Living to 100 and Beyond: Survival at Advanced Ages

Session 4: Sparse Data Session
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Dealing with Problems in Data Quality for the Measurement of Mortality at Advanced Ages in Canada

Robert Bourbeau, PhD and Bertrand Desjardins PhD

Mortality at Advanced Ages in Spain

Angeles Checa Maria Felipe and Antoni Vidiella Anguera

Emergence of Supercentenarians in Low Mortality Countries

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My job as discussant is made easier because the three papers all deal with centenarians. One is a paper from Spain, a second paper is from Canada, and the third presents international data on persons surviving to age 110 -- what Dr. James Vaupel calls supercentenarians.

I would like to begin by presenting a graph from a fine publication on centenarians by the United States Bureau of the Census. The graph makes two points. First, that counts of centenarians may be gross overestimates. Second, that the amount of error can be reduced when an effort is made.

FIGURE 1.

Counts and Preferred Estimates of Centenarians

Reproduced from the Bureau of the Census,
"Centenarians in the United States", p.15
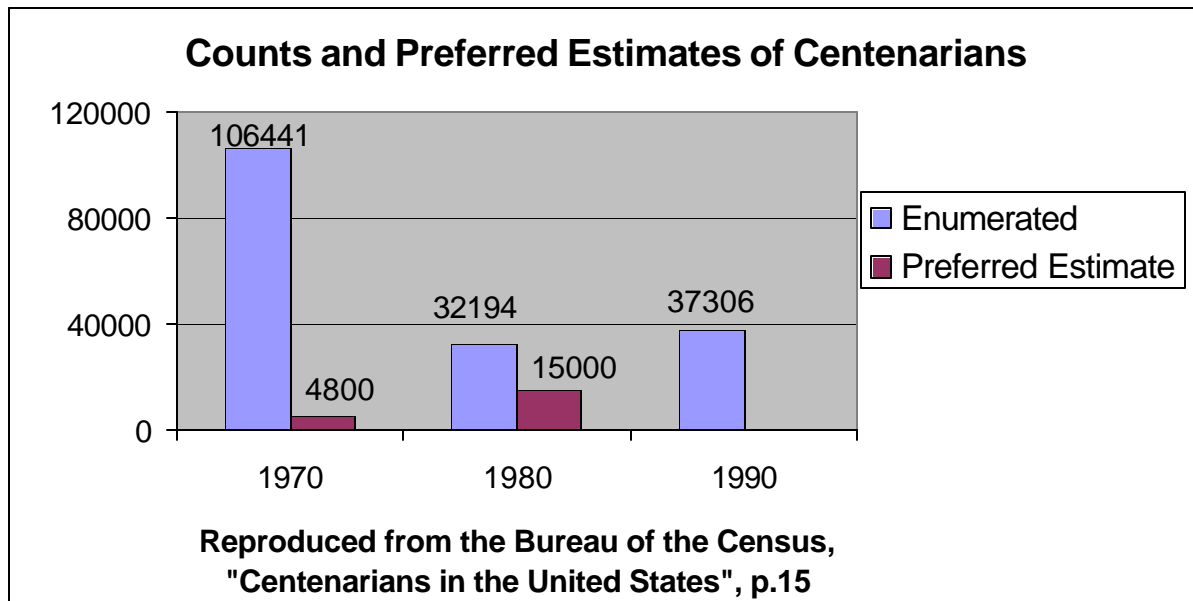
The paper from Spain is somewhat disappointing. How can we trust centenarian statistics derived from unedited population counts of 3500 and death registrations of 1200 when Spain's official statistical agency estimates the population at only 600? It is difficult to believe that the agency was unwilling to explain the reason and basis for its low estimate.

It is no wonder therefore that the derived statistics are suspect. Can we believe the progression: $\{q(100) = 0.25; q(101) = 0.33;$ and $q(102) = 0.50\}$? Also, the annual compound rate of growth of the centenarian population over the 20-year period studied has to be more than the 1.5% which is implied by the raw data.

Contributing to the problem is that the authors fail to compare the data for Spain with the data for other countries. From a look at the bibliography it seems that the authors did not search the literature. Two very good references are the Census Bureau report cited above and the website for Dr. Vaupel's Max Planck Institute for Demographic Research.

My remarks on the Canadian paper will be confined to its data on centenarians; I won't comment on the more fanciful analysis in the paper to map historical experience into a contemporary context. Clearly what stands out the most in the paper is the amazing accuracy of dates of birth on the death certificate for Quebec residents born in Quebec, based on verification from baptism records.

But the authors proceed to make what they term a "reasonable" assumption that the same accuracy holds for all native Canadians. I would prefer a different adjective -- "convenient": I am suspicious whether the accuracy of age at death information is as great in a context where there exist records at birth or shortly thereafter as when they do not exist.

I also had difficulty in following the argument. I believe they said:
1. Oldest-old mortality rates for the cohort born 1870-1879 show a slowing down of mortality, and the logistic model is an appropriate one.
2. Oldest-old mortality for the cohort born 1880-1884 shows less slowing-down, and the exponential model is best.
3. The age of death for Quebec residents born in Quebec is accurate for deaths occurring in 1985 through 1999. Note that few of these come from the earlier birth cohort but many come from the later cohort, so this finding should be supportive of the appropriateness of the exponential model.
4. It is "reasonable" to infer that data for all native Canadians is accurate.
5. The data for all native Canadians suggest a slowing down of mortality for females.

Are we therefore to conclude that Quebec and the balance of Canada are following different models?

