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Some Statistical Problems Suggested by the Sickness and Mortality Data of Certain of the Large Friendly Societies

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APRIL, 1913.

Some STATISTICAL PROBLEMS SUGGESTED by the SICKNESS and MORTALITY DATA of CERTAIN of the LARGE FRIENDLY SOCIETIES.

By E. C. SNOW, M.A., D.Sc.

[Read before the Royal Statistical Society, March 18, 1913,
the President, Professor F. Y. EDGEWORTH, M.A., F.B.A., in the Chair.]

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1. THE primary motive of this paper is to indicate one or two problems of statistical interest which are, in the opinion of the writer, amenable to treatment by certain of the methods employed

by the mathematical statistician. These problems do not lend themselves very readily to reading before this Society, but many of the facts connected with them, and which provide the data for them, are of particular interest at the present time, and some account of these facts has consequently been put into the paper, and in the actual reading will receive more emphasis than the problems themselves.

Only a few of the large societies will be referred to, and these include examples from two of the *chief* types of Friendly Societies—the Affiliated Orders, and the Centralised Societies. Of the former, the data of the Manchester Unity of Oddfellows, the “Foresters,” the “Rechabites,” and the “Shepherds”—each of which issue statistical accounts relating to quinquennial periods at various intervals—have been called upon. The bulk of the information stated in those accounts is financial, but the amount of space given over to the sickness and mortality of the members is increasing. The Centralised Societies to which reference will be made are the “Hearts of Oak” and the “Rational Association.” The former publishes a statistical volume every year, while the latter issues a comprehensive report every five years. No description of the various reports need be given here, but it may be pointed out that the Centralised Societies give data for individual age-groups with little regard to geographical situation, while the Affiliated Orders give much information according to locality, but with no reference to individual age-groups.¹

2. The variations in the membership of the societies touched upon in this paper during the past twenty-five years are given in Table I:—

TABLE I.—*Adult male membership of chief Friendly Societies.*

	1885.	1890.	1895.	1900.	1905.	1910.
Manchester Unity	542,313	594,868	665,233	736,181	754,239	749,363
Foresters.....	582,104	639,728	654,628	663,232	651,681	605,971
Hearts of Oak	108,688	140,722	205,748	248,025	284,063	303,483
Rechabites	59,863	95,074	103,045	137,316	175,639	213,352
National Association....	54,927	72,593	77,406	89,741	98,912	95,650
Shepherds	66,941	95,947	109,782	121,064	125,026	119,693

Up to 1900, all these societies showed continuous increases in the membership. A change set in with the present century, and between 1905 and 1910 four of the six actually showed a net

¹ An account of the operations of the various societies is given in a paper by Mr. A. W. Watson, “Some Points of Interest in the operations of Friendly Societies, Railway Benefit Societies, and Collecting Societies.” *J.I.A.*, vol. xlv, p. 168 (April, 1910).

loss of members. The most satisfactory state of growth occurred in the Hearts of Oak and the Rechabites. Of the big Orders, the decline set in first in the case of the Foresters, the membership in 1910 being considerably below that of 1890. The total membership of the six societies was 1,995,600 in 1900, 2,089,600 in 1905, and 2,087,500 in 1910.

The variation in the membership of a society, however, must be considered in conjunction with the possible alteration in its age distribution. Without any information of the age distribution at all, it would probably be inferred from general considerations that some at least of the apparently satisfactory increase of membership up to 1900 was due not so much to new entrants as to the diminishing mortality of the older members. The change which has occurred in this respect can be brought out by showing for some of the societies the actual age distributions at various dates. This can be done for the Hearts of Oak, the Manchester Unity, and the Shepherds, and in Table II. the percentages of the membership in the various age-groups at different dates are shown.

TABLE II.—*Proportionate age-distribution of members.*

		-20.	20-24.	25-29.	30-34.	35-39.	40-44.	45-49.
Hearts of Oak.....	1892	0.48	11.58	21.20	20.91	14.79	12.97	9.27
	1900	0.25	8.89	19.15	22.69	16.57	9.66	8.48
	'10	0.08	5.41	13.22	18.43	16.58	14.97	11.10
Manchester Unity	1892	3.43	14.86	16.20	14.61	12.13	10.29	8.56
	'97	3.45	15.11	15.88	14.27	12.22	9.97	8.26
Shepherds—								
England and	1900	6.19	14.31	15.36	14.28	12.46	10.36	8.43
	Wales	'05	5.22	12.44	14.17	13.75	12.64	10.74
Scotland	1900	7.44	19.85	20.93	16.95	12.87	9.53	6.41
	'05	6.57	16.83	19.56	17.28	13.63	9.83	7.02
		50-54.	55-59.	60-64.	65-69.	70-74.	75-79.	80-.
Hearts of Oak.....	1892	5.40	1.82	0.88	0.47	0.17	0.05	0.01
	1900	6.63	4.64	1.95	0.65	0.31	0.10	0.03
	'10	6.58	5.65	4.16	2.55	0.93	0.24	0.10
Manchester Unity	1892	7.00	5.18	3.34	2.00	1.36	0.70	0.34
	'97	6.76	5.47	3.90	2.34	1.27	0.72	0.38
Shepherds—								
England and	1900	6.47	5.04	3.56	2.05	1.05	0.33	0.11
	Wales	'05	7.53	5.56	4.14	2.69	1.35	0.56
Scotland	1900	3.86	1.50	0.54	0.12	—	—	—
	'05	4.88	2.89	1.10	0.34	0.07	—	—

An interesting feature of the table is that the figures for Scotland in the case of the Shepherds indicate a much younger Friendly Society population there. The result of grouping the percentages in the above table into three main age-groups is given in Table III.

TABLE III.

Age-group.	Hearts of Oak.			Manchester Unity.		Shepherds.			
						England and Wales.		Scotland.	
	1892.	1900.	1910.	1892.	1897.	1900.	1905.	1900.	1905.
—40....	68·96	67·55	53·72	61·23	60·93	62·60	58·22	78·04	73·87
40—60....	29·46	29·41	38·30	31·03	30·46	30·30	32·89	21·30	24·62
60—	1·58	3·04	7·98	7·74	8·61	7·10	8·89	0·66	1·51

The figures for the Hearts of Oak are particularly instructive. Up to the beginning of the present century the movement towards a higher age distribution had not been great, but it has since proceeded at a rapid pace. The average ages of the members at the three dates mentioned were 35·18, 36·65, and 40·16 respectively. The age distribution of the Hearts of Oak for 1892 and 1910 are of sufficient interest to be graphically represented, and generalised frequency distributions have been determined to fit them.

FIG. 1.—*Age-distribution of membership of Hearts of Oak, 1892 and 1910.*²

² These are both of Pearson's Type I, or limited range in both directions, and the chief statistical constants for them are given at the end of the paper. The curves are given only for the purpose of a general graphical illustration of the change which has occurred. They do not fit the data well at early ages on account of the very quick rise, and it must be emphasised that graduation of the statistics is no part of the object in drawing the curves.

As the Manchester Unity has been used as the standard for the purposes of the National Insurance scheme, it will be useful to compare the age distribution of that Order with that of the general population. This is done in Table IV for the three main age-groups previously used.

TABLE IV.—*Comparison of age-distribution of the Manchester Unity with that of the general male population (England and Wales).*

	Manchester Unity.			
	16—40.	40—60.	60—.	Total members.
1892.....	61·2	31·0	7·8	596,729
1897.....	61·0	30·4	8·6	673,394

	General population.			
	Over 16.			Total population.
	16—40.	40—60.	60—.	
1891.....	62·3	26·9	10·8	8,866,000
1901.....	62·8	27·2	10·0	10,412,000

	16—70.			Total population.
	16—40.	40—60.	60—70.	
	16—40.	40—60.	60—70.	
1891.....	64·8	28·0	7·2	85,24,000
1901.....	65·1	28·2	6·7	10,034,000

In spite of the fact that in the Manchester Unity the proportion of members between 16 and 20 was much less than the corresponding proportion in the general male population, the total proportion in the group 16—40 differed but little from that for the whole population. The general resemblance of the figures for the sample and those of the main population is rather surprising, but it would be unwise to assume that such a close relationship held between them for the Census of 1911. The age distribution of the population as disclosed by that Census has not yet been published, but the falling death and birth rates must have considerably affected it since 1901, though the alteration may not be brought out by the age-groupings here used.

The Hearts of Oak reports permit the question of the change in age distribution to be dealt with in each of the three geographical divisions—Metropolitan district, Large towns and Country districts—

in conjunction with the proportion of entrants to total members. Without giving the actual figures it may be stated that both the fall in the proportion of entrants and the increase in the average age have been appreciably less in the Country districts than in either of the other divisions, particularly in the Metropolitan district. An interesting commentary upon these facts is to be found in the population volumes relating to the recent census, in which it is pointed out that emigration has practically ceased in rural districts (0.9 per cent. between 1901 and 1911), and is now taking place to a much greater extent in small towns and to a lesser extent (but still greater than in rural parts) in large towns.

3. Space will permit of a very short account of the mortality data provided by the Friendly Societies, and only a brief description of some of those data under the headings (i) variation of mortality according to age, (ii) according to geographical position and (iii) secular variation in mortality will be given. The question of occupational mortality is entirely omitted, as the valuations referred to give little information on that important subject, which, moreover, has been treated of in various volumes by the Registrar-General.

A difficulty arises in the attempt to unravel the part played by age on mortality, since any data we have necessarily show the effects on mortality due to a complex combination of causes—geographical position, occupation, constitutional fitness, in addition to age. All we can do is to show that for a population with certain geographical position, and with certain proportions of its members in such and such occupations, &c., the variations of mortality with age are as stated. But the comparison of the mortality of this population with that of another is vitiated unless we know how these populations stand with regard to the other factors affecting mortality. We cannot, for example, in comparing the experience of the Manchester Unity for 1866-70 with that of 1893-97 given below, say that the improvement at most ages has been due to the advance in sanitation and medical knowledge unless we know that no great alteration has occurred in the proportions of members in various occupations and in geographical divisions. We tacitly assume when dealing with a population as large as that of one of the chief Friendly Societies that it is a random sample of the general male population above a certain age in respect of occupation and situation. Consequently it is not unusual for one society to use the mortality rates at particular ages of another society as its basis in calculating the deaths to be expected, implying that the occupation and geographical distributions of its members are the same as for the standard society.

Table V³ gives the mortality rates at different ages for the whole of the country for the Manchester Unity (1893-97), the Rational Association (1892-1901), and the Hearts of Oak (1883-96 and 1899-1901), and also for the same society for the ten years 1901-10. All these rates are unadjusted rates, *i.e.*, are unsmoothed by any process of interpolation. On account of the fact that the standard of mortality adopted for the purposes of the National Insurance scheme has been the English Life Table No. VI, the corresponding rates derived from the latter are also stated. The rates in each case are per 100 exposed to risk.

TABLE V.—*Comparison of death-rates in quinquennial age-groups.*

Experience.	20—24.	25—29.	30—34.	35—39.	40—44.	45—49.
Manchester Unity, 1893-97	0·37	0·46	0·55	0·70	0·96	1·18
Hearts of Oak, 1883-96 and 1899-1901	0·31	0·40	0·54	0·71	0·97	1·28
Hearts of Oak, 1901-10	0·25	0·30	0·41	0·52	0·70	0·98
Rational Association, 1892-1901	0·38	0·42	0·48	0·63	0·82	1·11
English Life-Table No. VI, 1891-1901	0·51	0·61	0·76	1·02	1·30	1·66

Experience.	50—54.	55—59.	60—64.	65—69.	70—74.	75—79.
Manchester Unity, 1893-97	1·70	2·84	3·63	5·48	8·20	12·32
Hearts of Oak 1883-96 and 1899-1901	1·63	2·33	3·23	5·38	8·51	12·97
Hearts of Oak, 1901-10	1·39	2·11	3·04	4·63	7·06	10·40
Rational Association, 1892-1901	1·51	2·32	3·40	5·06	7·87	12·69
English Life-Table No. VI, 1891-1901	2·19	2·98	4·15	5·91	8·71	12·85

The chief features of this table are (a) the general rough resemblance of the figures in the first two rows, and to a smaller extent of these with the fourth; (b) the quite considerable fall in each age-group in passing from the earlier to the later experience of the Hearts of Oak and (c) the large excess in the death rates at most ages in the general population over those existing in the Friendly Societies dealt with. These excesses are proportionally much greater up to age 50 than beyond, and the fact that the Friendly Society population is a strictly selected one as regards

³ Though desirable in the interests of scientific accuracy the distribution of mortality according to age cannot be shown for individual localities. It will readily be appreciated that such a table as Table V *might* give quite a misleading idea of the true effect of age on mortality, since the effect of geographical situation on mortality is considerable. But as age distribution changes but little from one geographical division to another in England, the figures given may be taken as giving the true effect of age alone when other causes are allowed for.

mortality is manifest. The figures for the Manchester Unity and the English Life Table are exhibited graphically in Fig. 2.

Fig. 2.

4. In dealing with variation of mortality due to geographical causes, it is still necessary, in order to avoid possible statistical fallacies, to take account of age, and we ought strictly to investigate these variations for populations of the same age. It is probably sufficient, however, to take only three well-defined age-groups, and those already employed will be adopted. To appreciate the significance of the differences between the rates found for the three divisions of the Hearts of Oak, it will be necessary to state the probable errors. These have been found on the assumption that the exposures in each age-group form the general population in

each case, and that we have from each taken three samples, according to geographical situation.⁴

Since the "exposed" column gives the number exposed to risk of death during ten years, and the "deaths" column the total mortality in the same period, the rates are for deaths per annum, and are expressed on 100 exposed to risk per annum. The probable errors are not put in Table VI, but in Table VII is given a list of the differences of the rates for the various divisions in age-groups, and the probable errors of these differences are stated.

TABLE VI.—*Hearts of Oak. Geographical variation in mortality, 1901-10.*

Age.	Whole country.			Metropolitan.		
	Exposed.	Deaths.	Rates.	Exposed.	Deaths.	Rates.
—40	1,767,000	6,855	0·388	564,500	2,225	0·394
40—60	907,400	10,287	1·130	387,900	5,122	1·320
60—	143,600	5,820	4·040	78,700	3,162	4·020
All.....	2,818,000	22,962	0·815	1,031,150	10,509	1·020

Age.	Large towns.			Country districts.		
	Exposed.	Deaths.	Rates.	Exposed.	Deaths.	Rates.
—40	480,200	1,940	0·404	722,300	2,690	0·372
40—60	232,800	2,458	1·060	286,700	2,707	0·940
60—	30,100	1,308	4·340	34,700	1,350	3·890
All.....	743,100	5,706	0·770	1,043,700	6,747	0·6

TABLE VII.—*Differences between rates for various divisions, with their probable errors.*

Age.	Metropolitan and Large towns.	Metropolitan and Country districts.	Large towns and Country districts.
—40.....	— 0·010 ± 0·008	+ 0·022 ± 0·007	+ 0·032 ± 0·009
40—60	+ 0·260 ± 0·018	+ 0·380 ± 0·020	+ 0·120 ± 0·017
60—	— 0·320 ± 0·089	+ 0·130 ± 0·085	+ 0·450 ± 0·104
All.....	+ 0·250 ± 0·009	+ 0·370 ± 0·008	+ 0·120 ± 0·009

⁴ It might, perhaps, be argued that these latter are really (geographical) sub-samples of a sample (selected by age), and that the more complicated formula for the probable error of a sub-sample of a sample should be used. But for the present purpose we are merely inquiring if the differences between the rates of the samples taken from the same age-groups are significant without comparing a sample from one age-group with one from another, and shall consequently employ the formula $\sigma^2 = \frac{pq}{n}$, the values of p and q being calculated from the experience of the whole of the age-group in each case.

In each case the positive sign is prefixed to the difference between the rates when that for the first-mentioned division is the greater. To deal with these tables in some detail. Had we given the difference in the rates and the probable errors only for all ages, we should have concluded that the mortality of the Metropolitan districts was very markedly greater than that of the Large towns. Yet in two of the three age-groups the reverse is the case, and in one of these groups (over 60) this reverse effect appears to be significant. A similar conclusion, though not so emphatically, can be drawn from the figures for the Metropolitan and Country districts. Only in the case of the 40-60 age-group is the excess mortality of the former certainly significant, and the Table appears to show very definitely that for the Hearts of Oak members the mortality for the metropolis is considerably in excess of that of the rest of the country for the age-group 40-60, but is certainly not in excess at the other age-groups. The mortality of the Large towns, however, is greater than that of the Country districts in each age-group. On the whole, the tables suggest that the geographical differentiation of mortality occurs more at the ages 40-60 than at other ages.

5. In the last section the effect of geographical position on mortality was discussed for certain main age-groups. In the present section, the actual frequency distribution of the various degrees of mortality throughout the country, when the effect due to age is allowed for, will be considered. This is rendered possible through the data given in the latest (eighth) valuation of the Manchester Unity. In that is given for practically every lodge in every district of England and Wales the mortality experienced and that expected from a knowledge of the age distribution on the basis of the 1866-70 standard. Thus an index can be formed in which the numerator is 100 times the mortality experienced and the denominator is the mortality expected, and this will indicate the effect of all causes other than age on the mortality. An index of 120 will demonstrate that the total effect of occupation, situation, constitutional fitness, etc., of the members in a particular lodge causes the mortality there to be 20 per cent. in excess of that for the whole of the society in 1866-70, the effect due to age being allowed for.

The lodges varied very considerably in number of members, some being quite small, and it was not advisable to treat of separate lodges. For this reason consecutive lodges within a district (where the lodges are arranged in order of foundation) were grouped together to form units varying in size from about 1,000 to 1,500 members. In this manner 601 units could be made out for England

and Wales, and for each of these units the mortality figures (experienced and expected) were worked up and the corresponding indices determined. The general mortality of the society in the period dealt with by the eighth valuation was much below that of the standard period, so that the total expected mortality was greater than that experienced, and a considerable majority of the indices were less than 100. The complete distribution of these is given in Table VIII. This is a normal or Gaussian distribution and is shown in Fig. 3.

TABLE VIII.—*Frequency distribution of mortality indices due to all causes other than age. (Total 601.)**

Indices.	30—	35—	40—	45—	50—	55—	60—	65—	70—	75—	80—
Frequency	1	1	5	10	25	27	44	64	70	75	71

Indices.	85—	90—	95—	100—	105—	110—	115—	120—	125—	130—	135—
Frequency	55	47	40	25	24	7	6	1	1	1	1

* The mean and standard deviations of this distribution are 79·29 and 16·34 respectively. The generalised frequency-curve has been fitted by Pearson's method, and the statistical constants are given at the end of the Paper. Those constants determining the type of curve to be used, together with their probable errors (found from Rhind's tables), are: $\beta_1 = 0\cdot0401 \pm 0\cdot02$, $\beta_2 = 2\cdot9715 \pm 0\cdot15$. Taking account of the probable errors, it will be seen that the distribution is sensibly normal or Gaussian ($\beta_1 = 0$, $\beta_2 = 3$), the range being (theoretically) unlimited in both directions. A curve of Pearson's Type I would also be a suitable one to adopt, and in this the range is limited at both ends, but with β_1 only twice its probable error, and β_2 only deviating from 3 by one-fifth of its probable error there is every justification for taking the simpler normal curve.

