

TUBERCULOSIS
AND
SOCIAL CONDITIONS
IN ENGLAND

WITH SPECIAL REFERENCE TO YOUNG ADULTS

(A STATISTICAL STUDY)

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FOREWORD

By The MARCHIONESS OF TITCHFIELD,
*Chairman of Council, National Association for the Prevention
of Tuberculosis.*

ONE of the chief aims of the National Association is to encourage the widespread publication of knowledge that will make it easier for doctors and social workers to understand and solve the problems of tuberculosis. My Council was therefore glad to hear of this Report, which closely examines one of the most pressing problems of tuberculosis—the trends of mortality among young men and women—against the background of the many important social changes that have taken place in recent years. We were informed that without assistance from the Association it was doubtful whether the work could be made available at a price to ensure its wide circulation.

The Council decided, therefore, to be responsible for publication, and I trust that the detailed arguments here presented, and the important conclusions, recommended as they are by the Chief Medical Officer to the Ministry of Health, will receive merited attention among those who care for the objects which the Association has at heart.

IVY TITCHFIELD,
CHAIRMAN OF COUNCIL.

July, 1939.

PREFACE

By SIR ARTHUR S. MACNALTY, K.C.B., M.D., F.R.C.P.,
Chief Medical Officer to the Ministry of Health.

A STRIKING feature of the modern outlook on tuberculosis is the public recognition of its social and economic setting. Tuberculosis is no longer solely a disease of medical significance and relegated entirely to the physician and the surgeon. Its social and economic implications are far-reaching. Farr, Newsholme, Hoffman, Biggs and others have repeatedly shown tuberculosis to be a source of financial loss to the community in wage-earning power and efficiency, which too frequently brings its victim to poverty and destitution. For these reasons sanatorium treatment was made a prominent feature in the National Health Insurance Act of 1911, a measure which led on to the tuberculosis schemes of local authorities with their machinery of prevention and treatment available for the whole community. This Report treats of the adverse effect of certain social and economic conditions in favouring the onset of tuberculosis—an even more difficult and complex question than the study of these conditions as dependent upon tuberculosis.

The triumphs of preventive work in tuberculosis are well known. An improved standard of living and hygiene, better wages, better nutrition and public health measures, together with the segregation of infectious cases in poor law hospitals and the cessation of indiscriminate expectoration, exerted their influence on the decline of tuberculosis in England and Wales before special attention was devoted to the problem by the State. Building on this good foundation, a wealth of medical and scientific knowledge has been assembled to prevent, diagnose and treat tuberculosis. The public have co-operated in taking advantage of the facilities provided. Voluntary and lay workers have toiled side by side with the professional workers, doctors, health visitors and nurses, and they have seen their reward in the steadily declining death-rate from tuberculosis year by year. In this awakening of the public conscience to tuberculosis the valuable educational work of the National Association for the Prevention of Tuberculosis calls for special mention.

While the general death-rate from tuberculosis has been declining, the high incidence and mortality of respiratory tuberculosis in young adults has been a source of anxiety to tuberculosis workers for over twenty years. The problem has been examined from various points

of view and a considerable amount of useful work has been done. In this report Dr. P. D'Arcy Hart and Prof. G. Payling Wright have surveyed the whole position systematically, as far as England is concerned, and have set out their findings.

It is gratifying to note that during recent years there has been a decline in the incidence and mortality of respiratory tuberculosis in young adults. ('Annual Report of the Chief Medical Officer of the Ministry of Health for 1937,' pp. 102-103.)

As already remarked, the close association between poverty and tuberculosis has been recognized for many years. Not only does tuberculosis lead to poverty, but poverty subjects the individual to a variety of unsatisfactory circumstances and conditions which favour the development of tuberculosis. There is a complex interaction of a considerable number of factors, and the respective shares taken by the various individual factors in the production of tuberculosis are difficult to assess. It is only during recent years that efforts have been made to evaluate these factors with some degree of exactness.

This report furnishes important evidence as to the relative influence of a considerable number of factors. The importance of certain of them is outstanding, especially the great influence of overcrowding and unsatisfactory housing in favouring personal infection. The authors state (p. 120) : "It would appear, therefore, that differences in housing inadequacy, implying differences in closeness of personal contact, are playing an important part in determining the present differences in levels of phthisis mortality between one English county borough and another" ; and again, "the differing declines in phthisis mortality in the various English county boroughs between 1911 and 1933 are also related to the levels of housing conditions".

While taking no official responsibility for the conclusions and the views expressed in this report, I regard it as an important contribution to the statistical study of tuberculosis, and commend it to the attention of all those engaged in combating this disease.

ARTHUR S. MACNALTY.

Ministry of Health,
Whitehall, S.W. 1.

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Chapter 1.—Introduction : The History of Respiratory Tuberculosis Mortality in England and Wales from 1850 to 1936, and in the English County Boroughs from 1911 to 1933.

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I. INTRODUCTION.

A comparatively short time after the publication of the first Annual Reports of the Registrar-General it became clear that the recorded mortalities from phthisis¹ and other tuberculous diseases in England and Wales were progressively declining. That the figures to be found in the early Reports indicated a true decline, and not one due to the progressive separation of these diseases from a former larger and confused group as a result of advances in medical knowledge, is to-day generally recognized by vital statisticians (see Brownlee, 1918, 1920). But recently it was noticed that, while the mortality from respiratory tuberculosis continued to decline in the population as a whole, young adults (15 to 24 years), and young women in particular, were no longer having their former share in the general improvement. Consequently, while the general position as shown by figures ungrouped by age and sex appeared to justify optimism, the retardation in decline in mortality peculiar to this important section of the population began to arouse considerable apprehension.

The first observations in England upon the growing seriousness of the position amongst young women were recorded by the Medical Officer of Health for the County of London (London County Council, 1922, 1926, 1931), whose figures were, however, limited to his own immediate administrative area. But subsequently Coutts (1928, 1932), and later Bardswell (1932), Bentley (1934), the Registrar-General (1931*a*, 1932*a*) and the Chief Medical Officer of the Ministry of Health (1930) showed that the phenomenon was not confined to London alone, but that in lesser degree it was affecting young adults

¹ Throughout this report the terms "respiratory tuberculosis" and "phthisis" are used synonymously.

of both sexes throughout the country. In fact, this retardation among young adults had come by 1933 to be widely accepted as one of the major problems of tuberculosis.

During the past few years (1934 to 1936) the mortality figures for the young adult age-group have taken a somewhat sudden change for the better, holding out the hope that the period of retardation in decline is ending. Indeed, in the case of young adult males it does not seem unreasonably optimistic to predict that within a few years the figures may be as low as they would have been had no set-back taken place. In the case of young adult females, however, among whom the set-back has been much the more severe, the position remains serious, and unless their phthisis death-rate exhibits an unforeseeably rapid rate of decline in the near future, it will for many years to come compare less favourably with the death-rates of the other age-groups of the same sex than it has done in the past. For the phthisis mortality for young women, aged 15 to 24, which from 1850 to the war was well below that for the other groups of females in the child-bearing age, is now the highest of the whole sex. Furthermore, the present mortality figure for young women is far above the point it would have reached had no set-back to its decline taken place.

Although the causes for the slackening in the decline in the phthisis mortality among young adults have been widely discussed, no explanation out of the large variety offered has yet received general approval. The principal object of the present report is to re-examine the phenomenon in the hope of determining the relative importance of certain possible factors in its causation, because, even if the period of retardation be now terminating, it is clearly desirable to elucidate the causes that brought it about. Respiratory tuberculosis in this country still causes more deaths than any other single disease among young men and women, aged 15 to 24 years; indeed its death-rate at this age is about two-thirds of that of all other diseases taken together. These facts, together with the value to the community of the lives and health of this age-group, a value that is enhanced both by the rapidly changing age-composition of the population towards a preponderance of older persons and by the recent decline in the birth-rate, make it desirable to analyse any set-back to the improvement in respiratory tuberculosis among young adults.

II. THE DECLINE IN RESPIRATORY TUBERCULOSIS MORTALITY IN ENGLAND AND WALES FROM 1850 TO 1936, BY SEXES AND IN AGE-GROUPS, WITH SPECIAL REFERENCE TO THE RECENT CHANGES AMONG YOUNG ADULTS.

In order to appreciate the peculiar retardation amongst young adults, the mortalities from respiratory tuberculosis in England and Wales from 1851 to 1936 are set out, by sexes and ages, in Table 1.

For the earlier part of the period the annual figures have been averaged for decades, but from 1911 (from 1901 in the case of males, 15 to 24, and females, 15 to 24 and 25 to 34) the rates for the individual years are shown. The mortality figures for certain age-groups have also been graphed on semi-logarithmic scale in Chart 1. The

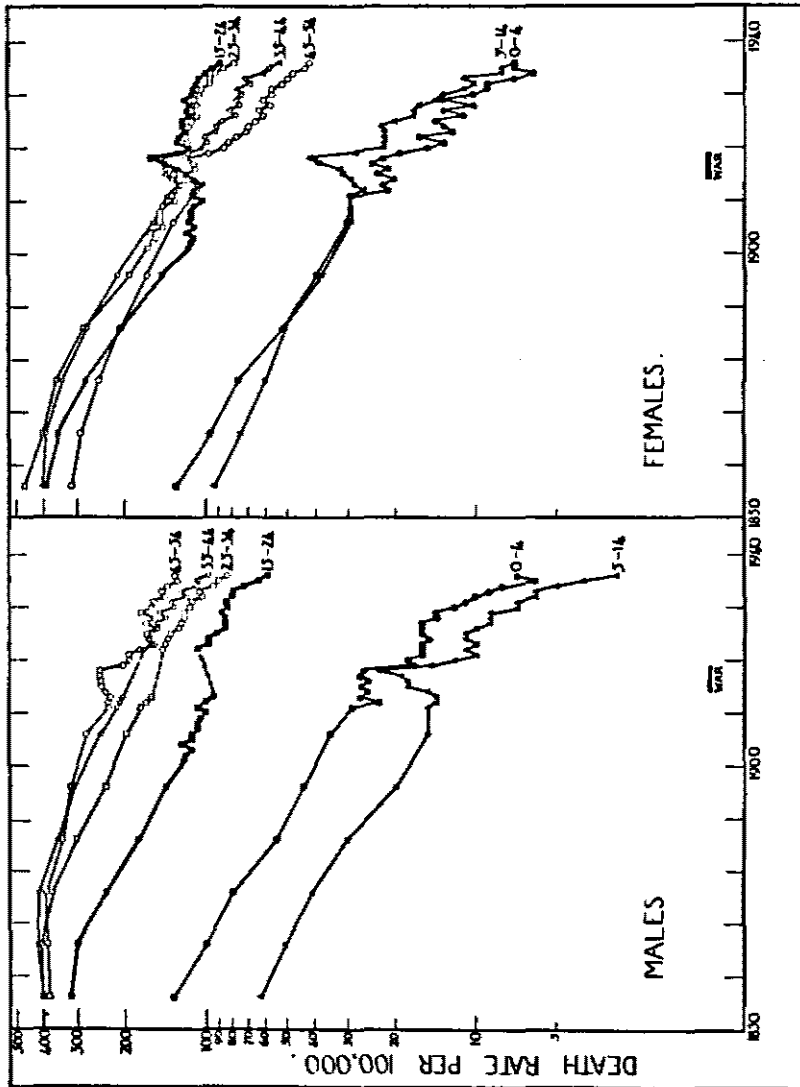


CHART 1.—The Mortality from Respiratory Tuberculosis, by Sexes and in certain Age-Groups, during the period 1851 to 1936 in England and Wales (semi-logarithmic scale). (Data taken from Table 1.)

semi-logarithmic method of charting shows clearly the extent to which *percentage-rates of decline* (which in general are more informative than absolute rates for the proper appreciation of movement) have varied from one age-group to another, or from one period to another for the same age-group.

Several important conclusions can be drawn from the consideration of Table 1 and of the individual curves of Chart 1:

- (1) Despite some serious set-backs during the war of 1914-18,

the percentage-rate of decline in respiratory tuberculosis mortality in the majority of the age-groups was on the whole maintained, or even increased, during the period subsequent to 1913.

(2) The phthisis mortality amongst young women of 15 to 24 years fell steadily after 1870, but a marked check in the decline took place at some time between 1901 and 1905. From this time until 1913 the mortality was practically stationary, and although, following on the oscillations of the war period, the decline was to some extent resumed, the percentage-rate of the decline in the post-war period was definitely less than that existing before 1900, and in 1933 the mortality of young women was no lower than it had been in 1913. From 1933 to 1936 the percentage-rate of decline has accelerated, but the mortality for this group is still far higher than it would have been had the trend prior to 1900 continued without a set-back. Though no precise date for the check in the decline in mortality can be given, it is most important to realize that *it certainly took place before the war*, and that, though war-time conditions affected tuberculosis amongst the women of this age-group more severely than amongst any other age-group, male or female, *the explanation of the check must probably be sought among causes that were coming into operation soon after the beginning of the present century, and perhaps even in the last years of the nineteenth century.*

(3) A check in the decline in mortality is also shown amongst young men, aged 15 to 24 years, though this is less pronounced than amongst young women, and there is no evidence to show that it took place before 1913. The average percentage-rate of decline between 1913 and 1933 was less than it had been previous to the earlier date. From 1933 to 1936 the percentage-rate of decline has accelerated, as was noted above for young women. Indeed, for young men this very recent acceleration has reduced their mortality to a figure only slightly higher than it would have reached had the pre-war trend continued without a set-back. The course pursued by this group during the war is not known with the same certainty as that for young women, on account of the large numbers of young men on military service, but some rise in its mortality undoubtedly occurred.

(4) Up to the time (about 1901-05 for females and about 1913 for males) when the check in the decline in mortality of the female and male age-groups, 15 to 24 years, took place, their percentage-rate of decline was as great as that of any age-group. After that time until 1933 it was less than that of any other age-group of the same sex. The contrast between young adults and other age-groups subsequent to the checks is most strikingly shown by their respective average percentage-rates of decline in mortality between 1913 and 1933. For the short period from 1933 to 1936 the trends both for young men and for young women appear to be not significantly different from those for other age-groups.

(5) For almost the whole of the period the mortality of young

For

women, aged 15 to 24, has exceeded the contemporaneous mortality of males of the same age.

(6) The respiratory tuberculosis mortality for young women, aged 15 to 24, which from 1850 until the war was well below that of the two other groups of the child-bearing age, has since the war been the highest of their whole sex.

(7) It may be noted that since 1923 there has been a slowing in the percentage-rate of decline amongst men in the age-groups 45 to 54 and upwards. This diminution in rate of decline followed upon a decade, 1913 to 1923, of unprecedented improvement. Since this group has one of the highest respiratory tuberculosis mortalities, the future course of this curve will require particular attention.

III. CHANGES IN RECENT YEARS IN RESPIRATORY TUBERCULOSIS MORTALITY AMONG YOUNG ADULTS, IN URBAN AND IN RURAL AREAS.

Since 1911, when the registration of deaths was transferred from the place at which death occurred to the place of usual residence of the deceased, it has been possible to obtain much more complete information upon the incidence and course of respiratory tuberculosis in urban and in rural areas separately. The Chief Medical Officer of the Ministry of Health (1933) has compared the mortalities in the age-group 15 to 24 years in different types of administrative area over the fifteen years between 1911-14 and 1926-30. His figures suggest that the reduction in the percentage-rate of decline in the respiratory tuberculosis mortality of young adults, as compared with other age-groups, which was described above for the country as a whole, was experienced most severely in London, to an intermediate degree in the English and Welsh county boroughs, and least of all in the rural areas. Because this experience has been most serious in the larger urban units, we have selected certain of them for special consideration in the greater part of this report.

IV: THE RECENT TREND (1911 TO 1933) OF RESPIRATORY TUBERCULOSIS MORTALITY IN THE COUNTY BOROUGHS.

Since the set-back to young adults appears to be greatest in urban communities, it seems most important to study the problem in these areas. Of the various types of urban administrative area available for investigation, the municipal boroughs are unsuitable, since detailed data for mortality and local social conditions are not obtainable for them. The Administrative County of London has suffered most in the set-back to the decline in phthisis mortality of young adults, but its structure presents special features that contraindicate its inclusion on equal terms with other large urban units for statistical purposes, either when it is treated as a whole, or when it is

subdivided into its various constituent Metropolitan Boroughs.¹ London, therefore, has been omitted from most of the chapters in the present report, though, on account of certain unique statistical data

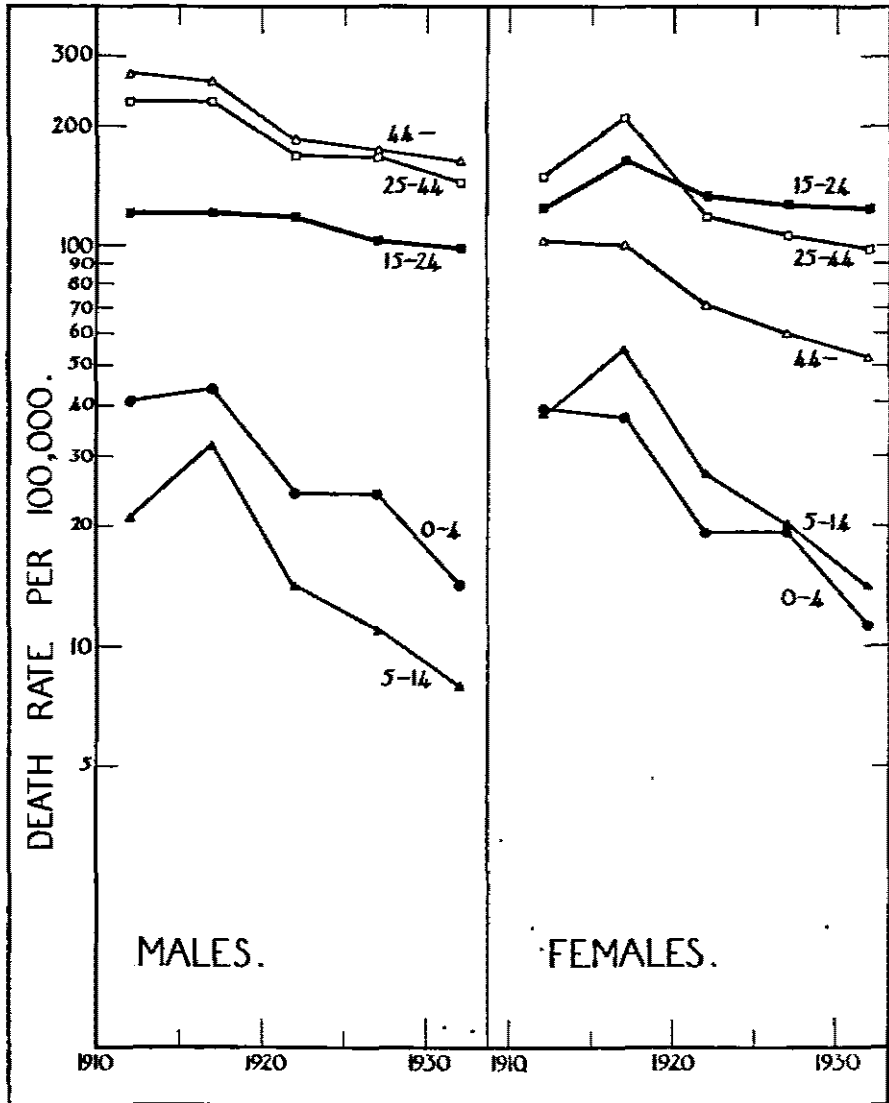


CHART 2.—*The Mortality from Respiratory Tuberculosis, by Sexes and in certain Age-Groups, during the period 1911 to 1933 in the English County Boroughs (semi-logarithmic scale). (Data taken from Table 10, "All Boroughs", weighted arithmetic average).*

¹ The Administrative County of London is composed of the City of London and 28 Metropolitan Boroughs. Greater London is at present composed of the Administrative County of London and the Outer Ring, which latter is formed by three County Boroughs (Croydon, East Ham and West Ham) and a number of other urban and rural areas.

available, Chapter 8 will be specially devoted to phthisis in relation to social conditions in its constituent boroughs.

The remaining larger urban units are the county boroughs. These are the most suitable for the present statistical treatment, since they have sufficiently detailed records of phthisis mortalities and of

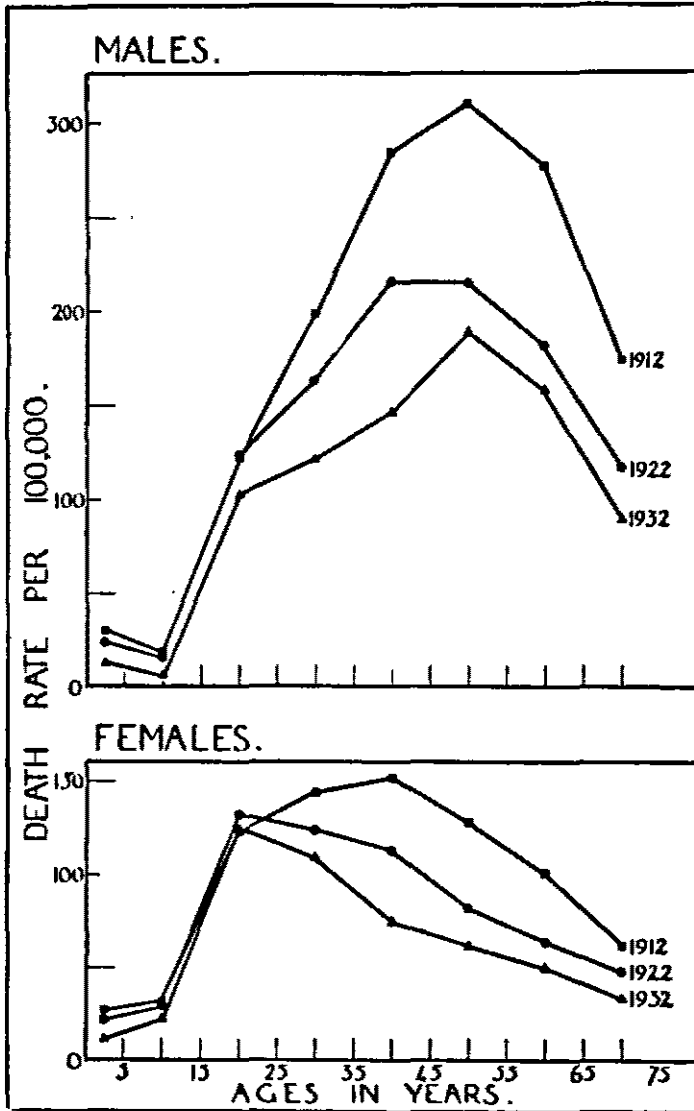


CHART 3.—*The Mortality from Respiratory Tuberculosis, by Sex and Age, in 1912, 1922 and 1932 in the Aggregate of County Boroughs in England and Wales. (Data from Table 2.)*

certain social conditions, and are adequate in number. The greater part of this report is therefore based upon the English county boroughs, making use of a group of 76 of the present 79. For this group detailed and comparable data are obtainable between 1911

and 1933.¹ In Chart 2 the respiratory tuberculosis mortality, by sexes and for certain age-groups, during the period 1911 to 1933, in this slightly restricted group of 76 county boroughs is shown on semi-logarithmic scale.

It will be seen that the trend in mortality in the county boroughs during these twenty years resembles closely that for England and Wales during the same period (*cf.* Chart 1). As in the country taken as a whole, the young adults in the county boroughs have, during this period, shown a smaller average rate of improvement, as judged from the average percentage-rate of decline in their mortality, than has any other age-group. In the case of young women the consequence is that they now suffer the highest respiratory tuberculosis mortality of their sex.

In Table 2 and Chart 3 will be found the respiratory tuberculosis mortalities of the Aggregate of County Boroughs of England and Wales for 1912, 1922 and 1932, by sexes and in certain age-groups. By the method of presentation used in this chart, which differs from that in Chart 2, it is intended to show, for county boroughs, the particular age-groups in which high or maximal mortalities occur, together with the alterations in the heights or positions of these maxima in the course of these two decades.

From examination of Chart 3 it is evident that accompanying a smaller average percentage-rate of decline in the mortality in the young adult age-group (males and females, 15 to 24 years), as compared with the other age-groups over this period, there have been changes in the shapes of the curves. In males the young adult age-group has become more conspicuous, while in females it has now displaced women of middle age as the group showing the maximal mortality.

V. OUTLINE OF THE PRESENT INVESTIGATION.

In the succeeding chapters of this report an attempt has been made to examine the possible connections between the problem of young adult phthisis and a variety of factors, paying particular attention to social conditions. The approach that has been made to this problem may be broadly outlined as follows:

(a) For England and Wales as a whole, the trend of respiratory tuberculosis mortality since 1850, especially that for young adults, is considered in relation to the changes in the general level of social conditions (standard of living), as estimated mainly from changes in real earnings (Chapter 2).

(b) The experiences in phthisis mortality in the different English county boroughs are considered in relation to the local variations in their social conditions, as estimated from poverty and housing data (Chapters 3 and 4).

¹ For the reasons for the omission of three English and of the four Welsh County Boroughs, see Appendix, p. 141.

(c) As a control for the results arrived at from the examination of phthisis mortalities, the mortalities from diseases other than respiratory tuberculosis are considered in a similar way (Chapter 5).

(d) An examination is made of the distorting effect of "internal migration" upon the relationship between the above mortalities and certain social conditions in the different county boroughs, and an attempt at correction for this effect is made for young women (Chapter 6).

(e) The effects of recent changes in the volume of occupation, particularly in that of young women, upon respiratory tuberculosis mortality are considered (Chapter 7).

(f) The mortalities from phthisis in the different London boroughs are examined in the light of social data, some of which are, and some of which are not, available for the county boroughs (Chapter 8).

(g) The more important findings in the earlier chapters are discussed in relation to one another (Chapter 9).

VI. SUMMARY OF CHAPTER I.

1. The trend in mortality from respiratory tuberculosis in England and Wales and in the English county boroughs has been examined by sexes and in age-groups.

2. The mortality for most age-groups in England and Wales has declined steadily since 1870, except during the war period 1914-18.

3. For young adults the mortality declined satisfactorily until the beginning of the present century, but a retardation set in about 1900-04 for young women and about 1912-14 for young men. This retardation has been particularly severe amongst young women, whose mortality in 1931-33 was scarcely lower than it had been in 1901-03. For the short period 1933 to 1936 the trends both for young men and for young women have not significantly differed from those for the other age-groups.

4. The retarded decline in mortality from respiratory tuberculosis amongst young adults has been most serious in the large urban areas of the country, *i. e.* the metropolitan and county boroughs.

TABLES TO CHAPTER I.

TABLE I.—*Mortality from Respiratory Tuberculosis, per 100,000 living, by Sex and Age, during the period 1851 to 1936 in England and Wales.*

Years.	Age-groups.							
	0-4.	5-14.	15-24.	25-34.	35-44.	45-54.	55-64.	65-74.
	MALES.							
1851-60	133	64	319	403	402	384	335	239
1861-70	99	51	299	411	417	388	331	204
1871-80	79	41	234	371	414	387	321	193
1881-90	55	30	177	304	358	351	292	182
1891-00	44	20	141	237	310	314	262	158
1901-10	35	15	112	197	245	275	238	152
1901	...	...	121	...	...	...	...	...
1902	...	...	119	...	...	...	...	...
1903	...	...	113	...	...	...	...	...
1904	...	...	123	...	...	...	...	...
1905	...	...	112	...	...	...	...	...
1906	...	...	113	...	...	...	...	...
1907	...	...	108	...	...	...	...	...
1908	...	...	108	...	...	...	...	...
1909	...	...	105	...	...	...	...	...
1910	...	...	100	...	...	...	...	...
1911	29	15	107	173	213	230	216	142
1912	23	14	100	168	209	228	220	132
1913	27	14	94	158	204	225	202	127
1914	25	15	...	...	...	234	213	124
1915	26	18	...	...	...	242	213	125
1916	25	18	...	...	...	242	213	137
1917	27	19	...	...	...	247	215	135
1918	26	23	...	...	...	245	202	134
1919	17	15	...	...	...	202	172	114
1920	18	12	...	...	...	191	152	99
1921	16	10	...	...	...	192	153	90
1922	16	11	106	145	170	172	149	94
1923	16	10	98	142	159	156	136	90
1924	15	11	98	137	161	162	133	91
1925	16	11	91	136	159	167	143	89
1926	16	10	85	127	152	153	124	77
1927	16	9	85	124	153	166	123	82
1928	14	9	85	120	142	153	123	82
1929	14	9	87	120	150	173	136	89
1930	12	7	83	114	131	158	125	83
1931	11	7	84	111	135	155	127	77
1932	10	6	80	102	119	142	122	74
1933	9	6	79	105	123	146	123	71
1934	8	5	72	94	107	139	118	76
1935	6	4	64	90	106	126	117	76
1936	7	3	59	84	98	128	120	72

Sources :

1851-1910.	Registrar-General (1851-1910).
1901-1910.	" (1901-10), Census (1911f.).
1911-1914.	" (1911-14).
1915-1920.	" (1915-20).
1921.	" (1921a).
1922-1924.	" (1922-24).
1925.	" (1925).
1926-1936.	" (1926-36).

TABLE I—(cont.).

Years.	Age-groups.							
	0-4.	5-14.	15-24.	25-34.	35-44.	45-54.	55-64.	65-74.
	FEMALES.							
1851-60	129	94	390	458	420	313	239	164
1861-70	95	74	353	440	391	287	208	125
1871-80	75	60	276	356	341	247	179	110
1881-90	52	51	205	280	274	206	152	98
1891-00	39	37	144	192	212	164	124	81
1901-10	30	29	111	148	155	131	105	76
1901	...	...	115	164	...	...	...	...
1902	...	...	112	155	...	...	...	...
1903	...	...	109	152	...	...	...	...
1904	...	...	117	158	...	...	...	...
1905	...	...	109	143	...	...	...	...
1906	...	...	114	146	...	...	...	...
1907	...	...	112	146	...	...	...	...
1908	...	...	112	147	...	...	...	...
1909	...	...	110	142	...	...	...	...
1910	...	...	102	129	...	...	...	...
1911	29	29	111	134	138	111	95	71
1912	21	26	109	127	129	108	90	66
1913	22	28	102	121	123	105	85	61
1914	20	29	109	124	131	115	88	64
1915	23	31	117	130	139	118	92	71
1916	21	32	126	130	139	108	92	64
1917	24	38	141	135	139	110	87	64
1918	22	41	158	156	147	118	89	62
1919	19	28	125	123	116	97	79	58
1920	15	22	115	112	103	85	65	53
1921	13	22	128	116	99	82	66	49
1922	16	22	124	117	100	77	62	53
1923	12	22	119	117	92	70	55	45
1924	13	23	121	115	91	69	56	42
1925	14	20	121	112	87	65	56	42
1926	11	17	114	107	78	61	49	36
1927	13	17	116	112	81	63	51	39
1928	10	16	113	106	74	57	47	38
1929	13	14	117	109	77	60	48	40
1930	10	13	111	105	73	56	45	33
1931	9	11	110	103	76	56	46	36
1932	9	10	107	95	68	51	43	32
1933	7	11	105	97	71	49	40	33
1934	6	8	99	91	60	47	36	28
1935	7	8	93	85	57	42	37	29
1936	7	7	88	78	53	41	36	30

EXPLANATORY NOTES.

Respiratory Tuberculosis Mortality : For the period 1851 to 1920 the deaths are those recorded under categories 28 and 29A of the International List of Causes of Death for 1911; for the period 1921 to 1930 the deaths are those recorded under category 31 of the International List for 1921; and for the period 1931 to 1936 they are those recorded under category 23 of the International List for 1931. Categories 28 and 29A, 31, and 23, of these three International Lists respectively, are co-extensive. These categories comprise tuberculosis of the respiratory system and exclude acute miliary tuberculosis. (See Registrar-General, 1921*b*, 1931*b*.)

TABLE 2.—*Mortality from Respiratory Tuberculosis, per 100,000 living, by Sex and Age, in 1912, 1922 and 1932 in the Aggregate of County Boroughs in England and Wales.*

Year.	Age-groups.							
	0-4.	5-14.	15-24.	25-34.	35-44.	45-54.	55-64.	65-74.
	MALES.							
1912	30	19	122	199	265	310	277	174
1922	24	16	124	163	216	215	182	117
1932	13	7	103	122	147	191	159	90
	FEMALES.							
1912	27	32	123	144	152	129	101	62
1922	21	29	132	124	113	82	64	48
1932	12	13	125	110	75	62	51	34

Sources :

1912. Registrar-General (1912).
 1922. „ (1922).
 1932. „ (1932*b*).

EXPLANATORY NOTES.

Respiratory Tuberculosis Mortality: For categories, see Table 1, Explanatory Notes.

County Boroughs: Data for 1912 refer to Aggregate of County Boroughs, England and Wales (71 English and 4 Welsh County Boroughs).

Data for 1922 refer to Aggregate of County Boroughs, England and Wales (78 English and 4 Welsh County Boroughs; Devonport having been absorbed into Plymouth, and Barnsley, Carlisle, Darlington, Dewsbury, East Ham, Southend-on-Sea, Wakefield and Wallasey having been constituted). Data for 1932 refer to Aggregate of County Boroughs, England and Wales, outside Greater London (76 English and 4 Welsh County Boroughs; Croydon, East Ham and West Ham being in Greater London, and Doncaster having been constituted). The changes in the number of boroughs forming these aggregates does not significantly affect the comparability of the rates in the different years given.

Chapter 2.—The History of the Standard of Living in the United Kingdom from 1850 to 1936, in Relation to Respiratory Tuberculosis Mortality.

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I. INTRODUCTION.

It is now generally accepted that an important ætiological relationship exists between social and economic conditions and tuberculosis. In the present chapter, therefore, the general movements of the average standard of living of the working class in the United Kingdom since 1850 are broadly considered in their relation to the trend of respiratory tuberculosis mortality since the same date.

To judge these movements an effort is made to integrate four contributory factors: (A) the course pursued by working-class real earnings over substantial intervals of years (*i. e.* their secular trend); (B) alterations in the ratio of workers to dependants; (C) changes in expenditure on public social services; (D) alterations in the hours of leisure. The first two of these factors, viewed broadly, together provide the best available indication of changes in the average "disposable" real income of the working-class population; the third factor indicates changes in its average "non-disposable" real income; while the fourth factor cannot be assessed in terms of income.

The changes since 1850 in working-class real earnings, allowing for unemployment, are set out in Table 3, and are graphed (together with certain tuberculosis curves which will be discussed later) on semi-logarithmic scale in Chart 4. The changes in the percentage occupied of the total population (which provides an indication of the ratio of workers to dependants) since 1901 are shown in Table 4, and those in the expenditure on public social services since 1890 are given in Table 5. (The compilation of the time series of real earnings, together with a discussion of the other contributory factors, will be found in the Appendix.)

II. MOVEMENTS OF THE STANDARD OF LIVING FROM 1850 TO 1936.

In reviewing the movements of the standard of living in the light of the four contributory factors, the ninety years under consideration may be conveniently divided into three periods: (*a*) from 1850 to 1900, (*b*) from 1900 to 1914, and (*c*) from 1914 to 1936.

(a) 1850 to 1900: During this period, except for the first five or ten years, real earnings rose at a fairly steady percentage-rate, as is shown by the nearly straight course of the curve in the semi-logarithmic presentation of Chart 4. Since the expenditure on public social services throughout this period remained relatively small, the effect of this factor upon the standard of living needs no particular consideration. A reduction in the length of the working week by about 5 or 6 hours has been estimated by Wood (1936) (see Appendix, p. 140).

It may be concluded, therefore, that a very substantial rise in the

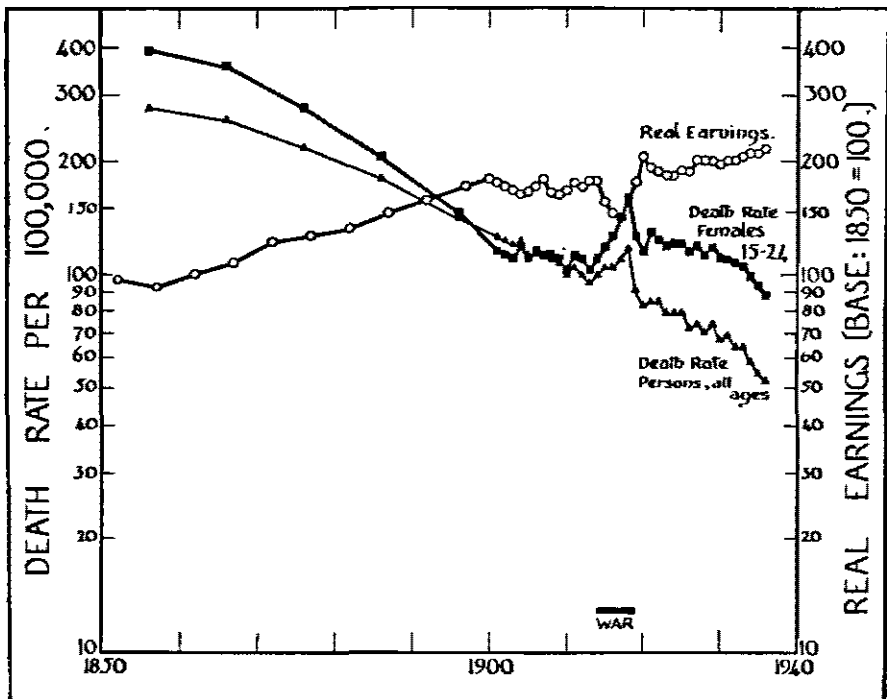


CHART 4.—*Real Earnings and Respiratory Tuberculosis Mortality in England and Wales from 1850 to 1936 (semi-logarithmic scale). (Data for Real Earnings taken from Table 3; for Respiratory Tuberculosis Mortality of Females, aged 15 to 24, from Table 1; for Respiratory Tuberculosis Mortality of Persons, both Sexes and all Ages, from Registrar-General (1936).)*

standard of living took place during the second half of the nineteenth century.

(b) 1900 to 1914: This period, as can be seen from Chart 4, is characterized by a marked and rather sudden check to the hitherto progressive rise in real earnings. Bowley (1926), commenting on his own data before adjustment for unemployment, described real wages as

being nearly stationary between 1897 and 1913. Allowance for unemployment, by the method described in the Appendix, has little effect upon the stationary trend in this period.

The rise in public social service expenditure, which was still taking place relatively slowly during this period, did little to compensate for this check by expanding the non-disposable fraction of the real income of the working-class (see Table 5). Similarly, the small increase in the ratio of workers to dependants (see Table 4), with its correspondingly slight effect on the *per capita* disposable real income, can also have compensated very little for this check.

There was no striking reduction in the hours composing the normal full-time working week, any decrease having probably taken place at much the same average rate as that during the previous half-century.

From these considerations it appears very probable that the average standard of living of the country showed no advance during this period as a whole, and may even have suffered some retrogression. In consequence this period stands in marked contrast to the preceding fifty years, during which improvement had been steady and progressive.

(c) 1914 to 1936: The interpretation of movements in the curve for real earnings during the earlier part of this period is much complicated by the peculiarities of the war years. Though these years were marked by an apparent sharp decline in real earnings, followed by an even sharper rise to a culmination in 1920, the introduction of a number of exceptional and temporary factors makes it difficult to judge the course of the standard of living from the movements of real earnings with the same degree of probability as in the years before the war or in those following it.

On account of the great demand upon the civilian population, both overtime and the employment of persons not normally occupied were prevalent. Overtime, which, like short time, cannot be taken into account in the present computations of average earnings, must have augmented actual money earnings, though it must have correspondingly increased the fatigue of the individual worker. Exceptional employment, by increasing the ratio of workers to dependants, also must have tended to add to the disposable income of the working class. Against this must, however, be set the absence on military service of a large number of the more active earners, leaving their relatives dependent upon Service allowances, which were probably smaller in amount than the figures taken as estimates for average money earnings prevailing at the time.

A temporary war factor, probably of much greater influence on the standard of living from the health standpoint than were the factors mentioned in the preceding paragraph, was the great restriction on the purchasability of necessary commodities such as foods, more especially those rich in vitamins, and household fuel. Whatever, therefore, may have been the changes in the purchasing power

of the working class, the movements of its standard of living during these peculiar years were probably largely determined by the availability or non-availability of necessary commodities.

Taking all these considerations into review, it is probable that the standard of living of the civilian population during the war years suffered material deterioration.

In the post-war years, 1921 to 1923, the country was affected by a serious industrial depression, and real earnings again fell. According to Bowley (1926), from his comparison of the post-war with the pre-war period, "it is doubtful if on the average real wages at the end of 1924 were higher or lower than in 1913". From 1924, however, there has been a fairly steady recovery to an average level considerably above that existing either in 1914 or 1924, the mean rate of increase of average real earnings between 1924 and 1936 appearing to be not very different from that in the latter part of the last century.

We have regarded the expenditure on public social services before 1914 as having been small in comparison with the national aggregate of working-class earnings, and the standard of living as having therefore run an almost parallel course with that of real earnings. In the present period (1914 to 1936), for the first time, this expenditure, even after that part of it devoted to unemployment benefits and to education has been deducted, must be taken into consideration in any examination of the movements of standard of living (see Table 5). The effect on *per capita* income of changes in the ratio of workers to dependants also gains in importance, though, except for the actual war years, the rise is almost limited to the second of the two decades of which the period consists (see Table 4). On the other hand, while there has been a definite reduction in the hours of work regarded as forming a normal full-time week, this reduction is almost confined to the first decade (see Appendix, p. 140).

From the rise in the curves depicting real earnings, together with the increased expenditure on public social services and the general improvement in the other relevant factors just discussed, it may be concluded with a high degree of probability that the *average* standard of living has risen since the war, and is now higher than it was in 1914. Such a conclusion is, however, subject to the possible fallacies, drawn attention to by Layton and Crowther (1935*b*), that may arise from the indiscriminating use of general averages. Caution becomes particularly necessary in the interpretation of movements of the average during the last ten years owing to the very divergent tendencies shown by earnings in different parts of the country, and in various occupations and grades of labour.

Reviewing the entire ninety years made up by these three periods, the most noteworthy feature is the check in the rise of real earnings, and consequently in the improvement of the standard of living, that took place in the United Kingdom about 1900. From that year

no reflection in this tuberculosis mortality curve, which continues to fall at an undiminished rate until 1914. On the other hand, during the war period the temporary fall in the value of real earnings was accompanied by a corresponding rise in mortality, and in the post-war period of improving real earnings this tuberculosis mortality curve shows a resumption of its downward trend along what is virtually a continuation of its original course.

The only previous comparison of this kind of which we are aware was made by Ewart (1922), who traced the course of mortality from phthisis of persons of all ages in England and Wales from 1850 to 1920, in conjunction with that of real wages over the same period, though he drew no very definite conclusions from his data. His curves for real wages and phthisis mortality show a general parallelism over this period, though it should be noted that both (the curves for phthisis and wages have, in error, become transposed in his chart) are set out on an arithmetic scale. If, for the better discernment of rates of change, a semi-logarithmic scale be used, the parallelism since 1900 becomes, as in our own curves, much less evident. Perhaps the most interesting feature of Ewart's work is the suggestion that changes in environmental conditions may be followed, after only a short lag period, by changes in phthisis mortality. This view is supported by the economic and mortality experience of civilians in belligerent and neutral countries during the war, though admittedly at that time the deterioration in conditions was exceptionally sudden and severe.

In the present examination the comparison of the changes in real earnings with those in respiratory tuberculosis mortality has been extended to the mortalities of various sex- and age-groups considered separately. Of the curves for the sixteen groups (see Table 1) so considered, the mortality curve for young women, aged 15 to 24 years, was found to exhibit much the closest match with the curve for real earnings, there being a striking mirror-image similarity between the two throughout the whole ninety-year period. This similarity shown by the mortality curve for young women, in contrast to the much less close similarity shown by that for persons of all ages, is seen in Chart 4. The period of steadily improving real earnings from 1860 to 1900 is also one of steadily declining mortality for young women. The cessation in the improvement in real earnings that took place about 1900 almost coincides with the check in the decline of their mortality. From this time until 1913 both real earnings and mortality were nearly stationary. The oscillations in the value of real earnings during the war period are closely reflected in those of this mortality. Finally, the post-war period of improving real earnings is one also of declining tuberculosis mortality for young women, at first slowly, and since 1933 more rapidly.

Second to the curve for respiratory tuberculosis mortality of young women in point of closeness of match with the curve of real earnings

is that for young men of the same age (not charted), though in their case no date so clearly separates the earlier period of steady decline in phthisis mortality from the later period of retarded fall.

Greenwood (1922*a*), in the discussion on Ewart's paper, pointed out the need for caution in drawing conclusions of a precise nature from such time charts. Similar caution must be observed in interpreting the curves shown in Chart 4. Nevertheless, the mirror-image similarity of the curve for real earnings and that for respiratory tuberculosis mortality among young women over several periods of varying directional tendency, in contrast with the much less close similarity found for other sex- and age-groups, suggests that there has existed between the standard of living and the mortality of females in this age-group a relationship more intimate than that existing between the standard of living and the mortality from respiratory tuberculosis of the population as a whole.

If it be correct that some such special sensitivity exists, the check in the decline in respiratory tuberculosis mortality amongst young women in the first few years of this century might be partly attributable to the corresponding check in the improvement in the standard of living as registered by the movements of real earnings. Furthermore, the slow decline in mortality among young women during the subsequent thirty years, both as compared with females of other age-groups and as compared with the same age-group in previous years, might be due to the diminished average rate of improvement in the standard of living during the same period. If the hypothesis of a special sensitivity to standard of living be extended to include males of this particular age-group, the recent retardation of the decline in respiratory tuberculosis mortality amongst young men, similar to, though less pronounced than, that amongst young women, might be similarly accounted for as a reaction to the changes in the rate of improvement in the standard of living.

