Description of document:	Two (2) Social Security (SSA) studies on centenarians and supercentenarians 2005
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SOCIAL SECURITY

March 4, 2005

Refer to:
S9H: PD9858

This is in response to your request of November 28, 2004, for "a copy of the Social Security Administration internal study or studies on centenarians and supercentenarians, which may also address the accuracy and reliability of data on the very oldest Americans."

We located two documents responsive to your request. They are enclosed. The first is a paper from a presentation given by the Social Security Administration (SSA) at a recent conference, "Living to 100 and Beyond." The second document is an SSA paper on supercentenarians.

I hope you find this information useful. There is no charge for this request.

If you disagree with this decision, you may request a review. Mail your appeal within 30 days after you receive this letter to the Executive Director for the Office of Public Disclosure, Social Security Administration, 6401 Security Boulevard, Baltimore, Maryland 21235. Mark the envelope "Freedom of Information Appeal."

Sincerely,

Jonathan R. Cantor

Jonathan R. Cantor
Freedom of Information Officer

Enclosure

NUMBER OF CENTENARIANS IN THE UNITED STATES 01/01/1990, 01/01/2000, AND 01/01/2010 BASED ON IMPROVED MEDICARE DATA

Bert Kestenbaum
B.Reneé Ferguson
Social Security Administration

The title of our conference is "Living to 100 and Beyond". People who have achieved this feat are called centenarians, and there has developed a small literature from population scientists interested in measuring the size of the centenarian population. Two assertions of a general nature which appear in this literature will be examined in our talk.

The first is an assertion by the esteemed Finnish demographer, recently deceased, Väinö Kannisto, which he based on data from about 20 developed countries for years around 1985, that the centenarian population in a developed country at that time was about one-twentieth of one percent – somewhat more or somewhat less -- of its population ages 75 and over (Kannisto, 1990). Kannisto then used this relationship – after noting that the latest official U.S. census count of centenarians was unsatisfactory -- to estimate that the number of U.S. centenarians in 1985 was about 5,500. He also estimated that the number of centenarians in the entire world at that time was about 30 thousand.

The second is the assertion by the noted demographers James Vaupel of the Max Planck Institute on Demographic Research in Germany and Bernard Jeune of the University of South Denmark in a chapter in their monograph on extreme old-age (Vaupel and Jeune, 1995), that the number of persons in a country achieving the century mark in a given year is about double the number achieving that milestone 10 years earlier, and it would seem, by extension, that the number of centenarians in a country about doubles with each decade. This assertion was based on data from 10 European countries and Japan.

The estimates that we present in this paper for the sizes of the centenarian population in the United Stated on January 1, 1990 and on January 1, 2000 and a projection for its size on January 1, 2010 are in strong conflict with both of these assertions.

In addition we will present information on the demographic composition of the centenarian population on January 1, 2000 which is somewhat at odds with information published by the U.S. Bureau of the Census from the 1990 decennial census.

Data and Methodology

The U.S. decennial census of population yields counts of the centenarian population as of census day (April 1) in the first year of each decade, as well as information on the composition of this intriguing population. Unedited census counts can be, and have at times been, laughably overstated. For example, according to unedited counts from the census just three decades ago there were 106 thousand U.S. centenarians on April 1, 1970. Counts from more recent censuses have been more believable; in particular, the

census count for census day, 1990 was 37 thousand, and in the 2000 census the count was 50 thousand.

Furthermore, the Bureau of the Census has invested resources towards the study of centenarians. One effort, by Gregory Spencer, was a sample study of census schedules to identify and adjust for reporting errors in the 1980 census (Spencer, 1986). The number of centenarians in 1990 that we quoted before was obtained from another effort -- a substantial Bureau of the Census report authored by Constance Krach and Victoria Velkoff and entitled, simply, "Centenarians in the United States" (Krach and Velkoff, 1999). This report also contains (a) information on the number of centenarians in selected other countries, (b) projections of the size of the U.S. centenarian population through the year 2050, and (c) a demographic profile of U.S. centenarians in 1990.

The middle projection of the Census Bureau, appearing in this publication, has the size of the centenarian population not doubling every 10 years, but increasing by about two-thirds each decade, on average. The high series, on the other hand, projects that this population will more than double, on average, over future 10-year periods. The demographic profile of centenarians in 1990 given in this publication is that about one-sixth is male, about one-sixth is black, about one-sixth is age 105 and over, and about one-sixth is foreign-born.

