation is negative while the latter is positive and relatively high. It must be concluded that no clear evidence of a reversal is provided by the more refined age-specific mortality correlations.