The suggestion that there has been a causal connection between these phenomena—based upon similarity of the courses followed by the curve for real earnings and the curves for tuberculosis mortality amongst young adults—can remain no more than a suggestion. It will, however, be found to be strengthened by the results obtained in investigating the kindred question of the extent to which, in local areas as distinct from the country taken as a whole, various social conditions composing the main aspects of the standard of living are reflected in respiratory tuberculosis mortality.

Though movements in the standard of living must necessarily attract most attention, it must not be forgotten that there have been other considerable changes affecting the lives of young adults, and particularly of young women, in the past forty years (such as changes in volume of occupation and proportion married), and these will, in turn, require investigation as additional potential factors in influencing respiratory tuberculosis mortality.

IV. SUMMARY OF CHAPTER 2.

1. The course of the standard of living of the country from 1850 to 1936 has been examined. This course has been estimated mainly from changes in working-class real earnings, and from changes in expenditure on certain public social services.

2. The standard of living rose steadily from 1860 to 1900. About 1900 a check in this improvement took place, and between that date and the war real earnings and standard of living almost certainly failed to rise and possibly slightly declined. Since the war, making an approximate allowance for public social services, there has probably been an improvement in the average standard of living. Taken as a whole, however, the improvement during the forty years of the present century has been distinctly inferior to that in the last forty years of the nineteenth century.

3. A graphical comparison has been made between the course of real earnings, the main determinant of standard of living, and the course of respiratory tuberculosis mortality in the various age-groups. There is a striking mirror-image similarity between the curve for real earnings and that for the respiratory tuberculosis mortality of young women. The curve for the mortality of young men comes next in order of similarity, while the curves for other age-groups show a much less close resemblance.

4. From this particular similarity it is suggested that young adults, especially young women, may be peculiarly sensitive to changes in the national standard of living, and that as a result of this sensitiveness the retardation in the average improvement in the standard of living since the beginning of the century has been a factor in producing the retardation in the decline in phthisis mortalities of young men and women.

TABLES TO CHAPTER 2.

TABLE 3.—*Changes in Working-Class Real Earnings in the United Kingdom from 1850 to 1936.*

Year.	Average money earnings.	Percentage unemployed.	Average money earnings allowing for unemployment.	Cost of living.	Real earnings allowing for unemployment.
(1).	(2).	(3).	(4).	(5).	(6).
1850-54	105	3.7	101	104	97
1855-59	113	6.4	106	115	92
1860-64	117	4.8	111	110	101
1865-69	130	5.5	123	114	108
1870-74	146	1.9	143	117	122
1875-79	150	5.8	141	111	127
1880-84	148	4.4	142	107	133
1885-89	151	6.8	141	98	144
1890-94	162	5.3	153	98	156
1895-99	166	3.4	160	94	170
1900	179	2.5	175	98	179
1901	179	3.3	173	99	175
1902	176	4.0	169	100	169
1903	176	4.7	168	101	166
1904	176	6.0	165	101	163
1905	175	5.0	166	101	164
1906	181	3.6	174	101	172
1907	190	3.7	183	103	178
1908	186	7.8	172	105	164
1909	184	7.7	170	105	162
1910	186	4.7	177	106	167
1911	188	3.0	182	104	175
1912	194	3.2	188	110	171
1913	197	2.1	193	110	176
1914 (July)	198	3.3	192	109	176
1915	213	1.1	211	134	158
1916	233	0.4	232	159	146
1917	272	0.7	270	192	141
1918	352	0.8	349	221	158
1919	421	2.4	411	234	176
1920	569	2.4	556	271	205
1921	550	14.8	470	246	191
1922	409	14.3	370	200	185
1923	378	11.7	348	190	183
1924 (Dec.)	386	10.3	360	197	183
1925	390	11.3	360	192	188
1926	386	12.5	354	188	188
1927	390	9.7	364	183	199
1928	386	10.8	358	181	198
1929	382	10.4	355	179	198
1930	378	16.0	337	172	196
1931	374	21.3	321	161	199
1932	366	22.1	312	157	199
1933	363	19.9	315	153	206
1934	363	16.7	323	154	210
1935	366	15.5	328	156	210
1936	376	13.2	343	160	214

The figures in Columns (2) and (5) are percentage relatives with bases : 1850 = 100.

Sources :

Column (2).

1850 to 1914 : Wood (1909, 1910), Bowley (1920, 1928a). (See Appendix, p. 136.)

1915 to 1919 : Bowley (1921). (See Appendix, p. 136.)

1920 to 1923 : Ministry of Labour (1933b). (See Appendix, p. 136, where these figures are stated to refer to money wage-rates and not to money earnings.)

1924 : Bowley (1929). (See Appendix, p. 136.)

1925 to 1936 : London and Cambridge Economic Service (1929, 1933, 1937). (See Appendix p. 137, where these figures are stated to refer to money wage-rates and not to money earnings.)

Column (3).

1850 to 1895 : Wood (1909).

1896 to 1921 : Ministry of Labour (1928a).

1922 to 1936 : Ministry of Labour (1933a, 1936a).

Column (4).

Figures derived from Column (2) by combining with estimated percentage unemployed (Column (3)), the assumption being made that up to 1921 workers unemployed received no income, and that from 1922 they received one-third of the corresponding figure for average money earnings. (See Layton and Crowther, 1935a.)

Column (5).

1850 to 1914 : Wood (1909, 1910), Bowley (1920). (See Appendix, p. 137.)

1915 to 1936 : Ministry of Labour (1933c, 1936b). (See Appendix, p. 137.)

Column (6).

Figures derived by dividing figures of Column (4) by those for corresponding years in Column (5), and multiplying by 100. Figures for the periods 1920 to 1923 and 1925 to 1936 refer to real wage-rates and not to real earnings.

TABLE 4.—*Total Occupied,¹ aged 10 years and over, per cent. of Total Population, all Ages, in England and Wales. (Figures in thousands.)*

MALES.						
Year.		Population.		Occupied. ¹		Percentage.
1901	.	15,729	.	10,157	.	64·5
1911	.	17,446	.	11,456	.	65·6
1921	.	18,075	.	12,113	.	67·2
1931	.	19,133	.	13,247	.	69·3
FEMALES.						
1901	.	16,799	.	4,172	.	24·9
1911	.	18,625	.	4,831	.	25·9
1921	.	19,811	.	5,065	.	25·6
1931	.	20,819	.	5,606	.	26·9
PERSONS.						
1901	.	32,528	.	14,329	.	44·1
1911	.	36,071	.	16,287	.	45·1
1921	.	37,886	.	17,178	.	45·4
1931	.	39,952	.	18,853	.	47·2

¹ "Occupied" includes employed and unemployed.

Sources :

1901 and 1911. Census (1911g).

1921 and 1931. Census (1931f).

TABLE 5.—*Public Social Services in England and Wales. Expenditure,¹ in millions, under certain Acts of Parliament.*

Service.	1890.	1900.	1910.	1920.	1932.
(1) Unemployment Insurance Acts	...	...	...	6·4 (9·7)	84·5 (101·7)
(2) National Health Insurance Acts	...	...	...	13·5 (26·4)	19·2 (33·6)
(3) Contributory Pensions Acts	...	...	...	...	26·3 (36·4)
(4) Old Age Pensions Acts	...	...	6·3	18·3	36·0
(5) War Pensions Acts	...	...	...	90·9	40·0
(6) Education Acts	10·1	17·0	29·1	76·4	87·6
(7) Public Health Acts	0·4	1·3	1·9	9·2	13·7
(8) Working Classes Housing Acts	0·2	0·4	0·7	1·9 (4·2)	15·4 (37·3)
(9) Poor Law Acts	8·5	11·5	15·0	31·9	39·0
Total	19·2	30·2	53·0	248·5	361·7
Total, less (1) and (6)	9·1	13·2	23·9	165·7	189·6

¹ The figures are total expenditure (derived from Parliamentary Votes, Local Rates, etc.; and other receipts including contributions for insurance from employers and employed, rents, etc.), except in certain instances. For Unemployment Insurance the figures are total expenditures, less insured persons' contributions (estimated at $\frac{7}{8}$ for 1920, and $\frac{1}{2}$ for 1932, of contributions), the unamended figures being given in brackets; for National Health Insurance and Contributory Pensions Scheme a similar procedure has been followed (deductions estimated at $\frac{1}{2}$ contributions for each year); for Working-Class Housing for 1920 and 1932 rent receipts have been deducted, the unamended total expenditure being shown in brackets; for Public Health the figures are expenditure so far as the Acts relate to hospitals, the treatment of disease, and maternity and child welfare work.

Sources :

1890. Treasury (1922).

1900, 1910. Treasury (1934).

1920. Treasury (1922, 1924, 1934).

1932. " (1934).

Chapter 3.—Mortality from Respiratory Tuberculosis in the Different English County Boroughs between 1911 and 1933, in Relation to Certain Local Social Conditions.

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I. INTRODUCTION.

In Chapter 2 the changes in phthisis mortality in the country as a whole were compared with those in the general level of social conditions (standard of living) over the long period of ninety years, and it was found that the period of retarded decline in phthisis mortality among young women coincided with the period of decreased rate of improvement in the general standard of living. Since the retarded decline in phthisis mortality among young adults has been more marked in urban areas than in the country as a whole (see Chapter 1), it is important to study these areas in particular detail in order to determine whether the mortality trends in various age-groups have been more or less uniform in this type of area throughout the country, or whether they have differed from one urban area to another and if so whether such differences can be related to differences in local social conditions.

On account of the relatively good statistics available, and on account of their large aggregate population (about one-third that of the whole country), the county boroughs are the urban areas selected for study in this chapter. Had it been feasible, the period of the detailed examination of these boroughs would have extended over the past forty or fifty years, so as to include the time of the check in the

decline in phthisis mortality of young women (about 1900-04) and the subsequent ten years during which this mortality was almost stationary. The present survey is, however, necessarily limited to the period 1911 to 1933 for lack of suitable data before and since (see p. 141). Yet, in spite of this enforced limitation, analysis of the data for the county boroughs during these two decades might be expected to yield valuable information upon the factors affecting young adult phthisis mortality. For although no direct information is available to show whether the decline in this mortality in the aggregate of county boroughs was proceeding more slowly between 1911 and 1933 than in previous years, a retardation may almost certainly be inferred from the reduction in rate of decline in this age-group in the country as a whole. In any case it is established that the decline in young adult phthisis mortality between 1911 and 1933 in the aggregate of county boroughs was, as in the country as a whole, materially slower than were the contemporaneous declines for the other age-groups (see Chapter 1).

The local social conditions examined in this chapter are mainly: the incidence of persons receiving poor relief, Stocks's "social index" as based upon occupational gradings, and the incidence of sub-standard housing conditions as measured by the proportion of persons living more than two per room. At the present time housing is the only major component of poverty for which there is satisfactory numerical information. Local statistics on sub-optimal nutrition, its other major component, are unfortunately not available for most of the English county boroughs.

II. MATERIALS, SOURCES AND METHODS.

The areas investigated in the present chapter are 76 of the 79 English county boroughs, subsequently referred to as "the 76 selected English county boroughs".

The respiratory tuberculosis mortalities (based on triennial averages) were derived from the returns of the Registrar-General and the census. The period for which such mortalities are available is from 1911 to 1933, the earlier limit being determined by the adoption in 1911 of the method of assigning deaths to the place of usual residence of the deceased, and the later limit by the date of the most recent census.

Of the social statistics used for each borough, poor relief and unemployment returns were utilized from 1930 to 1933; the social index was taken from the Registrar-General's Text (1934) for the year 1931; and the incidence of sub-standard housing conditions (percentage of the population living more than two per room) was obtained from the censuses for the years 1911, 1921 and 1931.

The statistical methods used were correlation, supplemented by group-averages of mortality. In the tables, significant correlation

coefficients (more than twice their standard errors) are printed in heavy type.

Full details and discussion of these data will be found in the Appendix.

III. ANALYSIS OF RESULTS.

A. Comparisons between Various Measures of Local Social Conditions.

Before examining the effects of social conditions upon phthisis mortality, the degree of inter-relationship between the various social data used may be briefly considered. The three statistics mainly employed, viz. poor relief, social index and housing, all provide from different angles measures of the differences in the degree and extent of poverty as a whole in the general population from one county borough to another. All three have advantages and disadvantages, which are discussed in the Appendix, and it seems at present impossible to decide which is the best index of poverty in its more general aspects.

In Table 6 are shown the correlation coefficients between all the various social data used. Those for poor relief at various dates, both in the county boroughs used in the present tuberculosis survey and in the Poor Law Unions that preceded them (see Appendix, p. 143), are given in Table 6, Nos. 1-4. It appears important that the economic depression that began in 1929, while increasing the absolute incidence of persons on poor relief, does not seem to have altered to any great extent the latter's proportionate local distribution, *i. e.* the areas most affected in 1931-33 were those in the least satisfactory state for some years before the onset of that depression. It is of interest in this connection that significant correlations are found between poor relief and unemployment incidences, taken at the same period (Nos. 5-7), in view of the fact that an interval usually elapses after an increase of unemployment before a rise takes place in the relief figures. These findings show that the relative distribution of poverty as between the various boroughs has remained much the same for a long period—a point of great importance in considering the effects of social conditions upon a chronic disease like phthisis.

The inter-correlations between poor relief, social index and sub-standard housing (Nos. 8-11) are not surprising, since all three are to some degree indicators of poverty. A correlation between various statistics of housing (Nos. 13 and 14) is also to be expected. The high degree of correlation between sub-standard housing incidence in 1911 and that in 1931 (No. 12), a finding of considerable importance in view of the later discussion, indicates that little change in the relative distribution of housing inadequacy can have occurred during the intervening period; this suggests that the use in the succeeding tables of the 1911 figures instead of those for 1931, in the instances

where the latter were alone employed, would have given much the same results as those presented.

B. Comparisons between Local Social Conditions and the Level of Respiratory Tuberculosis Mortality.

(i) *Simple correlations.*—In Table 7 are set out the simple correlation coefficients between the mortalities from respiratory tuberculosis in the county boroughs in the years 1931–33 and the returns for the various social conditions at roughly the same dates. (Since it seemed possible that the effect of poverty might be delayed owing to the prolonged clinical course of most cases of phthisis, two sets of poor relief figures, one for 1930 and the other for 1931–33, have been used. On the whole, the age-distribution of the significant coefficients of these two sets of correlations is almost the same, but the degree of significance is somewhat greater in the former.)

An examination of this table brings out two important points:

(1) All three measures—poor relief, social index, sub-standard housing—show significant positive correlations for both sexes and practically all age-groups.

(2) The sizes of the coefficients are smallest for poor relief, intermediate for social index, and largest for sub-standard housing. This applies to both sexes and to all age-groups except that of 45 and over.

These results, derived from three very different types of social data, strongly suggest a general relationship between the local level of poverty as a whole and the level of tuberculosis mortality.

Since data, both for incidence of sub-standard housing conditions and for respiratory tuberculosis mortality, are available in the county boroughs not only in 1931–33, but also as far back as 1911, correlation coefficients were calculated between these two variables at several dates from 1911 to 1933. They are set out in Table 8, where it can be seen that the number of age-groups showing significant coefficients, and the degree of significance, tend to increase in the later years. This increase in scope and degree of correlation occurring in most age-groups between 1911 and 1933 provides an interesting problem for which we cannot offer a solution. It might be due to the gradual elimination with time of some other factors of ætiological importance in tuberculosis that formerly masked the influence of the housing factor.

Support for the relationship, just given, between housing conditions and phthisis mortality among women aged 15 to 24 is to be found in subsidiary correlations in which housing in the different boroughs is measured by the population per occupied dwelling (1931) and also by the population per acre (1931). The results ($+0.362 \pm 0.115$; $+0.406 \pm 0.115$) are both significant, but the degree of significance is less than in the corresponding comparison of phthisis mortality with sub-standard housing incidence as measured

upon the basis of the "more than two persons per room" standard (see Table 7).

(ii) *Group-averages*.—As a general check upon the results shown in Tables 7 and 8, derived by the method of correlation, the supplementary method of grouping the same data (see Appendix, p. 149), and calculating averages of mortality, was employed for poor relief and housing. This method was not used for the social index.

For comparing local phthisis mortality with poor relief incidence, the boroughs were arranged in four groups according to their incidence of persons on poor relief in 1931-33. The results, which are shown in Table 9, support the correlations between the two variables given in Table 7.

For comparing local phthisis mortality with sub-standard housing incidence, the boroughs were arranged in four groups according to their incidence of sub-standard housing conditions in 1931. (This procedure differs from that used in deriving the corresponding correlation tables [Tables 7 and 8] in that the housing and phthisis statistics are not always contemporaneous [but see page 26, remarks on Table 6, No. 12].) Examination of Table 10 supports for 1931-33 the correlations between local housing and phthisis shown in Tables 7 and 8. It also shows the same progressive increase in the closeness of relationship in the twenty years from 1911 to 1933.

The figures for the war years in Table 10, which are not included in the corresponding correlation table (Table 8), are of considerable interest, since they show how each of the different age-groups were affected in each of the groups of boroughs. (The figures for males aged 15 to 24 and 25 to 44 are necessarily doubtful.) Among males and females aged 0 to 4 and 45 years and over the phthisis mortality for all boroughs taken together was scarcely affected, and no substantial increase in mortality is seen to have taken place in any of the individual groups of boroughs. Among both males and females aged 5 to 14, and among females aged 15 to 24 and 25 to 44, an increase, often of considerable size, took place in each group of boroughs.

(iii) *Partial correlations*.—In the preceding paragraphs the relationship of poverty with phthisis mortality has been inferred from correlations between the latter and the three social data—poor relief, social index and housing. The statistics for housing, however, more especially since they are based upon density of room-occupation, differ from the other data in that they not only serve as an index for poverty as a whole, but they also have a narrower and more specific connotation. For they serve as a measure for comparing the degree of closeness of personal contact prevailing locally among the inhabitants of the different county boroughs. They thus afford a close approach to one important aetiological factor in phthisis—exposure to "droplet-type" infection from human sources.

Since the simple correlations found between phthisis and housing

(see Table 7) were almost uniformly higher than those for poor relief and social index, it seemed desirable to calculate partial correlations, holding the latter two poverty indices constant, in an attempt to separate the influence of this more specific characteristic of housing from the influence of poverty in general.

The results of partial correlation between various social data and phthisis mortality at different ages are given in Table 11, which may be examined in conjunction with Table 7 where the corresponding simple correlations are set out. The following points emerge from these comparisons:

(1) When housing is held constant, the correlation coefficients between phthisis mortality and both poor relief and social index become insignificant, with the following exceptions: poor relief, males aged 0 to 4; social index, females aged 15 to 24; both poor relief and social index, males 45 and over. The first of these exceptions should probably be discounted, partly because of the small numbers of deaths in this age-group in the individual boroughs, and partly in view of the zero correlation for female children of the same age, who would presumably be exposed to an essentially similar environment. This leaves young women, aged 15 to 24, and men aged 45 and over as the only groups whose coefficients remain significant in spite of reduction. It may, however, be noted that almost all the correlations that are reduced to insignificance when housing is held constant are still positive, suggesting that in their case too there may be a real association though on a very low level.

(2) By contrast, when poor relief incidence and social index, taken either separately or together, are held constant, the correlation coefficients between sub-standard housing incidence and phthisis mortality become slightly smaller, but still remain strongly significant for both sexes and for all age-groups up to 44 years, though for both males and females aged 45 and over the coefficients become insignificant.

From these results it is inferred that there is a relationship between differences in average closeness of personal contact amongst inhabitants from one county borough to another and the different levels of phthisis mortality in these places. On the other hand, factors in poverty apart from closeness of personal contact would seem to be of less importance.

(iv) *Coefficients of regression of respiratory tuberculosis mortality on housing.*—To give further information as to the relationship between housing conditions and phthisis mortality in the different age-groups, coefficients of regression, signifying average changes in mortality for each unit change in housing, were derived from the significant correlation coefficients shown in Table 8. These regression coefficients are set out in Table 12. It may be seen that (1) in all the age-groups, except 45 years and over, the coefficients increase in value from 1911 to 1933; and (2) in recent years the coefficients for young adults, aged 15 to 24 years, have been greater than those for other age-groups, indicating that this age-group shows the greatest average *absolute* change in phthisis mortality for each unit change in housing.

Whether *absolute* or *relative* rates of change in mortality are preferable for comparing one age-group with another, in their reactions to social conditions, is debatable. It may be seen, for example (Table 12), that, absolutely, a mean rate of change of 3.67 at ages 15 to 24 is greater than 1.04 at 0 to 4 years, though relatively to the mean mortalities at these ages (92 and 11, see Table 8) it is a smaller reaction. If the absolute rates of change are accepted as being the more important in this connection, result (2) above suggests that young adults have been more "sensitive", as regards their mortality from respiratory tuberculosis, to housing conditions than have persons of other ages. A similar suggestion as to the special sensitiveness of young women to general social conditions was made in Chapter 2 as a result of comparisons between the course of the standard of living and the mortality from respiratory tuberculosis in the country as a whole over the past ninety years.

Additional information bearing upon the apparent special sensitiveness, in their mortality from respiratory tuberculosis, of young adults to housing conditions may be derived from the grouped data of Table 10. When the absolute differences between the mortalities shown in Group 1 and those shown in Group 4, in 1931-33, are compared by age-groups, it is found that the greatest values are obtained for the young adults (results are not tabulated here)—a result in conformity with that obtained from the regression coefficients of Table 12. Should, however, the percentage differences be compared, it is found that those for young adults are smaller than those for infants and children, though they still remain larger than those for both the older age-groups.

c. Comparisons between Local Housing Conditions and Recent Declines in Respiratory Tuberculosis Mortality.

In the previous sub-section (b) the social factors have been compared with the *actual* death-rates at particular *dates*, and of the three factors used, housing has shown the closest relationship with phthisis mortality. In the present sub-section housing is compared with the *changes* in death-rates over particular *periods* of time. Such comparisons are specially pertinent to the present problem, for it is the unsatisfactory *trend* of respiratory tuberculosis mortality among young adults in recent years that is the main concern of this inquiry.

(i) *Correlations*.—In Table 13 are set out the correlation coefficients between (y) *absolute* rate of decline, per annum, in respiratory tuberculosis mortality over the periods 1911-13 to 1931-33 (for females only) and 1921-23 to 1931-33 (for both males and females) and (x) incidence of sub-standard housing conditions in 1931, in the county boroughs. Table 14 shows a similar comparison using *percentage* rates of decline, which are probably a more correct measure of the changes than are the absolute rates of decline. In this latter

comparison the correlation coefficients given are for the age-groups 15 to 24, 25 to 44, and 45 and over. Since in some of the 76 boroughs the percentage changes were extreme, owing to the comparatively small numbers of deaths on which were based the mortalities from which the percentages were subsequently calculated, it was decided to follow Bradford Hill (1936) and give a second series from which all boroughs were excluded in which less than twenty deaths from respiratory tuberculosis were recorded in the particular age-group for the first triennium of the period concerned. These coefficients are placed below those of the principal series. In the two younger age-groups, 0 to 4 years and 5 to 14 years, the percentage changes were more often extreme than in the three adult age-groups, and, after removal of those boroughs having less than twenty deaths, the remainder were too few (less than 20 boroughs) for satisfactory statistical treatment. For these reasons the younger age-groups are not included in Table 14.

Examination of Tables 13 and 14 brings out the following points:

(1) With the exception of one for males ($+0.228 \pm 0.115$), which is just below the level of significance, all the coefficients shown for males and females aged 15 to 24 years, for both the periods concerned, and both for absolute and for percentage-rates of decline, are significant.

(2) The coefficients shown for males and females aged 25 to 44 years over the period 1911-13 to 1931-33, when percentage-rates of decline are used, also are significant. Over the period 1921-23 to 1931-33, both for percentage and for absolute rates of decline, the correlations are not significant.

(3) For no other age-groups are the correlation coefficients significant.

(4) The exclusion of certain boroughs on account of the small numbers of their deaths (Table 14) has increased the numerical value of the coefficients for the age-group 15 to 24, both sexes, but has made little difference to those of the other age-groups.

These results point to there being an inverse relationship between the recent rates of decline in respiratory tuberculosis mortality among young adults in the different boroughs and the local incidence of sub-standard housing conditions in these boroughs, as shown in the 1931 census, while among other age-groups such relationship is absent or less marked.

Correlation coefficients (not tabulated here) were also calculated, using incidence of persons on poor relief (1931-33) in place of sub-standard housing incidence. These comparisons corresponded to those of Tables 13 and 14, except that no correlations were made for the period 1911-13 to 1931-33 apart from percentage-rates of decline for young women, aged 15 to 24 years. As in Table 14, two series were computed, a principal series using all 76 boroughs, and a second, contracted series with exclusion of boroughs having less than twenty deaths. In the principal series none of the correlation coefficients was significant, while in the contracted series the only significant

coefficient (-0.284 ± 0.134) was for females aged 15 to 24 years for percentage-rates of decline over the period 1911-13 to 1931-33.

From the above simple coefficients (including also those of the contracted series), partial correlation coefficients were calculated between the decline in respiratory tuberculosis mortality and poor relief incidence, sub-standard housing incidence being held constant, and between the decline in tuberculosis mortality and sub-standard housing incidence, poor relief incidence being held constant. The ages and periods corresponded to those stated in the preceding paragraphs. The results (not tabulated here) showed that the single significant simple correlation coefficient found between the percentage decline in respiratory tuberculosis mortality and poor relief incidence was reduced to insignificance, while those that were insignificant remained so. On the other hand, the significant simple coefficients found between percentage and absolute rates of decline in respiratory tuberculosis mortality and sub-standard housing incidence among young adults of both sexes remained significant, while those that were not significant failed to become so.

(ii) *Group-averages*.—The comparisons of Tables 13 and 14 were expanded, and additional information obtained, by using the supplementary method of group-averages of mortality, the four groups of boroughs having the same composition as for Table 10. It should be noted that the average rate of decline of mortality for each group of boroughs, and for all the 76 boroughs taken together, was obtained by averaging the rates of the individual boroughs at the beginning and end of the period concerned and taking the difference, and not by averaging the rates of decline of the individual boroughs. Weighted averages were calculated as well as simple averages so as to mitigate the idiosyncrasies of particular boroughs, especially the smaller ones. The comparisons between the absolute rates of decline in mortality from respiratory tuberculosis over the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 and the incidence of sub-standard housing conditions in 1931 are shown in Table 15. Similar comparisons are set out in Table 16, using the percentage-rates of decline in mortality in place of the absolute rates. The second method is probably the more informative for comparing improvements, and more importance should probably be attached to the results so obtained.

Examination of Tables 15 and 16 brings out the following points:

(1) (see Table 16). When all the 76 county boroughs are taken together, the percentage-rates of decline in respiratory tuberculosis mortality among young men and women, aged 15 to 24 years, between 1911-13 and 1931-33 (1.2 and 1.0% per annum for men, and 0.2 and 0.0% per annum for women) were less—in the case of women markedly less—than those for any other age-group of the same sex. The same point has been briefly referred to in Chapter 1 (p. 8 and Chart 2).

For the decade 1921-23 to 1931-33 similar differences are shown, with the exception that there was a smaller percentage-rate of decline in

mortality among males aged 45 years and over than among young adult males. The occurrence of a recent diminution in the rate of decline in respiratory tuberculosis mortality among the older men was pointed out for the country as a whole in Chapter 1.

(2) (see Table 16). When the county boroughs are considered in groups, based on their housing conditions in 1931, it can be seen that among males aged 15 to 24 years in the best-housed group of boroughs (Group 4), the percentage-rate of decline in respiratory tuberculosis mortality between 1911-13 and 1931-33 was approximately the same as that among the male older age-groups (25 to 44 years and 45 years and over) in the same group of boroughs, but was smaller than that among the male younger age-groups (0 to 4 and 5 to 14 years). Among females aged 15 to 24 years in Group 4, the percentage-rate of decline in respiratory tuberculosis mortality between 1911-13 and 1931-33 was smaller than that among the other female age-groups, both older and younger, in the same group of boroughs. The inferiority in the rate of decline for young adults is also present in each of the other three groups of boroughs (Groups 1, 2 and 3), where, in both sexes, it is evident by comparison with all the other age-groups in the borough group concerned.

What is more important to note, however, is that this relative smallness in percentage-rate of decline in mortality among young adults, in comparison with the other age-groups, is much more marked in the worst-housed group of boroughs (Group 1) than in the best-housed group (Group 4). In this connection it may be observed that young adult males in Group 1 showed scarcely any decline in mortality over this period (0.2 [simple] and 0.1 [weighted] % per annum), while young adult females actually showed a considerable rise (0.7 [simple] and 0.5 [weighted] % per annum); indeed it is only in Group 4, containing the best-housed boroughs, that young women showed any substantial decline (1.1 [simple and weighted] % per annum).

The smallness of the percentage-rate of decline in the respiratory tuberculosis mortality among young adults, as compared with other age-groups, for all 76 county boroughs taken together over the period 1911 to 1933 appears, therefore, to be dependent upon all four groups of boroughs. The contributions are, however, very unequal, those of the worse-housed groups of boroughs being the greatest.

Consideration of the period 1921-23 to 1931-33 leads to similar conclusions, allowing for the peculiar course pursued by the mortality among men aged 45 years and over during this decade (see p. 32, para. (1)).

(3) (see Tables 15 and 16). A marked inverse relationship can be seen between the incidence of sub-standard housing conditions (1931) in the four groups of boroughs and both the absolute and the percentage-rates of decline in respiratory tuberculosis mortality over the period 1911-13 to 1931-33 among young adults of both sexes, aged 15 to 24 years, when calculated both upon simple and upon weighted arithmetic averages. A similar relationship, though somewhat less marked, is also seen for the decade 1921-23 to 1931-33. In the other age-groups, on the other hand, such relationship between the housing conditions and rates of decline in mortality is absent or inconsistent. Among females (other than 15 to 24 years) no relationship is present, while, although it does occur among males of certain other age-groups (0 to 4, 5 to 14 and 25 to 44 years), it has an inconstant distribution. For example, in males aged 5 to 14 years the relationship is seen for the percentage-rates of decline, but not for the absolute rates; while in the age-group 25 to 44 years the relationship is present for both the absolute and percentage-rates of decline over the period 1911-13 to 1931-33 when based upon simple averages, but

not when based upon weighted averages, and is not found by either form of calculation for the period 1921-23 to 1931-33.

The possibility of a relationship between housing conditions and percentage-rate of decline in mortality among males aged 5 to 14 years was not determined by the complementary method of correlation (see Table 14), because it was not considered desirable to include this age-group in that table owing to the exceptional variability of the mortality data (see p. 31). While such a relationship is suggested by the method of group-averages, its absence when absolute rates of decline are considered, as well as its absence among young females of the same age-group living in ostensibly similar environment, throws doubt on its essential significance.

On the whole, therefore, the results obtained by group-averages are in satisfactory agreement with those obtained by the method of correlation.

IV. DISCUSSION.

For the different county boroughs at the triennium 1931-33 a relationship between poverty (as assessed by three social measures—poor relief incidence, social index and sub-standard housing incidence) and the levels of phthisis mortality, for both sexes and at most ages, appears to be demonstrated both by simple correlation and by group-averages. The relationship is strongest for housing and weakest for poor relief. With housing, furthermore, some degree of relationship has also been demonstrated by similar methods between its levels and those of phthisis mortality at dates as far back as 1911, the earliest year at which relevant statistics became available.

It has been pointed out (p. 28) that while housing may be regarded in the *broad* sense as reflecting poverty in general in the various boroughs, it also possesses a special significance in the epidemiology of respiratory infection as indicating the closeness of personal contact prevailing among the inhabitants, and consequently the risk of their contracting infections conveyed by droplets. For this reason the results obtained by partial correlation appear to have a particular interest. The finding that the relationship between phthisis mortality and sub-standard housing incidence is maintained at a high degree of significance when the other two measures of poverty are held constant does suggest that the differences in level of phthisis mortality from one county borough to another during recent years can be partly accounted for by differences in the locally prevailing inadequacy of housing conditions in the *narrow* or more specific sense suggested above. Though the validity of this suggestion depends upon how far the process of partial correlation has in fact removed the influence of differences of poverty, the maintenance of the housing-phthisis correlations at a high degree of significance when poor relief incidence and social index are held constant together (second order partial correlation) as well as separately (first order partial correlation), seems to place the importance of the factor of closeness of personal contact upon a fairly firm foundation.

On the other hand, the evidence from partial correlation that

poverty contains other factors, besides that of closeness of personal contact, concerned in influencing the local levels of phthisis mortality is much more slender. When housing is held constant, the great majority of the phthisis-poor relief and phthisis-social index correlations are reduced to insignificance, though the uniformly positive small coefficients may suggest an association on a very low level. Only for young women (social index) and for older men (social index and poor relief) do the correlations remain significant. Since, however, it is uncertain whether holding housing constant in the process of partial correlation may not have removed other factors in poverty besides that of closeness of personal contact, it would be dangerous to infer that, for example, fatigue and sub-optimal nutrition are not operative as ætiological factors in phthisis mortality in the English county boroughs at the present time.

The coefficients of regression serve to extend the conclusions drawn as to the relationships between the housing conditions and the local levels of phthisis mortality in the county boroughs. The higher values found for young adults suggest that the latter have been *more* sensitive, as regards phthisis, to housing conditions than have persons of other ages.

The existence of a strong inverse relationship between the recent *rates of decline* in phthisis mortality among young men and women in the different county boroughs and the local incidence of sub-standard housing (1931) may similarly be interpreted to mean that the local differences in the rates of decline in phthisis mortality among young adults can, like the *actual levels* of their mortality, be partly accounted for by the local levels of housing conditions, which latter have persisted with little relative change since 1911 at least. Furthermore, the contrast shown by the less definite relationship among other age-groups supports the view that the young adult age-group is *selectively* sensitive to housing. A similar suggestion that young women are especially sensitive to general social and economic conditions was advanced in Chapter 2 when discussing the courses of standard of living and phthisis mortality in the country as a whole during the past ninety years.

An important corollary follows from the finding that the association between inadequate housing and poor improvement in phthisis mortality is much stronger for young adults than for other age-groups. It is that the unfortunate retardation in phthisis mortality decline among young men and women for all 76 county boroughs taken together (see Chart 2), while contributed to by all four borough groups, is more especially the result of the deplorably slow decline in mortality—more or less peculiar to this age-group—in a number of particularly ill-housed boroughs. In these ill-housed boroughs there was scarcely any decline in the phthisis mortality of the young men between 1911 and 1933, while among the young women a definite and not inconsiderable increase in mortality was actually recorded.

V. SUMMARY OF CHAPTER 3.

1. The mortality from respiratory tuberculosis at various ages in the different English county boroughs has been examined in relation to certain local social conditions. The social statistics mainly used have been: the incidence of persons on poor relief, the proportion of males in the lower economic grades (Stocks's social index), and the proportion of persons living under sub-standard housing conditions (more than two per room). The statistical method used has been mainly that of correlation, supplemented by averages of mortality calculated for borough groups.

2. A moderate degree of inter-correlation has been found between the above three social measures.

3. A relationship has been found between each of the three social measures and respiratory tuberculosis mortality in 1931-33 at most ages for both sexes. The relationship is strongest for housing and weakest for poor relief incidence. It is inferred that differing prevalence of poverty from one county borough to another is partly responsible for their differing levels of respiratory tuberculosis mortality.

4. The above relationships have been analysed further, by the method of partial correlation, in the hope of distinguishing the influence of certain of the components of poverty. When differences in poor relief incidence and social index between the county boroughs are excluded in this way, the relationship between local sub-standard housing incidence and local respiratory tuberculosis mortality remains evident. Conversely, when housing differences are excluded, only a small relationship remains between respiratory tuberculosis mortality and both poor relief incidence and social index. From these findings it is inferred that differences in average closeness of personal contact between inhabitants from one county borough to another—which, it is presumed, is measured with some degree of directness by the proportion of persons living under sub-standard housing conditions—are an important factor in determining the different levels of respiratory tuberculosis mortality in these places. On the other hand, factors in poverty apart from closeness of personal contact would seem, upon the evidence of these partial correlations, to be of less importance.

5. An inverse relationship has been found between the different rates of improvement in respiratory tuberculosis mortality in the various county boroughs from 1911 to 1933 and the proportions of their inhabitants living under sub-standard housing conditions. This relationship, however, is stronger for young men and women than at other ages, suggesting that young adults are peculiarly sensitive, as regards respiratory tuberculosis, to the housing conditions of the towns in which they live.

6. The retarded decline in respiratory tuberculosis mortality of young adults, as compared with other age-groups, is recognizable in most of the county boroughs, though there are marked differences from one

to another. These differences are in part due, it is inferred, to differences in the housing conditions of these boroughs. In a large group of particularly ill-housed boroughs the respiratory tuberculosis mortality for young men has shown practically no decrease, and that for young women an actual increase, between 1911 and 1933.

TABLES TO CHAPTER 3.

TABLE 6.—*Correlation Coefficients (r) between Returns for various Social Conditions (x and y) in English County Boroughs or Poor-Law Unions.*

No.	Social conditions.		Correlations, etc.			
	(x)	(y)	r_{xy}	$\pm S.E._r$	M_x	M_y
1.	Poor Relief (1931-33)	Poor Relief (1930)	+·938	±·125	324	248
2.	Poor Relief (1930)	Poor-Law Relief (1929)	+·873		248	272
3.	Poor-Law Relief (1929)	Poor-Law Relief (1922)	+·559		272	447
4.	Poor-Law Relief (1922)	Poor Relief (1931-33)	+·556		447	324
5.	Poor Relief (June, 1931)	Unemployment (June, 1931)	+·342	±·118	248	232
6.	Poor Relief (Sept., 1932)	Unemployment (Sept., 1932)	+·353		328	239
7.	Poor Relief (Dec., 1933)	Unemployment (Dec., 1933)	+·497		391	184
8.	Poor Relief (1931-33)	Social Index (1931)	+·459	±·115	326	358
9.	Poor Relief (1931-33)	Sub-Standard Housing (1931)	+·356		326	7·92
10.	Poor Relief (1930)	Sub-Standard Housing (1931)	+·420	±·115	246	7·92
11.	Social Index (1931)	Sub-Standard Housing (1931)	+·569		358	7·92
12.	Sub-Standard Housing (1931)	Sub-Standard Housing (1931)	+·961		7·92	8·92
13.	Sub-Standard Housing (1931)	Population per Dwelling (1931)	+·570	±·115	7·92	4·12
14.	Sub-Standard Housing (1931)	Population per acre (1931)	+·408		7·92	19·4

EXPLANATORY NOTES.

- 1-4. Poor Relief (1931-33): Total number of persons, per 10,000 population, in receipt of poor relief in each county borough; mean of returns for the twelve quarters, March, 1931 to December, 1933.
- Poor Relief (1930): As above, but mean of returns for the four quarters, June, 1930 to March, 1931.
- Poor-Law Relief (1929): Total number of persons, per 10,000 population, in receipt of poor-law relief in each poor-law union; mean of returns for the four quarters of 1929.
- Poor-Law Relief (1922): As above, but mean of returns for the four quarters of 1922.
- County Boroughs: 65 of the 76 selected English county boroughs. The 11 excepted county boroughs are Blackpool, Bootle, Bournemouth, Liverpool, St. Helens, Smethwick, Southend-on-Sea, Southport, Stoke-on-Trent, Wallasey and York (see Appendix, p. 144).
- Poor-Law Unions: 65 poor-law unions corresponding in name to the above-mentioned 65 English county boroughs.
- 5-7. Poor Relief (Specified Quarters): Total number of persons, per 10,000 population, in receipt of poor relief in the specified quarters of 1931, 1932 and 1933 in each county borough.
- Unemployment (Specified Months): Number of unemployed persons, per 10,000 insured population, on the registers of

- Employment Exchanges on a certain day in the specified months of 1931, 1932 and 1933 in each county borough.
County Boroughs: 73 of the 76 selected English county boroughs (Bootle, Tynemouth and West Ham omitted, see Appendix, p. 145).
- 8-11. Poor Relief (1931-33): See Notes 1-4 above.
Poor Relief (1930): See Notes 1-4 above.
Social Index (1931): Proportion, per 1000 of occupied (including unemployed) males, aged 14 up, whose occupation places them in social classes IV and V, in each county borough; returns at census in 1931.
Sub-Standard Housing (1931): Incidence of sub-standard housing conditions measured upon the basis of the "more than two persons per room" census density standard; *i. e.* percentage of the population in private families living at a "more than two persons per room" density, in each county borough; returns at census in 1931.
County Boroughs: The 76 selected English county boroughs.
- 12-14. Sub-Standard Housing (1931): See Notes 8-11 above.
Sub-Standard Housing (1911): As in Notes 8-11 above, but returns at census in 1911.
Population per Dwelling (1931): Population per occupied dwelling in each county borough; returns at census in 1931.
Population per Acre (1931): Population per acre in each county borough; returns at census in 1931.
County Boroughs: The 76 selected English county boroughs.
- r_{xy} . Symbol for correlation coefficient. Correlation coefficients having values exceeding twice their standard errors are regarded as significant and are printed in heavy type.
- S.E.*,. Symbol for standard error ($1/\sqrt{n-1}$) of correlation coefficient.
- $M_x M_y$. The simple arithmetic average, for all county boroughs or poor-law unions taken together, of the values of the x and y variables, respectively.

TABLE 7.—*Correlation Coefficients (r) between various Social Conditions (Incidence of Persons on Poor Relief [1930 and 1931-33], Stocks's Social Index [1931], Incidence of Sub-Standard Housing Conditions [1931]) (x) and Mortality from Respiratory Tuberculosis at specified Ages (1931-33) (y) in English County Boroughs.*

Social conditions. (x)	Age-groups.				
	0-4.	5-14.	15-24.	25-44.	45 and over.
	MALES.				
Poor Relief (1930)	r_{xy} +.431	+ .292	+ .374	+ .245	+ .288
Poor Relief (1931-33)	r_{xy} +.332	+ .218	+ .349	+ .246	+ .330
Social Index (1931)	r_{xy} +.409	+ .477	+ .454	+ .319	+ .377
Sub-Standard Housing (1931)	r_{xy} +.529	+ .679	+ .568	+ .460	+ .135
Mean R.T.M. (1931-33)	11	7	92	136	143
	FEMALES.				
Poor Relief (1930)	r_{xy} +.242	+ .327	+ .346	+ .372	+ .232
Poor Relief (1931-33)	r_{xy} +.187	+ .244	+ .298	+ .311	+ .235
Social Index (1931)	r_{xy} +.245	+ .393	+ .593	+ .370	+ .286
Sub-Standard Housing (1931)	r_{xy} +.496	+ .667	+ .663	+ .514	+ .237
Mean R.T.M. (1931-33)	9	14	118	94	48
Mean Poor Relief (1930)					246
(1931-33)					326
Mean Social Index (1931)					358
Mean Sub-Standard Housing (1931)					7'92

EXPLANATORY NOTES.

- Poor Relief (1930 and 1931-33): See Table 6, Notes 1-4.
 Social Index (1931): See Table 6, Notes 8-11.
 Sub-Standard Housing (1931): See Table 6, Notes 8-11.
 Respiratory Tuberculosis (1931-33): Death-rate from respiratory tuberculosis, per 100,000 living, in each specified age-group in each borough; mean annual death-rate for the triennium 1931-33.
 English County Boroughs: The 76 selected English county boroughs.
 r_{xy} : See Table 6, Notes. Significant coefficients printed in heavy type.
 Standard Error: See *ibid.* Throughout this table it has the value of $\pm \cdot 115$.
 Mean R.T.M.: The simple arithmetic average, for all boroughs taken together, of the mean annual death-rates from respiratory tuberculosis in the various boroughs.
 Mean Poor Relief: The simple arithmetic average, for all boroughs taken together, of the means of the returns for the four quarters June, 1930 to March, 1931, and for the twelve quarters March, 1931 to December, 1933, in the various boroughs.
 Mean Social Index: The simple arithmetic average, for all boroughs taken together, of the values of Stocks's Social Index, 1931.
 Mean Sub-Standard Housing: The simple arithmetic average, for all boroughs taken together, of the returns for the sub-standard housing in the various boroughs at the census, 1931.

TABLE 8.—Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1911 to 1931) (x) and Mortality from Respiratory Tuberculosis at specified Ages (1911 to 1933) (y) in English County Boroughs.

Dates.		Age-groups.				
		0-4.	5-14.	15-24.	25-44.	45 and over
MALES.						
1911 and	r_{xy}	+·053	+·358	+·109	-·114	+·010
1911-13	Mean R.T.M.	38	19	120	213	228
1921 and	r_{xy}	+·344	+·627	+·316	+·218	+·177
1921-23	Mean R.T.M.	19	13	112	169	162
(1926 and	r_{xy}	..	..	(+·628)	..	..
1926-28)	Mean R.T.M.	..	..	(98)	..	..
1931 and	r_{xy}	+·529	+·679	+·568	+·460	+·135
1931-33	Mean R.T.M.	11	7	92	136	143
FEMALES.						
1911 and	r_{xy}	+·201	+·495	+·273	+·421	+·297
1911-13	Mean R.T.M.	38	35	122	142	94
1921 and	r_{xy}	+·431	+·659	+·293	+·418	+·076
1921-23	Mean R.T.M.	16	26	124	116	66
(1926 and	r_{xy}	..	..	(+·580)	..	..
1926-28)	Mean R.T.M.	..	..	(122)	..	..
1931 and	r_{xy}	+·496	+·667	+·663	+·514	+·237
1931-33	Mean R.T.M.	9	14	118	94	48
Mean Sub-Standard Housing:						
	1911	.	.	.	.	8·92
	1921	.	.	.	.	10·52
	(1926	.	.	.	.	9·22)
	1931	.	.	.	.	7·92

EXPLANATORY NOTES.