FIG. 3.—*Frequency distribution of mortality indices. Manchester Unity.*

It is known that the distribution of mortality *due to all causes, including age* in a general population is far from normal (see the example given in Mr. Yule's "Introduction to the Theory of Statistics," p. 77), and although the corresponding distribution has not been worked out for the Manchester Unity material there is evidence that the same result will hold.

For reasons which will appear later, it was desirable to take as the standard of expectation of the individual areas the experience of the whole society *at the same time*, so that the total mortality experienced should be the same as the total mortality expected. Thus, an index of 120, under these circumstances, would indicate that the mortality of a particular district was 20 per cent. above that of the whole society *at the same time*. The only data given in the valuation are the expected deaths in each lodge on the basis of the standard of 1866-70, and the total deaths expected were less than those actually notified in the proportion of 80·5 to 100. To obtain the number of deaths to be expected in each lodge when the experience of the whole society in the period under review is taken as the standard would entail a very large amount of work, even if the information were available, which was not the case. An approximation to that number sufficient for *comparative* purposes will be reached, I think, by increasing the expected numbers (on the basis of the old standard), in the ratio of the total mortality experienced in the whole of the society to the total mortality expected in the whole society on the

TABLE IX.—*Distribution of modified mortality indices, due to all causes other than age. (Total 601.)**

Ratio.	40—	45—	50—	55—	60—	65—	70—	75—	80—
Frequency	1	1	3	11	11	22	21	41	56
Ratio.	85—	90—	95—	100—	105—	110—	115—	120—	125—
Frequency	47	58	58	58	48	40	33	28	22
Ratio.	130—	135—	140—	145—	150—	155—	160—	165—	170—
Frequency	18	10	6	5	—	1	1	—	1

* The mean of this distribution is at the ratio 98·28 and the standard deviation is 20·43. Thus the range of variation of mortality due to all causes other than age is greater when the whole society for the same period is made the standard of comparison than when the old standard is employed. The values of β_1 and β_2 are $\beta_1 = 0\cdot0508 \pm 0\cdot023$ and $\beta_2 = 2\cdot928 \pm 0\cdot135$. Thus the frequency curve is again Gaussian, a result which could readily have been foretold by a little mathematical reasoning from the nature of the previous one.

basis of the old standard. It can be mathematically demonstrated that this will not, in general, give the same figure as is reached if the death rate at each age-group of the whole population were applied to the corresponding age-group in the sub-population, and the summation over all the age-groups carried out, but it appears probable that in the large majority of cases this rough method will give a sufficiently good approximation *for comparative purposes*, and it has been carried out for the whole of the 601 areas. The distribution of these modified indices of mortality is given in Table IX.

The range of the distribution is very considerable, the mortality at one extreme being four times as heavy as that at the other.

6. It has already (section 3) been pointed out that the death rate of certain of the Friendly Societies is less than that shown to exist for the whole male adult population, age for age. It is of interest to investigate if the *relative* distribution of mortality according to locality is the same for the societies as for the general male population, though on a lower plane, the effect due to age being allowed for throughout. This can be conveniently done for counties, and the method adopted was as follows: From the last two decennial supplements to the Annual Reports of the Registrar-General the number of deaths which would have occurred in each registration county and in each of the standard age-groups from 15 upwards had the death rate for the whole of England and Wales for the particular age-group existed there were worked out. From these were obtained the numbers of deaths in each registration county of males over 15 which should be expected on the basis of the experience of the whole country. Indices were then formed expressing the actual number of deaths as a percentage of the expected number, and these indices give an indication of the effect of occupation, situation, etc., on the mortality of the various counties when the ratio for the whole country is taken as 100. A process similar to that of the last section has been applied to the data given for counties in the latest valuation (the only one with the information) of the Manchester Unity, and also for the last two valuations of the Foresters. The figures for the latter are not given for counties but only for individual districts according to name, and it was necessary to compile the county experience in an approximate manner from that given for the districts. Thus indices have been formed for both societies expressing the effect of all causes other than age on the mortality in counties when in each case the mortality of the whole society (England and Wales), is expressed by 100. It is not claimed that the distributions of the societies' members in counties are exactly comparable with the general populations in registration counties dealt with in the

decennial supplements, but they are sufficiently close for purposes of a rough comparison. Space is not available to show the figures for all of the counties, but a few to which reference will subsequently be made are as follows :—

	Decennial Supplement, 1881-90.	Decennial Supplement, 1891-1900.	Oddfellows. Eighth valuation.	Foresters.	
				1902 valuation.	1907 valuation.
England and Wales	100	100	100	100	100
Lancashire	126	125	123	138	127
Yorks., W. Riding	110	107	111	109	110
Glamorgan	104	105	118	111	108
Durham	99	100	107	113	113
Northumberland	107	106	109	108	106
Bucks	83	80	89	104	100
Dorset	81	83	86	91	87
Hertford	89	89	79	87	84
Wiltshire	84	84	84	93	87

The most suitable way of indicating the extent of the agreement between the relative distributions of the whole of the counties according to mortality (when correction is made for age) is by means of correlation coefficients. These coefficients are :

Decennial Supplement (1891-1900) and Oddfellows	$r = \cdot 75 \pm \cdot 05$
" " " and Mean of Foresters'	$r = \cdot 60 \pm \cdot 07$
Oddfellows and Mean of Foresters'	$r = \cdot 71 \pm \cdot 05$

Thus the agreement between the various experiences is fairly good, and certain conspicuous cases of agreement stand out. That of Lancashire is prominent, it being very considerably the worst county in each of the experiences.

The difference between the distribution in counties of the adult male mortality in the general population and the Friendly Society population can be demonstrated by means of maps. The data for 1891-1900 have been taken to represent the relative positions of the counties with regard to general adult male mortality, and these are shown on Map I, in five grades: (i) counties with mortality—due to all causes other than age—more than 15 per cent. less than that of the whole of England and Wales; (ii) between 5 per cent. and 15 per cent. less; (iii) between 5 per cent. less and 5 per cent. more; (iv) between 5 per cent. and 15 per cent. more; and (v) over 15 per cent. in excess, and these grades are portrayed by various shadings. Lancashire is the only county falling within (v), the mortality there—when age effects are allowed for—being very markedly above that of any other county. The general features brought out by the map are the heavy mortality existing in the northern and

MAP I.—*Variation in general male mortality over 15 years due to causes other than age.*

MAP II.—*Variations in Friendly Societies' mortality due to causes other than age.*

MAP III.—*Variations in total sickness due to causes other than age.*
Manchester Unity.

midland counties and South Wales, and the low mortality of the eastern and southern counties. In Map II the same shading is employed to represent the relative mortality in the counties according to the joint experience of the Manchester Unity and the Foresters, the mean of the indices for the two societies being taken as a general Friendly Society index indicating the relative mortality due to all causes other than age. The general resemblance between the two distributions is evident.

7. The secular change in mortality will be touched upon only very briefly. For this purpose the most homogeneous statistics are those of the Hearts of Oak. The data of this society enable us to follow the course of mortality from 1890 to 1905 (with the exception of the years 1897 and 1898) for the three geographical divisions in terms of a standard which remained fixed during those fifteen

TABLE X.—*Mortality indices from 1890-96 and 1899-1905.*

Year.	Metropolitan.	Large towns.	Country districts.	All.
1890.....	88	76	70	80
'91.....	101	76	75	88
'92.....	80	66	70	74
'93.....	90	69	70	79
'94.....	79	71	64	72
'95.....	78	63	65	71
'96.....	66	56	59	62
'99.....	77	76	53	69
1900.....	89	74	66	68
'01.....	75	74	62	71
'02.....	80	67	58	70
'03.....	65	70	59	64
'04.....	69	67	52	63
'05.....	72	61	60	66

years. This standard was changed in 1905 and again in 1906, and the comparison of 1905-10 with the earlier years cannot satisfactorily be made, though it was attempted. The mortality indices for the three divisions are plotted in Fig. 4, and in each case the "best fitting" straight line has been drawn.

The inclinations (regressions) of these lines give the rates at which the mortalities were falling in the period under review, and are -1.26 , -0.21 , and -1.04 per year for the Metropolitan districts, the Large towns and the Country districts, respectively. It appears then that the mortality fell least in the Large towns and most in the Metropolitan division, where it started from the highest level. The fluctuations, however, were greatest in the latter area, and were smallest in the Country districts.

FIG. 4.—*The change in mortality indices of Hearts of Oak, 1890-1905.*

8. The facts with regard to the claims for sickness benefit can be conveniently dealt with under the same heads as were used for mortality, with the addition of one showing sickness claims according to occupation. But there is a distinct statistical difference between the two cases. For mortality we merely require the number of deaths. Two elements, however, enter into the discussion of sickness claims—(a) the number of individuals sick, (b) the average duration of the claim. The method to be adopted in this paper is to treat of (a) and (b) separately whenever possible. This is expedient, for in discussing, for example, the possible increase of sickness in recent years it is desirable to know if the increase has been caused by a greater number of individuals falling sick, or by a greater duration of the claim, or by a combination of these. In each case the material will be arranged under four heads: (i) variations according to age, (ii) according to geographical position, (iii) according to occupation, and (iv) secular variation of sickness.

A few remarks should first be made concerning the comprehensive use of the term "sickness" by friendly societies. It has reference to the case of any member who receives financial benefit from his society when unable to follow his usual employment. This may be for true illness or for accident, or for other reasons, and includes the possibility of malingering beyond the period of true illness. Again, a statistical inquiry to ascertain the incidence of true sickness according to, say, occupation from the Friendly Societies' records is beset with many difficulties which the actuary does not have to worry about in the compilation of his tables. Among these is one which potentially affects the statistics, viz.—that in the case of a man

with responsible duties, *e.g.*, a locomotive engine driver, a longer period of convalescence must be allowed than for a man in a less onerous occupation, and a *statistical* comparison of occupational sickness is vitiated by such considerations as this. The actuary, however, is concerned more with the number and extent of the *claims* on the societies, and it follows that an actuarial investigation into occupational morbidity, such as Mr. Watson's, only gives an approximation to the statistician who desires to compare like with like in different occupations. Further, most friendly societies include a number of individuals of higher social standing than the bulk of the members, and these are (presumably) included by the actuary in the "exposed to risk" column, but are unlikely to lay claims for benefit in respect of illness. Strictness of administration, too, considerably affects the number and extent of sickness claims. For example, the Hearts of Oak permits a member over 60 in receipt of reduced pay benefit to follow a light occupation, and Mr. Watson attributes part of the excess in reduced pay benefit noticed in this society to this cause. Again, some societies have a rule which ensures that members having received reduced sick pay must pass through a probationary period before coming on the club again. These statistical defects in the data discussed should be borne in mind in the following sections.⁵

A further matter it is necessary to mention is the distinction made by all societies in practice (though not always in their published figures) between claims for different durations. The custom varies from society to society. In the Hearts of Oak reports the figures are tabulated according to Full Pay (first 26 weeks), Half Pay (next 26 weeks) and Reduced Pay. The Manchester Unity valuation gives details of two grades only—Full Pay and Reduced

⁵ The only statistics available upon which to base an opinion of the extent to which accidents are the cause of claims for sickness benefit are contained in the latest valuation of the Foresters (for the period 1902-07) in the report of a special inquiry into the causes of excessive sickness. The results of this inquiry deserve a fuller statistical analysis than can be given here, and only the frequency distribution of the various proportions of payments which were due to accident will be shown.

Proportion per cent.	0—5	—10	—15	—20	—25	—30	—35	—40
Frequency	10	17	17	23	13	8	7	10
Proportion per cent.	—45	—50	—55	—60	—65	—70	—75	—80
Frequency	3	1	1	2	1	1	0	1

In the whole of these 115 Courts selected on account of excessive payments for sickness, 80 per cent. of the members received sick pay during the five years,

Pay—while the Foresters have but one column for “All Sickness “Pay.” In the case of the former society I understand that the custom is not uniform throughout the country, and although “Full “Pay” in a large number of lodges refers to “first 26 weeks,” in others it stands for “first 52 weeks,” and in a few for the “first 13 “weeks.” It is not possible, therefore, in the description of statistics in the following pages to make any uniform differentiation of the various grades of claims according to their periods. In certain cases where no confusion is likely to arise the more detailed figures will be treated of, but where comparison of societies is involved only figures for total claims can be satisfactorily discussed.

In the division of sickness claims into the two categories, say, of “first six months’ sickness” and “second six months’ sickness,” the members receiving payment under the latter have passed through the former. The figures under this head, therefore, do not indicate the true amount of short period sickness of less than six months’ total duration, but are swelled by the inclusion of what develops into long period sickness. Some idea of the extent to which “long period” sickness is included within the figures given for “first twenty-six weeks” can be obtained from the actuarial report of Neison referring to the experience of the Rechabites for the ten years 1878-87. The following figures are there given:—

Weeks of sickness claim in respect of members (874) who experienced illness of greater duration than twenty-six weeks at any time during the ten years ending December 31, 1887 (males).

	Weeks.	Days.
First six months’ sickness	23,110	2
Second six months’ sickness	16,006	4
„ twelve months’ sickness.....	11,457	5
Remainder of sickness	18,981	5
Total.....	69,556	2

and 20 per cent. of the claims and also of the payments were on account of accidents. This 20 per cent. is, of course, much above the corresponding proportion in the whole society, and the figures are given solely to emphasize the fact that the payments made by Friendly Societies in the past have included an appreciable amount for accidents, and this cannot be detached from the total paid for all claims.

It is not possible to discuss the question of malingering on a statistical foundation. The data given by the Hearts of Oak upon the results of their sickness Inspectorship system are not sufficiently detailed to enable any conclusion to be drawn as to the effect of that system, and we can only assume the likelihood of malingering without having any very exact idea of its actual extent. I believe, however, that in recent discussions the prevalence of malingering has been magnified by various speakers. At any rate, the figures of the Hearts of Oak afford no *certain* evidence of its general existence.

Claims for sickness of a "temporary nature" were made by 15,729 members, and the total number of weeks claimed by these was 110,653½. Thus $\frac{111}{134}$, or roughly four-fifths of the total weeks of sickness "under twenty-six weeks," can be attributed to "short period" illnesses, while one-third of the weeks of illness of a protracted nature fall within the first six months.

9. For the question of the variation in the proportion of members sick according to age, information is contained in the annual reports of the Hearts of Oak, the quinquennial valuations of the Rational Association, and the Manchester Unity experience (1893-97). The Hearts of Oak material is not comparable with those of the other two societies, nor can it be made comparable by grouping together the figures from five consecutive annual reports. For the members who are "on the club" in December of one year, and whose claim extends into the following year, would be counted twice, and this renders comparison impossible with figures dealing with five years as a single unit. Table XI shows the figures for the three societies arranged in quinquennial age-groups, those for full pay (first twenty-six weeks) in the Hearts of Oak also being given:—

TABLE XI.—*Proportion of members making sick claims, in quinquennial age-groups.*

Age-group.	Manchester Unity, 1893-97.	Hearts of Oak.				Rational Association.		
		1901.		1910.		Age-group.	1897-1901.	1902-06.
		All.	Full pay.	All.	Full pay.			
— 19.....	28·6	15·7	15·6	20·5	20·5	15—18	26·7	27·2
— 24.....	24·5	22·3	22·2	23·7	23·5	19—22	29·2	29·5
— 29.....	23·5	23·8	23·6	24·2	23·8	— 26	29·9	29·3
— 34.....	23·6	25·9	25·6	24·7	24·3	— 30	29·6	29·6
— 39.....	24·1	25·0	24·5	24·2	23·4	— 34	29·3	29·4
— 44.....	25·5	23·6	22·7	24·8	23·6	— 38	29·8	29·0
— 49.....	27·1	24·7	23·5	25·7	24·0	— 42	30·9	28·6
— 54.....	29·6	28·0	26·1	26·5	23·7	— 46	33·4	30·1
— 59.....	33·7	33·4	29·8	30·8	25·6	— 50	35·3	31·9
— 64.....	39·9	40·7	32·0	41·9	29·1	— 54	37·1	33·8
— 69.....	49·2	52·3	33·9	54·1	28·4	— 58	40·7	37·4
— 74.....	60·6	68·4	29·7	68·6	24·6	— 62	45·9	42·3
— 79.....	73·2	82·9	25·2	84·5	17·1	— 66	52·8	50·9
						— 70	62·6	58·0
						— 74	72·2	73·1
						— 78	89·1	79·9
All*....	27·6	25·7	24·6	26·9	24·2	All*....	31·9	31·3

* This includes ages beyond the limit of the table.

The figures for the Manchester Unity are by far the most reliable, those for the first and the last two age-groups in the case of the Hearts of Oak and the last two in the case of the Rational Association being based upon comparatively few individuals (but the phenomenon of a lower sick claimant rate than for the Manchester Unity existed in *each* of the years from 1901 to 1910 for the Hearts of Oak). In the original Manchester Unity experience adjusted rates are given for every age from 16, and these show a gradual diminution in the proportion from 16 to 25, the rate being constant between 25 and 32, and varying very little between 23 and 36. The above table can be summed up sufficiently well for general purposes by the statement that the proportion of members making claim to sick benefit varies little with age up to 50, but increases rapidly afterwards. Roughly, between 25 and 30 persons out of every 100 can be expected to make claim for sickness benefit every year. In the Hearts of Oak, during 1910, 58,200 of the 60,100 claims (or 97 per cent.) for sick pay under the age of 50 were for full pay (under twenty-six weeks), compared with 14,800 of the 21,100, or 70 per cent. over that age. Information is not available to show how many of the claims to full pay at ages over 50 extend to claims for half-pay when the first twenty-six weeks are completed.⁶

10. The only available data giving details of geographical variations in the proportion of members sick are those published annually in the reports of the Hearts of Oak for the three divisions of the country previously used in this paper. As pointed out before, it will be advisable to arrange the figures in three main age-groups in order to guard against possible statistical fallacies arising through the dissimilar age distributions in the three divisions. The percentages for two separate years—1907 and 1910—have been worked out, and are shown in Table XII. 1910 is the latest year

TABLE XII.—*Numbers claiming sick-pay in main age-groups in Hearts of Oak, 1907 and 1910.*

Age-group.	Metropolitan.			Large towns.		
	1907.		1910. Percentage sick.	1907.		1910. Percentage sick.
	Number exposed.	Percentage sick.		Number exposed.	Percentage sick.	
—40....	56,043	23·5±·13	22·3	50,123	28·4±·13	26·6
40—60....	39,407	28·2±·15	25·4	26,081	30·4±·18	27·5
60—	9,089	53·1±·34	49·3	3,505	55·2±·54	53·5
All	104,539	27·7±·09	26·7	79,709	30·2±·11	28·4

⁶ The figures in Table XI for the Manchester Unity and for the Hearts of Oak (full pay) for 1910 are graphically represented in Fig. 2.

