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STATISTICS

AS TO THE

*Mortality Experience among Assured Lives
engaged in the Liquor Trade.*

BY

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Statistics as to the Mortality Experience among Assured Lives engaged in the Liquor Trade.

(Read before the Actuarial Society of Edinburgh, 8th March 1888.)

THAT the subject of the extra risk incurred by dealers in intoxicating liquors is still open for discussion is evidenced by the fact that, on inquiry at over thirty of the principal Scotch and English Life Offices as to the rates of extra premium charged for assurances on innkeepers and publicans, it has been found that the practices of the various Offices in treating such cases differ so much and so widely, that to give a table showing the results of the inquiries would almost necessitate the practice of each individual Office being detailed. Some offices, it appears, charge no extra premium on either innkeepers or publicans, while one or two other Offices will not, as a rule, entertain proposals on either class of lives. Some Offices, again, charge no extra for innkeepers, but a very considerable extra for publicans, while others require the same extra from both classes—such extra varying from 10s. to 20s. per £100. A few Offices charge 10s. for innkeepers and 20s. for publicans, while one or two others make the extra take the form of an addition to the age, varying from five to seven years for both classes.

Through the kindness of the Directors and Manager of the Life Association of Scotland, I have been permitted to lay before you the results of the Association's experience as to the mortality among innkeepers and publicans. By the general term "innkeepers" is denoted innkeepers, hotelkeepers, waiters, and such like, while the general term "publicans" includes publicans, retail wine and spirit merchants (apart from grocers), licensed victuallers, barmen, etc. Only male lives have been dealt with.

The Association's experience has extended over a period of nearly fifty years, and comprises 862 entrants, of whom 215 have died, 265 have discontinued, and 382 were still existing at the date of investigation, namely 31st December 1886. The youngest age at which any life entered was 13, and the oldest age at entrance 68, the age at which the greatest number entered being 34. The oldest age at death was 83, and the age beyond which

there were no lives still surviving was 82. The 862 entrants passed through 8,456·5 years of risk, giving an average of 9·8 years of risk for each.

As the title indicates, the nature of this paper is intended to be mainly statistical, and I shall therefore, to a great extent, confine my remarks to an explanation of the connection and bearing of the various tables herewith submitted.

I.—INNKEEPERS AND PUBLICANS COMBINED.

In the first instance, we shall look at the figures as they stand for the two classes together. We find that, as against the 215 deaths which occurred among the 862 entrants, the number of deaths expected by the Institute of Actuaries' H^M Table was only 142·9. I have seen it stated that the deaths among those engaged in the liquor traffic are supposed to be about 50 per cent. greater than the deaths among the general body of lives, and it is curious to notice that, in the case of the innkeepers and publicans before us, the actual deaths exceed the expected by 50·5 per cent. The following table contains particulars of the number entered, years of risk, and actual deaths, between given ages, together with the number of deaths expected by the H^M Table :—

TABLE I.

Ages.	No. Entered.	Years of Risk.	Actual Deaths.	Expected Deaths by H ^M Table.
13—19	4·	6·5	1·	·03
20—29	210·	522·	11·	3·66
30—39	387·	2,381·	40·	21·23
40—49	197·	2,780·	60·	33·77
50—59	55·	1,781·	48·	35·99
60—69	9·	796·	36·	31·92
70—79		180·	18·	14·72
80—83		10·	1·	1·58
Total,	862·	8,456·5	215·	142·90

The usual method of arriving at an idea of the amount of annual extra premium required per £100 in such cases is as follows :—

$$\frac{(\text{Actual Deaths}) - (\text{Expected Deaths})}{(\text{Years of Risk})} \times 100.$$

As the very important effect of interest is entirely left out of account, such a method can, of course, give only a rough approxi-

mation to the true extra premium required, and we shall accordingly, when referring to it in the course of this paper, designate it as the "approximate method."

Applying, then, the approximate method to the figures now before us, we find that, according to the Association's experience, the approximate extra premium required for innkeepers and publicans combined is 17s. 1d. per £100. The true extra premium will, of course, be somewhat less than this sum.

It will be interesting now to divide the statistics among the three countries to which they refer, namely, Scotland, England, and Ireland, and see how the figures applicable to the several countries compare with each other. The following table contains particulars of the experience in the three countries, separately and together, with the percentage of the actual over the expected deaths by the H^M Table, and the approximate extra premium required per £100.

TABLE 2.

