STATISTICAL AND SOCIAL INQUIRY SOCIETY OF IRELAND.

IRISH TUBERCULOSIS DEATH RATES:

A Statistical Study of their Reliability, with some Socio-Economic Correlations.

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In an important paper which was published in the Journal of this Society for 1930, Geary surveyed Irish Tuberculosis Statistics. This communication has as its first aim to analyse along similar lines the figures of the decade 1926–36. Various points which emerged during the discussion on his paper will be examined in some detail, and in particular the validity of Irish Tuberculosis Statistics is submitted to a close scrutiny.

Table I

Tuberculosis Death Rate (per 100,000 Population per Annum) at Various Dates, and the Annual Average Percentage Decline.

Country	Annual Average			Ann. av. Percentage Decline 1912–26	Ann. av. Percentage Decline 1926–36
	1911–13	1925–27	1935–37		
Austria	279[3]	171	103	3·9	4·0
Czechoslovakia	313	194	129	3·7	3·3
Eire	**211**	**150**	**121**	**2·1**	**1·9**
France	213	166	122[3]	2·2	2·9
Italy	157	152	88	0·8	3·9
N. Ireland	230	145	102	2·4	3·3
Norway	218	172	107[1]	1·7	4·2
Scotland	173	104	74	2·8	2·9
Spain	152	147	112[2]	0·2	3·0
Switzerland	206	147	96	0·4	3·5
Sweden	190	139	97[1]	1·9	3·3
General Average excluding Eire	213	155	103	2·2	3·4

[1] Last figures available, '34, '35, '36.
[2] Last figures available, '33, '34, '35.
[3] Pre-war territories.

The international position of Ireland on the Tuberculosis death rate list disimproved considerably in the decade 1926–36. Table I shows the movement of death rates in the countries with levels close to that of Éire in 1925–27, which period is chosen as a point of reference because it illustrates very well the change which has occurred. Between 1911–13 and 1925–7, Éire showed an average annual fall equal to 2·1 per cent. of the 1911–13 figure, which was almost equal to the mean fall shown

by the remaining nations of the group. During this first period of 14 years the movement of Éire relative to the group of countries with which it is associated on the death rate table, resulted in a gain of one place. In the decade 1925–7—1935–7, the picture is changed. The annual average percentage decrease calculated on the 1925–27 figure is now only 1 9 per cent. compared with a general average of 3 4 per cent ; and Éire has moved down three places on the list. The position of Éire is probably even more serious than these figures indicate, for a comparison of the death rates during the decade 1931–41 shows that there has been no significant fall in T.D R. during that period either in the critical age group 15–34 or for all ages

It is interesting to note that the standard deviation of the number of deaths of males in the 13 years 1929–41, during which there was no appreciable secular trend in the figures, which should be equal to $\sqrt{m}=43$, if changes were due to chance alone, in fact equals 96, a difference which is highly significant by the χ^2 test.* This confirms a suggestion which has been put forward to explain the very striking reduction of Tuberculosis deaths in all continental cities after the last war, and the constant phenomenon of oscillation around the trend line. Tuberculosis is a very chronic disease, the duration of which is dependent *inter alia* upon the environment. If environmental conditions, and particularly climatic, nutritional, or epidemic conditions, are unfavourable for a short or long time, an abnormal number of those suffering from the disease die during the unfavourable period. If the period is short and the excess therefore is small, the trend line which depends rather on prevalence than on deaths is not affected. If the period is long, as it was during the last war, the trend line may even be improved by the removal of so many infectious persons. This is in fact evident from an inspection of the trend lines in Germany, England, Austria and Belgium for a period before the war of 1914 compared with a period during and after the war.[2]

TABLE II

Annual Average T D R Percentage Decrease for Period before War Compared with Period during and After War.

COUNTRY	1901–3 to 1911–13	1911–13 to 1925–27
Belgium	1 8	2 0
Austria	1 7	3 9
Germany	2 7	3 6
England	2 1	2·9
Average (4 Countries)	2 1	3·1

The increase in T D R during the War of 1914-18 was much greater in Germany, Austria and Belgium than in England

Before we go on to consider the causes of this marked deterioration in the movement of our Tuberculosis death rates (T.D.R.), we must examine carefully the degree of reliability attaching to these figures. It is well known that a certain number of deaths from Tuberculosis are entered wrongly on the Death Certificate in every country, and it

* I owe this point to Dr Geary He has been constantly and copiously helpful in the preparation of this paper.

has been suggested that such false entries are commoner in rural than in urban areas [3] If this failure to register correctly deaths from tuberculosis results in a constant percentage error, it is unimportant for the statistical consideration of trends. If, on the other hand, the registration of Tuberculosis deaths were improving in some countries and not in others, then the countries with improving registration would show a slower fall in the death rate than the actual facts warranted, and their position on the international table would suffer accordingly * The same considerations apply to different districts within the country, though one must pay closer attention to the fallacy of small numbers in considering the material from small population units Can Éire's position relative to other countries be explained by a relative increase in the accuracy of registration during recent years ? Is the accuracy of registration in Éire comparable with that of other countries ?.

