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MORTALITY EXPERIENCE ACCORDING TO BUILD AT THE HIGHER DURATIONS

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INTRODUCTION

PAST studies of mortality according to build have shown rather conclusively that the extra mortality associated with overweight increases progressively during the early years after issue and that this increasing trend continues for at least 15 or 20 years in the case of policies issued at the younger adult ages. However, the published studies have not included sufficient data at the higher durations to indicate whether the relative mortality of overweights continues to increase or tends to level off or decrease. The *1955 Build and Blood Pressure Study* included no exposures after the 19th policy year and thus did not answer this question, although there was some indication of a tendency for the extra mortality of overweights to level off after approximately the first 15 policy years, even among the younger age groups. A 1948 study of "Mortality Experience According to Build on Standard Insurance in the Provident Mutual" (*TASA*, Vol. L) included experience during the first 27 years after issue. Although the exposures at the higher durations were somewhat scanty, the results suggested rather strongly that the increase in the relative mortality among overweights in general tends to level off about 20 years after issue. The main purpose of the present study is to determine, by investigating recent experience on a block of insurance exposed at the higher durations, whether the inferences derived from the earlier studies can be confirmed.

SCOPE OF THE PRESENT STUDY

The study covers original life and endowment policies issued by Provident Mutual at standard rates on white males during the years 1930–34,

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exposed between the 1947 and 1964 anniversaries. All these policies were medically examined. Reinsurance ceded is included. Policies issued at ages under 15 and policies on individuals with heights below 5′0″ or above 6′5″ are excluded because of the scantiness of the data and the lack of reliable weight standards for those ages and heights. Except for the periods of issue and exposure, these specifications are identical with those used in the 1948 study referred to above. Issues of 1930–34 were used because this is the oldest block of issues for which our mortality records have been kept up to date. Restricting the study to a 5-year issue period increases the homogeneity of the data and reduces the chances of anomalies due to the use of different underwriting standards at different times. The period of exposure commences at the point where the 1948 study terminated.

The study is based on policies only. In the 1948 study the mortality ratios by amounts were found to be practically useless because of fluctuations caused by large death claims, in spite of an artificial limitation of individual policies to $25,000.

The present study includes 5,408 deaths (policies), of which 5,274 are in the 16th and later policy years, compared with 5,312 deaths in the 16th and later policy years in the 1948 study.

WEIGHT STANDARD AND MORTALITY BASIS

In order to preserve consistency with the 1948 study, the "standard weights" used for classification according to degree of overweight or underweight are the same as those used in that study, namely, the average weights at age 37 at the various heights according to the Medico-Actuarial Mortality Investigation.

The expected deaths were first calculated on the basis of the 1946–49 Basic Ultimate Table. (The error introduced by applying ultimate rates to a small amount of exposure in the 14th and 15th policy years is inconsequential.) Subsequently, the expected deaths were adjusted by factors producing (for all heights and weights combined) expected deaths equal to the actual deaths in each of the three issue age groups and five duration groups studied. Thus the deviations of the mortality ratios from 100 per cent may be considered, insofar as they are statistically significant, to be related to build and to other elements of selection which have influenced the acceptance of applicants in the particular build group.

ANALYSIS BY AGE AT ISSUE AND DURATION

Table 1 presents the results of the study analyzed in broad groupings according to age at issue, policy year, and deviation from standard weight. For all ages combined, Table 1 shows that at the high durations both the favorable mortality of the underweight groups and the unfavorable

mortality of the moderately overweight group (deviations of +8 to +22 lb.) have tended to draw closer to the average rate. However, when the results in each of the three age groups are examined, it becomes apparent that these effects are confined almost exclusively to the youngest group (issue ages 15–34). In issue age groups 35–49 and 50–65, neither the underweights nor the overweights exhibit any consistent trend in their mortality ratios at the higher durations. All of this suggests that, as the individ-

TABLE 1

ANALYSIS BY AGE AT ISSUE AND DURATION

Issues of 1930–34 Exposed between 1947 and 1964 Anniversaries. Expected Deaths Based on Actual Experience in Same Period for All Builds Combined. By Policies

