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A NOTE ON THE REGISTRAR-GENERAL'S REPORTS ON OCCUPATIONAL MORTALITY IN ENGLAND AND WALES IN CONNEXION WITH RECENT CENSUSES

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THE recent publication of the Registrar-General's Report on Occupational Mortality in England and Wales in connexion with the 1931 Census has suggested that a Note on this Report and its recent predecessors, with reference mainly to the methods employed in the investigation, may be of use to actuarial students.

1. SOURCES OF STATISTICS

Census Schedules and Death Registers

Occupational Mortality has been investigated in connexion with every census since 1851. It may at first sight seem a simple matter to take, in each age group, the number exposed to risk in a given occupation from the census schedules and the number of deaths from the death registers, and from these figures to find the rates of mortality. In practice there are many pitfalls. The history of the successive investigations records various attempts to improve the statement and classification of the particulars and the presentation of the results, although there are still a number of known or suspected sources of error, the effect of which can only be estimated roughly, if at all.

In most of the recent investigations the deaths have been taken as the average for the three years round the census date, but in the 1921 investigation, owing to the large number of men discharged from military service who had not by 1920 found their way into permanent employment, it was decided to work on the deaths registered in 1921–23 instead of in the normal period, 1920–22.

In the 1931 investigation the deaths were those registered in the three years 1930–32, and the number of the exposed to risk was taken as three times the corresponding census population, the date of the census, viz. 26 April 1931, being regarded as sufficiently close to the centre of the three years 1930–32 to be accepted as a satisfactory mean without adjustment.

Classification of Occupations

One of the most important recent improvements is the radical change in the classification of occupations which was first made in connexion with the 1921 Census. In the previous censuses many of the so-called "occupational" headings related to an industry rather than an occupation, and embraced all kinds of workers within the industry, from employers to unskilled labourers. Where an industry included a dangerous process, those engaged in it might be combined with others engaged in less dangerous work to such an extent as to mask the real effect of the dangerous process when occupational mortality was under investigation. The 1911 Report referred to the preparations which were being made to ensure that the 1921 Census should provide for the separate treatment of dangerous processes by framing the classification on genuinely occupational lines, and presumably the registrars of deaths were given corresponding instructions in advance.

Cutlery Grinders

In the 1921 Report the effect of the new classification is clear. A famous example is the case of the cutlery grinders. Before 1921 these workers were grouped with all others concerned in the manufacture of cutlery under the heading "Cutlers and scissors makers", and the mortality of this group at ages 25–65 in 1910–12 exceeded the average for all men by 63%. For 1921–23 separate figures were for the first time available for the actual grinders of cutlery (i.e. men classed occupationally as metal grinders, and industrially as employed in the cutlery trade), and it was found that the mortality of this group in 1921–23 at ages 25–65 exceeded the average for all men by no less than 240%.

As was said in the 1921 Report: "This may be regarded as a new revelation of occupational risk, for the results of the old classification gave no indication of such an extreme degree of mortality excess."

In the census investigations into occupational mortality, the mortality from each principal cause of death has since 1881 been analysed separately, in addition to the analysis of the total mortality from all causes. It was found that in 1921–23 the mortality among cutlery grinders was excessively heavy from respiratory tuber-

culosis, bronchitis and pneumonia, and this was believed to be due to the inhalation of siliceous dust from the abrasive material used in grinding. The cutlery grinders worked for the most part in Sheffield, where local sandstone had for many years been used extensively as the abrasive material. The abolition of sandstone wheels for cutlery grinding and the substitution of less harmful abrasives seemed to be marked out as the course of action by which the high rate of mortality in this occupation might be substantially reduced.

It is too soon yet to say how far this object will be achieved. Between 1921 and 1931 there was a great reduction in the number of sandstone wheels in use for cutlery grinding. The mortality from all causes in 1930–32 for ages 20–65 showed a marked improvement on 1921–23, though it was still at the very high figure of 140% above the average for all men. The extremely high rate of mortality from respiratory tuberculosis (about seven and a half times the average for all men) was not appreciably different in 1930–32 from what it was in 1921–23, but the beneficial effect of the reduced use of sandstone upon mortality from respiratory tuberculosis could perhaps hardly be expected to appear so soon.

It may well be that in years to come the case of the cutlery grinders will be a striking example of an effective attack upon a high rate of occupational mortality. It is the hope of tracking down excess mortality to a definite cause in this way that has inspired the mass of work involved, at each successive investigation, in the detailed analysis of occupational mortality according to separate causes of death.

