RISK OF MORTALITY AMONG PERSONS WITH CHRONIC DISEASE

by ROLLO H. BRITTEN[1]

I

WITH continuously decreasing mortality for infants, children, and young adults, the more complex and difficult problem of the chronic diseases forces itself on our attention. Even in the prime of life, illness and mortality from these conditions have become of first importance. Two-thirds of all deaths among persons between 20 and 65 years of age are today due to such diseases, which are thus not simply the result of the wearing out of the body after a complete life has been lived. We must also keep in mind the vast economic effects on the family of long-continued illness, especially where the disabled person is a wage-earner.

The problem of combatting chronic diseases is very different from the customary public health procedures against acute communicable diseases. Mass methods are not equally effective, and for this reason the knowledge necessary is broader in scope and has not been developed to the same degree. Research must be stimulated in a large number of fields. Furthermore, there must be a piecing together of such information as is now available from many sources, and this body of facts must be brought within reach of public health, medical, and sociological experts. Let this be the justification for presenting a further[2] summary of a type of information which has a direct bearing on the problem of chronic disease—namely, the record of subsequent mortality among persons found

[1] Senior Statistician, Division of Public Health Methods, National Institute of Health, United States Public Health Service. Acknowledgment is made to Arthur Hunter, chairman, Joint Committee on Mortality, Association of Life Insurance Medical Directors and the Actuarial Society of America, and to Walter G. Bowerman, in charge of the Central Bureau of the Joint Committee, for their kind review of this paper.

[2] Britten, Rollo H.: The Physical Impairments of Adult Life: Association with Subsequent Rates of Mortality. *The Journal of Preventive Medicine,* July, 1932, 6, No. 4, pp. 249-272.

to have or giving a history of certain physical impairments on application for life insurance. Such information will give some conception of the specific diseases or impairments associated with high rates of mortality later on in life, and direct attention to methods of identifying the signs of these diseases in the individual at the earliest possible moment.

The studies which have made practicable this analysis are those conducted by the Joint Committee on Mortality of the Actuarial Society of America and the Association of Life Insurance Medical Directors. The purpose of these studies has been that of facilitating the revision by insurance companies of premium rates for persons substandard on account of medical defect. But what is of interest to public health workers is the basic information thus obtained on the subsequent rates of mortality among persons with certain specific impairments, the duration of any excess mortality found, and the causes of death.

The first major study of this kind was that known as the Medico-Actuarial Mortality Investigation of 1912.[3] The results had a profound effect on insurance practice and also extended our knowledge of the relation between disease and the chance of death. After the adoption of a standard medical impairment code in 1925,[4] a study was made of the risk of mortality in various occupations.[5] Next a continuation of the type of research of 1912-1914 was undertaken.[6] [7] This last year a further publication[8] dealt with certain

3 The Medico-Actuarial Mortality Investigation, prepared by the Joint Committee on Mortality of the Actuarial Society of America and the Association of Life Insurance Medical Directors. 5 Vols. 1912-1914.

4 Medical Impairment Code and Description of Mortality Cards, by the Joint Committee on Mortality of the Association of Life Insurance Medical Directors and the Actuarial Society of America. 1925.

5 Joint Occupation Study: 1928, compiled and published by the Actuarial Society of America and the Association of Life Insurance Medical Directors.

6 Medical Impairment Study, compiled and published by the Actuarial Society of America and the Association of Life Insurance Medical Directors. 1929.

7 Supplement to Medical Impairment Study, compiled and published by the Actuarial Society of America and the Association of Life Insurance Medical Directors. 1929.

8 Impairment Study, 1936, compiled and published by the Actuarial Society of America and the Association of Life Insurance Medical Directors.

diagnosis groups insufficiently represented in the prior studies. Special papers have also been published by those connected with the investigation.[9]

II

The reader's familiarity with the type of examination given to applicants for life insurance is assumed. Those accepted were placed in certain impairment groups depending on the findings in these examinations. Summary sheets for these specific impairment groups, with the subsequent mortality, were furnished by most of the large insurance companies in America for the 1929 study (about four-fifths of the total insurance in force in the United States and Canada and about two million policies).

