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HEALTH POLICY AND DATA QUALITY:

THE IMPLICATIONS OF THE CROSSOVER MORTALITY DEBATE

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HEALTH POLICY AND DATA QUALITY: THE IMPLICATIONS OF THE CROSSOVER MORTALITY DEBATE

Abstract

In this paper we discuss the importance of data quality in the determination of health policy. The focus of our attention is the black-white crossover mortality debate -- whether the crossover between the age-specific mortality rates of blacks and whites truly exists -- and how the debate impinges on possible health policy.

The consequences of resolving this debate are primarily two-fold. First, for purposes of determining (a) the nature and extent of the future demand for health care services, especially long-term care services, and (b) the distribution of public expenditures that would optimally address that demand, we must have accurate estimates of the prevalence of a range of chronic health care problems. Such estimates, in turn, can only be derived if we have an adequate demographic profile of the elderly population. Correct mortality rates are essential for reliable population projections. Second, the debate's resolution is of great importance in judging the total impact of health policy that addresses the physical and mental well-being of infants and children. Whether early-age mortality is positively or negatively correlated with old-age mortality is fundamental to our understanding of the later-life consequences of maternal and child health programs.

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Introduction

The assessment of health care needs, both current and future, is critically dependent upon the availability of accurate and comprehensive data. Without such data, there is the danger of developing misguided health care policy.

Health care may be defined as "those activities that are undertaken with the objective of restoring, preserving, or enhancing the physical and mental well-being of people" (Fuchs, 1986). Perhaps the most commonly relied upon indicator of a population's health care needs is its expectation of life at birth. It is an objective measure and one that, for many countries, has been available for years into the past. More informative, however, is the series of age-specific death rates associated with that population. Such a series reveals differences between populations that simple life expectancies are likely to mask.

Surely it would be inappropriate to assume a perfect correspondence between a population's current mortality level and the health status of that population. To predict the demand for health care and to identify the types of health services to be provided -- hospital care, home health care, nursing home care, or other sorts of institutional care -- one must be able to determine the future prevalence of a range of disabilities that may exist in a population, which impede to varying degrees the tasks of daily living.

The central objective of this article is to bring home the notion that first, although current mortality data may not accurately reflect the current extent of disabilities, such data are crucial to forecasting population size. Population projections, in turn, are critical to forecasting the level and variety of health care needs that will obtain in the future and the services that will be required. Knowledge of the age structure is of great importance due to the distinct association between age and type of illness (and cause-of-death structure), and thus between age and disability.

Concern has focused predominantly on the unprecedented growth in numbers of the "oldest old," that is, those aged 85 and above. As Soldo and Manton (1985) state, "Current public policy concern with the rapid increase in the number of the oldest old is motivated, in part, by the potential impact of this trend on levels of federal expenditures, particularly for chronic care health services."

In this light, it is incumbent upon us to obtain the best possible size estimate of the elderly population for the years to come. Indeed, accurate projections will be particularly important in the next few decades due to the unusually large number of persons born in the baby boom years. Consequently, small proportionate errors in estimated values may yet result in what may be considered unacceptably large absolute errors. The major ingredient in projecting the size of the elderly is the set of mortality rates to which the population is subject. However, there are often problems with the accuracy of these rates, the use of which ultimately may result in seriously biased projections.

When forecasting total mortality or cause-specific mortality, for example, errors stem from at least two sources: certainly from any sort

of model misspecification that may exist, but also from the data that are used in the forecasting procedures, data that are potentially subject to measurement error. However specific the available data may be, data quality must be assured, otherwise we may be misguided in our formation of policy predicated on conclusions drawn from analysis of those data.

In the following section, we describe the debate taking place in the literature over the reality of crossovers observed between age-specific death rates for different subgroups of the United States population. We devote special attention to the crossover found in the mortality schedules of blacks and whites in the United States.

The implications of the crossover mortality debate are profound and the fundamental question is this: By virtue of taking published mortality data essentially at face value, are we misestimating the number of "excess deaths" among blacks that could otherwise be eliminated (or deferred) if we had a policy appropriately designed to address the health care needs of this population?

Crossover Mortality

Crossover mortality occurs when the age-specific mortality curves of two populations — represented by some function of mortality such as the central death rate, the probability of dying in a given age interval, or the expectation of life — converge and eventually cross one another. In essence, then, one population is said to have an advantage over the other with regard to level of mortality up to a certain age, after which the reverse is true.

There is no shortage of examples of crossover mortality. In one

study, Nam and Ockay (1977) examined female death rates above age 60 for various time periods from 29 countries, for a total of 46 sets of data. Of the 1035 possible pairs of curves, 279 exhibited crossover mortality. Nam and Ockay noted that each of the 46 mortality curves contained in their sample crossed at least one other curve. This finding is thought-provoking. Suppose we were to take the further step of saying that for each set of death rates in the world, there existed another set with which it crossed. What, then, would be the significance of this phenomenon?

The data in the studies by Nam and his colleagues (see also Nam, Weatherby, and Ockay, 1978) refer to populations from time periods differing by as much as several decades as well as to populations from different continents. It is well documented, particularly by Omran (see, e.g., Omran, 1971), that as a country passes through various stages of development, it also experiences something of an epidemiologic transition. The cause-of-death structure of a population changes such that the substantial impact of infectious diseases ultimately gives way to the predominance of degenerative diseases.

