The first results of a study of the mortality experience of a group of males insured under the Old Age and Survivors Insurance system are reported. One significant point brought out is that the activity of the individual in terms of work is related to survivorship. Other aspects are also discussed.

FOUR YEARS MORTALITY EXPERIENCE OF A SEGMENT OF THE UNITED STATES WORKING POPULATION

Antonio Ciocco, Sc.D., F.A.P.H.A.; Thomas Mancuso, M.D., M.P.H., F.A.P.H.A.; and Donovan J. Thompson, Ph.D., F.A.P.H.A.

THIS paper presents the findings of a first analysis of the reported mortality experience from January 1, 1956, to December 31, 1959, of more than 250,000 white males between 20 and 64 years of age in 1955, who were living, and currently insured as of January 1, 1956, under the Old Age and Survivors Insurance system. This group is derived from the 1 per cent sample of white male wage earners selected and described by the Bureau of Old Age and Survivors Insurance (BOASI)[1,2]

The search to identify factors that have a bearing on the development of disability and mortality in adulthood requires a careful examination of the working environment, since people (at least most males) spend a substantial proportion of their time in this environment. This view, stimulated further by the findings relating, for example, carcinogenesis and the exposure to certain industrial processes, has led to the formulation of a broad program of investigation aimed at obtaining data on disability and mortality of groups exposed to specific work environments over a period of time. As part of this program two samples of wage earners utilizing the BOASI system have been established: (1) a 0.1 per cent sample[3] of wage earners employed during the years 1937-1940 followed for mortality to 1961, (2) a 1 per cent sample of wage earners covered by BOASI in 1955 and followed for mortality through 1959. Both samples will provide standards with which to compare the mortality of specific employed groups. The present paper provides an analysis of the mortality experience of the sample cohort established in 1955.

Material

By contract with the Bureau of Old Age and Survivors Insurance of the Social Security Administration, (a) punch cards were obtained on the 1 per cent sample of the workers in covered employment in 1955 used by the BOASI in its report, with information on age, sex, color, insurance status, classification of the industry of major job and its location, and taxable earnings by quarter worked; (b) information on death benefit claims made by beneficiaries of individuals in this sample from 1955 to 1959 inclusive with date of death and the state where claim was made. On the basis of information

Table 1—One Per cent Sample of Workers in 1955 Reported Covered by BOASI by Age, Sex, and Color*

Age Group	Number			
	Male White	Male Nonwhite	Female White	Female Nonwhite
<20	26,309	2,744	21,671	1,209
20–29	78,477	9,151	47,717	5,841
30–39	91,070	9,643	41,037	5,922
40–49	80,305	8,188	38,943	4,784
50–59	58,193	5,077	26,148	2,586
60–69	34,644	1,991	12,051	785
70 and over	9,169	439	2,391	145
Unknown	483	75	148	21
Total	378,650	37,308	190,106	21,293

* e.g. Table C200, Handbook of Old Age and Survivors Insurance Statistics, Employment, Wages, and Insurance Status of Workers in Covered Employment, 1955. U. S. Department of Health, Education, and Welfare, Social Security Administration, Bureau of Old Age and Survivors Insurance, Gov. Ptg. Office, 1961.

given in (b), copies of death certificates were requested from the vital statistics offices of the states in which death was alleged to have occurred.

The distribution of the 1 per cent sample by age, sex, and color is shown in Table 1. For purposes of this analysis, the following were selected:

1. White males between 20 and 64 years of age on January 1, 1955.
2. Individuals who were insured (permanently, fully, or currently) on January 1, 1956. This means that these persons had one or more of the following characteristics

(a) 40 or more quarters of coverage
(b) one-quarter of coverage for every two calendar quarters elapsed after 1950 or after attainment of age 21, whichever is later, with a total of at least six such quarters of coverage
(c) a minimum of six-quarters of coverage during the 12-quarter period 1953-1955.
3. Persons employed in nonfarm industry and commerce, nonprofit organizations, and state and local government. Excluded are persons with self-employment credits and persons employed on farms.

Table 2 shows the results of these exclusions. When, in addition, the deaths

Table 2—Male White Wage and Salary Workers Living and Insured, on January 1, 1956. Based on 1 Per cent Sample of Workers in 1955 Covered by BOASI.

