
Supercentenarians in the United States

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Abstract. We have identified 325 persons who lived in the United States during the prior two decades beyond their 110th birthday, and were deceased as of June 2003. In this chapter we discuss how these supercentenarians were identified, and tabulate their characteristics and mortality.

The United States has contributed to the International Database on Longevity (IDL) 325 persons who lived in the United States during the prior two decades beyond their 110th birthday, and who were deceased as of June 2003. The records used to authenticate their ages at death will be included in the IDL document file to the extent possible. In 2003 the United States' contribution was thus larger than the total contributions of all other IDL countries.

We would guess that the actual number of persons who lived in the United States during the prior two decades beyond their 110th birthday is more than 400, because there are two groups of these people who are not included in the 325. The larger group consists of persons known to us with a recorded age of 110 or more, but whose age has not been verified. Some of them will be added to the IDL as we continue in our verification efforts. Those in the smaller group are supercentenarians of whom we are unaware. These two groups are within our scope; by contrast, persons reaching 110 in the current decade, or who died before 1980, are outside of our scope.

In this chapter we discuss at length how U.S. supercentenarians were identified. We also tabulate their characteristics, and briefly describe two analytic studies involving U.S. supercentenarians. Then, using extinct-cohort methodology, we calculate the mortality schedule implied by the distribution of their ages at death. The chapter ends with our plans for the future.

At the outset, we wish to communicate the collaborative nature of the project, and acknowledge the major roles played by the Program on Population, Policy, and Aging at Duke University (and Cindy Owens, in particular), under the leadership of Dr. James Vaupel; and by the Population Studies Center at the University of Pennsylvania (and Leslie Stone, in particular), under the leadership of Dr. Samuel Preston. We would also like to acknowledge the assistance of Mr. Robert Young.

1 Casting the net and passing muster

Except for countries with very accurate population registers, a systematic search for supercentenarians proceeds through two stages. First a net is cast to “capture” possible supercentenarians. Then the candidates’ credentials are critically examined, and only those passing inspection receive the stamp of authentication. The net should be wide and the examination rigorous.

In countries without population registers, the net is typically cast over decedents with recorded ages of 110 or more on the death certificate, and personal information (name and parents’ names, date and place of birth) needed for the next step is collected from the certificate. This net is very wide when death registration is virtually complete, as is the case in the United States, and only the few supercentenarians whose age at death is incorrectly recorded as less than 110 are missed. (The net could be made wider still by including decedents with recorded ages close to 110.) At the present time, however, this approach is not feasible in the United States.

In the United States, the registration of vital events is generally performed by state governments: there are registrars in each of the 50 states, and in Washington, DC, and New York City, as well. Each year, the registration jurisdictions send copies of their files to the National Center for Health Statistics (NCHS) (a federal agency which is part of the Centers for Disease Control and Prevention of the Department for Health and Human Services). The NCHS merges the state files, removes personal identifiers, such as names, and makes a public-use file available to researchers. This file is not useful for our purposes because of the lack of personal identifiers needed to proceed to the validation stage of supercentenarian identification. The National Center does maintain a publicly-available data system from which the personal identifiers have not been removed, called the National Death Index (NDI), but this is a system designed to determine persons’ vital status, rather than to produce a list of decedents according to some criteria.

Only recently did we become aware that the NCHS does possess the capability of selecting death registration records with personal identifiers in which the recorded age is 110 or more, back to about 1960. However, this capability can only be exercised with the permission of states officials, who must be convinced of the merits of the endeavor. Despite the likelihood that the need to obtain many permissions means a protracted process, we sent a letter to NCHS in May 2003 informing the agency of our interest in pursuing this avenue.

Given this current status of death certificate files, we chose a different net, one designed to capture persons enrolled in Part B of the Medicare program beyond their 110th birthday. The Medicare program is a two-part federal health benefits program for persons who are ages 65 and over or disabled. Part A, which provides hospitalization benefits, generally does not require premium payments from enrollees; while Part B, which provides benefits for medical services, is partially funded by premiums paid by all program participants. According to estimates from the U.S. Bureau of the Census, more than 96% of the population ages 70 and over participate in the Medicare program.