TABLE III

Tuberculosis Death Rates and Tuberculosis Deaths as a Percentage of Total Deaths for Groups of Countries at Various Dates and Different Mean T.D R compared with Eire

Period		Group 1	EIRE	Group 2
1911–13	T D R	(6) 205 (173–230)	211	(6) 149 (123–157)
	Tuberculosis deaths as % Total Deaths	13 3 (11 3–16 4)	12 8	9 0 (8 1–11 5)
1924–29	T D R	(9) 153 (140–189)	145	(6) 96 (80–130)
	Tuberculosis deaths as % Total Deaths	10 8 (17 6—13 8)	10	7 9 (7 2—9 1)
1932–37	T D R	(8) 114 (102—137)	119	(7) 72 (55—93)
	Tuberculosis deaths as % Total Deaths	8 8 (7 0—10 9)	8 5	6·1 (5 0—6·7)

Numbers in brackets before rates show number of countries used for the calculation of each figure The smaller figure at the earlier date is due to lack of data Figures in brackets under rates and percentages indicate ranges of values. All data taken from the Annual Epidemiological Reports of the League of Nations 1927 ff

Table III shows that the figures for Tuberculosis deaths as a percentage of total deaths in Éire is closely parallel to that of other countries with comparable T.D.R. The answer to the two questions is, therefore, that, so far as this test goes, registration of Tuberculosis as a cause of death is probably as accurate in Éire as elsewhere.

* A clear-cut case in point is afforded by the change in the mode of establishment of mortality statistics in France in 1925, which resulted in an apparent rise in T D.R from 159 in 1925 to 174 in 1927 (vd. *Monthly Epidemiological Report. League of Nations* · February 1941)

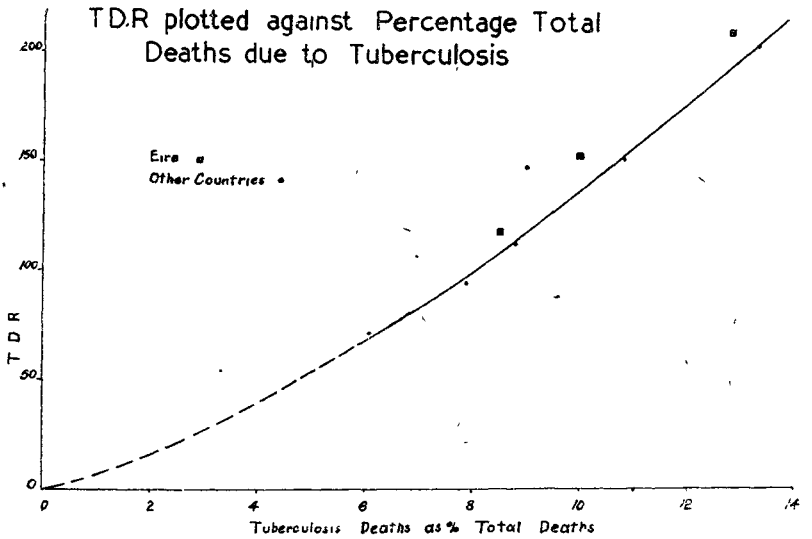


FIGURE 1.

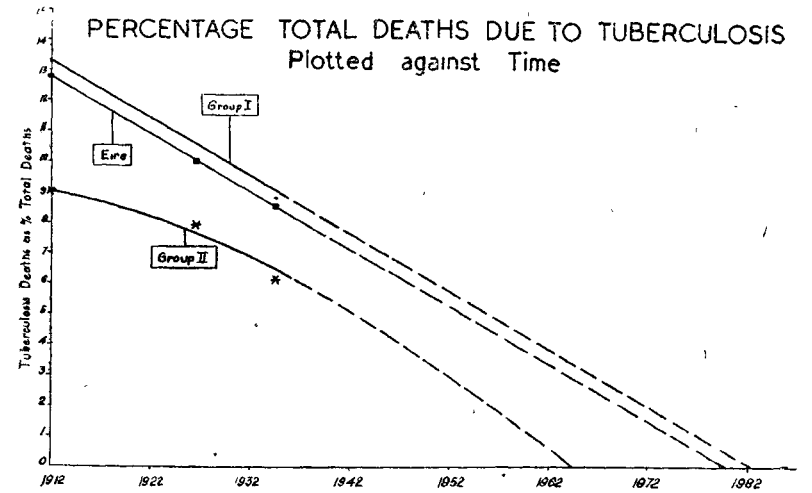


FIGURE 2.

