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**MORTALITY EXPERIENCE OF UNION
CIVIL WAR VETERANS**

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MORTALITY experiences of large closed groups carried through until the termination of all the lives are not often available. One valuable by-product of such an investigation is relatively reliable information on mortality experience at the very advanced ages. In the past, life tables have generally been terminated by arbitrary and artificial methods, rather than being based on actual experience.

In the United States, to date probably the only large closed group that can be followed over the lifetime of its membership is the pension roll of Union Civil War veterans. This military force numbering some 2.1 million in the 1860's has gradually dwindled down until at the end of fiscal year 1954 there was only one surviving member. Inaccuracy in age reporting, one of the usual difficulties in population data, is to a considerable extent not present in this instance because of the availability of military records and pension records proving age at claiming pension. Moreover, reasonable accuracy in regard to mortality rates at the very advanced ages should be present because the statements as to age were made 50 or more years ago at the time of entry to the pension roll. On June 27, 1890, legislation was enacted making any veteran with at least 90 days of service and an honorable discharge eligible to disability pension of \$6 to \$12 per month if he had a disability of permanent character, not the result of vicious habits, which so incapacitated him from performance of manual labor as to make him incapable of self-support. Beginning in 1906, all honorably discharged veterans with at least 90 days of service were eligible to pension if age 62 or older.

MORTALITY EXPERIENCE DURING 1915-54

Unfortunately, no age data are available before 1945 regarding both pensioners on the roll and pensioners at death. Table 1 shows for each fiscal year beginning with 1915, the number on the roll at the beginning of the year and the deaths during the year, from which data aggregate death rates were developed. These figures are on a reported, rather than an incurred, basis and so the number on the roll on a given date tends to be overstated by the deaths that occurred but were not reported before then. Likewise, the deaths shown for each year tend to be somewhat

TABLE 1
CRUDE DEATH RATES OF UNION CIVIL WAR VETERANS, BY YEAR

Fiscal Year*	Number Reported on Roll at Beginning of Year	Reported Deaths in Year	Crude Death Rate per 1,000	Nearest Age Corresponding to Death Rate†	Actual Average Age of Veterans at Beginning of Year
1915.....	429,646	33,001	77	74	†
1916.....	396,645	34,116	86	75	†
1917.....	362,529	33,092	91	76	†
1918.....	329,437	30,466	92	76	†
1919.....	298,971	27,451	92	76	†
1920.....	271,520	27,891	103	77	†
1921.....	243,629	24,752	102	77	†
1922.....	218,877	24,996	114	78	†
1923.....	193,881	25,258	130	80	†
1924.....	168,623	21,808	129	80	†
1925.....	146,815	20,189	138	81	†
1926.....	126,626	19,782	156	82	†
1927.....	106,844	16,795	157	83	†
1928.....	90,049	15,077	167	83	†
1929.....	74,972	14,988	200	86	†
1930.....	59,984	10,966	183	85	†
1931.....	49,018	9,569	195	86	†
1932.....	39,449	8,359	212	87	†
1933.....	31,090	7,213	232	89	†
1934.....	23,877	5,422	227	89	†
1935.....	18,455	5,182	281	92	†
1936.....	13,273	3,609	272	92	†
1937.....	9,664	2,633	272	92	†
1938.....	7,031	1,983	282	92	92
1939.....	5,048	1,532	303	93	93
1940.....	3,516	1,135	323	94	94
1941.....	2,381	821	345	95	95
1942.....	1,560	585	375	97	96
1943.....	975	350	359	96	97
1944.....	625	242	387	97	97
1945.....	383	154	402	98	98
1946.....	229	75	328	95	98
1947.....	154	63	409	98	100
1948.....	91	42	462	100	101
1949.....	49	23	469	100	102
1950.....	26	11	423	98	103
1951.....	15	9	600	103	104
1952.....	6	3	500	101	105
1953.....	3	2	667	105	106
1954.....	1	0	0	107

* A fiscal year ends with June 30 of the calendar year named.

† Based on U.S. White Males Life Table for 1929-31.

‡ Not available.

different than if the data were on actual date of death basis. By 1915, a half century after the end of the war, all veterans (except possibly a few unusual "drummer boy" cases) had reached the minimum automatic pensionable age of 62. From 430,000 pensioners on June 30, 1914, the roll gradually diminished until there was only one survivor on June 30, 1954. The aggregate death rate began at 77 per thousand and then advanced more or less regularly until it exceeded 500 per thousand in fiscal years 1951-53.

Beginning with fiscal year 1938 the average ages of pensioners on the roll are available. These may be compared with the age corresponding to the aggregate death rate according to an appropriate population life table. Since the range of ages of this group of veterans is narrow, there should be little difference between the average mortality rate and the mortality rate based on the average age. This comparison, crude as it is, does indicate that the mortality of the group conformed fairly closely to the population mortality rates for white men.

MORTALITY EXPERIENCE SINCE 1945

There were 210 pensioners on July 1, 1945, all but one of whom had died by June 30, 1954. These data were processed on a proper incurred basis, by adjustment for actual dates of death, and so differ somewhat from the figures in Table 1. The total exposure was 515 life years, admittedly relatively small. Nevertheless, this study probably gives one of the best available indications of mortality experience at the very advanced ages—at least in the United States.