TABLE XII *Contd.*—*Numbers claiming sick-pay in Hearts of Oak.*

Age-group.	Country districts.			All.		
	1907.		1910. Percentage sick.	1907.		1910. Percentage sick.
	Number exposed.	Percentage sick.		Number exposed.	Percentage sick.	
—40....	73,009	25.7 ± .11	24.2	179,175	25.8	24.3
40—60....	30,823	27.8 ± .17	26.1	96,311	28.7	26.2
60—	3,970	51.4 ± .51	49.1	16,564	53.1	50.2
All	107,802	27.2 ± .09	26.0	292,050	28.3	26.9

for which figures are available, but it was hardly a normal year, the figures being considerably lower than those obtaining in the previous few years.

The chief point arising out of this table to be considered is the significance of the differences in the proportions of sick members in the three divisions. Probable errors are put in for the 1907 figures, and it may be taken that those for 1910 are practically the same. In calculating these it has been assumed, as before, that the whole of the members in the society in a particular age-group form a statistical population from which are taken three samples, according to geographical situation, and the probable errors have been worked out on this basis (see section 4). The actual differences in the percentages in the above table are :—

	Metropolitan and Large towns.		Metropolitan and Country districts.		Large towns and Country districts.	
	1907.	1910.	1907.	1910.	1907.	1910.
—40	—4.9 ± .18	—4.3	—2.2 ± .17	—1.9	+2.7 ± .17	+2.4
40—60.....	—2.2 ± .23	—2.1	+0.4 ± .22	—0.7	+2.6 ± .25	+1.4
60—	—2.1 ± .64	—4.2	+1.7 ± .61	+0.2	+3.8 ± .75	+4.4
All ages	—2.5 ± .14	—1.7	+0.5 ± .13	+0.7	+3.0 ± .14	+2.4

The positive sign indicates that the figure for the first-mentioned division is the highest. The necessity for dealing with individual age-groups is well brought out by a study of the column concerned with the comparison of the Metropolitan districts with the Country districts. Had we taken no account of age we should have concluded that the Metropolis was significantly worse than the Country districts. The exact reverse, however, is the case for the largest age-group (under 40), and the conclusion for "all ages" is only brought about by the fact that the proportion of members in

the three age-groups differs very considerably between the two divisions. The percentages for the Metropolitan districts, too, are quite appreciably smaller than the corresponding ones for the Large towns, and we can definitely conclude from the experience of the Hearts of Oak that the proportion of sickness claims in London is smaller than that in the remainder of the country.

Although the proportion of sick claims of members between 40 and 60 is in no case very much larger than the corresponding proportion in the group under 40, the differences are always significant, being $4.7 \pm .20$, $2.0 \pm .23$, and $2.1 \pm .20$ for the three divisions respectively in 1907, and not so large (but still quite significant) in 1910.

11. For the same reason as was stated in the last section, the effect of occupation on the proportion of sickness claims must be considered in the main age-groups. The only available statistics are those compiled by Mr. Watson of the Manchester Unity for 1893-97, and these have been worked up and collected in the form of Table XIII. The occupation groups employed were roughly:—

A. Agriculture.

H. The remaining rural occupations not included below.

J. The remaining urban occupations not included below.

B C D. Outdoor building trades, brick and clay workers, masons, dock labourers, and unskilled labourers working in outdoor occupations, railway servants, sea-faring, fishing, &c.

E F. Quarry workers, iron and steel workers, artisans and labourers in lead, tinplate, chemical and glass works.

G. Mining occupations.

TABLE XIII.—*Percentage of sick-claims according to occupation. Manchester Unity, 1893-97.*

Age-group.	Occupation group.				
	A, H and J.	B, C and D.	E and F.	G.	All.
—40.....	22.1	26.8	32.9	39.1	24.1
40—60.....	26.1	31.9	37.4	45.2	28.2
60—.....	48.9	54.1	60.3	66.0	50.5
All	25.6	30.6	36.0	42.1	27.6

These figures require little discussion, since they are based on such large numbers that all the differences are statistically significant. The probable error of the differences between the proportion in the various occupations is greatest for that between occupations E F and G, and for the age-group over 60. The observed difference here is 5.7 per cent., and its probable error .51 per cent. The occupation groups are in the true order of increasing proportion of

sick claims for each of the three main age-groups. The variation is considerable. Between the worst and best occupations the number of sick claims differ by as many as 17 per 100 members.

12. For the question of the secular variation in the proportion of claims for sick benefit the only systematic data are those provided by the reports of the Hearts of Oak, and, through the kindness of Mr. C. W. Burnes and Mr. C. Davis, I was able to make use of the figures back to 1883 (with the exception of those for 1898, which have not been collected). These figures cannot be given here, but a diagrammatic representation of them is shown in Fig. 5. As pointed out in section 9, the number of sick claims per 100 exposed increases rapidly after age 50, so that figures dealing with the variation in that proportion at all ages must be interpreted with caution, as an apparent increase might be due to an alteration in age-distribution, and not to a secular change in the incidence of sick claims. Accordingly, to avoid possible fallacious inferences, the information relating to a single age-group—30–34—has been taken out, and the diagram refers to this group only. Evidence of the desirability of this procedure is given by the fact that *for all ages* the mean of the figures for the 27 years for the Metropolitan districts is 24.0 against 24.4 for the country districts, a difference of only 0.4. But for the *particular age-group* the corresponding numbers are 23.2 and 24.9, a difference of 1.7. Very considerable fluctuations will be noticed. The diagrams are entirely unlike those for the corresponding mortalities from 1890–1905 shown in Fig. 4. These latter can be represented fairly satisfactorily by straight lines, but much more complex analysis would be necessary to detect any law in the fluctuations in the number of sick claims from year to year, and the present material is not adequate enough to attempt it. A general resemblance is manifest in parts of the lines for the three divisions, and this has been numerically indicated by finding the correlation between the *changes* from year to year in the proportion of sick claimants. If

$\left. \begin{matrix} x_1 \\ x_2 \\ x_3 \end{matrix} \right\}$ denote the *change* in the proportion (per cent.) of sick claims from one year to next in $\left\{ \begin{matrix} \text{Metropolitan districts,} \\ \text{Large towns,} \\ \text{Country districts,} \end{matrix} \right.$

the following statistical constants are found:—

$\bar{x}_1 = +.81$	$\bar{x}_2 = +.23$	$\bar{x}_3 = +1.46$
$\sigma_1 = 30.14 \pm 2.81$	$\sigma_2 = 29.19 \pm 2.73$	$\sigma_3 = 22.92 \pm 2.14$
$r_{12} = .787 \pm .050$	$r_{13} = .626 \pm .080$	$r_{23} = .436 \pm .107$

The significance of the differences between the figures for the three divisions is shown by the following:—

$ \sigma_1 - \sigma_2 = .95 \pm 3.90$	$ \sigma_1 - \sigma_3 = 7.22 \pm 3.52$	$ \sigma_2 - \sigma_3 = 6.27 \pm 3.46$
$ r_{12} - r_{13} = .161 \pm .09$	$ r_{12} - r_{23} = .351 \pm .12$	$ r_{13} - r_{23} = .190 \pm .13$

FIG. 5.—*Hearts of Oak. Full-pay sick claim (first twenty-six weeks), age-group 30—34.*

These numbers are based on 26 observations only, and the ordinary form of the probable errors is, therefore, only of approximate validity, and no certain conclusions can be drawn. The most reliable inference which the figures will bear is that changes in the proportion of sick claimants in the Large towns are less correlated with those in the Country districts than with those in the Metropolitan area, but even this deduction can only be put in the form of considerable probability (20 to 1). There is comparatively little relationship between the changes occurring year by year in the Country districts and those which take place at the same time in the Large towns, but there is a fairly high degree of association between these latter and those befalling in the Metropolitan area.

13. The subject of the average duration of sickness claim will be considered under the same heads as the proportion of sick claimants in the past few sections. The variations in the average duration of sickness with age are shown in Table XIV.

TABLE XIV.—*Average duration of sick claim in quinquennial age-groups.*

Age-group.	Manchester Unity, 1895-97.	Hearts of Oak.				Rational Association.		
		1901.		1910.		Age-group.	1897-1901.	1902-06.
		All.	Full pay.	All.	Full pay.			
—19.....	3·20	2·85	2·77	3·3	3·3	15—18	2·86	3·09
—24.....	3·67	3·45	3·28	4·0	3·7	19—22	3·20	3·46
—29.....	4·06	3·86	3·55	4·1	3·6	—26	3·40	3·88
—34.....	4·52	4·29	3·76	4·5	3·8	—30	3·67	4·04
—39.....	5·25	4·89	4·03	5·2	4·1	—34	4·01	4·46
—44.....	6·22	5·93	4·48	5·9	4·3	—38	4·68	4·84
—49.....	7·33	7·18	5·01	7·2	4·9	—42	4·81	5·33
—54.....	9·30	8·64	5·69	9·6	5·6	—46	5·50	5·99
—59.....	11·9	11·4	6·66	13·0	6·3	—50	6·61	6·63
—64.....	15·8	16·4	7·32	20·2	7·3	—54	8·24	8·38
—69.....	21·5	24·0	9·17	28·7	8·7	—58	10·1	10·0
—74.....	28·7	34·1	10·5	36·4	9·8	—62	14·2	12·7
—79.....	34·4	40·1	10·5	41·5	11·5	—66	16·3	16·7
						—70	21·3	21·2
						—74	27·4	26·3
						—78	32·9	33·6
All*....	8·50	6·35	4·33	8·8	4·6	All*....	5·73	6·46

* This includes ages beyond the limit of the table.

Unlike the proportion of sick claims which (section 9) remains practically constant up to age 50, the average duration of claim increases continuously from the lowest age-group. A considerable increase is evident in the average duration at almost every age-group in passing from the 1901 experience to the 1910 of the Hearts

of Oak. The increase in the average duration at all ages is deceptive, on account of the change in the age distribution which took place between those dates. The Manchester Unity figures are in excess of those of the Hearts of Oak for 1901 at all ages except those over 60, but agree very closely with those for 1910 at ages below 50.

The numbers giving the average duration of sickness claim for the Manchester Unity and for the Hearts of Oak (full-pay), 1910, are represented in Fig. 2. The general tendency is the same as already noted for the mortality line, but the upward trend is not so rapid. Comparison of the figures for the Rational Association with those of the other societies is not of much value, on account of the different age-grouping employed, but the results of the two valuations of this society show the same movement as in the case of the Hearts of Oak, viz., an increase in the average duration of the claim up to middle life, and little, if any, increase beyond the age of 50. Collating the figures given in this section with those of section 9, we can sum up in a general way by saying that the movement of sickness is in the direction of (at most age-groups) a greater average duration of claim, with little (if any) increase in the proportion of members making claims.

14. The geographical variations in the average duration of sickness claim can be discussed only for the three divisions of the Hearts of Oak, and Table XV has accordingly been drawn up on

TABLE XV.—*Average duration of sickness claim (in weeks) in main age-groups in Hearts of Oak, 1901, 1904, 1907 and 1910.*

Age-group.	1901.			1904.		
	Metro-politan.	Large towns.	Country districts.	Metro-politan.	Large towns.	Country districts.
—40.....	3·93	4·22	4·42	4·01	4·44	4·68
40—60.....	8·42	7·28	7·89	8·74	7·61	8·28
60—	20·8	23·5	24·8	22·0	23·7	25·5
All	6·82	5·93	6·01	7·78	6·60	6·68

Age-group.	1907.			1910.		
	Metro-politan.	Large towns.	Country districts.	Metro-politan.	Large towns.	Country districts.
—40.....	4·16	4·32	4·52	4·32	4·50	4·68
40—60.....	8·71	7·63	7·88	8·80	7·77	7·91
60—	22·4	25·8	23·6	26·8	27·8	26·4
All	8·90	7·12	6·84	10·8	8·08	7·55

the same basis as Table XII of section 10. The calculation of the probable errors to test the significance of the observed differences is a more difficult matter, however, in this case, and cannot be done with the data provided. Consequently, two extra independent samples, referring to the years 1901 and 1904, have been taken to support the conclusions drawn from the figures for the years 1907 and 1910.

The differences between the geographical divisions are set out below, the same convention as to sign being used as before, viz., a plus sign indicates that the first named division has the larger average duration of sick claim :—

	Metropolis and Large towns.			
	1901.	1904.	1907.	1910.
—40.....	—0·29	—0·43	—0·16	—0·18
40—60.....	+1·16	+1·13	+1·08	+1·03
60—	—2·7	—1·7	—3·4	—1·0
All	+0·89	+1·18	+1·78	+2·72

	Metropolis and Country districts.			
	1901.	1904.	1907.	1910.
—40.....	—0·49	—0·67	—0·35	—0·36
40—60.....	+0·53	+0·46	+0·83	+0·89
60—	—4·0	—3·5	—1·2	+0·4
All	+0·81	+1·10	+2·06	+3·25

	Large towns and Country districts.			
	1901.	1904.	1907.	1910.
—40.....	—0·22	—0·24	—0·20	—0·18
40—60.....	—0·61	—0·67	—0·25	—0·14
60—	—1·3	—1·8	+1·8	+1·4
All	—0·08	—0·08	+0·28	+0·53

These figures are sufficiently uniform to enable quite definite conclusions to be drawn. At ages under 40, the metropolis has the smallest average duration of sickness claim, and the Country districts the largest. In the next age-group, however, the London area has the longest average duration of claim, and the Large towns the smallest, the difference between these being quite considerable. The figures for the final age-group are not so uniform, and the Large towns and Country districts cannot be placed in a

definite order. For each of the four years, however, the Metropolitan district had the smallest average duration of sickness claim. If these numbers are compared with those in section 14, it will be noted that the Metropolis stands better than the Large towns in both average duration and in actual number of sickness claims in each age-group, except in the central group for the former, and is also generally better than the Country districts. The most noteworthy feature of the figures is the high average duration of sickness claim in the Metropolitan district in the age-group 40—60. It is much above that prevalent in the rest of the country, and is distinctly different from the experience of other age-groups.

15. For the consideration of the effect of occupation on the average duration of sickness claim, the only statistics are those relating to the Manchester Unity for 1893-97. These have been worked up into main age-groups, and are collected in Table XVI:—

TABLE XVI.—*Average duration of sickness claim (weeks) according to occupation. Manchester Unity, 1893-97.*

Age-group.	Occupation group.				
	A, H and J.	B, C and D.	E and F.	G.	All.
—40.....	4·24	4·20	4·20	4·48	4·26
40—60.....	8·45	8·43	7·83	8·71	8·42
60—	23·6	23·5	23·7	24·3	23·7
All	8·78	8·21	7·38	7·30	8·50

The group G (miners) has for each age-group the largest average duration of sickness claim, and a reference to the corresponding table in section 11 shows that this group has also the largest proportion of members making claims. The occupation of mining, then, stands worse in both aspects of sickness—number of claims, and average duration of claim. Apart from this group, there is very considerable uniformity in the above figures, the only exception being for group E and F (quarrying, &c.) at age 40—60, and here the average duration of claim is about four days per annum *less* than that of the whole population. The agreement between the other figures which are comparable is very close, and the variations in the table are quite unlike those found in Table XV, when average duration of sick claim was arranged according to geographical situation. It would appear from the evidence here collected that Mr. Watson's oft-quoted conclusion that occupation has a greater effect upon the amount of sickness in a population than has geographical position may be stated in greater detail as follows: *occupation produces the greater variations in the proportion of sick*

claims, but *geographical situation* produces the greater variations in the *average duration of the claim*; the former is more potent than the latter, so that occupation affects the *total* amount of sickness in the population to a greater extent than does situation.

16. The information of the secular change in the average duration of sick claim can only be given diagrammatically in the same manner as was the secular change in the proportion of claims in section 12. The fluctuations from year to year are shown in Fig. 5, and, as before, refer only to the age group 30—34, and for full pay (first 26 weeks) sick claim. We should expect in a rough sort of way an inverse relationship to hold between the line showing average duration and that giving the proportion of claimants to benefit, since in an epidemic year (*e.g.*, 1890), when the number of members making claims is considerably increased, the denominator of the fraction giving the average duration is increased in a greater proportion than is the numerator, and this is seen to be the case. Since 1890 the average duration of sick claim (full pay) has been remarkably constant in the Metropolitan district. It will be noticed that changes from year to year in the average duration of claim are, on the whole, associated with each other for the three divisions (particularly for the Large towns and the Country districts), but it hardly seems necessary to work out a numerical coefficient of the degree of this association (as in section 12), since average duration of sick claim is a complex item and the interpretation of a numerical measure of association in such a case is not a simple matter. The line for the Metropolitan districts is invariably the lowest, and that for the Country districts is usually the highest in the figure. For the proportion of members sick the line for the Large towns is usually the highest and that for London generally the lowest.

17. We now come to the consideration of the *total* amount of sickness experienced by the various Friendly Society populations. It will still be convenient to deal with this subject under the same heads as before, and the figures showing the effect of age are first given. This is by far the most important aspect of the matter from the point of view of the actuary, who requires to know the total amount of sickness to be expected and not so much the number of individuals who are likely to make claims. Following the method employed in section 9 and section 13, Table XVII shows the number of weeks of sickness per annum per member exposed to risk in quinquennial age-groups. Each number is, of course, the product of the corresponding numbers in Tables XI and XIV.