Sub-Standard Housing: As in Table 6, Notes 8-11, but returns at censuses in 1911, 1921 and 1931, and mid-censal mean for 1926.

Respiratory Tuberculosis: As in Table 7, Notes, but mean annual death-rate for each of the triennia 1911-13, 1921-23, 1926-28 and 1931-33.

English County Boroughs: The 76 selected English county boroughs.

Dates: The first date given refers to housing, and the second to the triennium for respiratory tuberculosis mortality.

r_{xy} : See Table 6, Notes. Significant coefficients printed in heavy type.

Standard Error: See *ibid.* Throughout this table it has the value of $\pm .115$.

Mean R.T.M.: See Table 7, Notes.

Mean Sub-Standard Housing: The simple arithmetic average, for all boroughs taken together, of the returns at the respective dates in the various boroughs.

TABLE 9.—*Respiratory Tuberculosis Mortality (1931-33), by Sexes and at certain Ages, in Four Groups of English County Boroughs arranged in order of their Incidence of Persons on Poor Relief (1931-33).*

Group of Boroughs.	Age-groups.					All ages.
	0-4.	5-14.	15-24.	25-44.	45 and over.	
MALES.						
(Simple arithmetic average.)						
1 .	18 .	10 .	116 .	156 .	174 .	114 .
2 .	15 .	10 .	108 .	136 .	148 .	102 .
3 .	9 .	6 .	79 .	136 .	142 .	95 .
4 .	5 .	5 .	78 .	125 .	124 .	88 .
All boro's	11 .	7 .	92 .	136 .	143 .	97 .
(Weighted arithmetic average.)						
1 .	18 .	10 .	119 .	162 .	193 .	121 .
2 .	18 .	10 .	107 .	140 .	162 .	107 .
3 .	11 .	6 .	84 .	136 .	157 .	101 .
4 .	6 .	5 .	79 .	125 .	123 .	88 .
All boro's	14 .	8 .	98 .	143 .	162 .	106 .
FEMALES.						
(Simple arithmetic average.)						
1 .	15 .	20 .	139 .	103 .	54 .	75 .
2 .	9 .	16 .	131 .	112 .	53 .	74 .
3 .	10 .	13 .	109 .	89 .	47 .	63 .
4 .	6 .	9 .	106 .	81 .	41 .	57 .
All boro's	9 .	14 .	118 .	94 .	48 .	66 .
(Weighted arithmetic average.)						
1 .	15 .	19 .	140 .	106 .	58 .	77 .
2 .	11 .	16 .	134 .	110 .	52 .	75 .
3 .	11 .	10 .	108 .	94 .	54 .	66 .
4 .	5 .	9 .	102 .	81 .	41 .	57 .
All boro's	11 .	14 .	122 .	98 .	52 .	69 .

EXPLANATORY NOTES.

Respiratory Tuberculosis: Death-rates from respiratory tuberculosis, per 100,000 living, in each specified age-group in each group of boroughs; the rates computed for each group of boroughs being simple and weighted arithmetic averages of the mean annual death-rates for the triennium 1931-33 in the various individual boroughs composing the particular group. The figures for "all boro's" were obtained similarly by treating the 76 boroughs as a single group.

Poor Relief (1931-33): See Table 6, Notes 1-4.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs:

Group 1 (those with poor relief incidences [1931-33] of over 500): Sheffield (947), Lincoln (839), Liverpool (749), Norwich (695), Gateshead (681), Bootle (665), Newcastle-on-Tyne (640), Manchester (626), Kingston-on-Hull (605), West Ham (580), Rotherham (565), Sunderland (561), Derby (501).

Group 2 (those with poor relief incidences [1931-33] 500 to 325): Nottingham (466), St. Helens (463), Grimsby (443), Birkenhead (439), Walsall (413), West Hartlepool (394), Wakefield (387), Blackburn (377), Wigan (377), Smethwick (365), Ipswich (357), Leeds (355), South Shields (348), Salford (342), Northampton (334), Great Yarmouth (333), Middlesborough (330).

Group 3 (those with poor relief incidences [1931-33] 325 to 200): Bristol (320), Stoke-on-Trent (320), Bradford (318), York (318), Plymouth (313), Tynemouth (303), Burnley (290), West Bromwich (286), Barrow-in-Furness (280), Southampton (280), Bury (250), Warrington (249), Rochdale (237), Bolton (231), Worcester (230), Oldham (229), Eastbourne (227), Leicester (225), Chester (219), Brighton (217), Burton-on-Trent (214), Birmingham (208), Wolverhampton (203), Southend-on-Sea (202).

Group 4 (those with poor relief incidences [1931-33] of below 200): Huddersfield (198), Bath (191), Dudley (191), Reading (189), Dewsbury (176), Croydon (173), Stockport (169), Darlington (168), Southport (168), Canterbury (166), Hastings (165), Gloucester (162), Portsmouth (159), Wallasey (153), Blackpool (146), Bournemouth (145), Preston (145), Exeter (132), Carlisle (127), Coventry (124), Halifax (94), Oxford (72).

TABLE 10.—*Respiratory Tuberculosis Mortality (1911 to 1933), by Sexes and at certain Ages, in Four Groups of English County Boroughs arranged in order of their Incidence of Sub-Standard Housing Conditions (1931).*

Dates for R.T.M.	Group of Boroughs.	Age-groups.					All ages.
		0-4.	5-14.	15-24.	25-44.	45 and over.	
MALES.							
(Simple arithmetic average.)							
1911-13	1	39	26	123	201	221	133
	2	44	23	124	213	262	146
	3	32	15	112	218	245	143
	4	36	15	123	216	194	136
	All boro's	38	19	120	212	228	139
1916-18	1	44	42	(121)	(214)	227	143
	2	44	37	(117)	(235)	258	157
	3	27	26	(114)	(196)	242	142
	4	28	15	(117)	(211)	181	132
	All boro's	35	29	(117)	(212)	224	142
1921-23	1	27	22	120	174	167	115
	2	26	15	120	185	193	125
	3	17	11	104	158	167	110
	4	10	7	106	162	132	102
	All boro's	19	13	112	169	162	112
1926-28	1	33	18	122	154	151	108
	2	21	12	112	158	190	117
	3	18	8	84	138	155	100
	4	10	8	83	149	126	95
	All boro's	20	11	98	149	152	104
1931-33	1	19	15	117	155	143	105
	2	12	9	101	146	177	110
	3	8	5	81	124	143	93
	4	6	3	75	126	122	87
	All boro's	11	7	92	136	143	97
(Weighted arithmetic average.)							
1911-13	1	44	27	131	237	276	155
	2	45	21	123	232	295	159
	3	38	17	112	228	280	155
	4	35	15	122	211	196	134
	All boro's	41	21	121	228	266	152
1916-18	1	52	43	(132)	(245)	274	165
	2	53	34	(117)	(246)	283	167
	3	35	28	(117)	(209)	274	155
	4	28	17	(115)	(210)	187	133
	All boro's	44	32	(121)	(229)	259	157
1921-23	1	31	20	135	196	194	130
	2	25	13	112	188	202	127
	3	21	11	114	170	192	122
	4	13	8	106	161	139	104
	All boro's	24	14	117	180	184	122
1926-28	1	35	18	128	175	184	123
	2	22	10	100	160	193	117
	3	21	8	95	149	182	113
	4	11	8	85	149	128	96
	All boro's	24	11	103	159	175	113
1931-33	1	20	14	129	166	172	118
	2	15	7	97	140	181	109
	3	10	6	84	135	162	102
	4	6	3	79	128	126	90
	All boro's	14	8	98	143	162	106

TABLE 10—(cont.).

Dates for R.T.M.	Group of Boroughs.	Age-groups.					All ages.
		0-4.	5-14.	15-24.	25-44.	45 and over.	
FEMALES.							
(Simple arithmetic average.)							
1911-13	1	45	45	137	165	108	109
	2	44	44	119	143	97	98
	3	37	31	122	133	99	95
	4	29	24	112	131	74	86
	All boro's	38	35	122	142	93	96
1916-18	1	39	72	172	189	96	127
	2	41	61	167	161	102	118
	3	32	40	157	158	94	110
	4	23	43	135	144	89	101
	All boro's	33	53	156	162	94	113
1921-23	1	27	39	137	130	66	89
	2	15	33	136	124	74	87
	2	14	19	119	108	66	77
	4	9	18	110	104	60	72
	All boro's	16	26	124	116	66	80
1926-28	1	24	33	158	119	56	86
	2	21	24	120	110	60	76
	3	13	15	118	95	53	68
	4	10	11	96	94	52	64
	All boro's	16	20	122	103	55	73
1931-33	1	16	24	155	111	53	80
	2	9	14	124	96	52	68
	3	8	10	114	89	44	62
	4	6	9	88	85	44	56
	All boro's	9	14	118	94	48	66
(Weighted arithmetic average.)							
1911-13	1	44	50	138	178	122	117
	2	44	40	113	138	105	97
	3	38	33	122	142	106	100
	4	27	25	118	132	77	88
	All boro's	39	38	123	148	103	101
1916-18	1	46	75	186	196	110	136
	2	41	52	158	155	97	112
	3	32	45	162	156	101	114
	4	22	42	143	146	91	104
	All boro's	37	55	163	164	100	117
1921-23	1	25	37	150	138	78	96
	2	19	29	128	116	70	83
	3	17	20	129	114	72	82
	4	9	19	116	108	62	75
	All boro's	19	27	132	119	70	84
1926-28	1	28	31	158	122	69	90
	2	16	19	117	105	60	73
	3	16	15	124	99	57	72
	4	12	11	104	98	54	67
	All boro's	19	20	127	106	60	76
1931-33	1	16	23	152	115	62	83
	2	11	11	117	94	53	67
	3	10	10	120	95	49	67
	4	7	10	93	87	45	58
	All boro's	11	14	122	98	52	69

EXPLANATORY NOTES.

Respiratory Tuberculosis: As in Table 9, Notes, but for the triennia 1911-13, 1916-18, 1921-23, 1926-28 and 1931-33.
 Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Dates for R.T.M.: The dates refer to the triennia for respiratory tuberculosis mortality.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs:

Group 1 (those with sub-standard housing incidences [1931] of over 10 %): Sunderland (29.3), Gateshead (28.6), South Shields (26.3), Tynemouth (24.2), Newcastle-on-Tyne (23.3), West Ham (17.5), West Hartlepool (16.7), St. Helens (16.4), Middlesbrough (14.9), Dewsbury (13.9), West Bromwich (13.2), Stoke-on-Trent (12.4), Wigan (11.5), Dudley (11.3), Carlisle (10.9), Liverpool (10.9), Plymouth (10.5), Halifax (10.1).

Group 2 (those with sub-standard housing incidences [1931] of 10 to 7 %): Darlington (9.8), Salford (9.6), Bootle (9.5), Warrington (9.4), Birkenhead (9.3), Chester (9.1), Walsall (8.8), Wakefield (8.3), Leeds (8.2), Sheffield (8.2), Kingston-on-Hull (8.1) Huddersfield (7.9), Rotherham (7.3), Birmingham (7.1), Barrow-in-Furness (7.0).

Group 3 (those with sub-standard housing incidences [1931] 7 to 4 %): Bradford (6.9), York (6.9), Manchester (6.7), Wolverhampton (6.5), Oldham (6.2), Stockport (5.7), Bristol (5.3), Rochdale (5.2), Worcester (5.1), Bolton (5.0), Grimsby (4.9), Bury (4.6), Smethwick (4.6), Preston (4.5), Brighton (4.4), Burnley (4.2), Coventry (4.2), Nottingham (4.1), Canterbury (4.0), Exeter (4.0), Southampton (4.0).

Group 4 (those with sub-standard housing incidences [1931] of below 4 %): Gloucester (3.9), Hastings (3.8), Lincoln (3.8), Burton-on-Trent (3.7), Great Yarmouth (3.5), Norwich (3.5), Croydon (3.4), Oxford (3.4), Blackburn (3.3), Reading (3.3), Wallasey (3.3), Portsmouth (3.2), Derby (3.1), Bath (2.9), Eastbourne (2.7), Blackpool (2.5), Southport (2.4), Southend-on-Sea (2.3), Ipswich (2.2), Leicester (2.2), Northampton (2.0), Bournemouth (1.5).

TABLE 11.—*Coefficients of Partial Correlation between various Social Conditions (Incidence of Persons on Poor Relief [1930 and 1931-33], Stocks's Social Index [1931], Incidence of Sub-Standard Housing Conditions [1931]) and Mortality from Respiratory Tuberculosis at specified Ages (1931-33) in English County Boroughs.*

Social conditions.		Age-groups.				
Primary variable.	Variable held constant.	0-4.	5-14.	15-24.	25-44.	45 and over.
MALES.						
Poor Relief (1930)	Housing (1931)	+ .271	+ .010	+ .182	+ .064	+ .257
Poor Relief (1931-33)	Housing (1931)	+ .181	- .034	+ .191	+ .099	+ .304
Social Index (1931)	Housing (1931)	+ .155	+ .150	+ .193	+ .079	+ .368
Housing (1931)	Poor Relief (1930)	+ .425	+ .641	+ .488	+ .406	- .064
Housing (1931)	Poor Relief (1931-33)	+ .466	+ .659	+ .506	+ .411	+ .020
Housing (1931)	Social Index (1931)	+ .395	+ .564	+ .422	+ .357	- .104
Housing (1931)	Poor Relief (1931-33) and Social Index (1931)	+ .381	+ .569	+ .409	+ .347	- .132
FEMALES.						
Poor Relief (1930)	Housing (1931)	+ .043	+ .070	+ .100	+ .201	+ .150
Poor Relief (1931-33)	Housing (1931)	+ .013	+ .010	+ .089	+ .160	+ .166
Social Index (1931)	Housing (1931)	- .052	+ .023	+ .351	+ .111	+ .190
Housing (1931)	Poor Relief (1930)	+ .447	+ .617	+ .607	+ .424	+ .158
Housing (1931)	Poor Relief (1931-33)	+ .467	+ .640	+ .624	+ .454	+ .169
Housing (1931)	Social Index (1931)	+ .447	+ .586	+ .491	+ .397	+ .094
Housing (1931)	Poor Relief (1931-33) and Social Index (1931)	+ .441	+ .582	+ .490	+ .383	+ .079

EXPLANATORY NOTES.

Poor Relief (1930 and 1931-33): See Table 6, Notes 1-4.
 Social Index (1931): See Table 6, Notes 8-11.
 Sub-Standard Housing (1931): See Table 6, Notes 8-11.
 Respiratory Tuberculosis (1931-33): See Table 7, Notes.
 English County Boroughs: The 76 selected English county boroughs.
 Coefficient of Partial Correlation: Significant coefficients (more than twice their standard errors) are printed in heavy type.
 Standard Error: See Table 6, Notes. Throughout this table it has the value of $\pm .115$.

TABLE 12.—Coefficients of Regression (b) of Respiratory Tuberculosis Mortality at specified Ages (1911 to 1933) (y) upon Incidence of Sub-Standard Housing Conditions (1911 to 1931) (x) in English County Boroughs.

Dates.	Age-groups.				
	0-4.	5-14.	15-24.	25-44.	45 and over.
MALES.					
1911 and 1911-13	<i>b_{yx}</i>	..	0'54	..	..
1921 and 1921-23	<i>b_{yx}</i>	0'72	0'80	1'30	1'07
1926 and 1926-28	<i>b_{yx}</i>	..	..	3'15	..
1931 and 1931-33	<i>b_{yx}</i>	1'04	0'84	3'67	2'61
FEMALES.					
1911 and 1911-13	<i>b_{yx}</i>	..	1'20	1'27	1'77
1921 and 1921-23	<i>b_{yx}</i>	0'78	1'28	1'23	1'57
1926 and 1926-28	<i>b_{yx}</i>	..	..	3'56	..
1931 and 1931-33	<i>b_{yx}</i>	0'86	1'36	4'35	2'27

EXPLANATORY NOTES.

Respiratory Tuberculosis: See Table 8, Notes.
 Sub-Standard Housing: See *ibid*.
 English County Boroughs: The 76 selected English county boroughs.
 Dates: The first date given refers to housing, and the second to the triennium for respiratory tuberculosis mortality.
b_{yx}: Symbol for coefficient of regression. The latter were derived from those of the corresponding coefficients of correlation given in Table 8 that were regarded as significant.

TABLE 13.—Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1931) (x) and Absolute Rate of Decline in Respiratory Tuberculosis Mortality at specified Ages during the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 (y) in English County Boroughs.

Dates for period of decline.	Age-groups.				
	0-4.	5-14.	15-24.	25-44.	45 and over.
MALES.					
1921-23 to 1931-33	<i>r_{xy}</i>	..	..	..	..
	Mean decline	0'87	0'58	2'01	3'24
FEMALES.					
1911-13 to 1931-33	<i>r_{xy}</i>	..	..	..	..
	Mean decline	..	1'05	0'20	..
1921-23 to 1931-33	<i>r_{xy}</i>	..	..	..	..
	Mean decline	0'63	1'22	0'60	2'14
	Mean Sub-Standard Housing (1931)	..	..	..	7'92

EXPLANATORY NOTES.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Rate of Decline in R.T.M.: Average absolute rate of decline, per annum, in the death-rate from respiratory tuberculosis, per 100,000 living, in each specified age-group, in each borough, during each of the two specified periods: *i. e.* mean annual death-rate for the triennium 1911-13, *minus* that for the triennium 1931-33, divided by 20; and mean annual death-rate for the triennium 1921-23 *minus* that for the triennium 1931-33, divided by 10.

English County Boroughs: The 76 selected English county boroughs.

r_{xy} : See Table 6, Notes. Significant coefficients printed in heavy type.

Standard Error: See *ibid.* It has the value of $\pm \cdot 115$ throughout this table.

Mean Decline: The simple arithmetic average, for all boroughs taken together, of the average absolute rates of decline, calculated per annum, in the mean annual death-rates from respiratory tuberculosis in each specified age-group in the various boroughs, during each of the two specified periods.

Mean Sub-Standard Housing: The simple arithmetic average, for all boroughs taken together, of the returns for the sub-standard housing in the various boroughs at the census, 1931.

TABLE 14.—Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1931) (x) and Percentage-Rate of Decline in Respiratory Tuberculosis Mortality at specified Ages during the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 (y) in English County Boroughs.

Dates for period of decline.	Age-groups.			
	15-24.	25-44.	45 and over.	
MALES.				
1911-13 to 1931-33	$r_{xy} \pm S.E.r$	$-\cdot 431 \pm \cdot 115 (76)$	$-\cdot 388 \pm \cdot 115 (76)$	$-\cdot 044 \pm \cdot 115 (71)$
	Mean Decline	$-\cdot 490 \pm \cdot 137 (54)$	$-\cdot 388 \pm \cdot 115 (76)$	$-\cdot 073 \pm \cdot 119 (72)$
		1·0% (76)	1·7% (76)	1·6% (76)
1921-23 to 1931-33	$r_{xy} \pm S.E.r$	$-\cdot 228 \pm \cdot 115 (76)$	$-\cdot 180 \pm \cdot 115 (76)$	$+\cdot 147 \pm \cdot 115 (71)$
	Mean Decline	$-\cdot 445 \pm \cdot 146 (48)$	$-\cdot 174 \pm \cdot 116 (75)$	$+\cdot 089 \pm \cdot 118 (73)$
		1·5% (76)	1·7% (76)	0·8% (76)
FEMALES.				
1911-13 to 1931-33	$r_{xy} \pm S.E.r$	$-\cdot 353 \pm \cdot 115 (76)$	$-\cdot 318 \pm \cdot 115 (76)$	$+\cdot 070 \pm \cdot 115 (71)$
	Mean Decline	$-\cdot 467 \pm \cdot 134 (57)$	$-\cdot 311 \pm \cdot 116 (75)$	$+\cdot 091 \pm \cdot 140 (52)$
		-0·1% (76)	1·6% (76)	2·2% (76)
1921-23 to 1931-33	$r_{xy} \pm S.E.r$	$-\cdot 368 \pm \cdot 115 (76)$	$-\cdot 155 \pm \cdot 115 (76)$	$-\cdot 180 \pm \cdot 115 (71)$
	Mean Decline	$-\cdot 460 \pm \cdot 131 (59)$	$-\cdot 103 \pm \cdot 117 (74)$	$-\cdot 046 \pm \cdot 147 (47)$
		0·2% (76)	1·6% (76)	2·5% (76)
Mean Sub-Standard Housing (1931)				7·92 (76)

EXPLANATORY NOTES.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Rate of Decline in R.T.M.: Average percentage-rate of decline, per annum, in the death-rate from respiratory tuberculosis, per 100,000 living, in each specified age-group, in each borough, during each of the two specified periods: *i. e.* the difference between the mean annual death-rate for the triennium 1911-13 and that for the triennium 1931-33, divided by 20 and expressed as a percentage of the former; and the difference between the mean annual death-rate for the triennium 1921-23 and that for the triennium 1931-33, divided by 10 and expressed as a percentage of the former.

English County Boroughs: The 76 selected English county boroughs were used for the principal series of correlation coefficients. A second series of correlation coefficients is placed immediately below the principal series. This second series was calculated after excluding those boroughs in which less than 20 deaths from respiratory tuberculosis took place, in the age-group concerned, in the triennium 1911-13 in the case of the period 1911-13 to 1931-33, and in the triennium 1921-23 in the case of the period 1921-23 to 1931-33. In each series the number of boroughs used in the calculation is placed in brackets after the correlation coefficient.

Age-groups: For reasons for omission of age-group 0-4 and 5-14, both sexes, see p. 31.

r_{xy} : See Table 6, Notes. Significant coefficients printed in heavy type.

S.E., (Standard Error): See *ibid.*

Mean Decline: As Table 13, Notes, but percentage, instead of absolute, rates of decline.

Mean Sub-Standard Housing: See Table 13, Notes.

EXPLANATORY NOTES TO TABLE 15.

(FOR TABLE, SEE PAGE 48.)

Rate of Decline in R.T.M.: Average absolute rates of decline, calculated per annum, in the death-rates from respiratory tuberculosis, per 100,000 living, in each specified age-group in each group of boroughs, during each of the two specified periods: *i. e.* simple and weighted arithmetic averages, for each group of boroughs, of the mean annual death-rates for the triennium 1911-13 in the various individual boroughs composing the particular group, *minus* the corresponding averages for the triennium 1931-33 and divided by 20; and simple and weighted arithmetic averages, for each group of boroughs, of the mean annual death-rates for the triennium 1921-23 in the various individual boroughs composing the particular group, *minus* the corresponding averages for the triennium 1931-33 and divided by 10. The figures for "all boro's" were similarly obtained by treating the 76 boroughs as a single group.

The data used in the calculation of the above figures were obtained from Table 10.

Sub-Standard Housing: See Table 6, Notes 8-11.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs: See Table 10, Notes.

TABLE 15.—*Absolute Rate of Decline in Respiratory Tuberculosis Mortality, by Sexes and at certain Ages, during the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 in Four Groups of English County Boroughs arranged in order of their Incidence of Sub-Standard Housing Conditions (1931).*

Dates for period of decline.	Group o Boroughs.	Age-groups.						All ages.
		0-4.	5-14.	15-24.	25-44.	45 and over.		
MALES.								
(Simple arithmetic averages).								
1911-13	1	1.0	0.6	0.3	2.3	3.9	1.4	
	2	1.6	0.7	1.2	3.4	4.3	1.8	
to	3	1.2	0.5	1.6	4.7	5.1	2.5	
	4	1.5	0.6	2.4	4.5	3.6	2.5	
1931-33	all boro's	1.4	0.6	1.4	3.8	4.3	2.1	
1921-23	1	0.8	0.7	0.3	1.9	2.4	1.0	
	2	1.4	0.6	1.9	3.9	1.6	1.5	
to	3	0.9	0.6	2.3	3.4	2.4	1.7	
	4	0.4	0.4	3.1	3.6	1.0	1.5	
1931-33	all boro's	0.8	0.6	2.0	3.3	1.7	1.5	
(Weighted arithmetic averages.)								
1911-13	1	1.2	0.7	0.1	3.6	5.2	1.9	
	2	1.5	0.7	1.3	4.6	5.7	2.5	
to	3	1.4	0.6	1.4	4.7	5.9	2.7	
	4	1.5	0.6	2.2	4.2	3.5	2.2	
1931-33	all boro's	1.4	0.7	1.2	4.3	5.2	2.3	
1921-23	1	1.1	0.6	0.6	3.0	2.2	1.2	
	2	1.0	0.6	1.5	4.8	2.1	1.8	
to	3	1.1	0.5	3.0	3.5	3.0	2.0	
	4	0.7	0.5	2.7	3.3	1.3	1.4	
1931-33	all boro's	1.0	0.6	1.9	3.7	2.2	1.6	
FEMALES.								
(Simple arithmetic averages.)								
1911-13	1	1.5	1.1	-0.9	2.7	2.8	1.5	
	2	1.8	1.5	-0.3	2.4	2.3	1.5	
to	3	1.5	1.1	0.4	2.2	2.8	1.7	
	4	1.2	0.8	1.2	2.3	1.5	1.5	
1931-33	all boro's	1.5	1.1	0.2	2.4	2.3	1.5	
1921-23	1	1.1	1.5	-1.8	1.9	1.3	0.9	
	2	0.6	1.9	1.2	2.8	2.2	1.9	
to	3	0.6	0.9	0.5	1.9	2.2	1.5	
	4	0.3	0.9	2.2	1.9	1.6	1.6	
1931-33	all boro's	0.7	1.2	0.6	2.2	1.8	1.4	
(Weighted arithmetic averages.)								
1911-13	1	1.4	1.4	-0.7	3.2	3.0	1.7	
	2	1.7	1.5	-0.2	2.2	2.6	1.5	
to	3	1.4	1.2	0.1	2.4	2.9	1.7	
	4	1.0	0.8	1.3	2.3	1.6	1.5	
1931-33	all boro's	1.4	1.2	0.1	2.5	2.6	1.6	
1921-23	1	0.9	1.4	-0.2	2.3	1.6	1.3	
	2	0.8	1.8	1.1	2.2	1.7	1.6	
to	3	0.7	1.0	0.9	1.9	2.3	1.5	
	4	0.2	0.9	2.3	2.1	1.7	1.7	
1931-33	all boro's	0.8	1.3	1.0	2.1	1.8	1.5	

TABLE 16.—Percentage-Rate of Decline in Respiratory Tuberculosis Mortality, by Sexes and at certain Ages, during the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 in Four Groups of English County Boroughs arranged in order of their Incidence of Sub-Standard Housing Conditions (1931).

Dates for period of decline.	Group of Boroughs.	Age-groups.						All ages.
		0-4.	5-14.	15-24.	25-44.	45 and over.		
MALES.								
(Simple arithmetic averages)								
1911-13	1	2.6	2.1	0.2	1.1	1.8	1.1	
to	2	3.6	3.0	0.9	1.6	1.6	1.2	
	3	3.8	3.3	1.4	2.2	2.1	1.7	
1931-33	4	4.2	4.0	2.0	2.1	1.9	1.8	
	all boro's	3.6	3.2	1.2	1.8	1.9	1.5	
1921-23	1	3.0	3.2	0.3	1.1	1.4	0.9	
to	2	5.4	4.0	1.6	2.1	0.8	1.2	
	3	5.3	5.5	2.2	2.2	1.4	1.5	
1931-33	4	4.0	5.7	2.9	2.2	0.8	1.5	
	all boro's	4.2	4.6	1.8	2.0	1.2	1.3	
(Weighted arithmetic averages.)								
1911-13	1	2.7	2.4	0.1	1.5	1.9	1.2	
to	2	3.3	3.3	1.1	2.0	1.9	1.6	
	3	3.7	3.2	1.3	2.0	2.1	1.7	
1931-33	4	4.1	4.0	1.8	2.0	1.8	1.6	
	all boro's	3.3	3.1	1.0	1.9	2.0	1.5	
1921-23	1	3.5	3.0	0.4	1.5	1.1	0.9	
to	2	4.0	4.6	1.3	2.5	1.0	1.4	
	3	5.2	4.5	2.6	2.1	1.6	1.6	
1931-33	4	5.4	6.3	2.5	2.1	0.9	1.3	
	all boro's	4.2	4.3	1.6	2.1	1.2	1.3	
FEMALES.								
(Simple arithmetic averages.)								
1911-13	1	3.2	2.9	-0.7	1.6	2.5	1.3	
to	2	4.0	3.4	-0.2	1.6	2.3	1.5	
	3	3.9	3.4	0.3	1.7	2.8	1.7	
1931-33	4	4.0	3.1	1.1	1.8	2.0	1.7	
	all boro's	3.8	3.0	0.2	1.7	2.4	1.6	
1921-23	1	4.1	3.8	-1.4	1.5	2.0	1.0	
to	2	4.0	5.8	0.9	2.3	3.0	2.2	
	3	4.3	4.7	0.4	1.8	3.3	2.0	
1931-33	4	3.3	5.0	2.0	1.9	2.7	2.2	
	all boro's	4.4	4.6	0.5	1.9	2.7	1.8	
(Weighted arithmetic averages.)								
1911-13	1	3.2	2.7	-0.5	1.8	2.5	1.5	
to	2	3.8	3.6	-0.2	1.6	2.5	1.5	
	3	3.7	3.5	0.1	1.7	2.7	1.7	
1931-33	4	3.7	3.0	1.1	1.7	2.1	1.7	
	all boro's	3.6	3.2	0.0	1.7	2.5	1.5	
1921-23	1	3.6	3.8	-0.1	1.7	2.1	1.4	
to	2	4.2	6.2	0.9	1.9	2.4	1.9	
	3	4.1	5.0	0.7	1.7	3.2	1.8	
1931-33	4	2.2	4.7	2.0	1.9	2.7	2.3	
	all boro's	4.2	4.8	0.8	1.8	2.6	1.8	

EXPLANATORY NOTES.

Rate of Decline in R.T.M.: Average percentage-rates of decline, calculated per annum, in the death-rates from respiratory tuberculosis, per 100,000 living, in each specified age-group in each group of boroughs, during each of the two specified periods: *i. e.* the difference between (*a*) the simple and weighted arithmetic averages, for each group of boroughs, of the mean annual death-rates for the triennium 1911-13 in the various individual boroughs composing the particular group and (*b*) the corresponding averages for the triennium 1931-33, divided by 20 and expressed as a percentage of (*a*); and the difference between (*c*) the simple and weighted arithmetic averages, for each group of boroughs, of the mean annual death-rates for the triennium 1921-23 in the various individual boroughs composing the particular group and (*d*) the corresponding averages for the triennium 1931-33, divided by 10 and expressed as a percentage of (*c*). The figures for "all boro's" were obtained similarly by treating the 76 boroughs as a single group.

The data used in the calculation of the above figures were obtained from Table 10.

Sub-Standard Housing: See Table 6, Notes 8-11.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs: See Table 10, Notes.

Chapter 4.—The History of Housing Conditions in the Different English County Boroughs from 1891 to 1931, in Relation to Respiratory Tuberculosis Mortality.

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I. INTRODUCTION.

The analysis made in Chapter 3 of the relationship between respiratory tuberculosis mortality and certain social conditions in the different county boroughs brought out the special importance of housing as an aetiological factor in phthisis. This was particularly evident when the rates of change of mortality among young adults in the different boroughs were compared with the levels of housing conditions prevailing in the same boroughs in 1931.¹ Although the phthisis mortality data for the different boroughs, from which these rates of change were computed, are available only since 1911, the existence as far back as 1891 of housing data of the kind used in Chapter 3 makes it possible to pursue this interesting housing-phthisis relationship further by determining the history of the housing conditions in the different boroughs for the forty-year period, 1891 to 1931. For it might well be that alterations in a local condition such as housing would exert delayed effects upon local phthisis that would only become apparent after such an extended examination.

This further extension of the examination of the housing-phthisis relationship has been carried out in two directions: (A) by considering the levels of housing conditions in the various boroughs—both absolutely and relatively to one another—in the earlier as well as in the latter part of this forty-year period; and (B) by comparing, for the different boroughs, the rates of change in housing conditions

¹ Although only the 1931 housing data were used for this comparison, the high degree of correlation ($+0.961 \pm .115$; Table 6, No. 12) between sub-standard housing incidence in 1911 and that in 1931 showed that no essential difference in results would be obtained were the 1911 housing figures to be used instead.

over this lengthened period with the rates of change in phthisis mortality previously examined in Chapter 3.

II. MATERIALS, SOURCES AND METHODS.

The same 76 county boroughs were used as in Chapter 3. Their statistics for the incidence of sub-standard housing conditions were carried back to 1891, the earliest year for which this type of return is obtainable. In order to render the series of housing data properly comparable from 1891 to 1931, a considerable recalculation of the census material was needed (1) to allow for the lack of uniformity in the housing questionnaires in successive censuses, and (2) to correct as far as possible for changes in the boundaries of the boroughs that have taken place from time to time over this forty-year period. In this recalculation it was necessary to reduce the housing statistics for all five censuses to the uniform basis of families occupying less than five rooms apiece, and to make these statistics applicable to the areas of the boroughs as they existed in 1931.

Fuller details of materials and methods are given in the Appendix.

III. ANALYSIS OF RESULTS.

A. *Local Housing Conditions in the Different English County Boroughs from 1891 to 1931.*

The high degree of the correlation (+.961) found in Chapter 3 between the incidence of sub-standard housing conditions in the 76 boroughs in 1911 and that in 1931 was found to continue (+.868) when the comparison was extended by correlating the incidence in 1891 with that in 1931, though both sets of figures used in this latter correlation necessarily apply only to families that occupied less than five rooms. These high correlations demonstrate that the 1931 ranging of the boroughs according to their level of housing was much the same at least forty years before, the relative positions of the various boroughs having shown little change during the intervening period.

To trace conveniently the numerical course of housing conditions back to 1891, the 76 boroughs were separated into four groups on the basis of their sub-standard housing incidences in 1931, and the simple arithmetic average of the figures for the individual members of each group at a given census year was taken to represent the sub-standard housing incidence of the particular group at that date. For the sake of continuity with the preceding chapter the composition of the four groups used in that chapter (see Notes to Table 10) was retained (even though that grouping was based upon housing statistics applying to families occupying any number of rooms). The results are shown in Table 17 and in Chart 5.

Examination of Table 17 and Chart 5 brings out the following points:

(1) When Group 1, the worst-housed in 1931, is traced backwards to 1891, it is seen to have had a much higher sub-standard housing incidence than had any of the other three groups. Each of the latter has

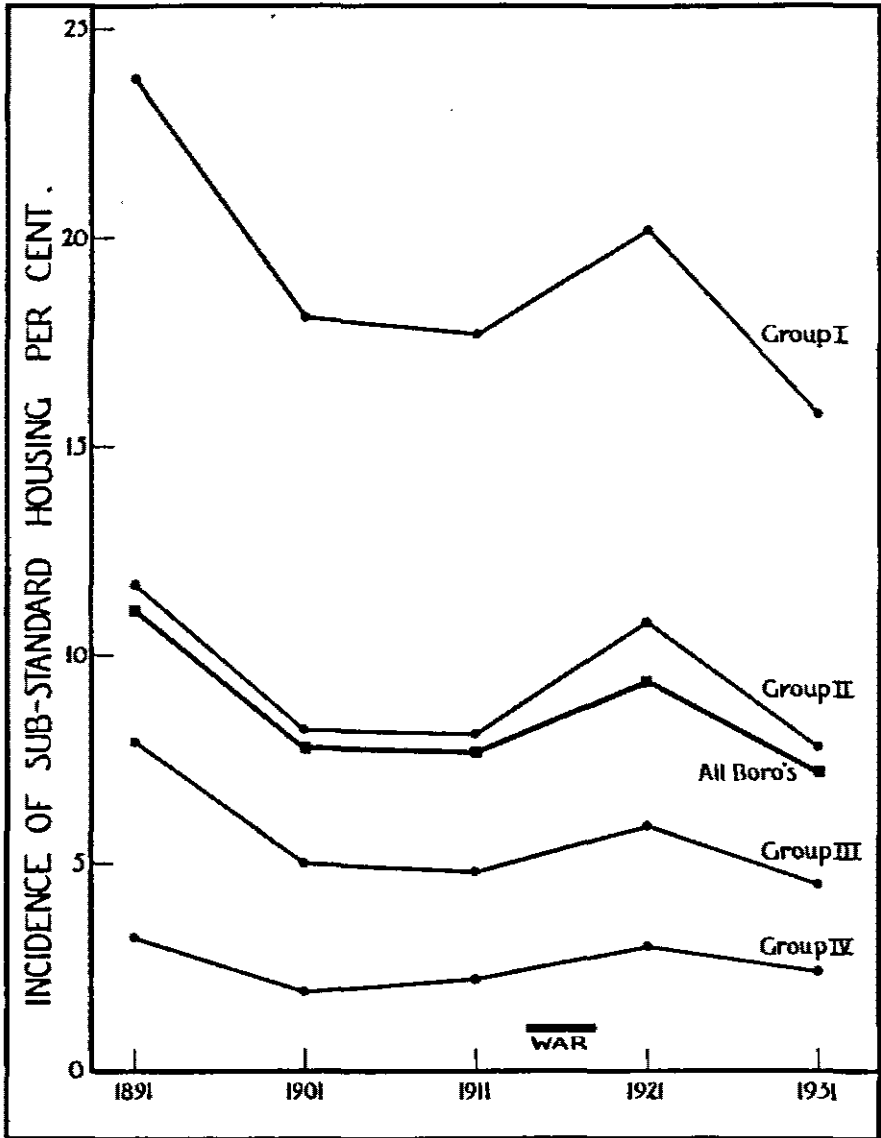


CHART 5.—Incidence of Sub-Standard Housing Conditions (Percentage of the Population living more than Two Persons per Room) at the Census Dates from 1891 to 1931 in Four Groups of English County Boroughs, the Grouping being determined by the 1931 Sub-Standard Housing Incidences. (Data taken from Table 17.)

similarly maintained its relative position during the entire forty years. Furthermore, an inspection of the records of the individual boroughs showed that the majority of them had followed closely the course of the group into which they fell in 1931. Thus of the 18 in Group 1, 13 are included in the worst-housed 18 boroughs in 1891, while of the 22 in Group 4, 17 are included in the best-housed 22 boroughs in 1891.

These results confirm the high correlations between sub-standard housing in 1891, 1911 and 1931 (see above) in showing that the relative positions, as to housing conditions, of the boroughs in 1931, whether relatively favourable or unfavourable, have for the most part continued little changed since at least 1891.

(2) Some improvement in housing took place in each of the four groups over the forty-year period, 1891 to 1931, taken as a whole; and the average percentage-rate of decline in sub-standard housing incidence (34, 33, 43 and 25% respectively) did not differ significantly from one group to another, and was thus unrelated to the actual level of housing conditions.¹ When, however, the period was subdivided into its four component decades, it can be seen that the course followed by each group was very different from one decade to the next. From 1891 to 1901 each showed considerable improvement. Between 1901 and 1911 this improvement came to a standstill, while between 1911 and 1921, which included the war period, considerable deterioration took place. After 1921 the improvement was resumed, but even by 1931 the conditions in each of the groups was little, if at all, better than they had been in 1911 or 1901.

The similarity in the rates of change in the housing conditions of the different borough groups between 1891 and 1931, taken in conjunction with the maintenance of the relative positions both of these groups and of the large majority of individual boroughs (see (1)), shows that the levels of housing conditions in the different boroughs in 1931 provide a very fair indication, *relatively*, of the levels throughout the entire forty-year period, (although the actual figures have fluctuated considerably, with a general tendency to improvement).

(3) In spite of the improvements noted above, it can be seen that housing conditions in Group 1 in 1931 were still at a worse level than those in any other group in 1891, while conversely, housing conditions in Group 4 in 1891 were even then better than those in any other group in 1931.

(4) There appears to be no reason to believe that, had the figures (indicated in the table by brackets) for families inhabiting accommodation of all sizes been available for 1891 and 1901, the above conclusions would have required any serious modification.

These results have an important bearing on certain conclusions in Chapter 3.

In the first place, it is clear that the levels of housing conditions in the different county boroughs in 1931 provide a very fair indication of those existing during the previous forty years. Although, there has been some variation in the extent of improvement, in the level of housing conditions among the various boroughs, their housing conditions *relative to one another* have kept fairly constant at

¹ Confirmation of the fact that the rate of change in housing conditions in the different boroughs was independent of the actual level of these conditions was obtained by comparing, by correlation, the percentage-rates of reduction in local sub-standard housing incidence in the 76 boroughs during the period of forty years with their actual sub-standard housing incidences in 1931. The coefficient so calculated had the insignificant value of $+ .020 \pm .115$.

successive census dates. This shows that the finding in Chapter 3 of an inverse relationship between the rate of decline in phthisis mortality between 1911 and 1933 amongst young adults in the different county boroughs and the local incidence of sub-standard housing conditions in 1931 would almost certainly have been repeated had the housing data of any of the previous four censuses been used instead.

In the second place, it is evident that Group 1 has maintained its relatively unfavourable position throughout the forty years; indeed, even by 1931 its improvement had been insufficient to bring its sub-standard housing incidence to a lower average value than that of any of the better groups in 1891. This adds importance to the conclusion in Chapter 3 that the small percentage-rate of decline in phthisis mortality over the period from 1911 to 1933 among young adults, as compared with other age-groups, in the entire 76 county boroughs taken together, is more especially the result of the peculiarly unfavourable mortality experience of this age-group in the boroughs whose housing has been particularly unsatisfactory—because their unsatisfactory condition is shown to have been continuously present at least since the end of the last century.

B. *Comparison of Changes in Housing Conditions with those in Respiratory Tuberculosis Mortality.*

The probable importance of the *actual* level of housing conditions in the different county boroughs during the past forty years in determining the recent local trends in respiratory tuberculosis mortality among young adults has been pointed out in the preceding subsection. It is now desirable to consider whether the differing *rates of change* in the level of housing conditions in the various boroughs in the period under survey were also a factor in affecting these trends. A direct comparison was therefore made between the local rates of change in housing conditions and the local rates of change in respiratory tuberculosis mortality.

The percentage-rate of reduction in sub-standard housing incidence from 1891 to 1931 was first compared, by correlation, with the percentage-rate of decline in respiratory tuberculosis mortality in the age-group 15 to 24 from 1911-13 to 1931-33. Those of the 76 boroughs that had less than twenty deaths from this disease in the triennium 1911-13 were excluded, leaving fifty-four boroughs in the case of males, and fifty-seven in the case of females (*cf.* Table 14). An insignificant coefficient ($+ \cdot 020 \pm \cdot 137$) was found for males, while for females the coefficient ($+ \cdot 302 \pm \cdot 134$) was moderately significant. Similar comparisons for the age-groups 25 to 44 and 45 and over gave insignificant coefficients for both sexes (males, $+ \cdot 082$ and $+ \cdot 099$; females, $+ \cdot 036$ and $+ \cdot 111$).

Since it seemed possible that any such relationship between the

local percentage-rate of change in housing conditions and that in phthisis mortality might not be demonstrable over the whole range of boroughs, a second comparison was made using only those boroughs that had particularly bad housing, and in which large variations in percentage-rates of improvement between 1891 and 1931 might therefore be accepted as indicating definitely divergent trends in this social factor. For this purpose all the 24 boroughs were taken that had sub-standard housing incidences of over 8% in 1911—the middle year of the housing period under examination. Each of these boroughs was placed in one or other of two sub-groups according to whether its sub-standard housing incidence fell between 1891 and 1931 by less or more than 40% of the initial value. Average percentage-rates of decline in respiratory tuberculosis mortality during the period 1911-13 to 1931-33 among males and females aged 15 to 24 years were calculated for each of these two roughly equal sub-groups. The results are shown in Table 18.

It may be seen from Table 18 that the boroughs with the greater improvement in housing show also the greater decline in respiratory tuberculosis mortality, for both males and females, and as judged both by simple and by weighted averages.

Since the number of boroughs used in this calculation was small, the significance of the differences in mortality found between the two sub-groups was assessed by the "t" test (see Fisher, 1936). The means for the two sub-groups compared were calculated from the percentage-rates of decline in mortality of the individual boroughs of each sub-group, after excluding boroughs that had less than twenty phthisis deaths in 1911-13. (This left 9 out of 12, and 11 out of 12, for males, and 8 out of 12, and 12 out of 12, for females.) As shown by this test, the differences were moderately significant, P being 0.02 for males, and between 0.02 and 0.01 for females.

Similar comparisons made for "diseases other than respiratory tuberculosis" (see Chapter 5) gave insignificant differences in mortality decline between the same two sub-groups, P being between 0.6 and 0.5 for males, and between 0.1 and 0.05 for females.

It seems probable, therefore, that gross local differences in the rate of improvement of housing conditions, at least among the worse-housed areas, have had an appreciable influence in determining the particular trends pursued in the various county boroughs by the respiratory tuberculosis mortality of young adults.

IV. SUMMARY OF CHAPTER 4.

1. The proportions of persons living under sub-standard housing conditions in the English county boroughs have been traced back to 1891. Comparability has been obtained, so far as possible, by re-calculating data from the various censuses, making allowance for changes in the boundaries of the boroughs and for changes in the form of the questionnaire.