Country.	No. Entered.	Years of Risk.	Actual Deaths.	Expected Deaths by H ^M Table.	Percentage of actual over expected Deaths.	Approximate Extra Premium required per £100.
Scotland, .	338.	3,708.5	106.	65.75	61.2	£1 1 9
England, .	396.	3,887.5	89.	66.12	34.6	0 17 10
Ireland, .	128.	860.5	20.	11.03	81.3	1 0 10
Total, .	862.	8,456.5	215.	142.90	50.5	£0 17 1

We see that whereas the actual deaths in the three countries combined were, as formerly mentioned, 50.5 % greater than the expected, the actual deaths in Scotland alone were 61.2 %, and in Ireland alone 81.3 %, more than the expected, while in England alone the actual deaths exceeded the expected by only 34.6 %. Further, we notice that while the approximate extra premium required overhead is 17s. 1d. per £100—for Scotland alone we would require an extra premium of £1, 1s. 9d., and for Ireland alone £1, 0s. 10d. per £100, while for England alone an extra premium of only 11s. 10d. per £100 would be sufficient. It is curious to observe also that, although the percentage of actual over expected deaths is much greater in Ireland than in Scotland, the extra premiums required for the two countries differ very slightly, the Irish, however, being the smaller of the two. From the *proportionately* smaller number of expected deaths to years of risk in Ireland than in Scotland, it will be seen that the Irish lives have, on the average, been under observation at *younger*

ages than the Scotch. The Irish extra premium—on the younger lives—has therefore in reality greater weight than the Scotch extra, and consequently provides for a greater percentage of extra mortality.

That the extra premium for innkeepers and publicans in Scotland and Ireland should be nearly double that required for the same class of lives in England is certainly striking; but we shall not stop to go into the matter further in the meantime, as we shall have occasion to refer to it again later on.

The practice of charging a fixed extra per cent. assumes that the additional risk of death incurred by dealing in intoxicating liquor is almost constant at each age; that is to say, that a man, say, of forty, runs as great an *additional* risk as a man of twenty; but according to the Association's experience such is far from being the case. To get a general idea of the true position of matters in this respect, although the data to go upon were so small, I thought it well, by combining the figures for several ages, to calculate a column showing the probabilities of dying in a year, based upon the actual statistics with which we are dealing; and having applied a rough graduation to it so as to remove only the principal irregularities, at the same time seeing that the adjusted probabilities sufficiently accurately reproduced the actual deaths in the various parts of the table, as well as giving the exact number in the total, I compared it with the probabilities by the H^M Table. As the readiest means of showing the relation at the several ages of the probability of dying in a year by the Innkeepers' and Publicans' experience to the probability by the H^M Table, the accompanying Diagram is given, and it, I think, sufficiently explains itself.

It will be noticed that while about age 25 the probability of dying in a year for innkeepers and publicans is more than *three* times as great as the probability for ordinary healthy male lives, about age 37 the probability for innkeepers and publicans is little more than *half* as great again as for the H^M lives; and that, although a somewhat greater difference immediately follows, the difference again decreases until between ages 60 and 65 the probabilities by the two tables very nearly approach each other. One cannot help being struck by the very marked peculiarities which are shown in the curve representing the probabilities of dying in a year for innkeepers and publicans, especially by the very decided dip which takes place about ages 30-40, with the rapid rise thereafter to about age 50, and the slow progression between that age and about age 60. At first I thought that the peculiarities must be due solely to the lives involved being too few to give average and satisfactory results, as it seemed very unlikely that the probability of dying in a year for age 35 should be less than

DIAGRAM showing from the LIFE ASSOCIATION Experience the probability of dying in a year
 for Innkeepers and Publicans combined, compared with the probability by the H^m Table.
 The abscissa represents the age, and the ordinate the probability of dying in a year.
 Innkeepers and Publicans in red. — H^m Table in black.

the probability for age 25 ; but, on looking further into the matter, I came to see that there was really no reason why such should not be the case in a class of lives such as those with which we are dealing ; and I was glad to find that the peculiarities in the figures based upon the Association's experience were borne out, more or less prominently, by the figures applicable to both the Scottish Amicable and Law Life Companies' experiences of the same class of lives. The following table shows the unadjusted mean probability of dying in a year between decennial ages, according to the Life Association, Scottish Amicable, and Law Life experiences, compared with the probability by the H^M Table :—

TABLE 3.

Ages.	Mean Probability of Dying in a Year.			
	Life Association.	Scottish Amicable.	Law Life.	H ^M .
20—30	·0211	·0227	·0122	·0068
30—40	·0168	·0209	·0086	·0088
40—50	·0216	·0222	·0169	·0122
50—60	·0270	·0379	·0337	·0207
60—70	·0452	·0428	·0745	·0414
70—80	·1000	·0824	·0988	·0895

In both the other Companies' experiences we observe the dip in the probability of dying in a year for ages 30 to 40, compared with the probability for ages 20 to 30 ; and the Scottish Amicable experience also shows the near approach of the probability for ages 60 to 70 to the probability by the H^M Table.

When I came to divide the Association's experience into the two classes, Innkeepers and Publicans separately, I received further corroboration of the probable correctness of the peculiarities in the curve above referred to, as in *each* of the two classes, which may be taken as forming two entirely distinct experiences, the probabilities of dying in a year showed the same characteristics, in a more or less marked degree, as the probabilities founded upon the combined experience. If the peculiarities in the combined experience had been purely accidental, it is by no means likely that each of the component experiences would so decidedly have shown the same characteristics. The accompanying table shows the unadjusted mean probability of dying in a year between decennial ages, according to the Life Association's experience, for Innkeepers and Publicans, together and separately :—

TABLE 4.