In the 9-year period the minimum age of any pensioner was 92, while the maximum age was 110. The latter is consistent with the conclusions of many experts that age 110 is probably about the highest that any human being has attained—at least in modern times—despite some rather fantastic claims of 150 or more, generally by persons living in isolated regions or relatively uneducated (see Walter G. Bowerman, "Centenarians," *TASA* XL, 360).

A mortality investigation was made using the customary general exposure formula, the detailed data being set forth in Table 2. Because of the paucity of data, death rates derived at both the lower and upper ages were disregarded, credence being given only to the rates for ages 96-107. In order to smooth the crude rates, a logistic curve was fitted to q_x for these 12 ages by the method of least squares and extended beyond age 107. This logistic curve is as follows:

$$q_x = \frac{1}{1 + B c^x}.$$

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B and c were determined by transforming this equation and then fitting a straight line by the method of least squares to the following equation:

$$\log \left(\frac{1}{q_x} - 1 \right) = \log B + x \log c.$$

B and c were found to be 1,492.82 and .933595, respectively.

COMPARISON OF EXPERIENCE WITH VARIOUS LIFE TABLES

The graduated mortality rates rise from about 300 per thousand at age 96 to almost 500 at age 105 and then to 600 at age 112. Quite close agreement exists between these rates and those of the U.S. White Males

TABLE 2
MORTALITY EXPERIENCE OF UNION CIVIL WAR VETERANS
JULY 1, 1945 TO JUNE 30, 1954

Age Nearest Birthday, x	Living on July 1, 1945 at Age x	Deaths at Age x^*	Exposure at Age x	Computed Death Rate	Smoothed Death Rate
92.....	1	0	1	.0
93.....	0	0	1	.0
94.....	2	3	3	1.000
95.....	3	0	3	.0
96.....	15	6	18	.333	.329
97.....	27	12	39	.308	.344
98.....	40	22	67	.328	.360
99.....	44	34	89	.382	.376
100.....	32	41	87	.471	.392
101.....	25	33	71	.465	.409
102.....	8	17	46	.370	.426
103.....	6	15	35	.429	.442
104.....	3	11	23	.478	.460
105.....	4	8	16	.500	.477
106.....	0	2	8	.250	.494
107.....	0	4	5†	.800	.511
108.....	0	0	1	.0	.528
109.....	0	0	1	.0	.545
110.....	0	1	1	1.000	.562
111.....	0	0	0	.0	.579
112.....	0	0	0	.0	.596
All Ages..	210‡	209	515

* Based on age nearest birthday on July 1 preceding death.

† After subtracting 1 still living at age 107.

‡ This figure differs from the corresponding one in Table 1 (namely, 229) because that figure included some deaths unreported on June 30, 1945.

Life Table for 1939-41 up through age 100, but thereafter the veterans rates are increasingly higher; at age 108, the limiting age in the 1939-41 table, the veterans rate is 11% higher.

This veterans experience in 1945-54 was compared with various United States white male population mortality tables by computing the tabular deaths based on such tables and relating them to the actual deaths, as follows:

Period of Mortality Table	Ratio of Actual to Tabular Deaths
1900-02	86%
1909-11	92
1919-21	88
1929-31	84
1939-41	104

Although some evidence of improvement in mortality seems to be present, it is impossible to state that this is definitely the case because of the empirical nature of the tabular rates, which were largely based on mathematical extensions and arbitrary limiting ages, rather than actual experience.

Using data of several European countries combined, mortality rates at the extreme ages for both sexes combined (since no significant difference was found by sex) have been developed by Vincent¹ (*TSA IV*, 191-196). For age 98, Vincent's smoothed rate is 433 per thousand, or 20% higher than the veterans rate. This relative differential increases as the age advances, because Vincent's method resulted in a mortality rate of unity at age 110 in the smoothed data. Consideration was given to graduating the veterans data by Vincent's method, but examination of the computed crude death rates seemed to indicate that q_x does not increase rapidly at the advanced ages. Accordingly, a curve concave upward to unity at a limiting age such as 110 did not seem appropriate.

USE OF EXPERIENCE IN U.S. 1949-51 LIFE TABLES

In the recent construction of the U.S. Life Tables for 1949-51, it was decided to base the concluding portion on the previously described experience among Union Civil War veterans. Since Vincent's study indicated that the experience of the two sexes merged at the extreme ages and since previous United States experience indicated no significant difference in mortality at the advanced ages by race, no distinction was made

¹ Vincent developed a technique for obtaining mortality rates at the older ages—the so-called "method of extinct generations." This method devolves into the usual exposure formula for the data here available.

by sex or race. Accordingly, the life tables adopted the mortality rates shown in Table 2 for the pivotal ages, 102, 107, and 112. The actual experience at the younger ages was then tied in with these pivotal values, and the appropriate single age mortality rates derived. Quite naturally, any comparison of tabular deaths for these veterans on the basis of the U.S. White Males Life Table for 1949-51 with the actual deaths yields a ratio very close to 100% (any difference arising being due to rounding).