Deviation in Pounds from Standard Weight	Actual Deaths						Ratio Actual to Expected*					
	Policy Years											
	14–15	16–20	21–25	26–30	31–34	14–34	14–15	16–20	21–25	26–30	31–34	14–34
	Ages at Issue 15–65											
—23 or more	12	110	149	180	89	540	(91%)	81%	82%	86%	89%	85%
—22 to — 8	22	257	348	390	190	1,207	(68)	83	85	86	92	85
— 7 to + 7	51	396	461	518	208	1,634	122	98	94	101	94	98
+ 8 to +22	40	350	397	372	148	1,307	128	121	116	110	110	115
+23 or more	9	176	239	211	85	720	.....	118	140	133	146	130
All weights	134	1,289	1,594	1,671	720	5,408	100%	100%	100%	100%	100%	100%
	Ages at Issue 15–34											
—23 or more	3	52	60	86	53	254	.....	102%	78%	80%	95%	86%
—22 to — 8	8	72	109	177	97	463	.....	77	76	91	98	86
— 7 to + 7	10	64	127	172	87	460	(135%)	82	107	108	108	103
+ 8 to +22	6	70	82	94	37	289	.....	166	131	115	94	125
+23 or more	1	26	51	51	18	147	.....	137	184	143	(110)	146
All weights	28	284	429	580	292	1,613	100%	100%	100%	100%	100%	100%
	Ages at Issue 35–49											
—23 or more	7	38	65	68	26	204	.....	67%	84%	86%	72%	80%
—22 to — 8	11	112	160	159	72	514	(68%)	79	83	77	84	80
— 7 to + 7	28	203	227	264	88	810	124	104	91	105	86	99
+ 8 to +22	23	177	227	212	94	733	(130)	116	117	108	119	115
+23 or more	2	97	130	123	56	408	.....	119	134	132	169	130
All weights	71	627	809	826	336	2,669	100%	100%	100%	100%	100%	100%
	Ages at Issue 50–65											
—23 or more	2	20	24	26	10	82	.....	(73%)	(89%)	120%	(129%)	95%
—22 to — 8	3	73	79	54	21	230	.....	97	108	102	(96)	100
— 7 to + 7	13	129	107	82	33	364	(111%)	98	87	81	88	90
+ 8 to +22	11	103	88	66	17	285	(119)	109	102	113	(104)	108
+23 or more	6	53	58	37	11	165	.....	107	125	122	(127)	118
All weights	35	378	356	265	92	1,126	100%	100%	100%	100%	100%	100%

* Ratios are not shown for groups with less than 10 deaths. Ratios based on 10–24 deaths are shown in parentheses.

uals in the youngest group grow older, weight changes occur which are predominantly in the direction of more normal weights, while the weights of the two older groups are more nearly stabilized at the time of issue.

Comparison of the mortality ratios for the three age groups confirms, as found in the 1948 study, that the relative extra mortality of overweights is highest in the youngest group and lowest in the oldest group. To some extent this is probably a spurious effect resulting from use in

TABLE 2

ANALYSIS BY DURATION, SHOWING RESULTS OF 1948 STUDY AND PRESENT STUDY

1948 Study—Issues of 1920–45 Exposed between 1937 and 1947 Anniversaries
Present Study—Issues of 1930–34 Exposed between 1947 and 1964 Anniversaries
Expected Deaths Based on Actual Experience in Same Period for All Builds Combined By Policies

Deviation in Pounds from Standard Weight	Ratio of Actual to Expected Deaths for Policy Years:								
	1–5	6–10	11–15	16–20		21–25*		26–30	31–34
	1948 Study	1948 Study	1948 Study	1948 Study	1965 Study	1948 Study	1965 Study	1965 Study	1965 Study
−23 or more.....	104%	95%	81%	83%	81%	80%	82%	86%	89%
−22 to − 8.....	95	99	87	81	83	82	85	86	92
− 7 to + 7.....	89	92	96	94	98	102	94	101	94
+ 8 to +22.....	112	102	116	119	121	125	116	110	110
+23 or more.....	108	123	123	140	118	131	140	133	146
All weights.....	100%	100%	100%	100%	100%	100%	100%	100%	100%

* Policy years 21–27 for 1948 study.

this study of average weights at age 37 as standard weights for all ages. Using this standard, the departure from average build for their age is much greater among the young overweights than it is among the old overweights. If age-specific average weights had been used as our standard, the difference between the mortality ratios of the young overweights and the old overweights would not have been so great.