2. The statistical data thus obtained show that for all boroughs taken together the housing improvement occurring between 1891 and 1901 was not continued in the present century until after the war. Since 1921 the improvement has been resumed, though even by 1931 the sub-standard housing incidences in most English county boroughs was little better than in 1911 or in 1901.

3. While the proportion of persons living under sub-standard housing conditions has decreased in most boroughs since 1891, the relative positions of these boroughs, when placed in order of goodness or badness of housing, have not changed materially over the forty years of this period.

4. When a group of 24 ill-housed boroughs is divided into two sub-groups according to whether the boroughs have shown substantial or slight improvements in their local housing conditions since 1891, it is found that the rate of improvement in respiratory tuberculosis mortality among young men and women has been significantly greater in the former than in the latter sub-group of places.

TABLES TO CHAPTER 4.

TABLE 17.—*Incidence of Sub-Standard Housing Conditions from 1891 to 1931 in Four Groups of English County Boroughs arranged in order of their 1931 Incidences.*

Boroughs.	1891.	1901.	1911.	1921.	1931.
Group 1	23·8	18·1	17·7 (19·2)	20·2 (21·5)	15·8 (16·8)
Group 2	11·7	8·2	8·1 (9·5)	10·8 (12·1)	7·8 (8·5)
Group 3	7·9	5·0	4·8 (5·9)	5·9 (6·8)	4·5 (5·1)
Group 4	3·2	1·9	2·2 (3·0)	3·0 (4·0)	2·4 (3·0)
All Boroughs	11·1	7·8	7·7 (8·9)	9·4 (10·5)	7·2 (7·9)

EXPLANATORY NOTES.

Sub-Standard Housing: Percentage-incidence measured upon the basis of the "more than two persons per room" census density standard. The main figures apply only to those families that occupied *less than five rooms* (for full definition and sources, see Appendix, pp. 153-4). The bracketed figures apply to families that occupied *any number of rooms* (for full definition and sources, see Appendix, pp. 146-8); such figures are not obtainable before 1911.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs: The four groups are constituted as in Table 10, the boroughs being grouped according to their 1931 sub-standard housing incidences applying to families that occupied *any number of rooms*. The housing figures for each group at each date are the simple arithmetic averages of the figures for the individual component boroughs. The figures for "All Boroughs" were obtained similarly by treating the 76 boroughs as a single group.

TABLE 18.—Percentage-Rate of Decline in Respiratory Tuberculosis Mortality, in the Age-Group 15 to 24, during the period 1911-13 to 1931-33 in Two Sub-Groups of English County Boroughs having the Highest Sub-Standard Housing Incidences in 1911, the Sub-Grouping being determined by the Rate of Improvement in Housing between 1891 and 1931.

	Sub-Groups of Boroughs.							
	Greater improvement in housing (12 boroughs).				Lesser improvement in housing (12 boroughs).			
	Respiratory Tuberculosis Mortality.		Rate of decline in R.T.M.		Respiratory Tuberculosis Mortality.		Rate of decline in R.T.M.	
	1911-13.	1931-33.	(Simple arithmetic average.)		1911-13.	1931-33.	(Weighted arithmetic average.)	
Males	127	98	1.15	..	126	135	0.35	..
Females	129	133	0.15	..	141	162	0.75	..
Males	129	101	1.10	..	135	143	0.30	..
Females	139	131	0.30	..	138	160	0.80	..

EXPLANATORY NOTES.

Respiratory Tuberculosis Mortality: Death-rates from respiratory tuberculosis, per 100,000 living, in the age-group 15 to 24, in the two sub-groups of boroughs; the rates computed for each sub-group of boroughs being simple and weighted arithmetic averages of the mean annual death-rates for the triennia 1911-13 and 1931-33 in the various individual boroughs composing the particular sub-group.

Rate of Decline in R.T.M.: Average percentage-rates of decline, calculated per annum, in the death-rates from respiratory tuberculosis, per 100,000 living, during the period 1911-13 to 1931-33; *i. e.* the difference, for each sub-group of boroughs, between the R.T.M. for 1911-13 and that for 1931-33, divided by 20 and expressed as a percentage of the former.

Sub-Standard Housing: Incidence measured upon the basis of the "more than two persons per room" census density standard, the figures applying only to those families that occupied less than five rooms.

County Boroughs: 24 of the 76 selected English county boroughs. These 24 boroughs were those with sub-standard housing incidences in 1911 of over 8%.

Sub-groups of Boroughs: "Greater improvement in housing" (those with reductions in sub-standard housing incidence between 1891 and 1931 of 40% or more). Twelve boroughs, *i. e.* Bradford, Carlisle, Darlington, Dewsbury, Dudley, Halifax, Huddersfield, Leeds, Newcastle-on-Tyne, Plymouth, Wakefield and Wigan.

"Lesser improvement in housing" (those with reductions in sub-standard housing incidence between 1891 and 1931 of less than 40%). Twelve boroughs, *i. e.* Gateshead, Liverpool, Middlesbrough, St. Helens, Salford, South Shields, Sunderland, Tynemouth, Warrington, West Bromwich, West Ham and West Hartlepool.

Chapter 5.—Mortality from “Diseases other than Respiratory Tuberculosis” in England and Wales and in the Different English County Boroughs, in Comparison with Mortality from Respiratory Tuberculosis.

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I. INTRODUCTION.

The four preceding chapters of this report have been concerned with mortality from respiratory tuberculosis. The importance of the results described there depends to a considerable extent upon how far they are peculiar to this disease. It is therefore necessary to ascertain whether analysis of the mortality figures of other diseases leads to similar or to different results. For this purpose two possible sets of figures must be considered, namely, the death-rates from all causes excluding respiratory tuberculosis, and the death-rates from all causes excluding both respiratory tuberculosis and violence. On account of the large proportion of deaths among young adults that results from violence, the second set of figures has been chosen as the more useful for the present purpose, and will be referred to in the text of this chapter as the mortality from “diseases other than phthisis”.

The present chapter thus serves as a control for the preceding chapters; the more important of the observations previously made with respiratory tuberculosis being here compared, table by table, with those obtained by essentially similar methods from analysis of the data for diseases other than phthisis.

It should be pointed out that the use of this method of control, always a stringent one, becomes particularly so with the younger age-groups, among which the deaths due to diseases other than phthisis in this country are largely respiratory in character, and thus resemble phthisis in that closeness of personal contact may also be expected to play some part in their production.

II. MATERIALS, SOURCES AND METHODS.

Sub-section III of this chapter corresponds to Chapter 1, the area investigated being England and Wales, and the period from 1850 to 1936. Sub-section IV of this chapter corresponds to Chapter 3, the

areas investigated being the same 76 English county boroughs, and the period similarly from 1911 to 1933. The mortalities from diseases other than phthisis in the various areas were calculated in the same way as those in the corresponding series of respiratory tuberculosis in Chapters 1 and 3, identical populations being used. The data for social conditions in the county boroughs, and the statistical methods used for comparing them with mortalities, were the same as those used in Chapter 3.

Fuller details of materials and methods are given in the Appendix.

III. THE DECLINE IN MORTALITY FROM DISEASES OTHER THAN RESPIRATORY TUBERCULOSIS IN ENGLAND AND WALES FROM 1851 TO 1936.

The mortalities from diseases other than phthisis from 1851 to 1936 in England and Wales as a whole are set out, by sexes and ages, in Table 19, and the figures for certain age-groups are also shown on semi-logarithmic scale in Chart 6. For males and females between 5 and 44 years of age, this table and chart are thus comparable with Table 1 and Chart 1 respectively.

Comparison of the series of data in these two tables and charts brings out the following points:

(1) The check in the decline in mortality among young adults, aged 15 to 24, that was apparent for respiratory tuberculosis is little if at all shown for other diseases. The contrast is especially evident in the case of young women, whose mortality from respiratory tuberculosis was almost stationary from 1903 to 1913 and showed no net fall from 1913 to 1933, but whose mortality from other diseases fell substantially during both these periods.

(2) Unlike the mortality from respiratory tuberculosis, the mortality from other diseases among young adults has at no time during the present century pursued a definitely less favourable course than has the corresponding mortalities among persons of other ages.

(3) The rise in mortality during the war period that was apparent for respiratory tuberculosis in the age-groups for which data are available is also strikingly shown for other diseases taken together; but the proportion of the increase that occurred in the year 1918 is considerably greater, the excessive deaths of that year being mainly the result of the influenza pandemic.

IV. MORTALITY FROM DISEASES OTHER THAN RESPIRATORY TUBERCULOSIS IN THE DIFFERENT ENGLISH COUNTY BOROUGHS BETWEEN 1911 AND 1933, IN RELATION TO CERTAIN LOCAL SOCIAL CONDITIONS.

In Table 20 are set out the simple correlation coefficients between the mortalities at various ages from diseases other than phthisis in the county boroughs during 1931-33 and the returns for certain social conditions at roughly the same dates. This table is thus complementary

with Table 7, which was concerned with respiratory tuberculosis and the same social factors.

An examination of the two tables together brings out the following points:

(1) The correlations between mortality from diseases other than phthisis and both social index and sub-standard housing show a general similarity

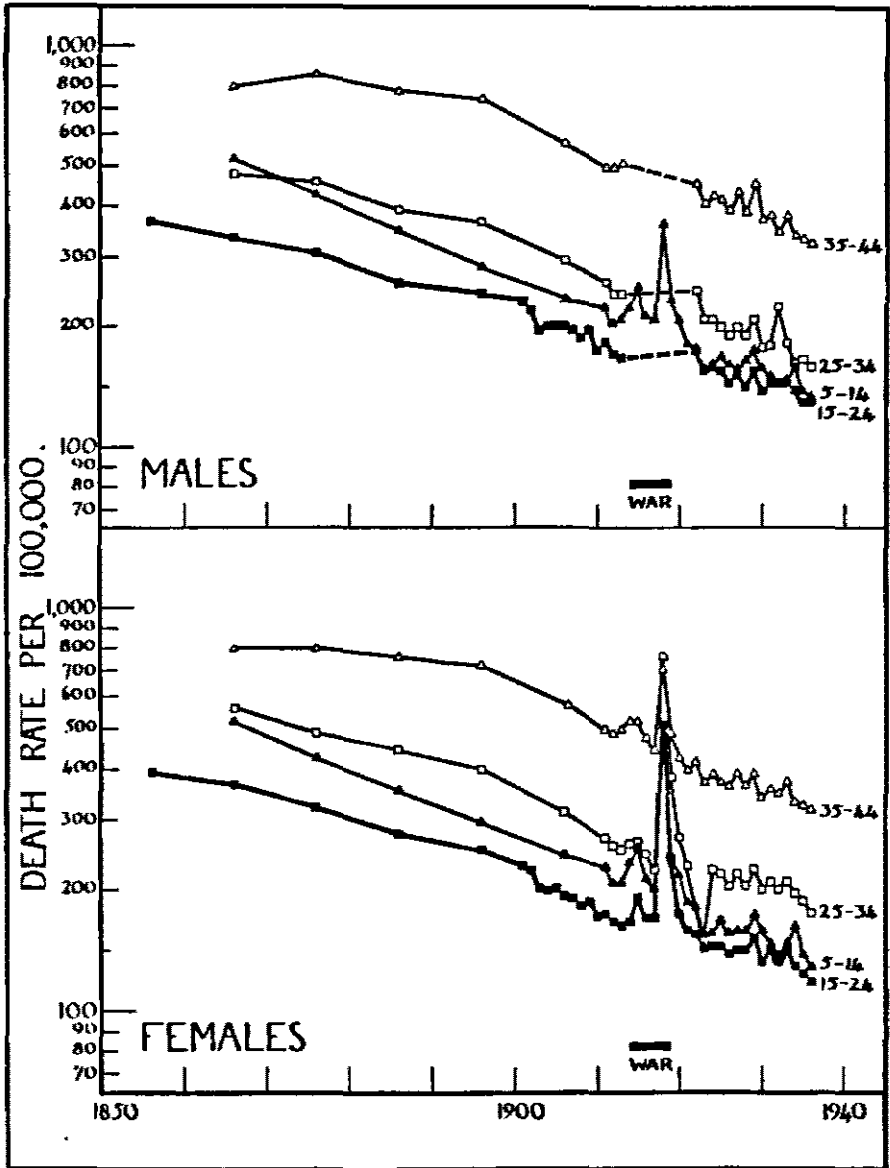


CHART 6.—The Mortality from "Diseases other than Respiratory Tuberculosis", by Sexes and in certain Age-Groups, during the period 1851 to 1936 in England and Wales (semi-logarithmic scale). (Data taken from Table 19.)

with the corresponding phthisis correlations in being positive and significant and of much the same value, in almost all the age-groups. The correlations between diseases other than phthisis and poor relief also resemble the corresponding phthisis correlations in being nearly all positive, but differ from them in being significant only in infants of both sexes and in young women.

(2) As was found for phthisis, the coefficients of correlation of disease other than phthisis with poor relief are smaller than those with the other two social factors. For diseases other than phthisis the social index and housing correlation coefficients are about equal, whereas for phthisis the housing correlation coefficients are the larger.

These results show that the general relationship between the local level of poverty, as measured by these social data, and the level of mortality from diseases other than phthisis in the various county boroughs is of much the same order as that between poverty and respiratory tuberculosis.

As a check on the correlations of housing with diseases other than phthisis among young adults, the supplementary method of calculating group-averages of mortality was also used. The boroughs were arranged, according to their incidence of sub-standard housing conditions in 1931, into the same four groups as in Chapter 3 (see Table 10, Notes), and the mortality (simple and weighted arithmetic averages) for males and females aged 15 to 24 years was calculated for each group of boroughs for 1931-33, and also for earlier triennia. Examination of Table 21, in which the results are shown, supports for the triennium 1931-33 the relationship for this particular age-group between the local sub-standard housing and diseases other than phthisis, which was shown in Table 20 by the method of correlation. For the earlier triennia the relationship is also evident, though for 1911-13, weighted arithmetic averages, it is less marked than at other dates.

In order to extend the comparisons of the present chapter with those of Chapter 3, coefficients of partial correlation were calculated between the various social data and mortality from diseases other than phthisis at different ages. The results are set out in Table 22 which should be compared with Table 11, the corresponding table for phthisis. The following points may be noted:

(1) The correlations between mortality from diseases other than phthisis and poor relief, housing held constant, and between this mortality and housing, poor relief held constant, are both substantially similar to the corresponding correlations for phthisis, the first being insignificant, the second significant, for almost all age-groups.

(2) The correlations between diseases other than phthisis and the social index, housing held constant, retain their significance for nearly all age-groups, whereas the corresponding phthisis-social index partial correlations, although positive, are nearly all insignificant. The correlations between diseases other than phthisis and housing, social index held constant, show a general similarity with the corresponding phthisis-housing partial correlations, although the values of the coefficients are mostly lower.

On the whole, therefore, while there is general similarity between the two series of partial correlations in Tables 11 and 22, there is a tendency for diseases other than phthisis to be more associated than phthisis with social index, and less than the latter with housing.

In order to pursue the comparison with respiratory tuberculosis, coefficients of regression of mortality on housing were derived from the significant correlation coefficients of Table 22, and are set out in Table 23. These results form a marked contrast to those for phthisis for the same triennium, 1931-33 (Table 12). The regression coefficients of phthisis mortality on housing were found to have their maximal value in the age-group 15 to 24 years, both sexes, whereas for all other diseases taken together the regression coefficients have their minimal value in this age-group. There is, therefore, no evidence from regression coefficients that young adults have been especially "sensitive" to housing conditions, as regards their mortality from diseases other than phthisis, in the sense suggested for their phthisis mortality in Chapter 3.

One of the most important comparisons made in Chapter 3 was that between the *rate of decline* of phthisis mortality, at different ages, over the twenty years from 1911 to 1933, in the different county boroughs, and the local incidence of sub-standard housing conditions in 1931. A strong inverse relationship was shown, both by correlation and by group-averages, for males and females aged 15 to 24 years. In Table 24 are set out the complementary correlation coefficients between (*y*) percentage-rate of decline, per annum, in mortality from diseases other than phthisis, in the age-group 15 to 24 years, over the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 and (*x*) local sub-standard housing incidence in 1931, in the county boroughs. Those of the 76 boroughs in which less than twenty deaths from diseases other than phthisis were recorded for the first triennium of the period concerned were excluded from these correlations (*cf.* Chapter 3, p. 31). It may be noted from the table that the correlation coefficients are all negative, suggesting the presence of a small association. They are, however, consistently lower than those in the corresponding table for phthisis (Table 14, second series), and contrast strongly with the latter in their degrees of significance.

As a supplement to the correlations of Table 24, a similar comparison was made using group-averages of mortality, the four groups of boroughs being the same as before. The results are given in Table 25. No definite inverse relationship is shown between the local sub-standard housing incidence and percentage-rate of decline in mortality from diseases other than phthisis among young men and women in the different county boroughs. This finding is in contrast to that in the corresponding table for phthisis mortality, Table 16, where such relationship was well-marked.

V. DISCUSSION.

From the observations upon England and Wales in this chapter, it is evident that the mortality from "diseases other than phthisis" has not shown the same retardation in rate of decline among young adults as phthisis itself has shown. Only during the limited period of the war, 1914-1918, was the downward course of mortality interrupted, and during that period all the age-groups for which data are presented were affected.

From the detailed observations upon county boroughs, mortality from diseases other than phthisis and mortality from phthisis itself show certain similarities and certain important differences.

The two mortalities resemble one another in their general relationship with local poverty in the different county boroughs, as shown by the comparison of mortality levels with the three local social measures; though the finding (from partial correlation) that the association of diseases other than phthisis with housing is less clearly, and with social index more clearly, shown than is the case with phthisis perhaps suggests that of the various factors in poverty, closeness of personal contact is more important ætiologically in phthisis than in the composite collection of other diseases taken as a whole.

Mortality from diseases other than phthisis and mortality from phthisis differ, however, in that the recent rate of decline of the former among young adults in the different county boroughs does not show the same strong inverse relationship with the local incidence of sub-standard housing conditions that is shown by the corresponding rate of decline of the latter disease. From this difference, as well as possibly from the two contrasting series of coefficients of regression, it may be concluded that the mortality from diseases other than phthisis shows no definite evidence of the closer relationship with housing conditions among young adults, as compared with the population as a whole, that is shown for phthisis. The evidence given in Chapter 3 that suggested a special sensitivity of young adults to housing conditions, as regards their mortality from respiratory tuberculosis, has, therefore, not been found in the present chapter for mortality from all other diseases taken together.

VI. SUMMARY OF CHAPTER 5.

1. The trend in the mortality in England and Wales from "diseases other than respiratory tuberculosis" has been compared with that from respiratory tuberculosis.

2. The retardation in the present century in the decline in mortality from respiratory tuberculosis among young men and women that has been noted in Chapter 1 is little, if at all, shown for all other diseases taken together. Only during the war has there been any serious interruption in the steady decline in the latter mortality for young adults or for any other age-group.

3. The main comparisons made in Chapter 3 between certain local social conditions and respiratory tuberculosis mortality in the different county boroughs have been repeated in the present chapter for all other diseases taken together.

4. As with respiratory tuberculosis, the mortality in the different boroughs from diseases other than respiratory tuberculosis in 1931-33 has been found to be related at most ages and in both sexes with the three social measures—poor relief incidence, social index and sub-standard housing incidence.

5. The partial correlations calculated between diseases other than respiratory tuberculosis and the three social measures in the county boroughs show a general similarity with those previously found for respiratory tuberculosis. The association of housing with diseases other than respiratory tuberculosis is, however, less clear than it was with the latter disease, so suggesting that of the various components of poverty, closeness of personal contact is perhaps more important in the ætiology of respiratory tuberculosis than in that of all other diseases taken as a whole.

6. The inverse relationship between the sub-standard housing incidences in the various county boroughs and the different rates of improvement of their young adult mortalities from 1911 to 1933 that has been shown for respiratory tuberculosis is much less strong for all other diseases taken together. From this difference it is suggested that young adults do not possess the same sensitiveness to housing conditions as regards the composite group of "diseases other than respiratory tuberculosis" that they appear to show for respiratory tuberculosis itself.

TABLES TO CHAPTER 5.

TABLE 19.—*Mortality from Diseases other than Respiratory Tuberculosis, per 100,000 living, by Sex and Age, during the period 1851 to 1936 in England and Wales. (Compare Table 1.)*

Years.	Age-groups.			
	5-14.	15-24.	25-34.	35-44.
	MALES.			
1851-60	...	362	...	...
1861-70	522	332	475	802
1871-80	430	303	462	841
1881-90	345	254	392	772
1891-00	281	239	364	735
1901-10	235	199	262	579
1901	...	227	...	...
1902	...	219	...	...
1903	...	196	...	...
1904	...	198	...	...
1905	...	198	...	...
1906	...	201	...	...
1907	...	196	...	...
1908	...	188	...	...
1909	...	194	...	...
1910	...	175	...	...
1911	226	181	257	506
1912	203	169	239	500
1913	208	166	241	509
1914	226	...	...	...
1915	250	...	...	...
1916	215	...	...	...
1917	209	...	...	...
1918	376	...	...	...
1919	233	...	...	...
1920	210	...	...	...
1921	183	...	...	...
1922	177	176	247	460
1923	160	157	210	411
1924	161	159	207	425
1925	169	155	198	413
1926	161	144	189	394
1927	160	151	200	433
1928	166	143	190	387
1929	176	156	210	458
1930	159	137	178	373
1931	152	146	180	383
1932	145	145	172	347
1933	148	145	183	384
1934	159	138	164	338
1935	138	129	165	333
1936	136	129	157	325

Sources :

1851-1910.	Registrar-General (1851-1910).
1901-1910.	" (1901-10), Census (1911 f7).
1911-1914.	" (1911-14).
1915-1920.	" (1915-20).
1921-1930.	" (1921-30).
1931-1936.	" (1931-36).

TABLE 19—(cont.).

Years.	Age-groups.			
	5-14.	15-24.	25-34.	35-44.
			FEMALES.	
1851-60	...	391	...	...
1861-70	525	362	519	797
1871-80	425	320	492	801
1881-90	357	277	444	764
1891-00	295	250	402	725
1901-10	246	198	313	578
1901	...	227	...	...
1902	...	225	...	...
1903	...	202	...	...
1904	...	198	...	...
1905	...	202	...	...
1906	...	193	...	...
1907	...	192	...	...
1908	...	183	...	...
1909	...	186	...	...
1910	...	172	...	...
1911	229	175	267	504
1912	211	167	255	494
1913	211	164	251	505
1914	234	167	260	520
1915	254	182	262	520
1916	213	171	246	475
1917	202	169	226	444
1918	414	511	761	701
1919	239	241	377	488
1920	219	174	269	423
1921	185	160	227	402
1922	184	155	257	419
1923	156	143	215	375
1924	157	146	224	391
1925	168	146	217	374
1926	157	138	212	367
1927	158	140	218	386
1928	159	140	205	364
1929	173	150	223	393
1930	158	131	201	337
1931	148	141	209	353
1932	139	133	200	347
1933	147	141	207	373
1934	163	130	196	330
1935	137	124	188	324
1936	128	118	180	319

EXPLANATORY NOTES.

Mortality from Diseases other than Respiratory Tuberculosis: For the period 1851 to 1920 the deaths are those from all causes *less* those recorded under categories 28 and 29A, and categories 155-186, of the International List of Causes of Death for 1911; for the period 1921 to 1930 the deaths are those from all causes *less* those recorded under category 31, and categories 165-203, of the International List for 1921; and for the period 1931 to 1936 the deaths are those from all causes *less* those recorded under category 23, and categories 163-198, of the International List for 1931. Categories 28 and 29A, 31, and 23, of these three International Lists, respectively, are co-extensive; they comprise tuberculosis of the respiratory system and exclude acute miliary tuberculosis. Categories 155-186, 165-203, and 163-198, of the three International Lists, respectively, are also co-extensive; they comprise violence (including suicide). (See Registrar-General, 1911*b*, 1921*b*, 1931*b*.)

TABLE 20.—Correlation Coefficients (r) between various Social Conditions (Incidence of Persons on Poor Relief [1931-33], Stocks's Social Index [1931], Incidence of Sub-Standard Housing [1931]) (x) and Mortality from Diseases other than Respiratory Tuberculosis at specified Ages (1931-33) (y) in English County Boroughs. (Compare Table 7.)

Social conditions.		Age-groups.				
		0-4.	5-14.	15-24.	25-44.	45 and over
MALES.						
Poor Relief (1931-33)	r_{xy}	+·385	+·188	+·163	+·169	-·177
Social Index (1931)	r_{xy}	+·688	+·446	+·475	+·527	+·078
Sub-Standard Housing (1931)	r_{xy}	+·681	+·491	+·476	+·560	+·084
Mean O.D.M. (1931-33)		2243	167	162	317	3214
FEMALES.						
Poor Relief (1931-33)	r_{xy}	+·406	+·171	+·244	+·186	-·098
Social Index (1931)	r_{xy}	+·689	+·374	+·577	+·628	+·119
Sub-Standard Housing (1931)	r_{xy}	+·720	+·347	+·529	+·474	+·038
Mean O.D.M. (1931-33)		1778	163	142	306	2835
Mean Poor Relief (1931-33)						326
Mean Social Index (1931)						358
Mean Sub-Standard Housing (1931)						7·92

EXPLANATORY NOTES.

Poor Relief (1931-33): See Table 6, Notes 1-4.

Social Index (1931): See Table 6, Notes 8-11.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Diseases other than Respiratory Tuberculosis (1931-33): Death-rate from diseases other than respiratory tuberculosis, per 100,000 living, in each specified age-group in each borough; mean annual death-rate for the triennium 1931-33.

English County Boroughs: The 76 selected English county boroughs.

r_{xy} : See Table 6, Notes. Significant coefficients printed in heavy type.

Standard Error: See *ibid.* Throughout this table it has the value of ± 0.115 .

Mean O.D.M.: The simple arithmetic average, for all boroughs taken together, of the mean annual death-rates from diseases other than respiratory tuberculosis in the various boroughs.

Mean Poor Relief: The simple arithmetic average, for all boroughs taken together, of the means of the returns for the twelve quarters March, 1931 to December, 1933, in the various boroughs.

Mean Social Index: The simple arithmetic average, for all boroughs taken together, of the value of Stocks's Social Index, 1931.

Mean Sub-Standard Housing: The simple arithmetic average, for all boroughs taken together, of the returns for the sub-standard housing in the various boroughs at the census, 1931.

TABLE 21.—*Mortality from Diseases other than Respiratory Tuberculosis (1911 to 1933), by Sexes and at certain Ages, in Four Groups of English County Boroughs arranged in order of their Incidence of Sub-Standard Housing Conditions (1931). (Compare Table 10.)*

Dates for O.D.M.	Group of Boroughs.	MALES.			FEMALES.		
		15-24.		All ages.	15-24.		All ages.
		S.A.A.	W.A.A.	W.A.A.	S.A.A.	W.A.A.	W.A.A.
1911-13	1	231	224		210	202	
	2	197	188		195	177	
	3	190	201		179	190	
	4	175	179		143	147	
	All boro's	196	200	1445	179	181	1286
1916-18	1	(260)	(266)		329	333	
	2	(250)	(245)		323	307	
	3	(220)	(218)		299	303	
	4	(182)	(190)		251	253	
	All boro's	(225)	(233)	1426	297	302	1302
1921-23	1	208	209		180	180	
	3	206	192		160	158	
	2	186	189		151	160	
	4	157	158		127	130	
	All boro's	186	190	1237	153	159	1100
1926-28	1	197	199		184	178	
	2	174	182		164	154	
	3	168	173		145	147	
	4	146	142		118	121	
	All boro's	170	177	1208	150	152	1073
1931-33	1	185	180		173	168	
	2	171	166		152	142	
	3	156	159		132	142	
	4	143	139		119	116	
	All boro's	162	163	1227	142	144	1108

EXPLANATORY NOTES.

Diseases other than Respiratory Tuberculosis: Death-rates from diseases other than respiratory tuberculosis, per 100,000 living, in each specified age-group in each group of boroughs; the rates computed for each group of boroughs being simple arithmetic averages (S.A.A.) and weighted arithmetic averages (W.A.A.) of the mean annual death-rates for the triennia 1911-13, 1916-18, 1921-23, 1926-28 and 1931-33 in the various individual boroughs composing the particular group. The figures for "all boro's" were obtained similarly by treating the 76 boroughs as a single group.

Sub-Standard Housing: See Table 6, Notes 8-11.

Dates for O.D.M.: The dates refer to the triennia for mortality from diseases other than respiratory tuberculosis.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs: See Table 10, Notes.

TABLE 22.—*Coefficients of Partial Correlation between various Social Conditions (Incidence of Persons on Poor Relief [1931-33], Stocks's Social Index [1931], Incidence of Sub-Standard Housing Conditions [1931]) and Mortality from Diseases other than Respiratory Tuberculosis at specified Ages (1931-33) in English County Boroughs. (Compare Table 11.)*

Social conditions.		Age-groups.				
Primary variable.	Variable held constant.	0-4.	5-14.	15-24.	25-44.	45 and over.
MALES.						
Poor Relief (1931-33)	Housing (1931)	+·209	+·016	-·008	-·039	-·223
Social Index (1931)	Housing (1931)	+·499	+·232	+·282	+·306	+·037
Housing (1931)	Poor Relief (1931-33)	+·630	+·462	+·453	+·543	+·160
Housing (1931)	Social Index (1931)	+·485	+·322	+·284	+·372	+·048
Housing (1931)	Poor Relief (1931-33) and Social Index (1931)	+·477	+·328	+·296	+·390	+·083
FEMALES.						
Poor Relief (1931-33)	Housing (1931)	+·230	+·055	+·071	+·021	-·119
Social Index (1931)	Housing (1931)	+·490	+·229	+·396	+·495	+·118
Housing (1931)	Poor Relief (1931-33)	+·674	+·310	+·487	+·444	+·078
Housing (1931)	Social Index (1931)	+·550	+·175	+·298	+·181	-·036
Housing (1931)	Poor Relief (1931-33) and Social Index (1931)	+·541	+·177	+·304	+·204	-·014

EXPLANATORY NOTES.

Poor Relief (1931-33): See Table 6, Notes 1-4.

Social Index (1931): See Table 6, Notes 8-11.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Diseases other than Respiratory Tuberculosis (1931-33): See Table 20, Notes.

English County Boroughs: The 76 selected English county boroughs.

Coefficient of Partial Correlation: Significant coefficients (more than twice their standard errors) printed in heavy type.

Standard Error: See Table 6, Notes. Throughout this table it has the value of $\pm \cdot 115$.

TABLE 23.—*Coefficients of Regression (b) of Mortality from Diseases other than Respiratory Tuberculosis at specified Ages (1931-33) (y) upon Incidence of Sub-Standard Housing Conditions (1931) (x) in English County Boroughs. (Compare Table 12.)*

		Age-groups.				
		0-4.	5-14.	15-24.	25-44.	45 and over.
MALES.						
b_{yx}		71	4	3	5	...
FEMALES.						
b_{yx}		56	3	3	4	...

EXPLANATORY NOTES.

Diseases other than Respiratory Tuberculosis (1931-33): See Table 20, Notes.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

English County Boroughs: The 76 selected English county boroughs.

b_{yx} : Symbol for coefficient of regression. The latter were derived from those of the corresponding coefficients of correlation given in Table 20 that were regarded as significant.

TABLE 24.—Correlation Coefficients (*r*) between Incidence of Sub-Standard Housing Conditions (1931) (*x*) and Percentage-Rate of Decline in Mortality from Diseases other than Respiratory Tuberculosis in the Age-Group 15 to 24 during the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 (*y*) in English County Boroughs. (Compare Table 14.)

Dates for period of decline.	MALES.		FEMALES.	
	$r_{xy} \pm S.E._r$		$r_{xy} \pm S.E._r$	
1911-13 to 1931-33	$r_{xy} \pm S.E._r$	$-.210 \pm .122 (68)$	$-.167 \pm .121 (69)$	
1921-23 to 1931-33	$r_{xy} \pm S.E._r$	$-.209 \pm .121 (69)$	$-.080 \pm .122 (68)$	

EXPLANATORY NOTES.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Rate of Decline in Mortality from Diseases other than Respiratory Tuberculosis: Average percentage-rate of decline, obtained in the same way as for respiratory tuberculosis in Table 14.

English County Boroughs: The 76 selected English county boroughs, after excluding those boroughs in which less than twenty deaths from diseases other than respiratory tuberculosis took place, in the age-group 15 to 24, in the triennium 1911-13 in the case of the period 1911-13 to 1931-33, and in 1921-23 in the case of the period 1921-23 to 1931-33. The number of boroughs used in each calculation is placed in brackets after the correlation coefficient.

r_{xy} : See Table 6, Notes. None of the coefficients is significant.

S.E._r (Standard Error): See *ibid*.

TABLE 25.—Percentage-Rate of Decline in Mortality from Diseases other than Respiratory Tuberculosis, by Sexes and at certain Ages, during the periods 1911-13 to 1931-33 and 1921-23 to 1931-33 in Four Groups of English County Boroughs arranged in order of their Incidence of Sub-Standard Housing Conditions (1931). (Compare Table 16.)

Dates for period of decline.	Group of Boroughs.	MALES.			FEMALES.		
		15-24.		All ages.	15-24.		All ages.
		S.A.A.	W.A.A.	W.A.A.	S.A.A.	W.A.A.	W.A.A.
1911-13	1	1.0	1.0		0.9	0.8	
	2	0.7	0.6		1.1	1.0	
	3	0.9	1.0		1.3	1.3	
	4	0.9	1.1		0.8	1.1	
1931-33	all boro's	0.9	0.9	0.8	1.0	1.0	0.7
1921-23	1	1.1	1.4		0.4	0.7	
	2	1.7	1.4		0.5	1.0	
	3	1.6	1.6		1.3	1.1	
	4	0.9	1.2		0.6	1.1	
1931-33	all boro's	1.3	1.4	0.1	0.7	1.0	-0.1

EXPLANATORY NOTES.

Rate of Decline in Mortality from Diseases other than Respiratory Tuberculosis: Average percentage-rates of decline per annum obtained in the same way as for respiratory tuberculosis in Table 16. The data used in the calculation of the figures were obtained from Table 21.

Sub-Standard Housing: See Table 6, Notes 8-11.

County Boroughs: The 76 selected English county boroughs.

Groups of Boroughs: See Table 10, Notes.

Chapter 6.—The Effect of Internal Migration upon the Relationship between Respiratory Tuberculosis Mortality of Young Women and Certain Social Conditions in the Different English County Boroughs.

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I. INTRODUCTION.

So far in this report the recorded mortalities in the county boroughs, and their variations both in time and in place, have been taken at their face value. A number of authorities have, however, pointed out that such figures are liable to additional variations of an artificial nature as between one district and another in consequence of migration. On the supposition that migrants are mainly physically select persons, unlikely to die of disease while still within their age-group, a considerable loss of persons from a district would have the effect of artificially causing a rise in the local mortality figure for that age-group, while a gain of persons would distort the figure correspondingly in the opposite direction. Such rises and falls in mortalities might prove misleading when studying the health of local communities in relation to environmental conditions.

In his valuable study of the recent trend of respiratory tuberculosis mortalities among young adults of both sexes, Bradford Hill (1936) has examined, in the light of this supposition, the differences in decline in death-rates recorded for various county boroughs. His main finding is a strong correlation between the declines in respiratory tuberculosis mortality between 1921 and 1931 among males and females at ages 15 to 24 in 28 representative county boroughs and the varying proportions of the population at all ages of the same sex lost or gained by migration by these towns (these proportions being assumed to indicate adequately the movements of their young adults).

Accepting the assumption that such young migrants have been physically select, Bradford Hill considers this relationship to be in part, at least, directly causal, resulting from the above-mentioned artificial effects of loss or gain of population by migration upon local death-rates; though he is prepared to regard it also as partly an

indirect association resulting from the dependence both of death-rates and of migration upon local social and economic conditions.¹

Lewis-Faning (1937), in a preliminary account of his Ministry of Health Report (1938) upon the effects of the recent economic depression upon health, has gone further than Bradford Hill in concluding in favour of the view that "the increase in the rate of mortality from tuberculosis among females in Merthyr Tydfil is due to emigration of healthy young adult females between ages 15 and 24, with the result that on the average the weaker lives are left behind and the death-rate increases".

So great is the importance of assessing the effect of migration itself in producing local differences in the decline in respiratory tuberculosis mortality among young adults that the present chapter is devoted to a reconsideration of certain findings of Chapters 3 and 5, concerning the influence of housing conditions both upon respiratory tuberculosis and upon "diseases other than respiratory tuberculosis".

II. MATERIALS, SOURCES AND METHODS.

Two methods seem available for assessing the effects of migration.

The first is to apply the method of partial correlation in order to attempt to separate the influence of local migration from that of local housing. From calculations on such lines Stocks (1936) has concluded that "at least half of the correlation (found by Bradford Hill) between migration and fall in the phthisis death-rate arises from the even greater negative correlation between fall in phthisis death-rates and bad economic conditions as evidenced by overcrowding, while the other half may well be due to selective migration of the fitter elements of the population".

The use of the method of partial correlation, however, seems unsatisfactory, since, while it takes into account the actual amount of migration, it necessarily excludes consideration of the relative mortalities of migrants and non-migrants (*i. e.* the degree of the physical superiority assumed). The difference between these two mortalities must determine the importance of the influence of migration itself on the differing rates of change of respiratory tuberculosis mortality from one borough to another. For as the mortality of the migrants approaches that of the non-migrants or stationary population, so the importance of migration as a direct causative factor in producing the local differences recorded for the various boroughs must inevitably diminish, until, in the event of such physical superiority being non-existent, it would disappear altogether, even though local changes in phthisis mortality might be closely correlated with local migration and the amount of the migration might be large.

¹ The correlation coefficient between incidence of sub-standard housing conditions in 1931 and net immigration-rate for females aged 15 to 24 from 1921 to 1931, in 59 county boroughs (see Table 26, Explanatory Note to Coefficient No. 4), is $-.537 \pm .131$.

In view of these disadvantages it was decided to adopt an alternative method of treatment. For each county borough, in both 1921 and 1931, a computation was made of the population at ages 15 to 24 that would have been resident there had no migration occurred during the previous decade. Such populations are subsequently referred to as "native" populations. This computation was made by using the generation or diagonal method (see Greenwood, 1936).

Taking 1921 for example, in each borough the number of persons in the generation aged 5 to 14 in 1911 (from 1911 census), less the total deaths from all causes occurring in this generation between 1911 and 1921, forms the native population aged 15 to 24 in 1921; and the difference between this figure and the actual 1921 census population in the age-group 15 to 24 represents the net migration of this generation between 1911 and 1921.

With the aid of such native populations for 1921 and 1931, together with the registered deaths at ages 15 to 24 from respiratory tuberculosis for 1921-23 and 1931-33, "native" death-rates were calculated for these two triennia. This procedure provides the extreme instance of physical superiority among migrants, the latter being assumed to have had *no* deaths from respiratory tuberculosis during the triennia 1921-23 or 1931-33. Since the insusceptibility of migrants to tuberculosis must be relative rather than absolute, it seemed desirable to recalculate a second series of native death-rates on the supposition that migrants suffered from *half* the respiratory tuberculosis mortality of the particular triennium among the non-migrants in the borough that they were entering or leaving.¹

The selection of the fraction one-half was not entirely arbitrary, but was based upon the assumption that migration took place uniformly throughout the decade, and that five or six years represented a generous estimate of the *average* expectation of life for clinically recognizable cases of pulmonary tuberculosis of this age.

The native death-rates for the county boroughs so obtained for the two triennia, 1921-23 and 1931-33, as well as the percentage changes over this decade, were correlated with the incidence of sub-standard housing conditions. The resulting relationships were compared with those shown in Chapters 3 and 5, where the death-rates used had not been subjected to any such adjustment, *i. e.* where the mortality of any migrating persons was assumed to be the same as that of the non-migrant population of the same borough.

¹ In the case of boroughs that had lost young men or women by migration in the previous decade, the mortality among the non-migrants was the same as the mortality recorded for the borough, *i. e.* the registered deaths rated upon the census population. In the case of boroughs that had gained by migration the non-migrant and the recorded mortalities necessarily differed, but the latter was used in preference to the former in estimating the deaths of migrants and so calculating the native death-rates, since much less computation was required and the error resulting was negligible.

Owing to the difficulty of ascertaining the migration of males between 1911 and 1921 (see Bradford Hill, 1925, p. 78), an essential requirement for the method of treatment outlined above, the present analysis has necessarily been restricted to young women.

Fuller details of the materials, sources and methods of treatment used in this chapter are given in the Appendix.

III. ANALYSIS OF RESULTS.

In Table 26 are set out the correlation coefficients between sub-standard housing incidence and respiratory tuberculosis mortality of young women in the county boroughs for 1921 (Nos. 1 and 2) and for 1931 (Nos. 3, 4 and 5).

Considering 1931 first, Coefficient No. 3, taken from Table 8 of Chapter 3, is based on recorded death-rates, *i.e.* before any adjustment for migration. Coefficient No. 4 also is unadjusted, but differs from No. 3 in being restricted, for purpose of comparability, to the same collection of 59 boroughs as (for reasons see Notes to Table 26) were used in the calculation of Coefficient No. 5. (It will be noted that in spite of this reduction in the number of boroughs used, Coefficient No. 4 has almost the same value as No. 3.)

Coefficient No. 5, the most important in this table, differs from Nos. 3 and 4 in that in its calculation "native" death-rates were used. These native death-rates were derived after adjustment for migration on the more extreme assumption that the migrants had suffered no mortality.

A comparison of these three coefficients shows that the high correlation previously noted in Chapter 3 between sub-standard housing incidence and respiratory tuberculosis mortality of young women continues, though at a reduced figure, after this stringent adjustment for the possible effects of migration has been made.

Coefficients Nos. 1 and 2, based similarly on recorded and "native" death-rates, afford a similar comparison for 1921; Coefficient No. 1 again being taken from Table 8. The reduction previously observed between No. 3 and No. 5 is also shown between Nos. 1 and 2, but in this instance the adjustment has reduced the original coefficient, which was already smaller in value than that for 1931, to insignificance.

In Table 27 are set out the correlation coefficients between the percentage-rate of decline in respiratory tuberculosis mortality of young women over the period 1921-23 to 1931-33 and the sub-standard housing incidence in 1931 in the county boroughs. Coefficients Nos. 1 and 2 are taken directly from Table 14 of Chapter 3, where the recorded death-rates (*i.e.* making no adjustment for migration) were used. Coefficient No. 3 also is unadjusted, but differs from Nos. 1 and 2 in being restricted, for purpose of

comparability, to the same 41 boroughs as (for reasons see Notes to Table 27) were used in the calculation of Coefficients Nos. 4 and 5.

Coefficients Nos. 4 and 5 are the most interesting in this table. They differ from No. 3, which was derived from the same 41 boroughs, in that "native" death-rates were used in their calculation. These death-rates had been derived by adjustment: for Coefficient No. 4 on the extreme assumption that the migrants had suffered no mortality, and for No. 5 on the less rigorous assumption that the mortality of the migrants had been half the recorded mortality for the borough concerned.

A comparison of these coefficients shows that the significant correlation noted in Chapter 3 between sub-standard housing incidence and rate of decline in respiratory tuberculosis mortality continues after both degrees of adjustment have been made, though after the more stringent of the two adjustments the coefficient has only a slightly significant value.

The supplementary method of arranging the boroughs in four groups according to their sub-standard housing incidence in 1931, which supported and amplified the correlation coefficients used in Chapter 3, has again been employed in the present chapter, but using the mortalities obtained after the more severe adjustment for migration. In Table 28, Part I, the simple and weighted arithmetic averages for the respiratory tuberculosis mortality in 1921-23 and 1931-33 are shown for each borough group (*cf.* Table 10), while in Part II the percentage-rates of decline in mortality between these dates are similarly set out (*cf.* Table 16).

Examination of both Parts I and II of Table 28 shows that the results by the method of group-averages agree with those derived by correlation and given in Tables 26 and 27. The figures in Part II are further noteworthy in that the rise between 1921 and 1931 in the mortality in Group 1, the worst-housed group of boroughs (see Table 16), still persists in spite of the stringent migration test applied.

The results of the above comparisons between housing and respiratory tuberculosis mortality were controlled by calculating corresponding figures for diseases other than respiratory tuberculosis, after similar adjustment for migration, just as Chapter 3 was previously controlled by Chapter 5. The figures are shown in Tables 29 and 30. In Table 29 it can be seen that the adjusted coefficient (No. 3) is reduced below the unadjusted coefficients (Nos. 1 and 2) in much the same way as for respiratory tuberculosis mortality (Table 26, Nos. 3, 4 and 5), though in the present case the adjusted coefficient is barely significant. The important control figures of Table 30, on the other hand, show that this stringent adjustment for migration fails to render significant the correlation between housing and the rate of decline in mortality from other diseases. Thus the contrast between the findings for respiratory tuberculosis and those for "diseases other than respiratory tuberculosis", which was

noted in Chapter 5, is still maintained, as can be seen by comparing Table 27 with Table 30.

IV. DISCUSSION.

The present chapter is an attempt to ascertain how far the conclusions of Chapters 3 and 5 upon the relationship between the recent mortality experience of young women in different county boroughs and the local housing conditions require modification in view of the possible distorting effects of internal migration.