Because the succeeding analysis depends on the ratio of actual to expected deaths, a little consideration of the summary sheet is necessary.[10] The basic mortality rates are graded and are specific for age and the number of years the policy has been in force. The basic table covered policies issued during the period 1909-1927. By multiplying

[9] For example: Hunter, Arthur: Heart Murmurs, An Historical Review. A New Mortality Experience. Modern Ratings. *Transactions of the Actuarial Society of America,* October, 1936, xxxvii, Part 2, No. 96.

[10] The form of the summary sheet is as follows, one age group being shown as an example:

Policy Year	Ages 20 to 24					
	Existing	Lapsed	Dead	Exposed	Basic Rate[a]	Expected Deaths
1					2.11	
2					2.82	
3					2.99	
4					3.09	
5					3.17	
—					—	
—					—	
—					—	
19					4.45	
Total						

[a] Per 1,000.

A summary sheet consists of corresponding units for each five-year age group. One sheet is used, by each insurance company, for each impairment or special subdivision included in the study. At the bottom are given the number of deaths for major causes in two age groups, 15-39 and 40 and over.

the number "exposed" by the basic rates (divided by one thousand), there is obtained the number of "expected deaths" for a given policy year and age group. These "expected deaths" are then added together to give the total for all age groups, regardless of the time the policy had been in force. The total number of deaths which actually occurred in the given impairment group is then divided by the "expected" number as thus calculated. We then have a *ratio,* actual to expected. An understanding of this procedure is important, since otherwise a person might not realize that this ratio is really one between two *death rates,* corrected for age differences and also for differences in the time the policies had been in force. The average age of persons in different impairment groups varies a good deal, and the results would be quite ambiguous if this difference had not been allowed for. Most important also is it to realize that there is nothing abstruse in this "expected death" idea. It does not need to be taken as a concept that non-actuaries cannot understand. Of course, back of the "expected deaths" do lie all the grading or interpolation procedures of actuaries, but these need not concern us, as they involve simply the smoothing of the basic mortality rates.

Some mention should be made of what the actuary calls "substandard" data. If a person is compelled to take out life insurance at a higher than normal premium because of physical findings or occupation, he is regarded as a "substandard" risk. The medical impairment study has separated these two groups for most of the comparisons, but interpretation of differences in the after-mortality for the standard and substandard groups is difficult without a detailed knowledge of insurance practice for specific impairments. For the present purpose the combination of standard and substandard, where given, is most desirable. In some cases the study involves substandard groups only and must then be shown as such.

The impairment classes deal with cases which have no impairment of importance other than the one referred to. By "impairment of importance" is meant one which of itself would have placed the

person in a substandard group. The impairment class may be a combination of more than one impairment, but in that case the combination will be specified. These facts add significance to the results.

As stated, the 1929 study covered policies issued between 1909 and 1927. The mortality of persons whose policies were issued in the first year could be followed for nineteen years; on the other hand, those whose policies were issued at a later date could be followed for shorter periods only. Where the impairment group constituted a history, the period between the first existence of the disease and that covered by the ratios would be relatively longer. However, the procedure does not enable us to follow a person through to the late effects of disease.

Table 1. Ratio of actual to expected mortality among persons with certain impairments on examination for life insurance (present or history).

Impairment Group	Ratio	Actual Deaths
Organic Heart Murmurs	2.50*	3,583
Cancer, With Operation (History)	2.35	35
Epilepsy (History or Found on Examination)	2.02	51
High Blood Pressure, 5 mm. or More Above Average	1.87*	1,503
Lungs Unsatisfactory (Dullness, Prolonged Expiration, Suspicious Apices)	1.81*	64
Hypertrophy of Heart, Without Murmur	1.64	99
Appearance Fragile, Not Robust	1.61	255
Abdominal Circumference Markedly Greater than Expanded Chest (Special Weight Group)	1.52	203
Gastric or Duodenal Ulcer (History)	1.48	334
Syphilis (History)	1.47	496
Asthma, not Hay Fever (History)	1.43	450
Functional Heart Murmurs	1.41*	502
Albumin in Urine	1.40	—
Persistent Rapid Pulse	1.39	409
Glycosuria, No Diet	1.37	118
Pleurisy (History)	1.36	1,073
Anemia (Hemoglobin 60 to 80 per cent)	1.30	26
Bronchitis, Chronic (History or Examination)	1.29	116
Spinal Curvature	1.27	196
Tuberculosis of Bones or Joints (History, Excludes Attacks Within 2 Years of Application)	1.25	200
Rheumatism, Acute Articular (History)	1.18	1,397

*Limited to substandard policies.

