THE SEX RATIO OF PNEUMONIA MORTALITY

By W. J. MARTIN (*Medical Research Council's Statistical Staff*), *From the Division of Epidemiology and Vital Statistics, London School of Hygiene and Tropical Medicine*

A feature of the mortality from respiratory diseases in England and Wales has been the excess of male over female mortality, the difference between the sexes being most pronounced during the period of working life. The suggestion, conveyed by the tabulation of the deaths from pneumonia in the Statistical Review, that the males suffer a relatively high mortality in many areas is confirmed when the death-rates are calculated. The average male mortality from pneumonia, for the fifteen years 1924–38, expressed as a percentage of the average female mortality for the areas of London, the county boroughs, urban and rural districts and for four age groups are given in appendix tables A, B and C. Large variations existed in the size of the mortality sex ratio within the divisions and the age groups, but the explanation of these large differences is not obvious and they form a fruitful source of speculation. The mean ratio for each division is given in Table 1.

Table 1. *Male mortality from pneumonia during* 1924–38 *expressed as a percentage of the female mortality*

	Ages			
	0–	1–	15–	65+
London	130	116	210	128
County boroughs	133	114	226	125
Urban districts	134	113	207	123
Rural districts	132	114	174	122
England and Wales	133	114	208	123

The table shows that urbanization had little effect on the mortality sex ratio at the younger ages and only to a slight extent in the oldest age group, but at ages 15–65 years there was, excluding London, a distinct progression with urbanization. In each age group the males experienced a higher mortality than the females and the males were at a greater disadvantage during infancy than in childhood or old age, but the striking difference between the sexes occurred at ages 15–65 when the males had a mortality twice as large as the females.

Before proceeding to examine the differences within the regions it is necessary to review, briefly, the national statistics. Pneumonia mortality and the mortality sex ratio tabulated by social class is shown in Table 2. The standardized mortality ratio progressively increased with descending order of social class for both males and females, but the sequence of the mortality sex ratio was broken by class II. The very high mortality sex ratio in this social class was partly due to the low death-rate experienced by the single women, the exclusion of the single women would reduce the mortality sex ratio to 232, and partly to the high crude death-rate of the males, due to the age constitution of this class which had a higher mean age than the other social classes.

Table 2. *Pneumonia mortality at ages* 20–65 *during* 1930–2

Social class	Standardized mortality ratio			Male mortality as a percentage of married and single women
	Males	Married women	Single women	
I	71	72	—	212
II	80	77	53	249
III	91	96	94	216
IV	109	105	115	226
V	139	133	134	230
All	100	100	100	223

The large mortality sex ratio found at ages 15–65 in Table 1 suggests that the differences between the mortality of the sexes may be caused by occupations with a high pneumonia risk. This can be examined nationally by considering the mortality within the various occupational groups of males and their wives. There were twenty-seven occupations in 1930–2 for which the data for married women were sufficiently numerous to permit a comparison with the males to be made. These occupations were classified in groups on the basis of the Registrar-General's criterion of significance. A summary of the results obtained is given in Table 3. The occupations in this table show a definite relation between the relative size of the males and married women's mortality from pneumonia, and there is little evidence of an occupational risk for males. The most striking difference that could occur is a male mortality significantly in excess of the average associated with a mortality for wives significantly in defect of their standard. No occupation had such an excessive male mortality risk. The largest differences observed were two occupations, inn-keepers, hotel-keepers, etc., and furnacemen, rollermen, etc., where the male mortality was

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

significantly in excess, but that for the wives was not different from the average of all married women. In the latter group the liability to respiratory diseases was attributed by Vernon* to the abrupt changes in the temperature to which the men were exposed by the conditions under which they worked, i.e. hot, heavy and exhausting spells of work alternated with periods of rest. The prognosis of pneumonia is more unfavourable among alcohol addicts than among the general population, and from the nature of the occupation in the former group a larger proportion of heavy drinkers than in other trades would be expected. A high pneumonia mortality was also found in the other, but smaller, occupation groups in which alcohol might be the occupational risk; these were barmen, etc., and makers of alcoholic drinks, with standardized mortality ratios from pneumonia of 142 and 159 respectively. Both these values exceeded the mean ratios by a little more than twice their S.E.'s. The deaths from pneumonia among the married women of these occupations, during the three years 1930–2, were too small to allow the usual comparison to be made, they were only 5 and 2 respectively compared with 8 and 7 standard deaths. These values, however, suggest that a difference existed between the males and married women in these occupations as large as or larger than in the group inn-keepers, hotel-keepers, etc. Commercial travellers who, because of the necessity of lodging in licensed premises, might be thought to have an alcoholic consumption above the average, had a standardized mortality ratio from pneumonia which was significantly in defect of the mean, whilst that of their wives did not differ from the mean of all married women. The expression of the male death-rates as a percentage of the rates for the married women yielded the following distribution:

Percentage	170–	180–	190–	200–	210–	220–	230–	240–
No. of occupations	1	1	2	5	9	4	2	3

* Industrial Fatigue Research Board, Rep. no. 5.

The two lowest ratios were given by the group comprising salesmen (dairy, meat, fish and greengrocery) and by textile spinners (cotton). The three occupations in which the mortality ratio was highest were inn-keepers, hotel-keepers, etc.; railway engine drivers; boilermen, firemen and stokers. These three groups of occupations are fairly generally distributed throughout the country and could not unduly influence the sex ratio of pneumonia mortality in any particular area.