Recalculation of much of the mortality data, making allowance for contemporary migration on the assumption that young persons who migrate have been in the main a physically superior group, appears to leave the chief conclusions of those chapters substantially undisturbed. Thus it is possible to reassert the relationships, for young women in the different county boroughs, between the levels of housing conditions in 1931 and (1) the local levels of their mortality in 1931-33, both from respiratory tuberculosis and from diseases other than respiratory tuberculosis, and (2) the local rates of decline in their mortality over the period 1921-23 to 1931-33, from respiratory tuberculosis, but not from diseases other than respiratory tuberculosis. Furthermore, the important observation that during the period 1921-23 to 1931-33 the respiratory tuberculosis mortality for young women living in the worst-housed group of boroughs has failed to decline also survives this stringent test.

Although the relationships previously found in Chapters 3 and 5 have been upheld, the effect of adjusting for migration has been to reduce their significance. The amount of this reduction has, of course, varied according to the mortality arbitrarily assigned to the supposedly physically superior young migrants, though the significance does not disappear even on the more severe test of assuming this mortality to be *nil*.

It would seem, therefore, that, *if the assumption that migration has been mainly confined to the fitter elements of the young adult population be correct*, migration is a factor of some importance in producing the local differences in level and recent rate of decline of respiratory tuberculosis mortality among young women in the county boroughs; but that, *whatever the physical superiority of the migrants*, migration will only partly account for these local mortality differences, the local level of social conditions remaining an important causative factor. Furthermore, the less the respiratory tuberculosis mortality of the migrants differs from that of the non-migrants, the smaller must be the influence of migration upon the local death-rates, and the more clearly does the association with local social conditions emerge.

The relative importance to be ascribed to migration on the one hand, and to local social conditions on the other, in bringing about

the local differences in respiratory tuberculosis mortality is thus dependent upon how far the assumption of physical superiority among migrants be carried. The assumption of a physical superiority of this kind has been largely derived from studying movements in rural populations from which the attractions of town life are believed to draw the more active and healthy (see Bradford Hill, 1925, 1936). On the other hand, the movements of population between one town and another, which must enter largely into the present problem, almost certainly include a somewhat different type of migrant—the workless young adult in search of better economic conditions than are offered by his or her native place.

Though the selection of any particular fractional mortality for migrants is difficult, it is suggested that in view of these considerations the arbitrary value of one-half that of the stationary population perhaps represents the actual position more correctly, and is therefore a fairer test, than is the extreme procedure of assuming the mortality of these young persons from phthisis, or from diseases other than phthisis, as the case may be, to be *nil*.

The present treatment of the problem of the effect of migration upon death-rates has differed substantially from that of Bradford Hill (1936). In the first place, the data used here for the calculation of migration have been more completely restricted to the age-generation of young adults. Bradford Hill, on the other hand, in most of his calculations, used the figures for males and females of all ages, regarding such movements as adequately indicating those of young adults of the same sex. The present migration estimates for young women provide an opportunity for testing this belief, and for this purpose the migration-rate for females of all ages in the 26 representative county boroughs, as given in his Table XIV, has been correlated with that for young women of the same places. The resulting coefficient has the high figure of $\pm .800$, so justifying Bradford Hill's belief. In the second place, Bradford Hill has restricted his comparisons to correlations between migration rates and rates of decline in mortality, whereas the present treatment, by the use of "native" death-rates (derived by adjustment on various assumptions as to the relative health and mortality of migrants), has allowed the simultaneous examination of the effects upon respiratory tuberculosis death-rates both of migration and of local social conditions.

It does not seem possible at the present time to go further in assessing the relative importance of local social conditions and of internal migration in affecting the differential trends of mortality among young adults in county boroughs, nor will it be so until a satisfactory comparison of the health of migrating and stationary populations is obtained by *ad hoc* studies.

V. SUMMARY OF CHAPTER 6.

1. The view that internal migration produces distorting effects on local recorded mortalities in county boroughs is discussed. Such distortions will arise for respiratory tuberculosis mortality if migrants, as a class, are selectively healthy as regards this disease. Loss of such healthy persons from a borough would artificially raise its recorded death-rate, while conversely a gain would lower this rate.

2. A method is described for computing for each county borough the populations of young women that would have been resident there in 1921 and in 1931 had no migration of their *generations* to or from the borough taken place during the previous decades. On the basis of these "native" populations, and with various assumptions as to the relative healthiness of the migrants, corresponding "native" death-rates from respiratory tuberculosis and from "diseases other than respiratory tuberculosis" have been computed for young women for the triennia 1921-23 and 1931-33.

3. The main comparisons between local housing and mortalities that were made in Chapters 3 and 5, using recorded death-rates, have been made afresh with these computed "native" death-rates. It is concluded that, if the assumption be correct that migration of young women has been mainly confined to the more healthy, internal migration is a factor of some importance in producing the local differences in level and recent rate of decline in respiratory tuberculosis mortality for that age-group in the county boroughs. Nevertheless, whatever be the degree of healthiness of these migrants, internal migration can only partly account for these local mortality differences, and the local level of social conditions must remain an important factor.

TABLES TO CHAPTER 6.

TABLE 26.—*Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1921 and 1931) (x) and Mortality from Respiratory Tuberculosis among Females in the Age-Group 15 to 24 (1921-23 and 1931-33) (y) in English County Boroughs, before and after making Adjustments for Migration. (Compare Table 8.)*

No.	Date for housing.	Dates for R.T.M.	$r_{xy} + S.E._{r_{xy}}$	Number of Boroughs.
1	1921	1921-23	$\left\{ \begin{array}{l} +.293 \pm .115 \\ \text{(unadjusted)} \end{array} \right\}$	76
2	1921	1921-23	$\left\{ \begin{array}{l} +.179 \pm .131 \\ \text{(adjusted)} \end{array} \right\}$	59
3	1931	1931-33	$\left\{ \begin{array}{l} +.663 \pm .115 \\ \text{(unadjusted)} \end{array} \right\}$	76
4	1931	1931-33	$\left\{ \begin{array}{l} +.648 \pm .131 \\ \text{(unadjusted)} \end{array} \right\}$	59
5	1931	1931-33	$\left\{ \begin{array}{l} +.477 \pm .131 \\ \text{(adjusted)} \end{array} \right\}$	59

EXPLANATORY NOTES.

Sub-Standard Housing (1921 and 1931): See Table 8, Notes.

Respiratory Tuberculosis: Recorded and "native" death-rates from respiratory tuberculosis, per 100,000 living, in each borough; mean annual death-rates for each of the triennia, 1921-23 and 1931-33. In calculating Coefficients Nos. 1, 3 and 4 the death-rates were unadjusted for migration (recorded death-rates), while in calculating Nos. 2 and 5 they were adjusted for migration on the assumption that the mortality of the migrants was *nil* ("native" death-rates).

English County Boroughs: The 76 selected English county boroughs were used for Coefficients Nos. 1 and 3. Nos. 2, 4 and 5 were calculated after excluding (a) those boroughs with changes of boundary between 1911 and 1921 (No. 2) or between 1921 and 1931 (Nos. 4 and 5) involving more than 2% of the total population, and (b) those boroughs with large proportions of summer visitors included in the 1921 census owing to the latter being held in the summer in that year (Nos. 2, 4 and 5).

r_{xy} : See Table 6, Notes. Significant coefficients (exceeding twice their standard errors) are printed in heavy type.

S.E., (Standard Error): See *ibid.*

TABLE 27.—Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1931) (x) and Percentage-Rate of Decline in Respiratory Tuberculosis Mortality among Females in the Age-Group 15 to 24 during the period 1921-23 to 1931-33 (y) in English County Boroughs, before and after making Adjustments for Migration. (Compare Table 14.)

No.	$r_{xy} \pm S.E., r$	Number of Boroughs.
1	$-.368 \pm .115$ (unadjusted)	76
2	$-.460 \pm .131$ (unadjusted)	59
3	$-.462 \pm .158$ (unadjusted)	41
4	$-.327 \pm .158$ (adjusted)	41
5	$-.404 \pm .158$ (adjusted)	41

EXPLANATORY NOTES.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Rate of Decline in R.T.M.: Average percentage-rate of decline, per annum, in the death-rate from respiratory tuberculosis, per 100,000 living, in each borough during the period 1921-23 to 1931-33; i.e. the difference between the mean annual death-rate for the triennium 1921-23 and that for the triennium 1931-33, divided by ten and expressed as a percentage of the former. In calculating Coefficients Nos. 1, 2 and 3 the death-rates for 1921-23 and 1931-33 were unadjusted for migration (recorded death-rates); in No. 4 they were adjusted for migration on the assumption that the mortality of the migrants was *nil* ("native" death-rates); in No. 5 they were adjusted on the basis that the mortality of the migrants was half that recorded in the borough concerned (also "native" death-rates).

English County Boroughs: The 76 selected English county boroughs were used for Coefficient No. 1. Nos. 2, 3, 4 and 5 were calculated after excluding those boroughs in which less than 20 deaths from respiratory tuberculosis took place among females aged 15 to 24 in the triennium 1921-23; and Nos. 3, 4 and 5 were calculated after the further exclusion of (a) those boroughs with changes of boundary between 1911 and 1921 or between 1921 and 1931 involving more than 2% of the total population, and (b) those boroughs with large proportions of summer visitors included in the 1921 census owing to the latter being held in the summer in that year.

r_{xy} : See Table 6, Notes. Significant coefficients are printed in heavy type.

S.E. (Standard Error): See *ibid.*

TABLE 28.—*Respiratory Tuberculosis Mortality in 1921-23 and 1931-33 (I), and Percentage-Rate of Decline in Respiratory Tuberculosis Mortality during the period 1921-23 to 1931-33 (II), among Females in the Age-Group 15 to 24 in Four Groups of English County Boroughs arranged in order of their Incidence of Sub-Standard Housing Conditions (1931), after making Adjustment for Migration. (Compare Tables 10 and 16.)*

Dates for R.T.M.	Group of Boroughs.	(I)	
		Simple arithmetic average.	Weighted arithmetic average.
1921-23	1 .	131	146
	2 .	144	137
	3 .	125	142
	4 .	126	133
	all boro's .	132	140
1931-33	1 .	142	147
	2 .	123	127
	3 .	118	130
	4 .	104	110
	all boro's .	122	131
Rate of decline in R.T.M.		(II)	
1921-23	1 .	-0.9	-0.1
to	2 .	1.5	0.8
	3 .	0.6	0.8
	4 .	1.7	1.7
1931-33	all boro's .	0.7	0.7

EXPLANATORY NOTES.

Respiratory Tuberculosis Mortality: "Native" death-rates from respiratory tuberculosis, per 100,000 living, in each group of boroughs; the rates computed for each group being simple and weighted arithmetic averages of the mean annual death-rates for the triennia 1921-23 and 1931-33 in the various individual boroughs composing the particular group. These death-rates were adjusted for migration on the assumption that the mortality of the migrants was *nil*.

Rate of Decline in Respiratory Tuberculosis Mortality: Average percentage-rates of decline, per annum, obtained directly from the data in (I) above.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

County Boroughs: The 76 selected English county boroughs, after excluding (a) and (b) as in Table 27, Notes. This left 50 boroughs.

Groups of Boroughs: The method of grouping was that used in Tables 10 and 16. The boroughs excluded were: Group 1, Sunderland, Middlesbrough, Stoke-on-Trent, Carlisle, Plymouth; Group 2, Darlington, Sheffield; Group 3, Wolverhampton, Stockport, Worcester, Grimsby, Smethwick, Brighton, Coventry, Exeter, Southampton; Group 4, Hastings, Lincoln, Great Yarmouth, Oxford, Wallasey, Eastbourne, Blackpool, Southport, Southend-on-Sea, Bournemouth.

TABLE 29.—*Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1931) (x) and Mortality from Diseases other than Respiratory Tuberculosis among Females in the Age-Group 15 to 24 (1931-33) (y) in English County Boroughs, before and after making Adjustment for Migration. (Compare Tables 20 and 26.)*

No.	$r_{xy} \pm S.E._r$	Number of Boroughs.
1	$\left\{ \begin{array}{l} +.529 \pm .115 \\ \text{(unadjusted)} \end{array} \right\}$	76
2	$\left\{ \begin{array}{l} +.466 \pm .131 \\ \text{(unadjusted)} \end{array} \right\}$	59
3	$\left\{ \begin{array}{l} +.266 \pm .131 \\ \text{(adjusted)} \end{array} \right\}$	59

EXPLANATORY NOTES.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Mortality from Diseases other than Respiratory Tuberculosis: Recorded and "native" death-rates from diseases other than respiratory tuberculosis, per 100,000 living, in each borough; mean annual death-rates for the triennium 1931-33. In calculating Coefficients Nos. 1 and 2 the death-rates were unadjusted for migration (recorded death-rates), while in No. 3 they were adjusted for migration on the assumption that the mortality of the migrants was *nil* ("native" death-rates).

English County Boroughs: The 76 selected English county boroughs were used for Coefficient No. 1. Nos. 2 and 3 were calculated after excluding the same boroughs as in the case of Table 26, Coefficients Nos. 4 and 5.

r_{xy} : See Table 6, Notes. Significant coefficients printed in heavy type.

$S.E._r$ (Standard Error): See *ibid.*

TABLE 30.—Correlation Coefficients (r) between Incidence of Sub-Standard Housing Conditions (1931) (x) and Percentage-Rate of Decline in Mortality from Diseases other than Respiratory Tuberculosis among Females in the Age-Group 15 to 24 during the period 1921-23 to 1931-33 (y) in English County Boroughs, before and after making Adjustment for Migration. (Compare Tables 24 and 27.)

No.		$r_{xy} \pm S.E._r$	Number of Boroughs.
1	.	$\left\{ \begin{array}{l} -\cdot080 \pm \cdot122 \\ \text{(unadjusted)} \end{array} \right\}$	. 68
2	.	$\left\{ \begin{array}{l} -\cdot084 \pm \cdot151 \\ \text{(unadjusted)} \end{array} \right\}$	. 45
3	.	$\left\{ \begin{array}{l} +\cdot058 \pm \cdot151 \\ \text{(adjusted)} \end{array} \right\}$	. 45

EXPLANATORY NOTES.

Sub-Standard Housing (1931): See Table 6, Notes 8-11.

Rate of Decline in Mortality from Diseases other than Respiratory Tuberculosis: Average percentage-rate of decline, obtained in the same way as for respiratory tuberculosis in Table 27. In calculating Coefficient Nos. 1 and 2 the death-rates for 1921-23 and 1931-33 were unadjusted for migration (recorded death-rates), while in No. 3 they were adjusted for migration on the assumption that the mortality of the migrants was *nil* ("native" death-rates).

English County Boroughs: Coefficient No. 1 was calculated after excluding from the 76 selected English county boroughs those in which less than twenty deaths from diseases other than respiratory tuberculosis took place among females aged 15 to 24 in the triennium 1921-23; and Nos. 2 and 3 were calculated after the further exclusion of (a) and (b) as in Table 27, Notes.

r_{xy} : See Table 6, Notes. None of the coefficients is significant.

$S.E._r$ (Standard Error): See *ibid.*

Chapter 7.—The Influence of Volume of Occupation upon the Recent Respiratory Tuberculosis Mortality of Young Adults.

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I. INTRODUCTION.

It has been suspected for some time that the recent alterations in the mortality from respiratory tuberculosis among young adults in the country as a whole, or in one locality as compared with another, might partly be due to the influence of occupation.

Occupation might produce effects on tuberculosis either (1) through the peculiar character of the employment (*e. g.* silicotic trades), or (2) more generally, through the greater liability of occupied over unoccupied persons to fatigue and to contact with infection. The present study, being mainly concerned with young adults and in particular with young women, is restricted to effects of the second kind, owing to the absence, for females, of published data combining place of residence, nature of occupation and age at death. Nevertheless, the type of employment is partly taken into consideration, since in some of the calculations certain occupational groups (agricultural occupations and domestic service) are excluded on the presumption that their risk of contact with human sources of tuberculous infection, as a result of their occupations, is much below the average.

Occupational effects of the second kind mentioned above may be accentuated by (*a*) changes in work-conditions affecting fatigue or closeness of contact to which gainfully occupied persons are subjected, *i. e.* in the "stress and strain" of occupation, or (*b*) differences in the proportion of persons gainfully occupied, *i. e.* in the "volume" of occupation. Owing to the absence of adequate information as to the influence upon health of changes in working conditions, such as speeding-up or increased introduction of piece-work, attention here is mainly confined to the "volume" factor of occupation.

The general plan of this chapter is, therefore, first to compare for 1931 the proportion occupied (*i. e.* gainfully occupied) at different

ages in the country as a whole, and in the county boroughs and the rural districts, with their respective phthisis mortalities; then to trace the changes in the proportions occupied at different ages between 1891 and 1931; and finally to correlate in various ways the proportions occupied among girls and young women in different county boroughs with their corresponding mortalities.

II. MATERIALS, SOURCES AND METHODS.

The proportions occupied in England and Wales, in the aggregate of county boroughs of England and Wales, and in the aggregate of rural districts of England and Wales, were obtained from the censuses. Two sets of figures were obtained: first, total occupied, and second, total occupied *less* those in agricultural occupations and domestic service. It should be noted that the term "occupied", as used in the census returns, includes unemployed as well as employed. Furthermore, it should be noted that some parts of England and Wales are so thickly populated that many persons may combine domicile in a "rural district" with occupation in an "urban district". The term "rural" must consequently be regarded as an administrative one, and does not invariably describe the character of the area.

For the individual English county boroughs the proportions of females occupied at ages 15 to 24 and 25 to 34 were obtained after deductions for agricultural occupations and domestic service. A further series of figures showing proportions occupied of female "juveniles" (ages 14 to 20) was obtained after deductions for domestic service, but for this age category the census table made it possible to deduct also those recorded as "out of work".

Mortalities from respiratory tuberculosis for England and Wales, and for the aggregates of county boroughs and of rural districts, were calculated from triennial averages of the deaths given in the Registrar-General's returns and from the populations provided by the census. For the individual county boroughs the respiratory tuberculosis mortalities were similarly calculated.

A fuller description of the materials and methods will be found in the Appendix.

III. ANALYSIS OF RESULTS.

A. *The Proportions Occupied (1931) among Persons at Different Ages in England and Wales, and in the Aggregates of County Boroughs and of Rural Districts, in Relation to Respiratory Tuberculosis Mortality (1931-33).*

The variations with age of phthisis mortality and of volume of occupation in England and Wales as a whole, in the aggregate of county boroughs, and in the aggregate of rural districts, are shown in Table 31. Occupational figures after the exclusions for agriculture

and domestic service are also shown, since these two categories seem to carry with them a much less than average risk of exposure to respiratory forms of tuberculosis. In Chart 7 this second set of figures is compared graphically with the corresponding phthisis figures.

From this chart it may be seen that for each sex, and in each of the three classes of area examined, the curve for the proportion occupied (1931) shows a general resemblance to that for the phthisis mortality (1931-33). On the other hand, there are striking

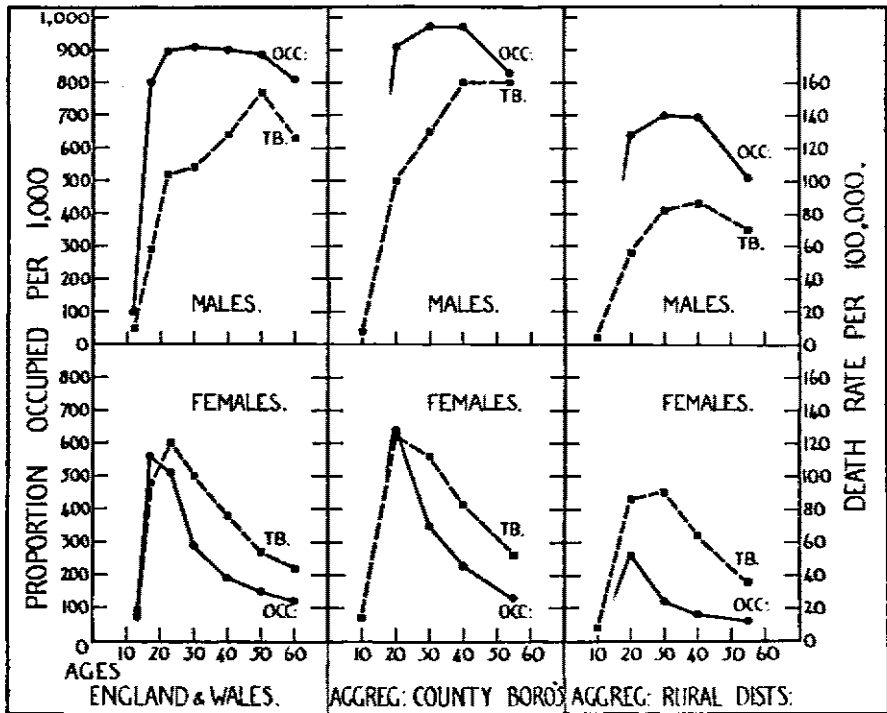


CHART 7.—*Proportions Occupied in 1931 and Respiratory Tuberculosis Mortalities in 1931-33, by Sex and Age, in England and Wales, in the Aggregate of County Boroughs in England and Wales, and in the Aggregate of Rural Districts in England and Wales. (Data taken from figures in italics in Table 31.)*

differences between each pair of curves for males and that for females. For, while the two sexes are similar in showing a sharp rise during adolescence both in proportion occupied and in mortality, a contrast between the sexes develops during middle life, when each pair of curves for males assumes plateau form, whereas for females each pair falls away as the proportion of married women increases. It may also be noted that the adolescent rise in occupation is rather steeper for males, while that in mortality is steeper for females.

(Occupation and tuberculosis curves—not shown here—similarly constructed for England and Wales for 1921–23 also show a fair resemblance, though those for 1911–13 agree less closely.)

The general resemblance between the age-distribution of the proportion occupied and that of the phthisis mortality in differing classes of area supports the view that this mortality is to some extent dependent upon the volume of occupation. That such volume of occupation could only partly account for the rise in mortality during adolescence is, however, shown by the fact that this rise is steeper for young females than for young males, while the reverse is the case for the rise in proportion occupied.

B. Changes in the Proportion Occupied among Persons at Different Ages in England and Wales between 1891 and 1931, in Relation to Respiratory Tuberculosis Mortality.

The relationship suggested in the previous sub-section in turn suggests the possibility that the retardation in the rate of decline in the respiratory tuberculosis mortality among young adults in England and Wales as a whole might be connected with alterations in recent years in the extent of their entry into gainful occupations.

This possibility was investigated by computing the proportion occupied at different ages in the country as a whole for the last five censuses (see Table 32). In spite of certain changes in classification (greatest between 1911 and 1921), this table probably provides a fair basis for a general comparison over this forty-year period. The following points may be noted :

(1) There has been little alteration in the volume of occupation among males aged 15 and over, or among females aged 35 and over. This applies both to total figures and to those computed after excluding agricultural occupations and domestic service.

(2) There has been a considerable decrease among boys and girls aged 10 to 14. This also applies to both sets of figures.

(3) There has been an increase in the proportions occupied among females aged 15 to 19 and 20 to 24 between 1901 and 1931, the two limits of the period available for this comparison. When agricultural occupations and domestic service are excluded, the rate of increase over the same period appears to have been considerably greater. During the forty-year period that can be used for this second type of comparison the rate of increase in the proportions occupied among young women of these ages is most marked between 1901 and 1921. The figures for women aged 25 to 34 show some of the same features as do those for the younger women, though to a lesser degree.

The principal interest of the above analysis lies in the finding of a material rise in the proportion occupied among young adult females, a rise which becomes considerably more evident when certain forms of occupation are excluded because of the presumed lesser contact with human sources of tuberculosis that they entail. The finding of this rise in proportion occupied seems doubly interesting in view of

its restriction to the particular age-group that has experienced a retardation in decline of respiratory tuberculosis mortality, and of its accentuation at about the period when this retardation first became noticeable. Alteration in the volume of gainful occupation is therefore suggested as a factor in causing the retardation in decline in respiratory tuberculosis mortality among *young women* in the country as a whole; though the constancy in the proportion occupied among *young men* in the same period, taken in conjunction with their definite though less marked retardation in decline in mortality, shows that changes in volume of occupation can only be one among several such factors.

c. *The Respiratory Tuberculosis Mortality in Different County Boroughs (1921 to 1933) in Relation to Local Differences in the Proportion Occupied (1931).*

The suggestion that changes in volume of occupation have played a part in the recent trend of respiratory tuberculosis mortality among young women in England and Wales *as a whole*, makes it desirable to ascertain whether some similar relationship exists between differences in the proportion occupied and in the respiratory tuberculosis mortality *from one county borough to another*. For this purpose the method of correlation was used.

The first three comparisons made were between the mortalities (1931-33) and the proportions occupied (1931) for the 76 county boroughs, the results being given in Table 33, Coefficients Nos. 1-3. When the mortality of females aged 15 to 24 was correlated with the proportion occupied at the same age and at the same date, the coefficient (No. 1) was found to be insignificant, and it remained so ($+0.076 \pm 0.115$) even when sub-standard housing incidence (1931) (which when correlated with proportion occupied at the age in question had the coefficient -0.179 ± 0.115) was held constant. A similar correlation for females at ages 25 to 34 also gave an insignificant coefficient (No. 2), which again remained so when housing was held constant. Further, having in mind the slow clinical evolution of phthisis, a correlation was computed between female young adult (15 to 24) mortality and the proportion occupied among female juveniles (14 to 20) at the same date, but its coefficient (No. 3), like the previous ones, was not significant, nor did it become so ($+0.055 \pm 0.115$) when housing (which when correlated with proportion occupied among female juveniles had the coefficient -0.225 ± 0.115) was again held constant.

The purpose of the remaining correlations was to explore the possibility that the extent to which a generation of children falls victim to phthisis in early adult life, as judged by the percentage increase in its mortality, is determined by the proportion of its number that after leaving school becomes engaged in gainful occupations. Accordingly, comparisons were made (Coefficient

No. 5) between (y) the percentage increase, during the decade 1921-23 to 1931-33, in the mortality of the generation of females that was aged 5 to 14 in 1921 and 15 to 24 in 1931 and (x) the proportion occupied among female juveniles (14 to 20) in 1931. To obviate the inclusion of erratic percentages those boroughs having less than ten phthisis deaths in 1921-23 at ages 5 to 14 were excluded. A further similar correlation (Coefficient No. 6) was made in which the 1931-33 phthisis death-rates (ages 15 to 24) had been adjusted for migration taking place in the previous decade (see Chapter 6), on the assumption that the mortality of migrants was half the recorded mortality for the borough concerned. It may be seen that both these correlations are significant, in spite of the large standard errors resulting from the necessarily reduced number of boroughs used.

These findings may appear difficult to reconcile with the absence of a positive correlation between phthisis mortality in young women and the contemporaneous proportion of juveniles occupied (see Table 33, No. 3). A possible explanation of the apparent contradiction is provided by the small but significant negative correlation present between the proportion of occupied juveniles (1931) and the phthisis mortality of young girls, aged 5 to 14, in 1921-23 (see Table 33, No. 4). It would seem, therefore, that those boroughs that have high female juvenile occupation-rates have also low phthisis death-rates for their young girls, but that when, at adolescence, the latter enter industry, their mortalities rise disproportionately as compared with those of the girls in other boroughs.

Owing to the small number of boroughs (12) having ten or more deaths from respiratory tuberculosis in 1921-23 among males aged 5 to 14, and to the much smaller variation from borough to borough in the proportion occupied among juvenile males than among juvenile females, the generation method of comparison used above for females was not considered applicable to males.

IV. DISCUSSION.

In his recent important epidemiological study, Bradford Hill (1936) has included some observations upon the influence of occupation upon tuberculosis in this country. His results will now be discussed in relation to the present analysis.

For England and Wales as a whole, Bradford Hill determined the changes between 1911 and 1931 in the proportion occupied among females. For those aged 14 and over he found that there had been a very slight decrease between these dates, while for those in the particular age-group 14 to 24 the proportion occupied had risen from 629 per 1000 in 1911 to 686 in 1931. He regarded this latter change as slight, and stated that "if the 'stress and strain of competitive wage-earning' is a factor in the phthisis death-rate of young

adult females, we must look for its influences in changes of *type* of employment rather than in an increased *volume* of employment”.

In the present study an attempt has been made to extend the period covered by the occupational data further back than 1911 so as to include the date of the check in the decline in phthisis mortality among young women, which (see Chapter 1) appears to have been soon after 1900. This procedure seems justifiable, since reasonably comparable figures appear to be obtainable as far back as 1901 for all occupied women, and as far back as 1891 for the more restricted group of occupations used, in spite of alterations in the occupational classification of the various censuses. (Such comparability might not, however, be possible if an attempt were to be made to exclude occupations other than agriculture and domestic service).

The figures thus obtained (Table 32), both for all occupied and for those occupied after exclusion of agriculture and domestic service, may be compared with Bradford Hill's figures for his shorter period. It can be seen that over the more extended period there has been a definite and progressive increase in the proportion occupied among young women—an increase that is especially evident in the restricted occupational group, and particularly between 1901 and 1921. The implications of this increase as concerns tuberculosis trend has been considered on p. 87, where it was suggested that the increase in volume of occupation had participated in producing the recent retardation in decline in phthisis mortality among young women in the country as a whole.

The second part of Bradford Hill's contribution was concerned with the different English and Welsh county boroughs, where he examined the relationship between the proportion occupied among females aged 14 and over and the phthisis mortality of females aged 15 to 24. He found an appreciable significant, but *negative* correlation between these two variables in 1929-31, the coefficient remaining significant even when the infant mortality-rate, selected by him as an index of local social and hygienic conditions, was held constant.

In the present analysis, since figures for proportion occupied were available subdivided by ages for each county borough for 1931 (by special extraction from census records), it seemed preferable to use the data for young women only, rather than those for all ages (as was done by Bradford Hill), for correlating with the phthisis mortality of this age-group. While this correlation also was found to give a negative coefficient, the latter was insignificant, and remained so when local incidence of sub-standard housing conditions—used here as a broad index of social conditions—was held constant.

A third examination made by Bradford Hill was of the changes between 1911 and 1931 in the proportion occupied among females aged 14 and over in the different county boroughs in relation to the corresponding changes in phthisis mortality of females aged 15 to 24

during the same period. The correlation between these two variables was positive though insignificant. To amplify this comparison of changes by restricting the figures for proportion occupied to the young adult age-group, as was done for the 1931 figures just mentioned, would have required similar special extraction from the 1911 census records, but the additional labour necessary to obtain these earlier figures did not appear to be justified.

The application of the "generation" method, in the form used in the present chapter, seems to offer a fresh approach towards elucidating the influence of the volume factor in occupation upon phthisis in young women. For if volume of occupation be important, then it might be expected that the larger the proportion of children leaving school to enter gainful employment with all its attendant risks, the larger should be the percentage increase in the phthisis mortality of their generation as it grows up from childhood into early adult life.

Since, when this generation method was applied to county boroughs, the correlation was positive and significant, it is suggested that the extent to which girls in different urban areas become affected with phthisis is partly determined by the extent to which they enter industrial life. Operating in this way, local differences in volume of occupation of girls would appear to be an important factor in determining local differences in their phthisis mortality when they grow up into young women. This finding, indicating the influence of volume of occupation in adolescence upon phthisis, supports the suggestion made above that recent increase in the proportion of young women engaged in industrial employment may have contributed materially to bringing about the check in the decline in the phthisis mortality at this age in England and Wales as a whole.

In several correlations in the present chapter, the proportion occupied among female *juveniles* has been selected for comparison with the phthisis mortality among *young adult* females. From some points of view this procedure seems preferable to the use of coeval comparisons, since, on account of the commonly prolonged clinical course of respiratory tuberculosis, the effects of occupation upon health might not become manifest for some years. The advantages of this procedure are probably unaffected by the use, in the generation method, of juvenile occupation figures for 1931 in place of the theoretically more correct, but unobtainable, juvenile occupation figures for a few years earlier, since there was probably little variation, relatively, in the figures during the interval.

The actual manner in which the volume factor of occupation, discussed in this chapter, exerts its effect upon respiratory tuberculosis is probably complex. It can scarcely be doubted that young persons who leave school, where they associate almost exclusively with children of their own age, to enter industrial occupations must run added risks of contracting respiratory tuberculosis from their

greatly increased frequency of contact with older persons. Furthermore, at a time of life when their physique is comparatively undeveloped, they are faced with the fatigue which is inseparable from their longer working day, and these disadvantages are necessarily enhanced where conditions of housing are poor, and facilities for recuperation after the working day are correspondingly reduced.

V. SUMMARY OF CHAPTER 7.

1. The proportions occupied (1931) at different ages among males and females in England and Wales as a whole, and in the aggregates of county boroughs and of rural districts, have been compared with the mortalities from respiratory tuberculosis (1931-33) in the corresponding classes of area. Two sets of occupation figures have been used, one with no exclusions, and the other after exclusions of agricultural workers and domestic servants in the belief that such forms of employment involve relatively small contactual risks.

2. In each of the above three classes of area, and for each sex, the curve for the proportion occupied at different ages shows a general resemblance to that for respiratory tuberculosis mortality, though there are striking differences between each pair of curves for males and the corresponding pair for females. From this resemblance it is suggested that occupation, by reason of its volume and apart entirely from specific industrial hazards, exercises an important influence upon respiratory tuberculosis mortality.

3. The changes in the proportion occupied at different ages among both males and females have been traced back to 1891. Again two sets of occupational figures have been used. There has been little alteration in the volume of occupation among males aged 15 and over, or among females aged 35 and over. There has been a considerable decrease among boys and girls aged 10 to 14. Over the forty years there has been a definite and progressive increase in the proportion occupied among young women aged 15 to 24—an increase that is especially evident in the restricted occupational group, more particularly between 1901 and 1921. The figures for women aged 25 to 34 show some of the same features as do those for the younger women, though to a lesser degree. From the facts that the rise in proportion occupied has been almost confined to young women, has been particularly noticeable when the forms of employment involving least contactual risks have been excluded, and has been accentuated about the beginning of the century, it is suggested that these occupational changes have played an important part in causing the retardation in decline in the respiratory tuberculosis mortality of young women in the country as a whole.

4. The mortality from respiratory tuberculosis among females in certain age-groups in the different English county boroughs has been examined in relation to local differences in proportion occupied (after excluding domestic service).

5. No relationship has been found between respiratory tuberculosis mortality among females aged 15 to 24 and 25 to 34 in these county boroughs in 1931-33 and the proportions occupied at these ages in 1931.

6. In a restricted series of county boroughs, the local proportions occupied among juveniles, aged 14 to 20, has been found to be related to the different percentage increases of the respiratory tuberculosis mortality in 1931-33 of young women, aged 15 to 24, over that in 1921-23 of girls, aged 5 to 14, (*i. e.* the same generation). This relationship suggests that in the different county boroughs the liability of girls to contract respiratory tuberculosis as they grow up into adult life depends partly upon the extent to which they enter gainful industrial occupation.

TABLES TO CHAPTER 7.

TABLE 31.—*Proportions of Persons Occupied in 1931 and Respiratory Tuberculosis Mortality in 1931-33, by Sex and Age, in England and Wales, in the Aggregate of County Boroughs in England and Wales, and in the Aggregate of Rural Districts in England and Wales.*

England and Wales.			Aggregate County Boroughs.			Aggregate Rural Districts.		
Age-group.	Proportion occupied.	Death-rates.	Age-group.	Proportion occupied.	Death-rates.	Age-group.	Proportion occupied.	Death-rates.
MALES.								
10-14	100 89	8	5-14	...	8	5-14	...	4
15-19	894 805	59	15-24	937 921	100	15-24	926 636	55
20-24	971 892	106	25-34	988 976	130	25-34	976 704	81
35-44	984 907	128	35-44	989 976	160	35-44	969 691	87
45-54	970 883	152	45 and over	848 829	160	45 and over	804 508	67
55-64	910 810	126						
FEMALES.								
10-14	77 60	18	5-14	...	14	5-14	...	8
15-19	760 561	95	15-24	764 636	124	15-24	565 259	86
20-24	671 506	121	25-34	403 347	112	25-34	241 123	90
35-44	245 187	73	35-44	269 227	83	35-44	162 82	65
45-54	210 155	54	45 and over	177 142	52	45 and over	122 68	36
55-64	178 123	45						

EXPLANATORY NOTES.

Proportion Occupied: Number of occupied (including unemployed) males or females, per 1000 male or female population, in each specified age-group in 1931. Italicized figures were calculated after excluding the following categories from the number occupied: Group II (Agricultural Occupations) and Group 850 (Indoor Domestic Service) for males and females, England and Wales, and for males and females, Aggregate of County Boroughs in England and Wales; Group II for males, and Groups 800-850 (Domestic Service, etc.) for females, Aggregate of Rural Districts in England and Wales.

Respiratory Tuberculosis: Death-rate from Respiratory Tuberculosis, per 100,000 living, in each specified age-group; mean annual death-rate for the triennium 1931-33.

Aggregate of County Boroughs in England and Wales: Aggregate of all 83 (79 English and 4 Welsh) County Boroughs.

Aggregate of Rural Districts in England and Wales: Aggregate of Rural Districts outside Greater London, as used in Registrar-General's Statistical Review.

TABLE 32.—*Proportion of Persons Occupied in 1891, 1901, 1911, 1921, and 1931, by Sex and Age, in England and Wales.*

Age-group.	1891.	1901.	1911.	1921.	1931.
			MALES.		
10-14	260	219	183	109	100
	...	<i>186</i>	<i>162</i>	<i>95</i>	<i>89</i>
15-19	912	918	921	924	894
	...	<i>813</i>	<i>810</i>	<i>820</i>	<i>805</i>
20-24	969	974	974	966	971
	...	<i>891</i>	<i>882</i>	<i>886</i>	<i>892</i>
25-34	979	983	986	978	985
	...	<i>902</i>	<i>909</i>	<i>901</i>	<i>912</i>
35-44	975	978	983	978	984
	...	<i>882</i>	<i>898</i>	<i>895</i>	<i>907</i>
45-54	958	961	967	967	970
	...	<i>848</i>	<i>860</i>	<i>869</i>	<i>883</i>
			FEMALES.		
10-14	...	120	104	75	77
	<i>96</i>	<i>81</i>	<i>78</i>	<i>58</i>	<i>60</i>
15-19	...	659	691	708	760
	<i>379</i>	<i>410</i>	<i>443</i>	<i>535</i>	<i>561</i>
20-24	...	563	620	622	671
	<i>330</i>	<i>345</i>	<i>403</i>	<i>477</i>	<i>506</i>
25-34	...	305	338	335	363
	<i>214</i>	<i>201</i>	<i>236</i>	<i>256</i>	<i>286</i>
35-44	...	225	241	229	245
	<i>187</i>	<i>168</i>	<i>183</i>	<i>175</i>	<i>187</i>
45-54	...	217	230	210	210
	<i>197</i>	<i>167</i>	<i>181</i>	<i>155</i>	<i>155</i>

EXPLANATORY NOTES.

Proportion Occupied: Number of occupied (including unemployed) males or females, per 1000 male or female population, in each specified age-group in 1891, 1901, 1911, 1921 and 1931. Italicized figures were calculated after excluding the following categories from the numbers occupied, both male and female: Agricultural Occupations (Group IV 7 in 1891; VII in 1901 and 1911; and II in 1921 and 1931) and Indoor Domestic Service (Group II 4 (1a) in 1891; IV 1 in 1901; IV 1 and IV 3 (6) in 1911; 900 in 1921; and 850 in 1931). The figures omitted for 1891 are those for which no satisfactory comparability was attainable.

TABLE 33.—*Correlation Coefficients (r) between Proportion Occupied (1931) (x) and Respiratory Tuberculosis Mortality (1921 to 1933) (y) among Females at specified Ages in English County Boroughs.*

No.	(x)	(y)	$r_{xy} \pm S.E._r$	Number of Boroughs.
1.	Proportion Occupied ages 15-24 (1931)	Respiratory Tuberculosis Mortality ages 15-24 (1931-33)	$-.063 \pm .115$	76
2.	Proportion Occupied ages 25-34 (1931)	Respiratory Tuberculosis Mortality ages 25-34 (1931-33)	$-.214 \pm .115$	76
3.	Proportion Occupied ages 14-20 (1931)	Respiratory Tuberculosis Mortality ages 15-24 (1931-33)	$-.109 \pm .115$	76
4.	Proportion Occupied ages 14-20 (1931)	Respiratory Tuberculosis Mortality ages 5-14 (1921-23)	$-.257 \pm .115$	76
5.	Proportion Occupied ages 14-20 (1931)	Percentage Increase R.T.M. from 1921-23 to 1931-33 of generation aged 5-14 in 1921	$+.413 \pm .196$	27
6.	Proportion Occupied ages 14-20 (1931)	Ditto (adjusted for migration)	$+.481 \pm .208$	24

EXPLANATORY NOTES.

Proportion Occupied: Nos. 1 and 2: Number of occupied (including unemployed) females, per 1000 female population, in each specified age-group in 1931, after excluding Group II (Agricultural Occupations) and Group 850 (Indoor Domestic Service) from the number of occupied.

Nos. 3 to 6: Number of occupied (excluding those recorded as "Out of Work") females, per 1000 female population, in age-group 14 to 20 in 1931, after excluding Group 850 (Indoor Domestic Service) from the number of occupied.

Respiratory Tuberculosis Mortality: Nos. 1, 2 and 3: Death-rate from respiratory tuberculosis, per 100,000 living, in each specified age-group; mean annual death-rate for the triennium 1931-33.

No. 4: As above, but for the triennium 1921-23.

No. 5: Percentage increase in the death-rate from respiratory tuberculosis during the period 1921-23 to 1931-33 of the generation that was aged 5-14 in 1921 and 15-24 in 1931; *i. e.* the difference between the death-rate for age-group 15 to 24 in triennium 1931-33 and that for age-group 5 to 14 in 1921-23, expressed as a percentage of the latter.

No. 6: Calculated as for coefficient No. 5, the death-rates (15 to 24) for 1931-33 being adjusted for migration on the assumption that the mortality of the migrants was *half* that recorded in the borough concerned ("native" death-rate) (see Chapter 6).

English County Boroughs: Nos. 1 to 4: The 76 selected English county boroughs. No. 5: The 76 boroughs after excluding those in which less than 10 deaths from respiratory tuberculosis took place in the triennium 1921-23 among females aged 5 to 14. No. 6: As for No. 5, but with the further exclusion of those boroughs with changes of boundary between 1921 and 1931 involving more than 2% of the total population.

r_{xy} : See Table 6, Notes. Significant coefficients (exceeding twice their standard errors) are printed in heavy type.

S.E., (Standard Error): See *ibid.*

Chapter 8.—Respiratory Tuberculosis Mortality in the Different London Boroughs in 1928–33, in Relation to Certain Local Social Conditions.

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I. INTRODUCTION.

In the study of the effects of local differences in social conditions upon respiratory tuberculosis mortality, the unit areas so far used in the present investigation have been the English county boroughs. London, taken either as a single urban unit or subdivided into its constituent metropolitan boroughs, has been excluded on account of several features that seemed to render its statistics less valuable for this purpose.

Of these features perhaps the most important are the exceptionally large migrations of population taking place between London and other parts of the country, between London and its ring of suburbs, and between the constituent metropolitan boroughs themselves. All these movements contribute to reduce the value of the London area in comparison with the more static and self-contained county boroughs where social conditions operate more continuously upon the same population from year to year. Again, the sub-standard housing figure for a county borough gives an indication of the environmental conditions to which its population is subjected during the greater part of the twenty-four hours, since place of work and home will usually both lie within the borough boundaries. In London, on the other hand, it frequently happens that persons reside in one metropolitan borough and carry out their daily work in another, where they may be subject to local conditions of congestion (likely to affect workshop and factory standards as well as houses) very different from those in their borough of domicile. For this reason the sub-standard housing figure for a metropolitan borough is probably less valuable than that for a county borough as a relative index of the degree of closeness of personal contact prevailing locally amongst the persons officially domiciled within it, and therefore affords less satisfactory statistical material for

examining the influence of personal proximity upon the risk of contracting and dying from respiratory tuberculosis.

In spite of the effects of large secular and diurnal population movements in impairing the value of the individual metropolitan boroughs as self-contained social units, a limited investigation into the relationship between phthisis mortality and certain social conditions in these different London boroughs is undertaken in this chapter because of the wealth of statistical material provided by the New Survey of London Life and Labour—material which is not available for the great majority of the county boroughs. With the help of this additional statistical material for London, it seemed quite likely that some direct light might be thrown upon the much discussed question of the influence of defective nutrition upon respiratory tuberculosis.

In studying the county boroughs, poor relief, social index and sub-standard housing were all used to provide approximate measures of the differences in degree and extent of poverty as a whole in the general population from one borough to another. Unfortunately, the incidence of persons on poor relief is not available for the individual metropolitan boroughs, since the areas for poor relief administration are not co-extensive with the borough boundaries. The social index and housing measures previously used are, however, obtainable for the metropolitan boroughs, so allowing some of the relationships between phthisis and social conditions in these boroughs to be compared with those found in county boroughs. In addition to these social data, other sets of statistics upon the local prevalence of poverty, of a kind not obtainable for the county boroughs, are provided by the New Survey of London Life and Labour.

Among these statistics are two estimates of the proportions of persons living below the "poverty-line" in 1929-30 in each borough: one being obtained from a "House Sample Analysis", and the other from a "Street Survey" (New London Survey, vols. III and VI). In spite of a highly significant correlation ($+ \cdot 883 \pm \cdot 186$) between these two measures of poverty in the 30 London boroughs, the "Street Survey" has been preferred for use in this chapter because it seems to give a better numerical representation of the state of each individual borough. Of the "Street Survey" it is stated that the figures "afford a real indication of the proportion of the population who are still living below Charles Booth's poverty-line in each district" (New London Survey, vol. III, p. 146). The "House Sample Analysis" of the New London Survey, though less satisfactory as it stands than the "Street Survey" for measuring poverty as a whole, provides, however, for each metropolitan borough in 1929-30 data for the average full-time weekly income and rent for the families investigated. From these data, together with those for the average number of persons per family, the average income in excess of rent, per head of population, can readily be calculated, and

this sum would seem to provide some comparative measure of the economic resources available for food (in addition, of course, to other necessities apart from rent) among the residents of the different metropolitan boroughs. This measure, however, takes no account of short time or unemployment.