The federal agency that administers the Medicare program is the Centers for Medicare and Medicaid Services (CMS) in the Department of Health and Human Services. However, the enrollment of most Medicare participants is performed by a different federal agency, the Social Security Administration (SSA), which explains why Medicare enrollment information is present on the SSA master file—the Master Beneficiary Record. The similar CMS master file, the Enrollment Data Base, receives enrollment information from the Master Beneficiary Record, and also receives enrollment records from the Railroad Retirement Board (yet another federal agency) for persons whose entitlement to Medicare derives from careers in the railroad industry.

The Social Security Administration's Office of the Chief Actuary recently completed a study of mortality in the United States during the prior two decades at ages 85 and over (Kestenbaum and Ferguson, 2002). The study tabulated the experiences of persons enrolled in Medicare Part B, as reflected in SSA's Master Beneficiary Record. It had previously been established (Kestenbaum, 1992) that (a) records of current enrollment in only Part A (for which premiums are generally not charged), and not in Part B (which requires the participant to be up-to-date on his premium payments), are suspect, and that (b) the SSA master file is more accurate than the similar CMS master file. In particular, the recent study found that single-age probabilities of death

increase fairly steadily with age, reaching a value slightly greater than one-half at age 109.

The identification of potential supercentenarians was a postscript to this mortality study. We have, therefore, chosen to limit the scope of this study to persons reaching age 110 no later than the year 1999, and dying no earlier than the year 1980. We have also chosen to omit three small in-scope groups of supercentenarians: those not enrolled in Medicare, those enrolled in Part A only, and those whose eligibility for Medicare derives from their career employment in jobs covered by the Railroad Retirement system, and who, therefore, will have a record in the CMS master file, but not in the SSA master file. Of course, supercentenarians whose age is less than 110 according to the date of birth recorded on the Medicare enrollment record will also be missed.

Given that the corroboration of date of birth generally requires that we share information with our partners outside the Social Security Administration, the privacy statutes and regulations which protect the confidentiality of the Social Security records of living persons make it impossible to substantiate the dates of birth of candidates not known to be deceased. At the present time, there are nine such candidates born in the U.S. (substantiation for the foreign-born is, in any case, very difficult), although we suspect that all but one of them are, in fact, deceased, and that their records, which show current Medicare B enrollment, are in error. The year of birth for the one person known to be alive has, in fact, been substantiated independently of our study; as of July 2003, she was alive at age 115.

Although the Medicare enrollment record lacks information on parents' names and place of birth, unlike the public-use death certificate record it does contain a Social Security number. With the Social Security number in hand, we can obtain the needed information from another Social Security Administration file, namely, the file of applications to obtain a Social Security number. Although, in fact, many of the old completed applications were not available electronically, we obtained microfilm copies from the agency's storage facility in Pennsylvania.

It is important to mention that we eliminated any candidates who were less than age 110 at death according to the date of birth on the application form. Likewise, we eliminated any candidates who were less than age 110 at death according to their Medicare enrollment record in the CMS master file, or according to their record—if any—in the Supplemental Security Income (welfare) enrollment file maintained by the Social Security Administration. In effect, the net was narrowed to in-

clude only those who were at least age 110 according to all their master records at the Social Security Administration and its sister agency.

Since Medicare records, unlike death certificate records, occasionally have incorrect dates of death (e.g., the recorded date may be the date of recordation, rather than the date of occurrence), the date of death required corroboration, as well as the date of birth. Accordingly, we worked together with the Program on Population, Policy, and Aging at Duke University to submit our list of candidates to the aforementioned National Death Index maintained by the National Center for Health Statistics. The NDI consists of a catalog of all registered deaths in the United States since 1979, and a procedure for searching in that catalog—using either the Social Security number or a set of personal identifiers—and reporting the results of the search, including the extent of agreement between the submitted record and the matching records, as well as providing the death certificate numbers of the matching records. We submitted records to the NDI in 2002, when the NDI covered deaths through the year 2000, and again in 2003, after 2001 deaths had been added. For the few deaths occurring in our study population after 2001, according to the Medicare record, we found confirmation for the date of death, sometimes in a death certificate obtained from a state registrar, but more often in an obituary notice published in a newspaper when we were alerted to it (by Mr. Robert Young, for example, who is familiar with the circumstances of several supercentenarians).