Age Group	Number		
	Living in 1955	Reported Dying During 1955	Surviving on January 1, 1956
20–29	65,324	82	65,242
30–39	76,554	128	76,426
40–49	63,741	263	63,478
50–59	44,454	466	43,988
60–64	15,382	244	15,138
Total	265,455	1,183	264,272

Table 3—Reported Mortality and Survivorship January 1, 1956-December 31, 1959 of Male White Wage and Salary Workers Living and Insured on January 1, 1956. Based on 1 Per cent Sample of Workers in 1955 Covered by BOASI.

Age Group	Living Jan. 1, 1956	Died Jan. 1, 1956-Dec. 31, 1959	Deaths per 1,000 Living	Survivors Observed	Expected Jan. 1, 1956-Dec. 31, 1959		Ratio Expected/Observed	
					(1)	(2)	(1)	(2)
20-29	65,242	359	5.5	64,883	64,779	64,830	0.9984	0.9992
30-39	76,426	673	8.8	75,753	75,491	75,625	0.9965	0.9983
40-49	63,478	1,587	25.0	61,891	61,522	61,710	0.9940	0.9971
50-59	43,988	2,624	59.7	41,364	40,802	40,980	0.9864	0.9907
60-64	15,138	1,535	101.4	13,603	13,228	13,233	0.9724	0.9728
Total	264,272							

Expected Survivors (1)—Calculated from 1949-1951 life table.
Expected Survivors (2)—Calculated from 1959 abridged life table.

reported during 1955 are subtracted, a total of 264,272 persons were presumably alive on January 1, 1956, and posssessed the indicated characteristics. This constitutes the cohort under study.

One of the main reasons for the above exclusions, aside from cost, was to achieve greater assurance of the completeness of the mortality reporting. The data on mortality result from a voluntary process, submission of a claim on the part of the beneficiary of the deceased insured. Therefore, we would expect no claims to be submitted if the beneficiary knew that the deceased was uninsured or regarded the monetary benefits not worth the efforts of collecting them. We have assumed that by limiting the analysis to persons fully and/or currently insured, we have reduced the magnitude of the error of incomplete reporting. But, the extent to which such error persists cannot be determined by us. This limitation must be kept in mind in interpreting the findings.

Mortality and Survivorship, 1956-1959

Comparison with U. S. Life Tables

In Table 3 are shown the basic data on mortality and survivorship by age groups as well as comparative survivorship estimates derived from U. S. Life Tables.

Data on white males from the Life Table for 1949-1951 and the abridged Life Table for 1959 have been employed for comparison. The observed findings are closer to the estimates for 1959 than to those for 1949-1951. This is to be expected since the cohort experience begins with 1956. In both instances, the ratio of expected to observed survivors decreased regularly with advancing age. In the comparison with the 1949-1951 Life Table this ratio decreases from 0.9984 for the 20-29-age group to 0.9724 for the 60-64-age group. The corresponding ratios for the comparison

Table 4—Mortality January 1, 1956-December 31, 1959 of Male White Wage and Salary Workers Insured on January 1, 1956, According to Quarters of Coverage Reported in 1955. Based on 1 Per cent Sample of Workers in 1955 Covered by BOASI.

Age Group	One Quarter		Two Quarters		Three Quarters		Four Quarters	
	No.	Deaths per 1,000	No.	Deaths per 1,000	No.	Deaths per 1,000	No.	Deaths per 1,000
20–29	4,170		5,827		9,096		46,149	
		7.4		6.0		6.4		5.1
30–39	2,735		3,427		6,063		64,201	
		15.4		17.2		12.9		7.7
40–49	2,123		2,758		5,045		53,552	
		38.7		43.5		35.7		22.5
50–59	1,635		2,041		3,819		36,493	
		75.2		82.3		76.7		55.9
60–64	659		794		1,421		12,264	
		150.2		127.2		121.7		94.8
All Ages	11,322		14,847		25,444		212,659	

with the 1959 Life Table are 0.9992 to 0.9728.

To the extent that a current life table will reflect the survivorship of a cohort, it would appear that the four-year experience of this cohort of wage earners is about the same as that of the general population, perhaps slightly better.