Now, because enrollment in the Medicare program is almost universal at advanced ages, estimates of the size and composition of the U.S. centenarian population can be made at any time by tabulating records of Medicare enrollees. Our most important discovery in our experience with Medicare enrollment records is that at very old ages only records of enrollment in Part B (medical insurance) of Medicare are trustworthy. Persons who appear to be enrolled at very old ages in Medicare Part A (hospital insurance) but not Part B are generally, in fact, deceased, but their fact of death was not received (or was received but not recorded.) Missing death information has a greater effect on the integrity of records of Part A, which is generally a free program, than on records of Part B, which requires payments of premiums by or on behalf of the enrollees, and the non-receipt of premium payments causes the termination of enrollment. .

Another discovery of ours, albeit less important than the first, concerns which Medicare data file is better suited to the task of identifying the centenarian population: the Enrollment Data Base of the Centers for Medicare and Medicaid Services (formerly the Health Care Financing Administration) or the Master Beneficiary Record (MBR) file of the Social Security Administration. We discovered that the latter, although not as easy to use as the former, has data of better quality,

At the first "Living to 100 and Beyond" symposium three years ago, we presented a paper, subsequently published in the *North American Actuarial Journal*, on the mortality of the very old (Kestenbaum and Ferguson, 2002). The paper, "Mortality of the Extreme Aged in the United States in the 1990s, Based on Improved Medicare Data, " reports single-year probabilities of death for males and females from the tabulation of the Medicare Part B experience during the decade, as reflected in the Social Security

Administration's Master Beneficiary Record, and after certain improvements to the data were incorporated. Chief among those improvements was the examination of other administrative records for persons in the Medicare experience for fact of death, date of death, and date of birth. Other initiatives were taken, (a) to eliminate duplicate records, (b) to evaluate and react to data anomalies, and (c) to obtain person-level records of utilization of Medicare services and infer death at extreme ages from protracted non-utilization.

The age-and-sex-specific mortality probabilities given in that paper were not smoothed. In table 1 we present sex-and-age-specific probabilities which have been smoothed by fitting the edited probabilities to a Gompertz function by weighted least-squares regression, together with the unsmoothed values.

Table 1. Deaths per Thousand among the Extreme Aged, 1990-1999, Before and After Fitting to a Gompertz Curve

Age	Males		Females	
	Before fitting	After fitting	Before Fitting	After fitting
85	126	127	84	86
86	136	137	94	95
87	148	148	104	104
88	161	160	115	115
89	174	173	127	126
90	189	187	140	139
91	203	202	155	153
92	221	218	171	168
93	239	235	187	184
94	255	252	205	201
95	274	272	223	220
96	294	292	241	241
97	313	313	260	263
98	330	336	281	287
99	348	359	298	313
100	368	384	319	340
101	384	410	342	369
102	405	437	362	399
103	433	465	373	431
104	425	494	394	465
105	436	523	415	499
106	423	554	429	535
107	450	584	462	572
108	494	616	469	609
109	489	647	492	647
110+	281	678	376	684

The methodology for the estimates we report today on the size and composition of the centenarian population at both the beginning and the end of the decade of the 1990s incorporates several additional data-quality initiatives. They are:

(1) A reexamination of the Master Beneficiary Record in June 2004 to inquire into whether any deaths occurring in the 1990s had been identified since our earlier study, which was based on the May 2001 Master Beneficiary Record.
(2) A record linkage to the set of public-use State of California death certificate files to determine whether any persons who were centenarians on January 1, 2000 according to the MBR were, in fact, deceased. California public-use death records were used because they contain social security numbers (a practice which California has discontinued effective for 2001 certificates) and because California is a large State. The effect on the count of California centenarians in 1/1/2000 was extrapolated to the other States and to 1/1/1990.
(3) For a 1-in-100 sample of both MBR centenarians as of 1/1/1990 and MBR centenarians as of 1/1/2000, an examination of the microfilm copy of the original application for a social security number, to determine whether the date of birth on that paper record is later than the date on the electronic administrative record.
(4) For the same 1-in-100 samples of MBR centenarians as of 1/1/1990 and 1/1/2000, an examination of decennial census records from (primarily) 90 years earlier: the 1/1/1990 sample was checked (primarily) against the 1900 census and the 1/1/2000 sample was checked (primarily) against the 1910 census. If a purported centenarian was found in the early census and listed with an age of less than 10 (as of the beginning of the year), he or she would no longer be considered a centenarian.

The number of false centenarians identified in either of these last two steps was then multiplied by 100, the reciprocal of the sampling fraction.