In this search for excessive occupational mortality and its causes, the value of the revised classification of 1921, based on the exact occupation within each industry, cannot be doubted, and the broad principles of the occupational classification introduced in the 1921 Census were maintained in the Census of 1931.

The "Retired"

Before 1901 the investigation was restricted to those returned as "occupied" (including those temporarily out of work), no account being taken of the "retired". This was open to the criticism that in many cases the mortality in a given occupation would be underestimated, because those retiring from ill-health would cease to

be included. For the purpose of the 1901 and subsequent investigations the attempt was made, both in the census schedules and in the registration of deaths, to ascertain the occupation followed before retirement, and the "occupied" and "retired" have been combined for each occupation. This again has been criticized on the ground that the former occupations of the "retired" are returned with less precision than the occupations of the "occupied", but even so it must be better to include such information as is available as to the "retired" than to omit them altogether.

The "Unoccupied"

That the particulars recorded as to the "retired" are incomplete is clear from the anomalous figures in all the recent Reports in respect of "unoccupied" men, that is, those recorded as never having had any remunerative occupation. The following table, taken from the 1931 Report, shows the figures recorded in each age group in the last two investigations, expressed as percentages of the corresponding figures for all men:

"Unoccupied" men

Age group	No. of "unoccupied", per cent. of all men		Rate of mortality among the "unoccupied", per cent. of all men	
	1921	1931	1921–23	1930–32
16–	6·01	7·94	332	196
20–	2·39	2·81	262	237
25–	1·39	1·08	234	294
35–	1·23	0·90	165	203
45–	1·49	1·09	108	124
55–	2·69	1·66	51	78
65–	5·64	3·89	25	37
70 and over	19·97	9·42	11	20

The relatively high proportion in the youngest age groups returned as "unoccupied" in the census may be in accordance with the facts, and possibly the excess mortality recorded at young ages among the "unoccupied" may be explained by the extent to which this group consists of persons whose health has been too poor to allow them to take up any kind of remunerative occupation. But the figures in the oldest age groups cannot be trustworthy.

The high proportion recorded in the census as "unoccupied" (i.e. never occupied) in the oldest age groups, together with the very low rates of mortality recorded among them according to the registration particulars, can only be explained as being due to the vain boasting of some retired old men in filling up the census forms that they have always been "of independent means", whereas, when the time has come to give a final account of them to the registrar of deaths, their relatives have known better and have told the truth.

It is satisfactory that in 1931 these figures have moved a little nearer to what could be regarded as true than they were in 1921, but the divergence is still considerable. It clearly implies that in a number of occupations the recorded rates of mortality at the older ages are overstated, owing to the omission of some of the exposed to risk. For age groups up to age 65 the error appears to be small, but above age 65 it may be serious.

Discrepancies between Statements on Census Schedules and in Death Registers

The lack of correspondence between the statements in the census schedules and those in the death registers in respect of the "unoccupied" is an instance of a far-reaching risk of discrepancy. The census particulars are supplied by the head of the household to which the individual belongs, usually himself, with the aid of such instructions as it is possible to convey by printed notes on the census schedules. The statements as to occupation in the death registers are communicated by "informants", usually relatives or friends of the deceased, who possess various degrees of knowledge, under cross-examination by the registrar. In the case of the "unoccupied", the "informants" appear to have given the more correct information, but this is by no means always the case.

Machine and Hand Compositors

As an example, take the case of the machine compositors in the printing trade. At one time it was stated that machine compositors were especially liable to phthisis, and in the 1911 investigation they were separated from hand compositors, so that this point could be investigated. The group of machine compositors was a small one, consisting of 6468 men, with 84 recorded deaths in 3 years at all

ages. So far from showing any excess mortality, they took the leading place, with lighter mortality than any other group, in the 1911 comparative mortality table for all occupations, based on ages 25–65.

The actual deaths between 25 and 65 numbered 60, compared with 127 expected according to the experience of all men, giving a percentage of actual to expected of only 47·2. The corresponding percentage for agricultural labourers was 59·—, and for clergymen 59·7. For hand compositors, who numbered 38,004, the corresponding percentage was 100·3; and for printers as a whole, who numbered 114,453, including both the machine compositors and the hand compositors, the percentage was 98·—.

The only reasonable explanation of these figures appears to be that some men who were correctly described in the census as "machine compositors" were not known by their relatives to be setting up type by machine, and were described for the purpose of death registration in such a way that they were grouped as "hand compositors".

In 1921–23 the recorded mortality of the machine compositors was much nearer to that of the hand compositors, and it might reasonably have been concluded that the men's relatives were becoming aware of the exact nature of their occupation.

