

A NEW EVALUATION OF UNITED STATES CENSUS DATA ON THE EXTREME AGED

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Abstract—Population and mortality data for the extreme aged have generally been considered subject to a large degree of error, particularly for nonwhites. In this study, estimates of the United States population 85 years of age and over in 1960 are devised through a procedure known as the “method of extinct generations,” which permits the reconstruction of “extinct” population cohorts from a series of annual death statistics. Estimates of the total population by single year of age and of sex-color groups by five-year age groups are compared with the 1960 census. With some exceptions, the data for whites show remarkable correspondence; the tally for nonwhites developed from death records falls considerably short of the census count, indicating a greater overstatement of age in the latter source.

INTRODUCTION

While a considerable amount of attention has focused on white-nonwhite differentials in death rates among the elderly and the resulting life expectancy values, not much more than lip service has usually been given to the important role of erroneous data. Unless numerators and denominators have an accuracy sufficient to truly reflect fact, the computed rates can have little validity and may totally distort the image of the real situation. In this paper an attempt is made to construct some denominators that may be viewed as alternatives to census figures for the population at the extreme ages. Persons at ages 85 and over have been selected for intensive examination here not because error does not exist at younger ages but because in this age category the bias in official data is generally recognized as most serious (Shryock and Siegel, 1973, vol. 2, p. 398).

A technique developed by Vincent (1951), the “method of extinct generations,” has been used to evaluate census statistics of persons of extreme old age.

The population 85 and over in a census taken in 1950 would have almost completely died by 1970; it should be possible, by cumulating the appropriate statistics of deaths in the period 1950–70, to reconstruct the “true” population 85 and over in 1950 (Shryock and Siegel, 1973, vol. 1, p. 228). When Rosenwaike (1968) applied this method to data for the United States, he found the difference between the 1950 census population 85 years of age and over and a population constructed from official statistics of deaths was only about two percent. His data, however, were neither sex nor race specific. Presumably, exaggeration of age was much greater for the nonwhite population than for the white population, but since nonwhites accounted for less than one-tenth of the total extreme aged their experience was largely lost in the aggregate data. Here we utilize the method of extinct generations and compare the results obtained with 1960 census data for whites and nonwhites.

In the comparison of age information from the two sources, a variety of limita-

tions and sources of discrepancy must be considered. Both sets of records are subject to coding errors and to errors in reporting, especially rounding of age (or year of birth) and exaggeration of age. The degree of census underenumeration is not clearly known. Alternative estimates of coverage in the 1960 census indicate net overcounts for white males in the age 75-and-over group as a whole of 1.8 percent and 0.1 percent; for white females in this group the corresponding estimates were of net undercounts of 1.7 and 4.1 percent. The various procedures have produced widely different estimates of census error for elderly nonwhites. Siegel (1974) has pointed out that "there is uncertainty not only about the magnitude of the error rate of the Negro aged population but about its direction as well." In the absence of any estimate for age subgroups among persons 75 and over, still less can be said of the count of individuals 85 and over. Death record reporting, although not subject to rigorous testing, is believed to have been close to complete in recent decades (U.S. National Center for Health Statistics, 1964). It must be emphasized, however, this does not mean the records are accurate, particularly in regard to age (U.S. Bureau of the Census, 1974).

A small proportion of all 1960 census records (2.2 percent) lacked any age information and were assigned responses mechanically (Shryock and Siegel, p. 229). Age was not filled out in less than 0.1 percent of death certificates tabulated during the 1960s (U.S. National Center for Health Statistics, 1963-1978). The effect of immigration or emigration must be considered entirely inconsequential.