If we examine populations cross-culturally and cross-temporally, we may observe crossovers in their mortality due to their different positions in the epidemiologic transition, and, therefore, their different cause-of-death structures. Differences in the relative contributions of particular causes of death to the overall mortality structure of populations are important to study. On the other hand, substantial differences in mortality structures -- even differences large enough to produce a crossover -- might very well be expected between two populations that vary by way of geographic region or

temporal location.

It is especially intriguing, however, when two contemporaneous subgroups within a national population, of a roughly similar environmental and cultural background, display this phenomenon. Such is the case with whites and blacks in the United States, although some may dispute the degree of similarity between these two groups. Moreover, it could be argued that they are so dissimilar, along a variety of dimensions, that we should expect a crossover.

In Figure 1, we present the 1980 age-specific mortality rates of the U.S. black and white populations for each sex separately, classified by five-year age groups from ages 50 through 100. The crossover within each sex is readily apparent, occurring at approximately age 85. At ages 50-54, black mortality rates are twice those of the white population. The ratio declines monotonically in dramatic fashion as age increases. By the time the population approaches the century mark, black mortality is less than two-thirds the level of white mortality.

Is a crossover due to a systematic selection process? Is there an underlying heterogeneity in the endowment of longevity in the population that could produce a crossover? How does the occurrence of a crossover jibe with the notion of the long-lasting cohort effect of poor health conditions experienced early on by a particular segment of a population?

Kenneth Manton and his colleagues have argued extensively for the heterogeneity hypothesis (see, e.g., Manton and Stallard, 1984). The process of differential mortality selection implies first, that the risk of mortality varies among individuals in a population, and second, that the parameters of the distribution of individual risks differ among the subgroups composing that population. These are necessary, though not sufficient conditions, for the existence of a mortality crossover.

For sufficiency, it is necessary that the population is appropriately distributed into these various subgroups.

Under the heterogeneous population model, then, the parameters of the distribution of individual risks among blacks in the United States are said to differ from those of whites. That segment of the population subjected to higher risks of mortality are systematically removed from the total population at the early ages. Late in life, then, blacks appear advantaged with regard to mortality risks because they are a more select group than whites at the same ages; that is, it is predominantly those at low risk who have survived to old age.

The disentanglement of cohort and period effects in mortality change has always been difficult. There has been evidence, however, dating back to the classic study of Kermack, McKendrick, and McKinlay (1934), and including a study of French mortality by Preston and van de Walle (1978), indicating that a birth cohort that is subject to high mortality in its younger ages will also have high mortality later on in life. Coale and Kisker (forthcoming) have marshalled a great deal of evidence supporting the positive correlation between early- and advanced-age mortality.

What, then, is the reason behind the apparent crossover existing between blacks and whites, given the positive correlation across populations between early and late mortality? The school of thought opposing the heterogeneity hypothesis centers on the quality of data that enter into the construction of the life tables for the two groups. There is extensive evidence of age exaggeration in the United States (see, e.g., Myers, 1978) as well as in other countries (see, e.g., Bennett and Garson, 1983 and Mazess and Forman, 1979). Specifically,

differences between whites and blacks in the type or extent of age misstatement could produce sets of age-specific death rates such that a crossover in mortality would be merely an artifact of poor data.

To intuitively understand how age misstatement could give rise to a mortality crossover, one might imagine, for example, a situation in which all ages of the living and the dead are overstated by five years. Thus, the death rate observed at any age x is actually the death rate that should be attributed to age x-5. One can easily see, then, how various patterns of age misstatement could result in a spurious crossover.

Illustrative Simulations

In order to help illustrate the nature of the debate and focus the contrasting arguments, we provide a simple simulation. The objective here is to present one set of mortality data and show how the two opposing perspectives would interpret what we see.

First, let us say that we are operating under the heterogeneity mode of thought. In Table 1, we have a hypothetical population distribution ranging in age from 50 through 95. The observed death distribution of the population is found in the third column, labelled "Heterogeneous Deaths." The fourth column provides the death distribution of all individuals who are subject to the "standard" mortality pattern.

That is to say, in a heterogeneous population, some individuals are subject to death rates that are average among their fellow cohort members at birth. Thus they are designated to have a "frailty" level of one. Others among the cohort have higher mortality, with frailty

greater than one, and yet others are of frailty less than one.

In this simulation, we have created a hypothetical black population that is composed of two subgroups — both of these groups follow a Gompertz mortality regime in which death rates are increasing nine per cent per year of age; however, the "strong" group begins at age 50 with a death rate of 1.5 per thousand, and the "weak" group begins at 4.5 per thousand. It is clear, then, that at every age the more frail group will have three times the mortality of the more robust group.

Given this interpretation, then, we have the observed death distribution in column 3. What does survivorship look like within each of the two subgroups? Figure 2 displays the survivorship or l_x curves for the two groups. Obviously, the weaker component of this population is dying out faster than the strong component. Figure 3 graphs the proportion of all survivors in the population that belong to each component. In this way it is easy to see that the overall death rates for the population will asymptotically approach the death rates of the robust component, since ultimately the only individuals remaining will be from the robust group.