Ages.	Mean Probability of Dying in a Year.		
	Innkeepers and Publicans.	Innkeepers.	Publicans.
20—30	·0211	·0216	·0207
30—40	·0168	·0151	·0184
40—50	·0216	·0213	·0219
50—60	·0270	·0226	·0321
60—70	·0452	·0505	·0394
70—80	·1000	·1013	·0990

We must bear in mind that the high rate of mortality among those engaged in the liquor trade is not due solely to the too free indulgence in strong drink, but that, especially as regards Publicans, much of it must arise from the conditions under which their business is carried on—the long and late hours during which they work, and the close and heated atmospheres in which they labour, rendering them, even although temperate, peculiarly liable to disease. More especially will this be the case among young lives, and this fact no doubt accounts, to a considerable extent, for the very high rate of mortality apparent in the early part of the table. The decided fall in the death-rate which is seen to occur about ages 30-40, is probably in some measure due to the fact that about those ages many, who have been brought up to other trades, forsake their original callings for what is supposed to be the easier and more lucrative business of innkeeper or publican, and these of course will, as a rule, be comparatively healthy and sober for the first few years of their new trade.

The next step is to divide the Association's experiences between the two general classes represented by Innkeepers and Publicans respectively; and when this is done we find, as a curious coincidence, that each class contains exactly one-half, or 431, of the 862 lives embraced in the investigation.

II.—INNKEEPERS.

Of the 431 innkeepers who entered, 103 have died, 127 have discontinued, and 201 were existing at date of investigation—the total years of risk being 4,244. The following table shows the number entered, years of risk, and actual deaths between given

ages, together with the number of deaths expected by the H Table :—

TABLE 5.

Ages.	No. Entered.	Years of Risk.	Actual Deaths.	Expected Deaths by H ^M Table.
13—19	1·	2·	...	·01
20—29	96·	231·5	5·	1·62
30—39	192·	1,129·	17·	10·05
40—49	107·	1,411·5	30·	17·24
50—59	29·	971·5	22·	19·59
60—69	6·	415·5	21·	16·57
70—79	...	79·	8·	6·45
80—82	...	4·	...	·62
Total,	431·	4,244·	103·	72·15

The actual deaths exceed the expected by 42·8 per cent. ; and by the approximate method, the annual extra premium for Innkeepers according to the Association's experience would require to be 14s. 7d. per £100.

Dividing the statistics as to innkeepers among the three countries, Scotland, England, and Ireland, we do not, as in the case of the innkeepers and publicans combined, find any great difference in the results for Scotland and England ; but, on the contrary, the results for the two countries very closely agree. *See* Table VI. The figures referring to Ireland are too small to have any weight attached to them.

TABLE 6.

Country.	No. Entered.	Years of Risk.	Actual Deaths.	Expected Deaths by H ^M Table.	Percentage of Actual over Expected Deaths.	Approximate Extra Premium required per £100.
Scotland, .	189·	1,974·0	48·	34·12	40·7	£0 14 1
England, .	221·	2,129·0	51·	36·20	40·9	0 13 11
Ireland, .	21·	141·0	4·	1·82	119·8	1 10 11
Total, .	431·	4,244·	103·	72·14	42·8	£0 14 7

As previously mentioned, the approximate method of calculating the extra premium makes no allowance for the important effect of

interest, and assumes the extra risk to be constant at all ages. It cannot therefore be held as giving satisfactory results, as we cannot well form an idea of how far the approximate extra will be from the truth. The only way of arriving at a more reliable extra premium for the various ages is by constructing a Mortality Table based upon the actual experience, and then to see what rates of premium such Mortality Table would require. Although the available data were so small, I thought it might be worth the trouble to see in what direction the results would point when so arrived at; and the first step was, by combining the figures for several ages, to calculate a column of q_x based upon the actual experience among Innkeepers, and, as in the case of the Innkeepers and Publicans combined, apply a rough graduation to it so as to remove only the principal irregularities. It appeared better to leave the column in a crude state as regards graduation, and so let the figures very much tell their tale in their own way, rather than (by endeavouring to smooth down the angularities and produce a better curve) run the risk of obliterating certain characteristics which might be peculiar to this particular class of lives. As already mentioned, this column of q_x applicable to Innkeepers partakes very much of the same characteristics, in a more or less marked degree, as the column of q_x framed from the experience of Innkeepers and Publicans combined, and illustrated in the diagram previously given.

Having got the column of q_x , the next step was to calculate the values of annuities and pure premiums, at $3\frac{1}{2}$ per cent. interest, founded thereon, and by comparing the pure premiums for innkeepers with the pure premiums by the H^M $3\frac{1}{2}$ per cent. Table, we find the extra premium required.

Table VII., on the following page, gives the results for ages 20-60.

The approximate method gave an extra premium of 14s. 7d. per cent. constant at all ages, but we find that instead of this the pure extra premium founded upon a rate of mortality based upon the actual experience varies between, say, 17s. per cent. at age 20, and 8s. 6d. per cent. at age 50. The rise in the extra premium which takes place towards age 60 is no doubt due to insufficiency of data after that age, as the extra falls again later on.

TABLE 7.