III

Table 1 gives the ratio of actual to expected deaths in those impairment groups which, taken as units, showed definite excess rates of mortality. The actual number of deaths is included as an indication of the significance of the figures. Since the death rate for the group under observation was about 5 per 1,000[11] an estimate of the population in the various impairment groups is possible. The Joint Committee reports also give the probable errors of these ratios.

Table 2. Ratio of actual to expected mortality among persons with certain impairments on examination for life insurance (present or history). Ratios of 2.50 or higher for specific subgroups.

Impairment Group	Ratio	Actual Deaths
Apex Murmur, Presystolic or Diastolic, Constant and Other Mitral Regurgitation, With Slight Hypertrophy	8.03*	20
Without Slight Hypertrophy	5.53*	61
Basic Murmur, Aortic Area, Diastolic, Constant, Transmitted Downward, With Other Aortic Regurgitation, With Slight or Moderate Hypertrophy	4.78*	78
Without Slight or Moderate Hypertrophy	4.55*	51
High Blood Pressure, 45 mm. and More Above Average	3.84*	34
Cancer, With Operation, Attack Within 3 to 5 Years of Application	3.73*	Few
Apex Murmur, Systolic, Constant, Transmitted to Left, With History of Rheumatism	3.58*	—
Albumin in Urine, Intermittent, Large Amount	3.33	17
Basic Murmur, Aortic Area, Systolic, Constant, Transmittted Upward	3.09*	212
Tuberculosis of Bones or Joints, Attacks 3 to 10 Years Before Application	3.02	80
Albumin in Urine, Constant, Large Amount	2.98*	70
Albumin in Urine, 30 per cent or More over Average Weight for Height and Age	2.91	124
Apex Murmur, Systolic, Constant, Transmitted to Left, With History of Infectious Disease Other than Rheumatism	2.90*	609
High Blood Pressure, 35.44 mms. Above Average	2.65*	138
Pulmonary Tuberculosis, With Physical Signs on Examination, and With History of Attack 3 to 5 Years Before Application	2.53	—
Apex Murmur, Systolic, Constant, Transmitted to Left, Without History of Infectious Disease	2.51*	2,430

*Limited to substandard policies.

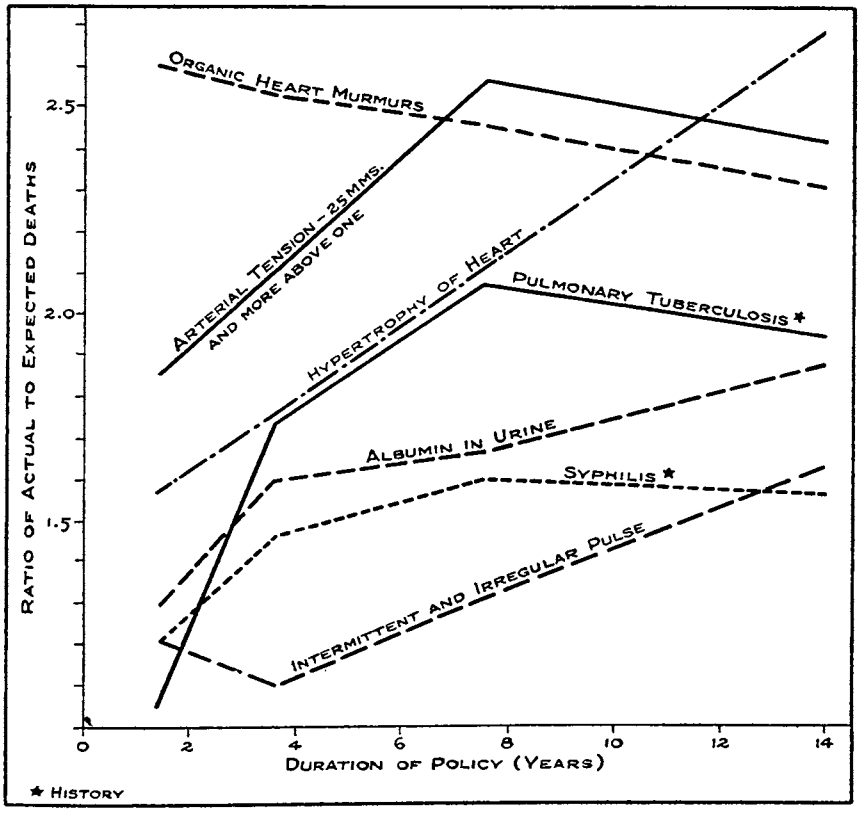
[11] The death rate is low primarily because the group was under observation for a maximum of nineteen years from the date of examination.