Figure 1, drawn from the data of Table III, shows that the fall in the percentage of total deaths due to Tuberculosis is linear with falling Death Rate for all countries, and that the figures for Éire fall just off the general line. Figure 2 shows that the fall in percentages of total Deaths due to Tuberculosis in the two groups of countries, when plotted against time, follows a roughly parallel course cutting the abcissa in the neighbourhood of 1960 and 1980 respectively. Extrapolation of such curves gives nothing more than a general indication, but the result is in agreement with calculations based on average annual falls in T.D.R., which ranged from 2 to 5 per cent. during the pre-war decade. . There is very little doubt that Tuberculosis will become as rare as Typhoid or Typhus within the next fifty years. We should not be alarmed by the

rise in T.D R. reported from continental countries during the present war Experience of the last war indicates that the rate of fall was, if anything, accelerated in the post war periods in those countries which had shown the sharpest rise during the war. (See Table II)

There is another possible test which we may apply to Irish figures as compared with those in other countries, which rests on the obvious fact that deaths due to tuberculosis, but not registered as such, will find their way into some other rubric. The most likely headings are chest diseases and unknown causes. Figures are not available for the international comparison of chest diseases as percentage of Tuberculosis deaths. The international comparison, based on other causes, is not very illuminating It we express deaths from unknown causes as percentage of deaths from Tuberculosis we see from Table IV that the figure for Éire is of the same order as that of the other countries with comparable T.D.R. There is a general tendency towards shrinkage of the number of deaths entered under this rubric which does not necessarily mean an increased accuracy of registration. It would however, in so far as it was due to transference of Tuberculosis deaths, act as a brake on the apparent fall of the T D.R In Éire the unknown causes rate has fallen

TABLE IV

COUNTRY	1923–32		
	Annual average T D R (1)	Annual average Death Rate from unknown causes (2)	(2) as percentage of (1) (3)
Austria	162	0 1	0
Czechoslovakia	180	41	22
Eire	**143**	**37**	**27**
France*	162	267	165
Italy	131	10	8
Norway	166	58	35
North Ireland	141	12	9
Scotland	100	25	25
Spain	138	42	30
Sweden	131	24	18
Switzerland	138	39	28
Median, including Eire and France	141	37	25
General Average without France and Eire	143	28	19

* The extremely high rate of deaths from unknown causes casts general doubt on the Tuberculosis Statistics in France It has been suggested that French T.D R. should be corrected by the addition of a proportion of deaths from unknown causes equivalent to the proportion of deaths due to tuberculosis amongst all other causes excluding unknown causes I have not made any correction in my tables

from 54 to 20 in the period 1923–1937, while in Austria, Scotland, Switzerland, Norway and Northern Ireland there has been no significant fall. It is possible, therefore, that the comparison between the T.D.R. in Éire and these five other countries is influenced to the disadvantage of the former by improved registration of Tuberculosis as a cause of death in Éire.

In as far as we are entitled to assume that our Tuberculosis statistics are comparable with those in other countries along a time series, we may

consider the possible causes of our apparent failure to achieve comparable results in the war against this disease.

There are four principal environmental conditions and one inherent property which appear to affect the Tuberculosis death rate The inherent factor is heredity, and we may deal with it briefly. There is evidence in American reports that an Irish or negro heredity predisposes to the disease, but from the same sources it is clear that white people of all races, except possibly the Jews, are at least as susceptible as Negroes and Irish when environmental conditions are similar [4] We do not propose to analyse the figures, as they are vitiated to a considerable extent by insufficient information on the social background of the persons observed.

The important environmental conditions are four. Nutrition, Housing, Medical facilities for diagnosis and cure, Urbanization. The first three have been dealt with elsewhere.[5] It must suffice here to state that malnutrition and a serious lack of bed accommodation are probably operative in Eire. There is a deficit of about 2,000 beds in institutions equipped for treatment of tuberculosis for the whole of Éire by accepted minimum standards; and if we accept the standard of 2 beds per death in institutions of all kinds laid down by the American National Tuberculosis Association, the deficit would amount to approximately 4,000. There is very little doubt that the rapidity of fall in T.D.R. is conditioned by the number of beds available in properly equipped and staffed institutions, if social conditions are not unfavourable.

Housing is probably relatively unimportant in Éire. In the table of correlations later on we show that there is no significant correlation between housing and T D.R. within the country, and a comparison with Northern Ireland suggests the same conclusion[5]. Housing is of major importance in England and Wales[6], and it seems possible that it emerges as a major conditioning factor only when malnutrition is no longer present Experience during periods of widespread malnutrition proves that it overshadows all other environmental causes of tuberculosis. Both of these conditions are concerned in the well known correlation, which has been repeatedly confirmed in every country between the Tuberculosis Death Rate and social position In Éire, as Geary showed, this social correlation is very marked. The difference between the T.D.R. amongst insured workers and that of the general population in Éire, recently pointed out,[5] can probably be explained by a very high T.D.R. amongst the unemployed; the fact that the T.D.R. for the whole population is so much higher than the rural T.D R. proves that this excess is not accountable to the rural population.