Now let us suppose that we add a homogeneous white population whose death rates follow the same Gompertz function, but with an initial value of 2.5 deaths per thousand. Thus, at age 50 the overall white death rate falls between the death rates of the two black subgroups, which were 1.5 and 4.5 per thousand. Since the average black death rate at age 50 is 3 per thousand, the white death rate starts out below the black level.

Figure 4 displays the mortality trajectories experienced by four different groups — the more and less vulnerable blacks, the total black population, and the total white population. In this simulation, a

black-white crossover has occurred at age 84. The heterogeneity perspective would tell us that weaker individuals have been removed from the black population to an extent such that the robust subgroup's death rates are weighted sufficiently to ensure a total rate lower than that of the white population.

There is another explanation for this crossover, however, that is just as compelling. Suppose that the black population under study is actually homogeneous -- that is, all members of the group are subject to one standard level of mortality, with frailty one. In this population, though, it is possible that a number of the decedents have had their age at death overstated. In our death registration system, then, we fail to observe the true, homogeneous death distribution. Instead, let us say, we observe a distorted death distribution that happens to be the same as the heterogeneous distribution from the other perspective. The observed distribution, then, is in column 3, but the true distribution (which we do not observe) is in column 4.

Under the assumption that the ages of some fraction of recorded deaths are exaggerated by ten years and that this fraction can differ for various ages, we can compute the number of deaths that had to have been misstated in order to give rise to the distorted death distribution. The number of misstated ages is presented in column 5, and the rate of misstatement (or the number of misstated deaths divided by the true number of deaths at each age) is shown in the last column.

This last column tells us that an increasing age pattern of misstatement of age at death could yield precisely the same death distribution and age-specific mortality rates as could a population with no age misstatement but instead with heterogeneity in mortality.

The two opposing explanations of the crossover mortality phenomenon are empirically indistinguishable. In the true, underlying, unknown world, either position could be correct, though there is no way to prove it, given the data that we have presented.

Resolving the Issues

Although this debate, strictly speaking, can never be resolved, one important step in the right direction is being taken jointly by the National Center for Health Statistics, the National Heart, Lung, and Blood Institute, and the Bureau of the Census. Through their combined efforts, we will soon be able to have access to more detailed mortality data, by way of the National Longitudinal Mortality Study (NLMS), than we have ever had access to before. The NLMS will allow researchers to derive socioeconomic differentials in mortality from the linking of the National Death Index with a series of Census samples. The prospective nature of this study should enable us to obtain improved estimates of these differentials since the history of various mutable characteristics -- characteristics that typically would be of limited use in cross-sectional analysis -- can be accurately determined.

The NLMS potentially has a good deal of bearing on the heterogeneity debate that we have discussed above. Until now, the number of attributes by which we could cross-classify a population in order to obtain different life tables has been few -- we most often see life tables categorized by race and sex. These characteristics represent the observed heterogeneity in our population.

We know that all members of a population are not subject to identical mortality risks. Further, there is little reason to believe

that a population can be partitioned into a small, manageable number of subgroups, each of which is comprised of persons who are subject to the same mortality risks. Nonetheless, our aim should be to increase the amount of observed heterogeneity that we can incorporate in our models, and consequently reduce the latent or hidden heterogeneity that confounds our interpretation.

For example, one could imagine that blacks could be separated into two subgroups, one representing what might be considered a black underclass and the other, a more advantaged group. Should variables such as educational attainment and employment status adequately describe this underclass, then it is conceivable that this dichotomy might account for much of the selection that we observe, if in fact that is what is actually occurring. In other words, should we gather enough details about the population such that we may sufficiently refine our cross-classification scheme, then it may well be that all individuals located within a specified cell are, for all intents and purposes, homogeneous with respect to unobserved characteristics. A researcher's hope would be to have access to data that are sufficiently refined such that any neglected dimensions of heterogeneity could be deemed empirically trivial. Data from the NLMS bring us closer to that goal.

The Crossover Mortality Debate and Policy Formation

Although the United States is one of the wealthiest and most modernized nations in the world, it ranks only 20th with respect to its infant mortality rate (Population Reference Bureau, 1986). Further, some parts of the country are experiencing extraordinarily high infant death rates, rates well beyond those that we would typically associate

with advanced industrialized nations: The current rate for New Haven, for example, is 17 per thousand, for Trenton, 22, and for one section of Chicago, 55 per thousand -- a rate similar to that for Latin America.

The high infant death rates of the various local areas cited above are very much a function of income and race. The U.S. Department of Health and Human Services has stated that improvements in these rates will be difficult to come by and that national goals for the year 1990 will most likely not be achieved. One such goal is to reduce the infant mortality rate of each racial or ethnic group to below 12 per thousand. The current (1985) rate among blacks is 18.2 (National Center for Health Statistics, 1986).

Just how "out of line" is the U.S. infant mortality rate given its level of wealth? Among the 19 countries designated by the World Bank (1986) as industrial market economies, the U.S. is second only to Switzerland in GNP per capita ($15,390 in 1984). In contrast, the U.S. infant mortality rate is tied for third highest (at 11 per 1000) among these same countries.