From the above tables we can infer that the social class differentiation of pneumonia mortality is not influenced to a large extent by direct occupational risk, but is associated with environmental conditions since the male and married women's standardized mortality ratio are approximately of the same order. A greater susceptibility among males than among females to infection or a greater power of recuperation possessed by females may be a possible explanation of the general excessive male mortality. During the working years of life a considerable part of the large male excess must be attributed to an indirect occupational risk, the general conditions of life that an occupation involves, rather than to the type of occupation. It does not appear from these tables that occupation or social class differences can solely account for the large local variations in the sex ratio of pneumonia mortality.

Table 3. *Differences between the standard pneumonia mortality and the observed standardized mortality ratio for ages* 20–65 *in* 1930–2

		Males					
		Significantly less	Probably significantly less	Not significantly different	Probably significantly greater	Significantly greater	Total
Wives	Significantly less	3	1	—	—	—	4
	Probably significantly less	2	—	1	—	—	3
	Not significantly different	1	—	7	2	2	12
	Probably significantly greater	—	—	1	—	1	2
	Significantly greater	—	—	—	—	6	6
	Total	6	1	9	2	9	27

LONDON

An inspection of the sex ratio of pneumonia mortality in London, given in appendix, Table A, shows that in each of the four age groups large variations occur between the boroughs. These differences are most marked in the first year of life and at ages 15–65. There appears to be little or no relationship between the relative size of the mortality sex ratio in age groups, i.e. the ratio is not consistently high or low at each age for the London boroughs. Two of the boroughs had ratios below the mean value of London in four age groups, in nine boroughs the ratio was above the mean value once, seven boroughs had a ratio in two groups above the mean, six boroughs had a ratio above the mean in three

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

age groups, and four boroughs had ratios that were in excess of the mean in each of the four groups. Taking as an approximate test of random distribution the chance of any value being larger than the mean as one-half the series obtained would be 1·75, 7·5, 10·5, 7·5 and 1·75. The numbers are rather small, but by grouping the tails the distribution is:

	Observed	Expected
3 and 4 age groups below mean value	11	8·75
2 age groups above mean value	7	10·5
3 and 4 age groups above mean value	10	8·75

This gives a $\chi^2 = 1{\cdot}9239$ with a $P = 0{\cdot}39$, which confirms the impression obtained by inspection that the boroughs cannot be divided into groups where the sex ratio of pneumonia was high or low throughout life.

Ages 0–1

The male infant mortality from pneumonia as a percentage of the female varies from a 7% excess in Woolwich and Stoke Newington to one of 65% in Hampstead. The general social conditions of the London boroughs vary considerably, and these are known to be associated with infant mortality. A comparison of social conditions and the infant mortality sex ratio from pneumonia was attempted. As an index of environmental conditions the percentage of the population living more than two to a room and the number of persons per room in 1931 were used. These were correlated with the infant sex ratio of pneumonia mortality and gave approximately equal and insignificant coefficients; the former index gave $r = 0{\cdot}2242 \pm 0{\cdot}18$ and the latter $r = 0{\cdot}2408 \pm 0{\cdot}18$. A closer examination of the data revealed that the results were greatly influenced by the two boroughs of Hampstead and Shoreditch, which displayed considerable divergence from the general trend. Hampstead had the lowest density value and the greatest mortality sex ratio, whilst Shoreditch had the highest density combined with a low mortality sex ratio. The pneumonia mortality ratio of infants in Hampstead was also very low, the male rate was 58% of the London male rate whilst the female rate was only 46% of the London female rate. It is known that a linear correlation between density and mortality cannot be applied to the whole range of density, since at both the very low and very high densities the curve of mortality tends to asymptote. For this reason Hampstead and Shoreditch were omitted from the series. The omission of these two boroughs from the calculations considerably increased the size of the correlation coefficient. The correlation coefficient, found from the remaining twenty-six boroughs, between the infant mortality sex ratio from pneumonia and the percentage of the population living more than two to a room, was $0{\cdot}5450 \pm 0{\cdot}14$, and between the infant mortality sex ratio and the number of persons per room was $0{\cdot}5786 \pm 0{\cdot}13$.

It seemed of interest to inquire whether the sex ratio of infant mortality from pneumonia varied with the level of the infant death-rate from pneumonia. The correlation coefficient from these two variables for the twenty-eight London boroughs was $0{\cdot}2466 \pm 0{\cdot}18$. The omission of Hamsptead and Shoreditch from the calculation had a greater effect than with the indices of density, the correlation was increased to $0{\cdot}6257 \pm 0{\cdot}12$. Since density is highly correlated with infant mortality from pneumonia, the partial correlation coefficients for the twenty-six London boroughs (omitting Hampstead and Shoreditch) were found. They were:

	r
Mortality sex ratio and percentage of population living more than two to a room, keeping constant the pneumonia death-rate under age 1	$0{\cdot}1467 \pm 0{\cdot}19$
Mortality sex ratio and number of persons per room keeping constant the pneumonia death-rate under age 1	$0{\cdot}3058 \pm 0{\cdot}18$
Mortality sex ratio and the pneumonia death-rate under age 1, keeping constant the percentage living more than two to a room	$0{\cdot}3912 \pm 0{\cdot}17$
Mortality sex ratio and the pneumonia death-rate under age 1, keeping constant the number of persons per room	$0{\cdot}4133 \pm 0{\cdot}16$

The effect of keeping the pneumonia mortality under age 1 constant was to reduce to insignificance the correlation between the two indices of density and the sex ratio of pneumonia mortality. It seems that for the twenty-six boroughs the sex ratio of infant deaths from pneumonia is associated with the level of infant pneumonia mortality.