TABLE V

Male T.D.R in Age Groups over 15 in Different Social Groups in two years 1940 and 1941

		Two years 1940 and 1941	
		T D R	Average total deaths from tuberculosis
Eire		157	3,429
Four County Boroughs	Employed males	129	448
	Unemployed males	835 (?)	522 (?)
	All males	236	949

Assumptions

1. That the T D R for all males > 15 in the classes enjoying a status as good as, or better than, the income of the Nat Health insured male population is the same as the T D R for the insured population

2 That the average monthly numbers on the Live Register from the four County Boroughs in 1940–1941 represent the same fraction of the total urban Live Register numbers as that calculated from the average of the figures for 30th November, 1936, and 29th November, 1937

3 That the fraction of the population represented by those > 15 remained constant from 1936–1941

N.B.—"Employed Males" means all Males—(Estimated Live Register numbers plus 25%)

"Unemployed Males" means Live Register numbers plus 25%

"Males" means total Male population > 15 estimated on basis given above from 1941 Census

Table V shows the relevant data for Éire in the years 1940–41 The estimated death rate for the unemployed is arrived at by dividing the surplus deaths among the unemployed males of the urban population. The details of the calculation are being published elsewhere [8] The calculations upon which this table is based are open to a number of objections While we believe that the results tabulated represent the order of difference between T.D.R of employed and unemployed workers, we consider that only by a detailed study of death registrations and case histories can we ascertain with any certainty the exact degree to which unemployment is responsible for a marked increase in the T D R This investigation is at present proceeding. Our object in presenting this table is to call attention to one probable cause of our recent failure to control the T.D.R. in the county boroughs. The effect of urbanization on the movement of the Tuberculosis Death Rate is well known, and may be illustrated admirably by our experience in the latter half of the 19th century, when urbanization and T.D.R. mounted steeply together * Rates tend to increase more rapidly in town than in country in times of increasing prevalence; when the tide of tuberculosis begins to ebb, the rate in the town falls more rapidly than the country rate.[8]

In many cases, e.g., Holland, Sweden, the urban rate has actually fallen below the rural rate. Urbanization has, therefore, an influence on the general rate which varies with the relative level of the urban and rural rates. If the urban rate is higher, and if urbanization is proceeding rapidly, then we may expect to find a flattening out of the trend line as compared with an earlier period with a lower rate of urbanization. Other countries in which urbanization is preceding less rapidly than in Éire, e.g., England, or in which the urban rate is falling faster than the rural, e.g. Holland and Sweden, will evidently show a more rapid decline of T.D.R. There is a further point to be noted that the T.D.R. is generally higher in the larger than in the smaller towns;[8] therefore a change in the direction of the population flow which causes

* The history of the movement of T D R in Sweden given by Wallgren (*Irish Journal Medical Science*, July 1939) is closely parallel to Irish experience, though the sharp rise occurred between 1780–1830 Sweden has now entered the period when her urban rates are falling faster than her rural rates See Tables I and IV. Denmark and Norway show secular trends similar to Sweden.

a relative increase in the rate of growth of the larger towns and cities will accentuate the urbanization effect

TABLE VI

Comparison of T.D R between Dublin and ten Other Cities over 10 Years

	Name of Town	Population	1925–27 T D R.	1935–37 T.D R	Percentage decrease per annum
Austria	Vienna	1,868	201	109	4·6
Czechoslovakia	Prague	745	195	130	3·3
Eire	**Dublin**	**404**	**191**	**166**	**1·3**
France	Paris	2,871	266	168	3·8
Italy	Rome	835	163	129	2·1
N. Ireland	Belfast	415	167	116	3 1
Norway	Oslo	254	160	97	3 9
Scotland	Edinburgh	425	122	77	3·7
Spain	Madrid	800	255	129	4 9
Switzerland	Zurich	213	115	71	3·8
Sweden	Stockholm	465	160	96	4 0
MEAN	The Capital Cities (other than Dublin)	863·5	181	102	4 4
Median	(mclu'. Dublin)	465	167	129	3·8

Figures taken from the Annual Epidemiological Reports League of Nations, Health Organisation The Dublin figures have been re-calculated

The mean percentage decrease for these ten countries weighted by the populations = 3·8

Table VI shows the Dublin death rate for 1925–27 and 1935–37, and the mean annual percentage decrease between these dates. It is compared with the capital cities of the ten countries listed on Table I. Table VI shows that Dublin compares even less favourably with the capital cities than does Éire with the 10 countries. During the decade Dublin dropped from seventh to the tenth place; and the mean annual average decrease in T.D.R. was 1 3 per cent. compared with 4.4 per cent. for the mean of the other capital cities. Six of the ten cities show a greater annual average decrease than their respective counties. It is, therefore, clear that any differential increase in the size of Dublin must have the effect either of increasing the general T.D.R. or at least checking the rate of decline.

Figure 3* shows the relative growth of Dublin and of other Irish towns from 1891–1936. It is clear that there has been for many years a selective trend of immigration towards the larger towns. It is, however, wise to note that a great part of this increase in population has been in the suburban districts and it might therefore be expected to exercise a less characteristic effect on T.D.R. than would a purely urban growth. This is however offset to some extent by the abnormal age distribution, and social characteristics of a large fraction of the recently created Dublin suburbs, e.g. Crumlin, Cabra. The number of children and adolescents is abnormally high, the percentage of unemployed is large,