Results

These initiatives, and a few small others, resulted in a 12% decrease in the size of the MBR 1/1/1990 centenarian population, to 21,830 and an 8% decrease in the size of the MBR 1/1/2000 centenarian population, to 32,920. Table 2, the first of several tabulations of the centenarian population as of January 1, 2000 that we will present, shows that about 92 percent enrolled in Medicare Part B when the program began in July 1966, when members of this population were at least age 65.5, and another 4 percent enrolled after that date but by the end of 1972, when all members were at least age 72 and could receive full social security benefits unencumbered by the retirement earnings test. Another 3 percent first enrolled between 1973 and 1989, and just 0.6 percent first enrolled in the decade prior to 1/1/2000, which all members began at ages 90 and above.

Table 2. Date of Enrollment in Medicare Part B Program, Persons Ages 100+ on 1/1/2000

Date of Enrollment	Percentage
July 1966	91.7%
August 1966 - December 1969	4.1
1970-1972	0.4
1973-1979	2.0
1980-1989	1.2
1990-1999	0.6
Total	100.0%

According to data on the Bureau of the Census website from Summary Tape File 1, the population of the United States ages 75 and above on census day, April 1, 1990 was about 13.1 million. Thus the ratio of 21.8 thousand centenarians to the population ages 75+ in the United States in 1990, which equals one-sixth of a percentage point, is more than 3 times what Kannisto had estimated for 1985 – just 5 years earlier.

More recent data from several countries continue to show that the proportion in the United States of the very old which is very, very old is above the same statistic in other countries. The table below, obtained from the impressively-done Kannisto-Thatcher database (Kannisto, 1994), gives values, at around the beginning of the millennium, of the ratios of the number of persons ages 100+ to the number of persons ages 80+ for several countries with good-quality data. Now, according to the 2000 Summary Tape File 1, the number of persons in the United States on census day, 2000 ages 80 & over was 9.2 million. Combining this with our estimated centenarian population of almost 33 thousand at the beginning of 2000, we see that the proportion in question – 36 per 10,000 -- is substantially higher in the United States than the pooled estimate for the countries in the Kannisto-Thatcher database, and is second only to France.

Table 3. Number of Aged Persons, circa 2000, Selected Countries
(Source: Kannisto – Thatcher Database)

Country	Age 80 and over	Age 100 and over	Age 100 and over, per 10,000 persons age 80 and over
Austria	280,554	453	16
Belgium	356,498	893	25
Denmark	208,879	483	23
England & Wales	2,099,739	6,320	30
Finland	171,111	246	14
France	2,131,882	8,752	41
Germany, West	2,428,787	4,925	20
Iceland	7,465	25	33
Italy	2,263,467	5,438	24
Japan	4,755,732	11,546	24
Netherlands	505,315	1,323	26
Norway	190,012	423	22
Sweden	436,373	907	21
Switzerland	282,535	678	24
Total	16,118,349	42,412	25

The lofty position of the United States with respect to this statistic is certainly related to the lower extreme-age mortality in the United States, relative to other highly-developed countries. In an important paper published in the *New England Journal of Medicine* in 1995, Kenneth Manton and James Vaupel speculated on possible explanations for the singularity of the United States and hypothesized that the availability and quality of health care under the Medicare program is the primary factor (Manton and Vaupel, 1995).

According to our enhanced Medicare data, the centenarian population has grown in the 10-year period from 1/1/1990 to 1/1/2000 by 51 percent, or at an annual compound growth rate of 4.1 percent. This is far less than the doubling phenomenon that has been observed in other developed countries for 10-year periods through the 1980-1990 period as reported by Vaupel and Jeune, and also significantly less than the two-thirds increase assumed in the Bureau of the Census middle projection.

How much has the centenarian population of other countries grown during the decade of the 1990s? The data we obtained for Denmark, Sweden, and France give a mixed picture. While the expansions of the centenarian population in Denmark and Sweden for the most recent 10-year period are 50 and 60 percent, respectively, the centenarian population of France more than doubled. In this regard, we would like to thank Bernard Jeune of Odense University in Denmark, Hans Lundstrom of Central Statistics in Sweden, and Jean-Marie Robine of INSERM in France for providing us with data for their countries.

For the current decade, 2000 to 2009, we are projecting that the growth in the U.S. centenarian population will be more than the increase of one-half of the prior decade, but less than two-thirds. The reasoning is as follows.