Ages 1–15

The distribution of the mortality sex ratios for this age group formed a more compact series than did the ratio for ages under 1 year. Only four boroughs had ratios that were markedly different from the general range. The adjacent boroughs of Hampstead and St Marylebone had the highest values, whilst the adjoining boroughs of Chelsea and Fulham had the lowest ratios. The extremes of the distribution, Hampstead and Chelsea, had a very low mortality from pneumonia. The rates expressed as a percentage of the value for the whole of London were: Hampstead, males 67, females 45; Chelsea, males 62, females 84. The number of deaths on which the mortality sex ratios of these two boroughs was based was rather small, 43 males and 25 females in Hampstead and 29 males and 34 females in Chelsea.

There is some suggestion of a geographical dis-

tribution of the mortality sex ratio from pneumonia. The highest ratios tended to appear in adjacent boroughs, whilst eight of the ten boroughs with the lowest ratios have a river frontage.

Ages 15–65

The chance of dying from pneumonia during this age period was, for London as a whole, over twice as great for males as for females, and between the boroughs the chance varied from $1\frac{3}{4}$ to $2\frac{3}{4}$. Although the distribution of the mortality sex ratio of the whole country suggested that social class differences would not be a factor of great importance in the variations that exist between various localities, it is of interest to examine this aspect for London. To obtain an index of the relative social status of the London boroughs, the proportion of males in social class V was used. This index, when correlated with the mortality sex ratio from pneumonia, gave a correlation coefficient $r = 0{\cdot}0458 \pm 0{\cdot}19$, an insignificant value in accordance with expectation. The usual and more direct estimation of environmental conditions, the percentage of the population living more than two to a room, was correlated with the mortality sex ratio from pneumonia and gave an insignificant association of $r = 0{\cdot}2625 \pm 0{\cdot}18$. It seems from these results that the fluctuations observed in the mortality sex ratio from pneumonia between the London boroughs cannot be due to differences in social and environmental conditions. With the elimination of general living conditions as a possible factor of the variations, occupation as a possible explanation must be considered. If a large part of the excess of male mortality during the years of working life can be attributed to conditions arising out of employment, i.e. the males are exposed to a greater risk of infection due to aggregation in workshop, factory, office and public vehicles than the females, it is reasonable to expect that if the females were similarly exposed their mortality rate would increase. If this were true, then the amount of female employment would be a factor in determining the size of the mortality sex ratio from pneumonia. We should expect a negative correlation, since an increase in the female rate would lead to a decreased ratio. To obtain an estimate of this possible factor the occupied females were expressed as a percentage of all females for each borough and the correlation with the mortality sex ratio from pneumonia found. This was $r = 0{\cdot}6029 \pm 0{\cdot}12$. Such a large positive correlation is in direct contradiction of the hypothesis. A possible explanation of the surprising result obtained is that the index of female employment used gave a very imperfect representation of the relative amount of female labour. An examination of the female occupations showed that a little more than one-fifth of the occupied females in London were domestic servants, and in some boroughs the proportion rose to almost one-half. Since the conditions of life of domestic servants would be similar to that of housewives, it is probable that their inclusion has biased the local values found for female employment. A second estimate was accordingly found by expressing the occupied females less domestic servants as a percentage of all females. The resulting correlation with the mortality sex ratio was insignificant, $r = 0{\cdot}1523 \pm 0{\cdot}18$. Neither of these correlations supports the theory that the excessive male mortality from pneumonia is associated with working conditions. This may be due to the crudeness of the index used which made no allowance for the differences between male and female occupations and their differing conditions of work. Another indirect approximation to the degree of the residential or industrial character of an area can be obtained by using the sex ratio, since it has been found that, generally, a preponderance of females is associated with residential districts, partly due to the inclusion of domestic servants, and as the industrial character increases in importance the proportion of males increase until in some areas of the country the males are in excess due to the female migration owing to lack of employment. The correlation between the sex ratio within the London boroughs and the mortality sex ratio from pneumonia was small but significant, $r = 0{\cdot}3676 \pm 0{\cdot}16$. This result suggests that there is some association between the commercial and industrial character of a borough and the mortality sex ratio from pneumonia, but whether the difference is due solely to occupation or in part to economic environment is a matter of speculation, since it is rather difficult to reconcile this correlation with the previous ones.

Ages 65 *and over*

There was a fairly well-marked geographical distribution of the mortality sex ratio from pneumonia in this age group. The group of seven northern boroughs of Paddington, St Marylebone, Hampstead, St Pancras, Holborn, Finsbury and Islington had ratios above the mean of the whole of London. The ten boroughs situated in the east and south-east, Shoreditch, Stoke Newington, Hackney, Bethnal Green, Stepney, Poplar, Deptford, Lewisham, Greenwich and Woolwich, had ratios below the mean value, and so did the four westerly boroughs of Hammersmith, Kensington, Westminster and Fulham. The other group of boroughs did not exhibit the tendency to have ratios that varied from the mean in the same direction.

The largest ratio was that of Chelsea, 198, and this borough also had the highest value in the preceding age group. Shoreditch, with the lowest ratio of 95, had a very high ratio at ages 15–65.

The pneumonia mortality in Chelsea at ages 65+ was, for males, 114% of the London male value, whilst that for females was only 74% of the London female rate. In Shoreditch the male rate was 88% and the female 118% of the value for the whole of London.

COUNTY BOROUGHS

Ages 0–1

The range of the mortality sex ratio was greater than among the London boroughs. A ratio below the lowest value in the London boroughs was found in the five towns of Worcester 99, Reading 104, Smethwick 104, Hastings 106, Ipswich 106, and a ratio greater than the largest in the London boroughs was found in the six towns of Doncaster 198, Oxford 196, Huddersfield 192, Chester 177, Exeter 166, Bury 166. There is a considerable variation in the degree of industrialization of the towns within both these groups, and it does not appear that the status of the town is related to the infant sex ratio of pneumonia mortality.