Sampling and mechanical processing have introduced new sources of error in each enumeration which may affect one age, race, or sex group far more than another. An unexplained peculiarity of the 1960 census was the fact that the full count tabulations of the population aged 65 years and over included about 350,000 persons—about two percent—more than the count derived by inflating the group

for which there were 25-percent census sample records. And most significantly, Myers (1966) stated that "this differential increases steadily by age and is as much as 7 percent for persons aged 85 and over." Unfortunately, the consequences are of considerable import in the study of the extreme aged population because all data for Americans 85 years of age and over from the 1960 census, save for the gross totals by sex and color, were derived from the 25-percent sample (U.S. Bureau of the Census, 1963). Thus data for five-year age groups (e.g., 85 to 89 years) or single years come from a sample known to be seriously deficient, and those who utilize the statistics need to adjust all figures to at least agree with the full count for the marginals.

METHOD

By making use only of vital statistics in the study of mortality among the extreme aged, one can avoid those sources of error which derive from the utilization of census figures. Vincent (1951), who developed the method of extinct generations for this purpose, looked at data from countries where there was a double classification of decedents in official reports—by year of age and by year of birth—and where there existed a long history of accurate vital registration. Since deaths in the United States are not tabulated by year of birth of the decedent, Rosenwaike (1968) found it necessary to modify this method of population reconstruction by assuming that one-half of the decedents at each single year of age were born in the earlier of the two mathematically possible calendar years in which a person of the given age could have been born and half in the later. This procedure is repeated in the present study where all generations that had reached their eighty-fifth birthday by the beginning of the calendar year 1960 are traced to extinction. The sum of the deaths for a given birth cohort, say that of 1874, provides the number of individuals aged 85 years at the point of commencement (1960). Combining cohorts

this way, the entire population 85 years of age and over is constructed from annual statistics of deaths. (For a more detailed description of the process, see Rosenwaike, 1968.)

Since, generally, each succeeding birth cohort is larger than the preceding one, it might be argued that the assumption made that deaths in a given year at a given age stem equally from two cohorts produces bias (although relatively small) by consistently underallocating the proportion due the more numerous recent cohort. However, precisely because it is a younger cohort it is subject to somewhat lower mortality. Thus the difference in cohort size is to some extent offset by the difference in the proportion dying.

Two adjustments have been found necessary in utilizing the vital statistics for the United States during the years 1960 through 1976. First, deaths not classified by race in 1962 and 1963 when this item did not appear on New Jersey death certificates (U.S. National Center for Health Statistics, 1963-1978) have been estimated. Deaths at each individual age not classified by race in 1962 were distributed pro rata by sex in accordance with the white-nonwhite proportions shown for New Jersey in 1961; similarly, unclassified 1963 deaths were distributed on the basis of 1964 proportions. Second, all deaths reported of persons aged more than 110 were treated as if they were 110 years of age. Virtually all of these instances must be considered erroneous. (See Myers and Shudde [1955] and Depoid [1973].)

Since we are assuming there are no survivors beyond the age of 110, it follows that by the end of 1976 (the last year for which we have used annual vital statistics) all generations of persons aged 93 years or over in 1960 had become extinct. However, small numbers of survivors remained of the generations aged 85 to 92 years, some of whom would not be recorded as decedents for several years to come. Accordingly, it is necessary to estimate the size of this group of survivors (all aged 102 years or more) to accumulate the

complete generation of persons in all of the cohorts of extreme aged individuals in the 1960 population. The simplest method assumes that the number of deaths at ages 102 and over in the years immediately following 1976 remains unchanged from the figures for that year. This procedure yields an estimated number of survivors at the beginning of 1977 of 4,433. Even if this estimate errs by as much as ten percent, plus or minus about 440 individuals, it affects minimally the total for the reconstructed population.

