

MORTALITY OF THE EXTREME AGED
IN THE UNITED STATES IN THE 1990S,
BASED ON IMPROVED MEDICARE DATA

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The most extensive mortality experience of very old persons in North America is the experience reflected in the master records of Medicare enrollment. Furthermore, the data are of high quality; for example, the age in the record generally is not a mere allegation, but rather is supported by documentation. Indeed this experience is used for the older ages in the construction of the decennial U.S. life tables.

Even the best data, however, are not free of error, and the Medicare data contain errors of duplicate information, incorrect ages, and unreported deaths. These errors understandably are most serious at the oldest ages, when the true experience is least extensive. We have undertaken several initiatives at the microdata level to improve the quality of the information, and report those initiatives and the mortality probabilities we obtained in this paper.

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INTRODUCTION

Actuaries in the Office of the Chief Actuary in the Social Security Administration have used the Medicare program experience to study the mortality of the aged almost since the inception of the Medicare program. Papers by Bayo and by Wilkin, based on tabulations of the Medicare files, appeared in the *Transactions of the Society of Actuaries* in 1974 and 1982, respectively. More recently, Kestenbaum (1992) tabulated the Medicare experience during calendar year 1987 and later (Kestenbaum, 1997) the experience during calendar year 1991 to study the mortality of persons ages 85 and over, to address the phenomenon of the race crossover in mortality, and to estimate the size of the centenarian population.

In each of the three U.S. decennial life tables since the inception of the Medicare program, the Medicare experience has been used beginning with age 85 and ending with the age after which the probabilities are judged to be no longer reasonable. The tables are then closed by a mathematical formula.

Kestenbaum also made several suggestions with respect to the quality of the Medicare data; though of good quality, the data do suffer from problems of birth date misstatement, unreported or unrecorded deaths, and duplicate information. He suggested first that the quality of mortality data is enhanced by excluding the experience of persons ostensibly enrolled only in Part A of Medicare. In fact, many of these persons are deceased, but their death has not been reported or has not been recorded; their Part B (medical insurance) enrollment terminates when the premiums due are in default, but Part A (hospital insurance) is generally free of charge.

Second, that the Medicare mortality experience, which can be studied with either the Enrollment Data Base, which is the master file maintained by the Centers for Medicare and Medicaid Services (formerly the Health Care Financing Administration), or the Master Beneficiary Record, which is the master file maintained by the Social Security Administration, is best studied with the latter -- the Master Beneficiary Record. Transactions are generally posted first to the Master Beneficiary Record and then shared with the Enrollment Data Base; over the course of many years there is a substantial accumulation of failed transmissions from one file to the other.

The third suggestion was that for the oldest ages, the ones where data are the most suspect, it is prudent to check other agency administrative files to see whether a later date of birth is entered there.

The first of these three suggestions was, in fact, adopted for the construction of the latest decennial life tables, for the 1989-1991 period, but not the other two. The life table construction program, however, has another method to improve the quality of the Medicare mortality

experience data, namely by confinement to the experience of people receiving monthly earnings-related social security benefits, to the exclusion of persons receiving a flat benefit or no benefit at all. The data for the latter groups are known to be more error prone. The drawback to this approach is that a large fraction of the experience at the very oldest ages is lost.

OUR STUDY

In this paper we present a large-scale study of the Medicare Part B mortality experience over the entire decade of the 1990's based on the Social Security Administration's Master Beneficiary Record, and featuring an extensive effort to edit the microdata, particularly by comparison with other data files. As we heard at yesterday's session, centenarianship is no longer the "rage", having been replaced by supercentenarianship as the focus for scientists interested in the extremes of longevity. Accordingly, we have gone to even greater lengths to edit the records of ostensible supercentenarians.

The first column of data in Table 1 contains values of $q(x)$ by sex and single year of age tabulated from the Medicare Part B experience over the decade, with a moderate amount of editing and manipulation, taken from the Master Beneficiary Record as it stood in May 2001. The sequence of $q(x)$ reaches its maximum at age 103 for men and at age 107 for women, and the $q(x)$ for supercentenarians is about half of what it probably should be. For comparison, the $q(x)$'s in the 1989-1991 decennial life table are displayed in the rightmost column of Table 1. These life-table values generally lie below our tabulated values, except at the oldest ages where probabilities by mathematical formula have replaced probabilities by observation.

