

The Importance Of Cardiovascular Diseases As Causes Of Death In Centenarians In The United States

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Abstract

Centenarians or individuals > 100 years of age comprise an exceptional group in that they are predominantly white females who are relatively few in number. This paper examines whether the underlying cause of death is different in centenarians as compared to octogenarians and nonagenarians. This study includes 5,674,885 United States residents who were > 80 years of age at the time of death and died between 2009 and 2013. The Centers for Disease Control Wonder mortality database was used to identify these deaths. There were 113,983 centenarians who died between 2009 and 2013; these persons were only 2% of decedents > 80. Compared to their younger counterparts, deceased centenarians had a higher proportion of women and were less diverse racially. The number of deaths in octogenarians increased only 2% from 2009 to 2013, while the number of deaths in centenarians increased 18%. Cardiovascular diseases accounted for 46% of deaths in centenarians, whereas malignant neoplasms comprised only 4% of deaths. For those 80 and 90 years old, there were relatively more deaths due to cancer and relatively fewer due to cardiovascular causes. A major strength of the study was its comprehensiveness in that it included all deaths in the United States. This study raises questions about the adequacy of a single underlying cause of death in the very old, as well as the potential for age misreporting. As is the case for the United States population, cardiovascular diseases were the leading causes of death in centenarians.

Centenarians or individuals > 100 years of age comprise an exceptional group of individuals who differ from octogenarians or nonagenarians. In 2010, of those > 70 years of age, only 0.19% were centenarians, while 34% were octogenarians and 6% were nonagenarians.[1] Furthermore, almost 83% of centenarians were female, whereas 62% and 72% of octogenarians and nonagenarians, respectively, were female.[1] In 2010, centenarians were predominantly white (82%) as were octogenarians (88%) and nonagenarians (88%).[1] In addition to these demographic differences, causes of death may be different in centenarians as compared to the younger old; in particular the percent of deaths due to cancer was reported to be much lower in centenarians while the proportion of deaths due to "old age" was reported to be higher in comparison to individuals in their 80s or 90s.[2,3] The purpose of this paper is to compare cause of death in all octogenarians, nonagenarians, and centenarians who died in the United States between 2009 and 2013.

METHODS

This study includes 5,674,885 United States (US) residents who were > 80 years of age at the time of death and died between 2009 and 2013. The Centers for Disease Control (CDC) Wonder underlying cause of death mortality database was used to identify these deaths.[4] This publicly available database has a query system which permits the user to construct tables examining age, sex, race, and underlying cause of death. The database includes selected items from state death certificates and in addition to demographic variables and underlying cause of death has information on Hispanic origin, place of death, state, census region, Department of Health and Human Services region, urbanization, day of week, and whether an autopsy was performed. Underlying cause of death is reported using International Classification of Diseases 10th (ICD-10) codes.

The CDC Wonder underlying cause of death mortality database was used to construct tables that examined the association between demographic characteristics and year of

death as well as the association of the 3 age groups, year of death, and underlying cause. The underlying cause of death was categorized using the CDC Wonder 113 cause list. The CDC Wonder database provides aggregate level data and does not permit the extraction of individual level death information. Because of this and because the database is publicly available, this study did not undergo human subjects review. As this study includes deaths of all US residents, it does not use inferential statistical tests. Furthermore, the large number of deaths is likely to produce highly significant p values in the face of small differences.

RESULTS

There were 113,983 centenarians who died between 2009 and 2013; these persons were only 2% of those individuals > 80 years who died during this time (table 1). The proportion of females increased rapidly with age from 55% in octogenarians to 83% in centenarians (table 1). Decedents in all 3 groups were predominantly white, although the proportion of black decedents increased from 6% in nonagenarians to 10% in centenarians. The number of deaths in octogenarians increased only 2% from 2009 to 2013, while the number of deaths in nonagenarians and centenarians increased 20% and 18%, respectively.

The underlying cause of death for centenarians is shown in table 2 for general categories defined by the 113 cause list. Notably, cardiovascular diseases accounted for slightly less than half of all deaths, whereas malignant neoplasms comprised only 4% of deaths. A significant proportion of deaths fell under the R series which includes senility (R54); the numbers of deaths due to senility were 538 in 2009, 590 in 2010, 651 in 2011, 631 in 2012, and 614 in 2013. Related to senility, Alzheimer's disease accounted for about 7% of deaths, and the overall number of deaths due to this cause increased 21% from 2009 to 2013. Influenza or pneumonia and lower respiratory causes, which are associated with old age, were also important causes of death. Although they accounted for only 2% of deaths, accidental deaths increased 37% from 2009 to 2013. Finally, there were many other underlying causes too numerous to list. Significantly, these accounted for 26% of all deaths; moreover, the numbers of deaths due to all other causes increased 37% from 2009 to 2013.