Indeed, if one regresses infant mortality on GNP per capita for the industrial market economies in 1982 and again in 1984, an important fact is revealed. Whereas in 1982 the U.S. did not deviate significantly from the overall relationship found between these two variables, by 1984 the U.S. emerged as a statistical outlier in the pattern observed. That is, given its relative position among the industrial market economies, the U.S. today has an unusually high infant mortality rate — one which has improved only minimally in recent years.

What can be done to curb the high levels of infant mortality experienced by many regions of the country? One mechanism would be to promote family planning programs. Improved contraceptive use, for

example, would serve to delay the age at first birth, and thereby decrease the incidence of teenage childbearing. Delayed childbearing, coupled with good prenatal care provided by maternal health programs, can raise the birthweight of a child and consequently improve a baby's chances for survival.

One program designed to improve the health of mothers and their children is the Special Supplemental Food Program for Women, Infants and Children (WIC). The WIC Program, which was instituted in 1972, provides Federal assistance to pregnant, breastfeeding and postpartum women, and to children under five years of age. This assistance takes the form of supplemental foods, nutrition education, and access to health care. Eligibility is determined on the basis of economic need (at most, 185 percent of poverty) and nutritional risk (as diagnosed by a health professional) (U.S. Department of Agriculture, 1986a).

Although the size of the program has increased dramatically along several dimensions since its inception, the annual rate of growth of the number of program participants has declined steadily over the lifetime of the program. Further, the corresponding rate for total program costs (i.e., food costs plus administration costs) has also dwindled with the years (U.S. Department of Agriculture, 1986b). Falling growth rates would be expected as the program nears saturation, that is, as needs are met with greater and greater success.

At this point, we have no precise notion of the proportion of those in need who are being served. However, we do know that only 3.3 million women and children were served in fiscal year 1986 from among an estimated 8.4 million "income eligibles" (U.S. Department of Agriculture, 1986b). This estimate of eligibles represents a ceiling to

the true number, as the estimate is based only on income and does not address nutritional risk. Nonetheless, it is plausible that there is a significant shortfall in the extent to which the WIC program addresses the needs of its target population.

One question that immediately arises concerns the later-life consequences of poor health and high mortality rates in infancy for those subgroups subject to these high rates. Will the young survivors of a cohort with a high infant death rate continue throughout their lifetime to suffer the sequelae associated with the poor health conditions giving rise to that high death rate (such as low birth weight), or will the cohort exhibit mortality rates that appear to improve relative to other subgroups under the assumption that these individuals are "fitter" on average in the advanced ages than their peers belonging to other subgroups? Will the consequences of inadequate maternal and child health care, although clearly negative in its impact on infant mortality, prove to be "beneficial" (in its own perverse way) with respect to the future health of the affected cohorts? Or, will these individuals ultimately suffer profound costs in terms of loss of life, increased debilitation and reduced quality of life?

We do not attempt to answer here the question of how far a nation should go to ensure equity in infant and childhood mortality. One among many considerations among policy-makers is economic. Equity in early-age mortality cannot be achieved without the joint provision of equitable access to tertiary medical services and "preventive efforts addressing the underlying determinants of differential mortality" (Wise et al., 1986). The direct cost of such programs is readily calculable.

It is the indirect or later-life cost that is confounded by the crossover mortality debate. Those who claim the crossover is

artifactual would tend to believe that the later-life cost would be lower than that believed by those who claim the crossover is a real consequence of heterogeneous mortality risks. As Soldo and Manton (1985) note, "Increasing survivor heterogeneity of younger cohorts may result in increased prevalence of extreme disability and consequent demand for long-term care services. Thus, the impact of increasing numbers of the very old in the future is likely to be magnified by its relationship to other demand factors, including increases in the intensity and duration of health care needs at the oldest ages."

Aside from the economic components that must be addressed, there are moral factors as well that surround the inherent value of human life. The complex process by which one might weigh these contrasting dimensions of consideration is only exacerbated by the fact that this process takes place within a political context. Regardless of the process by which policy is ultimately formulated, the need for data of the highest quality to inform that policy is clear.

Conclusions

We have described in this paper the importance of data quality in the determination of health policy. The focus of our attention has been the black-white crossover mortality debate — whether the crossover truly exists and how the debate over its existence impinges on possible health policy.

The consequences of resolving this debate are primarily two-fold. First, for purposes of determining (a) the nature and extent of the future demand for health care services, especially long-term care services, and (b) the distribution of public expenditures that would optimally address

that demand (the definition of optimal, of course, will forever be a subject of heated debate), we must have accurate estimates of the prevalence of a range of chronic health care problems. Such estimates, in turn, can only be derived if we have an adequate demographic profile of the elderly population (i.e., its size and structure). Correct mortality rates are essential for reliable population projections.

Furthermore, age-specific mortality rates themselves serve as a proxy for the relative health status of populations. A mortality crossover might or might not signal that relative health status is dynamic over age and we should therefore search for the causes underlying a group's apparent relative advantage within one segment of the age range and relative disadvantage within another segment.

Second, the debate's resolution is of paramount importance in judging the total impact of health policy that addresses the physical and mental well-being of infants and children. Whether early-age mortality is positively or negatively correlated with old-age mortality is fundamental to our understanding of the later-life consequences of maternal and child health programs.