COMPARISON WITH 1948 STUDY

The 1948 study mentioned earlier covered issues of 1920–45, exposed between the 1937 and 1947 anniversaries. A comparison of the results (for all ages combined) in that study and the present one is given in Table 2. The number of deaths is not shown in this table because all the groups are of substantial size (the smallest group has 85 deaths).

Table 2 illustrates the confirmation by the present study of the tentative indications found in the 1948 study that neither the improvement of the underweight mortality nor the deterioration of the overweight mortality continues after approximately the first 20 policy years. For the policy durations covered by both studies, the results of the two studies are remarkably consistent, especially when it is considered that there was no overlapping of the exposures. Both these points are more clearly brought out when the results for the 16th and later policy years are combined into (approximately) 10-year duration groups to eliminate some of the fluctuations that occur when 5-year groups are used (see accompanying tabulation).

Deviation in Pounds from Standard Weight	1948 Study	1965 Study	
	Policy Years 16–27	Policy Years 16–25	Policy Years 26–34
−23 or more	81%	82%	87%
−22 to − 8	82	84	88
− 7 to + 7	97	96	99
+ 8 to +22	121	118	110
+23 or more	137	129	136
All weights	100%	100%	100%

It should perhaps be mentioned that the proportion of policies issued on extreme overweights (+43 lb. or more) was considerably higher in the 1948 study than in the present study, mainly because of different underwriting standards in effect prior to 1930. In the 1948 study, 0.9 per cent of the expected deaths was on these extreme overweights, as compared with only 0.1 per cent in the present study. This difference, however, would not have any significant effect on the comparability of the two studies.

ANALYSIS BY AGE AT ISSUE AND HEIGHT

Table 3, which is similar to Table IV in the 1948 study, shows the material divided into three broad height groups as well as age at issue and weight groups in order to bring out any mortality differentials that may be related to height. As in the 1948 study, there is no consistent pattern of mortality related to height. For all weights combined, the only significant feature is the excess mortality on issues at ages 15–34 in the short group. For these young ages at issue, the short group had the highest mortality in each of the three weight groups in the current study and in both the underweight and average-weight groups in the 1948 study. Other

TABLE 3

ANALYSIS BY AGE AT ISSUE AND HEIGHT

Issues of 1930–34 Exposed between 1947 and 1964 Anniversaries. Expected Deaths Based on Actual Experience in Same Period for All Builds Combined. By Policies

Height Group*	Actual Deaths				Ratio Actual to Expected			
	Age at Issue							
	15–34	35–49	50–65	All Ages	15–34	35–49	50–65	All Ages
	All Weights							
Short	213	379	241	833	115%	97%	99%	102%
Medium	849	1,606	654	3,109	98	103	100	101
Tall	551	684	231	1,466	98	95	101	97
All heights	1,613	2,669	1,126	5,408	100%	100%	100%	100%
	More than 7 Pounds under Standard Weight							
Short	80	93	64	237	96%	78%	111%	91%
Medium	362	402	179	943	84	78	96	83
Tall	275	223	69	567	85	86	94	87
All heights	717	718	312	1,747	86%	80%	99%	85%
	Within 7 Pounds of Standard Weight							
Short	72	124	96	292	117%	92%	86%	95%
Medium	262	495	197	954	105	104	89	101
Tall	126	191	71	388	95	91	96	93
All heights	460	810	364	1,634	103%	99%	90%	98%
	More than 7 Pounds over Standard Weight							
Short	61	162	81	304	154%	118%	110%	122%
Medium	225	709	278	1,212	119	126	112	121
Tall	150	270	91	511	146	107	111	117
All heights	436	1,141	450	2,027	132%	120%	112%	120%

* Short, 5′ 0″ to 5′ 6″; medium, 5′ 7″ to 5′ 10″; tall, 5′ 11″ to 6′ 5″.

than this there are no clear indications of significant differences in mortality related to height.

CONCLUSIONS

The results of the current study indicate that build at issue continues to affect mortality significantly even after 30 years. Considering the results of both the current study and the previous study, the following more specific conclusions appear to be justified:

1. The favorable mortality observed among underweights in the early policy years has continued through the higher durations studied, although there appears to be a tendency for the mortality ratios to increase slightly at the high durations.

2. The high mortality ratios of overweights have increased over the first 20 years or so but at the higher durations have tended to level off or, in the case of the moderately (8–22 lb.) overweight group, to diminish.