Quarters of BOASI Coverage, 1955

The Social Security System obtains individual contributions by quarters of the calendar year. Except in the case of persons whose earnings are from farm wages or self-employment (not considered in this study), the individual is covered in relation to Old Age and Survivors Insurance for each quarter in which he obtains $50 or more in wages. This means that he is not covered for any quarter in which taxable earnings of $50 or more have not been reported. Thus, a wage earner covered in one, two, or three quarters only is a person who has received $50 or more in wages in a covered employment in only one, two, or three of the four calendar quarters. However, due to a special adminis-

trative rule, a wage earner whose taxable earnings in one, two, or three quarters during a calendar year have reached the maximum annual taxable earnings set by law for the year ($4,200 in 1955) will be credited with four quarters of coverage during that calendar year.

Table 4 shows the four-year mortality rates (1956-1959) of this cohort classified according to quarters under covered employment in 1955.

Two findings are noteworthy: (a) The great majority of the workers were covered for all four quarters, and (b) the four-year mortality rates are markedly lower for the four-quarter workers than for the remainder.

This finding could indicate that illness may have been an important reason why some of the wage earners were not covered by BOASI for the total calendar year.

Before discussing the above finding further, let us examine cause of death. In order to acquire data on cause of death, it was necessary to obtain the death records. This entailed obtaining

the cooperation of all vital statistics offices in the country and was the most time-consuming operation in the collection of data for this study. Assistance was generously given by all except one (city of New Orleans) of the vital statistics offices of the United States. Even so, for 13.6 per cent of the deaths reported by BOASI, no death certificate has been located to date. The search work, seeking better information on place of death, continues with further assistance from BOASI, and will undoubtedly reduce the above percentage. The percentage of unlocated death certificates is somewhat less among the four-quarter workers than among the others: 13 and 16, respectively. It is somewhat less among older workers than among the younger ones.

For purposes of comparing 1956-1959 mortality by cause of death in four-quarter workers and in the one-two-three-quarter workers, and between these groups and the United States white male population, the deaths from unknown causes have been distributed proportionally to the frequency of each cause as observed among the deaths for whom death certificates were found. This procedure assumes that inability to locate a death certificate is due primarily to factors such as misspelling, inadequate information on place of death, and the like, and that these factors have nothing to do with the fact of death or cause of death.

The pertinent findings with reference to major groups of causes of death among the wage earners are presented in Table 5. Examination of the four-year mortality rates for "all causes" reveals that the rates for United States are generally somewhat higher than those of the four-quarter workers, but except for the youngest age group much lower than corresponding rates in one-two-three-quarter workers. This pattern of difference is generally observed for the several groups of causes of death,

indicating that the higher subsequent mortality experience of the one-two-three quarter workers is not related to any one group of causes of death.

Reported Annual Earnings, 1955

In Figure 1 are presented graphically the findings on the four-year mortality experience among these wage earners classified according to reported earnings in 1955. For each of the quarter-coverage classes, the workers were grouped into the following three categories of annual earnings: one-quarter workers into earnings of (1) less than $450, (2) $450-$899, (3) $900 and over; two-quarter workers into (1) less than $900, (2) $900-$1,499, (3) $1,500 and over; three-quarter workers into (1) less than $1,350, (2) $1,350-$2,699, (3) $2,700 and over; four-quarter workers into (1) less than $1,800, (2) $1,800-$3,599, (3) $3,600 and over. The median earnings for each of the 12 categories in the five age classes, and the number of deaths per 1,000 living in 1955 in each category of age provide the coordinate points for Figure 1. Thus, for the 40-49-age class, the median earnings of the four-quarter workers in the less than $1,800 category was $1,200 and the mortality rate 32 per 1,000, while in the $3,600 and over category the median earnings was $5,300 and the mortality rate was 20 per 1,000.

From Figure 1, it is clearly apparent that mortality in 1956-1959 was higher among the workers whose earnings were lowest, and that the workers with highest earnings had the lowest mortality. The earnings effect is observed for all age groups and in most instances for each quarter-coverage group. Furthermore, with the possible exception of the one-quarter workers who are numerically the smallest group, the impression from Figure 1 is that the difference in mortality rate between four-quarter workers and the other workers tends to disap-

Table 5—Mortality January 1, 1956-December 31, 1959, by Category of Causes of Death of Male White Wage and Salary Workers, Insured on January 1, 1956, According to Quarters and Coverage Reported in 1955. Based on 1 Per cent Sample of Workers in 1955 Covered by BOASI.