Intelligent choice of intervention strategies and decisions regarding resource allocation will depend on the validity of the mortality data that we rely upon in policy formation. Further, accurate mortality data provide one important means of assessing the impact of a particular intervention.

Most generally, the black-white mortality crossover is likely due to a combination of the two opposing beliefs outlined above. That is, it seems most plausible that both differential age misstatement and heterogeneity of frailty have given rise to this phenomenon. However,

it is necessary to examine the quality of mortality data and verify the presence of a mortality crossover before we explore the reasons underlying its presumed existence. It is only by this logical sequence of research that we shall formulate policy that will most effectively address the health care needs of the population.

While resolution of the crossover mortality debate may not be possible, it is imperative for researchers and those involved in public policy determination to gather more and better data. In this way, though we may not definitively confirm or reject any hypotheses we seek to test, we will continue to advance our knowledge of mortality patterns, albeit incrementally, and thus better inform the public policy decisions that will guide our future.

REFERENCES

Bennett, Neil G. and Lea Keil Garson. 1983. "The Centenarian Question and Old-Age Mortality in the Soviet Union, 1959-1970." Demography 20(4): 581-600.

Coale, Ansley J. and Ellen Eliason Kisker. "Mortality Crossovers: Reality or Bad Data?" Population Studies, forthcoming.

Fuchs, Victor R. 1986. The Health Economy. Cambridge: Harvard University Press.

Kermack, W. O., A. G. McKendrick, and P. L. McKinlay. 1934. "Death Rates in Great Britain and Sweden: Some General Regularities and their Significance." The Lancet, 698-703.

Manton, Kenneth G. and Eric Stallard. 1984. Recent Trends in Mortality Analysis. New York: Academic Press.

Mazess, R. B. and S. H. Forman. 1979. "Longevity and Age Exaggeration in Vilcabamba, Ecuador." Journal of Gerontology 34: 94-98.

Myers, Robert J. 1978. "An Investigation of the Age of an Alleged Centenarian." Demography 15(2): 235-236.

Nam, Charles B. and Kathleen A. Ockay. 1977. "Factors Contributing to the Mortality Crossover Pattern: Effects of Development Level, Overall Mortality Level, and Causes of Death." XVIII General Conference of the International Union for the Scientific Study of Population, Mexico City.

Nam, Charles B., Weatherby, Norman L., and Kathleen A. Ockay. 1978. "Causes of Death which Contribute to the Mortality Crossover Effect." Social Biology 25: 306-314.

National Center for Health Statistics. 1986. "Annual Summary of Births, Marriages, Divorces, and Deaths, United States, 1985." Monthly Vital Statistics Report 34(13). DHHS Pub. No. (PHS) 86-1120. Public Health Service, Hyattsville, Md., September 19.

Omran, Abdel R. 1971. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change." Milbank Memorial Fund Quarterly 49(4), Part 1: 509-538.

Population Reference Bureau. 1986. "1986 World Population Data Sheet." Washington, DC: Population Reference Bureau, Inc.

Preston, Samuel H. and Etienne van de Walle. 1978. "Urban French Mortality in the Nineteenth Century." Population Studies 32(2): 275-297.

Soldo, Beth J. and Kenneth G. Manton. 1985. "Changes in the Health Status and Service Needs of the Oldest Old: Current Patterns and Future Trends." Milbank Memorial Fund Quarterly 63(2): 286-319.

U.S. Department of Agriculture, Food and Nutrition Service. 1986a. "Study of WIC Participants and Program Characteristics." (April.)

U.S. Department of Agriculture, Food and Nutrition Service. 1986b. Various tables accompanying personal communication. (December.)

Wise, Paul H., Milton Kotelchuck, Mark L. Wilson, and Mark Mills. 1986. "Racial and Socioeconomic Disparities in Childhood Mortality in Boston." New England Journal of Medicine 313: 360-366.

The World Bank. 1986. World Development Report: 1986. New York: Oxford University Press.

AGE	POPULATION	HETEROGENEOUS OR INCORRECT DEATHS	STANDARD OR TRUE (HOMOGENEOUS) DEATHS	NUMBER OF DEATHS MISSTATED	MISSTATEMENT RATE
50	100000	314	314	0	.000
51	98611	338	339	0	.001
52	97195	364	365	1	.002
53	95751	392	394	1	.003
54	94277	422	424	2	.004
55	92774	454	457	2	.005
56	91241	488	491	3	.007
57	89676	524	528	4	.008
58	88080	562	568	5	.010
59	86451	603	610	7	.011
60	84789	646	654	9	.013
61	83093	691	702	11	.016
62	81363	739	752	14	.018
63	79597	789	805	17	.021
64	77795	841	861	21	.024
65	75957	896	919	26	.028
66	74082	953	981	31	.032
67	72169	1013	1046	38	.036
68	70218	1074	1113	45	.041
69	68228	1137	1184	54	.046
70	66199	1201	1257	64	.051
71	64132	1267	1332	77	.058
72	62025	1333	1410	91	.064
73	59879	1389	1489	107	.072
74	57695	1465	1570	126	.080
75	55472	1530	1652	148	.089
76	53212	1592	1734	172	.099
77	50916	1652	1815	200	.110
78	48584	1708	1895	232	.123
79	46219	1759	1972	268	.136
80	43823	1803	2046	308	.150
81	41400	1839	2115	352	.167
82	38951	1867	2177	402	.184
83	36483	1883	2232	455	.204
84	33999	1888	2275	514	.226
85	31506	1879	2307	576	.250
86	29011	1855	2325	641	.276
87	26523	1816	2325	710	.305
88	24051	1760	2307	779	.338
89	21607	1687	2268	848	.374
90	19205	1593	2206	916	.415
91	16859	1492	2119	979	.462
92	14588	1372	2006	1036	.516
93	12409	1238	1867	1084	.581
94	10344	1095	1703	1121	.659
95	8416	945	1516	1147	.757