The figures in the first column of this table are of particular interest at the present time, since they represent in quinquennial age periods the rates which at individual ages are the basis of the

TABLE XVII.—*Weeks of sickness per member per annum in quinquennial age-groups.*

Age-group.	Manchester Unity, 1893-97.	Hearts of Oak.				Rational Association.		
		1901.		1910.		Age-group.	1897-1901.	1902-06.
		All.	Full pay.	All.	Full pay.			
—19.....	·91	·45	·43	·68	·68	15—18	·76	·84
—24.....	·90	·77	·73	·94	·86	19—22	·93	1·02
—29.....	·95	·92	·84	·98	·85	—26	1·02	1·13
—34.....	1·07	1·11	·96	1·12	·92	—30	1·09	1·20
—39.....	1·27	1·22	·99	1·25	·95	—34	1·17	1·31
—44.....	1·33	1·39	1·02	1·46	1·03	—38	1·40	1·36
—49.....	1·99	1·78	1·18	1·86	1·17	—42	1·48	1·52
—54.....	2·75	2·42	1·49	2·55	1·33	—46	1·83	1·81
—59.....	4·01	3·81	1·99	3·99	1·60	—50	2·33	2·11
—64.....	6·30	6·69	2·34	8·46	2·12	—54	3·06	2·83
—69.....	10·58	12·54	3·11	15·48	2·48	—58	4·11	3·73
—74.....	17·39	23·35	3·11	25·03	2·41	—62	6·53	5·37
—79.....	25·18	33·22	2·65	35·09	1·97	—66	8·62	8·52
						—70	13·35	12·32
						—74	19·70	19·21
						—78	29·53	26·91
All*....	2·34	1·63	1·07	2·37	1·11	All*....	1·83	2·02

* This includes ages beyond the limit of the table.

sickness part of the National Health Insurance scheme. They are graphically represented in Fig. 2 (*ante*), and from that diagram a general idea can readily be obtained of the rate at which sickness increases with age. If the rates for each group of the Manchester Unity and Hearts of Oak are compared, quite a good agreement will be noticed, except in the first and last three groups (and these, in the Hearts of Oak, are based upon comparatively few observations). Up to age 30 the rate, in the Hearts of Oak, for full pay is but little below that for all-pay, but the difference increases rapidly at higher ages. At ages over 70 the claims for full pay are but a small portion of the whole, and the amount of the former appears, if anything, to diminish. This is not improbable, as with a considerable portion of the population over that age “on the club” for reduced pay, the portion exposed to risk for full pay is reduced also, and consequently there is a limit beyond which the rate for full pay cannot reach.

18. Many more data are available for the discussion of the effect of geographical situation on the total amount of sickness than were procurable concerning the effect on the number of sick claimants and also on the average duration of the claim, and these will be considered in some detail. We shall first briefly deal with the variations in the three divisions of the Hearts of Oak after the manner of sections

TABLE XVIII.—*Number of weeks of sickness per member exposed in Hearts of Oak, 1907 and 1910.*

Age-group.	Metropolitan.		Large towns.		Country districts.		All.	
	1907.	1910.	1907.	1910.	1907.	1910.	1907.	1910.
—40....	0·98	0·96	1·23	1·20	1·16	1·13	1·10	1·12
40—60....	2·46	2·24	2·32	2·14	2·19	2·06	2·34	2·14
60—	11·90	13·20	14·20	14·90	12·10	13·00	12·40	13·50
All	2·47	2·88	2·15	2·29	1·86	1·96	2·16	2·37

10 and 14. Table XVIII shows the amount of sickness per member exposed in each of the three divisions in the main age-groups. This contains further instances of how quite fallacious inferences might have been drawn had the material not been divided into age-groups. Confining attention to the group under 40, it would appear from the figures for the whole society that the sickness rate had slightly increased from 1907 to 1910 while, as a matter of fact, in each of the three geographical divisions it had diminished, the effect being produced by changes in the relative proportions of members in the three divisions. In all cases the results for 1910 support the conclusions to be drawn from the 1907 figures as to the differences in total sickness per member according to geographical situation. For the first age-group the order is Metropolitan districts, Country districts and Large towns in ascending scale. In the second the order is Country districts, Large towns, Metropolitan districts, while in the third there is practically no difference between the London area and the Country districts, but the position of the Large towns is much inferior. These conclusions could, to some extent, have been anticipated from the figures given in section 10 and section 14, and should be read in conjunction with these sections; it will then be noticed, for example, that the superiority of the metropolitan district in the first age-group arises in part from a smaller proportion of sickness claims and in part also from a smaller average duration of claim.

19. The data in the latest valuation of the Manchester Unity, referred to in section 5, allow of the geographical distribution of sickness throughout England and Wales being dealt with in detail. For most of the lodges are shown the amount spent on sickness both for full pay and reduced pay, and the corresponding amounts which were expected on the basis of the 1866-70 experience. These lodges have been, for the purposes of this paper, grouped together into "units," as described in section 5, and the cost of sick pay (expected and actual) both "full" and "reduced" aggregated

for each unit. Then indices have been formed which indicate the effect of all causes *other than age* affecting sickness, both for "full pay" sickness and for "reduced pay" sickness. The aggregate actual "full pay" throughout the country was practically equal to the corresponding "expected" amount, but the actual "reduced pay" was 55 per cent. in excess of that "expected" on the basis of the 1866-70 experience. As before stated, 601 of the "units" were formed, and the nature of the distribution of the "full pay" sickness indices throughout these is given in Table XIX:—

TABLE XIX.—*Distribution of "full pay" sickness index throughout England and Wales.**

60—64.	65—69.	—74.	—79.	—84.	—89.	—94.	—99.	—104.	—109.
2	—	3	17	55	79	86	84	62	73
—114.	—119.	—124.	—129.	—134.	—139.	—144.	—149.	—154.	
40	29	20	16	9	6	6	2	3	
—159.	—164.	—169.	—174.	—179.	—184.	—189.	—194.	—199.	
2	1	1	2	1	—	—	1	1	

* The mean, standard deviation, mode and skewness of this distribution are 101·56, 17·24, 91·28, and ·597 respectively. Pearson's method has been employed to fit the generalised frequency curve to these figures, the statistical constants for determining the nature of the curve being $\beta_1 = 2·377$ and $\beta_2 = 7·318$. These are high values, and fall outside Rhind's Diagram A, but if the lines in this are extended a little it is readily seen that the distribution lies well in the area covered by Pearson's Type VI, and accordingly this curve has been fitted to the statistics, the equation and further constants being given in the Appendix.

Type VI is a curve with limited range in one direction, and unlimited (theoretically) in the other. In this case the curve commences at the ratio 73·12, so that an outlier 2 at 62·5 is left outside the curve. Of course, we are not sure that we are dealing with really homogeneous material, and it is possible that the two "units"—the whole of the Altrincham district of Cheshire and the major portion of the Uttoxeter district of Staffordshire—contain a larger proportion than usual of honorary members referred to in section 8. At any rate, the curve suggests that there is something exceptional about these two units. For reduced sick pay the corresponding indices are high — 171 and 214 respectively, against 155 for the whole society. Their mortality indices, too, are above those of the whole society.

This distribution is represented in Fig. 6, and the skewness is considerable.

FIG. 6.—*Frequency distribution of “full-pay” sickness, corrected for age. Manchester Unity.*

The corresponding distribution for “reduced pay” sickness ratio is shown in Table XX:—

TABLE XX.—*Distribution of “reduced pay” sickness ratio throughout England and Wales.**

45—49.	50—54.	—59.	—64.	—69.	—74.	—79.	—84.	—89.	—94.	—99.	—104.	—109.
1	2	2	4	2	3	4	5	5	6	10	15	24
—114.	—119.	—124.	—129.	—134.	—139.	—144.	—149.	—154.	—159.	—164.	—169.	—174.
18	21	26	27	32	26	28	21	26	27	26	28	27
—179.	—184.	—189.	—194.	—199.	—204.	—209.	—214.	—219.	—224.	—229.	—234.	—239.
21	23	18	20	20	11	11	9	8	15	5	3	2
—244.	—249.	—254.	—259.	—264.	—269.	—274.	—279.	—284.	—289.	—294.	—299.	—304.
3	2	1	3	4	1	1	—	1	—	1	—	1

* The mean, standard deviation, mode and skewness are 155.62 , 42.95 , 148.16 , and $.174 \pm .033$ respectively. The skewness is thus much smaller than in the previous distribution, but is almost certainly significant. The parameters fixing the type of curve fitting the above crude figures are $\beta_1 = .190 \pm .092$, $\beta_2 = 3.712 \pm .46$, and the curve is consequently of Type IV—unlimited range in both directions, though, as indicated by the probable errors, such a distribution might arise from a true normal frequency. The equation and further statistical constants are given in the Appendix.

This distribution is quite dissimilar to the last, and the range is about twice that there found. Before dealing with it, further grouping was performed, the unit being doubled.

It is represented in Fig. 7, the skewness being much less than in the last distribution.

FIG. 7.—*Frequency distribution of "reduced pay" sickness, corrected for age (Manchester Unity).*

A similar distribution might be given to indicate the variations throughout the country of the *total* amount of sickness. This has not been constructed, but it is clear that it will be quite skew and approach the first of the above distributions rather than the second, since the "full pay" sickness is about three-quarters of the total.

20. The data in the latest valuation of the Manchester Unity enable us readily to deal with the distribution of sickness in counties. The reports of the Foresters also permit of the sickness cost (actual and expected) being arranged approximately in counties, but only for total sickness. But the standards are not the same for the Foresters and the Manchester Unity, and they cannot be compared in the original state. The difficulty can be obviated in an approximate way by expressing the figure for each county in terms of that of the *whole* society to which it belongs as the standard, in the same manner as that employed to modify the mortality ratio in section 5. Thus the index 115 for the Monmouth membership of the Manchester Unity indicates roughly that, when correction is made for age, the total sickness of the Oddfellows in that county was 15 per cent. in excess of that to be expected from the experience of the whole society for the same period. The counties can in this manner be arranged in a general sort of order according to the sickness incurred, and this order will be comparable with that obtained in a similar way for the Foresters. For the Manchester Unity indices have been worked out for "full pay," "reduced pay," and for "total pay." For the Foresters "total pay" only can be given, but for each of the last two valuations (1902 and 1907). These are shown below for

the same counties for which the corresponding mortality indices have been given.

	Manchester Unity.			Foresters. Total pay index.	
	Full pay index.	Reduced pay index.	Total pay index.	1902.	1907.
England and Wales	100	100	100	100	100
Lancashire	97	89	95	93	97
Yorks, West Riding	102	91	99	96	101
Glamorgan	130	126	129	119	121
Durham	125	129	126	111	106
Northumberland	107	135	115	153	134
Bucks	110	101	106	96	92
Dorset	104	108	105	99	91
Hertford	98	115	101	91	101
Wiltshire	101	107	105	110	105

It should be emphasised that these figures are put forward to give an approximate view of the facts, and that no great weight attaches to any single index. As pointed out before, the county division in the case of the Foresters may not be quite the same as for the Manchester Unity. The few figures given above suggest that the relative distributions of the counties, according to the experiences of the two societies, are in fair agreement, and the numerical measure of this agreement is indicated by the fact that the correlation between corresponding figures in the two columns for the Foresters is $.78 \pm .040$, while when mean indices are formed from those two columns the correlation between these and the total pay sickness indices for the Manchester Unity is $.61 \pm .066$. On the whole, I am of the opinion that the figures for the Manchester Unity represent more closely the relative distribution of sickness of the general male adult population than do those for the Foresters, since for most counties they are based upon larger numbers and the boundaries approach nearer to the administrative counties of the same names. For this reason the Manchester Unity indices have been used in Map III to indicate graphically the variation in sickness-claim in the counties of England and Wales. The shading adopted is the same as that employed in Maps I and II and referred to in section 6, and relates to the "Total Pay" sickness index. But with very little alteration, the same map would represent the distribution of the "Full Pay" sickness index.

The most striking feature of the map and the table is the comparatively lowly position of Lancashire as regards sickness claim. When dealing with mortality in section 6, it was noted that all the data agreed in fixing Lancashire as the county of greatest mortality (correction having been made for age), the index being from 25 per

cent. to 30 per cent. in excess of that for the whole of England and Wales. Both the Foresters and the Manchester Unity, however, agree in placing the sickness-claim index for that county well below the index for the whole country (correction, again, having been made for age).⁷ As the sample of the Lancashire male adult population in the Foresters embraces about 15,000 persons, and that in the Manchester Unity no less than 60,000, the indices in the table can be taken as a very fair approximation of the relative position of the general adult male population of the county. The question is one of such interest that the valuations of other societies admitting geographical comparison have been investigated, and the relative position as regards the whole of the society of the sickness and mortality experience of the Lancashire sample has been worked out. This has also been done for the three counties of Durham, Northumberland and Glamorgan, which occupy prominent positions in the tables. The results can be summed up as follows :—

Manchester Unity.		Foresters.				Rechabites.				Shepherds.	
Sick-ness.	Mor-tality.	1902.		1907.		1900.		1905.		1900. Sick-ness.	1905. Sick-ness.
		Sick-ness.	Mor-tality.	Sick-ness.	Mor-tality.	Sick-ness.	Mor-tality.	Sick-ness.	Mor-tality.		
LANCASHIRE.											
95	123	93	138	97	127	99	110	87	112	80	90
DURHAM.											
126	107	111	113	106	113	107	83	123	95	135	141
NORTHUMBERLAND.											
115	109	153	108	134	106	94	80	124	89	107	113
GLAMORGAN.											
129	118	119	111	121	108	125	95	129	107	113	122

The statistics of the Rechabites and Shepherds give confirmation of those already put forward from the Manchester Unity and the Foresters. In Lancashire the sickness claims (when allowance has been made for age) are always below the general figure for the whole of the country, while the mortality is much higher. Of course, the incidence of sickness-claims is by no means homogeneous throughout the county, and particular districts can be picked out

⁷ The case of the West Riding of Yorkshire is similar, though not so pronounced, the mortality being about 10 per cent. above that of England and Wales (when age is allowed for), but the sickness, if anything, is below the general, the figures referring to about 60,000 members of the Manchester Unity.

where the sickness index is very high. Perhaps the most prominent of these is St. Helens, the sickness index for this being as high as 150 for the Manchester Unity (3,200 members), and 113 and 122 for the two valuations of the Shepherds. With far more comprehensive and reliable data likely to be forthcoming in the near future, it would be premature at this time to discuss the causes of the low rate of sickness-claim. It may be a partial outcome of the very heavy mortality from which Lancashire suffers at early ages, or it may be connected with the fact that the high wages received by textile workers and others in that county render it especially desirable to shorten the period of convalescence as much as possible.

The indices given for the four societies above for the sickness and mortality in Durham, Northumberland and Glamorgan support one another, on the whole, quite well. Durham and Glamorgan appear to be the counties with highest rates of sickness claim, which, since both contain a large proportion of miners, is in accordance with the figures given for occupational morbidity in section 11 and 15. The experience of the Foresters in Northumberland is much worse than that of any of the other societies, and this may be caused by the inclusion of a greater proportion of miners. A further noticeable point in the table is the position occupied by a number of the southern counties—Buckingham, Dorset, Hertford and Wiltshire—which, considered from the point of view of mortality, are usually looked upon as healthy districts, but which for the Manchester Unity population show total sickness indices of 106, 105, 101 and 105 respectively against mortality indices of 89, 86, 79 and 84. This is not due, as might, perhaps, be suggested, to a large proportion of aged members being disabled and receiving reduced pay, for the corresponding indices for "Full Pay" sickness are 110, 104, 98 and 101, all very much higher than the indices showing the relative positions as regards mortality among those counties.

On the whole the survey of the statistics of sickness claims which are available leads to the conclusion that their relative distribution throughout the counties is quite dissimilar to the relative distribution of mortality. The data, of course, are not sufficient to dogmatize upon, but there is such a general—though rough—agreement between comparable material that we appear to be justified in concluding that high mortality is not associated, in general, with excessive sickness.⁸

⁸ The absence of association between sickness and mortality was pointed out as long ago as 1846 by Mr. F. G. P. Neison. ". . . many fatal diseases . . . do not to any great extent incapacitate from labour, and in these "diseases the mortality may be high, while the amount of sickness is small."—*Contributions to Vital Statistics*, 2nd Edn., p. 108.

21. The effect of occupation on the total amount of sickness can be briefly regarded in the same manner as in sections 11 and 15. The number of weeks of sickness per member exposed in each of the three main age-groups for the four grades of occupation is shown in Table XXI.

TABLE XXI.—*Number of weeks of sickness per member exposed in occupation groups, Manchester Unity, 1893-97.*

Age-group.	Occupation group.				
	A, H, J.	B, C, D.	E, F.	G.	All.
—40.....	·93	1·13	1·38	1·75	1·03
40—60.....	2·20	2·68	2·92	3·94	2·38
60—.....	11·57	12·70	14·30	16·04	11·94
All	2·25	2·51	2·65	3·07	2·34

The increase in sickness in passing from the left of the table to the right is pronounced and persists in each age-group. Except in Group G—miners—it is caused almost entirely by the increase in the number of members making sick claims, and hardly at all by changes in the average duration of sickness. The table may be considered in the light of the facts brought out in the last section. It has already been stated that the higher sickness claims made by miners probably accounted for much of the high figure noticed in Durham, Northumberland and Glamorgan. The textile and woollen industries of Lancashire and the West Riding of Yorkshire are included in Group J, which helps to account for the moderate rates noticed there. Agriculture is included in the group with the lowest incidence of sickness, but, as pointed out in the last section, some of the agricultural counties of the south of England have sickness indices above that prevailing for the whole country.

Mr. Watson, from his wide experience, has expressed elsewhere the opinion that “it cannot, I think, be questioned that the rate “of sickness experienced in agricultural communities is lower “than the general average rate”—though in his survey of the Manchester Unity experience of 1893-97 he found so little difference between A and H-J (see section 11) that no advantage could be gained by treating them separately. These three contained about 13 per cent., 31 per cent., and 33 per cent. respectively of the exposed to risk in the whole Society. His investigation will bear the conclusion that while agriculture is below the general average as regards sickness rate it is not nearly to the same extent as it is below the general average as regards mortality rate.

22. The presentation of the facts of the subject will be completed in this section by tracing the changes which have occurred in the amount of sickness claim per member exposed over a series of years. As in the case of mortality touched upon in section 7, most societies give information which can be arranged under this head. A selection only, however, can be made and that of the Hearts of Oak—which admits of systematic statistical classification—will be dealt with.

Since change in age will, of course, affect the figures the age-group 30–34, for which I have information back to 1883, will alone be considered. The total amount of sickness per member in this age-group over a series of years for each of the three divisions is shown in Table XXII.