Since death statistics by age are reported on a calendar year basis, all of the calculations involved in reconstructing generations produce populations at the beginning (or end) of a calendar year. The population at the U.S. census, which is taken on April 1, is thus not strictly comparable with the population reconstructed from death statistics to January 1. In the interest of simplicity, the most convenient adjustment is to convert the April 1, 1960 census data to January 1, 1960. It is assumed that in the quarter year between January 1, 1960 and April 1, 1960 the population change for the age category 85 years and over amounted to one-fortieth (2.5 percent) of the aggregate change between April 1, 1950 and April 1, 1960. Since the total increase was from 577,939 to 929,252 or 351,313, the estimated January 1, 1960 to April 1, 1960 change was 8,783, and the estimated January 1, 1960 figure was 920,469. The need for an adjustment of approximately 7 percent in all single year of age color-sex groups to make the 25 percent sample of the returns correspond with the 100 percent count has already been stated. This "corrected" figure is then uniformly reduced to fit the January 1, 1960 interpolation controls when deriving estimates for each individual age within a sex-color group.

COMPARISON OF DATA

A detailed comparison of the population derived from the extinct generation method with that estimated from the census is presented in Table 1. The almost

Table 1.—Comparison of Two Estimates of Population of the United States 85 Years of Age and Over, by Color and Sex, January 1, 1960

Color, Sex and Age Group	Estimate derived from Census	Estimate by Extinct Generation Method	Difference as Percent of Census Estimate
TOTAL			
85 years and over	920,469	918,753	-0.2
85-89 years	691,170	685,591	-0.8
90-94 years	181,851	193,860	+6.6
95-99 years	36,411	34,180	-6.1
100 and over	11,037	5,122	-53.6
White male, Total	328,097	321,061	-2.1
85-89 years	253,702	247,242	-2.5
90-94 years	61,100	63,439	+3.8
95-99 years	10,326	9,415	-8.8
100 and over	2,969	965	-67.5
White female, Total	521,389	535,134	+2.6
85-89 years	389,262	397,313	+2.1
90-94 years	106,335	115,625	+8.7
95-99 years	20,725	19,950	-3.7
100 and over	5,067	2,246	-55.7
Nonwhite male, Total	31,054	26,926	-13.3
85-89 years	21,797	18,322	-15.9
90-94 years	5,852	6,077	+3.8
95-99 years	2,243	1,838	-18.1
100 and over	1,162	689	-40.7
Nonwhite female, Total	39,929	35,632	-10.8
85-89 years	26,409	22,714	-14.0
90-94 years	8,564	8,719	+1.8
95-99 years	3,117	2,977	-4.5
100 and over	1,839	1,222	-33.6

exact correspondence between the total population in each of the two series, despite the numerous sources of potential discrepancy already mentioned, certainly must enhance confidence in both sets of

statistics. The estimate of the population 85 years and over on January 1, 1960 yielded by the extinct generation procedure is 918,753 while the estimate based on interpolated census data is 920,469, a

difference of less than one-half of one percent. This aggregate agreement, however, masks more marked differences in the two series exhibited when subgroups are compared. The overall total heavily reflects the experience of white persons and of the large group aged 85 to 89 years. For both of these major categories, differences between the two series were slight, less than one percent. On the other hand, the total nonwhite extreme aged population as estimated by the extinct generation method was some 12 percent smaller than the census estimate. In addition, for age groups 90 to 94 years and above, for whites as well as nonwhites, there were considerable differences in the results obtained from the two series.

If one assumes age reporting on the death certificate is no less accurate than on the census record, then it can be assumed that the very small excess of whites (0.8 percent) appearing in the extinct generation estimate signifies a slight degree of census underenumeration. Among nonwhites, however, a markedly excessive number of aged turn up in the census relative to the count based on decedents. The most plausible explanation would seem to be overstatement by individuals reporting their age in the census compared with ages given by relatives of decedents at the time of death.

Comparison of the data for five-year age groups from the two sources indicates a pattern inconsistent with the expectation of an increment in differentials with mounting age. Peculiarly, census data show a very modest overstatement compared with extinct generation figures at ages 85 to 89 years (about 1 percent), a rather marked understatement (almost 7 percent) at ages 90 to 94 years, then marked overstatement (approximately 6 percent) at ages 95 to 99 years. Furthermore, the distinctly larger differences in the two series for whites than for nonwhites at ages 100 and over seem entirely implausible. The only conclusion that seems reasonable in accounting for inconsistencies is that census data were subject

to processing errors that distorted the counts for certain ages.