Age x .	q_x Innkeepers.	a_x $3\frac{1}{2}\%$ Innkeepers.	π_x $3\frac{1}{2}\%$ Innkeepers.	π_x HM. $3\frac{1}{2}\%$.	Δ = Extra pre- mium required.
20	·0196	17·001	2·174	1·330	·844
1	·0200	16·947	2·191	1·365	·826
2	·0203	16·902	2·204	1·401	·803
3	·0207	16·854	2·220	1·438	·782
4	·0209	16·818	2·231	1·478	·753
5	·0210	16·773	2·245	1·521	·724
6	·0209	16·735	2·258	1·566	·692
7	·0207	16·690	2·271	1·614	·657
8	·0201	16·639	2·288	1·664	·624
9	·0195	16·575	2·309	1·715	·594
30	·0186	16·501	2·333	1·769	·564
1	·0172	16·401	2·366	1·824	·542
2	·0156	16·275	2·408	1·883	·525
3	·0145	16·107	2·464	1·944	·520
4	·0141	15·918	2·530	2·008	·522
5	·0140	15·709	2·602	2·076	·526
6	·0143	15·493	2·682	2·146	·536
7	·0148	15·267	2·766	2·221	·545
8	·0157	15·036	2·855	2·298	·557
9	·0167	14·817	2·941	2·380	·561
40	·0178	14·593	3·032	2·465	·567
1	·0193	14·380	3·120	2·557	·563
2	·0204	14·172	3·209	2·654	·555
3	·0210	13·978	3·295	2·758	·537
4	·0214	13·779	3·385	2·868	·517
5	·0216	13·572	3·481	2·985	·496
6	·0217	13·356	3·584	3·108	·476
7	·0218	13·127	3·698	3·237	·461
8	·0219	12·895	3·816	3·372	·444
9	·0220	12·644	3·948	3·515	·433
50	·0221	12·384	4·090	3·667	·423
1	·0222	12·099	4·253	3·828	·425
2	·0223	11·811	4·424	4·000	·424
3	·0225	11·506	4·614	4·184	·430
4	·0227	11·179	4·829	4·379	·450
5	·0231	10·843	5·062	4·588	·474
6	·0237	10·479	5·330	4·809	·521
7	·0246	10·116	5·614	5·044	·570
8	·0260	9·736	5·933	5·295	·638
9	·0282	9·337	6·293	5·563	·730
60	·0316	8·952	6·667	5·848	·819

There seems little reason to doubt that some such scale of extra premiums, varying according to the age at entry, is what such a class of lives engaged in the liquor trade would require. Nevertheless it may be considered that it would be *impracticable* to have a scale of extra premiums for innkeepers, varying so much

according to the age at entry. It is certain that the young lives would refuse to see why they should be charged so much more than the older lives for being engaged in the same trade: rather would they be inclined to think that, if anything, they should be charged less. I thought it well, therefore, to adopt some method which, while giving an extra premium nearer the truth than the approximate method, would still not give extras varying so much according to the age as those just found; or, in other words, which would give a pure *average* extra premium for all ages. The only way, of course, of getting this is to distribute the extra mortality more uniformly over the table, and so, in effect, by making the lives entering at certain ages pay rather too much, and those entering at certain other ages pay rather too little, get an average extra premium as required. We get very nearly what is wished by adopting a Hypothetical Mortality Table based upon a constant addition of .75 to the rate of mortality per cent. by the H^M Table—that is, when the probability of dying in a year by the Hypothetical Table, which we shall call q'_x , is equal to the H^M $q_x + .0075$. The true addition would be .00727. Using this Hypothetical q_x (q'_x) to calculate the expected deaths, we find that it would give the total number expected as 103.29, while the actual deaths were 103. Of course in certain parts of the table the expected and actual deaths do not so closely agree; but on reference to Table VIII. it will be seen that no very serious error can be made by adopting the column of q'_x as the basis of the Mortality Table, since by taking the ages in the special groups there given, the largest of which does not include more than twelve ages, we can get a tolerably close agreement throughout.

TABLE 8.

Ages.	Expected Deaths by q'_x .	Actual Deaths.
20—24	.49	...
25—34	10.25	10.
35—39	11.15	12.
40—51	33.63	34.
52—57	16.36	16.
58—68	22.88	22.
69—76	7.37	8.
77—79	1.16	1.
Total,	103.29	103.

The next table gives the column of q'_x ($=H^M q_x + \cdot 0075$) and the values of annuities and pure premiums at $3\frac{1}{2}$ per cent. interest founded thereon, together with the H^M pure premiums and the differences or extra premiums required.

TABLE 9.