Between 1911 and 1921 there was no extension of machine composing, but between 1921 and 1931 there was a great change in the distribution of the census population between hand compositors and machine compositors. Yet there was little change in the apparent distribution of deaths between the two groups as shown in the following table:

	Census population aged 20–65		Registered deaths at ages 20–65	
	1921	1931	1921–23	1930–32
Hand compositors	24,729	16,728	739	700
Machine compositors	5,443	16,157	116	152

It would seem that the relatives had not become fully aware of the extensive change from one group to the other which took place between 1921 and 1931. In any case, the 1931 investigators felt bound to decide that the attempt to distinguish between the two

occupations had failed, and that the only course open to them was to combine the two groups in their analysis.

Foremen

Another type of discrepancy between census schedules and death registers is illustrated by the various groups of foremen. These almost invariably show very light mortality at the working ages, 20–65. Two explanations are suggested in the Reports: (1) selection for promotion to the status of foreman partly on grounds of good health, and (2) a tendency to magnification of status in filling up the census schedules. A third is possible, viz. ignorance on the part of those giving particulars of deaths to the registrars that the deceased had been promoted to the status of foreman.

It is stated in the Reports that the same feature of very light mortality is marked in the case of "Heads of commercial office departments". Those who have had experience of the organization of the staffs of various offices, and the varied meanings attached in different offices to the terms "department" and "head of department", will not be surprised to find evidence of confusion, either in the minds of the employees themselves or of their relatives.

The wisest conclusion is that which was drawn in the 1931 Report, viz. that the effect of this source of error on mortality rates should be eliminated wherever possible by suitable combination of the foremen or "head of department" class with the larger group of workers with whom they are associated.

Labourers

Every case of erroneously recorded light mortality in one group will lead to erroneously recorded heavy mortality in another group, though if one of the groups is large and the other small the effect on the larger group may not be appreciable. An example of the twofold effect may be seen in the case of labourers in 1911.

High mortality is to be expected in the group of "general labourers", for ill-health and other misfortunes must help to recruit its ranks, but its place in 1911 at the bottom of the table of comparative mortality in different occupations, with an apparent excess mortality so high as 183 % above the average was surprising,

until it was realized that part of this excess was due to the method of census classification adopted in 1911. On that occasion the attempt was made in the census to ascertain, where possible, the industry in which each labourer was then employed. There are, of course, specialized labourers attached permanently or for long periods to particular industries and rightly returned as such, but there are also "general labourers" who wander from one industry to another. In 1911 the census officials tried to discover the industries to which general labourers were then attached, and to allot them to those industries. In this they were only partly successful, and a large class of general labourers remained. But the informants of registrars of deaths appear to have described a still larger proportion of those labourers who died simply as "labourers" or "general labourers" without reference to any industry.

The result was that in the 1911 investigation the mortality of the group of "general labourers" is recorded as exceptionally heavy, whereas a number of groups of specialized labourers show very light mortality. "Navvies", for example, come out nearly at the top of the list of occupations, with lighter mortality even than clergymen. These results are clearly illusory. This source of error was to a large extent avoided in 1921 and 1931 by better grouping.

It is evidently necessary that before each investigation the registrars should be given instructions corresponding to those to be given to the census officials, and that by consultation with representative workers every effort should be made to use descriptions and classifications of occupations familiar to, and accepted by, the workers themselves and their relatives. There will no doubt continue to be some lack of correspondence between census and registration particulars, but by examining the recorded figures in each group before much analysis is attempted, and by combining groups together and refraining from pursuing attempts at subdivision which have obviously broken down, the effect of the discrepancies may to some extent be overcome.

The clear instances of lack of correspondence in the two sets of particulars in the past investigations are bound to lead to doubt as to whether there may not be many other cases which have not been detected. It must be recognized that many details of the investigations may be unreliable, particularly for small groups, and

that only the broad outlines of the results can be accepted with confidence.

Transfers from one Occupation to another on account of Health

Even if the census and registration particulars of occupations were in all cases in agreement, the recorded particulars could only give the rates of mortality among those for the time being engaged in or retired from particular occupations, and could take no account of their previous occupational history. From the point of view of these investigations transfers from one occupation to another are only of importance if considerations of health are involved. It is clear that there may be many cases where a man who has been engaged in a strenuous occupation and has fallen into ill-health may be compelled to adopt a less strenuous occupation some time before his death. In general, such transfers will have the effect of understating the rates of mortality in strenuous occupations and overstating them in occupations open to men of impaired physique.