The Canadian authors are very concerned that one of their results, that 8 percent of centenarian deaths occur after age 104, is much above the ceiling of 4 or 5 percent postulated by the European expert, Kannisto. They are correct, I believe, in suggesting that the demography of the extreme-aged in North America could well be different from their demography in Europe on which are based Kannisto's guidelines. We know that Kannisto's estimate for 1985 of 5 thousand centenarians in the United States, based on certain relationships observed in European populations, is almost certainly well below the true number.

Let's look at the country of Adanac, where the number of persons achieving centenarianship is almost doubling every 10 years, mortality begins at $q(100)=0.30$ and proceeds in increments of 0.02 -- not unlike mortality in the U.S. Life Table -- and all centenarians are born January 1. We find that 7 out of 100 centenarians are ages 105 and over, while 9 out of 100 centenarian deaths are at ages 105 and over. The 4 or 5 percent that Kannisto speaks about *is* realized in a country like Ecnarf, where $q(100)$ begins at 0.40 and proceeds in increments of 0.01.

Table 1. Centenarians of Adanac and Ecnarf

	Country of Adanac			Country of Ecnarf		
AGE	Population	Deaths	q(x)	Population	Deaths	q(x)
100	197	59	.30	197	79	.40
101	129	41	.32	110	45	.41
102	82	28	.34	61	26	.42
103	50	18	.36	33	14	.43
104	30	11	.38	18	8	.44
105	17	7	.40	9	4	.45
106	10	4	.42	5	2	.46
107	5	2	.44	2	1	.47
108	3	1	.46	1	1	.48
109	1	1	.48	1	0	.49
110	1	0	.50	0	0	.50
Total	525	172		437	180	
Percent age 105 and over	.07	.087		.041	.044	

The third paper, on supercentenarians, demonstrates quite convincingly that the portion of Louis Epstein's list that does not overlap with the list of the International Database on Longevity (IDL) is not to be trusted. However, I wonder about the characterization of the IDL lists as "valid and complete". How is validity defined? And how can the IDL be assured that all of a country's living supercentenarians are included unless the country maintains and permits access to a population register.

I'd like to offer two somewhat related observations. First, that the surprisingly moderate values of q(x) for supercentenarians perhaps is to some extent attributable to special care that they receive from persons anxious to preserve these long-lived marvels; the mortality of any species in a controlled environment could well differ from its mortality absent of such control. Second, how remarkable is the achievement of Madame Calment to survive to age 122: even if the annual probability of death after age 110 is a constant 0.5, the probability of surviving from a birthday at age 110 to past a birthday at age 122 is about 1 in 5000.

The paper expects less than 200 U.S. supercentenarians. Because that expectation is based in part on incomplete data for Japan, an expectation of about 225 is more reasonable. **Our earlier observation should be kept in mind, however, that the extrapolation from the European experience to the North American may be misleading.** How many U.S. supercentenarians are there, then? Actually, we have done some work in our Office on U.S. supercentenarians.

From nearly 2 thousand persons who appeared to be supercentenarians during the 20-year period from 1980 to 1999 according to information in their records of enrollment in the Medicare program as maintained in the Social Security Administration's master file, we have reduced the number of apparent supercentenarians to 723. This reduction was accomplished mostly by discovering later dates of birth in other records. We are more confident about the 587 persons for whom we have death certificate information than about the balance of 136 persons who either are still alive according to our records, or who died in 2001 so that death certificates are not available, or for whom we could not locate a death certificate corroborating their date of death.

In the group of 587 supercentenarians whose death between 1980 and 2000 is confirmed by a death certificate, there are 274 persons for whom we have either a birth certificate, a religious record from infancy, or a record in the 1880 or 1900 census. For the balance of 313, the only confirmation we have of the date of birth in the Medicare enrollment record is from the death certificate. In appreciating these numbers, it is important to bear in mind that for the majority of States and counties in the U.S., birth certificates are not available for births before 1890.

In table 2 we show the distribution along several dimensions of our two groups of U.S. supercentenarians, as well as the IDL supercentenarians, when applicable. With respect to several variables, the distribution of U.S. supercentenarians with strong confirmation of date of birth seems more plausible than the distribution of the other U.S. supercentenarians. The category that needs some explanation is the grouping of the States Alabama, Georgia, Mississippi, and Texas; we had noticed that this group of States accounted for a share of the supercentenarian population disproportionate to their 11 percent share of the U.S. population at the end of the 19th century, making us suspicious of data quality. We should also point out that the number of persons achieving supercentenarianship in the 1995-1999 period is substantially understated because of our requirement that a supercentenarian be deceased by the end of 2000 to be included in our database.

Table 2. Supercentenarians

ITEM	U.S.SUPERCENTENARIANS WITH STRONG CONFIRMATION OF DATE OF BIRTH	U.S. SUPERCENTENARIANS WITH WEAK CONFIRMATION OF DATE OF BIRTH	SUPERCENTENARIANS IN THE IDL COUNTRIES
NUMBER	274	313	179
SEX			
MALE	27	66	20
FEMALE	247	247	159
AGE AT DEATH			
NOT DECEASED	0	0	20
110	162	138	82
111	63	75	38
112	24	37	22
113	12	25	7
114	11	19	5
115	1	5	4
116+	1	14	1
PLACE OF BIRTH			
UNKNOWN	1	22	N/A
ALABAMA, GEORGIA, MISSISSIPPI, TEXAS	35	77	
REST OF US, INCL. PUERTO RICO & VIRGIN ISLANDS	226	139	
FOREIGN COUNTRY	12	75	
YEAR OF ATTAINMENT OF AGE 110			
BEFORE 1975	0	0	6
1975-1979	5	7	9
1980-1984	28	62	13
1985-1989	56	63	17
1990-1994	92	99	37
1995-1999	93	82	77
After 1999	N/A	N/A	20