Age x .	q'_x $=H^M q_x + \cdot 0075$.	a'_x $3\frac{1}{2}$ per cent.	π'_x $3\frac{1}{2}$ per cent.	π_x $H^M 3\frac{1}{2}$ per cent.	Δ $=$ Extra Premium required.
20	·0138	17·818	1·933	1·330	·603
1	·0142	17·696	1·967	1·365	·602
2	·0143	17·585	2·000	1·401	·599
3	·0143	17·463	2·035	1·438	·597
4	·0141	17·341	2·071	1·478	·593
5	·0141	17·204	2·112	1·521	·591
6	·0142	17·061	2·156	1·566	·590
7	·0144	16·916	2·200	1·614	·586
8	·0147	16·761	2·249	1·664	·585
9	·0149	16·609	2·297	1·715	·582
30	·0152	16·443	2·351	1·769	·582
1	·0154	16·290	2·402	1·824	·578
2	·0156	16·118	2·461	1·883	·578
3	·0158	15·943	2·521	1·944	·577
4	·0160	15·771	2·581	2·008	·573
5	·0163	15·585	2·648	2·076	·572
6	·0166	15·398	2·717	2·146	·571
7	·0170	15·208	2·788	2·221	·567
8	·0173	15·005	2·866	2·298	·568
9	·0176	14·811	2·944	2·380	·564
40	·0178	14·601	3·029	2·465	·564
1	·0180	14·388	3·117	2·557	·560
2	·0182	14·163	3·214	2·654	·560
3	·0186	13·932	3·315	2·758	·557
4	·0191	13·692	3·425	2·868	·557
5	·0197	13·451	3·539	2·985	·554
6	·0204	13·200	3·661	3·108	·553
7	·0212	12·944	3·790	3·237	·553
8	·0219	12·683	3·927	3·372	·555
9	·0227	12·428	4·065	3·515	·550
50	·0235	12·166	4·213	3·667	·546
1	·0242	11·897	4·372	3·828	·544
2	·0250	11·604	4·553	4·000	·553
3	·0261	11·323	4·733	4·184	·549
4	·0272	11·029	4·932	4·379	·553
5	·0285	10·733	5·142	4·588	·554
6	·0300	10·450	5·352	4·809	·543
7	·0315	10·149	5·588	5·044	·544
8	·0331	9·845	5·840	5·295	·545
9	·0350	9·534	6·111	5·563	·548
60	·0372	9·217	6·406	5·848	·558

It will be noticed that the extra premiums now obtained are not very far from being constant at all ages, the average being

about $\cdot 575 = 11\text{s. } 6\text{d.}$ per £100; and this sum, I think, may be taken as the pure *average* extra premium for all ages, which would provide for an extra rate of mortality similar to that hitherto experienced by the Association in the case of those engaged as innkeepers.

The difference between the extra premium by the approximate method and that just obtained is fully 3s. per £100. Of course it by no means follows that the pure average extra premium should be accepted. Rather should it, like all other premiums, receive a loading to provide for contingencies, as well as for the commission, to which it will of course be subject by being included in the policy premium. It is well, however, that we should have a definite idea of what the loading is, and what is the bare sum required to provide for the extra risk alone.

III.—PUBLICANS.

Of the 431 publicans who entered, 112 have died, 138 have discontinued, and 181 were existing at the date of investigation—the total years of risk being 4,212·5. As against the 112 actual deaths, only 70·75 were expected by the H^M Table, the actual thus exceeding the expected by 58·3 %. The following Table shows the number entered, years of risk, and actual and expected deaths between given ages :—

TABLE 10.

Ages.	No. Entered.	Years of Risk.	Actual Deaths.	Expected Deaths by H ^M Table.
17—19	3·	4·5	1·	·02
20—29	114·	290·5	6·	2·03
30—39	195·	1,252·	23·	11·17
40—49	90·	1,368·5	30·	16·53
50—59	26·	809·5	26·	16·41
60—69	3·	380·5	15·	15·36
70—79	...	101·	10·	8·27
80—83	...	6·	1·	·96
Total,	431·	4,212·5	112·	70·75

The approximate method brings out the extra premium for publicans, according to the Association's experience, as 19s. 7d. per £100. The true extra premium will, of course, be considerably less. I was scarcely prepared for the extra for publicans

coming out so low as this; but on breaking up the experience into the three countries, Scotland, England, and Ireland, I found that if it had not been for the exceptionally good quality of the English lives as compared with the others, the result would have been very different. The following table contains particulars of the mortality experience in the three countries, together and separately, with the percentage of the actual over the expected deaths, and the approximate extra premium required:—

TABLE 11.

Country.	No. Entered.	Years of Risk.	Actual Deaths.	Expected Deaths by H ^M Table.	Percentage of Actual over Expected Deaths.	Approximate Extra Premium Required per £100.
Scotland, .	149·	1,734·5	58·	31·64	83·3	£1 10 5
England, .	175·	1,758·5	38·	29·92	27·0	0 9 3
Ireland, .	107·	719·5	16·	9·21	73·8	0 18 11
Total .	431·	4,212·5	112·	70·77	58·3	0 19 7

In none of the other tables have we seen such a divergence between the results applicable to the three countries, and one is sorry to find the Scotch publicans showing to such disadvantage. It will be noticed that while the approximate extra premium required overhead is 19s. 7d. per £100, for English publicans by themselves we would require an extra of only 9s. 3d., and for Irish publicans by themselves an extra of 18s. 11d., while for Scotch publicans the extra would require to be as much as £1, 10s. 5d. per £100, or more than three times the extra for England, and more than half as much again as the extra for Ireland.