Items with an asterisk are those where the data were limited to substandard risks.

If, now, the impairment groups are broken into their component parts, a far greater excess can be found in special instances. This is done in Table 2, which is limited to groups with mortality two and one-half times the normal—in other words, really stopping at the point where Table 1 begins.

The ratios for many conditions in these two tables are of great interest—especially for organic heart murmurs, high blood pressure, syphilis, albumin in urine, tuberculosis—but it should be emphasized that the tables give only a glimpse into the subject. The

Fig. 1. Ratio of actual to expected mortality after a specified number of policy years, for certain impairment groups.



Impairment Groups	Ratio				Number of Deaths			
	1–2 Years	3–5 Years	6–10 Years	11–19 Years	1–2 Years	3–5 Years	6–10 Years	11–19 Years
Arterial Tension (Examition) 25 mm. and More Above Average	1.85	2.11	2.57	2.40	216	263	224	47
Organic Heart Murmurs (Examination)	2.61	2.53	2.45	2.29	996	1,215	1,038	334
Hypertrophy of Heart (Examination)	1.57	2.09	1.79	2.68	23	34	20	8
Pulmonary Tuberculosis (History)	1.03	1.74	2.07	1.93	55	93	69	21
Arterial Tension (Examination) 5-24 mm. Above Average	1.40	1.68	1.96	1.71	211	293	228	47
Albumin in Urine (Examination)	1.28	1.60	1.66	1.87	303	452	369	141
Syphilis (History of an Attack)	1.21	1.47	1.60	1.55	86	150	162	98
High Abdominal—Chest Ratio	1.60	1.63	1.98	1.45	68	92	133	58
Intermittent and Irregular Pulse (Examination)	1.22	1.10	1.31	1.62	72	80	74	42

Table 3. Ratio of actual to expected mortality after a specified number of policy years, for certain impairment groups.

medical impairment study presents the ratios for a couple of hundred impairment groups or subdivisions. Certainly these figures give to the findings of medical examinations a very specific reality, and set up one possibility of approach to the problem of chronic disease.

Table 4. Ratio of actual to expected mortality among persons found to have abnormal arterial tension without other serious impairment in relation to the duration of the policies. Substandard.

Policy Years	Ratio			Deaths		
	5–15[1] Mms.	16–24[1] Mms.	25+[1] Mms.	5–15[1] Mms.	16–24[1] Mms.	25+[1] Mms.
1– 2	1.37	1.43	1.85	105	106	216
3– 5	1.62	1.96	2.11	153	140	263
6–10	1.59	2.44	2.57	104	124	224
11–19	1.69	1.73	2.40	9	12	47

[1]Excess of systolic blood pressure reading over the average.

How long does this excess persist? As stated, there is a maximum of nineteen years set in this study from the date of issuance of the policy. It is clear from Figure 1 and Table 3 that the excess for many important conditions is still present at the end of this period. Again, the comparison is to be taken as a sample. The original study gives the ratios in the four periods for about two hundred impairment groups or subdivisions. Table 4 indicates the excess mortality for persons found to have different degrees of high blood pressure (without definite heart disease) on application for insurance.

A point of some interest is the nature of the excess mortality

Table 5. Ratio of actual to expected mortality from pulmonary tuberculosis among persons having or giving a history of certain impairments on application for life insurance. Limited to groups showing a ratio of two or more. Substandard policies.

	Ratio
Pleurisy (History of One Attack Within 10 Years)	
With Effusion	13.7
No Details	9.5
Purulent	3.8
Dry (Standard Policies)	3.1
Pulmonary Tuberculosis (History of One Attack 2 Years or More Prior to Application)	
10 Per Cent Underweight	10.7
All Weights	7.0
Lungs Unsatisfactory (Dullness, Prolonged Expiration, Suspicious Apices) on Examination	7.9
Persistent Rapid Pulse (90-100) on Examination	5.7
Appearance Fragile, Not Robust, 10 Per Cent or More Underweight	5.4
Asthma (Not Hay Fever), Moderate or Severe on Examination or History, or Attack Within 5 Years	3.7
Tuberculosis of Bone or Joint, One Attack More Than 2 Years Before Application	3.4
Hysteria, Nervousness, Neurasthenia, Nervous Prostration (Examination or History)	3.0
Gastric Ulcer, Operation, One Attack 3-10 Years of Application, or 2 or More, Last 10 Years Before	2.5
Bronchitis, Chronic (Examination or History)	2.4
Syphilis, Cured, Thorough Treatment (History of One Attack)	2.1
Albumin in Urine, Constant Trace	2.0