Although the NDI system is satisfactory for date of death corroboration, we proceeded to take advantage of the NDI feature that provides death certificate numbers, and requested copies of death certificates from all registration jurisdictions. There are three reasons for taking this step. Probably the most important is that the death certificate might contain personal information which is missing or incomplete on the application for a Social Security number, and which could lead to the authentication of some supercentenarian candidacies that otherwise would not have been authenticated.

Second, we plan to present the death records for any jurisdiction that gives its permission to the IDL for inclusion in the IDL collection of documents. Third, the death certificates provide information on decedent characteristics, such as occupation and educational attainment, as well as other information.

The tasks of establishing contact, completing applications, controlling receipts, and entering data were shared by our Office of the Chief Actuary in the Social Security Administration and the Program at Duke University, and the latter paid for the certificates. The initiative

was quite successful in obtaining the cooperation of the many jurisdictions: only three jurisdictions felt the need to either deny us the certificates (Illinois), or to provide a subset of the information on the certificate, rather than the certificate itself (New Hampshire, New York City).

With respect to corroboration of the date of birth, a certificate of birth is, clearly, the ideal evidentiary record. From the entry on the application for a Social Security number (or on the death certificate), we knew the place of birth. Guided by a reference list of the availability of birth certificates from the various state and local registration jurisdictions, and, again, jointly with the Program at Duke University, we requested a birth certificate from the jurisdiction in which a candidate was born if the registration system in that jurisdiction was in operation at the time of the candidate's birth. Unfortunately, given the belated development of U.S. birth registration, much more often than not the system was, in fact, not in place. We were successful in obtaining 52 U.S. birth certificates. We should clarify that we only accepted birth certificates that were recorded in a timely manner, i.e., soon after birth, and not certificates that were recorded years later.

Although for most supercentenarian candidates the folder containing paper documents relevant to an individual's initial and continuing eligibility for Social Security benefits and/or participation in Medicare no longer exists, for a few we were successful in retrieving folders from the various holding areas across the country. In these we found four baptism or family Bible records—including one for a person born in Africa—for persons for whom no birth certificate was found.

A satisfactory alternative to the birth certificate for establishing date of birth is a record from a census about a century ago, when our supercentenarians were very young. In the United States, censuses are conducted decennially, in years ending in zero, and are confidential for 72 years, after which they are released to the public. Considering that our scope is limited to persons born before 1890, the 1890 census would be best; however, the 1890 census records were destroyed by fire. Instead we used the 1900 census, and, additionally, for persons born before June 1880, the 1880 census. These census records are available on microfilm in the National Archives at several locations, including Philadelphia, Pennsylvania.

Additionally, the Church of Jesus Christ of Latter-Day Saints has embarked on an ambitious and arduous venture to computerize and index the census records, and to develop software for searching the files. We were able to benefit from the new technology for the 1880 census

records, but the computerization and indexing for the 1900 census were not completed until most of our microfilm searching was done, and the software for searching the files is not yet fully developed. While some of the work with the census records was done in our office, the majority was done in the Population Studies Center at the University of Pennsylvania. A detailed description of the protocol for matching, including the treatment of partial matches, is given in Rosenwaike and Stone (2003); we merely note here that the match rule was fairly sophisticated, incorporating commonness of name into the decision.

Another 256 persons were found in these early census records. This number includes 29 cases where the match was successful only because personal information was obtained from the death certificate when it was missing or incomplete on the Social Security number application. Work with the census records continues, and we anticipate that several more candidacies will be validated.

The policy of the IDL is to classify supercentenarians by their country of last residence, and not by their country of birth. With the assistance of Social Security Administration contact persons in several countries, and of members of the IDL team, we secured birth certificates from abroad for four supercentenarians born in Italy, three born in England, two born in Germany, two born in Greece, one born in Denmark, and one born in Canada. With these 13, the number of foreign-born supercentenarians reaches 14, while the total reaches 325.

The counts of supercentenarians according to the document used to establish their date of birth are gathered together in Table 1. Figure 1 shows the distribution of supercentenarians by the year of attainment of age 110, and Table 2 by the year of death. Deaths in 2003 are for part of the year only.