TABLE XXII.—*Number of weeks of sickness (full pay) per member in age-group 30–34, Hearts of Oak, 1883–1910.*

Year.	Metro- politan.	Large towns.	Country districts.	All.	Year.	Metro- politan.	Large towns.	Country districts.	All.
1883....	·82	1·09	·94	·89	1897	·78	1·17	1·03	·97
'84....	·83	1·03	·97	·91	'99	·96	1·19	·89	·99
'85....	·82	1·00	·98	·89					
'86....	·84	1·01	1·02	·92	1900	·92	1·14	·92	·99
'87....	·79	1·02	·89	·85	'01	·88	1·18	·89	·96
'88....	·79	·94	·92	·86	'02	·90	1·15	·86	·95
'89....	·74	·95	·83	·82	'03	·85	1·17	·90	·95
					'04	·86	1·18	·90	·96
1890....	·90	1·16	1·05	1·02	'05	·79	1·05	1·04	·96
'91....	·90	1·09	1·00	·98	'06	·82	1·09	·97	·95
'92....	·93	1·11	1·19	1·07	'07	·86	1·11	1·02	·99
'93....	·95	1·16	1·18	1·09	'08	·89	1·13	1·06	1·03
'94....	·77	1·04	1·04	·94	'09	·90	1·12	1·02	1·01
'95....	1·00	1·10	1·20	1·10					
'96....	·77	·91	1·14	·93	1910	·79	1·00	·95	·92

These figures are diagrammatically represented in Fig. 5 together with the corresponding percentages of members making sick-claims, and the average duration of the claims. The movements from year to year are very much the same as for the latter, and this indicates that alteration in the number of weeks of sickness-claim per member from year to year is due much more to the variations in the number of members sick than in the average duration of the claim. There was a very marked rise in the sickness in 1890 due to an epidemic which appears to have attacked each division equally. This epidemic visited the Manchester Unity severely, and reference is made to it in the 7th Valuation of that Order, but no statistics are given of it. It is interesting to note, that, following the epidemic of 1890–91 the sickness-claims were distinctly high in the following three or four years—with the exception

of 1894—in each division, but dropped considerably in the Metropolis and Large towns in 1896.

To illustrate in more detail the change which has occurred in the sickness experience of the Hearts of Oak during the present century Table XXIII has been constructed. This shows the sickness rates for each age-group in the quinquennia 1901-05 and 1906-10, and the change per cent. of the latter over the former.

TABLE XXIII.—*Change in total sickness rates in Hearts of Oak, 1901-05 and 1906-10.*

Age-group.	Metropolitan.			Large towns.		
	1901-05.	1906-10.	Change per cent.	1901-05.	1906-10.	Change per cent.
20—24....	·67	·81	+ 21	·92	1·03	+ 12
—29....	·79	·86	+ 9	1·10	1·09	— 1
—34....	·96	·97	+ 1	1·31	1·27	— 3
—39....	1·14	1·17	+ 3	1·48	1·42	— 4
—44....	1·32	1·44	+ 9	1·63	1·65	+ 1
—49....	1·80	1·79	— 1	1·93	1·98	+ 3
—54....	2·68	2·75	+ 3	2·59	2·77	+ 7
—59....	3·95	4·34	+ 10	4·49	4·22	— 6
—64....	7·07	8·70	+ 23	8·41	9·53	+ 13
—69....	12·6	14·9	+ 18	14·6	16·3	+ 12
—74....	21·4	23·9	+ 12	27·8	25·2	— 10
—79....	30·1	35·4	+ 18	33·3	32·1	— 4

Age-group.	Country districts.			All.		
	1901-05.	1906-10.	Change per cent.	1901-05.	1906-10.	Change per cent.
20—24....	·84	·91	+ 9	·80	·92	+ 15
—29....	·94	1·04	+ 11	·93	1·00	+ 7
—34....	1·09	1·20	+ 10	1·11	1·15	+ 4
—39....	1·24	1·38	+ 11	1·27	1·33	+ 5
—44....	1·54	1·69	+ 10	1·48	1·60	+ 8
—49....	1·64	2·02	+ 23	1·78	1·92	+ 8
—54....	2·12	2·50	+ 18	2·51	2·67	+ 6
—59....	3·48	3·72	+ 7	3·91	4·13	+ 6
—64....	6·59	7·47	+ 13	7·16	8·50	+ 19
—69....	11·8	13·6	+ 15	12·8	14·7	+ 15
—74....	20·4	23·2	+ 14	22·2	24·0	+ 11
—79....	33·5	31·8	— 5	31·4	32·7	+ 4

The figures in this Table are particularly enlightening. They show that the change has not occurred uniformly throughout the country nor at all age-groups. In the Metropolitan district and the Large towns little, if any, change is discernible in the later half of the first decade of the century over the earlier so far as regards the ages between 30 and 50, but, in the Country districts, the

alteration has been much more marked. Remembering the imperfections of the data, it is hardly advisable to hazard any conjectures on the possible causes of this distinct difference between the Country districts and the rest of the Society. The figures may not represent any physical change at all, but, at any rate, they show that the increase in the amount of sickness benefit claimed in the Country districts is considerable in middle life.

23. The rest of the paper will be given over to the discussion of two or three problems suggested by the facts previously described.

The first of these problems has already been touched upon when discussing the geographical distribution of sickness in the counties of England and Wales and comparing it with that of mortality. This is to investigate the magnitude of the association which exists between the total extent of sickness claim and the number of deaths in the same population within a district. A positive association between these might by some appear to be axiomatic, though so long ago as 1885 Dr. Ogle pointed out that "a vast number of children of permanently "unsound constitutions, who under former conditions would have "perished in youth are now saved from early death by sanitary "interference," and "these grow up to adult life and diminish the "average healthiness of the adult classes, and so add to their death-"rates."

To demonstrate the existence or non-existence of this association we require data from a number of districts concerning *random* samples of the population drawn from them. The material collected by Friendly Societies affords the only possible data for such a problem, but the published valuations of most societies fail to give detailed information for individual districts, the only exceptions which could be found being the Rechabites, and, in less detail, the Manchester Unity. The last two valuations of the Rechabites and the last of the Manchester Unity afford material to work at.

At the time of the latest valuation (as at December 31, 1905) the Rechabites was divided into nearly 100 "districts," each containing a number of "tents," the "districts" varying considerably in number of members. On p. 61 of the Report of the valuation are shown the number of deaths occurring among members in each of the "districts" during the five years 1901-05, while in the following pages are given the comparative figures of "weeks of illness," dividing the latter up into "first twenty-six weeks," "second "twenty-six weeks" and "remainder of sickness." The corresponding "expected" amounts of sickness and "expected" mortality for each "district" are given, the standard taken being Neison's valuation of the *whole* of the Society for the ten years 1878-87. It is important to note that in working out these "expected" figures,

variations in age distribution only are allowed for, so that as regards all the other causes which affect amount of sickness and mortality, each "district" is looked upon as a *random* sample of the general society. In each district, therefore, the number of years exposed to risk at each age had to be known, due regard being paid to the time of entry of new members and withdrawal of seceders. This information is not given in the valuation, but only the number of members on the last day of the quinquennium. From a statistical point of view this is a great imperfection. It must also be remembered that practically all of the members who came within the "second twenty-six weeks" and "remainder of sickness" periods must have had the full benefit of the "first twenty-six weeks." (A few members would be receiving benefits under one or other of the former heads at the beginning of the quinquennium, and therefore would have passed through the "first twenty-six weeks" stage in the *previous* five-year period.) Thus the total number of weeks of sickness under the latter head cannot all be attributed to true short period sickness. In section 8 it was shown from Neison's report that roughly four-fifths of the total weeks of sickness "under twenty-six weeks" can be attributed to "short period" illnesses, while about one-third of the weeks of illness of a protracted nature fall within the first six months.

The information given in the report of the previous valuation is similar to that referred to above, but refers to the five-year period ending December 31, 1900.

Variations in the amount of sickness or of mortality in different districts, and in populations with the same number of years of life exposed to risk (for shortness in the remainder of the section, the phrase "populations of the same size" or of "constant size" will be used), will depend chiefly upon the age distributions of those populations. Other causes of variation will be due to differences of locality, occupation, habits, &c., while finally there will be a residuum due to random causes. If we correlate the number of weeks of sickness of, say, "under twenty-six weeks," with the number of deaths throughout many districts, and correct for a constant size of population, we shall discover what is the extent of the influence of variations in age, occupation, locality, &c., acting altogether on the association between illness "under twenty-six weeks," and mortality. Of these causes age is a very potent one, as is shown by the figures given in Tables V and XVII.

It is clear that "districts" with a large proportion of old members will suffer to a great extent from sickness of all types, and also have the heavier mortality, the total number of years exposed to risk being the same throughout. Thus we should expect to find

a positive correlation between the amounts of the various grades of sickness and between each of these and mortality for such districts solely from the fact that all of these variables are correlated with age distribution. To ascertain the magnitude of that correlation is undoubtedly of interest, but it is of more interest to find the corresponding degree of association in populations of the same age distribution. Variations in the amounts of sickness and of mortality would then be due only to occupation, locality, &c., and we should then be able to discover if the resultant effect of occupation, locality, habits, &c., is to increase both claims for sickness benefit and mortality together, or the reverse, and to measure the correlation between the variations produced by the sum total of these causes alone, but not by differences of age distribution. The problem is statistically possible if we can correct our correlation for "constant age distribution," and to suggest an answer to it is the chief object of this section. Does a population—*e.g.*, the members of a branch of a Friendly Society—which by reason of its peculiar occupation, locality, habits, &c., sustains heavy claims for sickness benefit, suffer, on the average, from a high rate of mortality from these same causes?

The chief part of the problem is to find an adequate measure of age distribution. The prospect of finding a factor which will represent the age distribution of a particular population *for all purposes* does not appear hopeful. We cannot say that the age distribution of a population is represented by a certain index, in the same way as the sex distribution is represented by the ratio of males to total persons. For the *purpose of mortality rates* the death-rate in a "standard population" is used by the Registrar-General, and by this means we know what the death-rate of a particular district would have been had the proportion of its population within each age-group been the same as for the whole of the country. Thus, if the death-rate for the whole of the country is 15 per 1,000 per annum, and "the death-rate in standard population" for a particular town is 18 per 1,000 per annum we know that the resultant effect of occupation, locality, habits, &c., in the latter is to increase the number of deaths by 3 per 1,000, the differences due to age having been completely allowed for. But this "death-rate in "standard population" does not lend itself satisfactorily to treatment by the method of correlation. Pearson, in a paper dealing with Maynard's problem of the correlation between the death-rates from diabetes and cancer, has used a modification of this method by dealing with the "corrective factor" necessary to convert the crude death-rate into the standard death-rate (*Journal of the Royal Statistical Society*, 1910, vol. lxxiii, p. 534), and a similar method could be

employed when dealing with the various types of sickness. The material necessary for calculating these corrective factors in the case of sickness, however, is not given in the data used for this paper, and I therefore suggest another method of attack.

As before stated, the only data given, other than the figures of sickness and mortality actually experienced, are the "expected" amount of sickness of each type and of mortality, and the number of members in each district at the close of the quinquennium considered. We must assume that the latter really represents on some scale the population exposed to risk. This is probably not so unsatisfactory as it appears, and unless it can be shown that the particular times within the quinquennium at which entries and withdrawals occur is correlated with the amount of sickness and mortality, no appreciable effect on the correlations found in this paper is likely to be caused by this approximation.

If two "districts" have the same "expected" number of weeks of sickness, say, "under twenty-six weeks," they may differ considerably in age distribution, for one may consist of fewer members but of older ages. Even if the "districts" have the same number of members and the same number of "expected" weeks of illness "under twenty-six weeks," the age distributions need not actually be the same, though there is much greater probability that the difference will not be large. Thus by making constant the number of members, and also the number of "expected" weeks of sickness of a particular type, we do not make the absolute age distribution exactly the same. But it is not essential that the *absolute* age distributions of the "districts" should be the same in order that the necessary correction may be made; it is sufficient that the *effective age distributions for the given problem in hand* should be the same. If two districts have the same number of members and the same number of "expected" weeks of sickness "under twenty-six weeks," there may be differences between the numbers in the various sub-groups of age which may effect the number of weeks of sickness of the other types; but if the inquiry in question concerns only sickness "under twenty-six weeks," we can say that the *effective age distributions for the problem in hand* are the same. To take a hypothetical example: two districts of the same size are divided into age-groups, as follows:—

	Under 30.	30—40.	40—50.	50—60.	Over 60.	Total.
District A.....	15	20	30	20	15	100
„ B.....	25	25	20	20	10	100

the rates of sickness (number of weeks per member per annum) being for “under twenty-six weeks,”

	Under 30.	30—40.	40—50.	50—60.	Over 60.	Total.
	1·0	1·1	1·3	1·4	2·5	—

and for “second twenty-six weeks,”

	·06	·10	·16	·30	1·20	—
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The numbers are so arranged that the total number of weeks of sickness “under twenty-six weeks” is the same for each district, viz., 141·5. The total number of weeks of sickness of “second “twenty-six weeks,” however, is 31·70 for District A and 25·20 for District B. Thus, by making constant the number of weeks of sickness of the former type, in addition to the total size, we do not absolutely make constant the actual age distribution and the number of weeks of sickness of the latter type. The *effective* age distributions, so far as concerns sickness “under twenty-six weeks,” are, however, the same. It is claimed, then, that by making the number of “expected” weeks of sickness “under twenty-six weeks” constant, in addition to rendering constant the number of members throughout a series of “districts,” the age distribution of those districts is the same for the purposes of sickness of that type, and that if variations occur in the number of weeks of sickness *actually experienced* by the districts, these variations are due to causes other than age differences, e.g., occupation, locality, habits, &c. If, therefore, we want the correlation between amount of illness of one type and of another, or of illness of a particular type and mortality, for a constant age distribution, it is sufficient to correct for (1) constant size; (2) constant “expected” number of weeks of illness of the first type; (3) constant “expected” number of weeks of sickness of the second type, or of “expected” number of deaths. This method will enable us to suggest an answer to the question: Do the “districts” which from causes other than those produced by age have heavy claims for sickness benefit of a particular type, have also, on the average, a large mortality or heavy claims for sickness benefit of another type?

It may be pointed out here that the same method can be applied to the important problems concerning the correlation between death-rates from various causes. Thus, to take, for example, Maynard’s case of the correlation between deaths from cancer and from diabetes. The “expected” number of deaths from cancer and from diabetes could be worked out for every district on the basis of the age distribution of the whole community, or, in fact, of any other

standard population. Then the association between cancer and diabetes would be tested by finding the correlation between the number of deaths from cancer and from diabetes for constant size of population and for constant "expected" number of deaths from each disease (see Pearson, *supra* sections 3 and 4).

While discussing the subject from this particular point of view, it may be suggested that a useful addition to the knowledge given by the "standard death-rate" published in the Registrar-General's supplements for each registration district would be to give the number of "expected" deaths in each age-group, based upon the experience of the whole country. These numbers can readily be used to ascertain the "standard death-rate," and their publication would enable us at once to see in what age-group the extra mortality of a district with a high "standard death-rate" existed. They were found *ab initio* for the purposes of section 6 of this paper in order to get the "expected" numbers of male deaths over 15 in registration counties. Had they been stated for the individual age-groups, simple addition would have given the figures required. But no simple arithmetical operation on the *rate* for individual age-groups will give the *rate* for a composite group containing them.

It has already been pointed out that the variate taken to represent the number of years of life exposed to risk, viz., the number of members on the last day of the quinquennium, is not quite satisfactory. The imperfections, from a statistical point of view, are not so large as they would be for purely actuarial purposes, and this for two reasons: (i) The fifty-six "districts" which had between 1,000 and 10,000 members at the latest valuation were dealt with, the mean number of members being 2,412 and standard deviation 1,766. The range is thus considerable, and little error is likely to arise from taking the number of members in a district as 1,500, when, determined from the true number of years exposed to risk, it should lie between, say, 1,480 and 1,520. (ii) As in most statistical problems, we can group our observations, and the working unit was taken to the nearest hundred.

The data given by the latest valuation were first dealt with, and for the fifty-six districts the following figures were tabulated:—

- x_0 = "Expected" number of deaths.
- x_1 = Actual number of deaths.
- x_2 = " " weeks of sickness of first twenty-six weeks.
- x_3 = "Expected" number of weeks of sickness of first twenty-six weeks.
- x_4 = Total members.
- x_5 = Actual number of weeks of sickness of second twenty-six weeks.
- x_6 = "Expected" number of weeks of sickness of second twenty-six weeks.
- x_7 = Actual number of weeks of "remainder of sickness."
- x_8 = "Expected" number of weeks of "remainder of sickness."

The mean values, standard deviations, and correlations obtained from the data of the latest valuation are given at the end of the paper.

The final partial correlations which are of interest are $_{034}r_{12}$, $_{046}r_{15}$, $_{346}r_{25}$, $_{048}r_{17}$, $_{438}r_{27}$, and $_{468}r_{57}$. A knowledge of many of the other correlations is also useful, and they are given below:—

$r_{12} = \cdot774$	$r_{15} = \cdot900$	$r_{25} = \cdot856$
$4r_{12} = \cdot182$	$4r_{15} = \cdot734$	$4r_{25} = \cdot434$
$0r_{12} = -\cdot256$	$0r_{15} = \cdot410$	$3r_{25} = \cdot127$
$3r_{12} = -\cdot299$	$6r_{15} = \cdot467$	$6r_{25} = \cdot463$
$_{034}r_{12} = -\cdot280$	$_{06}r_{15} = \cdot392$	$_{36}r_{25} = \cdot365$
$_{034}r_{12} = -\cdot156 \pm \cdot088$	$_{046}r_{15} = \cdot459 \pm \cdot071$	$_{436}r_{25} = \cdot386 \pm \cdot077$
$r_{17} = \cdot857$	$r_{27} = \cdot533$	$r_{57} = \cdot839$
$4r_{17} = \cdot865$	$4r_{27} = \cdot264$	$4r_{57} = \cdot875$
$0r_{17} = \cdot692$	$3r_{27} = -\cdot295$	$6r_{57} = \cdot455$
$8r_{17} = \cdot394$	$8r_{27} = \cdot137$	$8r_{57} = \cdot596$
$_{06}r_{17} = \cdot583$	$_{38}r_{27} = \cdot113$	$_{68}r_{57} = \cdot775$
$_{048}r_{17} = \cdot583 \pm \cdot059$	$_{438}r_{27} = \cdot158 \pm \cdot088$	$_{468}r_{57} = \cdot857 \pm \cdot024$

In each of the above sets the correlation for a constant x_4 alone shows the effect of correcting for size only, *e.g.*, we find that the effect of *all* causes—age, locality, occupation, &c.—in districts of the same size is to produce a positive association of $\cdot182$ between mortality and illness “under twenty-six weeks” (80 per cent. being true “short period” sickness). Making x_0 constant gives us the result of correcting for effective age distribution as it affects x_1 only, and making x_3 constant gives the result of correcting for effective age distribution as it affects x_2 only. Similarly when x_0 and x_3 are put constant together. The chief correlation in this first set is $_{034}r_{12}$ and indicates that the resultant effect of occupation, locality, habits, &c.—in fact, of all causes other than age and size—is to produce a *negative* association between the amount of “short period” sickness (using this term approximately) and of mortality. This is hardly significant when compared with its probable error, but before commenting upon this and the other correlations, the corresponding figures from the data of the earlier valuation will be given.