associated with specific impairments. It is not surprising that very high ratios should be secured for certain causes of death in some impairment groups; that, for instance, the groups with apex murmur, presystolic or diastolic, constant, and other mitral regurgitation, should show a mortality from organic heart disease 31 times the normal. These ratios will not be reviewed here, as the subject is a little outside the scope of this discussion; but it is of interest to show that frequently there is excess mortality from causes which are not identical with the impairments themselves. For instance, the group having pleurisy with effusion, one attack within five years, shows 14 times as many deaths from pulmonary tuberculosis as expected. (Table 5.)

IV

It will be advantageous to summarize the data of the Joint Committee on Mortality by making a slightly more detailed comparison for a single disease. Many could be selected, but perhaps none would be more useful than syphilis. However, the same type of specific and valuable information will be found in the reports for many other diseases.

The subdivisions of the data for syphilis (which are limited to cases with a history of one attack) are of three types: (a) standard and substandard; (b) "cured, thorough treatment," and others; (c) how long prior to the application for insurance the attack occurred. ("Cured" implies freedom from any active symptoms of the disease as indicated by two or more negative Wassermann tests.)

The ratio in the standard group was 1.52, and in the substandard, 1.45. Variations in insurance practice are no doubt responsible for a result that seems a little inconsistent.

The distinction between "cured, thorough treatment" and the other cases is affected by factors of selection. The "cured, thorough treatment"[12] group had ratios of 1.63 and 1.50 for standard and sub-

[12] Owing to difficulties of interpretation, the distinction between "cured, thorough treatment" and the other group is not carried in the accompanying tables.

	Ratio	Deaths
One Attack, 3–5 Years of Application	1.47	39
One Attack, 6–10 Years of Application	2.12	124
One Attack, Over 10 Years of Application	1.18	170

Table 6. Ratio of actual to expected mortality among persons giving a history of syphilis, by type of history. Substandard policies.

standard risks, against ratios of 1.42 and 1.41 for the group other than "cured, thorough treatment." In spite of this selective difference, we can feel particularly interested in the after-mortality of the "cured, thorough treatment" group. There was a continuing excess mortality for this group which was still present at the end of the period covered.

Before discussing the tables, let us consider the third basis of classification, namely, the time since the reported attack. The groups used are: one attack, within two years of application for insurance; one attack within three, four, five years of application; one attack within 6-10 years of application; one attack over ten years prior to application. The figures will show that the time between the attack and the application is closely tied up with the rate of mortality.

The data will be available in the Joint Committee's report against the duration of the policy; and also, separately, against the age of the insured. Finally, information will be available as to the causes of death.

Thus, we have for this disease a wealth of material which de-

Table 7. Ratio of actual to expected mortality among persons giving a history of syphilis and whose policies had been in force for 6 to 19 years, by type of history obtained. Substandard policies.

	Ratio	Deaths
One Attack, Any Time Prior	1.59	179
One Attack, Within 6–10 Years of Application	2.33	90
One Attack, Over 10 Years of Application	1.17	76

serves more careful consideration than can be given to it in this discussion. Some few points only will be exemplified.

Table 6 presents the ratio against the interval between the attack and the issuance of the policy. Table 7 gives corresponding information for the 6-19 policy years. Table 8 relates the excess to the years the policies had been in force.

Table 8. Ratio of actual to expected mortality by time policies had been in force, for persons giving a history of one syphilis attack within ten years of application. Substandard.