Table 1. Evidence for date of birth

Evidence	Number
Birth certificate (timely)	
U.S. born	52
Foreign born	13
Baptism or Bible record	4
1880 or 1900 census	256
Total	325

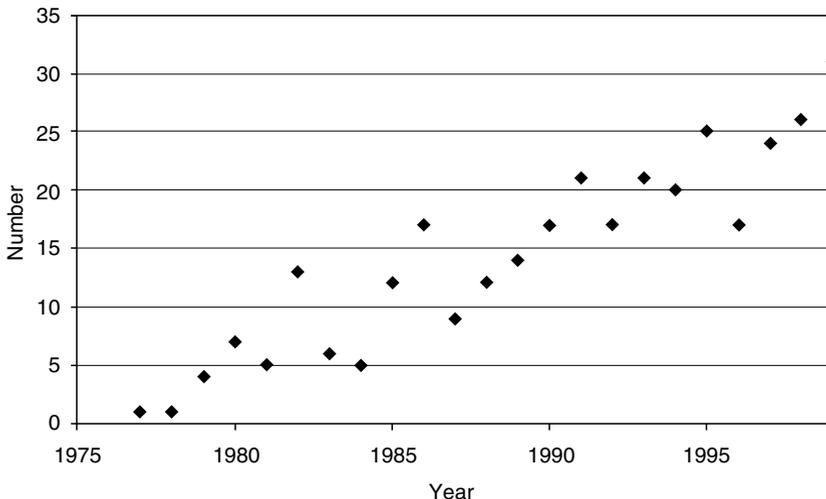


Fig. 1. Year of attainment of age 110

Table 2. Year of death

Year	Number
1980 - 1984	33
1985 - 1989	58
1990 - 1994	88
1995 - 1999	101
2000	18
2001	17
2002	7
2003	3
Total	325

2 Characteristics

The oldest supercentenarian in our contribution to the IDL database is Sarah Knauss, age 119 at death, about whom quite a lot is known (Robine and Vaupel, 2002). The next oldest is Lucy Terrell Hannah, age 117 at death. The oldest male is the Danish-born Christian Mortensen, age 115 at death. Three other supercentenarians survived to age 115. The numbers of deaths at each single year of age beginning with 110 and ending with 114 are: 166, 81, 37, 23, 12. Age at death is the difference

in completed years between the date of death on the death certificate and the preferred date of birth. A timely certificate of birth clearly has the highest preference. For most supercentenarians, for whom of course there is no timely birth certificate, we preferred the latest of the dates of birth on the early census records and the set of SSA (and CMS) records—unless there was compelling evidence on the census schedule to discredit the date recorded on SSA records.

Nine out of 10 supercentenarians are females—more precisely, 294 of the 325. Blacks are more numerous than would be expected based on their share of the elderly population: in fact, 15% of native-born supercentenarians are black. Table 3 contains these results, as well as information on place of birth. Sex, race, and place of birth distributions are shown in Table 3, not only for the 325 confirmed supercentenarians, but for the unconfirmed candidates, as well, and the comparison from Table 3 helped us reach our conclusion that most of the unconfirmed cases are not valid. For example, it is not plausible that a large fraction of supercentenarians were born in the set of the four Southern states of Alabama, Georgia, Mississippi, and Texas; rather, the logical explanation is that, in this area of the country, extreme-age misreporting is more acute.

The state in which the largest number of confirmed supercentenarians were born is New York, with 23, followed by Texas (20), Pennsylvania and Illinois (19), and Ohio (16). The states in which the largest number of confirmed supercentenarians resided at the time of their deaths are California (32), Texas (20), Illinois (19), New York (18), and Massachusetts (17).

The earliest achievement of supercentenarianship among the group of 325 was in 1977. Of course, there may be persons in the United States who reached this milestone earlier, but are outside our scope—that is, if they died before 1980.

The initiative to purchase death certificates from registrars, described earlier, produced certificates for all but 11 of the 325 supercentenarians. Data collected on the death certificate provides information on the socioeconomic characteristics of supercentenarians and their marital status. Also present on the death certificate are the cause of death and the relationship of the informant to the decedent. These various data are summarized in Tables 4 and 5, and discussed briefly in the next paragraphs.