Table 2 is a list of the various data files that were used to edit the Master Beneficiary Record, and also shows the purposes for which they were used. We should also mention that we checked for duplicate records by finding pairs of records that either had in common a particular identification number or had the same uncommon name and the same date of birth and the same State of last residence.

The first two files listed are Social Security Administration administrative files. The Supplemental Security Record is the master file for participation in the supplemental security income program for impoverished aged persons, just as the Master Beneficiary Record is the master file for participation in the social security and Medicare programs. The NUMIDENT is the file of the hundreds of millions of applications for an original or replacement social security card, as well as the repository for the death information reported to the agency. Both the Supplemental Security Record as it stood in June 2001 and the NUMIDENT as of March 2001 were examined for both date of death and date of birth information. A date of death from either of these files was accepted if the Master Beneficiary Record had no date of death or had a later date of death. A date of birth from either of these files was accepted if it was later than the Master Beneficiary Record date of birth, but only if the Master Beneficiary Record date of birth was before 1900.

The identifier common to the Master Beneficiary Record on the one hand and the Supplemental Security Record and the NUMIDENT on the other, which enabled the record matching, is the social security number. However, some records on the Master Beneficiary Record have a missing, impossible, or incorrect social security number. Accordingly, we used the Social

Security Administration's Electronic Verification System to search the NUMIDENT file for social security numbers in these instances.

The Centers for Medicare and Medicaid Services were kind enough to furnish us an extract of their Enrollment Data Base for Part B enrollees age 85 and over in the decade of the 1990's. We utilized this file not only for date of birth and date of death information, but also for date of enrollment termination information and to uncover further duplication, as well. Furthermore, the extract included information on membership in HMOs, on hospice care, and on the date of the last change of residence, all of which was useful, as we will explain later.

Our preliminary tabulations revealed to us an underrecording of deaths for enrollees who are Federal government annuitants. Accordingly, we requested and received from the Office of Personnel Management a file of annuitant deaths occurring during the decade.

The second data column in Table 1 presents the revised values for $q(x)$ after the appropriate substitutions from the files matched to the Master Beneficiary Record, and after efforts to recognize duplication. The probabilities of death are noticeably higher, with the maxima climbing to age 108 for men and remaining at age 107 for women.

The next -- and last-- two initiatives affect the $q(x)$ values at the oldest ages. An idea that had occurred to several of us who wanted to improve the quality of Medicare data but had never before been implemented is that a lack of utilization of Medicare services over a protracted period of time by a very aged enrollee probably indicates his or her demise. We interpreted a

complete lack of utilization of services during the 1990s by a person aged 90 or over at the beginning of the decade as evidence of death, but only if the person had no other activity during the decade, such as an address change, and only if the person was not a member of an HMO during the decade. The utilization of Medicare services by HMO participants is not reported to the administering agency.

For persons who according to the data were supercentenarians in the 1990s, we undertook several special initiatives -- listed in Table 3 -- to question the date of birth and, to a lesser extent, vital status and the date of death. For the initiatives that we could achieve ourselves we sought information for all supercentenarians; for those we needed to collaborate on with others we were limited, by privacy considerations, to supercentenarians who were deceased according to our records. At this point we would like to acknowledge and express gratitude for the collaboration of two groups: one in the Program on Population, Policy and Aging at Duke University under the leadership of James Vaupel, the other in the Population Studies Center of the University of Pennsylvania under the leadership of Samuel Preston.

First, we obtained from the Agency's storage facility in Boyers, Pennsylvania microprints of the supercentenarians' original applications for a social security card, on the chance that a data transcription error might have occurred in entering information into the NUMIDENT. Then we recalled from the various storage facilities around the country claims folders that had not been destroyed, hoping for a field worker's note in the folder that the person was deceased. Native-born persons achieving supercentenarianship in the 1980's would have been enumerated as

children in the 1880 census, and we searched for them in the census public-use file with the help of the parents' names that we obtained from the social security card application record.