Age Group and Quarter Covered	Inf. and Paras. 001-138	Neoplasm 140-239	Allerg. etc. 240-289	Cardiovascular 330-334 400-468	Resp. 470-527	Dig. 530-587	G. U. 590-637	Accid. 800-969 980-999	Suicide and Poisoning 970-979	All Other	All Causes
20-29											
1-2-3 q. w.	7	53	20	80	20	14	14	402	33	7	650
4 " "	8	74	8	47	3	3	25	284	50	8	510
U. S.	10.6	56.2	9.0	47.5	16.1	12.1	16.6	400.1	44.8	36.0	649
30-39											
1-2-3 q. w.	27	109	18	400	36	146	46	528	64	91	1,465
4 " "	10	120	11	277	23	40	17	180	59	32	769
U. S.	21.2	113.3	19.2	220.8	26.6	49.9	22.0	277.6	65.7	49.1	865
40-49											
1-2-3 q. w.	109	627	48	1,604	229	338	85	458	157	193	3,848
4 " "	13	423	41	1,170	56	142	32	215	90	67	2,249
U. S.	51.2	353.2	36.9	1,012.7	74.2	166.8	38.5	287.6	104.9	95.5	2,222
50-59											
1-2-3 q. w.	111	1,748	111	4,282	283	330	63	488	141	236	7,793
4 " "	66	1,167	75	3,194	177	290	72	290	140	118	5,589
U. S.	119.1	1,124.1	112.8	3,135.6	223.8	338.8	81.0	331.7	148.9	161.9	5,778
60-64											
1-2-3 q. w.	338	2,749	338	7,483	507	380	169	508	84	423	12,979
4 " "	65	2,202	158	5,768	325	391	139	149	93	186	9,476
U. S.	188.9	2,238.7	234.6	6,349.0	502.2	499.1	165.4	397.3	170.5	233.0	10,979

q. w. = quarter worker

pear for equal levels of earnings. Although it is not shown in Figure 1, the relation between mortality and earnings was examined in terms of the broad categories of cause of death used in Table 5. In general, the inverse relation of earnings level and mortality appeared to be present in each of these broad categories.

Could the relationship of low earnings in 1955 and high subsequent mortality in 1956-1959 be simply a manifestation of underreporting of death claims, assuming that underreporting occurs more frequently among beneficiaries of high earnings workers than among those of low income workers? We do not believe that underreporting plays an important role. In the first place, the differences are too regular. In the second place, the levels of earnings, which constitute the bulk of the observations considered here, are of modest magnitude. It is difficult to believe that families with male wage earners whose earnings were at this modest level could afford to forego the death and widows benefits which had accrued to the deceased.

Summary and Discussion

The major findings of this study of a group of wage earners observed for four years are that the earnings level and the work experience (expressed in terms of quarters of a calendar year) under BOASI covered employment in 1955 are related to the subsequent survivorship from 1956 to 1959, inclusive. Male white wage earners whose work experience under covered employment was less than the full calendar year in 1955 had a higher subsequent four-year mortality than those wage earners with full calendar year coverage. In both groups of individuals, those with a full year's coverage and those with less than a year's coverage, mortality was inversely related (and survivorship directly related) to level of reporting earnings. The differential mortality was observed for all broad groups of causes of death.
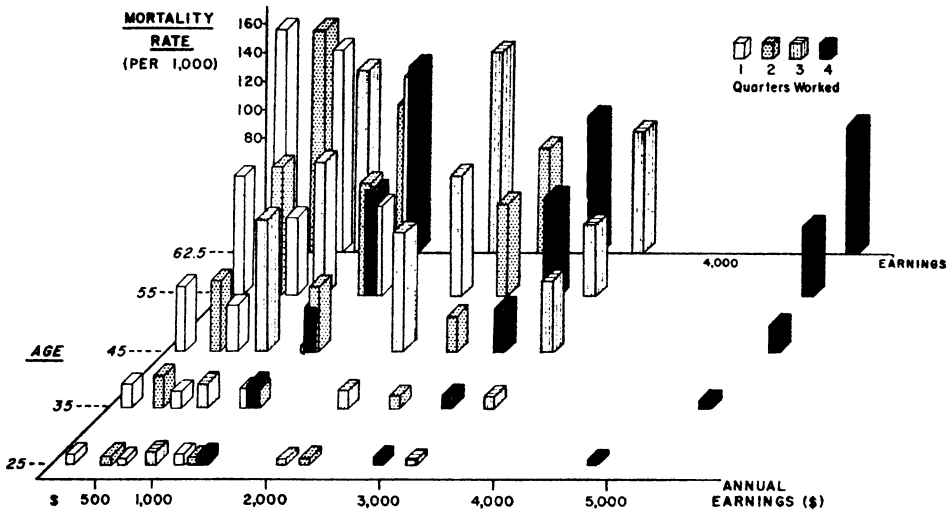
The finding that the entire cohort had