To find a more exact extra premium for publicans than that given by the approximate method, in the same way as was done in the case of innkeepers, I had, in the first instance, to calculate a column of q_x based upon the actual statistics, and then, as in the previous cases also, remove the principal irregularities in it by rough graduation—at the same time seeing that the special features of the various parts of the table were fully preserved. The following table gives the adjusted probability of dying in a year for ages 20-60, based upon the actual experience, and the values of annuities and pure premiums at $3\frac{1}{2}\%$ interest founded thereon, together with the H^M pure premiums at $3\frac{1}{2}\%$, and the differences or extra premiums required:—

TABLE 12.

Age x .	q_x Publicans.	a_x $3\frac{1}{2}\%$ Publicans.	π_x $3\frac{1}{2}\%$ Publicans.	π_x HM $3\frac{1}{2}\%$	Δ = Extra Premium required.
20	·0195	16·749	2·252	1·330	·922
1	·0196	16·681	2·275	1·365	·910
2	·0197	16·613	2·296	1·401	·895
3	·0198	16·535	2·322	1·438	·884
4	·0199	16·463	2·345	1·478	·867
5	·0200	16·383	2·371	1·521	·850
6	·0199	16·304	2·398	1·566	·832
7	·0198	16·215	2·428	1·614	·814
8	·0197	16·123	2·459	1·664	·795
9	·0196	16·023	2·493	1·715	·778
30	·0195	15·912	2·531	1·769	·762
1	·0193	15·804	2·569	1·824	·745
2	·0190	15·679	2·613	1·883	·730
3	·0186	15·538	2·665	1·944	·721
4	·0182	15·389	2·719	2·008	·711
5	·0179	15·223	2·783	2·076	·707
6	·0178	15·043	2·852	2·146	·706
7	·0179	14·850	2·928	2·221	·707
8	·0180	14·644	3·010	2·298	·712
9	·0182	14·436	3·097	2·380	·717
40	·0184	14·218	3·190	2·465	·725
1	·0187	13·995	3·288	2·557	·731
2	·0193	13·765	3·392	2·654	·738
3	·0201	13·527	3·503	2·758	·745
4	·0211	13·289	3·617	2·868	·749
5	·0223	13·050	3·736	2·985	·751
6	·0237	12·820	3·854	3·108	·746
7	·0254	12·589	3·978	3·237	·741
8	·0268	12·367	4·099	3·372	·727
9	·0280	12·158	4·218	3·515	·703
50	·0291	11·934	4·350	3·667	·683
1	·0301	11·720	4·480	3·828	·652
2	·0310	11·517	4·608	4·000	·608
3	·0317	11·295	4·752	4·184	·568
4	·0323	11·082	4·896	4·379	·517
5	·0328	10·843	5·062	4·588	·474
6	·0332	10·606	5·235	4·809	·426
7	·0336	10·354	5·426	5·044	·382
8	·0341	10·081	5·643	5·295	·348
9	·0347	9·821	5·860	5·563	·297
60	·0354	9·514	6·129	5·848	·281

It will be noticed that according to the Association's actual experience, the extra for Publicans, so far from being constant at

all ages, varies from 18s. 6d. per £100 at age 20, to 13s. 8d. at age 50, and 5s. 8d. per. £100 at age 60. Now, although, as I have previously said, there seems good reason for believing that some such scale of extras, varying according to the age at entry, is more likely to be correct than an extra constant for all ages, still it will be well, as in the case of the innkeepers, to ascertain what pure *average* extra premium would sufficiently provide for the extra mortality among publicans; and if we calculate a table of premiums by a Hypothetical Mortality Table based upon an addition of 1 to the rate of mortality per cent. by the H^M Table—that is, when the probability of dying in a year by the Hypothetical Table, which we shall call q''_x , is equal to the $H^M q_x + \cdot 01$ —we shall get very nearly what is required. The true addition would be $\cdot 00979$. As will be seen from the following table, the total expected deaths calculated by this hypothetical q_x (q''_x) amount to 112·87, while the actual deaths were 112; and it will be observed also that, by taking the ages in the special groups there given, we can have a tolerably close agreement throughout the various parts of the table.

TABLE 13.

Ages.	Expected Deaths by q''_x .	Actual Deaths.
17—24	·97	1·
25—32	8·93	9·
33—39	18·81	20·
40—49	30·20	30·
50—60	26·58	26·
61—64	8·17	8·
65—75	16·31	15·
76—79	1·88	2·
80—83	1·02	1·
Total,	112·87	112·

From the basis of q''_x ($=H^M q_x + \cdot 01$) the next step was to calculate the values of annuities and pure premiums founded thereon, and, by comparing the latter with the H^M pure premiums, find the extra premiums required. The accompanying table gives the results :—

TABLE 14.