For obvious reasons it was hoped to have used the same 56 “districts” when dealing with the earlier valuation. This was not possible, and only 53 could be employed for most of the correlations. For the most interesting, however, 55 were available. Most of the “districts” appear to have been in a state of rapid growth in the period under review, and the general impression formed when working at the earlier material was that it was not so reliable as the later. The means, standard deviations and correlations given at the end of the paper refer to the 53 “districts”; the figures in brackets refer to 55. The figures for “expected” sickness and

“expected” mortality for this valuation were derived in the same way as previously described, the same standard experience being taken.

The partial correlations are also given below in the same form as before:—

$r_{12} = \cdot821$ ($\cdot813$)	$r_{15} = \cdot893$	$r_{25} = \cdot927$
$4r_{12} = \cdot357$ ($\cdot465$)	$4r_{15} = \cdot688$	$4r_{25} = \cdot775$
$0r_{12} = -\cdot371$ ($-\cdot335$)	$0r_{15} = \cdot312$	$3r_{25} = \cdot291$
$3r_{12} = +\cdot262$ ($\cdot406$)	$6r_{15} = \cdot365$	$6r_{25} = \cdot335$
$03r_{12} = +\cdot137$ ($+\cdot156$)	$06r_{15} = \cdot409$	$36r_{25} = \cdot555$
$034r_{12} = +\cdot041 \pm \cdot093$ ($\cdot096 \pm \cdot090$)	$046r_{15} = \cdot310 \pm \cdot084$	$436r_{25} = \cdot524 \pm \cdot067$
$r_{17} = \cdot843$	$r_{27} = \cdot631$	$r_{57} = \cdot779$
$4r_{17} = \cdot797$	$4r_{27} = \cdot411$	$4r_{57} = \cdot695$
$0r_{17} = \cdot648$	$3r_{27} = \cdot319$	$6r_{57} = \cdot474$
$8r_{17} = -\cdot113$	$8r_{27} = -\cdot132$	$8r_{57} = -\cdot077$
$08r_{17} = \cdot074$	$38r_{27} = \cdot305$	$68r_{57} = \cdot355$
$048r_{17} = -\cdot005 \pm \cdot094$	$438r_{27} = \cdot297 \pm \cdot084$	$468r_{57} = \cdot360 \pm \cdot081$

The use of x_7 —the number of “remaining weeks of sickness” after the first twelve months—is not very satisfactory, and I do not think that much reliability is to be attached to the correlations involving it. For this reason it is not proposed to discuss the last three sets of partial correlations given above for the two valuations. The other sets show a satisfactory agreement between the results derived from the material given by the two distinct valuations. The figures in these *suggest*—but at present no more than suggest—that the following statements may ultimately be found to indicate the relationships holding between the amount of mortality and the extent of the claims for sickness benefit.

(i) The resultant effect of *age*, occupation, locality, &c., is to establish a small correlation ($\cdot2$ to $\cdot4$) between the amount of illness claims of short period (80 per cent. of illness “under twenty-six weeks,” *i.e.*, of x_2 , is true “short period” sickness) and amount of mortality in the series of over 50 “districts.”

(ii) When the effect of *age* is allowed for, the resultant effect of the other influences—occupation, locality, habits, &c.—is to produce no correlation whatever (if anything, it is negative rather than positive) between the amount of “short period” sickness claim and the mortality in the “districts.”

(iii) The effect of *age* plus other causes is to establish a moderately large ($\cdot7$) correlation between the number of deaths and the amount of sickness of the “second twenty-six weeks” in the “districts.”

(iv) When *age* is corrected for there is still a significant association ($\cdot4$) between the amount of this type of sickness and of mortality.

(v) The correlation between the amount of sickness of “first twenty-six weeks” and that of “second twenty-six weeks,” when

the variations among the "districts" are produced by all causes other than by differences of size, is moderate ($\cdot4$ – $\cdot8$), and when this is corrected for age it is reduced but slightly ($\cdot45$).

These are the chief inferences which, I think, can be drawn from the material so far examined, but I would repeat that until further data are investigated these conclusions must be regarded very tentatively and as indications of what to seek for rather than statements to verify when better material is available.

The data provided by the latest valuation of the Manchester Unity would enable a similar investigation to be carried out on the relation between sickness and mortality throughout a series of districts. It could not be exactly comparable, however, since number of weeks of sickness is not given for the Manchester Unity, but only sickness cost, and this is divided into only two grades—Full Pay (*see* section 8) and Reduced Pay. A short investigation on approximate lines only has been carried out to ascertain the possible verification of the above suggested results. This has been attempted by correlating the mortality index (*see* section 6) with the corresponding sickness (Full Pay) index for various groups of the units into which the lodges of the Manchester Unity were collected. I think this is not so sound a process as dealing with actual numbers (not percentages) and forming partial correlations. The point can be tested to some extent by working out the correlation between similar indices in the case of the Rechabites and comparing with the corresponding partial correlations obtained when actual numbers and not percentages are employed. These correlations between indices to be compared with the values of $_{084}^{712}$ given above for the latest and the penultimate valuations of the Rechabites, viz.: $+ \cdot041 \pm \cdot093$ and $- \cdot156 \pm \cdot088$, are found to be $+ \cdot343 \pm \cdot080$ and $+ \cdot113 \pm \cdot090$ respectively.⁹ Thus there is evidence that the correlation between the indices is in excess on the positive side of the corresponding partial correlations by an appreciable amount, and the correlations shown below for the Manchester Unity are, therefore, likely to indicate an association in excess on the positive side of these which would be reached by the more laborious process of computing partial correlations similar to those worked out for the Rechabites.

⁹ In the hope of throwing further light on these correlations, the districts were divided into two groups according as they gave a positive or negative contribution to the general product moment for the later period. The former (30) gave a correlation of $+ \cdot782 \pm \cdot046$, and the latter (25) $- \cdot611 \pm \cdot084$. When the correlations for the same districts were worked out on the data of the earlier period they were found to be $+ \cdot412 \pm \cdot103$ and $+ \cdot227 \pm \cdot128$. Thus the districts with positive correlation in the second period also had positive correlation in the first period. This suggests further problems, which, however, cannot be discussed in this paper.

The object sought after in grouping the units in well-defined homogeneous geographical areas was to remove as far as possible one of the causes affecting sickness claims and mortality. The correlations shown below are independent of age effects and of geographical variations, and they indicate consequently the effect only of variations in occupation, habits, &c., on the extent of the association between sickness and mortality. They are therefore more restricted than are the correlations reached from the Rechabite material in which the effect of geographical variations could not be accounted for. The notation employed is:—

$$\alpha_1 \equiv (\text{Full Pay}) \text{ sickness ratio.} \quad \alpha_2 \equiv \text{mortality ratio.}$$

the statistical constants for the various groups of districts are:—

	$\bar{x}_1$.	$\bar{x}_2$.	σ_1 .	σ_2 .	r_{12} .
North, South and West London and Stepney (54 units)*.....	95·9	74·4	12·3	13·9	—·119±·09
Lancashire (50 units))	96·6	98·1	19·6	13·0	—·094±·095
Yorkshire (62 units)	102·4	88·6	19·6	12·5	—·174±·085
Wales (38 units).....	127·7	88·7	23·7	16·0	+·141±·107
Dorset, Devon, Cornwall, Somers- et and Wilts (43 units).....	100·8	71·5	7·9	12·4	+·130±·100
The rural parts of the counties of Lincoln, Bedford, Norfolk, Suffolk, Essex, Cambridge and Hertford (50 units).....	91·4	65·7	8·3	10·9	+·215±·091

* When the correlation for this group is corrected for constant size, no difference whatever is made, the correlation between size and sickness and mortality indices being +·011 and —·016 respectively.

The first three groups are, for the most part, urban, and the last three rural. The first three correlations are negative and the last three positive, but not one of the whole six is in itself significant. The figures are rather tantalizing, and conclusions can hardly be drawn from them. They suggest that the true correlation for urban populations is negative, and for rural ones positive. Supposing the three urban groups are *independent* random samples from a population for which the true correlation is just positive, the chances are about 130 to 1 against the three negative correlations of the magnitudes shown occurring. But, as stated before, these correlations are likely to be in excess on the positive side of the corresponding partial correlations of the type that were worked out from the Rechabites' data, and the inference is that the effect of occupation, habits, &c., is to cause a negative correlation between the extent of sickness claims and mortality in the districts. The subject is worthy of fuller investigation, but all the evidence collected in this

paper tends to the conclusion that those causes (other than age) which produce high mortality in a district, do not, on the average, produce excessive (short period) sickness claims, and that there may be a small difference between urban and rural areas in this respect.

24. The second of the problems suggested by the facts set forth earlier in the paper is to determine what is the degree of permanence in the deviations from the "expected" (as determined from considerations of age alone) of the sickness claims and mortality actually experienced throughout a series of districts. This will be measured by the correlation between the sickness or mortality index in one period and in a consecutive one. The indices are determined by questions of locality, occupation, habits, &c., which for the members of a particular district of a friendly society change but little from one quinquennium to the next, so that some degree of permanence in the indices should be anticipated. Suitable data for this problem are not prepared for the Manchester Unity, but the two valuations of the Rechabites used above permit of an inquiry being made. Let—

y_a denote the index for sickness of "first twenty-six weeks" in the earlier period.

y_b denote the index for sickness of "first twenty-six weeks" in the later period.

y_c denote the index for mortality in the earlier period.

y_d denote the index for mortality in the later period.

Then r_{ab} and r_{cd} respectively will give the degree of permanence in the deviations from the "expected" of the sickness and mortality actually experienced. These have been worked out for the 47 "districts" which contained over 1,000 members at the close of both valuations. The correlation in the case of the mortality has also been worked out for the whole of the 55 "districts" dealt with earlier in the paper, and the results for these are given in brackets. The full statistical constants are:—

$\bar{y}_a = 102.553$	$\sigma_a = 15.866$	
$\bar{y}_b = 101.553$	$\sigma_b = 20.555$	$r_{ab} = .693 \pm .051$
$\bar{y}_c = 95.468$ (93.600)	$\sigma_c = 22.187$ (23.047)	
$\bar{y}_d = 85.511$ (83.400)	$\sigma_d = 21.939$ (21.826)	$r_{cd} = .661 \pm .055$ (627 $\pm$.054)

These figures indicate a fairly large correlation between the deviations from the "expected" in one quinquennium and the next, both for sickness and mortality. Possibly a more accurate measure of this degree of permanence would be reached by weighting each deviation according to the size of the population (roughly, the number of members) on which it is based. This has not been done, since the modification produced in the correlations dealt with in other similar problems in which weighting has been attempted has

always been small, and also because it is the unweighted correlations which are required for the regression equations. These regression equations are given below, the partial standard deviation being shown as well:—

$$\begin{array}{ll} y_b = .898y_a + 9.25 & a\sigma_b = .721\sigma_b \\ y_d = .653y_c + 21.16 & c\sigma_d = .750\sigma_d \\ (y_d = .594y_c + 27.81) & (c\sigma_d = .779\sigma_d) \end{array}$$

Thus the mean for all the 47 “districts” of the indices for sickness in the first period was 102.5 and in the second 101.5. Those districts which deviated by + 10 from the mean in the first period, deviated, *on the average*, by as much as 9.0 in the second. For the mortality the mean value changed considerably from the first to the second period, and a deviation of + 10 from the mean in the first period was followed, *on the average*, by one of 6.5 in the second.

The insight obtained through working at a similar problem previously (*Journal*, May and June, 1911) suggested that higher correlations might be found by grouping the “districts” in some way. The material was hardly sufficient to warrant the expenditure of much time on this object, and only two attempts were made. In the first of these the “districts” which were above the general mean index in the first period were taken together, and likewise those which were below that mean. This was a failure, the correlations reached being much smaller than those obtained when all were taken together.

The second attempt was to deal separately with those which were roughly northern “districts” and with those which were southern. The division aimed at no great geographical accuracy, the 23 “districts” which were more northern than the remaining 24 being taken together. The results were not altogether satisfactory, but are worth recording. The statistical constants for the two cases were:—

<i>Northern districts.</i>		<i>Sickness.</i>	<i>Southern districts.</i>	
$\bar{y}_a = 102.17$	$\bar{y}_b = 101.52$		$\bar{y}_a = 102.87$	$\bar{y}_b = 101.17$
$\sigma_a = 12.265$	$\sigma_b = 21.190$		$\sigma_a = 18.787$	$\sigma_b = 19.926$
	$r_{ab} = .429 \pm .115$			$r_{ab} = .890 \pm .030$
Regression line $y_b = .742y_a + 25.67$			Regression line $y_b = .944y_a + 4.13$	
	$a\sigma_b = .908\sigma_b$			$a\sigma_b = .329\sigma_b$
<i>Northern districts.</i>		<i>Mortality.</i>	<i>Southern districts.</i>	
$\bar{y}_b = 100.96$	$\bar{y}_d = 90.26$		$\bar{y}_c = 85.92$	$\bar{y}_d = 77.71$
$\sigma_c = 23.387$	$\sigma_d = 21.719$		$\sigma_c = 20.167$	$\sigma_d = 20.313$
	$r_{cd} = .671 \pm .072$			$r_{cd} = .560 \pm .095$
Regression line $y_d = .623y_c + 27.0$			Regression line $y_d = .564y_c + 29.0$	
	$c\sigma_d = .741\sigma_d$			$c\sigma_d = .828\sigma_d$

The only significant increase in the correlation is for sickness in the southern districts, for which it has now the quite high value of .89. In two of the other cases the association is actually less than that obtained when dealing with the "districts" as a whole.

An interesting feature of these constants when division is made into northern and southern districts is that while for sickness the mean indices are practically the same, for mortality the mean index for the northern is considerably higher than the corresponding value for the southern districts. Thus the statistics provided by the Rechabites support the conclusion before stated from Mr. Watson's investigation that the variation effected by locality is smaller in the case of sickness than for mortality.

The question of the permanence in the amount of sickness claims from year to year in individual localities can be dealt with, to some extent, by means of information contained in the annual reports of the Hearts of Oak. For each of the 38 towns composing the "Large towns" frequently referred to in the course of this paper is given, every year, the estimated number of members and the average number of weeks of sickness per member "well" or "ill." This information is not so satisfactory for the present purpose as is that given by the Rechabites, since it does not allow of account being taken of alteration in age distribution of the members. But this alteration from one year to the next must be small, and if the number of weeks of sickness claim per member changes, say, from 1.1 to 1.3, we may be fairly certain that little of the change has been caused by an increase in the general age of the members. What the Hearts of Oak data permit us to investigate, then, is the degree of permanence in the actual amount of sickness per member in districts, and not in the deviation from the "expected," and for this purpose the figures for 30 of the 38 Large towns (the remaining eight had fewer than 1,000 members, approximately) were made use of. As these are given on a uniform basis over a long series of years we need not restrict ourselves to the correlation between figures for consecutive years, but can also use those referring to years at wider intervals apart. We can thus ascertain if there is any diminution in correlation as the interval is increased, or if it follows any "period." No greater interval than six years has been employed, and the results are set out below. The numbers above the diagonal running from the left-hand top corner show the correlations, and those vertically downward on the left-hand side the means and standard deviations.

Means, standard deviations of and correlations between the number of weeks of sickness per member for various years. Hearts of Oak (30 towns).

Mean.	Standard deviation.	Year.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
1·19	·227	1901	·786	·843	·800	·625	·661	·631	—	—	—
1·20	·210	'02	—	·878	·803	·505	·687	·676	·765	—	—
1·19	·222	'03	—	—	·900	·653	·860	·725	·856	·821	—
1·27	·208	'04	—	—	—	·784	·851	·737	·770	·734	·798
1·13	·182	'05	—	—	—	—	·758	·560	·666	·642	·627
1·23	·226	'06	—	—	—	—	—	·651	·802	·724	·753
1·26	·256	'07	—	—	—	—	—	—	·711	·678	·622
1·32	·207	'08	—	—	—	—	—	—	—	·891	·837
1·25	·210	'09	—	—	—	—	—	—	—	—	·770
1·16	·202	'10	—	—	—	—	—	—	—	—	—

The correlations can best be considered according to the interval between the years to which they refer, and can be summarised thus:—

Interval.

	One year.	Two years.	Three years.	Four years.	Five years.	Six years.
Mean Correlation.....	·792 (9)	·753 (8)	·702 (7)	·700 (6)	·711 (5)	·754 (4)

the figure in the bracket giving the number of correlations from which the mean is obtained. The correlation is as high as ·8 between the amounts of sickness in successive years, falls to ·7 when the interval has increased to three and four years and for the longer intervals appears to increase. The uniformity in the trend of these numbers would, if the differences were significant, be decidedly suggestive. To test the significance of the differences is a complicated matter, and as it would involve the determination of a number of other correlations not previously worked out the attempt to obtain the probable errors of the above means of correlations has been abandoned. From rough general considerations (probably of little value) I have formed the opinion that the difference between any two of the above means is not, *per se*, significant. The uniform tendency of the figures, however, introduces a further factor, and, on the whole, I think it must be conceded that no conclusive inferences can be drawn except that there is a fairly high degree of permanence persisting throughout many years in the amount of sickness claim per member exposed in individual towns.

25. The third of the problems to which reference has been made is the possibility of reaching a more reliable knowledge of the amount of sickness to be expected in individual areas than is given by the methods in general use. These consist, generally,

in knowing the age distributions of the local populations, and applying to each age-group the sickness rate experienced in some large standard population. The desideratum is to have the standard population as nearly alike in respect of occupation, situation, &c., the local population as possible. Frequently they are totally unlike, and the information for every one of the hundreds of courts and lodges is obtained from the experience of a previous period of the whole of the society to which they belong, and in certain cases of other societies. The two alternatives to this are (a) to use the experience of the locality itself for a previous period without reference to the age distribution, (b) to subdivide the whole society into a few main groups according to some well defined characteristic (as done, for example, in Mr. Watson's investigation of the Manchester Unity, 1893-97) and to use the experience of each group for the districts contained within it. With regard to (a) it has been shown that there is quite a large degree of permanence in the amount of sickness per member in spite of changes in age distribution, and if the object is to obtain beforehand a knowledge of the amount of sickness to be anticipated in a particular locality in a given period (which is not necessarily the actuaries' object when giving figures of "expected" sickness) the method will, as indicated below, in some cases give better results than are obtained by the more laborious process of finding the age distribution and applying the experience of some standard population, though this, of course, depends upon the particular standard population adopted. The method, however, is open to the objection that for small populations random fluctuations are likely to be proportionally large. (b) would give better results than are reached by having one standard population for the whole of a society, but would entail much more detailed "experiences" being worked out, and these would require a knowledge of the age distribution of local populations. Mr. Watson's "experience" of the Manchester Unity was arranged in groups for sickness, but according to occupations. Thus, if the details of these groups were used to ascertain the "expected" sickness for a locality not only would the age distribution of the members be required, but also the occupation-distribution, and the labour involved would be considerable.