For deceased persons we obtained information from the death certificate from the National Death Index (National Center for Health Statistics, 2000) maintained by the National Center for Health Statistics. Interestingly, the National Death Index editing process converts the date-of-birth item to "unknown" when it implies an age of death of 110 or more; fortunately, the process does not alter the age item. Our collaborators at the University of Pennsylvania searched the microfilm public-use file of the 1900 census, where all our native-born supercentenarians should be found. In the only initiative that is not complete as of this writing, we and our collaborators at Duke University wrote (see sample letter in the Appendix) to many State and county registrars whose birth registration system were mature enough, requesting birth certificates for those supercentenarians born in their jurisdictions (again, according to the application record). Finally, because our agency's Office of International Operations has established contacts in other countries for securing evidentiary documents, we were able to obtain birth certificates from the country of birth for certain foreign-born supercentenarians.

The values of $q(x)$ after the two steps of (a) inferring death from the non-utilization of Medicare services and (b) incorporating the results of the supercentenarian study are in column 3 of Table 1. Clearly there is a substantial effect at the very oldest ages, with the exception of the open-ended 110+ interval. Note that the probabilities of death for women now always increase from one age to the next, except from 109 to 110+.

We mentioned earlier that the experience of persons not receiving monthly earnings-related social security benefits as workers, auxiliaries, or survivors is excluded in the construction of the decennial U.S. life tables, because data for this experience is more error-prone, albeit at the cost of a loss of a significant fraction of the total experience at the oldest ages. Indeed, such an exclusion has a dramatic effect on $q(x)$ at the oldest ages in our study, as well. An alternative, which we offer here for the first time, has an even slightly more dramatic effect but a larger loss of experience, namely the exclusion of persons whose Medicare Part B premiums is paid by a third party, including State governments for their impoverished residents, the Office of Personnel Management for Federal government annuitants, and an assortment of private group payers. If the well-known inverse relationship between mortality and socioeconomic status exists in very old age, the effect of the last exclusion is to leave a group with below-average mortality.

The values of $q(x)$ for these two subsets of the Medicare population comprise columns 4 and 5 of Table 1. There now are probabilities of death exceeding one-half. The loss of experience because of subsetting can be seen in Table 4. The differences in Table 1 can perhaps be best appreciated by referring to Figure 1 and Figure 2.

CONCLUSION

The several initiatives undertaken in this study result in mortality probabilities at the very oldest ages which are substantially higher than the probabilities obtained before these initiatives are put in place. Although we would like to think that we are close to the true values -- and this is clearly the cases at ages 110+, we may be still underestimating mortality because of remaining data errors, or we may be overestimating mortality because of the aggressiveness of our editing.

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- National Center for Health Statistics. 2000. *National Death Index User's Manual*. Hyattsville, MD.
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APPENDIX:
LETTER TO REGISTRARS

RE: Request proof of birth

Because of the great scientific and popular interest in the human life span, our Program on Population, Policy, and Aging at Duke University has undertaken to try to validate the length of life for deceased persons who MAY have lived to age 110 or more before their death. We are attempting to obtain copies of birth certificates for these persons, and one or more of these persons was born in your jurisdiction. Please find enclosed information on such persons, as well as payment of the required fee for obtaining birth certificates (if any).

We contacted you last month to determine the protocol of requesting birth certificates in your area for persons born so long ago. We trust that we have correctly followed instructions, that the enclosed amount of payment (if any) is accurate, and that our letter is in the right hands. If this is not the case, please contact either of my staff persons, Cindy Owens or Tanya Exum-Coston at (919) 668-6900 or 6901 (owens@pps.duke.edu or tanya@pps.duke.edu). Researchers involved in the study contacted your office by phone in July in regards to this request.

The results of our investigation will appear in aggregate form; no identifying information will be made public. We hope that you will assist us in this important study, and thank you in advance for your cooperation.