From tabulations of the mortality of the aged for many years, the Social Security Administration's Office of the Chief Actuary has concluded that while mortality continues to improve for the elderly at most ages, at the very oldest ages the mortality rates are recently increasing slightly. The Office of the Chief Actuary expects that during the current decade these rates will turn around and begin decreasing. As a result, it seems that applying the single-age-and-sex-specific mortality experience of the 1990s, given earlier in table 1, to a starting population age 90 and above as of January 1, 2000, arrayed by single year of age and sex, will produce, in our opinion, a reasonable approximation of the centenarian population 10 years later, on January 1, 2010. As for net migration, the data presented earlier in table 2 suggest that there are relatively few entrants to the Medicare B rolls after age 90; and there are likely to be relatively few exits, as well, because Part B is a bargain for the money, especially at advanced ages when the need for health care is high, and because generally the States pay the premiums for their impoverished residents.

The resulting estimate for the size of the centenarian population on January 1, 2010 is 52.8 thousand. The growth over the decade is about 60 percent. This estimate uses the unsmoothed probabilities in table 1; the estimates would be slightly lower were we to use the probabilities fitted to a Gompertz function.

Earlier we presented the Bureau of the Census' universal constant for the composition of the centenarian population on census day, 1990: one-sixth is male, one-sixth is black, one-sixth is age 105+, and one-sixth is foreign-born. Since sex, race, and age information are items on each Medicare record, we can easily tabulate the information shown in table 4. In fact, according to Medicare records, the proportion male is slightly less than one-seventh, and the proportion black is about one-eleventh. And, as one would expect, given

mortality probabilities in the range of 0.32 to 0.49 among centenarians, the proportion ages 105 and over is less than half of the Census Bureau estimate – about 1 in 13.

Table 4. Characteristics of Persons Ages 100+ on 1/1/2000

Age:	Number	Percent
100	11,824	35.9%
101	8,217	25.0
102	5,303	16.1
103	3,118	9.5
104	1,946	5.9
105	1,167	3.5
106	640	1.9
107	319	1.0
108	168	0.5
109	113	0.3
110+	105	0.3
Total, all ages	32,920	100.0%

Sex:	Number	Percent
Male	4,646	14.1%
Female	28,274	85.9
Total, both sexes	32,920	100.0%
Race:		
White	28,883	87.7%
Black	2,969	9.0
Other	722	2.2
Unknown	346	1.1
Total, all races	32,920	100.0%

Place-of-birth information is not part of the Medicare record, but it was collected years earlier on the application for a social security card. Unfortunately, until the middle of the 1970's when the Social Security Administration converted its paper records to an electronic medium, the practice was that in adjudicating a claim for entitlement to social security benefits or Medicare protection, the paper application form was removed from the file of applications and made part of the adjudication folder, with its place in the applications file taken by a skeleton record lacking the place-of-birth item. Hence, most centenarians do not have an electronic initial application record, and a tabulation of place-of-birth for those who do would certainly reflect a bias. However, as mentioned before in the description of our data editing efforts, we have obtained microprints of the application for a 1-in-100 sample of centenarians; in this sample we do, in fact, find that one-sixth of centenarians are foreign-born.

Because efforts to study U.S. centenarians in greater depth are done on a regional basis or State basis, such as the New England Centenarian Study and the Georgia Centenarian Study, we include a table which provides information on the distribution of centenarians by State. The States are listed in descending order according to the size of their centenarian population.

Table 5. Number of Persons Ages 100+ on 1/1/2000, by State (in Size Order)

Number	State
More than 1,500	CA, NY, FL, TX
1,000 - 1,499	PA, IL, OH, MA, MI
750 - 999	NJ, WI, MN, MO, IN, IA
500 - 749	VA, NC, WA, TN, CT
250 - 499	GA, KY, MD, KS, AZ, OR, LA, CO, SC, MS, NE, OK, AR, AL
Less than 250	WV, ME, SD, RI, NM, NH, ID, ND, MT, DC, NV, VT, DE, HI, WY, AK, UT

Conclusion

We believe that records of enrollment in Medicare Part B, particularly when enhanced with edits, provide a solid basis for studying the size, growth, and character of the centenarian population. We have shown that the fraction of the U.S. population age 75 and above which was age 100 and above is much higher in 1990 -- and almost certainly in 1985, as well -- than Kannisto postulated. We find that the growth in the centenarian population of the United States during the final decade of the millennium was about 4 percent per annum, and we project that the growth will be only slightly more over the current decade. Also, we provided a more accurate demographic profile of the centenarian population than is forthcoming from the decennial census.

We would like to end with a riddle. This riddle is based on an insight of Russell Hudson of the Social Security Administration. What population is bigger on October 1st than on the following April 1st? Does anyone want to guess? Correct, the centenarian population! Among centenarians on January 1, 1990, the number of deaths since then in the six-month periods from October to March is greater than the number of deaths in the six-month periods from April to September, by a margin of 4 to 3.