Although the reason for the short count in the 25 percent sample compared with the 100 percent enumeration for persons 85 years of age and over is not known, it may be that certain segments of this population were more likely to have been "missed" than others. In this connection, it is of interest to note the Akers and Larmon (1967) finding of spurious numbers of nonwhites at certain selected ages that resulted from smudges on the 1960 census sample returns.

Data for single years are subject to errors which tend to be larger than those for grouped intervals. One source of error is age heaping, or the tendency for age to be reported at particular years, usually rounded figures such as 80 or 90. Hambright, who looked at the 1960 census record and matched death record age distributions, observed that "on the whole, heaping is greater for females than males and greater for nonwhite individuals than for white" (U.S. National Center for Health Statistics, 1968, p. 5). Table 2, which provides comparisons by individual year of age, indicates no very pronounced heaping for either whites or nonwhites in the ages reconstructed from the death records. Nor is there much evidence of heaping in the single year of age census data for whites. Among census nonwhites, however, a tendency to report certain preferences shows up in apparently excessive numbers at 89, 94, and 99 years of age, where in each instance the count exceeds that for the next youngest year of age. This probably can be explained by reference to the fact that in processing the 1960 census the information entered for date of birth was used for the age item. Thus heaping took place on the basis of year of birth, with preference given to round number years such as 1900. Approximately three-fourths of all those who reported their year of birth as the year 1870, for example—all those with birthdays after April—were tabulated as age 89 and only one quarter as age 90.

Table 2.—Comparison of Estimates of White and Nonwhite Population of the United States 85 Years of Age and Over, by Single Year of Age, January 1, 1960

Age Group	White			Nonwhite		
	Estimate derived from Census	Estimate by Extinct Generation Method	Difference as Percent of Census Estimate	Estimate derived from Census	Estimate by Extinct Generation Method	Difference as Percent of Census Estimate
Total 85 years and over	849,486	856,195	+0.8	70,983	62,558	-11.9
85-89 years	642,964	644,555	+0.2	48,206	41,036	-14.9
85	187,956	187,777	-0.1	14,312	11,279	-21.2
86	147,241	153,096	+4.0	10,310	9,306	-9.7
87	129,720	125,041	-3.6	9,269	7,868	-15.1
88	97,212	99,365	+2.2	6,822	6,663	-2.3
89	80,835	79,276	-1.9	7,493	5,920	-21.0
90-94 years	167,435	179,064	+6.9	14,416	14,796	+2.6
90	58,372	60,735	+4.0	5,259	4,641	-11.8
91	40,045	44,369	+10.8	2,588	3,308	+27.8
92	30,101	33,365	+10.9	2,454	2,664	+8.6
93	22,917	24,143	+5.3	1,997	2,232	+11.8
94	16,000	16,452	+2.8	2,118	1,951	-7.9
95-99 years	31,051	29,365	-5.4	5,360	4,815	-10.2
95	11,011	11,084	+0.7	1,660	1,496	-9.9
96	7,829	7,574	-3.3	992	1,130	+13.9
97	5,393	5,068	-6.0	1,021	886	-13.2
98	3,882	3,404	-12.3	757	692	-8.6
99	2,936	2,235	-23.9	930	611	-34.3
100 years and over	8,036	3,211	-60.0	3,001	1,911	-36.3

Among whites, some other effect, perhaps resulting from processing error, seems to have produced a peculiar pattern of discrepancy that shows up in the single year of age data for the two series. Although irregular changes occur, differences between series are no greater than four percent for single years 85 through 90 and 94 through 96. However, for individuals aged 91, 92, and 93 there is a marked deficit in the census returns compared with the extinct generation method estimates. Similarly, among the nonwhite

population very substantial deficits also occur in the census figures for individuals aged 91, 92, and 93. These in fact are the only instances of understatement in the census count for nonwhites with a single exception (age 96).