Sincerely,

James W. Vaupel

Director, Program on Population, Policy, and Aging

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Table 1. Deaths per Thousand among the Extreme Aged, by Age, 1990-1999

		Entire Master Beneficiary Record File			Subset of MBR		Other
		1	2	3	4	5	6
<u>Gender</u>	<u>Age</u>	<u>Original</u>	<u>After Other Data Sources</u>	<u>After Special Initiatives</u>	<u>Receiving Regular Monthly Benefits</u>	<u>Premium Not Paid by Third Party</u>	<u>Official 1989-1991 Life Tables</u>
Male	85	126	126	126	126	124	124
	86	137	136	136	136	135	134
	87	148	148	148	148	146	146
	88	161	161	161	161	160	158
	89	174	174	174	174	174	171
	90	189	189	189	189	189	185
	91	204	203	203	204	204	200
	92	221	221	221	221	222	216
	93	240	239	239	240	241	232
	94	256	255	255	256	258	246
	95	274	274	274	275	279	260
	96	294	293	294	295	298	275
	97	313	313	313	314	320	289
	98	331	330	330	332	340	304
	99	347	348	348	349	355	319
	100	367	368	368	371	375	335
	101	385	383	384	386	389	352
	102	403	404	405	407	420	369
	103	426	432	433	439	447	388
	104	417	423	425	431	458	407
105	425	431	436	454	472	428	
106	403	415	423	444	451	449	
107	408	432	450	475	479	471	
108	421	450	494	539	535	495	
109	383	393	489	568	545	520	
110+	281	281	281	394	409	---	

Table 1. Continued

	Entire Master Beneficiary Record File				Subset of MBR		Other
	1	2	3	4	5	6	
<u>Gender</u>	<u>Age</u>	<u>Original</u>	<u>After Other Data Sources</u>	<u>After Special Initiatives</u>	<u>Receiving Regular Monthly Benefits</u>	<u>Premium Not Paid by Third Party</u>	<u>Official 1989-1991 Life Tables</u>
Female	85	84	84	84	84	82	84
	86	94	94	94	94	92	94
	87	104	104	104	104	102	104
	88	115	115	115	115	114	114
	89	128	127	127	127	127	126
	90	141	141	141	140	141	139
	91	155	155	155	155	155	154
	92	171	171	171	171	174	170
	93	187	187	187	187	190	184
	94	205	205	205	205	209	199
	95	223	223	223	223	229	215
	96	241	241	241	242	248	231
	97	260	260	260	261	268	248
	98	280	280	281	281	291	264
	99	297	297	298	298	308	280
	100	318	318	319	320	332	296
	101	340	342	342	345	358	314
	102	358	361	362	365	381	333
	103	369	372	373	378	395	353
	104	387	391	394	400	413	374
	105	405	411	415	419	438	397
	106	412	420	429	443	450	420
	107	421	443	462	486	490	446
	108	409	431	469	493	507	472
	109	405	417	492	519	567	500
	110+	312	343	376	446	448	---

Table 2. Files Linked to Master Beneficiary Record

<u>Files</u>	<u>Time Period & Age Covered</u>	<u>Date of Birth</u>	<u>Fact and Date of Death</u>	<u>Part B Stop Date</u>	<u>Duplicate</u>
Supplemental Security Record, June 2001	All records	X ¹	X		
NUMIDENT, March 2001	All records	X ¹	X		
Enrollment Data Base, August 2001	Age 85+ in 1990-99	X	X	X	X
Deceased Federal Government annuitants	Deaths in 1990-99	X	X		
Utilization of services paid for by Medicare	Utilization in 1990-99		X		

¹ Date of Birth for Supplemental Security Record and NUMIDENT are only for persons born before 1900 according to the Master Beneficiary Record.

Table 3. Special Sources for Supercentenarians

All Supercentenarians:

Microprints of original applications for a social security card

Claim folders retrieved from archives

1880 Census public-use file, on CD

Deceased Supercentenarians:

National Death Index of the National Center for Health Statistics

1900 Census public-use file, on microfilm

Birth Certificates from many U.S. registration jurisdictions

Birth Certificates from foreign countries

Table 4. Person Years of Experience among the Extreme Aged, both Sexes combined, by Age, 1990-1999

Entire Master Beneficiary Record File		Subset of MBR	
<u>Age</u>	<u>After Special Initiatives</u>	<u>Receiving Regular Monthly Benefits</u>	<u>Premium Not Paid by Third Party</u>
85	6202257	6006845	4620392
86	5445194	5267050	3985712
87	4730519	4568773	3401115
88	4057506	3911428	2862737
89	3438640	3307261	2378065
90	2870428	2753956	1945412
91	2346219	2244689	1558775
92	1887172	1799814	1227693
93	1491674	1417765	949029
94	1160217	1098455	721711
95	882143	831260	535763
96	655048	613973	387395
97	473844	441426	272656
98	334131	309299	186734
99	229166	210552	124064
100	153307	139660	80252
101	100270	90326	50432
102	62967	55919	30271
103	38131	33297	17413
104	22545	19269	9688
105	12912	10738	5214
106	7144	5768	2693
107	3916	3018	1398
108	2021	1455	674
109	1020	675	299
110+	1132	576	242
Total	36,609,523	35,143,247	25,355,829