	Ratio	Deaths
1– 2 Years	1.14	23
3– 5 Years	2.15	51
6–10 Years	2.45	62
11–19 Years	2.11	28

One caution is desirable. Although the groups under consideration do not include any persons who are substandard risks at the time of issuance of insurance because of some other impairment, their history subsequent to the issuance of the policy is not a part of the record, except the one question as to their death. Therefore, some check as to the cause of death is desirable. For the "cured, thorough treatment" group the ratios of actual to expected deaths from a particular cause (adjusted to two age groups) were: cancer, 2.3; pneumonia, 2.1; tuberculosis of the lungs, 2.1; suicide, 1.8; accident, 1.4. For the other syphilis group they were: organic heart disease, 3.0; nephritis and Bright's disease, 2.1; cancer, 1.7; pneumonia, 1.5. A significant difference in type between the two groups might be inferred.

Table 9. Ratio of actual to expected mortality among males classified by their deviation from normal weight at the time of examination. By age. Height 5 feet 3 inches to 6 feet 2 inches.

Variations from Average Weight in Pounds	Age at Issuance of Policy			
	20–29	30–39	40–49	50–59
—25 or More	1.18	1.05	.83	.77
—10 to —20	1.01	.94	.76	.85
—5 to +5	.92	.84	.87	.92
+10 to +20	.99	.88	.94	.90
+25 to +45	1.13	1.23	1.25	1.19
+50 or More	1.63	1.43	1.44	1.30

V

The studies of the Joint Committee make available a great deal of information of a type not included in the above comparisons. For instance, an interesting subject is the relative rates of mortality of persons by type of build. The general outlines of this picture are well known because they were given considerable publicity after the publications of 1912-1914. Overweight is a disadvantage at all ages; underweight is a disadvantage among young persons, but an advantage in mature and later life. This is brought out briefly in

Fig. 2. Ratio of actual to expected mortality among males classified by their deviation from normal weight at the time of examination. By age. Height 5 feet, 3 inches to 6 feet, 2 inches.

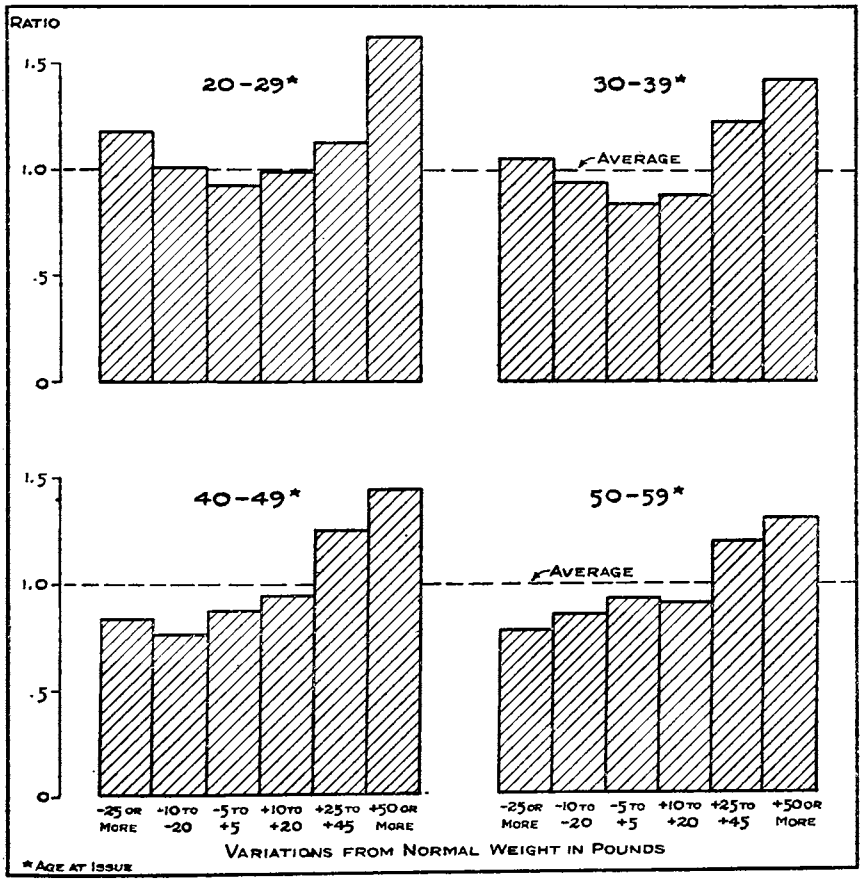


Table 9 and Figure 2. Again it should be stressed that these comparisons are for persons who did not have important recorded defects. The nature of the excess mortality in the overweight group is shown in Table 10—it is clearly the so-called degenerative diseases that are largely responsible—organic disease of the heart (exclusive of deaths classified as endocarditis, myocarditis, and pericarditis), cerebral hemorrhage and apoplexy, and nephritis and Bright's disease.