In sum, beginning with age 92 there is a regular stepward progression year by year in the census aged, from maximum underestimate compared with the death-derived population to maximum overstatement at 99 (and still greater at 100 and over). This pattern is in accord with the expected

lower level of agreement in age statements with mounting age.

More white females 85 years and over were generated by the extinct cohort method than were enumerated in the 1960 census; just the reverse was true for white males. Similarly, although nonwhite males and nonwhite females both were less likely to be tallied at very advanced ages on the basis of death certificate than census data, the correspondence of the two series was greater for the latter, i.e., women were more likely to have death certificate ages closer to the apparently overstated age of the census record than were men. The same pattern was exhibited among adult women of all ages in the definitive 1960 study that compared the statement of age on the death certificate with the matching census record. Hambright (U.S. National Center for Health Statistics, 1968, p. 26) finds support for the assumption that women reporting for themselves on the census record have a tendency to understate their age and contends that "some of the age inconsistency for females might arise from a difference in respondents on the two records. That is, information for males might be more likely to come from the wife or other household member on both the census record and the death certificate whereas information for females might be more likely to come from themselves on the census record and hence from a different respondent on the death certificate."

DISCUSSION

Bayo (1972) has commented that "the degree of lack of confidence of many demographers and actuaries in the quality of data at the older ages is such that most official life tables are ended at the upper ages by a purely mathematical procedure or by substituting a set of known rates for the actual experience." The remarkably close agreement between the 1960 census total for persons 85 years and over and the total based solely on mortality statistics assembled in the present study demonstrates that the problem of comparability

of census data with death registration data is not so extensive as perhaps it may have been earlier. (To be sure, this comparability does not assure accuracy, indicating only agreement.)

Among whites there is no outstanding difference between the estimated coverage and accuracy of the all-ages census count in 1960, as determined by demographers through a synthesis of methods and techniques, and the census count of the extreme aged, as evaluated on the basis of the extinct cohort technique. The undercount among white males of all ages has been estimated by the U.S. Bureau of the Census (1974) at 2.4 percent; for white females the corresponding figure has been placed at 1.6 percent. Data derived here from mortality statistics indicate an excess of extreme aged males in the census amounting to 2.1 percent and a deficit of 2.6 percent for white females 85 and over. Some of the differences for five-year age groups in the span from 85 to 99 years are, of course, larger than this, but they are not markedly in excess of some differences estimated for some younger age groups.

Despite the overall close agreement in the two series of statistics for white extreme aged, full confidence cannot be placed in the detailed census data. The general correspondence between the census figures and the extinct generation estimates for single years of age between 85 and 97 is inexplicably out of balance at ages 91 and 92. In the absence of any other likely explanation, one must assume computer or similar manipulation has led to greater rather than lesser census error. When frequencies are small (as in the case of very advanced individual ages), minor errors in processing can exert a large effect. What is encouraging, however, is the probability that reporting itself may not be at fault. By and large, a mechanical error is more amenable to correction than incapacity to supply a correct statement of age.

Review of the data for nonwhites is more problematic. A simple glance at the mortality-based data (Table 2) reveals

very probable gross overstatement of age among nonwhites compared with whites. While 0.4 percent of all whites 85 years and over were aged 100 years or above, fully 3.1 percent of extreme aged nonwhites were reportedly centenarians. Exaggeration of age must be evident from the following statistic: although nonwhites constituted less than one-twelfth of all persons aged 85 or more in 1960, they accounted for approximately three-fourths of decedents reported as 110 years of age and above during the period from 1960 through 1976 (U.S. National Center for Health Statistics, 1963–1978).

Undoubtedly, the extinct generation method overstates the number of nonwhites among the extreme aged, and the higher the age the larger the relative overstatement. Nevertheless, it seems there is substantially less overreporting of age for nonwhites on the basis of the mortality statistics approach than on census records. Those who have given serious consideration to the issue (Myers, 1966; Kitagawa and Hauser, 1973, p. 97) concur that the death certificate has tended to have less overstatement of age than the census return. This would explain why the data in Table 2 indicate 12 percent fewer nonwhites at ages 85 years and over, when the extinct generation method rather than the census count is utilized.

