Number of Centenarians in the United States Jan. 1, 1990, Jan. 1, 2000, and Jan. 1, 2010 Based on Improved Medicare Data

Bert Kestenbaum
B. Reneé Ferguson
Social Security Administration

Presented at The Living to 100 and Beyond Symposium
Sponsored by the Society of Actuaries

Orlando, Fla.

January 12–14, 2005

Copyright 2005 by the Society of Actuaries.
All rights reserved by the Society of Actuaries. Permission is granted to make brief excerpts for a published review. Permission is also granted to make limited numbers of copies of items in this monograph for personal, internal, classroom or other instructional use, on condition that the foregoing copyright notice is used so as to give reasonable notice of the Society's copyright. This consent for free limited copying without prior consent of the Society does not extend to making copies for general distribution, for advertising or promotional purposes, for inclusion in new collective works or for resale.

The title of our conference is "Living to 100 and Beyond." People who have achieved this feat are called centenarians, and there is a small literature from population scientists who are 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, Väinö Kannisto, who is recently deceased. He based it on data from about 20 developed countries for the years around 1985. The assertion is that the centenarian population in a developed country at that time was about one-twentieth of 1 percent – somewhat more or somewhat less – of its population aged 75 and older (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 30,000.

The second is the assertion by 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). They say the number of people in a country achieving the century mark in a given year is about double the number who achieved 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 in this paper of the sizes of the centenarian population in the United States on Jan. 1, 1990, and on Jan. 1, 2000, and a projection for its size on Jan. 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 Jan. 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 about 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 106,000 U.S.

centenarians on April 1, 1970. Counts from more recent censuses have been more believable; in particular, the count for the 1990 census was 37,000, and in the 2000 census the count was 50,000.

Furthermore, the Bureau of the Census has invested resources toward 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 written by Constance Krach and Victoria Velkoff titled "Centenarians in the United States" (Krach and Velkoff, 1999). This report also contains (a) information about the number of centenarians in selected other countries, (b) projections about 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, during 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 older, 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 payment of premiums by or on behalf of the enrollees, and the non-receipt of premium payment 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 that have been smoothed by fitting the edited probabilities to a logistic function, together with the unsmoothed values.

TABLE 1

Deaths per Thousand Among the Extreme Aged, 1990-1999, Before and After Fitting to a Logistic Curve

Age	Males		Females	
	Before Fitting	After Fitting	Before Fitting	After Fitting
85	126	126	84	86
86	136	136	94	95
87	148	148	104	105
88	161	161	115	115
89	174	174	127	127
90	189	188	140	140
91	203	203	155	154
92	221	219	171	168
93	239	236	187	184
94	255	254	205	202
95	274	272	223	220
96	294	291	241	239
97	313	312	260	260
98	330	332	281	282
99	348	354	298	304

Age	Males		Females	
	Before Fitting	After Fitting	Before Fitting	After Fitting
100	368	376	319	328
101	384	399	342	353
102	405	422	362	379
103	433	445	373	405
104	425	469	394	432
105	436	493	415	459
106	423	517	429	486
107	450	540	462	514
108	494	564	469	541
109	489	587	492	568
110+	281	610	376	595

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 Jan. 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 Jan. 1, 2000 was extrapolated to the other states and to Jan. 1, 1990.
(3) For a one-in-100 sample of both MBR centenarians as of Jan. 1, 1990 and MBR centenarians as of Jan. 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 one-in-100 samples of MBR centenarians as of Jan. 1, 1990 and Jan. 1, 2000, an examination of decennial census records from (primarily) 90 years earlier: the Jan. 1, 1990 sample was checked (primarily) against the 1900 census and the Jan. 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 Jan. 1, 1990 centenarian population, to 21,830 and an 8% decrease in the size of the MBR Jan. 1, 2000 centenarian population, to 32,920. Table 2, the first of several tabulations of the centenarian population as of Jan. 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. 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 Jan. 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 Jan. 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 Web site 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 three times what Kannisto had estimated for 1985 -- just five 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 and older 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 Older	Age 100 and Older	Age 100 and Older, per 10,000 Persons Age 80 and Older
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 Jan. 1, 1990 to Jan. 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 Jan. 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 Jan. 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 Jan. 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 logistic 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. According to Medicare records, the proportion of males is slightly less than one-seventh, and the proportion of blacks 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 higher is less than half of the Census Bureau estimate – about one in 13.

TABLE 4
Characteristics of Persons Ages 100+ on Jan. 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 1970s 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 one-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 Jan. 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 older, 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 than in 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 Oct. 1 than on the following April 1? Does anyone want to guess? Correct, the centenarian population! Among centenarians on Jan. 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 4:3.

References

Kannisto, Väinö. 1994. *Development of Oldest-Old Mortality, 1950-1990: Evidence from 28 Developed Countries.* Odense University Press: Odense. ISBN:877838015 4.

Kannisto, Väinö. 1990. "Les Centenaires dans le Monde". *Population* 45: 423-426.

Kestenbaum, Bertram and B. Reneé Ferguson. 2002. "Mortality of the Extreme Aged in the United States in the 1990s, Based on Improved Medicare Data." *North American Actuarial Journal* 6(3): 35-44.

Krach, Constance A. and Victoria A. Velkoff. 1999. *Centenarians in the United States*. Washington: Government Printing Office.

Manton, Kenneth G. and James W. Vaupel. 1995. "Survival after the Age of 80 in the United States, Sweden, France, England and Japan." *New England Journal of Medicine* 333: 1232-1235.

Spencer, Gregory. 1986. "The Quality of Centenarian Data in the United States". Paper presented at the annual meeting of the Population Association of America.

Vaupel, J.W. and B. Jeune. 1995. "The Emergence and Proliferation of Centenarians". In Jeune, Bernard and James W. Vaupel (eds.), *Exceptional Longevity: From Prehistory to the Present.* Odense: Odense University Press.