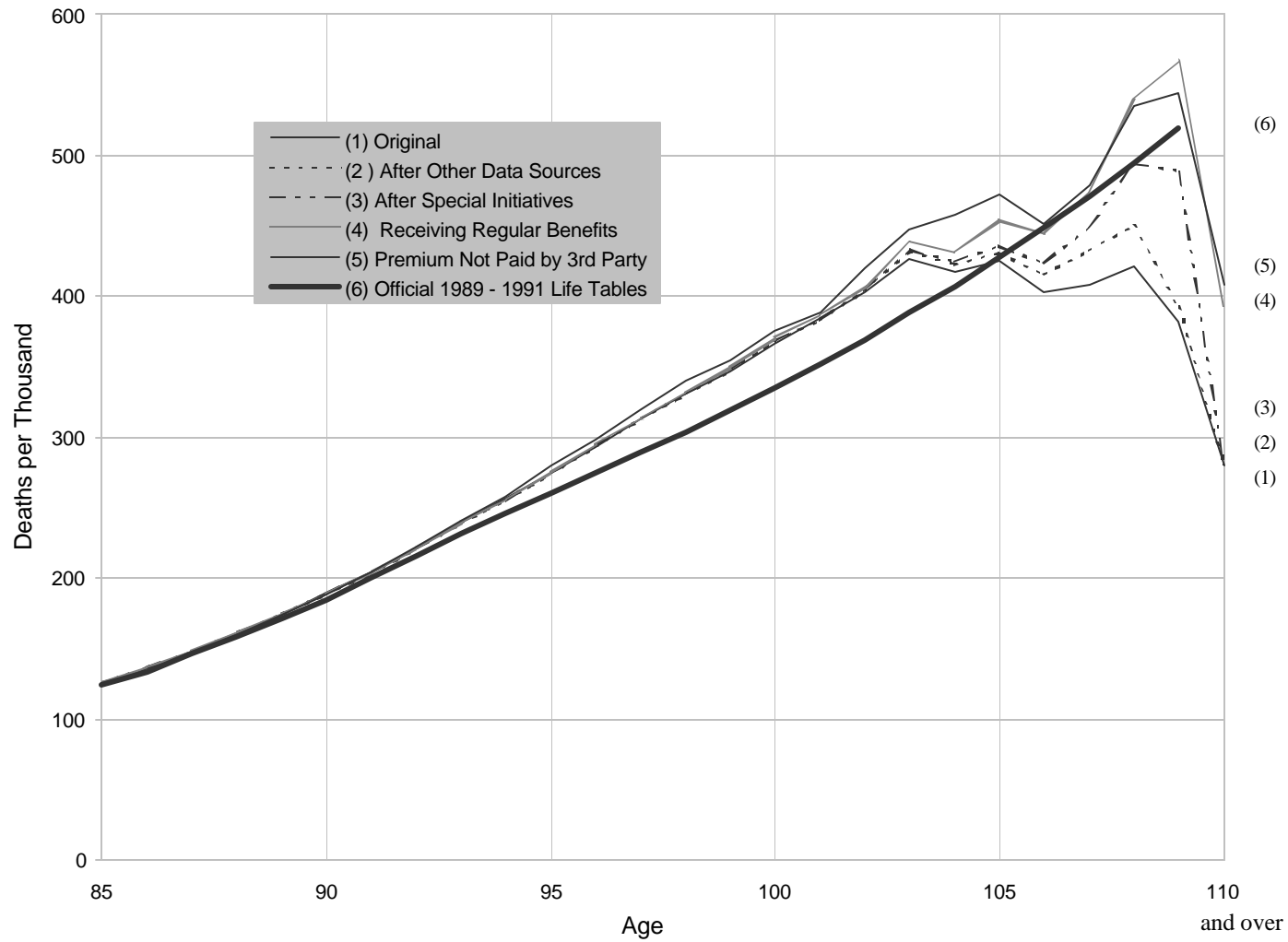


Figure 1. Comparison of Male Deaths per Thousand at the Oldest Ages According to Various Sources