On the other hand, impaired health may in some cases make it difficult for a man to find a new occupation. If an industry is severely depressed or declining, and a number of the workers transfer to other industries, it will be the most healthy and enterprising men who will tend on the whole to seek work elsewhere, and the average state of health of those in the industry will tend to decline. The rather high rates of mortality among coal-miners in the younger age groups in 1930–32 are considered by the investigators to be due to the migration of healthy young men out of the industry between 1921 and 1931.

Women

No attempt was made before 1931 to analyse the mortality of women according to their occupations, owing to the great discrepancy between the proportion returned as without remunerative occupation in the census schedules and the corresponding proportion in the death registers. In the 1931 investigation the occupational mortality of single women was analysed, but as there still appears to be considerable non-statement of occupation in the death registers the results are of doubtful value.

2. METHOD OF PRESENTATION OF RESULTS

Age Groups

From the time of Dr Farr it has been realized that in any investigation of occupational mortality allowance must be made for age distribution. If each year of age were investigated separately there would be too many groups, and in the recent Reports the principal age groups have included ten years of age. In the 1931 Report there were nine age groups, as follows:

16–, 20–, 25–, 35–, 45–, 55–, 65–, 70–, 75 and over.

For each of these groups one rate of mortality was calculated, no account being taken of the age distribution within the group. In an investigation of this kind, in which in any case precision is impossible, the fact that allowance is not made for the age distribution within such wide groups of ages is not important in the younger age groups, but its effect may be serious above age 65. When to this is added the serious discrepancy between the census records and the death registers as to the "unoccupied" above age 65, it is clear that the recorded figures as to occupational mortality beyond age 65 are unreliable.

It is mainly for this reason that in the recent Reports the comparisons between different occupations have been made on the basis of a range of ages ceasing at 65. In 1911 the range was from 25 to 65, and in 1921 from 20 to 65. There was some criticism of the extension of the range to 20–65, on the grounds that at ages 20–25 the data were less trustworthy than at older ages, and that rates of mortality at ages 20–25 were more a measure of the degree of health necessary for entrance to an occupation than an indication of the effect of the occupation upon mortality. The investigators of 1931 retorted that these objections applied with nearly as much force to ages 25–35, and gave their results on the basis of two ranges, one from 20 to 65, and the other from 35 to 65. It seems more important that there should be continuity of practice, so that the results of each investigation may be compared with others, than that any particular age should be chosen as the starting-point.

Method of Comparing Mortality in Different Occupations (C.M.F. and S.M.R.)

When the numbers recorded as being engaged in a particular occupation in each age group at the census date have been ascertained, together with the corresponding numbers of deaths during the period under investigation, the recorded information for the age groups comprising the significant ages 20–65 may be set out in the following form.

Table 1. 1931 Investigation: Coal-Miners conveying Material to the Shaft

	Age group				
	20–	25–	35–	45–	55–65
Population in the occupation in 1931	37,724	32,518	16,310	11,240	6,521
Deaths from all causes in 3 years, 1930–32	386	365	265	296	365
Occupation death-rate % p.a.	·341	·374	·542	·878	1·866

This is a plain statement of the information available, as recorded. If the death-rates from a particular cause are being considered, they can be set out in similar form.

When different occupations are being compared, the most complete comparison available is that between sets of figures arranged as above. But the human mind hankers after something more simple, and various attempts have been made by successive investigators to represent *by a single figure* the mortality in a particular occupation, either from some particular cause or from all causes, relatively to some standard, such as the experience during the same period for all men. The two principal methods which have been used in the Census Reports on Occupational Mortality are those indicated in the 1931 Report as C.M.F. (Comparative Mortality Figure) and S.M.R. (Standardized Mortality Ratio).

The C.M.F. method is the traditional method that was used for many years in these Reports. In the 1921 Report both methods were used. In the 1931 Report the superiority of the S.M.R.

method is definitely recognized and this method is in general use throughout that Report.

In the S.M.R. method, the actual deaths in the occupation group are compared with the expected deaths in that group calculated on the basis of the rates of mortality for all men.

In the C.M.F. method, the actual deaths in a standard population (in which the number living and the number of deaths in each age group are proportionate to the numbers recorded for all men) are compared with the expected deaths in that standard population calculated on the basis of the rates of mortality experienced in the occupation group.

The S.M.R. method is consistent with what has been normal actuarial practice for many years. Both methods are described here, as it is instructive to consider the reason for judging the S.M.R. method to be the better.

So far as the C.M.F. method was used in the 1931 investigation for purposes of comparison, the standard population for men was taken as the 1931 Census population of all men at ages 20–65, reduced in such a proportion that when the rates of mortality from all causes experienced in 1930–32 among all men in the various age groups are applied to the reduced population the number of deaths is 1000. The C.M.F. for coal-miners conveying material to the shaft was then calculated as shown in Table 2.