*Figures taken from Irish Census 1936, Vol IX, p. 5, Table 5

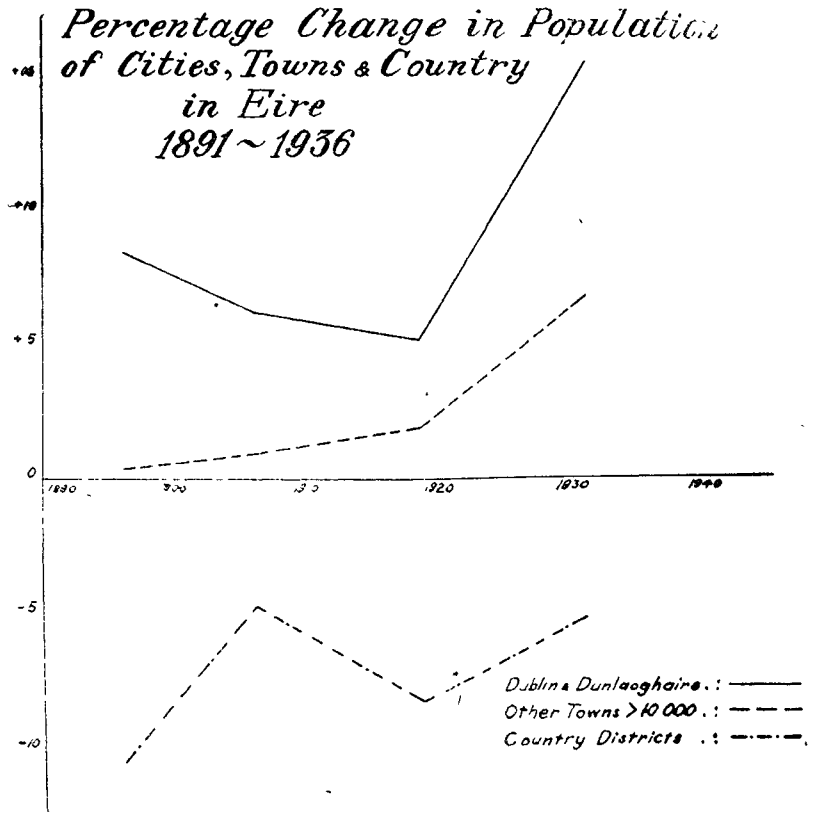


FIGURE 3.

Curves represent successive percentage changes in population at different dates as compared with preceding count.

and the districts are liberally sprinkled with families one at least of whose members is tuberculous, all these facts would combine to produce a higher general T D R. for all ages taken together

Two assumptions underlie the above discussion The first is that the difference between urban and rural rates is due to a real difference in the frequency of deaths from Tuberculosis, and not only to deficient registration in rural areas as the result of defective diagnosis and social pressure The second assumption is closely connected with the first; it is that rates for different areas are comparable inside Ireland Before examining these points we wish to point out that an increase in urban population will in any event act as a brake on the reduction of T D R in any country such as Eire where urban T D R is higher than rural T D R But if the difference between Dublin and Eire is a real one and constitutes a principal cause of our failure to achieve the international level of annual average decrease in T D.R, then we may expect by applying the well-known remedies of early diagnosis and adequate treatment to achieve very rapid results, since the rate tends to fall faster in towns (see Table VI) than in the country when effective measures are taken.

Comparison of County and Co. Borough T.D.R. Rate inside Ireland.

The information on which this Section is based is collected in Tables VII, VIII, IX, and illustrated in map form on page 12.

TABLE VII.

Annual Mortality Rates per 100,000 Population from Tuberculosis in the Years 1935–37 at All Ages

County	Tuberculosis, all forms			Pulmonary		Non-pulmonary		Rural	Urban
	Standardised.	Crude	Per cent. decline in crude rate since 1923–28	Male	Female	Male	Female		
Carlow	117	117	22	80	110	29	30	106	170
Dublin	145	137	2	117	100	30	28	157	100
Dublin Co. Borough	151	162	26	145	114	30	33	—	162
Kildare	113	118	22	75	118	27	17	113	149
Kilkenny	104	105	29	74	99	12	29	95	156
Laoighis	117	117	23	80	92	31	33	117	—
Longford	92	90	10	66	76	22	17	87	113
Louth	130	133	22	101	103	34	27	137	129
Meath	122	121	18	96	86	30	30	120	131
Offaly	123	122	20	88	86	39	31	109	185
Westmeath	123	123	23	71	130	17	33	122	138
Wexford	149	150	18	108	120	35	37	138	188
Wicklow	118	119	21	93	100	29	16	114	130
Clare	111	110	16	85	101	19	17	106	143
Cork	109	112	20	92	90	22	20	105	154
Cork Co. Borough	143	152	31	141	102	35	27	—	152
Kerry	120	121	10	95	97	30	19	112	179
Limerick	101	101	20	74	82	23	24	101	—
Limerick Co. Borough	148	155	10	125	115	35	31	—	155
Tipperary	120	121	12	87	99	31	25	108	160
Waterford	121	121	18	80	99	36	29	108	223
Waterford Co Borough	150	151	23	150	102	33	21	—	151
Galwarv	115	114	12	90	88	27	22	109	142
Leitrim	98	96	16	77	78	18	20	96	—
Mayo	101	98	19	82	70	22	21	91	163
Roscommon	84	82	12	67	73	16	7	82	—
Sligo	123	124	+4*	93	92	32	32	110	184
Cavan	79	78	22	59	73	10	18	76	100
Donegal	100	99	30	68	81	24	24	98	111
Monaghan	102	101	12	70	73	31	28	95	129
EIRE	122	122	18	96	96	28	25	107	155
County and Co. Borough Mean	118	118	18	91	95	24	25	104	150

* Increase.