Figure 1—Mortality Rates, January 1, 1956-December 31, 1959, Among Male White Wage and Salary Workers, Insured on January 1, 1956, According to Age, Quarters of Coverage, and Reported Earnings in 1955. Based on 1 Per cent Sample of Workers Covered by BOASI in 1955.

a somewhat better survivorship experience than that of the general population could be merely the result of an artifact due to underreporting of deaths. Or it could be due to a combination of a number of factors. The findings of the study group may be due to a certain extent to (a) selective pre-employment practices of employers relating to job requirements of employment, in terms of physical and health status, as well as selective policies and forces pertaining to sickness, disability, compensation, and age which screens from the currently employed population persons who are or represent potential health risks, (b) industry and job selection by the individual in relation to certain physical characteristics and those who leave jobs because of the development of sickness, (c) beneficial effects of the use of hospital and sickness insurance and the extension of these provisions on a national basis since 1955, (d) the presence or absence of industrial medical programs.

Some of the these factors might be expected to operate to improve the survivorship experience of a cohort of active workers while others might be expected to place such workers at an increased risk of mortality. Perhaps for short-run survivorship, the fact that an individual must be in fairly good health to remain actively employed is a sufficiently strong factor to produce the results observed in this admittedly complex situation.

That individuals with less than a full year's coverage have a higher mortality risk in subsequent years could mean simply that in a substantial proportion of such individuals no covered work was actually no work, and that this unemployment was due to development of illness and disability. The inverse relationship of earnings level and mortality unrelated to cause of death is not as easily explainable. As alternative explanations one could consider: (1) wage earners in the lower brackets come from the lower socioeconomic strata of our society, have the least skills, and consequently can command only the lower-paid jobs where working conditions may be more hazardous. This additional hazard, in conjunction with all the other health related factors associated with membership in these strata of our society, produces the increased mortality in the lower earnings groups, (2) some wage earners are in the lower earnings brackets because of sickness or disability and others for the same reasons gravitate to certain low paid employment or intermittent employment, and the observed association is occasioned by the increased risk of mortality among such persons.

The fact that mortality is inversely related to income level constitutes one of the oldest vital statistics findings and was a major stimulus to the public health movement. The persistence of this relationship to the present, while somewhat surprising in view of the general improvement in all socioeconomic characteristics in this country, has been indicated in a number of ways; the recent study by Patno[4] on the population of Pittsburgh, by Stockwell[5] on Hartford and Providence, and by Guralnick[6] for the United States in 1950 are good illustrations. However, this relationship has been specified in terms of the characteristics associated with income level; crowding, personal hygiene, nutritional status, medical care, and so forth, that are factors in the onset and progression of particular disease conditions. In this study, no clue is obtained regarding the specific nature of the relationship of reported earnings to mortality. The broadness of the grouping of causes of death could be a confounding factor and, therefore, the data should be re-examined in terms of more specific causes of death. Steps to do so, within the limits of our data, have been taken, as well as steps to examine, within the limits of the information available, whether or not industry of major job and changes in relative earning levels

are factors in the differential mortality.

One positive point brought out by the findings of this study is that the activity of the individual in terms of work is related to his survivorship; and consequently, community knowledge of individuals who become inactive while still under the usual retirement age may identify individuals subject to higher risks of mortality for whom community preventive and therapeutic measures should be instituted.

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Alice Hamilton Lectureship

Through the generosity of friends and colleagues of Alice Hamilton, M.D., assistant professor of industrial medicine, Emerita, the Harvard School of Public Health has established a fund in her honor. The first use of this fund will be for the Alice Hamilton Lecture to be given May 27 in the Auditorium of the Jimmy Fund Building at 35 Binney Street, Boston, Mass. The first Hamilton Lecturer is Harriet L. Hardy, M.D., who will speak on "Beryllium Disease: Lessons in Control of Man-Made Disease."