When compared to underlying causes for octogenarians and nonagenarians, the distribution of causes was quite different for centenarians. First, the proportion of deaths due to malignant neoplasms declined with age and was much lower

for centenarians (table 3). Second, the proportion of deaths due to cardiovascular diseases was higher in centenarians than in the other 2 groups. For centenarians there were relatively more deaths in the R category. In octogenarians, senility accounted for 17% of deaths in the R category, and in nonagenarians senility comprised 28% of the R category. Yet for centenarians there were 3024 deaths due to senility; this was 42% of the R category. On the other hand, chronic lower respiratory deaths were not as evident as they were for the other 2 age groups. The distributions of Alzheimer's disease and influenza/pneumonia were similar across the 3 groups.

The distribution of specific types of cardiovascular causes of death is shown in table 4. Ischemic causes accounted for not quite half of all cardiovascular causes, although the proportion of deaths due to acute myocardial infarction declined with age as did the proportion of deaths due to cerebrovascular conditions. Significantly, the proportion of deaths due to heart failure increased with age.

Table 1

Number of deaths 2009-2013 by selected characteristics and age group

Characteristic	Age group		
	80-89	90-99	100+
Men	1,641,064 (45%)	606,788 (32%)	19,162 (17%)
Women	2,020,120 (55%)	1,292,930 (68%)	94,821 (83%)
Hispanic origin	169,062 (5%)	68,772 (4%)	4803 (4%)
Race			
White	3,296,332 (90%)	1,738,528 (92%)	99,951 (88%)
Black	279,163 (8%)	10,449 (6%)	11,339 (10%)
Asian/Pacific Islander	74,451 (2%)	36,379 (2%)	2375 (2%)
Alaskan Native/American Indian	12,238 (<1%)	4362 (<1%)	318 (<1%)
Year of death			
2009	721,872 (20%)	343,654 (18%)	20,392 (18%)
2010	731,740 (20%)	364,208 (19%)	21,829 (19%)
2011	737,861 (20%)	383,823 (20%)	22,810 (20%)
2012	732,754 (20%)	397,082 (21%)	23,963 (21%)
2013	736,957 (20%)	410,951 (22%)	24,989 (22%)
Total	3,661,184	1,899,718	113,983

Table 2

Underlying cause of death 2009-2013 by year for centenarians

Cause of death (ICD-10)	Year of death				
	2009	2010	2011	2012	2013
Malignant neoplasms (C00-C97)	817 (4%)	901 (4%)	894 (4%)	972 (4%)	943 (4%)
Major cardiovascular diseases (I00-I78)	9671 (47%)	10,109 (46%)	10,296 (45%)	10,656 (46%)	11,172 (45%)
Alzheimer's disease (G30)	1513 (7%)	1655 (8%)	1705 (7%)	1794 (8%)	1881 (7%)
Influenza or pneumonia (J09-J18)	948 (5%)	999 (5%)	1073 (5%)	1032 (4%)	1147 (5%)
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)	1231 (6%)	1430 (7%)	1529 (7%)	1596 (7%)	1474 (6%)
Accidents (unintentional injuries) (V01-X59,Y85-Y86)	391 (2%)	444 (2%)	518 (2%)	534 (2%)	538 (2%)
Nephritis, nephrotic syndrome and nephrosis (N00-N07,N17-N19,N25-N27)	402 (2%)	436 (2%)	367 (2%)	388 (2%)	410 (2%)
Chronic lower respiratory diseases (J40-J47)	477 (2%)	540 (2%)	563 (2%)	600 (3%)	635 (2%)
All other causes	4942 (24%)	5315 (24%)	5865 (26%)	5391 (23%)	6789 (27%)
Total	20,392	21,829	22,810	22,963	24,989

ICD International Classification of Diseases version 10

Table 3

Underlying cause of death 2009-2013 by age group

Cause of death (ICD-10)	Age group		
	80-89	90-99	100+
Malignant neoplasms (C00-C97)	686,170 (19%)	175,846 (9%)	4527 (4%)
Major cardiovascular diseases (I00-I78)	1,309,229 (36%)	799,695 (42%)	51,904 (46%)
Alzheimer's disease (G30)	198,189 (5%)	144,438 (8%)	8548 (7%)
Influenza or pneumonia (J09-J18)	94,221 (3%)	64,569 (3%)	5199 (5%)
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)	52,293 (1%)	51,883 (3%)	7260 (6%)
Accidents (unintentional injuries) (V01-X59,Y85-Y86)	86,462 (2%)	45,942 (2%)	2425 (2%)
Nephritis, nephrotic syndrome and nephrosis (N00-N07,N17-N19,N25-N27)	83,715 (2%)	40,500 (2%)	2003 (2%)
Chronic lower respiratory diseases (J40-J47)	245,729 (7%)	80,108 (4%)	2815 (2%)
All other causes	905,176 (25%)	496,737 (26%)	29,302 (26%)
Total	3,661,184	1,899,718	113,983