TABLE VIII

T.D.R. Persons, all ages

Area	1923–28	1931–41	Percentage Decline
Four Co. Boroughs	212	154	38
Urban Areas	185	142	23
Rural Areas	129	106	18

The standardized rates were calculated by the indirect method used by Geary. They differ significantly from the crude rates only in the Dublin, Cork and Limerick County Boroughs, in Dublin Co. and in Kildare. The crude rates in the other columns give therefore a reliable picture of the comparative regional rates. The main cause of a difference between crude and standardized rates is, of course, the higher T.D.R.'s in the age groups 15–34 (See Table IX), combined with the relative excess of population at these ages in the County Boroughs and Kildare

The highest standardized rates occur in Dublin Co. Borough, Waterford Co. Borough and Wexford. There has been a substantial decrease in all counties except Sligo, which alone shows an increase of 4 per cent in the period under review The distribution of rates is much more even than in 1923–8, which is explained by the fact that the percentage decline has been highest in the counties with the highest rates, which are for the most part the more urbanized regions. Thus the average urban per cent decrease during the period is 20 per cent, while the rural average amounts to 18 per cent., and only 9 counties out of 22 show a higher rural than urban per cent. decrease Donegal, with a decrease of 30 per cent., has answered Dr. Geary's appeal for a special effort, and is second only to Cork County Borough in per cent. decrease of standardized rates. Donegal rural, with 30 per cent. decrease, is almost as successful as Donegal Urban with 31 per cent. decrease. Dublin County, excluding Dublin County Borough, with 41 per cent. urban decrease, heads the list of urban district decreases, while Waterford County (excluding the Borough) alone shows an urban increase of 8 per cent. For the rural districts Kilkenny heads the list with 31 per cent. decrease, while Dublin County, with 4 per cent decrease, is at the bottom. The same general picture emerges from Table IX Cavan, Roscommon and Leitrim show the lowest standardized rates; and Roscommon has the lowest female T.D.R (standardized) in Eire.

The relatively rapid decline in urban rates, which is further illustrated in Table VIII, agrees with the experience of the great majority of countries in which the T.D.R is falling, and is probably a reflection of the influence exercised by environmental conditions on T.D.R. The discrepancy between these figures and those on Table VI arises partly from the fact that the exact level of Dublin rates in 1925–27 is still uncertain, and partly from the grouping together of all County Boroughs in Table VIII. A full examination of outstanding difficulties connected with Dublin rates is at present in progress and the results will be published. There is no doubt that there has been a general rise in the housing and nutritional standards of urban areas during the last 20 years, both in Eire and other countries, and the accelerated fall in T.D.R resulting, indicates where we most economically apply our maximum effort. Map 1 (like that in Geary's paper) illustrates the changing distribution of rural T.D.R. The figures for pulmonary tuberculosis manifest clearly the well established fact that the normal female excess becomes a deficit in the larger cities. Thus the four County Boroughs show a marked male excess, while in the other counties only six (Meath, Offaly, Cork, Galway, Mayo, Sligo) out of 26 show a male rate higher than the female, and in no case does the difference reach the level of the County Boroughs The non-pulmonary types of the disease, which are now regarded as belonging in the main to the period of secondary spread, do not show is phenomenon.

MAP 1.—ANNUAL AVERAGE TUBERCULOSIS DEATH-RATE PER 100,000 LIVING 1935-37, RURAL, ALL AGES, ALL FORMS OF TUBERCULOSIS.