Table 4. *Sex ratio of the infant pneumonia mortality in County Boroughs*, 1924–38

Division	No. of county boroughs	Mortality sex ratio	Range of ratios of the county boroughs in the division
North	8	126	109–152
Yorkshire	13	140	125–198
North-western	21	131	114–177
North-midland	5	133	106–142
West-midland	12	133	99–162
South-midland and eastern	8	128	106–196
South-east and south-west	12	132	104–161
Wales	4	142	123–159
England and Wales	83	133	99–198

The geographical distribution of the ratios follows no decided trend, although in Yorkshire twelve of the thirteen county boroughs had a mortality sex ratio that was in excess of the mean of all county boroughs, and in the eastern counties five of the six towns had a ratio in defect. A summary showing the average of the sex ratio of pneumonia mortality among infants in the principal divisions of the country is given in Table 4. The mortality sex ratio of the county boroughs within each division fluctuated over a wide range, but the limits varied between the divisions. There were three divisions, comprising thirty-eight boroughs, without a very small ratio (20 or more in defect of the mean of all county boroughs) and two divisions with thirteen towns without a large ratio (20 or more above the mean).

Ages 1–15

The mortality ratios of four towns differ considerably from the remainder, Eastbourne with the very low ratio of 59, which was 27 below the next lowest, and the high ratios of Oxford 182, Bath 168 and Coventry 157. The mean value for all county boroughs was 114. If local conditions such as social and environmental factors or geographical position were of importance in determining the relative size of the male and female child mortality from pneumonia, we might expect that surroundings which were adverse for infants would affect similarly the older children. This possibility was examined by constructing a fourfold table for the two age groups under 1 and 1–15. The dichotomy was made at the mean value of all county boroughs for each age group and the unusual distribution which resulted was:

		Ages under 1: Ratio above the mean	Ages under 1: Ratio below the mean	Total
Ages 1–15	Ratio above the mean	20	21	41
	Ratio below the mean	22	20	42
	Total	42	41	83

From this table the value of χ^2 was 0·00014 with a probability of almost unity. This distribution is too highly improbable for conclusions to be safely drawn and as an alternative the product moment was employed. The coefficient of correlation between the ratios under 1 and 1–15 was $0{\cdot}140 \pm 0{\cdot}11$. From this insignificant association we may conclude that the mortality sex ratio in infancy and childhood are independent.

Ages 15–65

The striking feature of the mortality from pneumonia during the working years of life is the large male excess. In the county boroughs the average rate mortality was $2\frac{1}{4}$ times that of the females, the range was from less than $1\frac{1}{2}$ in Wigan to almost 3 in Smethwick. Although the mortality sex ratio was considerably larger than in the preceding age groups, the relative range of the differences was not so great, at ages 1–15 the largest ratio was three times the smallest. Since many towns have an industry that dominates its economic life, an attempt has been made to group the county boroughs according to the principal occupations of the inhabitants. The criterion used to determine the classification of a town was that at least one-quarter of the occupied males or females were returned as employed in one occupation in the 1931 census. An exception was made for the two

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

Table 5. *County boroughs grouped*

Female

Male occupations	Textile workers	M/F	MSR	Makers of textile goods	M/F	MSR	Makers of bricks and pottery	M/F	MSR
Metal workers	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
Mining	Wigan	2·1	143	—			—		
	—			—			—		
Textile workers	Burnley	1·3	205	—			—		
Makers of textile goods	—			Northampton	2·0	222	—		
Metal and textile workers	Rochdale	1·5	253	—			—		
	Halifax	1·7	249	—			—		
	Bradford	1·6	242	—			—		
	Stockport	1·7	231	—			—		
	Oldham	1·6	227	—			—		
	Huddersfield	1·9	222	—			—		
	Bury	1·5	218	—			—		
	Blackburn	1·2	207	—			—		
	Bolton	1·7	201	—			—		
	Preston	1·5	187	—			—		
Metal workers and makers of textile goods	Leicester	1·5	242	—			—		
Mining and metal workers	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
Mining and textile workers	Dewsbury	1·9	219	—			—		
Mining and bricks, pottery, etc.	—			—			Stoke	1·7	259
Defence	—			—			—		
	—			—			—		
General and water transport	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
General	Nottingham	1·8	252	Manchester	1·8	249	—		
	—			Leeds	1·8	249	—		
	—			Norwich	2·0	149	—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		
	—			—			—		

M/F = occupied males/occupied females.

boroughs listed under defence, Portsmouth and Plymouth, where only 21·8 and 21·2 of the males were classified under this occupational heading. The grouping of the county boroughs by their principal occupations is shown in Table 5. The classification of towns by female occupation is, perhaps, rather defective, since the conditions governing the demand for female operatives varies considerably between the county boroughs. In the textile towns a large number of females are employed, and in these towns are found the greatest proportion of married women engaged in industry, whilst in the towns where the males are principally engaged in heavy industry the opportunities for women to obtain employment are, generally, more restricted. To allow this factor to be considered the number of occupied males per occupied female was also tabulated. The table shows that considerable variation existed between the mortality sex ratio of the county boroughs within the same group.