The 1960 study of age comparability, derived from the Social and Economic Differentials in Mortality Study, provided valuable direct evidence that statement of age tended to be higher in the census than on the matching death certificate for the same individual. Among white decedents on the census record, approximately 4 percent appeared in a higher age group and 13 percent in a lower age group on the death certificate. Among nonwhites aged 85 to 89 years according to the census record, about 7 percent were in an older age group on the matching death certificate, while fully 43 percent were in a younger category. Similar patterns were observed at census ages 90 to 94 years and 95 to 99 years (U.S. National Center for Health Statistics, 1968, pp. 30–33).

Because overstatement of the number of centenarians is recognized as widespread, and since there is particular interest in persons living to an extremely high age, considerable attention has focused on the group 100 years and over. Siegel and Passel (1976) have developed estimates of this population by four procedures at the time of the three most recent censuses. Their preferred estimate of centenarians on April 1, 1960—3,300—is somewhat less than the estimate of 5,365 they obtain from population reconstruction using death statistics for 1960–73, and only about 32 percent of the count of the centenarian population given in the 1960 census.

Bureau of the Census statisticians have estimated that about 95 percent of the reported centenarians in the 1970 enumeration were in fact less than 100 years old. They attribute this massive overstatement to systematic errors in recording responses and to processing errors (Siegel and Passel, 1976). Evidence of the degree of reliability in the age group 95 to 99 years has not yet been presented. A preliminary estimate prepared by the author from population reconstruction, utilizing death statistics for 1970 to 1976 and estimated survivors as of January 1, 1977, amounts to 55,901 as of January 1, 1970. Since the April 1, 1970 census count of persons 95 to 99 years of age was 73,076 (U.S. Bureau of the Census, 1973), this suggests substantial overstatement in the 1970 population count for this five-year age group, considerably more than seems to have been the case in 1960. It is worth noting that mortality rates used to derive the official United States life table values for 1969–71 at ages 95 and over were based on the experience of the Medicare program rather than on census data and registered deaths (U.S. National Center for Health Statistics, 1975).

In the 1960 Matched Records Study, mortality rates were calculated where age for both numerator and denominator (deaths and population) was drawn from a single source—the census record (Kitagawa and Hauser, 1973, p. 95). Similarly,

Bayo (1972) computed rates based on populations and deaths obtained from a common source: registrations of persons enrolled in Medicare. The common pattern that emerged in both series of "corrected" data was the narrowing of the color differential in mortality among persons 85 years and over, the age group for which U.S. vital statistics have consistently shown substantially lower death rates for nonwhites than for whites.

Sutton (1971) argues that the seeming lack of interest in differentials in mortality among the aged can be ascribed, at least in part, to "difficulties encountered in interpreting data for Negroes at the older ages." Investigation is needed that will utilize previously unexploited data to corroborate age statements given on the death records if we are to attempt to determine whether the "crossing" of the mortality curves for whites and nonwhites at the very old ages is a real phenomenon resulting from some type of selection in survival patterns (see Nam et al., 1978) or is an artifact of faulty data.

SUMMARY

A procedure known as the "method of extinct generations," which permits the reconstruction of a population of deceased individuals from death statistics, has been utilized to develop estimates of population of the United States aged 85 years and over by single years of age, by sex and color, as of 1960. These estimates have been compared with appropriate census figures and, in general, a very close correspondence is noted among whites, although some discrepancies occur which seem to stem from peculiarities of census sampling or computer processing. For nonwhites the death reconstruction method yields an estimate that is 12 percent lower than the census tally. Other evidence, such as the sample of death certificates matched with records for the same individual in the 1960 population census, confirms the greater exaggeration of age in the latter source. Thus, while the nonwhite population estimate constructed from death statistics is a biased one, it

very likely is closer to reality than is the census.

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