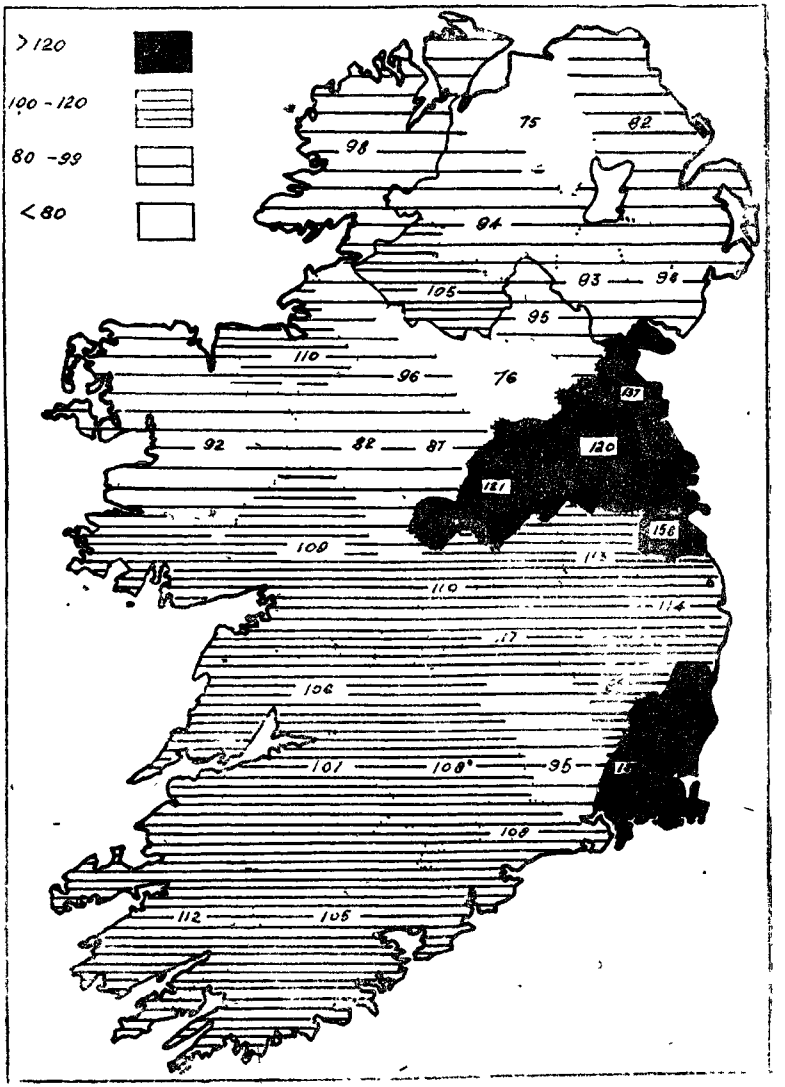


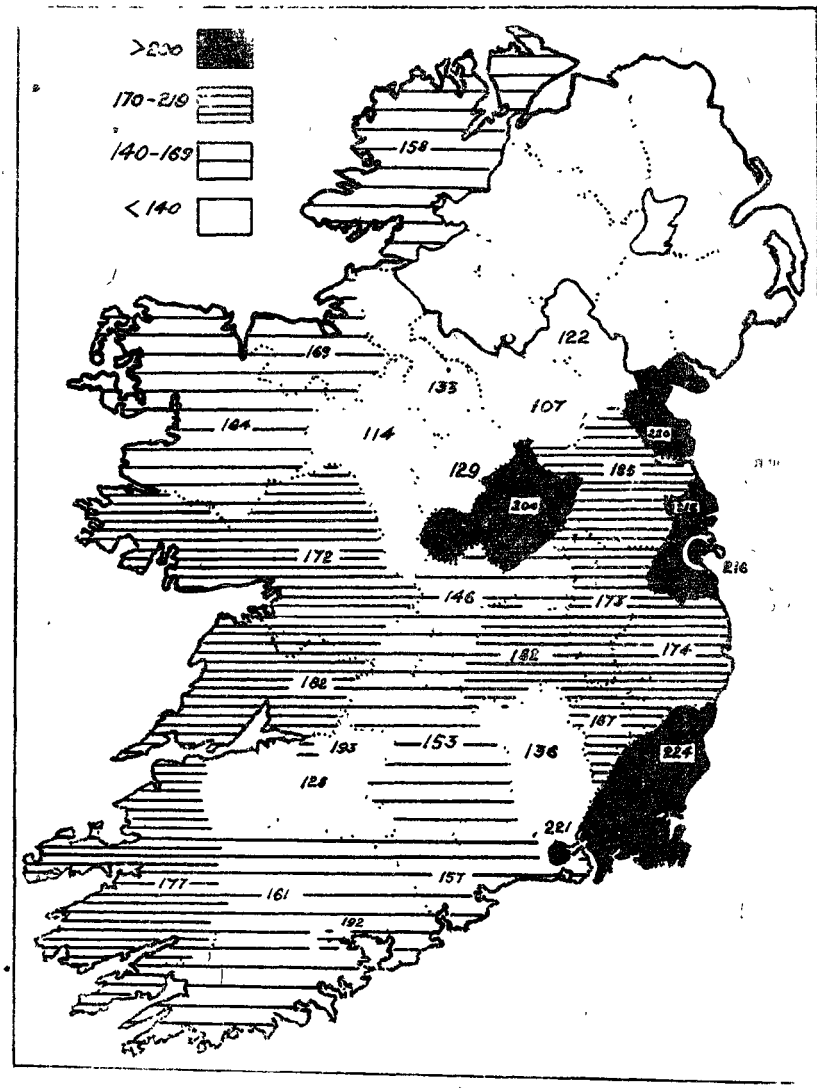
TABLE IX

Annual Average Mortality from Tuberculosis in the Eleven Years 1931–1941 at Ages 15–34