TABLE 1

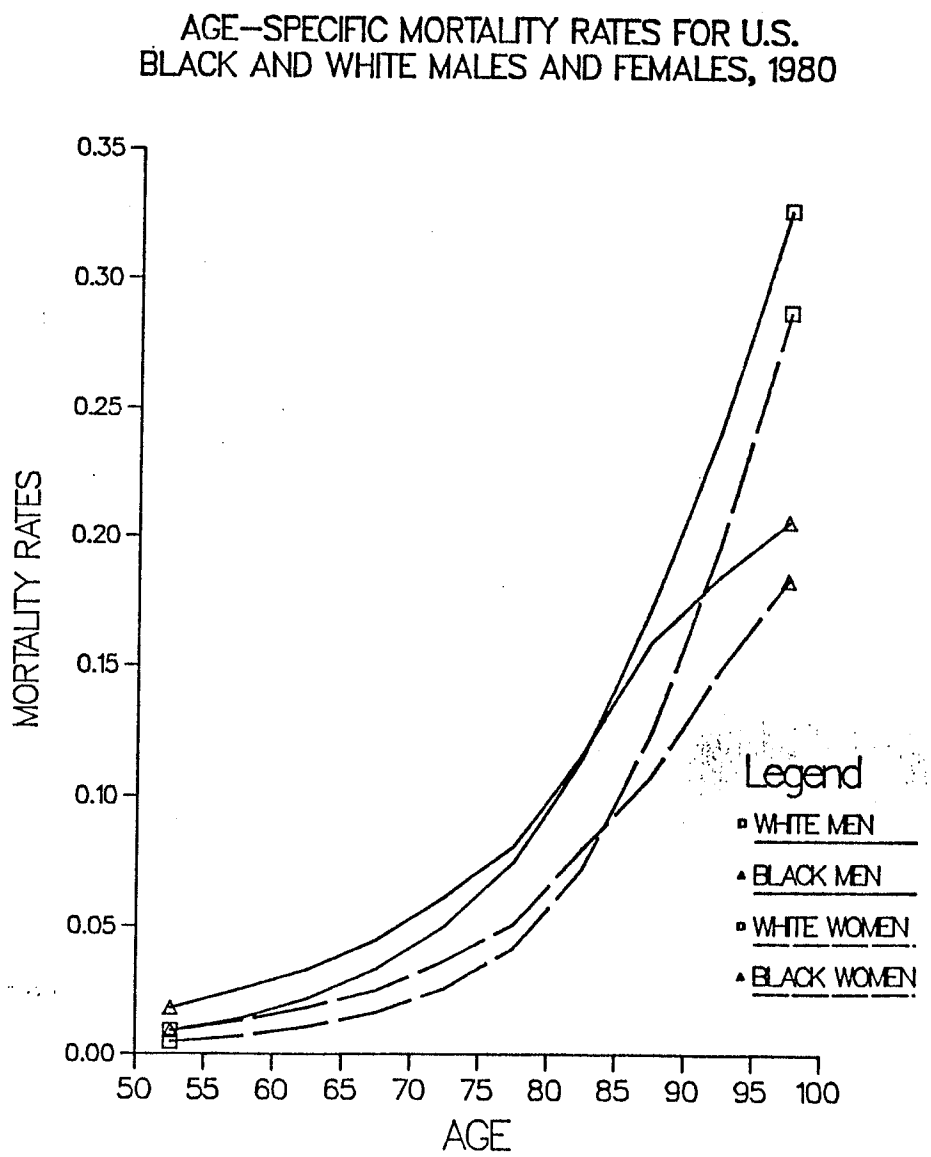

FIGURE 1

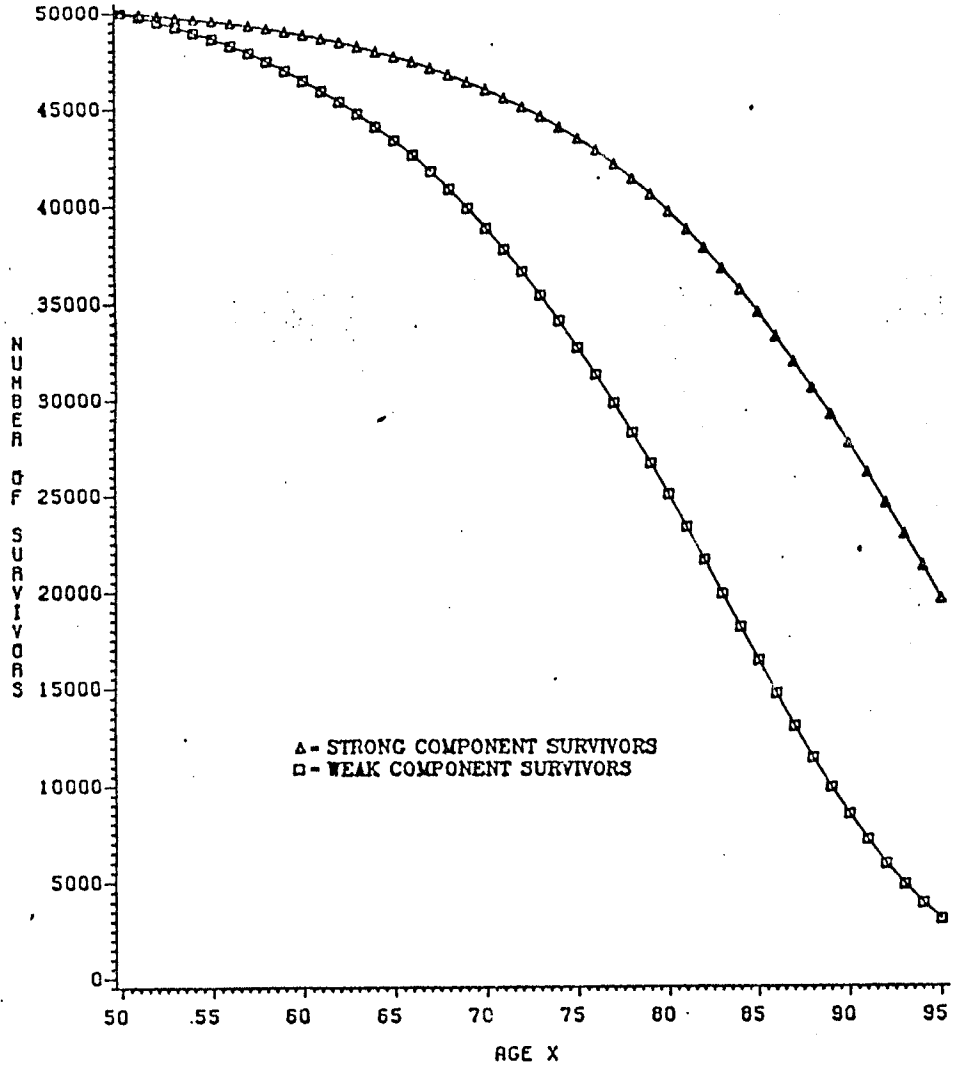

FIGURE 2

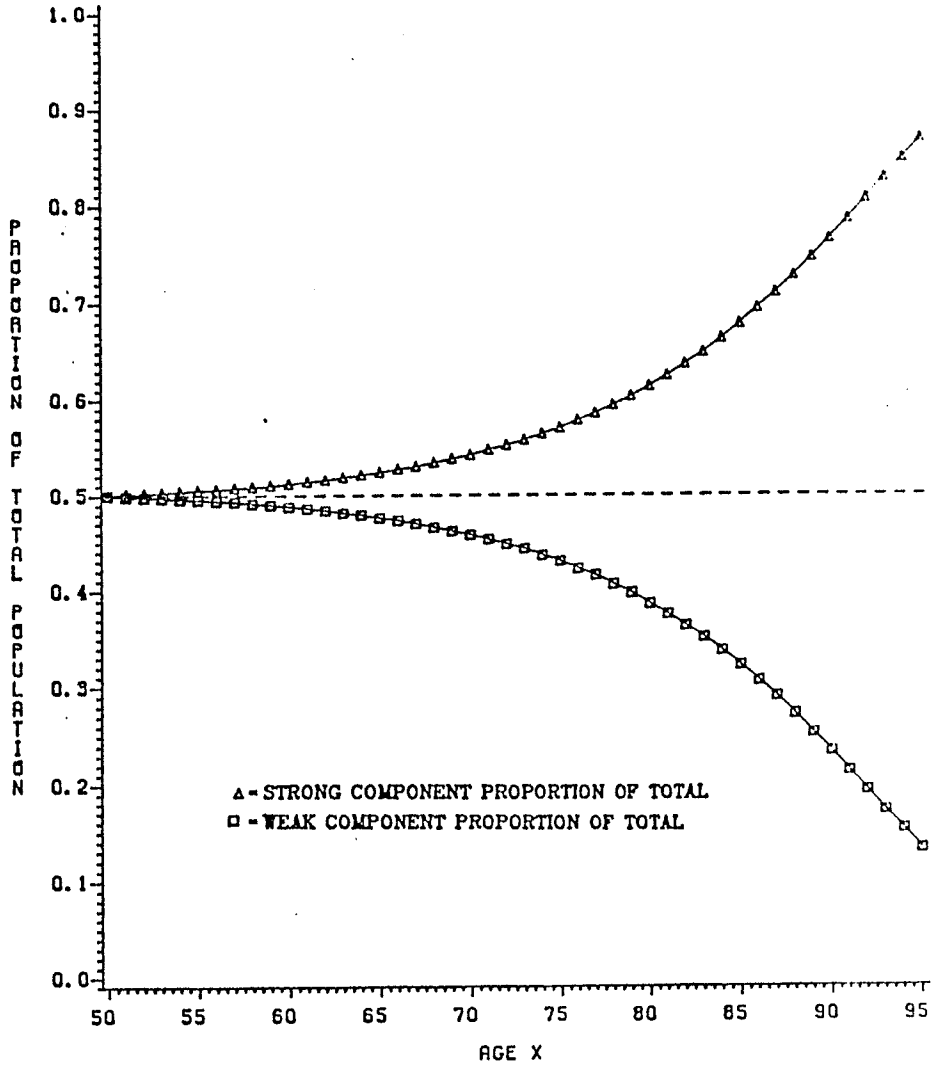