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

according to occupations

occupations

General			One-quarter to one-third of occupied females engaged in personal service			One-third to one-half of the occupied females engaged in personal service			More than one-half of the occupied females engaged in personal service		
	M/F	MSR		M/F	MSR		M/F	MSR		M/F	MSR
Smethwick	2·2	290	Wolverhampton	2·4	274	Chester	2·2	258	—		
Birmingham	1·9	279	Sheffield	2·6	264	Lincoln	3·1	240	—		
Derby	2·5	262	—			Birkenhead	2·5	234	—		
Walsall	2·3	237	—			Barrow	4·2	229	—		
Dudley	2·5	235	—			Darlington	3·0	209	—		
W. Bromwich	2·5	234	—			—			—		
Coventry	2·6	222	—			—			—		
			St Helens	3·7	215	Merthyr Tydfil	6·4	189	—		
—			Barnsley	3·4	180	—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			—			—			—		
—			Wakefield	2·7	201	Doncaster	3·2	204	—		
—			Gateshead	2·9	194	Sunderland	3·0	197	—		
—			—			Rotherham	4·3	179	—		
—			—			South Shields	3·7	161	—		
—			—			—			—		
—			—			—			—		
—			—			Plymouth	3·3	151	—		
—			—			Portsmouth	2·9	146	—		
West Ham	2·3	188	Liverpool	2·2	219	Newport	3·3	278	—		
—			Bootle	2·4	176	Wallasey	2·2	237	—		
—			—			West Hartlepool	3·4	236	—		
—			—			Cardiff	2·6	232	—		
—			—			Middlesbrough	3·7	230	—		
—			—			Swansea	3·7	216	—		
—			—			Kingston-on-Hull	2·8	215	—		
—			—			Tynemouth	3·0	214	—		
—			—			Southampton	3·0	208	—		
—			—			Grimsby	3·3	161	—		
Salford	1·7	259	Gloucester	2·4	221	Burton	3·1	252	Bournemouth	1·4	211
Warrington	2·5	259	Bristol	2·1	208	Southend	2·0	239	Blackpool	1·6	203
East Ham	2·5	187	Worcester	1·9	184	Reading	2·3	217	Hastings	1·5	202
Carlisle	1·9	173	—			Newcastle	2·5	215	Bath	1·6	198
—			—			Ipswich	2·5	214	Southport	1·6	197
—			—			Croydon	2·2	200	Eastbourne	1·3	196
—			—			York	2·4	184	Canterbury	2·4	195
—			—			Exeter	2·2	176	Brighton	1·9	179
—			—			Great Yarmouth	2·1	154	Oxford	2·0	161

MSR = sex ratio of pneumonia mortality.

Twelve of the fouteeen towns where metal workers formed the principal male occupational group had a mortality ratio above the mean for all county boroughs, and five of the six highest ratios in the country were found in these groups. The four towns where mining was the chief male occupation had a mortality ratio below the mean. A low ratio was also found in the seven towns where mining was the joint principal occupation with metal or textile workers. Stoke was the only town with an important proportion of miners that had a high mortality ratio, the other male occupation in this town was makers of bricks, pottery, etc. The nine boroughs with a more residential than industrial status (without an industry which absorbed a predominant share of the occupied males and where more than half of the occupied females were engaged in personal service) had mortality sex ratios below the average. The very low ratios of the two cities where defence services were the most

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

important of the male occupations might be explained by selection, since the males were of a higher standard of physique than the general population, but such a ready explanation of the still lower mortality ratio of Wigan cannot be advanced. The low ratio in Wigan was due to the high female mortality, which was 162% of the average female pneumonia mortality for all county boroughs, whilst the male mortality was only 102% of the male average. There is a suggestion from these selected groups of occupation that a relation exists between the industrial nature of the town and the sex ratio of pneumonia mortality. The remaining subgroups, however, did not exhibit this trend, but had ratios above and below the mean value, e.g. the mortality ratio of the ten towns, where the chief occupational group was textile workers among the females and textile and metal workers among the males, had ratios that were equally distributed above and below the mean value of all county boroughs. Within the subgroups of occupations there does not appear to be any relation between the sex ratio of pneumonia mortality and the degree of industrialization, as judged by the proportion of male to female operatives.

Environmental conditions may also be a factor influencing the size of the mortality sex ratio, but the variations in the industrial undertakings of the county boroughs makes an estimation of the effects of social conditions difficult. There is probably less difference in the industrial conditions between the ten towns with male metal and textile workers and female textile workers than in any other occupational group of towns. This group gives the following distribution of the sex ratio of pneumonia mortality with the degree of industrialization and density:

Percentage of population living more than 2 to a room	No. of occupied males per occupied females							
	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9
3·33	207	—	—	—	—	—	—	—
4·47	—	—	—	187	—	—	—	—
4·60	—	—	—	218	—	—	—	—
4·97	—	—	—	—	—	201	—	—
5·22	—	—	—	253	—	—	—	—
5·73	—	—	—	—	—	231	—	—
6·18	—	—	—	—	227	—	—	—
6·91	—	—	—	—	242	—	—	—
7·92	—	—	—	—	—	—	—	222
10·08	—	—	—	—	—	249	—	—

The mortality sex ratio increases with increasing density for a constant ratio of occupied males to occupied females, but the numbers are too few to draw any definite conclusion, especially as this definite trend is not apparent in the other occupational subgroups where the range of the ratio of occupied males to occupied females is more varied. The mortality sex ratio and the ratio of occupied males to occupied females does not follow a definite trend for constant levels of the overgrowing index.