It should be noted that the New London Survey was carried out in 1929-30, *i. e.* before the onset of the economic depression, while the phthisis figures used here extend from 1928 to 1933, the longer period being employed to eliminate chance variations due to the small number of deaths in each borough in any one year, and also in order to bracket the census year, 1931.

Consideration of the possible relationship between local social conditions and the recent *decline* in phthisis mortality, which formed a large part of the county borough survey, is omitted from the study of the metropolitan boroughs, the correlations tabulated being limited to comparisons of approximately contemporaneous social and mortality data obtained in recent years.

II. MATERIALS, SOURCES AND METHODS.

The areas investigated were the 28 metropolitan boroughs, together with East Ham and West Ham. These 30 areas will be referred to as the London Boroughs.

The respiratory tuberculosis mortalities were derived from averages of deaths over the period 1928-33, given in the Registrar-General's returns, and from the 1931 census populations. The mortalities were restricted to females aged 15 to 24 and 25 to 44.

Of the social statistics used for each borough, Stocks's social index for 1931 was calculated by us by the method given in the Registrar-General's text (1934) and used in Chapter 3 for the county boroughs ; the incidence below the poverty-line for 1929-30 was obtained from the "Street Survey" of the New London Survey ; the average income less rent, per head, for 1929-30 was derived from figures given in the same publication ; and the incidence of sub-standard housing conditions (the percentage of the population living more than two per room) was obtained from the 1931 census.

Correlation was the only statistical method used.

Fuller discussion of the materials and methods will be found in the Appendix.

III. ANALYSIS OF RESULTS.

A. *Correlations for the London Boroughs between the Various Measures of Social Conditions.*

In Table 34 are set out the inter-correlations between the four sets of social data used in this chapter. All these inter-correlations are significant, though in differing degree, those between the social index and the other social measures being particularly high.

B. Correlations for the London Boroughs between Local Social Conditions and Respiratory Tuberculosis Mortality.

In Table 35 are set out the simple correlation coefficients between the phthisis mortalities of females aged 15 to 24 and aged 25 to 44 in the London boroughs for 1928-33, and each of the four sets of social data at about the same period. Certain partial correlation coefficients are also shown.

Examination of this table brings out the following points:

(1) For both age-groups, social index and incidence of persons below the poverty-line are highly correlated with, and average income less rent moderately correlated with, phthisis mortality (Nos. 1, 2 and 3).

(2) For females aged 25 to 44, sub-standard housing incidence also is moderately correlated with phthisis mortality, but for the younger age-group the coefficient, though positive, is below the level of significance (No. 4).

(3) When housing is held constant, the correlation coefficients between phthisis mortality and both social index and incidence below poverty-line remain highly significant for both age-groups (Nos. 5 and 6).

The implications of these findings will be considered in the following discussion.

IV. DISCUSSION.

In the present survey of the London boroughs, as in the parallel inquiry upon the county boroughs, various forms of social data have been used as measurements of poverty. Of these forms, Stocks's "social index" (extended for the present report to apply to the metropolitan boroughs) and sub-standard housing incidence are common to the two sets of boroughs; and it is of interest that the inter-correlation between these two social measures for the 30 London boroughs (Table 34) does not differ significantly from that for the 76 English county boroughs previously used (*cf.* Table 8). The other two forms of social data, incidence below poverty-line and average income less rent, are only obtainable for the London boroughs, where to some extent they take the place of the poor-relief measure used in the county boroughs.

Taken broadly, the correlations for the London boroughs between these four measures of poverty and the phthisis mortality of women in the two age-groups examined show that in these areas, as in the county boroughs, poverty and phthisis are strongly associated. The finding of significant correlations for the social index, one of the measures common to the analyses in both types of area, seems especially noteworthy. Some divergency, however, appears in the results for the two sets of boroughs when the correlations between phthisis mortality and sub-standard housing incidence, the other social measure common to both analyses, are compared. From Tables 7 and 35

it may be seen that while the correlation coefficients between sub-standard housing incidence and phthisis mortality for women aged 25 to 44 have practically the same values in the London as in the county boroughs, those for young women, aged 15 to 24, are much smaller in the former than in the latter. Moreover, for the county boroughs the coefficients are significant for both these age-groups, whereas for London boroughs the coefficient is insignificant in the younger age-group.

This divergency in the housing correlations suggests that local housing conditions in London boroughs are less influential as an ætiological factor in phthisis for women aged 15 to 24 than for women aged 25 to 44, and are also less influential for women aged 15 to 24 in the London boroughs than in the county boroughs. This difference may be related to the tendency of older women, a much larger proportion of whom are married, to spend the greater part of their time in their houses or in the immediate vicinity; while the younger women, a large proportion of whom is gainfully occupied, go much further afield. Such re-distribution of young women during the working day among boroughs different from those in which they are domiciled tends to reduce the extent to which the figures for the housing conditions of their boroughs of domicile represent the character of the environment to which they are subjected. The young women in the county boroughs, on the other hand, though perhaps just as much gainfully occupied as those in London boroughs, tend to remain, for both work and domicile, more continuously within the precincts of the single unit for which the social conditions are measured.

One of the purposes of introducing an examination of the London boroughs into the present report was to use certain information, which was available only for this group of boroughs, to throw some light on the obscure association between nutrition and phthisis mortalities in large urban areas. The average income per head of the population, *after deduction* of the rent paid for housing, provides a series of figures which, it is believed, give an indication of the money available for the purchase of food and other necessaries. The significant correlation between this series of figures and phthisis mortality, for both the female age-groups used (Table 35), is perhaps the most interesting of the London findings. If average income in excess of rent, per head of the population, in the various boroughs can be taken as a sufficient comparative measure of the locally prevailing extent of sub-optimal nutrition, the significant coefficients suggest that in London at any rate this social factor is operative in influencing phthisis.

This apparent association of phthisis with nutrition in London is supported by the partial correlations of Table 35, where it can be seen that the correlations between phthisis mortality and both social index and incidence below the poverty-line are still strongly significant for both the groups of women when sub-standard housing incidence is held constant. It may be inferred, therefore, from these

partial correlations that in London at any rate other factors in poverty besides closeness of personal contact are concerned in influencing local levels of phthisis mortality as between different boroughs. In view, however, of the suggested peculiar limitations of London housing data as an indicator of the contact factor in tuberculous infection among young women in the various boroughs, the results of the London correlations after excluding the influence of housing must be treated with caution. None the less, it is interesting that these results are in agreement with the more direct comparisons made with average income less rent.

In connection with the present results, certain other investigations of social conditions in the various London boroughs and their relationship to tuberculosis or general mortality must be considered.

Greenwood and Thompson (1921) calculated partial correlation coefficients between certain social factors and tuberculosis mortality for 1911-13 in 28 London boroughs, using both sexes and various age-groups. Among the correlations was that between the percentage of population living more than two per room (1911) and tuberculosis mortality (1911-13), the proportion industrially employed and the death-rate from other diseases being held constant. For females aged 15 to 24, 25 to 44 and 45 to 64, the coefficients were: $-.38$, $+.05$ and $+.60$, respectively, the last-mentioned being significant. These partial correlation coefficients have this in common with the present and more recent simple correlations, namely, that in London boroughs a positive significant association between housing and tuberculosis is more likely in females at older than at younger ages.

Stevenson (1921) studied the relationship between poverty, as measured by the proportion of domestic servants (excluding those in hotels) to total population (1911), and crude and standardized tuberculosis mortality at all ages (1911-13) in the London boroughs. He found that when the boroughs were placed in order according to poverty measured in this way, tuberculosis mortality increased with poverty, though the increase was somewhat irregular. His results are in substantial agreement with those of the present inquiry, bearing in mind that the measure of poverty differed, and that no subdivision into age-groups was made.

Stocks (1934, p. 1145) correlated the crude death-rate *from all causes* and at all ages in 37 districts in or around London with certain social factors. He took some of his data from the New London Survey. He found an insignificant correlation between housing (measured by mean number of persons per room) and crude death-rate ($+.274$), though the correlation became significant ($+.399$) when the mean income in excess of rent was held constant (*cf.* Table 35, No. 4). On the other hand, correlations between the proportion below the poverty-line and crude death-rate, and between the mean income in excess of rent and crude death-rate, were both significant ($+.371$ and $-.447$) (*cf.* Table 35, Nos. 2 and 3). Stocks also correlated his

various social measures with one another. The index of mean persons per room was highly correlated with the proportion living below the poverty-line ($+ \cdot 848$), more highly even than was the proportion living more than two per room with the proportion below the poverty-line ($+ \cdot 734$). Yet, as Stocks points out, the index of mean persons per room had no negative correlation with the average income available for the necessities of life over and above rent ($+ \cdot 172$). In the present investigation, on the other hand, the correlation between proportion living more than two per room and average income in excess of rent is both negative and significant ($- \cdot 384$). This difference is less likely to be due to exclusion of some of the areas used by Stocks, or to the use of a different measure of housing, than it is to be due to the calculation, in the present inquiry, of average income less rent on a *per head* basis and not on a *per family* basis.

Other recent demographic studies containing assessments of the social status of the individual London boroughs have been made by Mitra (1937), Martin (1937) and Glass (1938).

V. SUMMARY OF CHAPTER 8.

1. The mortality from respiratory tuberculosis amongst women aged 15 to 24 and 25 to 44 in the different London boroughs has been examined in relation to certain local social conditions. Two of the social statistics used have been the same as those employed in Chapter 3 for the county boroughs, namely, proportion of males in the lower economic grades (Stocks's social index) and the proportion of persons living under sub-standard housing conditions (more than two per room). Two further statistics have been obtained from the New Survey of London Life and Labour, namely, the proportion of persons living below the poverty-line and the average income less rent per head.

2. There is in the main a high degree of inter-correlation between the above four social measures in the London boroughs.

3. A relationship has been found, for both the female age-groups, between phthisis mortality in 1928-33 and three of these social measures, viz. social index, incidence below poverty-line and average income less rent. At ages 25 to 44 there is also a relationship with sub-standard housing, but at ages 15 to 24 this is less definite. It is inferred that differing prevalence of poverty in the London boroughs, as in the county boroughs, is partly responsible for their differing levels of respiratory tuberculosis mortality. It is suggested that the less definite relationship between sub-standard housing and tuberculosis at ages 15 to 24, both as compared with older women in London and with women of the same age in the county boroughs, is attributable to the fact that many young women in London work in boroughs that differ from those in which they are domiciled, with the consequence that the sub-standard housing incidence of their

borough of domicile less adequately measures average closeness of personal contact for this age-group.

4. If the average income less rent *per head* can be taken as a measure of the differing extent of sub-optimal nutrition from one London borough to another, the relationship found between this social measure and the respiratory tuberculosis mortality in the two age-groups examined suggests that in London boroughs at any rate sub-optimal nutrition is a factor in influencing the mortality from this disease. Unfortunately, no information bearing directly on nutrition, such as the average income less rent, is available for the series of English county boroughs.

TABLES TO CHAPTER 8.

TABLE 34.—Correlation Coefficients (r) between Returns for various Social Conditions (x and y) in London Boroughs.

No.	Social conditions.		Correlations, etc.		
	(x)	(y)	r_{xy}	M_x	M_y
1.	Social Index (1931)	Incidence below Poverty-Line (1929-30)	+·876	346	9·83
2.	Social Index (1931)	Average Income less Rent (1929-30)	-·724	346	19·3
3.	Social Index (1931)	Sub-Standard Housing (1931)	+·716	346	13·66
4.	Incidence below Poverty-Line (1929-30)	Average Income less Rent (1929-30)	-·591	9·83	19·3
5.	Incidence below Poverty-Line (1929-30)	Sub-Standard Housing (1931)	+·743	9·83	13·66
6.	Average Income less Rent (1929-30)	Sub-Standard Housing (1931)	-·384	19·3	13·66

EXPLANATORY NOTES.

Social Index (1931): Proportion, per 1000 of occupied (including unemployed) males, aged 14 up, whose occupation places them in social classes IV and V, in each London borough; returns at census in 1931.

Incidence below Poverty-Line (1929-30): Percentage of persons living below poverty-line in 1929-30 in each London borough; from "Street Survey" of New London Survey.

Sub-Standard Housing (1931): Incidence of sub-standard housing conditions measured upon the basis of the "more than two persons per room" census density standard; *i. e.* percentage of the population in private families living at a "more than two persons per room" density, in each London borough; returns at census in 1931.

Average Income less Rent (1929-30): Average income in excess of rent, per head of population, for each London borough in 1929-30; *i. e.* average *full-time* family income, in shillings, less average family rent, divided by average persons per family; data from "House Sample Analysis" of New London Survey.

London Boroughs: The 28 Metropolitan boroughs plus East Ham and West Ham, *i. e.* 30 areas in all.

r_{xy} : See Table 6, Notes. Significant coefficients (exceeding twice their standard errors) are printed in heavy type.

Standard Error: See *ibid.* Throughout this table it has the value of ± 186 .

M_x , M_y : The simple arithmetic average, for all London boroughs taken together, of the values of the x and y variables, respectively.

TABLE 35.—Correlation Coefficients (r) between various Social Conditions (Social Index (1931), Incidence of Persons below Poverty-Line (1929-30), Average Income less Rent (1929-30), Incidence of Sub-Standard Housing Conditions (1931)) (x) and Mortality from Respiratory Tuberculosis of Females aged 15-24 and 25-44 (1928-33) (y) in London Boroughs.

No.	(x)	r_{xy} Females aged	
		15-24.	25-44.
1.	Social Index (1931)	+·631	+·741
2.	Incidence below Poverty-Line (1929-30)	+·568	+·726
3.	Average Income less Rent (1929-30)	-·420	-·414
4.	Sub-Standard Housing Incidence (1931)	+·249	+·475
5.	Social Index, Sub-Standard Housing Incidence held constant	+·669	+·653
6.	Incidence below Poverty-Line, Sub-Standard Housing Incidence held constant	+·591	+·634

EXPLANATORY NOTES.

Social Index: See Table 34, Notes.

Incidence below Poverty-Line: See *ibid.*

Average Income less Rent: See *ibid.*

Sub-Standard Housing Incidence: See *ibid.*

Respiratory Tuberculosis: Death-rate from respiratory tuberculosis, per 100,000 living, in each specified age-group in each borough; mean annual death-rate for the six years, 1928-33.

London Boroughs: The 28 Metropolitan boroughs plus East Ham and West Ham, *i. e.* 30 areas in all.

r_{xy} : See Table 6, Notes. Significant coefficients are printed in heavy type. Standard Error: See *ibid.* Throughout this table it has the value of $\pm \cdot 186$.

Chapter 9.—General Discussion.

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I. INTRODUCTION.

The present report deals with the problem of the unsatisfactory trends of respiratory tuberculosis mortality among young adults in the present century.¹ By comparison both with the trends followed formerly by this age-group, and with those followed during the present century by infants, children and older adults, the trends for young adults, and particularly that for young women, have been disappointing. An attempt has been made therefore to survey, over the past ninety years, the changes in certain social conditions which, by reason of their believed aetiological importance, might be expected to have contributed to these exceptional trends.

The statistics for some of these social conditions are available for the whole ninety-year period, while those for others are obtainable only for the present century or even only for the past few years. With such heterogeneous material it has been difficult to pursue an entirely logical inquiry, since data that are necessary for ascertaining facts or for testing hypotheses are often incomplete or even entirely lacking. The report has therefore tended to develop along two lines:

¹ This phenomenon, in certain of its aspects, is also apparent in a number of other industrialised countries (Wright and Hart, 1939).

first, a survey concerned chiefly with the country as a whole and extending back into the last century, in which the mortality experiences of the two sexes at various ages have been set out against a background of concurrent changes in those social conditions for which the necessary information is obtainable; and second, a more intensive examination of the differences in mortality, particularly in that of young women, experienced from one locality to another during the past twenty-five years, making use of large urban areas for which increasingly diversified and accurate statistics of relevant social conditions are now becoming available. This second line of approach has the further interest that the set-back in the phthisis mortality of young adults has been more severe in these large urban areas than in other types of administrative area.

The dual approach employed in this report must not obscure the essential unity of the problem—the recent serious set-back to the bettering of phthisis mortality among young men and women. It has been forced on the investigators by the gaps in the statistical material available, and in this last chapter an effort will be made, after first reviewing the two main parts into which the inquiry has fallen, to present a short synthesis of the conclusions and suggestions in relation to the problem as a whole.

II. THE RETARDATION IN THE DECLINE IN PHTHISIS MORTALITY EXPERIENCED BY YOUNG ADULTS IN THE COUNTRY AS A WHOLE, IN RELATION TO CHANGES IN CERTAIN SOCIAL CONDITIONS.

It was pointed out in Chapter I that the serious retardation in the decline in phthisis mortality of young adults began in the years before the war, and had resulted in their death-rates persisting at higher figures than would have been predicted from the fairly consistent downward trends of the preceding fifty years. This retardation, which forms the central theme of this report, is clearly epitomized by the following death-rates, per 100,000, for women aged 15 to 24, taken from Table I (p. 10): 1851-60, 390; 1871-80, 276; 1891-1900, 144; 1901-03, 112; 1911-13, 107; 1931-33, 107. Though the retardation is at last showing signs of terminating, the high mortality from phthisis among young women still presents one of the most serious problems confronting the tuberculosis services.

In the present sub-section the various factors likely to have affected phthisis among young adults will be considered in the light of any *country-wide* changes for which statistical evidence is available either for the whole or part of the ninety years of the survey. The influence of some of these factors has been examined separately in detail in the earlier chapters, and the more relevant findings will now be discussed together in a more general manner.

A. *Influence of Changes in Standard of Living of the Country.*

(i) *Influence of Changes in Standard of Living as a Whole.*—The inclusion of phthisis among the "*morbi pauperum*" is now so widely accepted that it is unnecessary here to review the earlier literature upon which that conclusion was based (see discussion by Hart, 1937). Special interest in the statistical aspects of this problem has, however, been intensified since the publication by Hersch in 1920 of his study on the relationship of tuberculosis to poverty, and by the subsequent parallel investigations made by Stevenson (1921) and by Greenwood and Wolff (1928).

The broad problem of the relationship of tuberculosis to the standard of living in the country as a whole was first considered by Ewart (1922), who, in a comparison of the trend of phthisis with that of real wages as ascertained by economic statisticians, found a general parallelism between the courses followed by the two sets of statistics between 1850 and 1920.

In Chapter 2 of this report a re-presentation of the course followed by real earnings between the years 1850 and 1936 was given, from which it was evident that certain divergencies which appeared in the latter part of Ewart's series had become further magnified. When, however, the curves for phthisis mortality for particular sex- and age-groups taken separately, instead of the single curve for persons of all ages, were individually compared with the curve for real earnings, it was found that the different sex- and age-groups showed differing closenesses of resemblance. The mortality curve for young women matched the real earnings curve most closely, while that for young men came next. From this particular closeness of match it was suggested that young adults, especially young women, might be peculiarly sensitive to changes in the national standard of living, and that as a result of this sensitiveness the retardation in the improvement in the standard of living since the beginning of the century—described fully in Chapter 2—had been a factor in producing the retardation in the decline in phthisis mortalities of young men and women.

The reasons why young adults should be specially sensitive to general economic and social conditions, if the suggestion be true, must be largely conjectural. Several possible contributory causes, some common to both sexes, others peculiar to young women, may be briefly reviewed. The young adult population includes the age-group that has just left the comparatively sheltered life of school to enter the more strenuous environment of industry with its longer hours and increased fatigue, and the effect of these changed conditions in lowering resistance to phthisis at an age of immature physical development might be expected to be greater the lower the standard of living and the fewer the facilities for recuperation.

While a combination of such environmental and biological

causes might account for the special sensitiveness of both sexes at this time of life, the sensitiveness of young women may possibly be further augmented by a sex difference in resistance to tuberculous infection. That sex constitution may play a part in affecting susceptibility to phthisis during adolescence and early adult life is suggested by evidence from several sources. In a detailed study of the sex differences in tuberculosis mortality at various ages in the United States, Putnam (1927) showed that the excess mortality for young women over young men was statistically significant. She considered this excess to arise "primarily from biological differences between the sexes in their reaction to tuberculosis, which seem to be associated with physiological changes occurring at puberty and adolescence". She believed her conclusion to be greatly strengthened by the marked excess of deaths among girls, aged 10 to 14, when, owing to the similarity of home and school life of boys and girls, the environmental differences are practically negligible. A similar view as to the importance of inherent sex differences was advanced by Nicholson (1932, 1933) upon the basis of two careful *ad hoc* studies of the personal histories of girls and young women who had died from phthisis in Detroit and New York City. Further, it is interesting and probably significant that the higher phthisis mortality for girls, aged 10 to 14, than for boys—to which attention was drawn by Putnam in her American study—has been noted for a number of countries whose characters, from the point of view of industrialization and of economic resources, are very diversified (see Table 36, p. 128). The excess mortality can be seen from this table to be present in practically all the countries given, so that the phenomenon seems to be of widespread occurrence and, to judge from those countries for which older data (not tabulated) are available, to have been longstanding.

Of the various social factors that combine to determine the standard of living, housing and nutrition are the most important, and defects in both, it is now believed, play an influential part in the ætiology of phthisis. Unfortunately, an exploration of the various sources of information for data which might show what changes have taken place in these factors in this country in recent years yields rather meagre results. There are, however, a few statistics that appear helpful and important, and these will now be discussed as supplements to the data for the more comprehensive factor, standard of living.

(ii) *Influence of Changes in Housing Conditions.*—Various methods of comparing housing conditions from place to place and from time to time were considered at length in the Appendix to Chapter 3, and it was concluded that the most satisfactory data for the present purpose were those of density of room-occupation. Data suitable for such comparisons became available for the first time in 1891, but owing to changes in the details of the questionnaires used from one census to another,

considerable re-calculation is necessary to obtain reasonable comparability for all five censuses from 1891 to 1931 (see Chapter 4).

The course of housing conditions since 1891 for the country *as a whole* can be found by re-calculation of data by the method used in Chapter 4 for the county boroughs (Census, 1911*h*, 1921*j*, 1931*s*). Between 1891 and 1901 sub-standard housing incidence for the country as a whole (percentage of persons living more than two per room) underwent a considerable reduction (11·2 to 8·2); between 1901 and 1911 it was nearly stationary (8·2 to 7·8); between 1911 and 1921 it rose (7·8 to 8·5); and between 1921 and 1931 it underwent a further considerable fall (8·5 to 6·2), bringing it to a figure well below that for 1901. Though the optional nature of the questionnaires used in the first two censuses leaves some doubt as to the correctness of the earlier figures, it is likely that they under- rather than overstate the deficiency of housing at the time, and that with more definite questions in succeeding censuses the figures have become progressively more accurate.

Since housing data, expressed in this way, are unfortunately not available before 1891, it is not possible fully to compare the course of housing conditions with the ninety-year curve for real earnings given in Chapter 2. Nevertheless, for the forty years for which such a comparison is possible, the movements of the two sets of data show a considerable similarity. Like that of real earnings, the rate of improvement in housing conditions between 1891 and 1901 was substantial; between 1901 and 1921 little change took place in the level of either, except for the oscillations in real earnings during the war period; while the post-war decade between 1921 and 1931 shows a resumption in the improvements both of housing conditions and of real earnings. This improvement is probably still in progress (see below).

When discussing in Chapter 2 the trend of real earnings, it was stated that the average rate of improvement during the forty years of the present century had been distinctly inferior to that during the last forty years of the nineteenth century. It is difficult, and perhaps not altogether fair, to attempt a similar broad comparison for the course of housing conditions, owing to limitations in data, but it may be noted that the rate of improvement recorded between 1891 and 1901 was of such a size that even if no improvement at all had taken place in the twenty years before 1891, the diminution in sub-standard housing during the last thirty years of the nineteenth century would have been as great if not greater than that in the first thirty years of the present century.

The lack of information on housing before 1891 handicaps also any long-term comparison with phthisis mortality for the country as a whole. Nevertheless, the retardation in the improvement of housing conditions in England and Wales at about the same time as that of real earnings suggests that the former, like the latter, may be partly

responsible for the check in the improvement in phthisis mortality of young women and, to a lesser degree, for that of young men. This suggestion is supported by the finding in Chapter 4 that in 24 ill-housed boroughs, allocated to two equal sub-groups according to their individual rates of improvement in housing between 1891 and 1931, there was a significantly greater improvement in phthisis mortality for young adults of both sexes between 1911 and 1931 in the sub-group that had made the greatest progress in housing.

In view of the more favourable course of phthisis mortality among young adults since 1933, it would be interesting to know what improvements have taken place in housing conditions since the last census. While none of the necessary information is available during an intercensal period, it is noteworthy that the building of new houses in England and Wales since 1931 has been proceeding at an average annual rate nearly double that of the previous decade (Ministry of Health, 1937).

(iii) *Influence of Changes in National Nutrition.*—The sharp and often striking rises in the prevalence of phthisis at times of acute food shortage, such as wars and sieges, has strongly suggested the importance of widespread sudden deterioration in nutrition in raising the contemporary tuberculosis mortality (see Cobbett, 1930; Hart 1937). How far changes in the prevalence of *sub-optimal* nutrition in more normal times may be reflected in country-wide changes in phthisis can scarcely be determined, since no satisfactory information is yet available upon the dietary required to give good protection against tuberculosis—a dietary which itself may well vary greatly from person to person. However, some information from which to judge broadly of changes in the level of national nutrition is available from Board of Trade and other statistics of the *per capita* consumption in the past seventy years of certain foods likely to have prophylactic value against phthisis (see Collis, 1922; Layton and Crowther, 1935c; Orr, 1936). These figures for food consumption, though few and spaced at wide intervals, appear to show a fairly progressive increase in the consumption of meat, butter, cheese and possibly milk. It is not possible, therefore, to account for the retarded decline in young adult phthisis mortality on the basis of these data for national average food consumption, though it is evident that such data are necessarily very crude and incomplete.

Stocks (1936), in the course of the discussion on Bradford Hill's (1936) paper, introduced a new view of the way in which sub-optimal nutrition might possibly affect phthisis mortality, by suggesting that sudden and widespread deteriorations in the level of national nutrition might not only cause almost contemporary rises in tuberculosis mortality, but could continue for years subsequently to exercise delayed deleterious effects upon persons exposed during their formative years. He attributed the retarded decline in phthisis mortality at the ages 15 to 24 years in the country as a whole to the

long-persistent after-effects of war-time privations. He was "now inclined to think that we have been witnessing a temporary aftermath of the shortage of fats, vitamins or other essential factors in diets during the years of food shortage, 1916-18, which may have resulted in lowering the average resistance to tuberculosis as these children have been coming to adolescence and young adult life". The difficulty in accepting Stocks's suggestion as a complete explanation lies in the fact that in young adult females the check to the decline in mortality began some ten years before the beginning of the war.

B. Influence of Changes in Volume of Occupation in the Country.

The sudden demand for labour during the war resulted in a rapid increase in the number of women engaged in factory employment. The steep rise in the tuberculosis mortality-rate in the later years of the war amongst those groups of adult women most affected by the occupational changes attracted considerable attention to the likelihood of a close association between the two (Stevenson, 1916; Greenwood and Tebb, 1919; Collis and Greenwood, 1921). For a time this association was believed to be so close that the possible effects of the many other changes, such as the deterioration of housing and nutrition, which were taking place simultaneously, received comparatively little attention, with the result that perhaps undue stress came to be laid upon fatigue and exposure to contact in industry as ætiological factors in the war-time rise in phthisis.

The alterations in the proportions occupied, for England and Wales as a whole, among males and females in various age-groups between the years 1891 and 1931 were reviewed in Chapter 7. Examination of the figures showed that the proportion occupied among young women rose after 1901, especially when, for the reasons given in that chapter, agricultural workers and domestic servants had been excluded. From the fact that this increase in volume of occupied, which became especially noticeable when these forms of employment, involving small contactual risks, were excluded, was almost confined to young women, aged 15 to 24 (though to some extent present among women aged 25 to 34), and was accentuated about the beginning of the century, it was suggested in Chapter 7 that these occupational changes might have been an important factor in causing the retardation in phthisis mortality decline among young women.

Further evidence that occupation, by reason of its volume and apart entirely from the well-known occupational hazards, exercises an effect on tuberculosis mortality, is suggested by a comparison of the age-distribution of these two variables, both for males and for females, in urban and in rural areas in England and Wales (see Chapter 7). It is of interest that a study of the differences between urban and rural tuberculosis mortalities at various ages in New

York State led Parkhurst (1933) to the same conclusion that occupation was an element of primary importance (see also Sydenstricker, 1933).

c. Influence of Changes in the Proportion Married among Young Women.

The possible effects of marriage upon phthisis in young women appear to be two-fold, and operate in opposite directions.

On the one hand, the withdrawal of the majority of women from gainful occupations, in consequence of marriage, as they pass from the age-group 15 to 24 to that of 25 to 34 years, may account for the lesser phthisis mortality of the latter age-group—an explanation which is supported by the indirect observation that the rise in phthisis mortality among young women in the County of London in recent years has been almost exclusively amongst the unmarried (London County Council, 1931). On the other hand, as a result of pregnancy, married women possibly incur an additional risk from tuberculosis. The added risk of fatality in recognized cases of phthisis as a result of pregnancy is, however, now believed to be less than was formerly thought, though little is yet known of the influence of pregnancy upon lesions in their earlier stages of development.

These considerations make it difficult to predict whether changes in the proportion of young women, aged 15 to 24, who are married would be reflected in changes in their phthisis mortality. An examination of the census records for England and Wales from 1871 to 1931 (Census 1931^r) shows a steady increase in the percentage unmarried in this age-group from 1871 (81·3) to 1911 (87·3), followed by a slight decline (1921, 85·9; 1931, 86·0). However, even were the phthisis mortality among the single as much as twice that among the married in this group, these alterations would appear to be too small to have had other than a negligible effect upon the decline in phthisis mortality.

d. Influence of Possible Recent Changes in Specific Immunity of Adolescents.

A lessened incidence of tuberculous infection in those reaching young adult life, with resulting reduction of their acquired immunity as a group, was first suggested by Coutts (1932), for England and Wales, and by Dahl (1933), for Norway, as a partial cause of the recent retardation in the decline in phthisis mortality at this age. Dahl's suggestion was based upon a comparison of the courses of the mortality from tuberculous meningitis among various age-groups during the past fifty years. He found that in Norway, between 1901-05 and 1926-29, the mortality from tuberculous meningitis among children had fallen considerably, while that for adults aged 20 to 30 years had risen substantially. Assuming, from pathological considerations, that tuberculous meningitis was pre-eminently a lesion of first infection (see also Wallgren, 1935), he inferred that this

shift in meningitis mortality from childhood to early adult life was largely due to postponement, for an increasing fraction of the population, of the age at which primary infection usually took place. As direct evidence in support of such postponement having taken place in Norway, Dahl cited the results of the two tuberculin surveys carried out in Trondheim in 1914 and 1930.

In the absence of any direct evidence from successive tuberculin surveys in England and Wales (see Hart, 1932), Dahl's assumption has been made the basis of an alternative and indirect method of determining whether there has been any postponement of tubercularization in this country. This method is to compare, for young adults, changes, over a period of years, in the ratio of the acute forms of tuberculosis (acute miliary tuberculosis and tuberculous meningitis) to all forms of tuberculosis. Any tendency for this ratio to increase would suggest a postponement in tubercularization of the population at risk.

In Table 37 (p. 128) are set out the deaths from acute miliary tuberculosis, from tuberculous meningitis, and from the two combined, expressed as percentages of the deaths from all forms of tuberculosis, among males and females aged 15 to 24 in England and Wales, for the triennia 1911-13, 1921-23 and 1931-33. Examination of this table shows that for both these acute forms of tuberculosis combined (No. 4), the percentage ratio for males underwent some rise during the twenty-year period, whereas for females the ratio underwent little change. (A similar set of figures for the Aggregate of County Boroughs in England and Wales gave closely similar results.) When the figures for males were further subdivided into those for ages 15 to 19 and those for 20 to 24, it was found that the younger group had contributed most to this rise in the percentage ratio.

The results given in Table 37 suggest that in England and Wales there may have been some postponement in tubercularization in recent years among males but not among females. It is, however, difficult to accept postponement of tubercularization as a serious cause of the retardation in decline in phthisis mortality amongst young adults in the period from 1911 to 1933 since this apparent postponement is confined to young men, while the retardation has been much more marked among young women.

Bradford Hill (1936) made an approach along another line towards testing the hypothesis that the decline in total phthisis incidence in this country, by effecting less immunization in childhood, had led to a relative increase in the death-rate in adolescence. He accepted the death-rate from all forms of tuberculosis at ages 0-5 as a measure of the extent to which infection takes place in childhood, and consequently of the extent of immunity in this generation subsequently. Changes in this childhood death-rate over a period of years in a group of English counties were found to be unrelated

to changes in the mortality at young adult ages in subsequent years. Similarly, towns with high death-rates from tuberculosis at ages 0-5 appeared to have no lower phthisis death-rates in young adult life fifteen to twenty years later than had towns with low death-rates in childhood—the general health factors being so far as possible equalized. Bradford Hill concluded that “in general the statistical evidence available (admittedly slender) does not suggest that the level of the phthisis death-rate amongst young adults in different areas of the country is materially due to different degrees of immunization in childhood”.

On the whole, therefore, whether or not the proportion of children in this country who reach adult life without becoming tuberculin-positive is increasing, the evidence is against any reduction in immunity having taken part in producing the retardation in decline in phthisis mortality among young adults. In any case if, as recent figures suggest is possible, this decline is now being resumed, it would be difficult to reconcile such resumption with any hypothetical reduction in the group immunity at this age.

E. Recent Changes in Personal Habits, etc.

Bradford Hill (1936) summarized a number of contributions dealing with the possible effects of recent changes in the personal habits of young women upon their phthisis mortality. The majority of these contributions were based upon *ad hoc* studies or upon clinical impressions. Among the changes mainly implicated were the supposed increased stress and strain of living, and the neglect of the rules of hygiene affecting diet and clothing.

Bentley (1934) examined the personal habits of a group of young, single, tuberculous women, and compared them with those of a corresponding group of non-tuberculous women of the same social status and weekly wages. He found no significant difference in the hours spent in bed, the hours of work, the adequacy of meals or the money spent on luxuries between the two groups.

Lastly, Crowther (1935) has stated that in his experience a higher proportion of first-born children contract tuberculosis than do children by subsequent births. This view had been formerly put forward by Pearson (1907), though the correctness of his methods for estimating the proportion of first-born children in his population, was later questioned by Greenwood and Yule (1914). Crowther suggested that the effect that he noted might be due to the increased strain imposed upon first-born children in assisting in the care and support of their younger brothers and sisters. In the absence of knowledge of the proportion of first-born children in the non-tuberculous population from which his cases were drawn, it is difficult to determine how significant Crowther's observation may be. It is an interesting suggestion, however, in view of the increase in the

proportion of first-born to all children that has necessarily resulted in recent years from reduction in the sizes of families.

III. LOCAL DIFFERENCES IN DECLINE IN PHTHISIS MORTALITY AMONG YOUNG ADULTS IN THE VARIOUS URBAN AREAS, IN RELATION TO LOCAL DIFFERENCES IN CERTAIN SOCIAL CONDITIONS.

The retardation in the decline in phthisis mortality among young adults that has taken place in the whole country has been especially serious in the larger urban areas. On closer examination the retardation has been found to be very unequally spread among these areas. Partly upon that account, partly upon account of the relatively copious social data available, it seemed both desirable and important to give this aspect of the problem a particularly detailed consideration. It was also hoped that the influence of factors which, for the whole country as a single population unit, could only be studied from one date to another, might be analysed further by an examination at the same dates of their effects as between one locality and another on a large number of population units.

The urban areas mainly investigated were the English county boroughs, but in addition a more limited examination was made of the differences in phthisis mortality among the London metropolitan boroughs in relation to certain local social factors for which special information was available.

A. Influence of Migration to and from the County Boroughs in Producing Errors in Interpretation of their Recorded Mortality Data.

The considerable re-distribution of population, and especially of the young adult population, that has taken place since the war must be taken into account in comparing the differing mortality experiences of different places. This becomes all the more necessary if, as is believed by certain investigators, the migrating population is of a selected type having a comparatively small phthisis incidence. If this belief be correct, this internal migration might cause substantial aberrations in the death-rates of many places as these are ordinarily calculated. For example, in the North of England, whence a large emigration from many of the larger towns has taken place in recent years, the death-rates of such towns might be artificially raised by the loss of some of the more healthy members of their population.

The observations recorded in the literature upon the extent to which tuberculosis affects migrants in comparison with non-migrants have been mainly concerned with those moving between country and town (de Besche and Jorgensen, 1925; Bradford Hill, 1925; Ostenfeldt, Heitmann and Neander, 1931). It is doubtful if these

observations are applicable to the present problem, which is concerned with the large towns in England, for, as Greenwood (1922*b*) had previously pointed out, it is not possible to determine whether there is a "sufficient supply of country-born persons to furnish the immigrants" to large towns, or whether they "must be no more than transfers from one town to another". The applicability of the above observations to the present problem appears to be all the more doubtful since there seem to be good grounds for believing that in recent years the rural-urban movement has lost, while the urban-urban movement has gained, in importance. Whatever may be known about the health of the rural-urban type of young adult migrant, little or nothing is known about that of the urban-urban type. The health of the latter is largely a matter of surmise.

In view of the absence of any direct information as to the supposed peculiar healthiness, as regards tuberculosis, of young men and women migrating to and from the large towns in England, it seemed to be desirable, when testing for the possible distorting effects of migration upon recorded death-rates, to make three alternative assumptions as to the degree of physical superiority of migrants over the stationary population of the same age. These were: (i) that the migrants had *the same* phthisis mortality as the corresponding stationary population; (ii) that the migrants suffered *no* mortality from phthisis so long as they were below the age of twenty-five, *i. e.* remained within the age-group 15 to 24; (iii) that the migrants had a phthisis mortality *half* that of the stationary population in the town that they were entering or leaving. On these three assumptions three series of death-rates were calculated for young women for the various county boroughs in the two triennia, 1921-23 and 1931-33, each series thus involving a different allowance for the healthiness of the migrating young women. The first series is of course the ordinary recorded death-rates, and the second and third were termed "native" death-rates. (For method see Chapter 6.) The extent of the divergencies between these series of recorded and native death-rates will now be examined.

The employment of the two extreme assumptions, Nos. (i) and (ii) above, makes practically no difference in the values of the averages—125.5 on assumption (i) and 125.1 on assumption (ii)—of the two series of phthisis mortalities for 1931-33 for the group of 59 boroughs examined (these being the boroughs in which alterations in area between 1921 and 1931 were inconsiderable). Further, the use of these two assumptions makes comparatively little difference to the relative positions of the individual boroughs in the two series, since the value of the correlation between the two series of mortalities—recorded and native—is nearly unity (+.926), and their coefficients of variation are nearly equal (30.7% and 26.8%). It seems therefore, that migration of young women between 1921 and 1931 can have played very little part in producing the very considerable differences shown by their recorded death-rates in the various

English county boroughs in 1931-33, and that the errors resulting from neglecting migration are comparatively slight, at least in this triennium.

The effects of internal migration upon the *trends* of phthisis mortalities in the different boroughs during the decade 1921-23 to 1931-33 is a complementary problem which was closely examined by Bradford Hill (1936). This author came to the conclusion that although the trends of mortality from phthisis among young adults were of complex causation, alterations in internal migration were a factor, directly or indirectly, of some importance in determining them. If this conclusion be correct, the differing trends of mortalities (as estimated by percentage changes) in the various boroughs between 1921-23 and 1931-33 should tend to be equalized could the distorting effect upon mortality of the migration of adolescents and young adults, *both in the decade 1911 to 1921 and in the decade 1921 to 1931*, be mitigated or eliminated by suitable statistical computation, *i. e.*, were the trends to be based on native death-rates.

This tendency of the trends towards equalization has been tested by the method used above for the phthisis death-rates in the triennium 1931-33, again employing the two extreme assumptions (Nos. (i) and (ii)), and calculating two series of percentage declines in mortality over the period 1921-23 to 1931-33 in 41 boroughs (see Chapter 6 for methods of computation and reasons for restricted group of boroughs). Again the value of the correlation coefficient between these two series is found to be high (+.955), and their means and coefficients of variation to be nearly equal (means, 94.3% and 92.3% ; coefficients of variation, 26.5% and 24.3%). From this slight effect that even the extreme assumption (No. (ii) above) regarding the health of migrants has in equalizing the differing trends of phthisis mortality in the various boroughs, it would seem that while, as Bradford Hill stated, internal migration is a factor that "must be recognized in interpreting in specific areas the recent changes in the death-rate from phthisis amongst young adults", migration would seem perhaps to be less important than he suggested.

B. *Influence of Certain Social Factors in the County and London Boroughs upon Local Phthisis Mortality.*

The choice of social factors for special study in the present problem is determined at the same time by the likelihood of an ætiological relationship to tuberculosis, and by the availability of suitable data with which to compare their differences from one borough to another. Few social factors comply with both these requirements, and of them poverty, quality of housing accommodation, state of nutrition of the inhabitants, and the volume of gainful occupation of the young men and women, were selected for detailed examination.

At the same time it should be noted that influences outside the scope of the present survey and of a kind unsuited for statistical treatment of this type, such as the local occurrence of special industrial hazards, and the success of local anti-tuberculosis campaigns, may also have played a considerable but statistically indeterminate part in many of the boroughs.

(i) *Influence of Differing Extent of Poverty in the Various Boroughs.*

(a) *Influence of Differing Extent of Poverty as a Whole.*—Special interest in the problem of the regional association of high phthisis mortalities and poverty has resulted from the publication by Hersch in 1920 of his studies on the relationship of tuberculosis to poverty in the various districts of Paris, and by the subsequent investigations by Stevenson (1921) and by Greenwood and Wolff (1928) on similar relationships in London, Berlin and Birmingham. Among the more recent surveys deserving attention is that carried out by Green (1932) in Cleveland, U.S.A. The estimates of poverty used in these studies have necessarily been indirect. For example, liability to local house taxation, extent of employment of domestic servants, and monthly house-rental have been variously used for this purpose.

The only data available for the English county boroughs for estimating poverty as a whole are also indirect, since there is no information that allows the proportion of the local population living below an arbitrary poverty-line in these different boroughs to be ascertained. In the present survey three indirect measures of poverty have been used: the incidence of persons receiving poor relief, Stocks's "social index", and the incidence of sub-standard housing. Each of these measures has certain advantages and disadvantages.

Figures for poor relief might seem at first sight to be too labile a measure for comparing the extent of poverty from one place to another, through being too sensitive to trade cycles of a national or a merely local order. An examination of the proportions of persons on poor relief in English county boroughs (see Chapter 3) showed, however, that although their actual levels had varied somewhat widely at different times in recent years, the series order into which the boroughs had fallen at various dates in the post-war period had been fairly constant. Though fluctuations in volume of poor relief have taken place all over the country on a considerable scale, it is substantially true to say that the majority of those towns with high relief incidences in 1931-33 have had relatively high figures ever since the war. Consequently, the comparative figures for poor relief, as between one borough and another, have considerable stability.

The "social index", recently used by Stocks for comparing social conditions in county boroughs, has the advantage over poor relief of being based upon estimates of the earning capacity of the whole local

male population, and is less affected by administrative differences. On the other hand, the social index fails to take unemployment into consideration, and consequently may give a somewhat distorted comparison between boroughs which have grossly different unemployment rates.

While it is generally accepted that differences in local housing conditions serve as a broad index for comparing poverty between one borough and another, some aberrations are introduced by the existence in certain localities of housing scarcity, with unduly high rentals. Differences in local housing conditions have, however, the advantages over those in poor relief incidence that they have been compiled by the same method for the past twenty-five years, and have also been less dependent upon local differences in administrative interpretation.

The various comparisons made in Chapter 3 between the above three statistical measures and phthisis mortality in the different county boroughs agree with previous work upon other urban areas in demonstrating a general relationship between this disease and poverty. Of the three measures, poor-relief incidence showed the weakest, and sub-standard housing incidence the strongest, association.

A supplementary examination (limited to females aged 15 to 24 and 25 to 44) of the relationship between phthisis and poverty was made for the London boroughs. The social index and the sub-standard housing incidence were again used, with the addition of two other measures obtained from the New London Survey, namely, incidence of persons below the poverty-line ("Street Survey") and average income less rent, per head. In the main the London correlations supported the poverty-phthisis relationship found for the county boroughs.

While all the social statistics mentioned above provide general measures of poverty as a whole, two of them tend to measure, with some degree of directness, two of the more particular ætiological factors in phthisis—closeness of personal contact and nutrition. The housing density measure appears to have a special significance in connection with droplet-borne diseases such as phthisis, since it must reflect the closeness of personal contact between members of the population, and to that extent indicate the risk of acquiring infection. Similarly, the figures for the average income *less rent* in a given borough (unfortunately obtainable only for the London boroughs) seem to provide direct information as to the money that its population has available for the purchase of food. Accordingly, the influence of housing and nutritional inadequacy will be specially considered in turn in the two following sub-sections.