Table 2. 1931 Investigation: Coal-Miners conveying Material to the Shaft

	Age group					Total
	20–	25–	35–	45–	55–65	
Standard population	17,436	31,422	25,779	23,630	18,116	
Actual deaths p.a. in standard population	57	109	144	263	427	1000
Calculated deaths p.a. based on occupation death-rates shown in Table 1 above	59	118	140	207	338	862

The C.M.F. was taken as one-tenth of the total in the last line, viz. 86.

The corresponding S.M.R. was calculated as shown in Table 3.

Table 3. 1931 Investigation: Coal-Miners conveying Material to the Shaft

	Age group					Total
	20–	25–	35–	45–	55–65	
Death-rate % p.a. for all men	·328	·346	·559	1·114	2·355	
Calculated deaths in 3 years at these rates in the population in the occupation in 1931	371	338	274	376	461	1820
Actual deaths in 3 years in the occupation as in Table 1	386	365	265	296	365	1677

The S.M.R. was taken as 100 times the ratio between the totals in the last two lines, viz. $100 \times 1677 \div 1820 = 92$.

It will be seen that, in the C.M.F. method, differences between the death-rates experienced in the occupation and the corresponding standard death-rates in the age groups are weighted in proportion to the age distribution of the standard population, whereas in the S.M.R. method they are weighted in proportion to the age distribution in the occupation under investigation.

The two methods give much the same results unless there are substantial divergencies from one age group to another, both in the ratio between the actual and standard death-rates and in the ratio between the actual and standard populations.

In the above example of coal-miners conveying material to the shaft, the ratio between the actual and standard death-rates falls in the older age groups, and the proportion engaged in the occupation in those age groups also falls below the standard proportion. In the S.M.R. method the light rates of mortality in those age groups are allowed for in proportion to the comparatively small numbers of men among whom they are experienced, whereas in the C.M.F. method they are weighted in proportion to the much larger numbers in those age groups in the standard population.

That this feature of the C.M.F. method is a defect is perhaps brought out most clearly in cases where the number in one or more age groups is very small, and incidentally this illustrates the fallacies lurking in small numbers in investigations of this kind. The following figures for railway-engine drivers (Table 4) are an example.

Table 4. 1931 Investigation: Railway-Engine Drivers

	Age group					Total
	20–	25–	35–	45–	55–65	
Population in the occupation in 1931	302	2,613	12,210	13,991	10,515	
Deaths from all causes in 3 years, 1930–32	6	29	152	371	677	
Occupation death-rate % p.a.	·662	·370	·415	·884	2·146	
Standard population	17,436	31,422	25,779	23,630	18,116	
Actual deaths p.a. in standard population	57	109	144	263	427	1,000
Calculated deaths p.a. based on occupation death-rates	115	116	107	209	389	936
Death-rate % p.a. for all men	·328	·346	·559	1·114	2·355	
Calculated deaths in 3 years at these rates in the population in the occupation in 1931	3	27	205	468	743	1,446
Actual deaths in 3 years in the occupation	6	29	152	371	677	1,235

C.M.F. = 936 ÷ 10 = 94. S.M.R. = 100 × 1235 ÷ 1446 = 85.

The figures here which lead to difficulty in the C.M.F. method are those in the age group 20–, where the population is 302 and the number of deaths 6 in three years. This number of deaths is not in itself remarkable, but it is given undue importance by a method which merely records that the rate of mortality in this age group is twice the standard rate and takes no note of the small number involved. If the mortality in this age group had been normal, there would have been three deaths in it in the three years instead of six, and this would have reduced the C.M.F. from 94 to 88. The S.M.R. would have remained 85. It is evident that the C.M.F. method greatly overrates the importance of the three additional deaths, and that if an attempt must be made to represent by one figure the actual mortality in an occupation, compared with the standard and corrected for age distribution, the S.M.R. method is much better than the C.M.F.

It may be noted that the features, of which the C.M.F. method tends to exaggerate the importance, may themselves be errors. The light rates of mortality recorded at the older ages for coal-miners conveying material to the shaft may be due to errors in description of the various groups of coal-miners in the death registers; and the fact that the recorded rates of mortality for locomotive-engine firemen at young ages are very light suggests that possibly the excess deaths in the youngest group of engine drivers may be due to the registration as "engine drivers" of several young firemen whose relatives knew of their ambition to become drivers but did not realize that they had not quite achieved it.

Measure of Significance of Excess or Defect in S.M.R.