Ages 65 and over

The average male mortality during this period of life was 1¼ times that for females, but there were five towns in which the females experienced a higher mortality from pneumonia than the males. The male mortality was relatively very high in three towns; these mortality sex ratios were 202 in Doncaster, 187 in Barnsley and 177 in Wakefield, and were considerably above the next highest ratio of 157. There does not appear to be any relation between the mortality sex ratios and the industrial character of the towns, as classified for the preceding age group. The only group that displayed any evidence of an association was the residential towns where seven out of the nine ratios were below the mean. There was no apparent geographical distribution of the mortality sex ratios, e.g. in both the large groups of towns of Lancashire and Yorkshire, half of the county boroughs had mortality ratios above and below the mean of all county boroughs.

URBAN AND RURAL DISTRICTS

Table 1 showed that practically no association existed between the varying degrees of urbanization and the average sex ratio of pneumonia mortality in the two youngest and the oldest age groups. The largest difference between the average mortality ratio of the county boroughs, and the mean of the urban and rural districts within these three age groups, was only 3. But some striking contrasts existed between the mortality sex ratio found in the urban and rural districts of the same county, at ages under 1 the ratio for Hereford was only 81 in the urban districts, but 203 in the rural areas, at ages 1–15 the ratio for Sussex was 148 in the urban and 104 in the rural districts, and at ages 65 and over the ratio for Flint was 173 in the urban and 108 in the rural areas.

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

It seemed of interest to inquire whether within the counties the mortality ratio of the urban district bears any relation to that in the rural area. For this purpose a fourfold table was constructed for each age group from Appendix, Table C, with a dichotomy at the mean mortality sex ratio of the urban and rural districts. There was no relation between the size of the mortality sex ratio in the urban and rural areas in these age groups, since the results obtained were:

	χ^2	P
Ages under 1	0·0267	0·87
Ages 1–15	0·2921	0·59
Ages 65+	1·3461	0·25

There was no association between the mortality sex ratios of the two youngest age groups in the county boroughs, but as environmental conditions in the large towns differ appreciably from those in the less congested areas this point was examined for the urban and rural districts. The size of the infant mortality sex ratio was again unrelated to that at ages 1–15, the results obtained from a fourfold table were:

	χ^2	
Urban districts	0·0031	$0·95 > P > 0·90$
Rural districts	0·0147	$P = 0·9$

Ages 15–65

The sex ratio of pneumonia mortality at ages 15–65 is the most interesting, not only is the ratio larger than in the other age groups but it showed a clear association with urbanization, the mean mortality ratios were for county boroughs 226, urban districts 207 and rural areas 174. In contrast to the other three age groups there was a correlation between the mortality sex ratios of the urban and rural districts. A fourfold table gave $\chi^2 = 10·3802$ with $P < 0·002$, and using the product-moment method the correlation coefficient was $r = 0·5560 \pm 0·105$. This correlation may possibly be due to the overlapping of urban and rural occupations. In the non-agricultural counties a large proportion of the rural inhabitants are engaged in industry and commerce under working conditions comparable to those of the town dweller, and conversely in the counties where the rural areas are almost solely agricultural there is an important proportion of urban dwellers engaged in this pursuit, e.g. in the 1931 census the rural areas of Norfolk had 518 per 1000 males employed in agriculture, and in the urban districts 123 per 1000 males followed this occupation. An examination of this point presents difficulties because of the variety of occupations in most counties, and it is only in a few areas that one industry is of outstanding importance. Using very broad groups an attempt has been made to classify the counties according to their principal male occupations, and the results are shown in Table 6. The rural areas classified as agricultural had one-third or more of the males engaged in this occupation. There is considerable variation in the value of the mortality sex ratio within the group of districts, but as a whole there is a decrease with decreased industrialization. The mean value for the fourteen urban areas with a specific occupation was 211 compared with a mean of 200 for the remaining districts. In the rural areas the mean ratio was 186 for the twelve counties where mining was an important source of occupation, 179 for the fourteen counties which were not highly agricultural and 155 for the seventeen counties which were primarily agricultural in character. The largest mortality ratios in the urban and rural districts were found in the areas where mining was an important occupation. This is in contrast to the experience of the county boroughs where the mining towns had a relatively low ratio. The mean mortality ratio for the mining districts was 201 for the twelve mining towns, 209 for the thirteen urban districts and 186 for the twelve rural districts. The urban ratio is only slightly larger than that for the county boroughs, but the decided fall in the rural value may be accounted for by differences in occupations of the non-mining section of the community, since the rural districts include an important proportion of agricultural workers, and not by degree of urbanization. This is supported by the fact that the ratio of the rural mining districts is approximately the mean of the urban mining districts and the rural agricultural districts.

SUMMARY

The size of the mortality sex ratio from pneumonia depends upon several factors which exert varying pressure with age, since it was shown for the London boroughs that the relative male risk was not high or low throughout life but displayed considerable variations.

In infancy social conditions have little effect upon the ratio, and there was no association with the degree of urbanization. In London the correlations with the indices of density became insignificant when the infant death-rate from pneumonia was kept constant. The male infant risk increases with the prevalence of the disease, and significant correlations were obtained when the indices of overcrowding were kept constant.

In childhood the size of the mortality sex ratio is not related to urbanization. The conditions operating for a high male mortality in childhood varies from those in infancy, since, for the eighty-three county boroughs, there was no correlation between the two ratios.