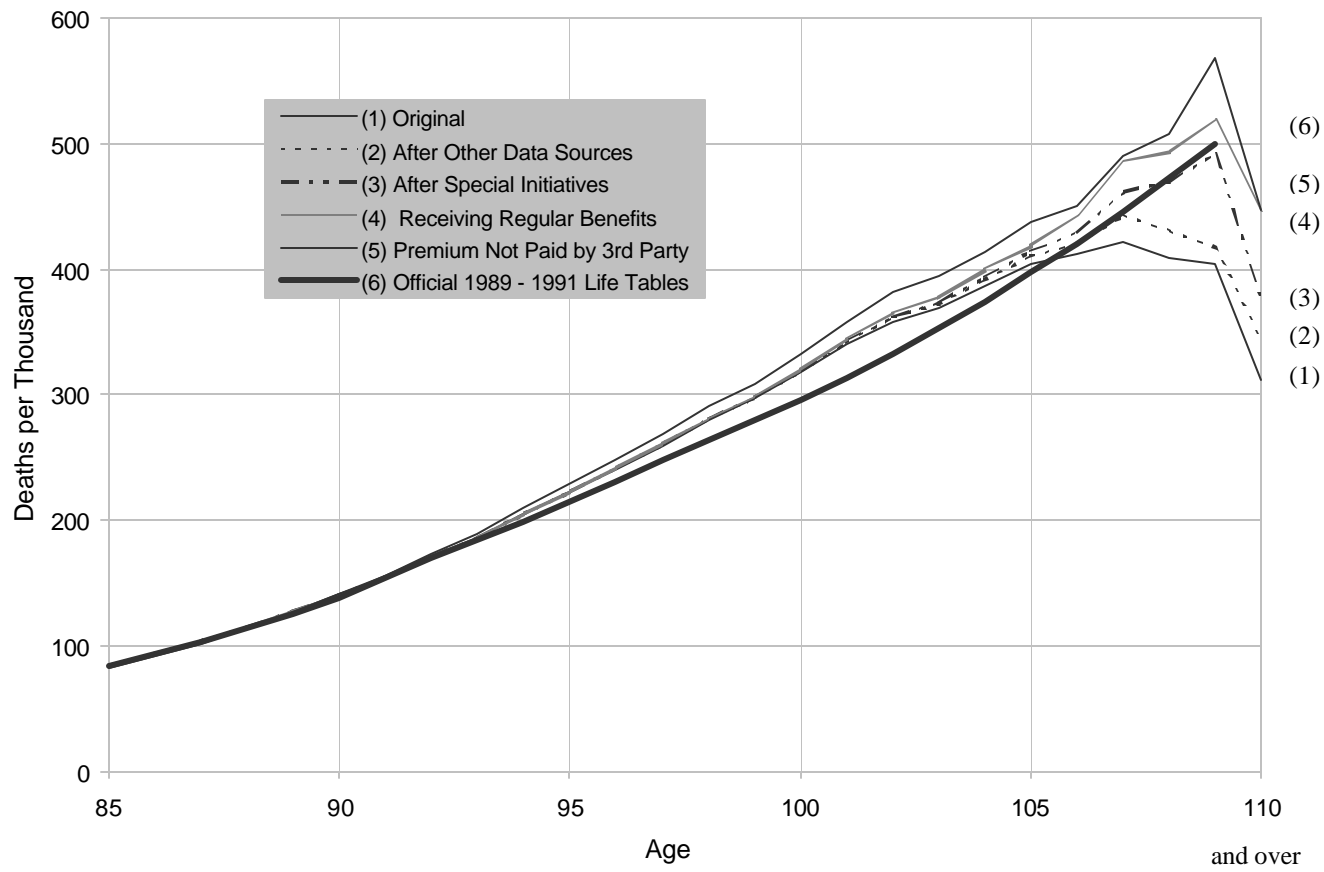


Figure 2. Comparison of Female Deaths per Thousand at the Oldest Ages According to Various Sources