When the available figures have been recorded, it is necessary to ask whether, assuming that the recorded figures are accurate, the divergence between the actual number of deaths in a group and the corresponding standard number is likely to be significant, or is merely an insignificant random deviation. The 1931 Report has adopted a definite measure of significance.

If R represents the actual deaths in a group, and S the standard deaths based upon the death-rates of all men, the "standard error" in R may be taken approximately as $\sqrt{R}$, and the "standard error" in S may be regarded as zero. The S.M.R. is equal to 100 R/S, and its "standard error" may be taken as approximately $100\sqrt{R}/S$.

The 1931 Report, in speaking of the significance of an excess or defect in S.M.R., uses the convention that an excess or defect as great as $2\frac{1}{2}$ times the "standard error" is "significant", and that an excess or defect as great as $1\frac{1}{2}$ times but less than $2\frac{1}{2}$ times the "standard error" is "probably significant". A table is given in the Report indicating the application of this convention and the following examples are extracted from this table:

When the registered deaths in a group number	Ranges of percentage ratios of registered to standard deaths which are				
	"Significant"	"Probably significant"	"Not significant"	"Probably significant"	"Significant"
25	66 or less	67–76	77–142	143–199	200 and over
100	80 or less	81–86	87–117	118–133	134 and over
1000	92 or less	93–95	96–104	105–108	109 and over

Further, in tables of group rates and S.M.R.'s, a figure is not printed if the actual number of deaths which it represents is less than 20; but where in such cases the actual number differs from the standard number by 5 or more, the letter "E" or "D" is inserted to indicate that the group experience rate may be significantly in excess or defect of the national rate.

3. INTERPRETATION OF RESULTS

Mortality Rank of Occupations

In the 1931 Report, the great bulk of male occupations, divided into 200 groups, are shown in their order of ranking on the basis of their S.M.R. for death from all causes for ages 20–65. In the case of the 86 principal groups the corresponding order of ranking for death from a number of separate causes is also shown.

The outstanding points in these tables are at the two extremities —the occupations with lowest S.M.R., and those with highest S.M.R.

The men engaged in agricultural occupations showed S.M.R. from all causes in the three years 1930–32 of 73. This is a figure which may be accepted with confidence. Discrepancies may arise if an attempt is made to subdivide work in agriculture, but the group *as a whole* is well marked off from other occupations; and the men engaged in agricultural work between ages 20 and 65 numbered 874,000 in the census, a number so high that random fluctuations in the rates of mortality must have been reduced to a very low point.

There were 12 groups with lower S.M.R. than the workers in agriculture. Among them, as might be expected, were clergymen, whose S.M.R. was 69. There were others whose figures were surprising; for example, navvies with S.M.R. of 58. As the investigators point out, this figure must be illusory, and due to lack of correspondence between descriptions of occupation in the census schedules and death registers respectively.

As regards the other groups with S.M.R. lower than the workers in agriculture, the writer of this Note feels less confidence in the results than the investigators appear to do. We can all form the best judgment about the groups with which we are best acquainted. Consider the case of bank and insurance officials. They are grouped

together in the principal tables, and form one of the groups recorded as showing lighter mortality than workers in agriculture, their S.M.R. being 66. Separately, the S.M.R. of bank officials was 62, and of insurance officials 69. Now in the investigation "officials" were distinguished from "clerks". Bank and insurance clerks were not investigated separately, but were included in a very large group of "other clerks", whose S.M.R. was 98. It might be expected that bank and insurance clerks would stand higher than this in the comparative table if they had been investigated separately, perhaps not far from Civil Service clerks, whose S.M.R. was 77. Even so, there would be, in the recorded figures, a substantial gap between the S.M.R. of "bank and insurance officials" and the S.M.R. of "bank and insurance clerks".

But can anyone who knows bank and insurance officials and clerks believe that a clear-cut line can be drawn in these occupations between "officials" and "clerks", or that if such a line were drawn for census purposes it would coincide with that in the minds of relatives and friends giving information to registrars of deaths?

Except in the case of clergymen, in the description of whose occupation there is little room for error, it is doubtful whether much confidence can be placed in any of these returns of groups with lower S.M.R. than that for workers in agriculture.

At the other end of the tables, where the S.M.R. is high, it is unfortunately the case that most of the results appear to be definite and reliable. The occupations are clearly defined, like that of the small group of "sand blasters", whose work consists "in forcibly directing through a nozzle a stream of abrasive material, often sand, on to a surface for cleaning, finishing, or etching", and whose S.M.R. is 304, their ratio for diseases of the respiratory system being the highest recorded for any occupation.