For the age group 15–65, in which the male

Table 6. *The sex ratio of pneumonia mortality and the type of occupation in urban and rural districts*

County	Urban districts	Rural districts			
		Mining	Mining and agriculture	General and agriculture	Agriculture
Mining:					
Cumberland and Westmorland	207	—	—	—	196
Derby	217	—	179	—	—
Durham	192	158	—	—	—
Northumberland	176	—	209	—	—
Nottingham	215	—	168	—	—
Glamorgan	206	219	—	—	—
Monmouth	213	—	—	194	—
Mining and metal workers:					
Stafford	250	—	184	—	—
Warwick	235	—	213	—	—
Brecknock and Carmarthen	215	—	189	—	—
Mining, metal and textile workers:					
Lancashire	210	—	—	194	—
Leicester	296	—	214	—	—
Yorkshire	205	—	—	182	—
Makers of textile goods:					
Northampton and Peterborough	221	—	—	245	—
General:					
Bedford	186	—	—	—	128
Berkshire	201	—	—	184	—
Buckingham	191	—	—	167	—
Cambridge, Ely and Huntingdon	146	—	—	—	163
Chester	224	—	—	212	—
Cornwall	211	—	—	168	—
Devon	196	—	—	—	152
Dorset	143	—	—	—	111
Essex	182	—	—	167	—
Gloucester	185	—	—	161	—
Hampshire	177	—	—	147	—
Hereford	188	—	—	—	154
Hertford	234	—	—	181	—
Kent	191	—	—	162	—
Lincoln	260	—	—	—	131
Middlesex	208	—	—	—	—
Norfolk	169	—	—	—	142
Oxford	178	—	—	—	175
Shropshire	217	—	—	—	152
Somerset	187	—	—	—	196
Suffolk	167	—	—	—	160
Surrey	203	—	—	165	—
Sussex	198	—	—	—	139
Wiltshire	187	—	—	—	152
Worcester	291	—	—	—	206
Anglesey and Caernarvon	218	—	194	—	—
Cardigan and Pembroke	123	—	—	—	133
Denby	250	—	213	—	—
Flint	240	—	185	—	—
Merioneth, Montgomery and Radnor	253	—	—	—	202

pneumonia rate was twice that for females, there was a distinct association with degree of urbanization. In the London boroughs the mortality sex ratio was unrelated to social and economic conditions when the usual indices, the proportion of the population living more than two to a room, and the proportion of males in social class V were used. That environmental conditions had little effect on the ratio is also suggested by the experience of the mining communities which showed little difference in the mortality sex ratio between the county boroughs and urban districts. The rural mining areas were in agreement with the urban when allowance was made for the agricultural workers in

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

these districts. In London there was a small significant correlation between the sex ratio and the pneumonia mortality sex ratio, indicating that the residential or industrial character of the borough was associated with the mortality ratio. Some support for this is given by the county boroughs where high ratios were found in the industrial towns and low ratios in the residential towns. Some occupations involve a direct risk of pneumonia, i.e. furnacemen, rollermen, etc., and others have a more indirect risk, e.g. inn-keepers, hotel-keepers, etc. Although the prognosis of pneumonia is affected by previous indulgence in alcohol, the effect of this factor can only be a matter of speculation. The mortality sex ratio from pneumonia in the three occupations in which a higher proportion of heavy drinkers are found than in the general population, inn-keepers, hotel-keepers, etc., barmen, etc., makers of alcoholic drinks, all of which have a high standardized mortality ratio from pneumonia, form an interesting progression. These values were 247, 394, and 1200, but the number of deaths among wives in the last two groups, 5 and 2, was so small that the ratios are really of no value. Yet there is, perhaps, an indication that as the opportunity for the wives to indulge in heavy drinking decreases with each class the mortality sex ratio from pneumonia increases. This factor of alcoholic indulgence probably operates in most occupations, and since the proportion of heavy drinkers is larger among men than among women, it would be necessary for only a small proportion of men to carry a heavy risk of pneumonia mortality to effect a large increase in the mortality sex ratio. It seems that the factors responsible for the relatively high male mortality from pneumonia, in this age group, were an occupational risk and the habits of the males.

In old age, as with the young age groups, there was no association with degree of urbanization. The mortality sex ratios of the London boroughs showed evidence of a geographical distribution. This was apparently a local characteristic, since the ratio of the county boroughs did not show any tendency to vary geographically.

(*MS. received for publication* 20. IV. 43.—Ed.)

APPENDIX

Table A. *London. Pneumonia mortality during* 1924–38. *Male death-rates expressed as percentage of female rates*

Borough	Ages				Borough	Ages			
	Under 1	1–	15–	65+		Under 1	1–	15–	65+
Battersea	129	130	233	138	Lambeth	123	123	202	127
Bermondsey	145	109	213	135	Lewisham	111	136	187	104
Bethnal Green	152	132	206	98	Paddington	138	121	232	133
Camberwell	111	134	188	134	Poplar	139	105	223	123
Chelsea	114	85	270	198	St Marylebone	115	154	248	143
Deptford	121	126	185	125	St Pancras	140	119	223	132
Finsbury	135	128	213	146	Shoreditch	115	112	251	95
Fulham	131	94	190	120	Southwark	131	105	208	122
Greenwich	142	102	222	100	Stepney	130	126	192	125
Hackney	145	125	225	119	Stoke Newington	107	113	216	127
Hammersmith	150	117	190	125	Wandsworth	131	123	195	129
Hampstead	165	172	205	130	Westminster	108	102	199	122
Holborn	142	119	267	139	Woolwich	107	108	192	117
Islington	128	107	200	141					
Kensington	128	103	232	127	London	130	116	210	128

Table B. *County boroughs. Pneumonia mortality during* 1924–38. *Male death-rates expressed as a percentage of female rates*