Age x .	q''_x $= H^M q_x + \cdot 01$.	a''_x $3\frac{1}{2}\%$.	π''_x $3\frac{1}{2}\%$.	π_x $H^M 3\frac{1}{2}\%$.	Δ = Extra Premium required.
20	·0163	17·119	2·137	1·330	·807
1	·0167	17·011	2·171	1·365	·806
2	·0168	16·907	2·203	1·401	·802
3	·0168	16·797	2·238	1·438	·800
4	·0166	16·687	2·273	1·478	·795
5	·0166	16·563	2·312	1·521	·791
6	·0167	16·427	2·357	1·566	·791
7	·0169	16·293	2·401	1·614	·787
8	·0172	16·152	2·448	1·664	·784
9	·0174	16·014	2·496	1·715	·781
30	·0177	15·866	2·548	1·769	·779
1	·0179	15·717	2·600	1·824	·776
2	·0181	15·564	2·655	1·883	·772
3	·0183	15·400	2·716	1·944	·772
4	·0185	15·240	2·776	2·008	·768
5	·0188	15·064	2·843	2·076	·767
6	·0191	14·896	2·910	2·146	·764
7	·0195	14·714	2·982	2·221	·761
8	·0198	14·537	3·055	2·298	·757
9	·0201	14·349	3·133	2·380	·753
40	·0203	14·154	3·217	2·465	·752
1	·0205	13·950	3·307	2·557	·750
2	·0207	13·745	3·401	2·654	·747
3	·0211	13·526	3·503	2·758	·745
4	·0216	13·301	3·611	2·868	·743
5	·0222	13·067	3·728	2·985	·743
6	·0229	12·833	3·848	3·108	·740
7	·0237	12·597	3·974	3·237	·737
8	·0244	12·348	4·110	3·372	·738
9	·0252	12·105	4·249	3·515	·734
50	·0260	11·857	4·397	3·667	·730
1	·0267	11·588	4·563	3·828	·735
2	·0275	11·322	4·734	4·000	·734
3	·0286	11·059	4·911	4·184	·727
4	·0297	10·783	5·105	4·379	·726
5	·0310	10·491	5·321	4·588	·733
6	·0325	10·212	5·537	4·809	·728
7	·0340	9·931	5·767	5·044	·723
8	·0356	9·630	6·026	5·295	·731
9	·0375	9·340	6·290	5·563	·727
60	·0397	9·044	6·575	5·848	·727

It will be seen that the extras now obtained are much nearer being constant in amount at the various ages—the average being about $\cdot 767 = 15s. 4d.$ per £100 ; and this sum, I think, may be taken as the pure *average* extra premium which would provide for an extra mortality similar to that experienced by the Association in the

case of those engaged as publicans. Of course, as in the case of innkeepers, the pure extra premium should receive a considerable loading to provide for contingencies and commission.

Reverting to the individual experiences of the three countries, we find that, among innkeepers and publicans combined, the Scotch and Irish lives show almost twice as badly as the English, and that, so far as Scotland and England are concerned, the difference is not among the innkeepers, the experiences of that class in the two countries being almost parallel, but that the difference lies solely among the publicans, the experience in Scotland for such lives giving an extra three times as great as that required for England, the extra for Ireland coming in half-way between the other two. It is singular to notice also that, as regards England by itself, the experience has actually been much worse among the innkeepers than among the publicans, the excess mortality being half as much again under the former as under the latter. It is not within the province of this paper to inquire into the *causes* for the differences in the experiences relating to the three countries; but if the subject were gone into, I have no doubt some interesting facts might be elicited as to the differences in the nature of the trade itself, or the conditions under which it is carried on in the individual countries, as there is no reason to suppose that the experience of the Association should have been entirely singular in regard to the points alluded to.

From the report in the Insurance Journals, I see that in his paper on the "Rate of Mortality among Liquor-Sellers,"¹ read before the Society last year, Mr. Wallace stated that he had been "led to the conclusion that the beneficial effects of selection, which are so apparent in assured lives generally, are counterbalanced by other influences to which this class of persons is exposed"; and the experience of the Association with which we are dealing to a great extent bears out Mr. Wallace's conclusion. From the total experience referring to innkeepers and publicans, I had the experience relating to the first five years of assurance excluded, and so obtained a table bearing the same relation to the original table as the $H^{(5)}$ bears to the H^M . I next calculated for innkeepers and publicans, and also for healthy male lives, the mean probabilities of dying in a year between decennial ages based on the experience after the first five years of assurance, and compared these with the probabilities based on the total experience. The following table gives the results :—

¹ Mr. Wallace's Paper had not been published when this Paper was written.

TABLE 15.

Ages.	Healthy Male Lives.			Innkeepers and Publicans.		
	Mean Probability of Dying in a Year based on		Ratio of 3 to 2.	Mean Probability of Dying in a Year based on		Ratio of 6 to 5.
	Whole Experience.	Experience after first five years.		Whole Experience.	Experience after first five years.	
1.	2.	3.	4.	5.	6.	7.
30—39	·0088	·0100	1·14	·0168	·0152	·90
40—49	·0123	·0131	1·07	·0216	·0222	1·03
50—59	·0209	·0220	1·05	·0270	·0282	1·04
60—69	·0425	·0435	1·02	·0452	·0477	1·06