(b) *Influence of Differing Degrees of Housing Inadequacy.*—It was stated above that of the three social measures correlated with the level of phthisis mortality in the various county boroughs, sub-standard

housing incidence showed the strongest association. This applies to both sexes and to all age-groups below 45 years. What seems more important is the finding that this association remained highly significant when the other two social measures, social index and poor relief incidence, were held constant, either separately or together, by partial correlation (see Chapter 3). It would appear, therefore, that differences in housing inadequacy, implying differences in closeness of personal contact, are playing an important part in determining the present differences in levels of phthisis mortality between one English county borough and another.

The above relationships were in the main derived from comparisons made from social and mortality data collected for the years 1931 to 1933. The availability of similar housing data at the earlier census years, 1911 and 1921, allowed similar correlations to be computed for these dates. Apart from one unimportant exception (males, 15-24, 1926-28), it was found that the numerical values of the coefficients had risen progressively during the two decades. This rise was particularly evident among young adults of both sexes (see Table 8, p. 39). It is possible to interpret this fairly steady rise in the values of the coefficients of correlation as indicating a progressive increase in the relative importance of housing inadequacy in the epidemiology of phthisis in the county boroughs. Since it is difficult to believe that this rise into prominence of the housing factor could be due to any increase in its absolute importance, it would seem more likely to be due to a recession of some other ætiological factors that formerly were more prominent.

Not only did the differing *levels* of the local respiratory tuberculosis mortality in 1931-33 in the various English county boroughs appear to be related to the contemporaneous levels of housing conditions, but the differing *declines* in phthisis mortality between 1911 and 1933, reckoned both in terms of absolute and percentage-rates of change, were also related to these levels of housing conditions (see Chapter 3). Here, moreover, the relationship appeared to be stronger for the young adult age-group than for other ages, suggesting that young men and women were *selectively* sensitive, as regards phthisis, to the housing conditions of the towns in which they lived. The essential points of the special effect of housing at this age are strikingly shown by the following figures (from Table 16, p. 49, Groups 1 and 4) for the average percentage changes in phthisis mortality of females over this twenty-year period: females all ages, best-housed boroughs, decrease of 34%, worst-housed boroughs, decrease of 26-30%; females aged 15 to 24, best-housed boroughs, decrease of 22%, worst-housed boroughs, *increase* of 10-14%.

The influence that housing conditions have had on the improvement in phthisis mortality of young adults is further evident from the finding (see Chapter 4) that in two sub-groups of badly-housed county boroughs, one of which had shown, over forty years, a markedly

greater rate of improvement in its housing than had the other, the decline in phthisis mortality at this age was significantly greater in the former than in the latter sub-group.

The foregoing conclusions are all based upon data in which no allowance had been made for the markedly differing extent of the internal migration taking place to and from the various boroughs concerned. How far such migrants are selectively healthy as regards phthisis has already been questioned, but even when, for young women, the extreme assumption (No. (ii), p. 116) was made that none died from phthisis before the age of twenty-five, the correlations between housing conditions and both the levels and the rates of decline in phthisis mortality in the different county boroughs were still maintained, though at a reduced significance (see Chapter 6). On the less extreme and more reasonable assumption that the phthisis mortality of the migrants was half the recorded mortality for the same sex- and age-group in the boroughs that they were entering or leaving, the significances of the correlations were again reduced, though to a much less extent. It appears, therefore, that a part of the differences that are found from one county borough to another in the local levels and recent rates of decline of phthisis mortality among young women may be accounted for by internal migration—always presuming the correctness of the assumption that such migrating young women are, in fact, less subject to phthisis than is the corresponding stationary population. How great or small is the part thus accounted for must depend on the degree of superiority in health possessed by the migrants, but whatever the assumption, the housing-phthisis relationships for young women, found in Chapter 3, still remain definite enough to indicate the great importance of this social factor in respiratory tuberculosis.

The limited extent to which migration can account for the different declines in phthisis mortality in the various county boroughs is shown by the fact that the recent increase found in the recorded phthisis mortality of young women in the worst-housed boroughs (Group 1) persisted even when the most extreme assumption was made as to the healthiness of migrants (see Table 28, p. 81).

From the above considerations it may be concluded that differences in housing conditions from one locality to another are an important factor in producing the differences both in the levels and in the recent rates of change in phthisis mortality among young adults in the English county boroughs. This conclusion is in substantial agreement with that of the Registrar-General (1932c). The fact that the retardation noted for this age-group, both in the country as a whole and in the aggregate of its county boroughs, has been more severe in certain boroughs than in others is attributable, at least in part, to the deleterious influence of bad housing on an age-group that has been rendered especially sensitive to social conditions through biological stresses and exposure to industrial

fatigue. The practical deduction to be drawn is that the boroughs with poor housing conditions are those that have been taking particularly heavy toll of young adult lives through phthisis, and that unless these places do something to improve these conditions to a satisfactory level, their future, between loss of young persons by disease and loss by emigration, is gloomy.

In the supplementary observations for London boroughs, made on women aged 15 to 24 and 25 to 44, the housing-phthisis correlation coefficient in the older age-group had almost the same value as for the county borough series. For the younger women, however, the correlation coefficient for the London series was considerably smaller than for the other series. This comparatively slight association of housing with phthisis for young women in the London boroughs does not necessarily mean that closeness of contact is less important there as an ætiological factor than in the county boroughs. Rather may it signify that a housing index representing a given London borough is not an adequate measure of closeness of contact for an age-group whose occupations take many of its members for a large part of the working day into other boroughs with possibly very different degrees of congestion. This disadvantage in the character of the statistical material is a natural outcome of an inherent difference between county and metropolitan boroughs. The former are for the most part single and separate social units, whose populations mingle relatively seldom; the latter are essentially adjoining components of a large composite unit that is highly integrated for many of its activities.

(c) *Influence of Differing Degrees of Nutritional Inadequacy.*—While the importance of differing housing inadequacy in determining differences in phthisis mortality between the various county boroughs seems fairly clear, there is much less definite evidence for the importance of nutritional inadequacy—another great component of poverty. Unfortunately there are no statistics upon this component of poverty that are suitable for direct comparison with phthisis mortality in this series of boroughs, so that to estimate its influence it was necessary to fall back upon an indirect comparison based on partial correlations between phthisis and two measures of poverty, viz. social index and poor relief incidence, when the sub-standard housing incidence was held constant. It was thought that any correlation remaining after this procedure would provide some indication of the influence of any differences in nutritional levels between the boroughs. The resulting coefficients were found to be small, suggesting that if an association existed it was of a low order. However, the risks attaching to inferences drawn from the indirect evidence supplied by these partial correlations are considerable, as was pointed out in Chapter 3.

For the London boroughs, on the other hand, certain statistics bearing more directly upon nutrition could be derived from data in

the New London Survey. These statistics were the average income less rent, per head, in a large sample of population investigated in each borough. While these figures do not measure actual food consumption, there are strong grounds for believing that, from family to family, the income available for food and the level of nutrition are closely correlated. The significant correlation coefficients found in Chapter 8 between average income less rent and phthisis mortality among women aged 15 to 24 and 25 to 44 in the London boroughs are suggestive that in these areas at any rate sub-optimal nutrition is a factor in producing phthisis differences.

From the preceding discussion on housing and nutrition it is clear that it is extremely difficult to disentangle the components in the poverty-phthisis relationship. Summarizing the present findings, it seems that in the various county boroughs, and probably also in the various London boroughs, housing accommodation of high density is a factor of great importance in producing high phthisis mortality. On the other hand, the evidence for the importance of sub-optimal nutrition is slender for the county boroughs—though the data are rather unsatisfactory—but stronger for the London boroughs where the data are rather more direct.

The dilemma, as it is commonly presented in discussions of the problem of the relative importance of housing and food, may be thus put: is it reasonable for a working man to move to a higher-rented house on a new estate even if that move means a fall in the amount available per head for food? The dilemma in this form seems unanswerable on the evidence presented in this report, but to the closely cognate problem of whether a working man who has an *increase* in income should devote the *extra* to food or to housing, the evidence suggests that, from the point of view of guarding his family against phthisis, he should be advised to spend it on improving his housing.

It seems unlikely that any more complete estimate of the relative importance of nutrition and housing in the ætiology of phthisis in urban areas can be obtained from statistical treatment of this kind. It is probable that extensive field studies of the type carried out by Bradbury (1933) in the Tyneside area will be required. This author found a relationship between tuberculosis and both overcrowding and undernourishment (as judged by deficient dietary), and concluded that both these social factors were important in the development of tuberculosis. It should be remembered, however, that during the period of this survey the Tyneside was an especially depressed area, and that application of these findings to other parts of the country must therefore be made with caution. It is to be hoped that the present inquiry undertaken by the Rowett Institute will yield information of the type required upon nutrition and disease.

(ii) *Influence of Differing Volumes of Occupation in the Various Boroughs.*

It was pointed out in Chapter 7 that the ætiological relationship of industrial occupation to phthisis mortality might be two-fold. In the first place, the occupation might be of a nature to entail special risks, as in the tin-mining industry. In the second place, the occupation might operate more generally by increasing the liability to phthisis through fatigue and greater opportunities for contact with infective cases. Since the types of industrial occupation usually undertaken by young women seldom involve special industrial hazards of the first kind, the second mode of operation of occupation is the one that needs consideration in this report. Furthermore, since working conditions in different parts of the country vary so widely in character, and are therefore unsuitable for numerical treatment, the present comparisons of one borough with another are necessarily limited to variations in the proportion gainfully occupied, *i. e.* to the volume of occupation as obtained from census returns.

A correlation made for the county boroughs (see Chapter 7) between the levels of the phthisis mortality of young women, aged 15 to 24, in 1931-33 and the proportions occupied among this age-group (after excluding domestic servants because of their presumed smaller risk of contact with phthisis) failed to show any definite relationship between these two variables. Nor was any relationship found when the phthisis mortalities of young women, aged 15 to 24, were correlated with the proportions occupied among female "juveniles", aged 14 to 20, on the supposition that fatal cases of phthisis usually pursue a clinical course of several years.

A further correlation was carried out in order to determine whether the proportions of female juveniles, aged 14 to 20, engaged in industrial occupations in the different county boroughs affected the *percentage increases*, in these boroughs, of the phthisis mortality experienced by the generation aged 5 to 14 in 1921, when it grew up to be in 1931 the generation aged 15 to 24. In short, does a high degree of industrialization of girls in a locality tend to augment their phthisis mortality as young women, differences in concomitant social conditions being in effect excluded? This correlation was found to be significant, even after allowance had been made for the possibly distorting effect of internal migration.

At first sight there appears to be difficulty in reconciling the findings set out in the two preceding paragraphs. The two points under consideration are, however, rather different. On the one hand, the levels of phthisis mortality in the different county boroughs are the result of the cumulative action of many individual social factors, some with favourable and others with unfavourable influences, operating during *many decades*. On the other hand, the mortality generation method, by using the girls, aged 5 to 14, in each county borough to act in a sense as a control group for the young women,

aged 15 to 24, has the effect of minimizing the influence of many of the important social factors, such as housing, which are common to both age-groups, and singles out the action of a particular social factor, namely, volume of occupation, during a *single decade*.

From these considerations it would seem that the differences in phthisis mortality *levels* of young women from one county borough to another cannot be accounted for by local differences in the proportion occupied in industry, either among that age-group or among the rather younger group of girls classified officially as juveniles. Such a causal relationship, were it to exist, would probably be prevented from showing itself by reason of the over-weighting influences of other social factors, such as housing. On the other hand, there does seem to be a relationship between differences in the frequency with which fatal phthisis develops among girls *as they grow up* into adult life in the various county boroughs and the differences in the extent to which these girls enter industrial occupations. This latter finding supports the view, already expressed in the earlier part of this chapter, that the recent increase in the proportion of young women in industrial occupations may provide a partial explanation of the check in the decline in the phthisis mortality at this age in England and Wales as a whole.

IV. SYNTHESIS OF THE VARIOUS FACTORS CONSIDERED RESPONSIBLE FOR THE RETARDATION IN DECLINE IN PHTHISIS MORTALITY AMONG YOUNG ADULTS.

It is quite evident from the foregoing discussion that no single cause will suffice to explain the remarkable retardation that has taken place in the decline in phthisis mortality in young adults. The phenomenon must depend on the complex interaction of a number of factors. Any hypothesis as to its causation should take into account the following salient facts:

(a) The retardation has affected young women considerably more than young men.

(b) In the country as a whole, it began about 1901 to 1905 for young women and about 1913 for young men.

(c) It has shown signs of coming to an end since 1933.

(d) Diseases other than respiratory tuberculosis, taken as a whole, have not shown the same retardation among young adults.

(e) It has affected all parts of the country but to different degrees. Taken as a whole, urban areas have been considerably more seriously affected than have rural districts.

(f) The urban areas themselves have been very unequally affected.

(g) The county boroughs most affected are also in general those with the worst housing. This remains true even after allowance has been made for internal migration in calculating mortality-rates.

(h) In the worst-housed county boroughs there was an actual increase in phthisis mortality amongst young women between 1911 and 1933.

The following hypothesis is advanced to account for these facts:

(1) During the latter part of the nineteenth century the steady rate of improvement in the average standard of living was sufficient to permit the steady decline in phthisis mortality in every age-group of both sexes in the country as a whole, in spite of the high sub-standard housing incidences in many urban areas.

(2) About 1900 a rather sharp check took place in the improvement in the standard of living, and subsequently its advance occurred at a distinctly slower rate. This retardation in the rise in the standard of living was accompanied by a set-back, which continued until after the war, to the improvement in the housing conditions of the country as a whole.

At the beginning of the century also there was an accentuation in the already increasing proportion of young women entering gainful employment, with its necessary accompaniment of strain and fatigue. This increase in employment among young women was accounted for largely by industrial occupations, the latter to some extent replacing domestic service. The increase in industrial employment, by tending to bring young women more into contact with large numbers of persons, provided more opportunities for them to acquire tuberculous infection.

These social changes (in standard of living, housing, and volume and type of occupation), that took place in the country as a whole, exerted an effect selectively upon phthisis among young adults, who are considered to be particularly sensitive, as regards this disease, to the conditions to which they are subjected during the formative years of adolescence and early adult life. Their sensitiveness to social conditions is suggested to be due partly to the stress and strain arising from the environment of industry, and partly to biological changes occurring during adolescence. The latter possibly also account for young women being apparently more sensitive than young men.

The selective effect upon phthisis among young adults produced by the above far-reaching social changes took the form of a serious retardation in the rate of decline in their mortality from this disease. The retardation began about 1901-05 for young women, and about 1913 for young men, and persisted for both until about 1933. While this set-back was taking place, the phthisis mortalities for the other age-groups of both sexes continued to decline much as before, except during the war period of 1914-18.

No corresponding retardation in the decline in mortality from "diseases other than phthisis" took place amongst young men and women. From certain evidence obtained from study of the county boroughs, this difference is attributed to a lesser sensitiveness of

these young persons to social conditions as regards the very heterogeneous collection of diseases that this composite term embraces.

(3) The evidence here presented is against the hypothesis that the retardation in phthisis mortality decline among young adults has been due to decreased tuberculization in childhood with resulting reduced immunity in adolescence.

(4) During the war period, 1914-18, the sharp deterioration of the standard of living, with the acute food shortage, the increased overcrowding and the increased industrialization, was sufficient to convert the retardation in the decline in phthisis mortality among young women into an actual gross but temporary rise. This rise was shared by other female age-groups, though the elderly and the very young were only slightly affected.

(5) While the retardation in the decline in phthisis mortality among young adults took place in all parts of the country, its local distribution was uneven. It was severe in the larger urban areas (London and the county boroughs), and more especially so in those where the local social conditions, particularly housing, were most unfavourable.

(6) The trend of internal migration of young women from the county boroughs with bad social conditions towards those with better conditions may have tended to produce distortions in the local mortalities recorded, since it is possible that these young migrants are selectively healthy. While such distortions would exaggerate the true mortality differences between the good and the bad boroughs, they would be incapable of entirely accounting for the differences in the recorded figures. Even if the very improbable assumption be accepted that the migrants are quite free from tuberculosis, the mortality differences remaining between the good and the bad boroughs after adjustment for migration are still marked.

(7) The possible ending, about 1933, of the retardation in the decline in phthisis mortality for young adults may possibly be attributed to an acceleration in the building of new houses, with its effect upon overcrowding. However, the short period involved, and the absence of any direct data upon housing conditions during an intercensal period, make any such explanation at present conjectural.

TABLES TO CHAPTER 9.

TABLE 36.—*Mortalities from Tuberculosis, per 100,000 living, by Sexes and at various Ages in certain Countries.*

Country.	Date.	Ages.					
		10 to 14.		15 to 19.		20 to 24.	
		M.	F.	M.	F.	M.	F.
England and Wales	1929	28	38	79	116	122	147
Australia	1929	6	9	24	44	54	77
Austria	1927	30	52	101	140	167	198
Denmark	1927	27	27	54	120	102	163
Esthonia	1927	25	80	180	231	389	271
U.S.A.	1926	13	22	54	102	107	147
France	1927	37	68	141	232	240	309
Irish Free State	1929	42	71	110	208	211	277
N. Ireland	1927	23	77	120	213	211	317
Norway	1927	39	79	169	227	356	306
Sweden	1926	40	66	128	185	247	255
Prussia	1928	22	35	60	93	117	133

Source: League of Nations (1931, Tables XV and XVI).

TABLE 37.—*Deaths from Tuberculosis, All Forms, and Acute Forms (Acute Miliary Tuberculosis and Meningitis), at ages 15 to 24, in England and Wales in 1911-13, 1921-23 and 1931-33.*

	Males.			Females.		
	1911-13.	1921-23.	1931-33.	1911-13.	1921-23.	1931-33.
1. Tb. All Forms	11,569	11,839	9,770	13,072	14,915	12,458
2. Acute Miliary Tb.	170	167	195	230	224	238
Per cent. of All Forms	1.47	1.41	2.00	1.76	1.50	1.91
3. Tb. Meningitis	468	503	486	579	497	499
Per cent. of All Forms	4.05	4.25	4.98	4.43	3.33	4.00
4. Total of Acute Forms	638	670	681	809	721	737
Per cent. of All Forms	5.52	5.66	6.98	6.19	4.83	5.91

Sources:

- 1911-13. Annual Reports of Registrar-General for England and Wales, Tables.
 1921-23. Statistical Review for England and Wales, Part I, Medical, Tables.
 1931-33. As for 1921-23.

EXPLANATORY NOTES.

1. Tuberculosis All Forms: Deaths recorded under following categories of International Lists of Causes of Death: 1911-13, Nos. 28 to 35; 1921-23, Nos. 31 to 37; 1931-33, Nos. 23 to 32. These three sets of categories are practically co-extensive.
2. Acute Miliary Tuberculosis: Deaths recorded under following categories: 1911-13, No. 29B; 1921-23, No. 37A; 1931-33, No. 32A. These three categories are co-extensive.
3. Tuberculous Meningitis: Deaths recorded under following categories: 1911-13, No. 30; 1921-23, No. 32; 1931-33, No. 24. These three categories are co-extensive.
4. Total of Acute Forms: Figures for Nos. 2 and 3 combined.

GENERAL CONCLUSIONS¹

1. The problem under examination is the development, distribution and causation of the retardation in the decline in respiratory tuberculosis mortality among young adults that made its appearance early in the present century.

2. The phenomenon is examined mainly in relation to such important social conditions as can be ascertained from national and local statistical sources. These include general standard of living, poverty, housing, internal migration and volume of occupation.

3. The retardation in decline in respiratory tuberculosis mortality has affected young women more severely than young men. For the former the retardation began between 1901 and 1905, while for the latter it began about 1913.

4. The retardation has been most evident in London and in the county boroughs. In the latter there have been marked differences from one to another, and these differences may have been increased by internal migration. In some county boroughs the retardation has been only slight, while in others it has been so severe that the mortality from respiratory tuberculosis among young women was higher in 1931-33 than it had been twenty years before.

5. It is suggested that the retardation has been brought about by—

(a) *A predisposing factor, i. e.* the special sensitiveness of young adults, in comparison with persons of other ages, to social conditions, as regards their mortality from respiratory tuberculosis. This sensitiveness is possibly the effect of combined environmental and biological causes—the stress and strain of industrial occupation during the important formative period of adolescence and early adult life.

(b) *General determining factors, i. e.* the contemporaneous country-wide changes in general social and economic trends, affecting the young adult respiratory tuberculosis mortality in all areas. The most important of these changes are the check to the rise in the standard of living occurring about 1900, which was accompanied by a set-back in the improvement in general housing conditions, and the accentuated increase in the industrial employment of young women also taking place about that date.

(c) *Local determining factors, i. e.* unsatisfactory local social conditions, rendering the effect upon the young adults in certain localities especially severe. Of these local social conditions, housing appears to be of great importance. The part played by other factors in poverty is less clear. In the London boroughs, where the poverty data available are more complete than in the county boroughs, and information is obtainable for average income less rent per head, there is some evidence that other factors in poverty, such as inadequate nutrition, have also been influential.

¹ A summary will also be found at the end of each chapter.

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APPENDICES ON MATERIALS, SOURCES AND METHODS

The statistical sources and methods used in this report have been briefly referred to in the earlier parts of the respective chapters. Since much of the material has required extensive re-calculation, it seems desirable to state and discuss its sources and treatment in greater detail, chapter by chapter.

Appendix to Chapter 2. (The History of the Standard of Living in the United Kingdom from 1850 to 1936, in Relation to Respiratory Tuberculosis Mortality.)

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A. THE COURSE OF WORKING-CLASS REAL EARNINGS FROM 1850 TO 1936.

(i) *Explanation of Terms used.*—*Real Earnings* may be defined as money earnings evaluated, by means of cost-of-living index numbers or some similar estimate, in terms of their real purchasing power. Changes in the average level of working-class real earnings from one year to another can conveniently be represented by a time series of percentage relatives, *i. e.* figures expressed as percentages relative to the particular figure for the year chosen as base. These percentage relatives of real earnings are themselves derived from a time series of percentage relatives of estimated *working-class average money earnings*, in conjunction with a time series of percentage relatives (often termed index numbers) of estimated *working-class cost of living*, by arranging for the latter two series to have a common base year and base number, and then dividing, for each year, the money-earnings percentage relative by the corresponding cost-of-living index number.

Two of the possible measurements of *working-class average money earnings* must be considered at this point. The first is an estimate of *working-class average actual annual money earnings*. These earnings may be defined as the average actual remuneration in a year per worker in the industrial community in the country as a whole, including all occupations and industries, piece-work as well as time-work, taking account of overtime, short time and unemployment, as well as of full-time work, and allowing also for absence through sickness and holidays. The second possible measurement is an estimate of *working-class average full-time weekly money earnings*. These earnings may be defined as the average remuneration in a week of full-time work (*i. e.* a normal week) per worker in the industrial community in the country as a whole, including all occupations and industries, and both piece-work and time-work, but taking account only of full-time employment.

Changes from year to year in the average level of working-class actual annual money earnings are usually brought about by the operation of one or more of the following factors: (1) changes in weekly time-rates (or hourly rates calculated on a weekly basis), or in piece-rates; (2) changes in the proportion of workers on time-work and on piece-work in individual occupations; (3) alterations in facilities for earning on piece-rates (*e. g.* through technological developments or through changes in average skill and efficiency); (4) alterations of the hours of work in a full-time week for piece-workers (affecting, like (3), the average number of "pieces" worked

in a week); (5) changes in the average proportion of a full-time week actually worked (due to variations in the amounts of overtime, short time or unemployment); (6) changes in the amount of holidays and of sickness; (7) changes in the relative numbers of workers in the various component occupations of each industry (through migration from one occupational wage-grade to another within the particular industry); and (8) changes in the relative numbers of workers in the different industries (through migration from one industry to another). Changes from year to year in the average level of working-class full-time weekly money earnings are usually brought about by the operation of these same factors, with the exception of (5) and (6), which by definition cannot be effective.

Of these two possible measurements of working-class average money earnings, time-comparisons of the first (*i. e.* actual annual earnings) would probably be the more satisfactory for estimating the course of real earnings, and consequently of the standard of living. Direct computation of either measurement is, however, a matter of considerable difficulty, and for complete accuracy would require periodic censuses of the earnings of all workers occupied in each individual industry, together with the numbers of workers in the various industries. Such an objective, even on a limited scale, has only been directly approached at the occasional official earnings inquiries (1886, 1906, 1924, 1928 and 1931), though private investigations have enabled additional estimates to be made covering considerable periods. Having regard to the type of data available, it is probably better to use percentage relatives of the estimated working-class average full-time weekly money earnings, rather than of estimated working-class average actual annual money earnings, for the present purpose of measuring movements of working-class average money earnings. The figures of these time series are, nevertheless, subsequently modified by allowing for the variations of unemployment (see factor (5) above), before computing the movements of working-class average real earnings and estimating the changes in the standard of living.

Since for the last decade of the period under consideration (1850 to 1936) no suitable estimates of changes in working-class average money earnings as a whole have been derived from the official earnings inquiries (1928, 1931), it is necessary to judge their course from that of *working-class average money wage-rates*. Instead of time series of percentage relatives of estimated working-class average full-time weekly money earnings, time series of percentage relatives (index numbers) of estimated working-class average money wage-rates are consequently used for these latter years.

The expression *working-class average money wage-rates* is here used to mean the general average of the full-time weekly wage-rates of the various working-class occupations, and of the industries composed by these occupations, selected to represent industry as a whole. A series of index numbers of working-class average money wage-rates is usually obtained by a twofold computation.¹ In the first step the wage-rates of the various occupations within each industry are combined, for each year, into a simple or a weighted (fixed weights) average, expressed as a percentage relative, to

¹ This computation involves the use, in some occupations or industries, of piece-rates in place of, or in addition to full-time weekly time-rates. Even if the piece-rates are converted into time-rates for convenience of calculation, by means of a factor determined by the estimated average number of "pieces" worked in a full-time week, this factor (which is an approximation subject to variation from one worker to another) is usually kept unaltered, and will therefore become incorrect if significant alterations, either in the hours of a full-time week or in the facilities for earning on piece-rates, occur in the particular occupation or industry during the period covered by the series of index numbers. On account of this limitation the description of these index numbers as applying to full-time weekly wage-rates may be inaccurate and misleading.

represent the particular industry. In the second step the various series of percentage relatives, representing the different industries, and having a common base year and base number, are combined, usually with fixed weights, to form a single time series of percentage relatives (index numbers) to represent industry in the country as a whole.

Changes from year to year in the average level of working-class money wage-rates, represented by a time series of index numbers obtained as described above, are brought about by changes in piece-rates, or in weekly time-rates (*i. e.* factor (1), p. 133), but the remaining factors ((2) to (8)) considered in connection with earnings will, by definition, be ineffective. That is to say, movements of estimated working-class average money wage-rates refer to the changes in the average of the *rates* of corresponding industrial and occupational *grades*, whereas movements of estimated working-class average money earnings go further, and refer to changes in the average of the *remunerations* received by the *workers* in all industries and occupations taken together.

Any series of index numbers of working-class average money wage-rates (as defined above) may not pursue the same course as would a contemporaneous series of percentage relatives of working-class average full-time weekly money earnings, since no account is taken in the former of the factors (2) to (4) and (7) and (8), which, as already mentioned, are liable to affect the level of average full-time weekly money earnings, and which are likely to be in operation to some extent during the period covered by the series. Further deviation might be caused by the use, in the wage-rate series of index numbers, of inappropriate fixed weights (usually settled by the relative importance of individual industries, or of individual occupations within an industry, in the base year of the series); by delay in introducing a fresh system of newly fixed weights and therewith starting a new series of index numbers (after significant alterations of the relative importance of industries and occupations have taken place); or by the use, for conversion of piece-rates into weekly time-rates, of incorrect factors (determined by estimates of the output per worker). In spite of all these possible sources of discrepancy, there is good reason to suppose that certain series of index numbers of working-class average money wage-rates, covering comparatively short periods of years, reflect sufficiently well the contemporaneous course of working-class average full-time weekly money earnings. As with the figures of the earnings series, the wage-rate index numbers used in Chapter 2 are modified, by making allowance for the varying amounts of unemployment, before they are evaluated in terms of real purchasing power for the purpose of estimating movements of the standard of living.

Whether the time series employed in the present survey is one of percentage relatives of estimated working-class average full-time weekly money earnings (as for the greater part of the period), or is one of index numbers of estimated working-class average money wage-rates (as for the last decade), the time series of index numbers of estimated working-class cost of living to be used in conjunction with it is the same. The resulting quotient represents real earnings in the first case, as already stated, and what is termed *real wage-rates* in the second.

The expression *working-class cost of living* must now be explained. It may be defined as the average cost of an assumedly unchanged standard of life throughout the period considered. Changes in the average level of working-class cost of living from year to year are represented by a time series of percentage relatives (index numbers). These index numbers are usually obtained by averaging percentage relatives that represent the year-to-year changes in the cost of certain selected articles of consumption, as well as of

clothing, rent, etc., using fixed weights; or by combining index numbers of average retail prices with the percentage changes in the cost of rent.

(ii) *Changes in Working-Class Average Money Earnings.*—In order to show the changes in the average level of working-class money earnings from 1850 to 1936, various time series, each covering a part of the period, were linked together to form a composite series covering the whole. The time series used, as pointed out above, were of percentage relatives of estimated working-class average full-time weekly money earnings, except for 1920 to 1923 and 1925 to 1936, when index numbers of estimated working-class average money wage-rates were employed. For the individual series used and for the methods adopted for linking them together, we followed Layton and Crowther (1935*a*), except for the important period 1903 to 1914.

(a) 1850 to 1914: A time series of percentage relatives of estimated working-class average full-time weekly money earnings for the period 1850 to 1902 was published by Wood (1909). It was obtained in the following manner. First, average earnings, time or piece as the case might be, for a worker in each clearly defined occupation in as many industries as possible were obtained. The average earnings per worker in each of the various industries were then calculated from one year to another, allowing for changes in the relative numbers employed in its different component occupations. Having expressed the figures for each of the industries as a series of percentage relatives (base: 1900 = 100), these various series were combined to form a single time series of weighted averages to represent the changes in the earnings per worker in the country as a whole. The weights used in this latter computation were proportioned according to the estimated relative numbers in each of the various industries, and were re-proportioned at intervals of a few years to keep pace with the estimated alterations in these numbers. In the column headed "Average Money Wages" in the Appendix to Wood's (1909) paper, this final series of percentage relatives was tabulated for each year from 1850 to 1902, the figures having been re-arranged in order that the first year, 1850, of the series should form the base.

Subsequently, Wood (1910) continued this series of average money earnings from 1903 to 1910, and Bowley (1920, 1928*a*), using a similar method, extended it to July, 1914.

(For some of the above information we are indebted to Mr. G. H. Wood (1936).)

(b) 1915 to 1919: Bowley's (1921) estimates made for the period 1914 to 1920 were used for the war years, 1915 to 1919. His time series paid attention to the factors (1), (2), (3) and (7) (see p. 133), and therefore seems to approach more closely to money earnings than to money wage-rates. The base of this series was July, 1914.

(c) 1920 to 1923: For this short period the Ministry of Labour's (1933*b*) index numbers of average money wage-rates (base year, 1924) were intercalated in order to bridge the gap existing between Bowley's war-time figures and his subsequently ascertained earnings figures for 1924. There remains, however, some discrepancy between the present figure for 1920, which was calculated backwards from 1924, and that, for the same year, calculated forwards from 1914 in Bowley's war-time estimates. This discrepancy, which merely involved two or three years about 1920, does not affect the continuity of the main pre-war and post-war series.

(d) 1924: Bowley (1929) estimated the level of working-class average full-time weekly money earnings in December, 1924, as a percentage relative to that obtaining in July, 1914, so performing the valuable service of connecting the pre-war and post-war periods. After careful

consideration of the various sources of error, he concluded that the figure 195 provided the best estimate of this percentage relative. In making this calculation Bowley derived his information largely from the official earnings inquiries of 1906 and 1924. He took into account the factors (1) to (4) and (7), but ignored (8) (p. 134), considering that during the period under review the net movements of workers between industries would not have significantly affected the result.

(e) 1925 to 1936: For this decade the index numbers of working-class average money wage-rates published by the London and Cambridge Economic Service (1929, 1933, 1937), on the basis of Bowley's (1929) calculations, were employed. The base of this series was December, 1924. Bowley (1929) has expressed the belief that from 1924 to 1928 the movements of average full-time weekly earnings cannot have differed significantly from that of average full-time weekly wage-rates; the same is probably true to 1931 (see Bowley, 1935), and there is no evidence of any significant change in this respect up to 1935 (Bowley, 1936).

These various series, Nos. (a) to (e), were linked together into a single composite series having its base: 1850 = 100. The figure for July, 1914, in Wood's extended series was taken as a new base number for Bowley's series between 1915 and 1919. The same figure for July, 1914, multiplied by 195/100 (see above), was taken as the figure for December, 1924, and so formed the base number for both post-war series (1920 to 1923 and 1924 to 1936). The composite series, so constructed by successive linkings, is therefore numerically continuous between 1850 and 1936. It is set out in Table 3, column (2), quinquennial averages being given from 1850 to 1899, and yearly figures subsequently. This setting out by quinquennial groups for the earlier part of the period, and by single years for the later part, facilitates comparison with the corresponding respiratory tuberculosis mortalities given in Table 1 (see Chart 4).

This composite series of percentage relatives has been modified, following Wood (1909) and Layton and Crowther (1935a), by making some allowance for the varying incidence of unemployment. For this incidence the percentage unemployment among members of certain trade unions was used from 1850 to 1921, and the percentage unemployment among workers insured under the Unemployment Insurance Acts was used from 1922 onwards (Wood, 1909; Ministry of Labour, 1928a, 1933a, 1936a). In the first period unemployed workers were assumed to have no income at all, while in the second period the admittedly arbitrary fraction of one-third of the prevailing standard average full-time money earnings was assigned to them. This modified series of figures for earnings is set out in Table 3, column (4).

(iii) *Changes in Working-Class Cost of Living.*—In order to show the changes in the average level of working-class cost of living from 1850 to 1936 two time series of index numbers were linked together.

(a) 1850 to 1914: Wood (1909, 1910), in his two papers, gave a series of index numbers of estimated working-class cost of living which he derived from the average retail prices of certain commodities in combination with an amount for rents (the latter being assumed to have increased uniformly throughout the period). Bowley (1920), using a similar method, extended the series to July, 1914. This series had as base, 1850 = 100.

(b) 1915 to 1936: For this period the Ministry of Labour's (1933c, 1934, 1936b) index numbers of working-class cost of living (base: 1914 = 100), which takes rent into consideration, was employed.

These two series were linked together into a single composite series, having as base: 1850 = 100. The figure for July, 1914, of series (a)

was taken as a new base number for series (b), so attaining numerical continuity from 1850 to 1936. This composite series of percentage relatives (index numbers) of cost of living are set out in Table 3, column (5).

(iv) *Changes in Working-Class Real Earnings*.—Since real earnings are money earnings evaluated, by means of the cost of living, in terms of their real purchasing power, it was possible to calculate the changes in real earnings by making use of the time series of the percentage relatives of average money earnings (allowing for unemployment), and that of the index numbers of the cost of living. By dividing, for each year, the figure in Table 3, column (4) by that in column (5), and multiplying the quotient by 100, a time series of percentage relatives for the course of working-class average real earnings from 1850 to 1936 was obtained and is set out in column (6). It should, however, be noted that for certain periods (1920 to 1923 and 1925 to 1936) the figures in column (6) represent the changes in real wage-rates rather than in real earnings, though unemployment incidence is still taken into consideration.

Certain errors and deficiencies inherent both in average money earnings and in cost of living must be considered when interpreting this series of figures for real earnings.

In the first place, the use of single averages, representing the country as a whole, has the disadvantage of concealing the separate movements of earnings in individual industries and grades of occupation. For example, wage-rates in the coal-mining industry showed a greater improvement than those in many other important industries between 1896 and 1912, though since then they have retrogressed. Again, the movements of the wage-rates in sheltered and unsheltered industries, and among skilled and unskilled workers, even in the same industry, have differed significantly since 1914. The recent widespread unemployment has intensified the disparity between different groups, since it has particularly affected those industries that have experienced the greatest reductions in wage-rates.

The earlier estimations of average money earnings for workers in the country as a whole rest on a narrow basis, because the scarcity of data then available restricted the computations to comparatively few industries and occupations. Latterly, the collection of wage returns from a greater variety of industries and occupations has increased the representativeness of earnings and wage-rate figures. Though sheltered and unsheltered trades and skilled, semi-skilled and unskilled workers are included, such wage returns are largely limited to those industries or sections of industries in which organized arrangements exist for the negotiation of changes in wage-rates on a collective basis, even though such agreements may not be adhered to universally. Groups such as clerical workers, domestic servants and shop assistants are not subject to accurate assessment, since the existence of extensive non-collective bargaining in these occupations makes it difficult to obtain the requisite information.

Though the figures set out in Table 3 are modified by taking unemployment into consideration, no satisfactory adjustment for short time is practicable except in so far as this is included in the category "Temporarily Stopped" in the unemployment returns. Short time in the more usual meaning of the term was particularly prevalent from 1929 to 1934, and would, like unemployment, have depressed the level of actual average money earnings. Consequently, in the absence of such adjustment, the figures in columns (4) and (6) of Table 3 tend to present the movements of real earnings in those few years in too favourable a light.

The accuracy of the earlier estimates of the average cost of living is possibly affected by the relatively limited data, both for average retail prices and for rents, that were available at the time when they were drawn

up. For example, many of the figures were obtained by sampling certain localities only, and the general averages so derived were not necessarily true of the country as a whole. Other possible deficiencies result from the omission, or unsatisfactory weighting, of particular commodities, *e. g.* clothing, tobacco and certain articles of food, having regard to changes in habits and tastes, together with alterations in the quality of the articles consumed. These deficiencies are still present in the cost of living index now published by the Ministry of Labour, which is based upon the pre-war average expenditure of a number of working-class families as ascertained by an official inquiry. Bowley (1928*b*), however, considered that, so far as food was concerned, it was unlikely that a new collection of budgets would by any formula lead to a significant modification of the measurement of the *change* in the cost of living.

The effect of these errors and deficiencies is to reduce the significance of the oscillations in the figures of the present series of working-class real earnings that are found over short periods, as from one year to the next. It is, however, unlikely that they have, by a cumulative action, disturbed the series as indicating the general movements of real earnings over substantial intervals of years, and consequently the general movements so shown can most probably be regarded as a satisfactory basis for the purpose of the present statistical study.

(v) *Additional Data bearing on Movements of Real Earnings.*—As a general check upon the foregoing series of real earnings, we examined certain additional series. The first was a series of real wage figures recently published by Bowley (1937) for the period from 1880 to 1936, which, for purposes of comparison with our present series, we modified for unemployment in the manner previously described, and re-calculated to a new base. The second series, covering the period from 1920 to 1933, was Ramsbottom's (1935) recently devised index of real wage-rates, again modified by us for unemployment and re-calculated to the appropriate new base. The third was the Ministry of Labour's (1928*b*) series of index numbers of retail prices of food, clothing and rent for the period from 1895 to 1914. On examination, the courses of all three series were found to be closely similar to those of the present series set out in Table 3.

To depict the historical development of working-class real earnings, the present series (Table 3, Column (6)) has been charted on a semi-logarithmic scale in Chart 4.

B. ALTERATIONS IN THE RATIO OF WORKERS TO DEPENDANTS.

Changes in the average disposable real income of the working-class population are brought about not only by changes in real earnings, but also, though in lesser degree, by alterations in the relative proportions of workers to their dependants. In order to provide the basis of an estimate of these alterations for the only part of the whole period for which the requisite information is available, the populations and numbers occupied (males, females and persons) in England and Wales at the censuses of 1901, 1911, 1921 and 1931 are set out in Table 4. The figures show a slight but definite increase, from 44.1% to 47.2%, in the proportion of occupied persons to total population during this thirty-year period. Assuming that these figures, derived from England and Wales only, are applicable to the working-class population as a whole in the United Kingdom, the effect of the slowly altering ratio is to cause *per capita* real income to increase at a greater rate than real earnings. The numerical alterations in average disposable real income *per capita* of working-class population due to this cause are, however, inconsiderable except for the last decade for which information is available, 1921 to 1931.

C. CHANGES IN THE EXPENDITURE ON PUBLIC SOCIAL SERVICES.

While the standard of living of the working class is chiefly determined by its average *disposable* real income, it is also affected by the prevailing level of average *non-disposable* real income, the main source of which is public social service expenditure. The expenditure on the chief services at various dates between 1890 and 1932 is shown in Table 5.

For the present purpose certain of the items shown in this table must be entirely or partially disallowed, either because account has been taken of them in other ways, or else because they do not have an appreciable direct influence upon health. Since, following the method of Layton and Crowther, an arbitrary allowance of one-third of the corresponding figure for money earnings has already been made for unemployment when computing the figures for real earnings in Table 3, expenditure under item (1) of Table 5 has been disallowed. On the other hand, item (6), expenditure under the Education Acts, has been disallowed for the second reason. (The actual expenditure on free meals and milk to school-children under the Education Acts, while of unquestioned value to their health, has been so small relatively (since 1911 it has never exceeded £1·0 m., and has usually been below £0·5 m.), that its exclusion makes no appreciable difference to the present estimation of changes in standard of living.) The remaining items of Table 5, taken together, may be regarded as providing a fairly accurate indication of the changes in working-class non-disposable real income.

Examination of Table 5 shows that, even with certain items disallowed, the public social services have provided an increase in working-class non-disposable real income which began to assume considerable proportions in the decade 1910 to 1920. It should, however, be remembered that taxation on certain kinds of commodities not included in cost-of-living indexes, *e. g.* entertainments, alcoholic beverages, etc., contributes large receipts to the national revenue on which these services are charges. This form of indirect taxation has greatly increased since 1914, and has thus offset a considerable proportion of the rise in working-class non-disposable real income usually ascribed to increased social service expenditure.

(For a summarized account of the various public social services in 1930, see International Labour Office, 1933.)

D. ALTERATIONS IN THE HOURS OF LEISURE.

A considerable reduction in the usual number of hours in a full-time working week has taken place since 1850. According to an estimate made by Wood (1936) they fell from roughly 60 hours or more in 1850 to 54-55½ hours in 1902. Between 1914 and 1924 the hours of work were generally reduced by more than 10%, and for a large aggregate of industries averaged about 47 hours in the latter year (Bowley, 1929). This estimate would imply an average figure of more than 52 hours in 1914. There have been relatively few alterations of hours between 1921 and 1933 (Ramsbottom, 1935).

The increased leisure resulting from the reduction in the length of the normal working week has undoubtedly raised the standard of comfort of the working class. Partially offsetting this gain in leisure, however, more especially from its health aspects, may be the increased intensity at which work is often carried on (much of it due to the replacement of time-work by piece-work), and which may be expected to result in heightened fatigue to the worker, and consequent increase in his or her susceptibilities to certain types of disease (see Dobb, 1933).

Appendix to Chapter 3. (Mortality from Respiratory Tuberculosis in the Different English County Boroughs between 1911 and 1933, in Relation to Certain Local Social Conditions.)

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A. AREAS INVESTIGATED (76 SELECTED ENGLISH COUNTY BOROUGHS).

The county boroughs were chosen because they constituted the smallest individual areas for which sufficiently detailed mortality statistics were obtainable, and for other reasons (see p. 24). In 1933 there were 79 English and 4 Welsh county boroughs. The four Welsh county boroughs were excluded from the survey. Certain of the English county boroughs were constituted after 1911 (see notes to Table 2), and it was therefore necessary in their case to obtain from sources other than official publications some of the earlier data required. Since it was not found possible to obtain these unpublished data for Barnsley and East Ham, these boroughs unfortunately could not be included in the survey, while Doncaster was excluded on account of its very recent promotion to county borough status. These omissions left 76 English county boroughs available for investigation. The group is here referred to as "the 76 selected English County Boroughs". It should be noted that while two of these county boroughs (Croydon and West Ham) form part of the Outer Ring of Greater London, the Administrative County of London, with its component Metropolitan Boroughs, is not considered in this part of the investigation.

B. PERIOD OF SURVEY (1911 TO 1933).

The early limit of the survey is fixed by the introduction in 1911 of the present system of transferring deaths from the area where death takes place to the administrative area of the deceased's usual residence, where these differ (Registrar-General, 1911*a*). The later limit was determined by the availability of reasonably satisfactory mortality data, the accuracy of which declines progressively after each census year owing to unknown changes in population.

C. MORTALITIES (MORTALITY FROM RESPIRATORY TUBERCULOSIS).

(i) *Deaths*.—The deaths were obtained from the Registrar-General's Annual Reports and Statistical Reviews of England and Wales. (In the case of county boroughs constituted since 1911, the data were obtained either from the annual reports of the borough Medical Officer of Health or by personal communication from him.)

From 1911 to 1920 the deaths were those under No. 9 of the Registrar-General's abridged list of causes of death, corresponding to Nos. 28, 29A and 29B of the International List for 1911. This category (No. 9) comprises pulmonary tuberculosis and phthisis (including laryngeal tuberculosis), together with acute miliary tuberculosis, and excludes disseminated tuberculosis other than acute miliary tuberculosis. From 1921 to 1930 the deaths were those under No. 10 of the abridged list, corresponding to No. 31 of the International List for 1921. This category (No. 10) comprises tuberculosis of the respiratory system (including laryngeal tuberculosis), but excludes acute miliary tuberculosis, which was incorporated in the category of disseminated tuberculosis from the year 1921. From 1931 to 1933 the deaths were those under No. 9 of the abridged list, corresponding to No. 23 of the International List for 1931. In spite of the alteration of number, the content of this category remains unchanged from that of the previous decade, 1921–30.