	Ages					Ages			
	Under 1	1–	15–	65+		Under 1	1–	15–	65+
Barnsley	139	112	180	187	Manchester	126	114	249	136
Barrow-in-Furness	125	88	229	134	Middlesbrough	135	107	230	119
Bath	161	168	198	123	Newcastle-upon-Tyne	123	109	215	117
Birkenhead	134	104	234	106	Northampton	117	114	222	118
Birmingham	139	118	279	148	Norwich	127	132	149	103
Blackburn	122	94	207	116	Nottingham	140	116	252	141
Blackpool	122	129	203	148	Oldham	118	125	227	142
Bolton	123	108	201	118	Oxford	196	182	161	125
Bootle	121	128	176	123	Plymouth	130	120	151	114
Bournemouth	161	105	211	118	Portsmouth	130	111	146	121
Bradford	144	110	242	140	Preston	138	125	187	102
Brighton	115	101	179	108	Reading	104	118	217	125
Bristol	122	114	208	123	Rochdale	132	87	253	133
Burnley	142	132	205	109	Rotherham	146	109	179	106
Burton-on-Trent	134	104	252	157	St Helens	129	124	215	115
Bury	166	130	218	111	Salford	136	114	259	112
Canterbury	136	111	195	111	Sheffield	136	120	264	135
Carlisle	109	126	173	87	Smethwick	104	121	290	109
Chester	177	107	258	91	Southampton	159	99	208	130
Coventry	128	157	222	134	Southend-on-Sea	117	110	239	126
Croydon	129	122	200	116	Southport	140	111	197	145
Darlington	130	140	209	117	South Shields	147	116	161	114
Derby	142	108	262	154	Stockport	155	108	231	96
Dewsbury	149	98	219	142	Stoke-on-Trent	136	115	259	127
Doncaster	198	127	204	202	Sunderland	133	118	197	125
Dudley	125	112	235	132	Tynemouth	111	101	214	108
Eastbourne	133	59	196	106	Wakefield	125	118	201	177
East Ham	118	110	187	113	Wallasey	130	104	237	130
Exeter	166	94	176	140	Walsall	128	116	237	148
Gateshead	111	102	194	117	Warrington	165	116	259	126
Gloucester	139	114	221	120	West Bromwich	136	105	234	107
Great Yarmouth	145	135	154	95	West Ham	128	97	188	108
Grimsby	106	116	161	88	West Hartlepool	152	121	236	127
Halifax	148	121	249	118	Wigan	114	113	143	104
Hastings	106	109	202	116	Wolverhampton	162	118	274	138
Huddersfield	192	114	222	122	Worcester	99	146	184	145
Ipswich	106	116	214	115	York	163	121	184	114
Kingston-upon-Hull	139	113	215	111	Cardiff	159	145	232	122
Leeds	135	112	249	133	Merthyr Tydfil	155	107	189	134
Leicester	131	111	242	119	Newport	135	105	278	130
Lincoln	127	103	240	136	Swansea	123	116	216	135
Liverpool	132	115	219	121	All county boroughs	133	114	226	125

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press

Table C. *Urban and rural districts. Pneumonia mortality during* 1924–38. *Male death-rates expressed as a percentage of female rates*

	Urban				Rural			
County	Under 1	1–	15–	65+	Under 1	1–	15–	65+
Bedford	108	94	186	131	135	131	128	105
Berkshire	175	106	201	135	168	102	184	102
Buckingham	139	122	191	127	117	102	167	127
Cambridge, Ely and Hunts	145	139	146	129	117	94	163	97
Cheshire	120	113	224	126	127	105	212	133
Cornwall	131	122	211	120	121	124	168	126
Cumberland and Westmorland	130	107	207	134	144	99	196	148
Derby	143	109	217	114	140	132	179	128
Devon	119	110	196	111	120	126	152	134
Dorset	144	110	143	122	105	99	111	122
Durham	135	117	192	117	135	105	158	109
Essex	134	112	182	121	107	93	167	105
Gloucester	202	100	185	93	135	120	161	129
Hampshire	132	109	177	143	120	137	147	132
Hereford	81	82	188	131	203	131	154	106
Hertford	143	126	234	115	126	95	181	145
Kent	132	120	191	123	133	119	162	127
Lancashire	137	120	210	121	115	128	194	129
Leicester	106	76	296	114	163	130	214	130
Lincoln and Rutland	104	121	260	133	132	109	131	121
Middlesex	130	110	208	123	—	—	—	—
Norfolk	174	74	169	89	125	110	142	98
Northampton and Peterborough	116	117	221	103	158	148	245	108
Northumberland	126	109	176	104	123	111	209	138
Nottingham	152	109	215	126	121	119	168	113
Oxford	91	115	178	142	139	124	175	123
Shropshire	143	111	217	129	105	136	152	106
Somerset	137	108	187	131	143	99	196	137
Stafford	133	109	250	134	122	152	184	109
Suffolk	146	131	167	128	97	131	160	135
Surrey	126	105	203	126	131	139	165	153
Sussex	134	148	198	126	155	104	139	134
Warwick	132	138	235	120	160	94	213	123
Wiltshire	131	110	187	109	109	92	152	123
Worcester	144	105	291	114	190	143	206	137
Yorkshire	138	114	205	131	135	112	182	117
Anglesey and Caernarvon	128	119	218	103	176	107	194	133
Brecknock and Carmarthen	152	104	215	118	115	115	189	130
Cardigan and Pembroke	164	88	123	81	139	107	133	98
Denbigh	169	93	250	125	157	112	213	123
Flint	107	94	240	173	221	103	185	108
Glamorgan	131	116	206	133	127	119	219	116
Merioneth, Montgomery and Radnor	130	114	253	104	103	93	202	137
Monmouth	133	122	213	138	75	63	194	77
England and Wales	134	113	207	123	132	114	174	122

https://doi.org/10.1017/S0022172400013012 Published online by Cambridge University Press