ICD International Classification of Diseases version 10

Table 4

Select types of major cardiovascular diseases 2009-2013 by age group

Cause of death (ICD-10)	Age group		
	80-89	90-99	100+
Major cardiovascular diseases (I00-I78)	1,309,229	799,695	51,904
Ischemic heart diseases (I20-I25)	606,551 (46%)	354,631 (44%)	23,180 (45%)
Acute myocardial infarction (I21-I22)	179,262 (14%)	91,906 (11%)	5203 (10%)
Heart failure (I50)	116,630 (9%)	91,517 (11%)	7013 (14%)
Cerebrovascular diseases (I60-I69)	241,911 (18%)	133,472 (17%)	6808 (13%)
All other forms of heart disease (I26-I28,I34-I38,I42-I49,I51)	198,077 (15%)	122,418 (15%)	7013 (14%)
Total deaths	3,661,184	1,899,718	113,983

ICD International Classification of Diseases version 10

DISCUSSION

Centenarians comprise a rare group of individuals; those

who died in the US between 2009 and 2013 were predominantly white women, who died of cardiovascular causes. Deaths in centenarians comprised only 2% of deaths among decedents > 80 years of age, yet deaths in centenarians increased 18% from 2009 to 2013. Compared to the younger old, centenarians had a lower proportion of deaths due to cancer and higher proportion due to cardiovascular diseases. Another notable finding was the higher proportion of deaths due to causes in the R class. A significant proportion of deaths in this category was attributed to senility, which in combination with the Alzheimer and influenza/pneumonia categories, comprise conditions commonly associated with old age.

Results from this study are similar to those from studies of centenarians conducted in Minnesota and England.[2,3] Both studies, which used death certificates, reported a low proportion of deaths due to cancer which suggests that the centenarian population is “cancer resistant.”[5] As cancer became less important, other causes became more so. The Minnesota study, which used death certificates from 1998 before the introduction of ICD-10 to the standard death certificate, also found that cardiovascular diseases were responsible for about 45% of deaths in centenarians. In the current study, ischemic heart disease accounted for nearly half of all deaths due to cardiovascular disease for individuals > 80 years old. In autopsy studies, Roberts et al. have confirmed the importance of cardiovascular disease in persons between 80 and 99 years of age.[6] In 6 centenarians, 4 had significant coronary artery narrowing, but none had clinical evidence of myocardial ischemia or heart failure during life.[7]

It is likely that the underlying cause of death does not reflect the complex reality of death in older persons. There may be multiple conditions responsible for death, and in addition to this, there is the aging process which some believe should be a cause of death in its own right.[8] It has been suggested that when there is uncertainty regarding an underlying cause, cardiovascular disease is often chosen.[8] While the death certificate may simplify a complex process, it is the official record of death and is the only means we have for understanding how death occurs in populations.

There is also the concern about the accuracy of age reporting on death certificates for older persons. For the very old, age reporting on the death certificate may be suspect, because age is reported by relatives or others. In the current study, there was a slight increase in the proportion of black persons in the centenarian category. Given lower life expectancy of

black individuals, this finding is somewhat puzzling and raises the matter of age misreporting. For the very old and for very old African-Americans in particular, it may be that age is overstated on the death certificate.[9] This was noted when age on the death certificate was compared with age recorded in the Social Security Administration Death Master File for the same individuals.[9]

The very old in the years of this study were born in the early part of the 20th century when birth record systems were not as developed as they are today and when literacy levels were not as high as they are now. It is likely that accuracy of age reporting for the very old will improve with time. If this is the case, then it is very unlikely that the observed increase in deaths in centenarians was due to age misreporting. These concerns about the underlying cause of death and age reporting are balanced by the comprehensiveness of the CDC Wonder mortality database.

The population of centenarians in the US increased 43% from 37,306 in 1990 to 53,364 in 2010,[1] and deaths in centenarians increased 18% from 2009 to 2013. Just how many centenarians there are in the US at a given time is difficult to say, given the rarity of these individuals. The number of centenarians is increasing, but how rapidly this special group will grow or how many there will be 50 years from now is difficult to project. It is likely that the number of deaths in centenarians will continue to increase and that patterns of the underlying cause of death will not change

drastically, as they have been fairly constant for the past 5 years. As cancer deaths became less important, cardiovascular causes became more important for centenarians. In fact, cardiovascular diseases are the leading causes of death in centenarians just as they are for the larger US population.

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