As an example of other data of great interest, there is included Table 11, giving the excess mortality depending on the number of cases of tuberculosis in the family. There is a clear relation between the number of cases and the mortality rate in the 15-29 and 30-44 age groups.

Some material is available as to the excess mortality for some conditions figured from the date of attack or operation rather than

Table 10. Mortality rates (per 100,000) by cause among males, age 30+ at entrance who were markedly underweight and markedly overweight. Height 5 feet 3 inches to 6 feet 2 inches. Standard risks.

	Tuberculosis of Lungs	Other Tuberculosis	Diabetes	Cerebral Hemorrhage and Apoplexy	Organic Disease of Heart[1]	Appendicitis and Typhlitis	Nephritis and Bright's Disease	Cirrhosis of Liver
30–44 Years at Entrance								
Underweight, 25 Pounds or More	94	9	3	8	26	12	25	2
Standard	59	3	8	27	39	18	33	4
Overweight, 50 Pounds or More	4	1	19	34	71	29	63	16
45 Years+at Entrance								
Underweight, 25 Pounds or More	67	21	18	67	161	14	109	7
Standard	30	4	25	118	213	25	123	23
Overweight, 50 Pounds or More	10	–	35	156	253	43	171	31

[1]Exclusive of deaths classified as endocarditis, myocarditis, pericarditis.

from the date of issuance of the policy. Such data are shown in Table 12 for gastric and duodenal ulcers and for gallbladder disease.

	All Ages	15–29	30–44	45+
	RATIO			
One Case	.95	1.34	.91	.85
Two Cases	.98	1.71	.98	.83
Three or More	1.10	2.66	1.21	.81
	DEATHS			
One Case	8,360	1,816	3,261	3,283
Two Cases	1,856	328	726	802
Three or More	656	112	278	266

Table 11. Ratio of actual to expected mortality among persons with varying numbers of cases of tuberculosis in the family, according to the age at issuance of policy.

VI

By way of conclusion, it is manifest that many conditions, ascertainable by a type of relatively inexact physical examination and history, offer a definite risk of excess mortality in later years. This risk is present even for persons who were in good enough health at the time of examination to be accepted for life insurance. The conditions to which this excess after-mortality is attached are largely the chronic diseases or diseases with a chronic aftermath.

For example, the actual mortality among those who were found to have organic heart murmurs but no other important impairment were from two and a half to eight times the expected mortality among persons at similar ages; persons having blood pressure read-

Table 12. Ratio of actual to expected mortality among persons by duration from attack or operation.

	Duration from Attack or Operation			
	2–5	6–10	11–15	16–21
Gastric or Duodenal Ulcer				
Operated	1.66	1.32	1.43	1.39
Not Operated	1.24	1.06	.77	
Gallbladder				
Removed	1.16	1.12	.91	.87
Drainage (Not Removed)	1.42	1.25	1.21	

ings of 35 millimeters and more above standard and those having a large amount of albumin in the urine, either constant or intermittent (again with no other important defect recorded) had a death rate from two and a half to almost four times the normal. Those who gave a history of having had diseases such as cancer (with operation), syphilis, pleurisy, and tuberculosis, suffered an excess of deaths ranging from one and a half to four times the expected number. The excess mortality among persons with these diseases or conditions tended to continue throughout the nineteen-year period for which records were available.

A point of some interest is the nature of the excess mortality among persons applying for life insurance who gave a history of having had an attack of syphilis. Those who were not classed as cured (thorough treatment) suffered a marked excess of mortality, chiefly from such chronic conditions as organic heart disease, nephritis, and cancer. On the other hand, the excess deaths among those with a history of syphilis but considered as cured when the medical examination was made were largely due to cancer, pneumonia, tuberculosis of the lungs, suicide, and accident.

The chronic diseases cast their shadow before them. In the baffling problem of these diseases, therefore, one possible direction of attack is suggested, but it must not be overlooked that it is one thing to find a condition and another thing to cure that condition or to eliminate the risk of later effects. The public health administrator must determine what can be done in the light of these facts. There appear to be two problems: first, how to identify these signs of chronic disease at the earliest possible moment, and second, to determine how to eliminate the associated risk of mortality. For these problems there are obviously no simple solutions.