For ordinary healthy male lives, the effect of selection is such that the probability of dying in a year, based upon the experience after the first five years, is, of course, always greater than the probability based upon the total experience, for the obvious reason that the total experience includes a good proportion of recently selected lives. Column 4 shows the degree in which these two probabilities differ, by giving the ratios that the former bear to the latter. It will be observed that the ratios gradually decrease according to the age, showing, as was to have been expected, that the effect of selection is strongest at the youngest ages, and gradually diminishes until at the older ages, when there are few new entrants, it has only a very slight influence on the death-rate. But on turning to the experience for innkeepers and publicans, we find the results to be quite the reverse of this, the ratios gradually increasing with the age, and so indicating that the effect of selection among lives of that class is least at the younger ages and greatest at the older ages. It will be observed also that up to ages 50-59 the ratios applicable to innkeepers and publicans are less than the ratios referring to ordinary healthy male lives, showing that the deteriorating influences incidental to the trade of liquor-seller do counterbalance, to a greater or less extent, the effect of selection; and, in fact, it will be seen that between ages 30 and 39, according to the limited data with which we are at present dealing, the *whole* effect of selection, as regards that class of lives, is much more than counterbalanced by these adverse influences; the probability of dying in a year based upon the experience after the first five years being, for these ages,

actually less than the probability based upon the total experience, but fuller statistics would probably somewhat modify this result.

Before leaving the subject, I thought it would be interesting—seeing that we had ready means of doing so—to ascertain to what extent the extra mortality against innkeepers and publicans would, according to the Association's experience, affect their "Expectation of Life." The following table gives the complete expectation at quinquennial ages according to the H Table and according to the Innkeepers' and Publicans' Experiences, together with the differences in favour of the H^M lives.

TABLE 16.

Age.	Healthy Males' Expectation.	Innkeepers' Expectation.	Δ	Publicans' Expectation.	Δ
	Years.	Years.		Years.	
20	42·1	33·4	8·7	32·5	9·6
25	38·4	31·7	6·7	30·6	7·8
30	34·7	29·9	4·8	28·6	6·1
35	31·0	27·2	3·8	26·2	4·8
40	27·4	24·2	3·2	23·5	3·9
45	23·8	21·5	2·3	20·7	3·1
50	20·3	18·7	1·6	18·1	2·2
55	17·0	15·6	1·4	15·8	1·2
60	13·8	12·4	1·4	13·3	·5

We see that the difference in the Expectation of Life for innkeepers, as compared with the Expectation for ordinary assured lives, varies from 8·7 years at age 20 to 1·4 years at age 60; and that for publicans the difference varies from 9·6 years at age 20 to ·5 of a year at age 60.

Let us now, in conclusion, bring together a few of the more important points which this investigation has elicited in regard to the particular experience with which we have been dealing.

It would appear, then, that the additional risk of death incurred by those engaged in the liquor trade is not constant at all ages, but partakes, on the whole, much more of the nature of a *decreasing* rather than a constant extra risk, although the curve representing the death-rate shows some marked peculiarities, the principal of which are a very high rate at the younger ages, with a decided fall, say, about ages 30-40, and a somewhat rapid rise again for a few years thereafter. We have seen, too, that these peculiarities are, to a greater or less extent, exhibited in the experience of certain other Companies also.

226 *Mortality among Lives in the Liquor Trade.*

According to the Association's experience, it would seem that the pure extra premium per £100, to provide for the extra mortality among innkeepers and publicans, should be as follows :—For

Innkeepers,	17s. 0d. at age 20,	decreasing to	8s. 6d. at age 50.
Publicans,	18s. 6d.	„ „	13s. 8d. „

But, if it is considered that it would be impracticable to have extras varying according to the age at entry, the following pure *average* extras, constant for all ages, may be held as providing for the same amount of extra mortality; namely, for—

Innkeepers,	11s. 6d. per £100
Publicans,	15s. 4d. „

all these pure extras being, of course, subject to a considerable loading to provide for contingencies and commission. It must be borne in mind, however, that it is only as a matter of expediency that a constant extra can be defended, as a constant *extra premium* implies an almost constant *extra risk*, and this we have found does not exist in the class of lives with which we are dealing.

We have seen also that the extra mortality, as compared with the mortality among ordinary lives, may *overhead* be approximately represented, in the case of innkeepers, by an addition of $\cdot 75$, and in the case of publicans by an addition of 1, to the rate of mortality per cent. As death-rates are, however, usually quoted by the standard of so many deaths to each 1000 at risk, it will be more convenient to adopt this standard here also, and we have the following as approximate measures of the extra mortality, at all ages combined, among the two classes :—

Innkeepers,	an addition of $7\frac{1}{2}$ to the death-rate per 1000.
Publicans,	„ 10 „ „

Further, we have seen that, as regards innkeepers, the experiences in Scotland and England run on almost parallel lines, but that in the case of publicans the experiences in the two countries show materially different results, the Scotch experience for such lives giving an extra rate of mortality three times as great as that for the same class of lives in England.

Finally, it would appear that “selection” has by no means the same beneficial effect in the case of those engaged as innkeepers and publicans as it has among ordinary healthy male lives, and that, in fact, at the younger ages the whole effect of selection is altogether counteracted by the adverse influences to which those engaged in the liquor trade are exposed, and which adverse influences appear to have the greatest effect during the first few years of assurance.