In the majority of the other groups with high S.M.R., this is mainly due to high mortality from diseases of the respiratory system, in such occupations as tin and copper mine workers below ground, slate miners, glass blowers and file cutters. An excess mortality more widely spread among different causes is shown by such occupations as stevedores, dock labourers, and costermongers. The highest S.M.R. in the 86 principal groups is 155, returned in respect of inn and hotel keepers, the outstanding cause of their excess mortality being cirrhosis of the liver.

For purposes of life assurance, owing to the lack of precision, the results of the investigation are not of much value. Where the results are most reliable they confirm what was already regarded as known; for the rest, they provide some danger signals, but nothing more.

Analysis of Mortality from Separate Causes of Death

The main value of the whole investigation into occupational mortality lies in the use which may be made of it for the development of social welfare. It is from this point of view that an enquiry into the rates of mortality from various causes of death separately was first instituted in 1881, and has since been made the subject of more minute analysis, until by now it must absorb the greater part of the work involved in the whole investigation.

So far as a great part of this minute analysis is concerned, it may well be doubted whether the labour involved in calculating and printing the results can be justified from any point of view. In the 1931 investigation some improvement was effected, on what had become the traditional practice, by tabulating part of the results in a condensed form, and in the principal tables by indicating, or excluding altogether, figures derived from small numbers of deaths. But even so, 50 causes of death were separated in respect of the men engaged in the 86 principal occupational groups, and each of these was subdivided into nine age groups.

If we consider only the five principal age groups from 20 to 65, this gave $50 \times 86 \times 5 = 21{,}500$ subdivisions, and the whole of this part of the work is tabulated in the 1931 Report in full detail. Yet the total number of deaths among all men between ages 20 and 65 in the three years 1930–32 was only 292,375. It should surely be recognized before the investigation is begun that this number is quite insufficient to bear over 20,000 subdivisions, and that, if so great a number of subdivisions be used, the greater part of the mass of details tabulated in respect of separate causes of death is bound to consist of small numbers from which no trustworthy conclusions can be drawn.

There are particular occupations where an analysis of the mortality by separate causes, even though the numbers involved are small, may be of great value from the point of view of social welfare, as in the case of the cutlery grinders. Indeed, all occupations

showing exceptionally heavy mortality from all causes combined should be subjected to close analysis. But for the main investigation, a more extended grouping of the causes of death and of occupations seems necessary if useful results are to be obtained.

Occupation Groups—"Social Classes"

One possible line of investigation is to retain an extended list of causes of death but to reduce the number of occupation groups to a minimum. This has been done in what has been called a division by "social classes".

The first attempt on these lines was made in the 1911 investigation, when all occupations were divided into eight classes, as follows:

Class I: Professional, and generally well-to-do.
II: Intermediate between I and III.
III: Skilled artisans and analogous workers.
IV: Intermediate between III and V.
V: Labourers and other unskilled workers.
VI: Textile workers.
VII: Miners.
VIII: Agricultural labourers.

This division was rather rough, because in 1911 many of the original groups were not strictly occupational, but included members of all social classes engaged in a particular industry. The revised classification of 1921 was definitely occupational, and enabled the occupations carried on in textile factories and mines to be separated and assigned to their appropriate social classes I–V, besides making a better division possible in industry generally. At the same time agricultural labourers were transferred to Class IV. Clerks were transferred from Class I to Class II in 1921, and to Class III in 1931. A number of minor alterations were also made in 1931, of which the most important was the separation of certain groups of unskilled workmen previously included in Class IV, and their transfer to Class V. Officers and men of the Army, Navy and Air Force were excluded from the 1921 investigation, but were included in 1931.

The general results of this investigation in 1921 and 1931 can be seen from the following table:

Standardized Mortality Ratios. All Causes. Ages 20–65

Social class	1921–23	1930–32	
	Males (excluding non-civilians)	Males (including non-civilians)	Males (excluding non-civilians)
I	82	90	87
II	93	94	94
III	94	97	97
IV	99	102	101
V	124	111	112
All groups	100	100	99

It will be seen that, at each investigation, there was a continued progression in the S.M.R. from Class I to Class V, that the differences in Classes II, III and IV from the figure for all groups were small, the important deviations from that figure being at the two extremes, in Classes I and V. It will be noticed that as between the two periods there was a great diminution in the contrast between the results in these two classes.

As between the two periods there was an improvement in the rate of mortality in each age-group in every social class except Class I. In that class there was a considerable increase at ages under 35, owing mainly to the relatively high mortality among officers in the Royal Air Force, and to high mortality among young civilians due to aeroplane and motor-cycle accidents. The improvement in the rate of mortality was marked in every age group in Class V.