I suggest the use of regression equations to be well worthy of the consideration of actuaries dealing with these subjects. The data are not available to test the use of these modern statistical implements completely, but from figures given below it will be seen that their use may save considerable labour, and at the same time bring the "expected" figures more close to those actually experienced in individual localities. Regression equations have not been employed in practice for estimation and prediction purposes to the extent which might have been anticipated. The labour and

pertinacity required to develop them in any particular problem to their best form is probably one of the causes of this, while their theoretical foundation is not always understood. But their practical utility of enabling us in a simple way to make use of the mean experience of the past for purposes of estimation at the present or the future is considerable. In the question of the estimation of local populations, for example, it is difficult to give adequate theoretical reasons why the use of regression equations based on births and deaths can be made to give better results than are reached on the assumption that the birth and marriage rates in a locality remain constant throughout an intercensal period, but the fact remains that the results are, when the variables and arrangement for the regression equations are properly chosen, very much better.¹⁰

It has already been stated that the Hearts of Oak annual reports show the number of weeks of sickness per member for each of the 38 towns composing the "Large towns." An attempt has been made to estimate for 1910 the figures for the 30 towns referred to in the last section by means of the figures given for the previous three years. Thus if x_1, x_2, x_3, x_4 and x_5 , denote the number of weeks of sickness per member in 1906, 1907, 1908, 1909 and 1910, respectively, the following equations are found:—

$$x_4 = \cdot904x_3 + \cdot056 \quad (\text{i})$$

$$x_4 = \cdot839x_3 + \cdot075x_2 + \cdot048 \quad (\text{ii})$$

$$x_4 = \cdot834x_3 + \cdot074x_2 + \cdot007x_1 + \cdot047 \quad (\text{iii})$$

the statistical constants on which they are based being given in the previous section.

The equation (ii) was the one used in order to predict the figures for 1910 from those in the previous years, *i.e.*, the relationship $x_5 = \cdot839x_4 + \cdot075x_3 + \cdot048$ was assumed. Two other estimates were made (*a*) by assuming the figure for 1910 to be the same as for 1909, and (*b*) by assuming the 1910 figure to be given by the mean of those for 1908 and 1909. The number of weeks of sickness per member among the 30 towns in 1910 varied from $\cdot85$ in Reading to $1\cdot79$ in Doncaster, and the maximum errors by equation (ii), (*a*) and (*b*) were $\cdot30$, $\cdot34$ and $\cdot35$, respectively. The distributions of errors arranged in groups are:—

	0—·04.	·05—·09.	·10—·14.	·15—·19.	·20—·24.	·25—·29.	·30—·34.	·35—·39.
Equation (ii)	4	8	8	6	2	1	1	—
„ (<i>a</i>)	4	6	6	4	6	2	2	—
„ (<i>b</i>)	4	5	6	4	7	2	1	1

¹⁰ See *Journal of the Royal Statistical Society*, May and June, 1911. More recent work has considerably improved upon the arrangement of the equations used, and the results have been further improved.

The usual criterion taken as representing the general error—the square root of the mean of the squares of the individual errors—has the values .140, .167 and .175 for the three cases, respectively, these being calculated on the ungrouped errors. It is hardly necessary to express the errors as percentages of the actual figures, since the large errors occur, for the most part, by each method in the same towns. Thus it appears that the regression equation working upon rough data and with no grouping according to similar characteristics, gives appreciably smaller errors than are given by the other methods.

The next natural step would be to compare the errors above with those given by the “expected” figures determined by the actuaries’ usual method, *i.e.*, from a knowledge of the age-distribution of each town and the use of some standard experience. Unfortunately, however, this cannot be done. Even if the age-distribution of the members for each town were published, the labour of calculating the “expected” numbers would be very considerable. A substitute for this is possible from the material of the Rechabites, where the figures for two consecutive quinquennial periods are available as well as the “expected” numbers on the usual basis. From this material has been worked out the number of weeks of sickness (first twenty-six weeks) per member per annum for each of the 85 districts employed in section 23, and compared with (i) the number of “expected” weeks of sickness (first twenty-six weeks) on the basis of the standard experience, and with (ii) the number of weeks of sickness (first twenty-six weeks) per member for the previous quinquennium. In this manner the errors arising when using (i) and (ii) to indicate the amounts of sickness to be anticipated can be found, and their distributions are:—

	0—'04.	'05—'09.	'10—'14.	'15—'19.	'20—'24.	'25—'29.	'30—'34.	'35—'39.	'40—'44.	'45—'49.
(i)	11	13	8	6	4	5	4	2	1	1
(ii)	14	12	12	12	2	1	2	—	—	—

These figures are not strictly comparable with similar ones for the Hearts of Oak above, since (a) they are spread over a complete period of ten years, during which the age-distribution may change quite appreciably. This would diminish the reliability of the estimates by (ii). (b) the number of members at the end of the period has been used and not the number of years of life exposed to risk in calculating the sickness per member. But this does not affect the comparison of the results by (i) with those by (ii). It is clear that (ii) gives more reliable estimates than (i), the root mean squares of the corresponding errors (ungrouped) being .134 and .192.

Thus the use of the "expected" figures (obtained by the usual method) for number of weeks of sickness, gives a knowledge of the amount of sickness to be anticipated in localities inferior to that acquired by assuming that the number of weeks of sickness per member remains the same over two successive periods. And this is in spite of the fact that the former quite reasonably gives the amount to be anticipated for the whole country (the "experienced" was 3 per cent. in excess of the "expected") and that it requires a knowledge of the age-distribution of each local population.

It thus appears that for the Hearts of Oak the regression equation would predict the amount of sickness to be anticipated to a closer approximation than would be reached by assuming the number of weeks of sickness per member constant over two successive periods, and that for the Rechabites the latter method gives better results than does the usual method which requires a knowledge of the age-distribution of each local population. I prefer to look upon the actuaries' terms "expected sickness" and "expected mortality" as analogous to the Registrar-General's "Death-rate in standard population." As pointed out before there would be certain advantages accruing from the publication of the "expected" number of deaths in each registration district, the corresponding thing to the "Death-rate in standard population" being the index obtained by expressing the actual number of deaths as a percentage of the "expected" number. It is, I think, distinctly unfortunate that such a commonplace word as "expected" should be employed to denote what is in reality a highly technical term. The inverted commas are frequently overlooked or dropped altogether, and from platform, press and pulpit one could draw examples of the fallacies involved in its use by the non-statistically trained person. Yet the "Death-rate in standard population" is never heard of in polemical discussions; the mere sound is sufficient to reserve it for those acquainted with its real meaning. The actuary rarely attempts to take any factor into account other than age when giving his "expected" figures. A closer "expectation," *taking all factors into account*, can, I believe, be reached in a much simpler and less laborious manner.

26. The last of the problems which it is proposed to refer to in this paper is one suggested by the geographical distribution of sickness, dealt with in section 19. It was there shown that the distributions of sickness (when correction is made for age) both for full pay and reduced pay are quite skew, and have a long tail at their upper ends. Assuming that each Manchester Unity "unit" (see section 5) is a random sample of the male adult population of the district from which it is drawn, an interesting inquiry will be to ascertain what effect is produced on the estimated amount of

total sickness when the skewness of the distributions and the variations in the relative sizes of the samples are taken into account. If, for example, the "units" at the upper end of the distribution represented a much smaller proportion of the adult male population in their districts than the "units" at the lower end, it would be rash to take the sickness experience of the whole society as that to be anticipated for the whole adult male population. This problem, then, can be stated thus: If the sickness of the whole of the Manchester Unity be represented by the index 100, what figure will represent the sickness of the total male adult population of the country when account is taken of the heterogeneity in the distribution of sickness and of the relative sizes of the Manchester Unity samples? The calculations are to serve no practical purpose, and the result will consequently be only a rough approximation. It is not practicable to deal with the "units" previously employed (section 5) and accordingly the county areas have been taken as the boundaries of the samples. The sickness index for "Full Pay" and the *modified* index for "Reduced Pay" are those used in section 20. (The modified index has been taken so that the index for the whole society is 100). The male population between the ages of 16 and 70 for each of the counties at the Census of 1901 has been aggregated from the Census reports, and each of these populations has been assumed to have the same sickness indices, both "Full Pay" and "Reduced Pay" as the corresponding Manchester Unity sample drawn from it.¹¹ The whole of the 1,345,000 adult males in Lancashire, for instance, are assumed to conform to the indices, 96.8 for "Full Pay" and 88.6 for "Reduced Pay," which are the figures for the Manchester Unity sample in Lancashire. When the indices for each county are weighted according to the *Manchester Unity* population the index for the whole society is, of course, 100 for both "Full Pay" and "Reduced Pay." When they are weighted according to the *Census* (1901) male populations between 16 and 70 the resultant indices are found to be 101.1 and 100.8 respectively. These results are a little surprising and indicate that though the proportion of the adult males who are members of the Manchester Unity varies from county to county, the society has not, on the whole, drawn its members from those of high rather than of low sickness. Three of the four counties (or collection of counties) with the highest sickness indices show a greater proportion of their population in the Manchester Unity than the corresponding proportion for the whole

¹¹ It is clear from the details in the Manchester Unity Valuation that the counties used are not conterminous with the geographical counties used in the Census. The Unity's Middlesex, for example, appears to contain parts of Essex. I think the effect caused by such facts as this, however, is not likely to be large.

country. These are North Wales (10·3 per cent.), Monmouth (9·0 per cent.), and Glamorgan (8·1 per cent.), the percentage for the whole of England and Wales being 7·5. On the other hand, Durham, which has the second highest sickness index among the counties, has only 4·8 per cent. of its adult male population in the Manchester Unity, and Lancashire's 61,300 members represented only about 4·6 per cent. of its adult males between 16 and 70.¹²

A similar process has been carried out in the data given by the last two valuations of the Foresters, where the figures are given for total sickness only. The indices for the whole male adult population, when account is taken of the individual county indices in conjunction with the proportion of the population in each county, were found to be 99·5 and 99·8 for the 1902 and 1907 valuations respectively. This agrees roughly with the Manchester Unity result, and is accounted for, to a large extent, by the fact that a number of the largest counties—Lancashire, West Riding of Yorkshire, &c.—have indices not far from 100. The few with large deviations above 100 are balanced by a larger number of counties with moderate deviations below.

It may be remembered that in the first report of the actuaries concerning the National Insurance Scheme, rates were worked out for each age-group of the whole of the estimated number of insured males, when account was taken of the relative numbers of insured in the four occupation grades described early in this paper, and the individual rates found by Mr. Watson for each of these groups. The rates so deduced for each period of sickness were about 10 per cent. above the general Manchester Unity standard for nearly all groups (showing that the society is not a random sample drawn from all occupations), this including claims due to accident which are now met under the Workmen's Compensation Act.

27. A few words may, perhaps, be said at this point upon a subject which has received some attention since the introduction of the National Insurance Bill, viz., whether or not the incidence of sickness among the population which did not previously belong to the friendly societies is higher than that of the old friendly society population. The argument has been advanced, and, indeed, in some quarters it has been put forward as axiomatic, that as the old societies dealt for the most part with selected lives, those who were outside necessarily had higher sickness rates than those within. The statistical evidence for this view is hardly commensurate with the vigour by which it has, by some, been maintained. What the statistical evidence does show is that the *mortality* of those outside the societies was greater

¹² These percentages are only approximate, since the population figures are from the Census of 1901, but the Manchester Unity's are more recent.

than that within. A comparison of the death-rates given in Table V deduced from the English Life Table No. VI (that adopted for the actuarial purposes of the national scheme) with those of the Manchester Unity demonstrates this. The figures shown in that table, in fact, understate the real difference between the two classes, since the Life Table includes the experience of the professional and commercial classes, &c., which is much below that of the whole community. But the balance of the evidence put forth in this paper is to the effect that populations with high mortality do not suffer from excessive claims for sickness benefit. Lancashire and the West Riding of Yorkshire are salient cases in point, and although Durham and Glamorgan appear to point in the opposite direction, it must be remembered that in those counties many of the excessive sickness claims are due to accident. On the other hand, some of the southern counties with very low mortality rates show sickness rates not below the general average for the country. The facts brought out in this paper intimate that heavy sickness claims and high mortality are rarely associated and then only in counties where the sickness claims are more than usually swelled by the inclusion of much that is due to accident and which is now dealt with under the Workmen's Compensation Act.

On the whole, the review of the facts brought out in this paper suggests that the sickness experience of the newcomers to the societies through the National scheme is not likely greatly to exceed that of the members previously in those societies, and that the Manchester Unity tables (1893-97) will be, under adequate supervision, as applicable to the former as the latter. I believe, however, that the English Life Table (1891-1901) will over-state the mortality of the insured in future years, and that as this will lead to a larger proportion of survivors to the heavy sickness years between 60 and 70, more apprehension is to be felt on this head.

Before concluding this paper, a little may be said concerning the application of the method of correlation to the sickness data of Friendly Societies. No doubt this will be criticised on account of the imperfections of the material used. These have been pointed out in the paper, and the weight of them is fully appreciated by the writer. To some critics, the fact that there was a single imperfection would be sufficient reason to aver that the method is entirely inapplicable. Yet, with all the deficiencies of the data, I believe they are sufficiently good for more thorough analysis than has yet been given to them, and, in any case, their real value can only be assessed through working on them. It should be remembered that the correlation coefficient is essentially based upon the principle of averages, and in this connection a quotation from

a prominent actuary (Mr. G. F. Hardy) is particularly apt: "Whenever a group of persons or of societies is sufficiently homogeneous, the principle of averages will be found to apply as much in respect of sickness as for deaths." In applying a simple form of average—*e.g.*, in finding the average duration of sickness throughout the country—it is appreciated that the imperfections tend to neutralise one another, and precisely the same thing can be claimed when the average employed is the rather more complicated one of the correlation coefficient. So far as I am aware, the correlation coefficient has not before been employed on the sickness data of Friendly Societies, and no defence is needed for indicating the class of problems to which it can be applied. To the sceptical, I would point out the utilitarian results which have been achieved by the method, and the promise held out of further such results (section 25).

Finally, I must express my indebtedness to the following gentlemen, without whose assistance I should have had access to very little of the material here dealt with: Mr. W. Collins, of the Manchester Unity; Mr. W. Stead, of the Foresters; Mr. C. W. Burnes and Mr. C. Davis, of the Hearts of Oak; Mr. George Marshall, of the Rechabites; Mr. J. Duncan, of the Rational Association; and Mr. R. Kennedy, of the Shepherds. Above all, I have to express my thanks to Mr. A. W. Watson, since before invoking his aid I was able to make use of the data of but one society only.

APPENDIX.

(1.) *Statistical constants of curves in Fig. I.*

1892.	1910.
$\mu_2 = 3.7428, \mu_3 = 5.4647, \mu_4 = 45.8270.$	$\mu_2 = 5.4666, \mu_3 = 8.7587, \mu_4 = 89.3617.$
$\beta_1 = .5696, \beta_2 = 3.2713.$	$\beta_1 = .4698, \beta_2 = 2.9912.$
Mean = 35.70.	Mean = 40.68.
Mode (and origin) = 29.89.	Mode (and origin) = 33.04.
Skewness = .6007.	Skewness = .6545.
$y = 21.36 \left(1 + \frac{x}{2.1196}\right)^{.9935}$	$y = 17.34 \left(1 + \frac{x}{2.2966}\right)^{.7028}$
$\left(1 - \frac{x}{12.2968}\right)^{5.7636}$	$\left(1 - \frac{x}{12.0873}\right)^{3.6941}$

(2.) *Statistical constants of the distributions in Tables VIII and IX.*

TABLE VIII.	TABLE IX.
$\mu_2 = 10.6789, \mu_3 = 6.9915, \mu_4 = 338.8677.$	$\mu_2 = 16.7075, \mu_3 = 15.3855, \mu_4 = 817.3703$
$\beta_1 = .0401 \pm .02, \beta_2 = 2.9715 \pm .15.$	$\beta_1 = .0508 \pm .02, \beta_2 = 2.9282 \pm .14.$
Mean, mode, and origin at 79.29.	Mean, mode, and origin at 98.28.
$y = 68.95. e^{-\frac{x^2}{21.3373}}$	$y = 58.66. e^{-\frac{x^2}{33.4150}}$

(3.) *Statistical constants of the distributions in Tables XIX and XX.*

TABLE XIX.

$\mu_2 = 11.8863, \mu_3 = 63.1759, \mu_4 = 1033.9047.$
 $\beta_1 = 2.3766, \beta_2 = 7.3179.$
 Mean = 101.60.
 Mode = 91.32.
 Origin = Mean - 153.64.
 Skewness = .5967.
 $y = 30.0606(x - 125.2080)^{2.5664}x^{-20.2896}$

TABLE XX.