The categories used during these three periods are thus co-extensive except for the inclusion of the relatively insignificant group of acute miliary tuberculosis from 1911 to 1920 (See Registrar-General, 1921*b*, 1931*b*).

The deaths were subdivided by sexes, and into the following age-groups: 0 to 4 years; 5 to 14 years; 15 to 24 years; 25 to 44 years; 45 years and over. The years for which deaths were taken were: 1911, 1912, 1913; 1916, 1917, 1918; 1921, 1922, 1923; 1926, 1927, 1928; 1931, 1932, 1933.

(ii) *Populations*.—The populations used for deriving mortalities were subdivided by sexes, and into the age-groups already stated. Those for county boroughs in 1911, 1921 and 1931 were obtained from the corresponding censuses of England and Wales (Census, 1911*d*, 1921*c*, 1931*f*). For the years 1916 and 1926 arithmetical mid-censal means were calculated.

Alterations in the territorial area of a number of boroughs (extension of boundaries in almost all instances) took place between 1911 and 1933. For one of them, namely Birmingham, in which the changes were gross, the populations of the new area were used throughout, because adjustment of deaths could be made accordingly. For another of them, Plymouth (population 112,030), into which Devonport (81,678) and East Stonehouse (13,748) were absorbed between 1911 and 1921, a partial correction was made in a similar way by using the combined Plymouth and Devonport population for the 1911 entry in the tables (unfortunately deaths could not be adjusted for the inclusion of East Stonehouse for that year). For the other boroughs that underwent alterations, since adjustments of deaths in the various age-groups were not practicable owing to insufficiency of published data, no such corrections were made.

(iii) *Mortalities (Death-rates)*.—The mean annual death-rate for each of the above-mentioned triennial periods (1911–13, 1916–18, 1921–23, 1926–28, 1931–33) was calculated by sexes and age-groups for each county borough in the following manner: the deaths from respiratory tuberculosis shown for the borough for each of the three years were added together, divided by 3, and rated on the population of the first year of the

triennium, the death-rate being expressed per hundred thousand individuals living of the particular sex and age-group.

It has already been stated that in a number of boroughs, owing to changes in boundaries, alterations in territorial area took place between 1911 and 1933. Where corrections could not be made so as to base the populations and deaths on the same area throughout (as was possible in Birmingham), the resulting error in mortalities introduced by such changes in boundaries might be threefold: (1) An inter-censal change in borough boundaries (*e. g.* in 1929) would alter the area on which the populations and deaths of the succeeding censal triennium (1931-33) were based, and might thus render its mortality not precisely comparable with that of the preceding censal triennium (1921-23). (2) A change in boundaries occurring during a triennial period (*e. g.* in 1922) might, owing to the method of rating the deaths on the census population of the first year (in this example 1921), cause a distortion of the resulting mortality of the triennium (1921-23); for the deaths would be partly based upon the new area, while, on the other hand, the population would be that of the old area. (3) From the necessity of using mid-censal means in estimating the populations for the mid-censal years (*i. e.* 1916 and 1926) a similar distortion of the mortalities of the mid-censal triennia (1916-18 and 1926-28) might be produced by a change in boundaries taking place at any time in the inter-censal decade; for the deaths would be based upon the actual area at the time, while the populations, being arithmetical means of the preceding and succeeding censuses, would be a compound of the old and new areas.

In forming an estimate of the errors resulting from changes in boundaries, it should be noted that in the great majority of the 76 boroughs the increases in total population between 1911 and 1931, due to alterations in area, were less than 5% (in 39 boroughs the increases were *nil*; in 7 they were less than 1%; in 15 they were 1 to 5%). In the following thirteen boroughs, however, the increases were greater than 5%: Lincoln (7%), Smethwick (7%), Stockport (10%), Stoke-on-Trent (11%), Carlisle (13%), Southend-on-Sea (13%), Middlesbrough (14%), Sunderland (15%), Coventry (16%), Oxford (18%), Wolverhampton (19%), Exeter (21%), Southampton (22%). Our corrections for Birmingham and Plymouth (with Devonport), whose increases were very much greater even than these thirteen, have already been mentioned. In ten of the thirteen boroughs the areas incorporated were mainly urban districts; in the other three they were rural districts. This preponderance of urban districts has the effect of minimizing any error of mortality from any inter-censal alterations in area (see (1) above), since, as a whole, death-rates from respiratory tuberculosis in these urban areas more nearly resemble those of county boroughs than do those in rural districts (Registrar-General, 1932*c*).

D. SOCIAL CONDITIONS (POOR RELIEF AND UNEMPLOYMENT, SOCIAL INDEX, HOUSING).

The statistical materials considered for comparing the relative levels of social and economic conditions in different county boroughs were—(i) local returns of numbers on poor relief and of numbers unemployed; (ii) Stocks's social index, based on local occupation returns; (iii) various forms of official returns relating to housing conditions.

(i) *Poor Relief and Unemployment*.—Quarterly statements, which show for each county borough of England and Wales the number of persons in receipt of poor relief on a specified day per 10,000 of the population, have been published by the Ministry of Health since June, 1930. The comparison

that these figures allow to be drawn between various county boroughs at the same period is subject to certain errors: (1) An indeterminable error is introduced by variations in the local administration of the Acts, since certain discretionary powers were given to local authorities. (2) During the second and third quarters of 1930 the numbers on poor relief were affected by provisions of the Unemployment Insurance Act, 1930, regarding distribution of benefits to unemployed insured persons, but any variations in the extent to which different localities shared in the general reduction in numbers can probably be neglected for the present purpose. (3) The percentage of the population in receipt of poor relief increases steeply as age advances, and consequently a simple percentage based on total population is (like a crude death-rate) dependent upon the age-distribution in the different boroughs; poor relief figures might, therefore, be expected to give an exaggerated estimate of poverty in certain boroughs. However, as the Registrar-General (1934*b*) points out, larger proportions of older people are to be found in the more favourably circumstanced towns. The fact that the proportion of the population on poor relief increases sharply with age would, therefore, tend to minimize rather than to accentuate the differences in poverty between the boroughs as estimated from the poor-relief statistics.

The use of figures for the local incidence of persons upon poor relief as a measure for comparing the extent and degree of poverty from one borough to another does not mean that only such persons are accepted as being poor. Rather is it to be assumed that where there is a high incidence of persons on poor relief the incomes of other sections of the community will be correspondingly adversely affected, and that, therefore, poor-relief figures can be reasonably interpreted as giving some indication of the social and economic conditions obtaining locally in the *entire* population of the various county boroughs. At the same time these figures serve the useful purpose of giving a desirable prominence to that part of the population living at the less favourable end of the income scale. Accordingly, the quarterly statements issued between June, 1930 and December, 1933 were used in the present investigation for a comparison of local social conditions with respiratory tuberculosis mortalities, the statistical information being derived in both cases from the same administrative areas, namely, county boroughs. The tuberculosis mortalities were for the triennium 1931-33.

From 1920 to 1930 quarterly statements were issued by the Ministry of Health, giving similar information for the principal Poor-Law Unions. The functions of the Boards of Guardians of the unions were transferred to the Councils of counties and county boroughs in April, 1930. Although many of the old unions bore the names of county boroughs, they were not necessarily co-extensive with the latter; yet, as can be seen from Table 6, the poor-relief figures of these unions during the last year of their existence were highly correlated with the figures of the nominally corresponding county boroughs (65 in all) during the first year after the transfer. Nevertheless, because there remained some uncertainty of continuity, the returns from unions were not used in relation to tuberculosis in similarly-named county boroughs. Consequently, the comparison of relative social conditions, as measured by poor-relief returns, with respiratory tuberculosis mortalities in the different boroughs had to be limited to the period from 1930 to 1933.

Since 1927 the Ministry of Labour has published each month a Local Unemployment Index, showing for a large number of towns in Great Britain the number of insured persons, and the number of unemployed persons on the registers of employment exchanges on a specified day, per cent. of the insured population. For the following reasons the local

unemployment index was considered less suitable for comparison with tuberculosis figures of county boroughs than were the poor-relief statements:

(1) The employment exchange areas bearing the names of county boroughs are not necessarily co-extensive with these county boroughs. For two important boroughs, Bootle and Tynemouth, no separate index figures are published.

(2) While figures for poor relief and tuberculosis mortality both refer to place of residence, those for unemployment refer to place of registration. The two places may differ, since an unemployed worker is permitted to register in an area where the demand for his type of labour is likely to be greater than in the district in which he resides.

(3) Unemployed persons on the registers, as given in the local unemployment index, include, in addition to insured workers who form the great bulk of the total, an unascertainable fraction of the local uninsured population. This fraction varies with legislative changes (*e. g.* those made in 1930 and 1933) affecting insurability of persons as a whole. But it also varies from place to place because such changes in insurability affect some districts more than others, depending upon the industries characteristic of the region; and also because local factors affect the number of uninsured, but registrable, unemployed persons who choose to register. These local peculiarities diminish the comparability of the local unemployment index from area to area at the same period.

(ii) *Social Index*.—In the Registrar-General's Decennial Supplement, Part II, occupations are classified into five social groups denoted by I (upper and middle class), II (intermediate), III (skilled workers), IV (semi-skilled), V (unskilled workers). The 1931 census (Occupation Tables, Table 16) enumerates all males 14 years and over in each county borough according to occupation (including both employed and unemployed). From these figures Stocks (Registrar-General, 1934*a*) has calculated for each county borough the proportion of males aged 14 and over whose occupation places them in social classes IV and V. He considers that "although they refer only to males 14 years and over, they provide a good indication of the relative social grading of the entire population of the area concerned". He emphasizes, however, that no account is taken of the degree of unemployment at the time of the census. This has the serious disadvantage that men who have been unemployed for many years may be placed in higher categories than IV or V in virtue of the occupation they formerly actively followed.

This local social index for the county boroughs for 1931 was used for comparison with their respiratory tuberculosis mortalities for 1931-33.

(iii) *Housing*.—Various forms of official returns relating to housing conditions in the different English county boroughs have been published in the recent censuses. They provide information upon housing accommodation from three somewhat different aspects: (*a*) density of room-occupation; (*b*) density of dwelling-occupation; and, less directly, (*c*) density of population per unit area. All these aspects reflect, though in different ways, the closeness of personal contact existing among members of the population in the locality concerned. Consequently, the quality of housing accommodation, as expressed by various forms of density statistics, might be expected, from present views upon "droplet-type" infection in respiratory tuberculosis, to have a *direct* connection with mortality from this disease. Such direct connection, depending upon the degree of closeness of personal contact, would be additional to any *less direct*, though possibly quite as important, relationship that might exist between quality of housing accommodation

and phthisis mortality through both being correlated either with the average level of general social and economic conditions obtaining locally, or with another particular social factor, *e. g.* local level of nutrition. For the present investigation the choice of any particular form of official housing return had consequently to be considered from the standpoint both of the probable direct connection and of the less direct relationship. The position differs therefore from that of poor relief statistics and of social index, where any connection with respiratory tuberculosis mortality might be expected to be mainly of the less direct kind just mentioned, and little, if at all, direct.

(a) *Density of Room-Occupation*.—The two most important types of statistical data available in the census for density of room-occupation in different areas comprise: (1) the percentage of the population living more than two persons per room; and (2) the average number of persons per room. In Chapter 3 the first of these was chosen in preference to the second, because this type of density standard has been shown to have a close association with the two more comprehensive “formula” standards of housing adequacy employed recently by the census authorities and by the authors of the ‘New Survey of London Life and Labour’ respectively; and also because it emphasises the less favourable end of the density scale, and is, therefore, a better guide to the prevalence and distribution of overcrowding (Census, 1931*a*, 1931*c*).

This percentage (derived by methods which have been modified from time to time) has been published in the censuses since 1891, but its description as an index of “overcrowding” has been criticized on the grounds that the density standard chosen, namely, “more than two persons per room” was an arbitrary one, and was placed too near the worse end of the density scale. While it is probably true that a lower level of density (*e. g.* “more than one and a half persons per room”) would have been chosen had the standard first been introduced at the present time, and it is certainly true that the figures obtained by means of the simple census density standard were never intended to serve as a measure of the *absolute* amount of overcrowding or inadequate housing at any time or place (Census, 1931*b*), it would seem to be justifiable to use such figures, as in the present chapter, to provide a *relative* index for comparing housing adequacy at different times or in different places. In support of this conclusion, it should be noted that when the English county boroughs are tabulated according to their degrees of housing adequacy based on standards of “more than three persons per room”, “more than two persons per room” and “more than one and a half persons per room”, the order into which they fall under each standard is much the same (Census, 1931*c*). Nevertheless, since the usual census density ratio has been misconceived as implying an absolute standard of overcrowding or housing inadequacy, the expression “incidence of sub-standard housing conditions on the basis of the ‘more than two persons per room’ census density standard”, an expression that was adopted in the census for 1931, is to be preferred to the expression “overcrowding index” often employed.

The full definition of “incidence of sub-standard housing conditions measured upon the basis of the ‘more than two persons per room’ density standard”, as obtainable from the censuses for 1921 and 1931, can be stated as follows: “the population in those private families¹ that are living in the area at a density of occupation of more than two persons per room, expressed as a percentage of the total private family population”. For the census for 1911 the definition should read: “the population in those private families in the area under consideration that occupy less than ten

¹ For definition of private families, etc., see Census (1911*b*, 1931*e*, 1931*j*).

rooms apiece and are living at a density of occupation of more than two persons per room, expressed as a percentage of the total private family population."

The "more than two persons per room" census density standard has been considered by the census authorities to give figures for the incidence of sub-standard housing conditions having a high order of comparability from one county borough to another, though, as Llewellyn Smith (1930a) has pointed out, possible differences in the sizes of rooms in different parts of the country introduce an unmeasurable complicating factor.

These housing figures are also properly comparable with the contemporaneous respiratory tuberculosis mortalities for the various county boroughs, if the difference in basis—private family population in the one set of data, and total population in the other—be disregarded. Since the population in non-private families (which are excluded from these housing statistics) forms only a small proportion of the total population (4.3%, 4.5% and 4.75% in 1911, 1921 and 1931 respectively, taking the country as a whole [Census, 1911a, 1921a, 1931d]), the resulting discrepancy is probably of negligible consequence.

The comparability from one year to another between 1911 and 1931 (the period covered by the present chapter) of the "more than two per room" density statistics for the same county borough may in some instances have greater errors. In the first place, alteration in boundaries took place in certain boroughs with resulting changes in population (as outlined on pp. 142-3); secondly, the housing analysis for 1911 was limited to private families having less than ten rooms apiece (this category, however, accounting for 96% of all families enumerated [Census, 1921f]), while in 1921 and 1931 it included all private families irrespective of the number of rooms occupied by them; thirdly, in 1911 there was some ambiguity in the interpretation of the word "room", and the head of the family, who at that time was still responsible for making the return of rooms occupied, may, in some instances, have provided misleading information. While these errors affecting comparability are probably not of great consequence, comparisons of housing figures from one year to another have been used only to a limited extent in this chapter.

A noteworthy feature of the "more than two persons per room" density statistics of the census is that the unit taken in computing the population living in sub-standard housing conditions is the family, and not the individual. This population comprises only persons in those families in which the *average* density is more than two persons per room, not all persons (in families) who are living at a density exceeding this ratio. Thus, an individual who shares a room with two others (density three persons per room), the remainder of whose family is sufficiently well accommodated to give an average density of, say, one and a half persons per room for the whole family together, will be excluded from the category of population living at a density of more than two persons per room, and therefore will not be included among those living under sub-standard housing conditions. Conversely, some persons actually living above the standard may be placed in the sub-standard category.

Another feature of the simple "persons per room" density standard used in the census for measuring housing conditions is that only the number of persons in the family, and the number of rooms occupied by each individual family, are tabulated. The more comprehensive "formula" standard, used experimentally in the census for 1931 for certain selected areas, takes into consideration the constitution of the family as to age, sex and marital condition, though it, too, disregards the size and quality of the rooms, and does not distinguish between sleeping- and living-rooms in the principal

tabulations. However, in view of the correspondence, already referred to, in the selected areas between figures for the incidence of sub-standard housing conditions based on this "formula" standard and those based on the simple "more than two persons per room" density standard, the latter would seem to be adequate for comparisons such as those undertaken in the present report. In any case, the more elaborate standard was not available before 1931, and was then only applied to comparatively few areas.

From the above-mentioned considerations it may be concluded that, notwithstanding their limitations, statistics of density of room-occupation, based upon the usual census density standard of "more than two persons per room", are a sufficiently accurate form of official return for measuring relative housing conditions in the different boroughs, and for comparing these conditions with the respiratory tuberculosis mortalities, over the period 1911 to 1933. Accordingly, the percentage of the population in private families living at a "more than two persons per room" density was ascertained, for each of the 76 selected English county boroughs for the years 1911, 1921 and 1931, from the corresponding censuses (Census, 1911*c*, 1921*d*, 1921*e*, 1931*g*, 1931*h*); the borough area taken as basis being (like that for the tuberculosis mortalities) the actual area at the time of the particular census, except in the case of Birmingham, for which the 1931 area was used throughout, and in the case of Plymouth, which was regarded as combined with Devonport before the actual absorption of the latter took place (see pp. 142-3). For the two correlation coefficients calculated for the year 1926 the mid-censal arithmetic means were used. Comparisons were made (method of correlation) between these housing figures, representing the local incidences of sub-standard housing conditions, and the contemporaneous phthisis mortalities for the various county boroughs at the different dates of the period 1911 to 1933, the housing figure for a given year, *e. g.* 1921, being compared with the death-rate for the triennium whose first year was the same, *i. e.* 1921-23. Comparisons were also made (method of group-averages) between the housing figures for 1931 and the phthisis mortalities for the various boroughs at the different dates of the period 1911 to 1933; in these latter comparisons, therefore, the housing and the mortality statistics were not always contemporaneous. Finally, comparisons were made (methods of correlation and of group-averages) between the local housing figures for 1931 and the absolute and percentage-rates of decline in phthisis mortality for the various boroughs over the periods 1911-13 to 1931-33 and 1921-23 to 1931-33.

(b) *Density of Dwelling-Occupation.*—Statistics of population per occupied dwelling in the various county boroughs, as published in the census, might be considered to offer a fair measure of the social and economic conditions obtaining locally. They are, however, probably inferior to "room-occupation" density figures as a measure of the closeness of personal contact in the population concerned because of the wide variation in the proportions of small and large houses in different parts of the country (Census; 1911*e*), a variation which is probably considerably greater than that in sizes of rooms. For this and other reasons the "room-occupation" density figures were preferred for use in Chapter 3, although for purposes of further information a comparison between respiratory tuberculosis mortalities for young women for 1931-33 and the population per occupied dwelling for 1931 (Census, 1931*k*), in the different county boroughs, was made.

(c) *Density of Population.*—Statistics of population per acre are the earliest form of information available for ascertaining housing density in different parts of the country. Though these statistics still have value for certain purposes, they appear less suitable for comparing the actual quality of

housing accommodation from one borough to another than do any of the computations mentioned above. In the first place, different boroughs show considerable variations in the proportions of non-built-up to built-up areas, so that extensive semi-urban surroundings or park spaces would tend to obscure the existence of focal areas of gross overcrowding. Secondly, such statistics fail to give as adequate an idea of the intimacy of personal contact, and consequent risk of tuberculous infection, as do the more direct returns of density of room- and dwelling-occupation.¹ For these reasons no extensive comparisons of density of population with tuberculosis mortality were made. However, on account of their particular interest to the present investigation, the respiratory tuberculosis mortalities for young women for 1931-33 were compared with the populations per acre for 1931 (Census, 1931*i*), in the 76 county boroughs.

The assessment of housing conditions has been discussed somewhat extensively, on account of the complexity of the subject. For description of procedure and terminology in relevant censuses, see Census (1891*a*, 1901*a*, 1911*b*, 1921*b*, 1931*e*, 1931*j*).

E. STATISTICAL METHODS.

Two principal statistical methods have been employed for this chapter: (i) Correlation; (ii) Group-averages.

(i) *Correlation*.—Coefficients of correlation were extensively used in measuring the degree of relationship between the various data. Tables for the two variables (x and y) under consideration were drawn up, and the coefficients of correlation (r_{xy}) determined upon the ungrouped data, and their significance assessed by the derivation of their standard errors (*S.E.*).² The arithmetic mean of each variable was also tabulated.

In certain instances, where three variables were considered simultaneously, coefficients of partial correlation were used to measure the degree of relationship between two variables when the third was held constant.

The third measure of relationship used is the coefficient of regression (b), which was employed in conjunction with coefficients of correlation where the latter appeared to be significant. In conformity with the above symbols the coefficient of regression of y upon x is expressed as b_{yx} .

(ii) *Group-averages*.—For certain comparisons of social conditions with mortalities, the county boroughs were ranged in order of magnitude of a particular independent variable, *e. g.* housing, and separated into several (usually four) large groups, so far as possible of roughly equal size and equal total population. The data within each group so formed were treated by two methods for the purpose of obtaining a *single* dependent variable, *e. g.* death-rate, for the group: (1) by calculating, for each group, the simple arithmetic average of the mean annual death-rates for the particular triennium in the various individual county boroughs composing the group; (2) by calculating, for each group, the weighted arithmetic average of these mean annual death-rates, the weights used being proportional to the populations of the individual county boroughs at the time. By either of these two ways of calculating averages a single average death-rate is obtained for each group, though in the first method each borough

¹ Correlations of the population per acre and population per occupied dwelling with the percentage of the population living more than two persons per room, in county boroughs, are given in Table 6.

² In the tables of this and subsequent chapters a coefficient of correlation is regarded as significant if its numerical value exceeds twice that of its standard error (calculated as $1/\sqrt{n-1}$, where n is the number of boroughs used). Such significant coefficients are indicated by heavy type.

is given equal weight, while in the second, the larger boroughs have a greater effect upon the final average than have the smaller. The use of such group-averages minimizes the possibly disturbing effects of local peculiarities, *e. g.* prevalent occupational risks, associated with individual boroughs.

The results obtained by this method of group-averages afford a general check upon those derived by the method of correlation. The use of weighted averages forms a particularly valuable check upon the correlation method (in which rates of mortality for all boroughs—no matter what the size—have equal weight), since variation in size of borough is taken into consideration (see Brown, Greenwood and Wood, 1914).

Appendix to Chapter 4. (The History of Housing Conditions in the Different English County Boroughs from 1891 to 1931, in Relation to Respiratory Tuberculosis Mortality.)

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A. AREAS INVESTIGATED.

The same 76 county boroughs were used as in Chapter 3.

B. PERIOD OF SURVEY.

The survey extended from 1891 to 1931. The early limit of the survey was fixed by the introduction in 1891, at the suggestion of Charles Booth, of a specific questionnaire to enable the census authorities to analyse families as to number of persons and number of rooms occupied, thus making it possible to calculate the local incidence of sub-standard housing conditions on the basis of the percentage of the population in families living at a density of more than two persons per room. Prior to 1891 only the less satisfactory measures of number of persons per house and population per acre were obtainable (see p. 148 for discussion).

C. HOUSING STATISTICS.

The percentage of persons in families living at a density of more than two persons per room, which was the principal measure used in Chapter 3, was employed also throughout Chapter 4. In the attempt to obtain comparable housing figures from one census to another throughout this period of survey various difficulties were encountered. In the first place, owing to changes of boundaries, extensive alterations in the territorial areas of many county boroughs took place between the two limits of the forty years under consideration. Fortunately in most cases the necessary adjustments for these alterations could be made by incorporating the figures for added areas. Secondly, changes in the details of the questionnaire in regard to housing were made from time to time. On account of their importance in the later discussion, the main points in these changes are summarized here:

1891 and 1901 Censuses.—Particulars as to the number of rooms occupied by a family were filled up by its head. He was asked to state the number of rooms occupied by his family only if such number was less than five. If no answer to this question was received, it was assumed by the authorities that the number of rooms occupied by his family was five or more. The published analyses of families as to density of room-occupation were, therefore, limited to families that occupied less than five rooms apiece. Furthermore, owing to the optional nature of the questions involved there must have been at these censuses some indeterminable understatement of such families, and consequently of the published figure for the incidence of sub-standard housing conditions. The inquiry at these censuses included both private and non-private families (see pp. 146-7).

1911 Census.—Particulars as to the number of rooms occupied by a family were filled up by its head, but on this occasion he was instructed

to state the number of rooms occupied by his family, whatever that number might be. The analyses, published by the census authorities, of families as to density of room-occupation were, however, limited to those families that occupied less than ten rooms apiece. The inquiry included both non-private and private families, but only the latter were published.

1921 and 1931 *Censuses*.—Particulars as to the number of rooms occupied by a family were filled up by the enumerator, who stated the number of rooms, whatever that number might be. Analyses, published by the census authorities, of families as to density of room-occupation were at these dates extended to families that occupied any number of rooms. The inquiries included only private families.

These alterations in the questionnaire introduced two main causes of lack of comparability from census to census in the published incidences of sub-standard housing conditions for the various boroughs, based on the "more than two persons per room" standard. The first was the change from total population to private family population; the second was the progressive increase in the number of rooms from which the various census analyses were derived, in particular the extension from 1911 onwards of such analyses to include families that occupied more than four rooms. The error introduced by the first change probably becomes negligible when the statistics are re-calculated throughout on the uniform basis of those families that occupied less than five rooms (see below). The second and more serious cause of lack of comparability makes it essential to carry out extensive re-calculations of the census material.

The second cause of lack of comparability and the consequent necessity for these re-calculations was discussed by Llewellyn Smith (1930*b*) in his contribution to the 'New Survey of London Life and Labour'. He considered various methods for obtaining comparability of the overcrowding figures of the various London boroughs (as based upon the London Survey density standard of two persons or more per room) from one census year to another from 1891 to 1921. He finally chose a method depending upon the hypothesis that in each borough the *percentage* of overcrowding in *large* tenements (five rooms or more) bore a fairly constant ratio to the percentage of overcrowding in *all* tenements. He tested this hypothesis by calculating the ratio for 1911 and 1921 for each London borough, and also for the Administrative County of London, and found the ratio at the two dates for the same area to be approximately equal. For the County of London the ratio for 1911 was 0.140 to 1, and for 1921 was 0.134 to 1. The procedure was to obtain the following figures for the two censuses:

Population in those private families that were living at a density of two persons per room or more	(p).
Total private family population	(q).
Population in those private families that occupied five rooms or more apiece and were living at a density of two persons per room or more	(r).
Total population in those private families that occupied five rooms or more apiece	(s).
Then $\frac{r}{ps}$ to 1 is the required ratio.	

Using the mean of the ratios for 1911 and 1921 calculated for each area, and the published census data of overcrowding in 1891 and 1901, which for these years were derived only from *small* tenements (less than five rooms), Llewellyn Smith computed the estimated overcrowding in tenements of *all sizes* in 1891 and 1901 for each of the London boroughs.

The above method has been described in some detail because a similar difficulty arose in the present chapter in the attempt to obtain comparability of sub-standard housing figures for the various county boroughs from one census year to another over the period 1891 to 1931. Since the 1931 census data had become available and fresh ratios could therefore be calculated and their values compared with those for 1911 and 1921, it was thought desirable to test Llewellyn Smith's hypothesis further before employing his method. The computation was confined to the County of London (figures being obtained from Census [1931*m*]), and the ratio was found to be 0.101 to 1, as compared with 0.134 to 1 for 1921 and 0.140 to 1 for 1911. This inconstancy in the ratio impairs the value of the hypothesis on which Llewellyn Smith's method depends; indeed the approximate equality of the 1911 and 1921 ratios may possibly be explained by the standstill in housing development throughout the country during the war period.

For the purpose of the present comparison it was therefore decided to employ the somewhat simpler method of reducing the published data so that they applied uniformly to families that occupied less than five rooms apiece. The definition of "incidence of sub-standard housing conditions measured upon the basis of the 'more than two persons per room' density standard", as used in this chapter for the whole period 1891 to 1931, is therefore as follows (compare p. 146): "the population in those families (private and non-private families for 1891 and 1901; private families only for 1911, 1921 and 1931) in the area under consideration that occupy *less than five rooms apiece* and are living at a density of occupation of more than two persons per room, expressed as a percentage of the *total* population."

Some idea of the size of the errors in comparability from borough to borough and from one decade to another, introduced by the omission of families that occupied five rooms and upwards, may be obtained by considering the figures for sub-standard housing incidence in 1911, 1921 and 1931, both with and without this omission, for the 76 county boroughs when subdivided into the four groups (see Table 17). The differences shown in this table between the unbracketed and the bracketed figures do not vary greatly from one group to another, whichever census be considered. On the other hand, slight decrease in these differences, in each group taken individually, between 1911 and 1931 show that the method selected for use in the present chapter probably involves some under-estimation of the average rate of improvement during these twenty years, though to what extent this under-estimation affects the earlier twenty years is obviously not ascertainable.

Another cause for the under-estimation of improvement between 1891 and 1911 is the indeterminable understatement of the number of families that occupied less than five rooms, which took place at the censuses of 1891 and 1901 as a result of the optional nature of the housing questionnaire (see p. 151).

Other errors affecting the comparability, from one census year to another between 1891 and 1931, of the figures of sub-standard housing incidence are independent of the present method of considering only families that occupy less than five rooms. The most important is due to the alteration in boundaries and area that took place in many boroughs over these forty years, particularly during the earlier part of the period (see p. 151). For most of these boroughs it was possible to make adjustments so as to base both the number of persons living more than two per room and the total population upon the 1931 area throughout. The adequacy of these adjustments could be judged by the proportion of the population living in 1891 within the boundaries existing at the date of the 1931 census (Census, 1931*m*) that was accounted for in 1891 after the adjustments had been

made. In 68 of the 76 boroughs the proportions so accounted for were 95 to 100%. In the remaining eight boroughs, however, the discrepancies were greater than 5%: South Shields (6%), Bournemouth (7%), Smethwick (7%), Stoke-on-Trent (7%), Oxford (8%), Carlisle (9%), Wakefield (18%), Southend-on-Sea (21%).

The remaining recognized errors affecting the comparability from one year to another of the housing figures of Chapter 4 are probably of less importance. The exclusion of non-private families from 1911 onwards can have had but little effect, since it is extremely unlikely that many of the excluded families occupied less than five rooms (see Census 1911*b*). Finally, it should be noted that in 1921 the census was held during the holiday season instead of earlier in the year. The boroughs principally affected were those that received an influx of summer visitors, who formed the following percentages of the enumerated total population: Brighton (5), Southport (6), Great Yarmouth (7), Hastings (10), Bournemouth (11), Eastbourne (14), Southend-on-Sea (15), Blackpool (26).

In spite of the various disadvantages outlined above, it seems that information gained by the methods used in Chapter 4 should give an adequate idea of the history of housing conditions in the county boroughs over the period 1891 to 1931. Accordingly, the incidence of sub-standard housing conditions, as defined on p. 153, was calculated for each of the 76 selected English county boroughs from the analyses published in the various censuses (Census, 1891*b*, 1901*b*, 1901*c*, 1911*c*, 1911*d*, 1911*i*, 1911*j*, 1921*c*, 1921*d*, 1921*g*, 1921*h*, 1931*f*, 1931*g*, 1931*n*, 1931*o*), the borough area taken as basis being so far as possible the 1931 area (see above, p. 153).

D. RESPIRATORY TUBERCULOSIS MORTALITIES.

The sources of the figures for respiratory tuberculosis mortalities in the various boroughs were the same as those used in Chapter 3. The methods for obtaining simple and weighted arithmetic averages were also similar.

Appendix to Chapter 5. (Mortality from "Diseases other than Respiratory Tuberculosis" in England and Wales and in the Different English County Boroughs, in Comparison with Mortality from Respiratory Tuberculosis.)

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A. AREAS INVESTIGATED.

For the earlier part of the chapter the area used was England and Wales. In the remainder of the chapter the areas used were the same 76 English county boroughs that were examined in Chapter 3.

B. PERIOD OF SURVEY.

For England and Wales the survey extended, as in Chapter 1, from 1850 to 1936; and for the English county boroughs the period was from 1911 to 1933, as in Chapter 3.

C. MORTALITIES (MORTALITY FROM DISEASES OTHER THAN RESPIRATORY TUBERCULOSIS).

(i) *Deaths*.—The deaths were obtained from the Registrar-General's Annual Reports and Statistical Reviews of England and Wales. Details of the categories used for England and Wales are given in the explanatory notes to Table 19. Those used for the English county boroughs are detailed below.

From 1911 to 1920 the deaths used for county boroughs were those from all causes less those recorded under No. 9 and No. 26 of the Registrar-General's abridged list of causes of death, corresponding to Nos. 28, 29A and 29B, and to Nos. 164–186, respectively, of the International List of Causes of Death for 1911. Category No. 9 comprises pulmonary tuberculosis and phthisis, together with acute miliary tuberculosis, and excludes disseminated tuberculosis other than acute miliary tuberculosis. Category No. 26 comprises violence other than suicide.

From 1921 to 1930 the deaths were those from all causes less those recorded under No. 10 and No. 30 of the abridged list, corresponding to No. 31 and to Nos. 175–203, respectively, of the International List for 1921. Category No. 10 comprises tuberculosis of the respiratory system, but excludes acute miliary tuberculosis. Category No. 30 comprises violence other than suicide.

From 1931 to 1936 the deaths used for county boroughs were those from all causes less those recorded under No. 9 and No. 34 of the abridged list, corresponding to No. 23, and to Nos. 172–198, respectively, of the International List for 1931. In spite of alteration of numbers, the contents

of these categories remained unchanged from those of the previous decade, 1921-30.

The categories used during these three periods for the deaths in the county boroughs are thus co-extensive except for the exclusion of acute miliary tuberculosis from 1911 to 1920 (see Registrar-General, 1911*b*, 1921*b*, 1931*b*).

(ii) *Populations*.—For England and Wales the populations used for deriving mortalities were the same as in Chapter 1; and for the English county boroughs they were the same as those used in Chapter 3.

(iii) *Mortalities (Death-rates)*.—For England and Wales the death-rates were calculated in the same way as in Chapter 1. The constitution of the age-groups was also the same, but only the death-rates of those of from 5 to 44 years were calculated.

For the county boroughs the death-rates were calculated as in Chapter 3. The same age-groups as were used in that chapter were employed here for the triennium 1931-33, but for the earlier triennia (1911-13, 1916-18, 1921-23, 1926-28) only the death-rates for the age-group 15 to 24, and for all ages, were calculated.

D. SOCIAL CONDITIONS (POOR RELIEF, SOCIAL INDEX, HOUSING).

The poor relief, social index and housing statistics for the county boroughs were the same as those used in Chapter 3. The poor relief figures were limited to 1931-33, and those for the social index and the incidence of sub-standard housing conditions to the year 1931.

E. STATISTICAL METHODS.

The same methods of correlation and group-averages as were used in Chapter 3 were employed in the present chapter for comparison of social conditions with mortalities in the different county boroughs. For housing the boroughs were separated into the same four groups (see Notes, Table 10), and the method for obtaining the simple and weighted averages of mortality was also similar.

Appendix to Chapter 6. (The Effect of Internal Migration upon the Relationship between Respiratory Tuberculosis Mortality of Young Women and Certain Social Conditions in the Different English County Boroughs.)

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A. AREAS INVESTIGATED.

The same 76 county boroughs were used as in Chapters 3 and 5, though certain exclusions were made for some of the calculations. For details of these exclusions, see the individual tables.

B. PERIOD OF SURVEY.

This was from 1921-23 to 1931-33, though for the purpose of making adjustments for migration the movements of population as far back as 1911 required estimation.

C. MORTALITIES (MORTALITY FROM RESPIRATORY TUBERCULOSIS AND MORTALITY FROM "DISEASES OTHER THAN RESPIRATORY TUBERCULOSIS").

(i) *Deaths.*—The figures for deaths used in this chapter were the same as in Chapters 3 and 5.

(ii) *Populations.*—The "native" population (that which would have resulted had no migration taken place in the previous decade) of females aged 15 to 24, in 1921, was computed for each county borough from the census population aged 5 to 14, in 1911, by subtracting the estimated total of deaths from all causes between 1911 and 1921 in this "generation" group. This estimated total was obtained by adding together the following categories: 1911, all deaths, 5 to 14; 1912, 9/10 deaths, 5 to 14, plus 1/10 deaths, 15 to 24; 1913, 8/10 deaths, 5 to 14, plus 2/10 deaths, 15 to 24; . . . 1920, 1/10 deaths, 5 to 14, plus 9/10 deaths, 15 to 24. The difference between the "native" and census populations aged 15 to 24, in 1921, represents the net migration of this generation in the preceding decade, while this figure, expressed as a percentage of the census population aged 5 to 14, in 1911, represents the net migration-rate for the borough.

Similar computations were made to obtain "native" populations in 1931, and for obtaining the net migration-rates between 1921 and 1931.

(iii) *Mortalities (Death-Rates).*—The "native" death-rates for the triennial periods 1921-23 and 1931-33 were calculated for females aged 15 to 24 in the following manner: the deaths from phthisis (or from diseases other than phthisis) shown for the borough for each of the three years were added together, divided by three, and rated on the "native" population of the first year of the triennium. Death-rates obtained in this way

presume that the mortality of migrants from phthisis (or from diseases other than phthisis) was *nil*.

A subsidiary calculation was made in the case of respiratory tuberculosis on what seemed to be the more probable assumption that migrants had suffered a certain mortality from this disease. This was assumed, for convenience of computation and for other reasons (p. 74 and footnote), to be one-half the recorded mortality for the corresponding young adult females in the particular borough concerned. This second series of "native" death-rates was easily obtained by taking the mean of the first "native" rate (see above) and of the recorded rate used in Chapter 3.¹

The recorded rates given for purposes of comparison in certain tables of Chapter 6 were obtained in the same way as those in Chapters 3 and 5. Death-rates obtained in this way in effect assume that the migrants suffer the full mortality of the non-migrants in the boroughs that they are leaving or entering.

D. SOCIAL CONDITIONS (HOUSING).

The housing statistics of the county boroughs were the same as those used in Chapters 3 and 5.

E. STATISTICAL METHODS.

The same methods of correlation and group-averages were used as in Chapters 3 and 5.

¹The method of computation is conveniently set out in algebraic terms. Let d_r = recorded deaths; p_r = census population; p_a = "native" population. Then the recorded death-rate is d_r/p_r ; the first "native" death-rate is d_r/p_a ; the second is $\frac{d_r + \frac{1}{2}d_r p_r (p_a - p_r)}{p_a}$, which on simplification is $\frac{1}{2}(d_r/p_r + d_r/p_a)$, or the arithmetic mean of the two previous rates.

Appendix to Chapter 7. (The Influence of Volume of Occupation upon the Recent Respiratory Tuberculosis Mortality of Young Adults.)

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A. PROPORTIONS OCCUPIED.

(i) *England and Wales, 1891, 1901, 1911, 1921 and 1931.*—The proportions, per 1000 population, occupied in the years 1891, 1901, 1911, 1921 and 1931, by sexes and in certain age-groups, were obtained from the occupation tables of the censuses concerned (Census, 1891*c*, 1901*d*, 1901*e*, 1911*k*, 1921*i*, 1931*p*, 1931*q*). ("Occupied" persons include both employed and unemployed). A second set of figures for proportions of persons occupied was obtained after excluding, for each sex, "Agricultural Occupations" (Group IV 7 in 1891; Group VII in 1901 and 1911; Group II in 1921 and 1931), and "Domestic Service (Indoor)" (Group II 4 (1*a*) in 1891; Group IV 1 in 1901; Groups IV 1 and IV 3 (6) in 1911; Group 900 in 1921; Group 850 in 1931) from the numbers of occupied persons.

(ii) *Aggregate of County Boroughs of England and Wales, 1931.*—The proportions of persons occupied in 1931, by sexes, and in certain age-groups, were obtained for the Aggregate of the 83 County Boroughs of England and Wales. A second set of figures was obtained after exclusions had been made as for the second set of figures in (i) above. Since the published figures available were not subdivided by age-groups, the necessary data for these two sets of figures were specially obtained through the assistance of the census authorities.

(iii) *Aggregate of Rural Districts of England and Wales, 1931.*—The proportions of persons occupied in 1931, by sexes and in certain age-groups, were obtained for the Aggregate of the Rural Districts of England and Wales outside Greater London.¹ A second set of figures was obtained after excluding, for males, "Agricultural Occupations" (Group II), and, for females, Groups 800-850 (Domestic Service together with certain other occupations, the former composing more than 90% of the total). Both these sets of data were also specially obtained through the kindness of the census authorities.

(iv) *Individual English County Boroughs, 1931.*—The proportions of females occupied in 1931 at ages 15 to 24 and 25 to 34 were obtained for each of the usual 76 English county boroughs, deductions being made in the same way as for the second set of figures in (i) and (ii) above. The source of these data was the same as for (ii). A further series showing proportions of female "juveniles" (ages 14 to 20) occupied was obtained from the census

¹ It should be pointed out that some parts of England and Wales are so thickly populated that many persons may combine domicile in a "Rural District" with occupation in an "Urban District". The term "rural" must consequently be regarded as an administrative one, and does not invariably describe the character of the area.

(Census, 1931 q), deductions being made for " Domestic Service " (Group 850) and also for those recorded as " Out of Work ".

B. MORTALITIES (MORTALITY FROM RESPIRATORY TUBERCULOSIS).

(i) *England and Wales, 1931-33; Aggregate of County Boroughs of England and Wales, 1931-33; and Aggregate of Rural Districts of England and Wales, 1931-33.*—The deaths from respiratory tuberculosis (Registrar-General's Abridged List, No. 9) for the triennium 1931-33 were obtained from the Registrar-General's Statistical Review, and were rated upon the census populations in 1931. To make comparison possible between death-rates and proportions occupied in the same area, the same age-groups were used for the former as for the latter.

(ii) *Individual English County Boroughs, 1921-23 to 1931-33.*—The county boroughs were used individually for correlation between proportions occupied and respiratory tuberculosis mortalities. For the first set of correlations, mortalities in 1931-33 for females aged 15 to 24 and 25 to 34 were compared with proportions occupied in 1931 at the same ages, and the former also with the proportion occupied among juveniles. All 76 boroughs were used. For the second set of correlations a generation method was used (see Greenwood, 1936) ; the *percentage increase*, in each county borough, of the respiratory tuberculosis mortality in 1931-33 among females aged 15 to 24 over that in 1921-23 among females aged 5 to 14 was compared with the proportion occupied in 1931 among juveniles (aged 14 to 20). To obviate the inclusion of erratic percentages the boroughs used were restricted to those 27 of the 76 that had ten or more deaths from phthisis in the age-group 5 to 14 in the triennium 1921-23: these 27 boroughs had an aggregate population of approximately two-thirds that of the whole 76 boroughs. A subsidiary correlation was also made in which the mortalities in 1931-33 at ages 15 to 24 were adjusted for the migration taking place during the previous decade on the assumption that the mortality of the migrants was half the recorded mortality for the boroughs concerned (see pp. 74, 158).

**Appendix to Chapter 8. (Respiratory Tuberculosis Mortality
in the Different London Boroughs in 1928-33, in Relation to
Certain Local Social Conditions.)**

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A. AREAS INVESTIGATED.

These were the 28 metropolitan boroughs, together with East Ham and West Ham, making 30 areas in all. They are referred to as the "London Boroughs."

B. PERIOD OF SURVEY.

The mortality figures were for the period 1928-33, for reasons given on p. 98. The social index and housing statistics refer to the census year, 1931, while the other social data were obtained from the New London Survey, made in 1929-30.

C. MORTALITIES (MORTALITY FROM RESPIRATORY TUBERCULOSIS).

(i) *Deaths*.—The deaths were obtained from the Registrar-General's Statistical Reviews of England and Wales. From 1928 to 1930 the deaths were those listed under No. 10 of the Abridged List, and from 1931 to 1933 they were those under No. 9 of that List.

(ii) *Populations*.—These were the census populations for 1931.

(iii) *Mortalities (Death-rates)*.—The mean annual death-rates for the period 1928-33 were calculated for females aged 15 to 24 and 25 to 44, for each borough, in the following manner: the deaths from respiratory tuberculosis shown for the borough for each of the six years were summed, divided by six, and rated on the population for 1931.

**D. SOCIAL CONDITIONS (SOCIAL INDEX, INCIDENCE BELOW POVERTY-LINE,
AVERAGE INCOME LESS RENT, HOUSING).**

(i) *Social Index*.—The social index for the metropolitan boroughs for 1931 was obtained by the method introduced by Stocks for county boroughs, and used for them in Chapter 3 of the present report (see p. 145).

(ii) *Incidence below Poverty-Line*.—The percentage of persons living below the "poverty-line" in 1929-30, as estimated from the "Street Survey" of the New London Survey, was obtained for each borough from Table VIII (Column P) of the Borough Summaries in vols. III and VI of that investigation.

(iii) *Average Income Less Rent.*—The average income in excess of rent, per head of population, in 1929–30, was calculated for each borough from the figures of the “House Sample Analysis” of the New London Survey, in the following manner: the average family rent, expressed in shillings, was subtracted from the average *full-time* weekly family income, and the resulting figure was divided by the average number of persons per family. (The data of the “House Sample Analysis” were obtained from the Borough Summaries in vols. III and VI.)

(iv) *Housing.*—The incidence of sub-standard housing conditions, based upon the “more than two persons per room” census density standard, was obtained for each borough from Table 14 of the Housing Volume of the 1931 Census. It is thus the same measure as that used in Chapter 3.

E. STATISTICAL METHODS.

The method of correlation was used throughout this chapter.

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