The distribution of occupations reflects the preponderance of females among the supercentenarian population, and an era before women entered the labor force in significant numbers. Based on tabula-

Table 3. Sex, race, place of birth

Item	Confirmed supercentenarians	Unconfirmed candidates
Total	325	351
<i>Sex:</i>		
Female	294	279
Male	31	72
<i>Race:</i>		
White	274	168
Black	49	133
Other	0	35
Unknown	2	15
<i>Place of birth:</i>		
United States:	(305)	(242)
Alabama, Georgia, Mississippi, Texas	48	82
Other	257	160
Foreign country	14	91
Unknown	6	18

tions from the 1940 decennial census for females then ages 35 to 54, the educational attainment of supercentenarians was, overall, higher than that of their peers, assuming the informants for the death registration are not knowingly or unknowingly overstating such attainment. The proportion of supercentenarians ever married is about the same as for females ages 45 to 54 in the 1940 census, so there is no evidence of association between ever-married status and the achievement of this milestone age.

The non-specific entry of “old age” is the third most frequent entry for cause of death among supercentenarians. If a relative of the decedent is the informant, that relative is most likely to be the decedent’s child.

Leslie Stone of the University of Pennsylvania’s Population Studies Center has done two analytic studies using the census records of U.S. supercentenarians.

In the first study (Stone, 2002), the objective was to determine whether early-life conditions are associated with the achievement of supercentenarianship. Information was extracted from 1880 or 1900

Table 4. Occupation, educational attainment, marital status

Item	Number	Percent
<i>Occupation:</i>		
Homemaker	181	57.6
Farmer	20	6.4
Teacher	30	9.6
Laborer	2	0.6
Nurse	4	1.3
All others	63	20.1
Blank or unknown	14	4.5
Total	314	100.0
<i>Years of schooling:</i>		
(Numbers in parentheses are comparable percentages for females ages 35 to 54 in the 1940 census)		
1-4	11	5.7 (13)
5-8	72	37.5 (47)
9-11	16	8.3 (16)
12	49	25.5 (15)
13-15	23	12.0 (6)
16+	21	10.9 (4)
Total	192	100.0
<i>Marital status:</i>		
Never married	36	11.5
Married	1	0.3
Divorced	4	1.3
Widowed	264	84.1
Blank or unknown	9	2.9
Total	314	100.0

Source: Death certificates with usable data

Table 5. Cause of death and relationship of informant to decedent

Item	Number	Percent
<i>Cause of Death:</i>		
Arteriosclerosis	71	22.6
Pneumonia	40	12.7
Extreme age	29	9.2
Congestive heart failure	15	4.8
Atherosclerosis	18	5.7
Coronary artery disease	15	4.8
All others	105	33.4
Blank or unknown	21	6.7
Total	314	100.0
<i>Informant:</i>		
Wife or husband	0	0.0
Sister or brother	0	0.0
Cousin	3	1.7
Daughter or son	63	34.8
Niece or nephew	19	10.5
Granddaughter or grandson	20	11.0
Great-granddaughter or great grandson	2	1.1
Other relatives, in-law's	4	2.2
Relative, but relationship not known	49	27.1
Nursing home administrator	4	2.2
Doctor	5	2.8
Friend	3	1.7
Other	9	5.0
Total	181	100.0

Source: Death certificates with usable data

census records of both the eventual supercentenarians, and a random sample of persons in the same birth cohorts. In the comparison of the two groups, many bivariate relationships were statistically significant, but in a multivariate framework, the variable “resides on farm” stood out as significantly (p -value < 0.10) positively associated with such achievement. This finding suggests that an early-life rural environment enhances survivorship a century later!

In the second study (Stone, 2003), the research question was: Considering that siblings of eventual supercentenarians have a genetic

make-up similar to them, and generally were raised in the same environment, do they also enjoy a survival advantage relative to their peers? While this question was recently dealt with by Perls, Wilmoth, and their co-investigators in the New England Centenarian Study (2002), using information obtained from next of kin, the Stone study is not geographically limited and is based on recorded information. The siblings are the ones listed on the census schedules together with the eventual supercentenarians. SSA records were searched to determine the dates of death of these siblings, or, failing that, at least the dates of initial application for a Social Security number. Social Security numbers were first issued in November 1936. The study revealed a sustained mortality advantage for brothers of supercentenarians.