$\mu_2 = 18.4470, \mu_3 = 34.5158, \mu_4 = 1263.1527$
 $\beta_1 = .1898, \beta_2 = 3.7120.$
 Mean = 155.62.
 Mode = 148.16.
 Origin = 82.14.
 Skewness = .1786.
 $y = 11.425 \left(1 + \frac{x^2}{254.224} \right)^{-9.8540}$
 $e - 8.1605 \tan^{-1} \frac{x}{15.9444}$

(4.) *Statistical constants for partial correlations given in Section 23.*(a.) *Latest valuation.*

$\bar{x}_0 = 79.43$	$\sigma_0 = 51.56$		
$\bar{x}_1 = 67.59$	$\sigma_1 = 49.68$		
$\bar{x}_2 = 11225.0$	$\sigma_2 = 9165.2$		
$\bar{x}_3 = 10604.3$	$\sigma_3 = 7048.5$		
$\bar{x}_4 = 2412.5$	$\sigma_4 = 1766.1$		
$\bar{x}_5 = 1610.7$	$\sigma_5 = 1370.5$		
$\bar{x}_6 = 1350.0$	$\sigma_6 = 883.8$		
$\bar{x}_7 = 3457.1$	$\sigma_7 = 2951.0$		
$\bar{x}_8 = 2764.3$	$\sigma_8 = 2171.6$		
$r_{01} = .9296$	$r_{13} = .8494$	$r_{26} = .8362$	$r_{46} = .8442$
$r_{02} = .8807$	$r_{14} = .7711$	$r_{27} = .5328$	$r_{47} = .4893$
$r_{03} = .9300$	$r_{15} = .8997$	$r_{28} = .5422$	$r_{48} = .5312$
$r_{04} = .8779$	$r_{16} = .9310$	$r_{34} = .9803$	$r_{56} = .8777$
$r_{05} = .8995$	$r_{17} = .8674$	$r_{35} = .8718$	$r_{57} = .8287$
$r_{06} = .9606$	$r_{18} = .8661$	$r_{36} = .9183$	$r_{58} = .7349$
$r_{07} = .7368$	$r_{23} = .9620$	$r_{37} = .6195$	$r_{67} = .8098$
$r_{08} = .8288$	$r_{24} = .9639$	$r_{38} = .6579$	$r_{68} = .8950$
$r_{12} = .7740$	$r_{25} = .8556$	$r_{45} = .8188$	$r_{78} = .8833$

(b.) *Earlier valuation.*

$\bar{x}_0 = 51.79$	(52.96)	$\sigma_0 = 32.17$	(32.50)
$\bar{x}_1 = 50.70$	(51.38)	$\sigma_1 = 37.16$	(36.66)
$\bar{x}_2 = 8288.7$	(8523.6)	$\sigma_2 = 6059.9$	(6115.2)
$\bar{x}_3 = 7911.3$	(8296.0)	$\sigma_3 = 5206.6$	(5544.5)
$\bar{x}_4 = 1856.7$	(1952.7)	$\sigma_4 = 1178.8$	(1272.9)
$\bar{x}_5 = 1132.1$		$\sigma_5 = 1033.2$	
$\bar{x}_6 = 758.5$		$\sigma_6 = 538.6$	
$\bar{x}_7 = 2320.8$		$\sigma_7 = 2554.9$	
$\bar{x}_8 = 1749.1$		$\sigma_8 = 1668.3$	
$r_{01} = .9351$	$(.9210)$	$r_{13} = .8066$	$(.7722)$
$r_{02} = .9296$	$(.9334)$	$r_{14} = .7926$	$(.7533)$
$r_{03} = .9353$	$(.9290)$	$r_{15} = .8928$	
$r_{04} = .9333$	$(.9186)$	$r_{16} = .8871$	
$r_{05} = .9044$		$r_{17} = .8426$	
$r_{06} = .9494$		$r_{18} = .8869$	
$r_{07} = .7346$		$r_{23} = .9749$	$(.9645)$
$r_{08} = .7916$		$r_{24} = .9494$	$(.9349)$
$r_{12} = .8209$	$(.8128)$	$r_{25} = .9274$	
$r_{26} = .9441$		$r_{46} = .9145$	
$r_{27} = .6313$		$r_{47} = .5515$	
$r_{28} = .6801$		$r_{48} = .6221$	
$r_{34} = .9823$	$(.9809)$	$r_{56} = .9436$	
$r_{35} = .8789$		$r_{57} = .7791$	
$r_{36} = .9316$		$r_{58} = .8190$	
$r_{37} = .5886$		$r_{67} = .7084$	
$r_{38} = .6565$		$r_{68} = .7846$	
$r_{45} = .8363$		$r_{78} = .9654$	

DISCUSSION *on* DR. SNOW'S PAPER.

SIR EDWARD BRABROOK, in proposing the vote of thanks to Dr. Snow, said it was a satisfaction to him to hear a Paper read before the Royal Statistical Society on the subject of the experience of friendly societies. The Paper was a timely one, because, as it happened, the Council of the Society had recently appointed a Committee to consider the questions of mortality and morbidity, and undoubtedly the Paper would be of value to that Committee. It was evidently the result of a great amount of personal labour. It threw light on many interesting problems—such as the deaths in different districts, the diminution of mortality in recent years, and the value of selection—all of which were important practical questions. But he supposed that the main interest of the Paper related to the subject of sickness. Sickness benefit in friendly societies was a question of extreme difficulty. It was complicated by a variety of what he might call personal equations; it was varied by the occupation, the character, the climate, and by the surroundings generally of the persons who were under observation. He thought it was really hardly possible to construct a coherent definition of what sickness in friendly societies really was. It was not in any sense a definite physical fact; therefore, one had to deal with a variety of considerations, and he thought that the analysis with which Dr. Snow had favoured them would undoubtedly be extremely useful. The popular interest in the Paper was probably greatest in regard to those passages which related to the National Insurance Act. He did not think at that hour of the evening he ought to prolong the discussion by any detailed observations in regard to that part of the Paper, but he was sure that in its permanent form in the *Journal* it would be found to be exceedingly interesting.

Mr. A. W. WATSON, in seconding the vote of thanks, said he had to express his entire agreement with Sir Edward Brabrook as to the difficulty in defining the “sickness” with which the friendly societies had to deal. But the friendly societies found less difficulty in dealing with it in a practical manner, and in the great majority of friendly societies sickness was accepted as being a state of incapacity medically certified as preventing a member from following any remunerative occupation. The medical certificate was supposed to be the great safeguard of the society against malingering, but it was interesting to note that in some parts of the country where it was not the practice of the societies to employ medical officers and where medical certificates were not required, the sickness rate was comparatively low, and in these cases he thought it might be taken that the friendly societies themselves exercised responsibility which in other cases had been cast upon the doctor. That was a very admirable feature in the work of these societies, and it was a matter of regret that societies generally were ready to cast the entire responsibility upon the doctor, rather than satisfy themselves that the member was not only sick in a medical sense, but was suffering from the sort of incapacity for the relief of which their funds had

been accumulated. The "rate of sickness" with which actuaries had to deal in connection with the financial arrangements of friendly societies was sometimes very difficult to measure. It depended in any particular case, as Dr. Snow's investigation must convince them, very largely upon the occupational distribution of the membership. It might be said that in relation to the Manchester Unity whole society experience groups A, H and J, that was the agricultural and the general occupations involving no material risk, what one would call normal occupations, would bring about 92 per cent. of the general standard rate. Groups B, C, and D, representing the railway workers, outdoor labourers of all kinds, building trades and so forth, brought about 112 per cent. of the standard. The iron workers and steel workers brought about 140 per cent., and miners about 170 per cent. It was obvious that the proportions in which these varying degrees of risk, and many other degrees of risk, were mixed up in the general body would very considerably affect the total quantity of sickness properly to be expected in any particular case. The Hearts of Oak afforded a case in point. The valuations of that society were made upon the Manchester Unity standard. A certain degree of dissimilarity between the actual and the expected sickness was disclosed, and he had set himself to analyse the cause. Of course in such a case as the Hearts of Oak, it was quite impossible to dissect the entire experience of the society; but he considered that samples were admissible, and he took the occupations recorded at the date of entry of 1,000 members who had joined in a particular period 30 years ago, and another 1,000 who had joined a few years after that, and repeated the process with 4,000 separate members. He had found that the distribution had this effect. The Hearts of Oak excluded miners from its membership, but it had some miners in its ranks, because men had changed their occupations and had been allowed to remain in the Society; but it did not admit mining members, so he had no numbers in group G. On the other hand, the Hearts of Oak benefit was 18s. a week, and the rules of the society required, or did require, that a person should not be eligible for membership unless he were earning 24s. a week. The effect of that was to exclude the agricultural labourer. There was thus an elimination of risks at both ends, the lightest and the heaviest, and in the net result he found that the rate of sickness which he might expect according to occupational distribution of the society was almost exactly the same as the Manchester Unity. That, of course, was an accidental coincidence, but it was patent that without investigation an actuary would not have been entitled to look for the reproduction of the Manchester Unity sickness among the Hearts of Oak members. Then again he might refer to the case of the Rational Association. The Rational sickness rate had been increasing rather seriously of recent years. It appeared that over a series of years the mining members of the Rational had increased in great proportion with reference to the total membership of the society. Consequently the Rational experience was becoming excessive, not because the rate of sickness had changed, but because a large proportion of members had been infused into the total body of persons whose occupation rendered them liable to the maximum sickness rates known to

actuarial investigators of the subject. Another phase of the problem presented itself in relation to the general change in the rate of sickness. Dr. Snow's investigations had led him to a very distinct conclusion, with which he was in entire accordance—namely, that there was no necessary relation between the rate of sickness and the rate of mortality. Even without the aid of the valuable statistics which Dr. Snow had presented to them, he thought that might be held to be established by comparing the Manchester Unity experience of 1866-70 with the experience of the same society for the years 1893-97. In thirty years the rate of sickness in the Manchester Unity had increased very considerably. At the same time the rate of mortality had declined to a remarkable extent. If there were a close relation between the two experiences, certainly they could hardly expect to find a universal increase in the one and a decrease in the other. It would of course be very interesting if it were possible to find the reason for the increase in the rate of sickness, which could not be otherwise than disappointing in view of the great advance in medical knowledge, sanitary conditions, and the education of the people during the last forty years. If one hazarded a reason, it was probably not to be found in anything capable of statistical expression. It was probably to be found in the increase of the claim habit. Fifty years ago sickness benefit of friendly societies was called a sick gift. For many years, although after a proper contribution was paid for it, it was regarded more in the light of a gift than in the light of a definite insurance. That spirit did not obtain to-day. He desired to correct Dr. Snow's reference to the use of the English Life No. 6 Table, in connection with the subject of National Insurance. The table upon which the financial basis of the Act had been framed was issued in an official publication of the National Health Insurance Joint Committee (Cd. 6292). It would be found on referring to the rates of mortality of that table that it very closely conformed with the Manchester Unity Table of 1893-97. The new table was based on general population statistics, and it indicated that the general mortality rate had so far improved that what in 1893-97 was the experience of a select body of lives had now become the general experience of the whole community. The table had provided therefore to some considerable extent for the increased liabilities due to longevity to which Dr. Snow has drawn attention.

Mr. BARBER said he was particularly interested in what Mr. Watson had said about the sick pay increasing. It appeared to him from his experience that there was a certain amount of heredity about it. The members recalled that their fathers and grand-fathers were members of the society, and they thought that they were going to have the same benefits. The increase in sickness, he thought, was also due to modern conditions of life, which prevented a great many young men from following their occupations continuously.

Mr. P. M. REA said there was one point he would like to refer to—namely, the apparent anomaly existing as to the comparative sickness rates amongst persons who were not insured in any friendly society and those who were. The sickness rate apparently was

lower among those persons, and the converse was the case as regards the mortality rate. It was safe to assume that in a general sense the membership of a friendly society from a health point of view was of better status than in the case of those outside, because a number of those outside were probably not in a fit state to be admitted to membership. Yet they had the apparent anomaly that the inferior lives did not experience any more sickness than the selected lives, yet the mortality rate was higher among them. But he thought, if they looked closely at it, there was an explanation ready. To a man who was insured in a friendly society or two (and he thought the majority of those who were insured in a friendly society were insured in two, and sometimes three) there was a great inducement when a minor illness took place to "lay up," consult a doctor, and take his annuity until he got strong and vigorous; because, when a man was not insured in a friendly society at all, and he had nothing coming in, there was really no inducement for him to "lay up." He must work as long as he could; and he might work too long, which would of course undermine his health and hasten his death, and therefore help the mortality rate among uninsured persons. He said there were a great number of factors which were very important. There was the factor that a man had a larger income when he was ill than when he was working. Then there was another factor—some of the experiences of friendly societies showed a smaller sickness ratio than others, and it might be interesting to know what relation the more rigid supervision in those cases had to the others. Then the cold weather sometimes had something to do with the claims. The claim ratio was always much higher in the winter when the weather was cold, and it was much more comfortable—as a member who "laid up" every winter said—to sit near the fire and smoke one's pipe and read the paper while the snow and cold winds were outside, instead of working. That man was a carman. The Hearts of Oak and all other societies year after year had persons claiming illness periodically, while the large proportion of the membership never claimed anything at all, until finally when they got very ill and they had to claim something. It would be an interesting phase of the question to know how many of the claims which those societies paid went among a very small proportion of the membership. Institutions of that kind had bad members and good members. There was a moral hazard exercising a great influence on the question. Then there was the question as to what influence the National Insurance Act would have on the sickness claim ratio. It was frequently a misnomer to call it sickness, because many members were in quite good health when they became pensioners of the institutions of which they were members. They would also find, as the income of those members got larger, that there was a tendency for the claim ratio to get larger also. They would, no doubt, find that the amount to which they would be entitled under the National Insurance Act would be very appreciably increased, because it was found that most members of friendly societies continued their membership still, and yet they were entitled to their ten shillings also from the State. There was that to consider; and there was also the further fact that friendly societies had very largely

relaxed their rules for admission to membership. Some of them had extended the ages, and the result was that there had been a very large influx of new members into those societies since the introduction of the National Insurance Act. Everything seemed to indicate that the future experience of all those societies would show a marked increase in the claim ratio, and he thought also that the experience under the National Insurance Act would show the same tendency; and instead of underestimating the amount which would be required to meet the claims, he thought experience would show in the future that they had very considerably underestimated it, and would have to provide in the aggregate very much more than they had hitherto paid.

Mr. MOFFREY said that those of them who had endeavoured to guide the destiny of friendly societies had found that instead of stepping into waters in which they were unable to swim, it was better to follow the advice of expert advisers whom they had engaged to train them in the way they should go. They had also found that the most successful societies had been those who followed most closely the actuarial advice given to them, based on the investigations gained from the experience of the societies themselves. Therefore they welcomed any further investigation, in the belief that it might still further help them to achieve the success they all desired in the matter of sickness insurance on sound actuarial principles. Some thought that the National Insurance Act would put an end to any further necessity for those societies troubling themselves, but he entirely disagreed with that. In his opinion the present National Insurance Act had opened up a fresh field of research which would have to be gone into very deeply for the benefit of those concerned, and probably fresh problems would emerge which it would be the duty of the societies to grapple with and solve to the best of their ability, for the welfare of the members.

Mr. A. F. DYMANT said he would like to give a little information on two points—with regard to what Mr. Watson had said as to over-insurance, and also with regard to the inspection of the men who were ill. In the first place it had come to his knowledge a few days ago that a member of a society in which he was interested had asked his medical officer for nine certificates in order that he might make nine claims for sickness. The other point was that the society with which he was connected had had in operation for the last six or seven years a somewhat efficient system of independent inspection. They had an inspector who worked from the head office, and they found they had more than compensated themselves for his salary by the saving in the sickness claims, in addition to which a certain amount of moral effect had been instilled into the members, as they never knew exactly when the inspector was going to call upon them. That, to his mind, was a much more efficient method of checking the sickness claims than the system which was adopted by a very large number of friendly societies, namely, that of the visiting of sick persons by fellow-members residing in the same neighbourhood.

Dr. GREENWOOD said, with regard to the question which two or three speakers had raised as to medical certificates, he had at one time had experience of that, having been brought up in a working-class neighbourhood, where his father was a practitioner. There was this point to be remembered, that the commercial interests of the doctor as a general rule tended to favour his giving a certificate when it was really not necessary rather than to operate in the other direction; because if one refused a man, he might prefer a charge against one at the next meeting of the local court for neglect, and it was quite possible one might lose that club. It occurred to him that that might affect the question of geographical distribution in this way, viz., that in certain districts the clubs might form the main source of the doctor's income, and in other districts the clubs might be few, and they might be divided among the different doctors, so that the club practice only formed a very small proportion of any one practitioner's livelihood. The consequence was that in the latter case there was not anything like the same incentive to the doctor to be sycophantic to the faddy member. That might conceivably be a factor in some of the variations. Another point was as to the question of method. Dr. Snow had introduced an extremely ingenious proposal for dealing with the correction required to allow for the effect of different age-distributions, and he had referred to the case of Mr. Maynard's paper on cancer and diabetes rates. The point the speaker wished to raise was that all these proposals involved an increasing number of correlation coefficients to calculate. He was not quite clear whether in most ordinary statistical practice the additional result obtained by the additional labour was really commensurate with the effort. For example, if they took the case of Mr. Maynard's results and the method applied to them by Professor Pearson in their own *Journal*, the difference which Professor Pearson obtained in the coefficient after much laborious work was extremely slight. As a simple illustration, suppose they considered deaths from two diseases in a common population and that no question of age differences arose; for example, X deaths from one disease and Y deaths from another disease, the population being Z, then all ordinary statisticians considered the ratio of X to Z and Y to Z as measures of the prevalence of disease, i.e., the death rate from that disease. He was assuming that age did not come in. The natural idea would be to correlate, if they wished to proceed by correlation, $\frac{X}{Z}$ and $\frac{Y}{Z}$. But the question had been raised as to the existence of spurious correlation owing to the common population. The method which Mr. Maynard had pursued, and which he thought Dr. Snow usually used, was not to take the rates at all, but to correlate the total number of deaths from one disease X, and the total number of deaths from the other disease Y, each with Z, then to correlate X and Y, and finally to determine a partial correlation $r_{xy \cdot z}$. Supposing they correlated the two indices with population constant, i.e., found $r_{\frac{x}{z} \cdot \frac{y}{z}}$, then, as a matter of logic, the two partial correlations should be identical, but in actual practice $r_{xy \cdot z}$ and $r_{\frac{x}{z} \cdot \frac{y}{z}}$ were not always exactly equal for reasons

there was no time to go into. But the point he wished to emphasise was that the coefficients $r_{\frac{x}{z} \cdot \frac{y}{z}}$ and $r_{\frac{y}{z} \cdot \frac{x}{z}}$ were, in his experience, usually small, with the result that the ordinary total correlation between $\frac{X}{Z}$ and $\frac{Y}{Z}$ was very little different from the partial correlation $r_{\frac{x}{z} \cdot \frac{y}{z} \cdot z}$. In most cases also it did not deviate very appreciably from the partial correlation between X and Y , i.e., $r_{xy \cdot z}$. Of course the practical point was that in one case you only required to determine one correlation, but in the other case you must work out three. The labour was more than doubled in the second case. Consequently he was rather inclined to doubt whether in ordinary practice any great error was likely to be caused by using $r_{\frac{x}{z} \cdot \frac{y}{z}}$ instead of $r_{xy \cdot z}$ notwithstanding the risk of introducing spurious correlation which had been put before them so eloquently by Professor Pearson and others. He suggested that the dangers arising in that way might perhaps in practice be somewhat less than was suggested by theoretical computation, although in important cases the point had to be borne in mind. He heartily supported the vote of thanks.

Dr. SNOW, in reply, expressed his gratitude for the terms used by the proposer and seconder of the vote of thanks. He referred briefly to one or two points in Mr. Watson's speech, and particularly to his remarks concerning the use of the term "expected." He quite agreed that the actuary looked at the term in a technical sense, and that it did not of necessity stand for the best estimate of the amount of sickness or of mortality to be anticipated. But of recent years the results worked out by the actuary for his own purposes had been quoted to an increasing extent by the non-actuarially trained person—particularly with reference to the effect of alcoholic abstinence on mortality—without any regard to the many pitfalls and possible fallacies surrounding the use of the actuaries' terms. It was from this point of view of reaching a better estimate of the sickness or mortality to be anticipated in any particular case that he suggested the possibility of employing regression equations. With regard to Dr. Greenwood's remarks on Mr. Maynard's paper, it was quite true that a certain correlation between indices was found to be practically the same as the corresponding but more complicated partial correlation reached when indices were not employed, but he did not think any general conclusion could be drawn from that. Other similar cases could be pointed out, and also some showing quite different results.

The following Candidates were elected Fellows of the Society:—

Krishna Lal Datta, M.A.

Gerald Frank Shove, B.A.

Rev. J. Frome Wilkinson, M.A.