FIGURE 3

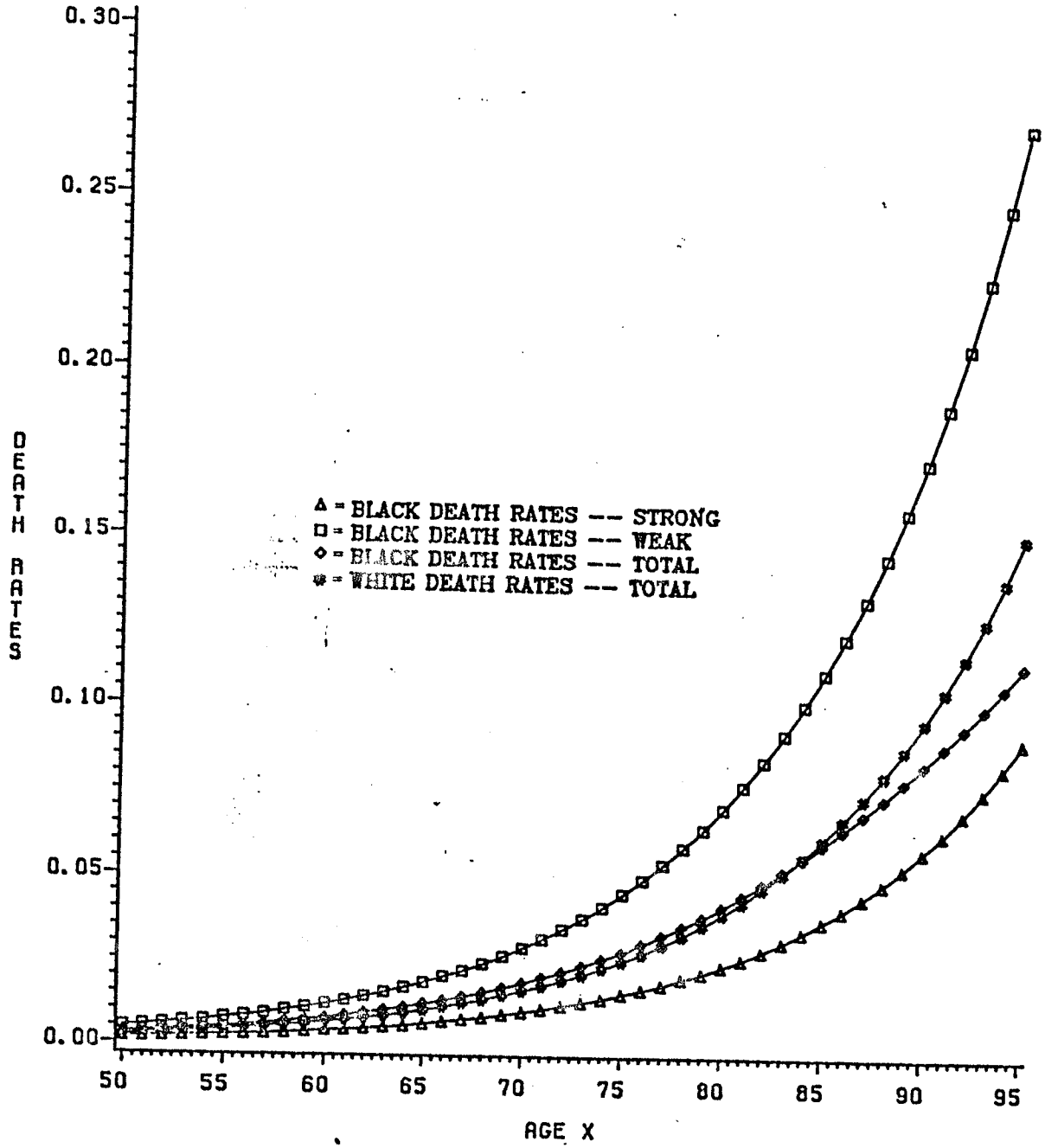
0.30
0.25
0.20
0.15
0.10
0.05
0.00
DEATH RATES
△ = BLACK DEATH RATES --- STRONG
□ = BLACK DEATH RATES --- WEAK
◇ = BLACK DEATH RATES --- TOTAL
* = WHITE DEATH RATES --- TOTAL
50
55
60
65
70
75
80
85
90
95
AGE X

FIGURE 4