3 Mortality

Using edited data on enrollment in Medicare Part B for the decade of the 1990s, Kestenbaum and Ferguson (2002) have shown that, in the United States, single-age mortality probabilities continue to increase past age 100 to reach a value of about 0.5 at age 109. The question remains, however, whether mortality probabilities follow the same pattern at the very oldest ages, level off, or perhaps even decline. If we assume that the age-at-death distribution for deceased U.S. supercentenarians not included in the IDL—either because their ages are not validated or because they were not captured in the SSA Medicare B net—is the same as the distribution for those included, we can proceed with the extinct-cohort method to calculate the extreme-age mortality. We recognize that this assumption is questionable because for supercentenarians who are missed because their age at death was understated in SSA records, the understatement is more likely to be small than to be large. So that we may treat the cohort as extinct, we need to guess the age at death of the 115-year-old still alive—say, 116. We also offer the caveat that (although the U.S. contribution to the IDL is relatively large), because the number of observations is small, particularly after age 111, the results must be characterized as suggestive, rather than definitive.

Given a closed group and its distribution by age at death, the mortality schedule for the group can be determined in a straightforward manner for cohorts which are extinct. Table 6 presents the distribution of deaths for cohorts reaching age 110 no earlier than 1980 (when observation begins). The numbers alive at the beginning of each age interval

are obtained in a straightforward fashion, and then the age-specific probabilities of death.

Table 6. Mortality of supercentenarians born 1870 - 1889

Exact age, X	Deaths between X and X+1	Survivors to X	Probability of death
110	165	320	0.516
111	79	155	0.510
112	36	76	0.474
113	21	40	0.525
114	12	19	0.632
115	4	7	0.571
116	1	3	0.333
117	1	2	0.500
118	0	1	0
119	1	1	1.000
120	0	0	

Note: One person still alive, now age 115, is assumed to die at age 116.

The methodology produces a probability of death at both age 110 and age 111 of slightly above one-half, about the same as the probability for females at age 109 during the decade of the 1990s presented in Kestenbaum and Ferguson (2002). The probability of death at the next age is lower, and the probability at age 113 is only slightly higher than at age 110, suggesting that the overall mortality of supercentenarians is not greater than mortality at age 109. Of course, the following caveat is in order: a decrease in mortality at these very extreme ages may not represent a natural phenomenon, but a contrived one, if extraordinary measures were taken to preserve the lives of these amazingly long-lived persons. The values at ages above 113 are based on very few observations.

4 Plans for the future

The scope of the U.S. contribution to the IDL is limited to persons achieving age 110 before 2000 (and not deceased before 1980). Persons achieving age 110 after 1999 are out of scope, but it is possible that they will be included at some future time. On the other hand, we have made

a commitment to add any in-scope person if and when the person's date of birth is corroborated by a birth registration or early census record.

If the initiative to obtain death certificates with personal identifiers from the National Center for Health Statistics with the approval of the states goes forward, it will provide for a net for supercentenarians that goes back to about 1960, which is easy to construct and that few will elude. In contrast, (a) the Medicare Part B enrollment data in the Master Beneficiary Record is difficult to work with, and (b) supercentenarians not enrolled in Medicare B through the Social Security Administration are missed. Presumably, our role at the Social Security Administration would be to inspect the list of candidates and delete from the list those whose age at death on the certificate of 110 or more is contradicted by information in our records.

An opportunity presented itself to examine the performance of this new approach in our investigation of California deaths. The public-use files of California death records for the years 1989 through 1999, which we have a copy of, contain Social Security numbers, and can, therefore, be easily linked to Medicare records. Among 82 Californians deceased at recorded ages of 110 and above during this 11-year period, our net missed just one male, in this case because his Medicare eligibility derived from career employment in railroad work. Among the other 81, the Medicare record agreed with the alleged achievement of supercentenarianship about one-half of the time, and disagreed about one-half of the time. This result cannot be generalized, however, because the extent of age misreporting on the death certificate is greater for some geographical areas, and some races, than for others.

We look forward to increasing the United States contribution to the International Database on Longevity.

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