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UNITED STATES

Bert Kestenbaum and B. Renee Ferguson

U.S. Social Security Administration

The United States contributes 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 are 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. The United States' contribution is 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 with a recorded age of 110 or more known to us whose age, however, 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 in our scope; by contrast, persons reaching 110 in the current decade or dying 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 the Population Studies Center at the University of Pennsylvania (and Leslie Stone, in particular) under the leadership of Dr. Samuel Preston, as well as the assistance of Mr. Robert Young.

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, typically the net is cast over decedents with recorded age 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 government: 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 government agency in 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 the States, 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 it of our interest in pursuing this avenue.

Given this current status of death certificate files, we chose a different net, to capture persons enrolled in Part B of the Medicare program beyond their 110th birthday. The Medicare program is a two-part Federal government health benefits program for persons ages 65 and over or disabled. Part A, providing hospitalization benefits, generally does not require premium payments from enrollees, in contrast to Part B, providing benefits for medical services, which is partially funded by premiums due from all program participants. According to estimates from the U.S. Bureau of the Census, more than 96 percent 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 experience 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 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. Thus the limitation in scope to persons reaching age 110 no later than the year 1999 and dying no earlier than the year 1980, as well as the omission of 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 who therefore will have a record in the CMS master file but not 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 9 such candidates born in the U.S. (substantiation for the foreign-born is anyhow 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; she is currently (July 2003) 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 for 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 include 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, which could lead to the authentication of some supercentenarian candidacies which otherwise would not have been authenticated.

Secondly, for any jurisdiction which gives its permission, we plan to present its death records to the IDL for inclusion in the IDL collection of documents. Thirdly, the death certificates provide information on decedent characteristics, such as occupation and educational attainment, and 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 terms of 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, clearly a certificate of birth is 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, in fact, was 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 timely, 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 4 baptism or family Bible records -- including 1 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 '0', 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 Latter-Day Saints has embarked on an ambitious and arduous venture to computerize and index the census records and 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 was 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 4 supercentenarians born in Italy, 3 born in England, 2 born in Germany, 2 born in Greece, 1 born in Denmark, and 1 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.

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 record 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 ten supercentenarians are females -- actually 294 of the 325. Blacks are more numerous than would be expected based on their share of the elderly population: in fact, 15 percent 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 coming 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 were born the largest number of confirmed supercentenarians 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 death are California (32), Texas (20), Illinois (19), New York (18), and Massachusetts (17).

The earliest achievement of supercentenarianship in 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. Overall, the educational attainment of supercentenarians was higher than their peers', basing our comparison on tabulations from the 1940 decennial census for females then ages 35 to 54 -- if 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 female's 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. Although she reports on them in another chapter in this monograph, for the sake of presenting a more complete picture of U.S. supercentenarians we briefly describe the two studies here.

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

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 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 cohort 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.

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.

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, for 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 110 and above during this 11-year period was just one male that our net missed, 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.

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

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

Table 3. Sex, race, place of birth

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

Table 4. Occupation, educational attainment, marital status (Source: death certificates with usable data)

Item	Number	Percent
Occupation:		
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
Years of schooling: (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 (100)
Marital status:		
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

Table 5. Cause of death and relationship of informant to decedent (Source: death certificate with usable data)

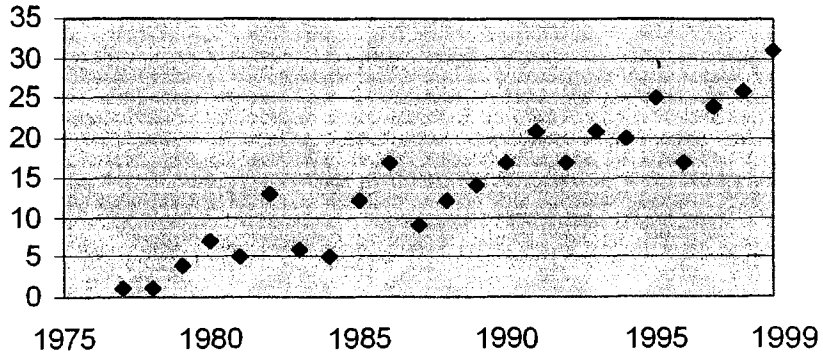
Item	Number	Percent
Cause of Death:		
Arteriosclerosis	71	22.6
Pneumonia	40	12.7
Extreme age	29	9.2
Congestive heart failure	15	4.8
Atherosclerosis	18	5.7
Coronary artery disease	15	4.8
All others	105	33.4
Blank or unknown	21	6.7
Total	314	100.0
Informant:		
Wife or husband	0	0.0
Sister or brother	0	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

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.

Figure 1. Year of attainment of age 110



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