It must not be supposed that the ideal conditions for light mortality are to be found in Class I. There are certain "diseases of affluence" (e.g. angina pectoris, cirrhosis of liver, diabetes, nephritis) from which the rates of mortality among men are substantially higher in Classes I and II than in Class V. A better standard of light mortality is to be found among workers in agriculture, whose S.M.R. in 1930–32 was 73.

All the "social classes" are composite groups, but the composite character of Class IV should be specially noted. It includes the large group of agricultural labourers. If they were omitted

from Class IV, the remainder of that class, comprising over four-fifths of the total class, would show rates of mortality almost as high as those for Class V.

Analysis of the Mortality of Married Women according to their Husbands' Occupations

The high S.M.R. for Class V in the 1921 investigation suggested that the effect of occupation upon mortality might be on the whole more indirect than direct—that in most occupations mortality might be more influenced by the general conditions of life accompanying those occupations than by any direct occupational risk.

In the 1921 Report it was suggested that the two types of occupational influence might be distinguished if the mortality of the wives, grouped according to the occupations of their husbands, were investigated, for the mortality of the wives would not, as a rule, be subject to any direct occupational risk, but only to indirect.

The first analysis of married women's mortality according to their husbands' occupation and social class was carried out in the 1931 investigation. It showed a progression from Class I to Class V, rather more marked than in the case of men, in the rates of mortality from all causes, which is summed up in the following table:

Standardized Mortality Ratios. All Causes. Ages 20–65. 1930–32

Social class	Married women by class of husband
I	81
II	89
III	99
IV	103
V	113
All groups	100

The wives of the men in Classes I and II do not seem to suffer the same penalties of a comfortable income as do their husbands—the "diseases of affluence" do not produce excess mortality among the wives.

But in Class V there are a number of causes of death which show a significant excess mortality in the case of both the wives and the husbands (tuberculosis, bronchitis, pneumonia, and

others). These diseases are termed in the 1931 Report "poverty diseases", because there appears to be definite evidence that the rates of mortality from them are enhanced by poor social circumstances.

Analysis of the Mortality of Young Children according to their Fathers' Occupations

An analysis of the mortality of children in the first and second years of life according to the occupation and social class of the father was also made in the 1931 investigation. The progression in the rates of mortality from Class I to Class V was even more marked than in the case of their mothers, as will be seen from the following table:

Standardized Mortality Ratios. All Causes. Ages 1 and 2. 1930–32

Social class	Children by class of father
I	53
II	73
III	94
IV	108
V	125
All groups	100

Among separate causes of death, the progression from Class I to Class V was most marked in the case of bronchitis and pneumonia.

The high rates of mortality among married women and young children in Class V are undoubtedly due to unsatisfactory home environment and economic circumstances, and the fact that they diverge from their respective standard rates even more than the high rates of mortality among men in Class V indicates that the latter also are probably mainly due, not to specific direct risk involved in the men's occupations, but to the same causes as the high rates among the women and children.

Analysis according to Geographical Regions

It must not, however, be concluded that small incomes are necessarily associated with high rates of mortality. The low rates of mortality among agricultural labourers are a clear indication

that this is not so. The high rates of mortality in Class V must, then, be due to small incomes combined with some other conditions, and the attempt to discover those other conditions led to a further new feature in the 1931 investigation—the analysis of mortality in each social class in separate geographical regions, and for urban and rural subdivisions of those regions.

The outstanding features of this regional analysis are that the progression in rates of mortality from Class I to Class V is much more marked in the large industrial towns of northern England than in any other part of the country, and that whereas men of the unskilled class and their wives show no "northern excess" mortality in northern rural districts as compared with other rural districts, their "northern excess" mortality in northern towns as compared with other towns is greater than for any other class.

The general conclusions of the 1931 investigation are, then, that in 1930–32 there were some occupations in which high rates of mortality were due to a direct occupational risk involved in some dangerous process such as "sand blasting" or in some special feature such as association with the sale of alcohol; but that in general the direct effects of occupation on mortality were of relatively small importance compared with the environmental and economic conditions of home life, and that the most marked effects of unfavourable environmental and economic conditions were to be found among those who were trying to live on meagre incomes in the industrial towns of the north.

The principal Reports referred to in this Note are:

Supplement to the *Seventy-fifth Annual Report of the Registrar-General for England and Wales*, Part IV: *Mortality of Men in Certain Occupations in the Three Years* 1910, 1911 *and* 1912.

The Registrar-General's Decennial Supplement. England and Wales. 1921. Part II: *Occupational Mortality, etc.*

The Registrar-General's Decennial Supplement. England and Wales. 1931. Part II *a*: *Occupational Mortality.*