3. Mortality among short individuals insured at ages 15–34 has been somewhat excessive, regardless of weight. For other age groups, there is no consistent evidence of mortality variations related to height.

DISCUSSION OF PRECEDING PAPER

ERNEST J. MOORHEAD:

Publication of this sequel to a 1948 paper causes one to reflect that our underwriting knowledge might expand more rapidly if other actuaries would follow the example of Messrs. Blair and Haines in making repeated, diligent studies of an individual impairment. When every company dabbles in investigations of the whole range of observable impairments, the result may often be wasteful duplication of effort.

For the underwriting of build abnormalities, these authors' extended analysis to the thirty-fourth policy year adds usefully to our knowledge. But there is yet much to be learned. Actuaries should be aware that our techniques have recently been subjected to criticism by a student of the subject from outside our industry. Canadian actuaries surely know about this, since the criticism was emblazoned in the *Financial Post* under the banner headline "Insurance Mortality Figures Dead Wrong, Says U.S. Expert."

Our critic is Carl C. Seltzer, who is a research associate in the Department of Nutrition of the Harvard School of Public Health in Boston. His ideas are to be found in an article with the short title "Ponderal Index of Mortality," published in *New England Journal of Medicine* (CCLXXIV, No. 5 [February 3, 1966]). Dr. Seltzer voices two separate and independent criticisms. First, he recommends that greater attention be paid to variations in body-build structure and body composition and to the distinction between overweight and obesity. Second, he urges that, in considering mortality purely in terms of height and weight, we use an abstraction that he has named the "ponderal index." Ponderal index is the height in inches divided by the cube root of the weight in pounds. For adults, it will normally have a value in the neighborhood of 12.5–13.0; markedly overweight individuals would have a ponderal index of 11.6 or less.

With regard to Seltzer's first point, we can readily agree that differentiation within a particular height and weight category, according to body structure, is desirable to the extent that it is feasible. But Seltzer seems to give us less credit for awareness of this than actuaries and underwriters have earned. Practice for many years has been to grant more lenient underwriting treatment if, for example, chest measurement in relation to abdomen measurement is favorable.

It remains to be seen whether Seltzer's ponderal index really fits well

the mortality curve for overweights, and, if it does, whether this is a coincidence or a basic truth. But Seltzer seems to be of the mistaken opinion that life insurance companies assume a straight-line relation of increasing mortality ratio with increasing weight at each height level. That no such linear relationship exists or is assumed for rating purposes can readily be observed by charting the figures in the *1959 Build and Blood Pressure Study*, or by differencing the rating debits for overweight in individual companies' underwriting manuals, or most clearly by studying the excellent Tables 4–8 in Mr. Edward A. Lew's paper "Some Implications of the Build and Blood Pressure Study, 1959," published in the *1960 Proceedings* of the Home Office Life Underwriters Association.

HARRY A. WOODMAN, JR.:

In view of the fact that so few data have been published regarding mortality data on medically substandard lives at the longer durations, we thought it would be appropriate to include some statistics on this subject as an addendum to the informative experience on build presented by Messrs. Blair and Haines.

The accompanying tabulation covers the mortality experience of New

NEW YORK LIFE SUBSTANDARD ISSUES OF 1925–34
EXPOSED BETWEEN 1946 AND 1954 ANNIVERSARIES

Medical Impairment	Ratio of Actual to Expected Deaths* for Policy Years:										Average Rating
	13–15		16–19		20–24		25–29		13–29		
Syphilis	170.8%	(5)†	143.8%	(22)	115.0%	(37)	101.2%	(16)	120.8%	(80)	145.5
Rheumatism	206.3	(9)	175.0	(30)	138.8	(36)	134.5	(13)	154.1	(88)	148.3
Heart murmurs	165.8	(33)	191.2	(171)	183.4	(301)	145.3	(98)	176.9	(603)	173.6
Rapid pulse	183.2	(6)	218.4	(29)	151.8	(32)	148.6	(12)	172.9	(79)	167.0
Irregular pulse	66.2	(3)	210.4	(35)	145.6	(44)	121.9	(16)	151.9	(98)	151.3
Elevated blood pressure	216.3	(152)	213.1	(419)	199.9	(408)	193.6	(91)	206.6	(1070)	160.0
Pulmonary tuberculosis	35.7	(2)	120.8	(35)	101.9	(57)	135.1	(31)	110.2	(125)	162.7
Asthma	249.5	(4)	167.3	(10)	194.9	(19)	224.6	(8)	196.3	(41)	147.3
Bronchitis	465.9	(10)	238.6	(15)	249.2	(24)	97.1	(3)	245.8	(52)	154.3
Gall bladder disorders	155.7	(6)	157.1	(26)	169.6	(41)	113.8	(7)	157.7	(80)	150.4
Albuminuria	280.6	(23)	247.7	(93)	223.6	(144)	203.7	(47)	230.4	(307)	158.3
Kidney disorders	142.9	(7)	158.8	(29)	151.9	(42)	103.0	(10)	145.4	(88)	155.9
Female disorders	143.7	(6)	87.5	(13)	100.5	(21)	58.0	(4)	94.0	(44)	144.7
Family history of tuberculosis	162.9	(22)	120.8	(68)	109.5	(100)	115.1	(42)	117.4	(232)	149.6
Nonconformity	273.9	(15)	252.7	(48)	216.5	(59)	170.0	(16)	225.7	(138)	159.5
Eye disorders	232.1	(10)	176.0	(29)	144.2	(32)	146.9	(9)	162.9	(80)	137.8
Ear disorders	76.9	(4)	153.2	(27)	124.9	(31)	97.4	(7)	125.8	(69)	137.2
Deformity	295.5	(6)	270.4	(20)	254.1	(29)	227.5	(9)	258.1	(64)	144.6
Spinal curvature	353.3	(3)	193.7	(7)	140.9	(10)	282.0	(8)	194.5	(28)	147.2

* Expected deaths based on Basic Table, 1935–54, policy years 16–19 (*1959 Build and Blood Pressure Study*, I, 7).

† Figures in parentheses indicate the number of deaths.

York Life medically substandard issues of 1925–34, exposed between 1946 and 1954 anniversaries. The study included single major medical impairments only and was limited to impairments symptomatic of a chronic

or degenerative condition; medical histories of acute disorders were not studied.

Because the data were not subdivided according to the size of the rating, the average rating was calculated so as to provide a basis for comparing the mortality experience. The basis selected for expected deaths was the mortality rates for durations 16–19 used in the 1935–54 Basic Table developed for the *1959 Build and Blood Pressure Study*. The period of exposure for durations 16–19 in the 1959 study was 1950–54. This duration group and exposure period are comparable to those in the study presented herein.

For many of the impairment groups studied, the mortality ratios are quite close to the average ratings. Those that produced mortality ratios significantly higher than the average ratings are elevated blood pressure, asthma, bronchitis, albuminuria, nonconformity, deformity, and spinal curvature. Those that produced mortality ratios significantly lower than the average ratings are syphilis, pulmonary tuberculosis, family history of tuberculosis, and female disorders. The results for most impairments show a decrease by duration.

These results tend to confirm previous findings in studies of mortality at the early durations.

(AUTHORS' REVIEW OF DISCUSSION)

B. FRANKLIN BLAIR AND LAWRENCE W. HAINES:

The two discussions presented have not been directed to the content of our paper but rather have presented additional information suggested by its subject. It is valuable to have this information published in the *Transactions*.

Mr. Moorhead has called attention to a criticism of the techniques used by actuaries in studying mortality by build. All actuaries would probably agree that theoretically "greater attention [should] be paid to variations in body-build structure." However, the practicalities of the situation seem to overbalance the theoretical desiderata. In the absence of data on body-build structure for insured lives, it is surely better to study the variations in mortality by height and weight alone than not to study mortality variations by build at all.

Mr. Moorhead refers to the "ponderal index" used by Seltzer. This index has been traced back as far as 1898 to an Italian anthropologist, Ridolfo Livi. He seems to have used this index in the form:

$$\text{Ponderal index} = \frac{100\sqrt[3]{\text{Body weight}}}{\text{Stature}}.$$

This form has body weight in the numerator and thus gives larger indices as weight increases. Therefore, this form seems preferable to that used by Seltzer, where body weight is in the denominator with the anomalous result that for a given height the index decreases as weight increases.

The data presented by Mr. Woodman are helpful in extending our limited knowledge of mortality on impaired risks at the higher durations. This represents a continuation of the sharing of information on special underwriting risks, which over the years has been characteristic of New York Life.