County	Ages 15–34						Pulmonary T B Deaths at ages 15–34 as per cent of total deaths at ages 15–34	
	Pulmonary T B			Non-pulmonary T B				
	Male	Female	Ratio (3)×100/(2)	Male	Female	Ratio (6)×100/(5)	Male	Female
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Carlow	145	229	158	42	34	81	39 5	47 2
Dublin	181	168	93	35	29	84	43 7	48 2
Dublin Co Borough	179	180	100	36	30	83	43 4	48 4
Kildare	133	252	190	41	46	114	36 5	48 0
Kilkenny	117	188	160	19	41	214	35 8	42 3
Laoighis	139	181	130	44	17	108	38 3	41 7
Longford	108	138	128	21	27	126	37 6	37 8
Louth	177	247	140	43	41	95	43 3	50 2
Meath	144	169	118	41	45	111	36 8	40 7
Offaly	113	187	165	33	44	134	36 4	42 3
Westmeath	193	227	140	41	60	147	40 3	44 7
Wexford	192	261	136	31	44	140	41 5	48 1
Wicklow	147	255	173	27	39	142	39 6	49 5
Clare	153	201	131	28	30	108	44 9	47 0
Cork	138	172	125	23	26	112	37 3	44 7
Cork Co Borough	169	161	95	24	18	75	40 2	43 2
Kerry	148	201	136	29	37	127	40 2	45 0
Limerick	101	172	170	27	25	91	32 2	42 4
Limerick Co Borough	169	206	122	25	30	119	41 0	44 1
Tipperary	122	200	163	31	31	100	35 3	45 7
Waterford	122	190	155	35	39	109	37 2	45 3
Waterford Co Borough	199	203	102	22	21	95	48 9	45 5
Galway	139	176	127	33	40	121	38 5	41 0
Leitrim	160	153	153	33	33	102	29 5	36 2
Mayo	135	159	118	30	29	97	39 0	40 1
Roscommon	95	139	146	20	19	94	32 1	37 5
Sligo	125	168	134	44	52	117	35 1	43 1
Cavan	90	138	152	17	18	106	33 4	35 1
Donegal	122	169	138	37	37	100	35 2	41 9
Monaghan	93	142	153	29	37	125	33 8	37 6
TOTAL	143	186	130	31	32	102	39 2	44 9

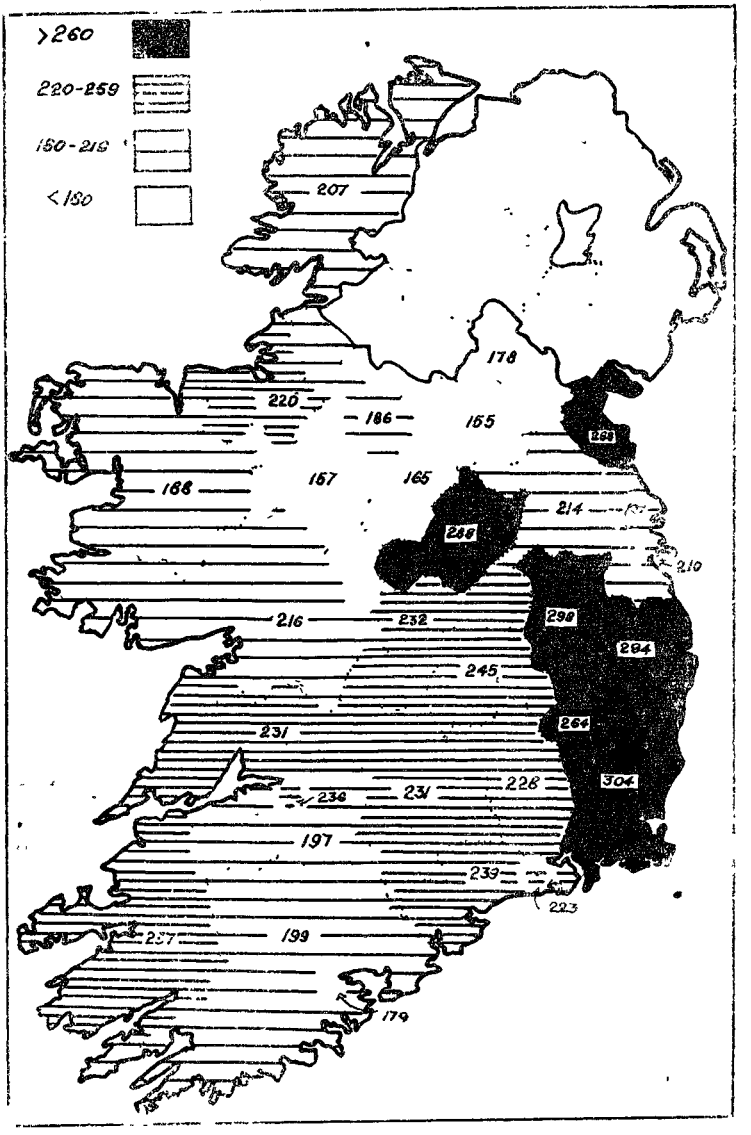
Table IX, which shows the rates at age 15–34, for the period 1931–41 during which there was no significant change in the T D R. for this age group, brings out this relationship between male and female pulmonary T D R. very clearly. Column 3 shows the relationship in the form of ratio Female T D R × 100 Male T D.R and this is seen to be < 100 in Dublin County and Cork County Boroughs only Dublin County Borough and Waterford County Borough show ratios of 100 and 102 respectively, while the general average of the other counties and Limerick County Borough is 145, with values ranging from 122 for Limerick County Borough to 190 for Kildare · The full significance of this phenomenon will be discussed in another place.[1] Maps 2 and 3 show male and female rates all forms, 1931–41 Age group 15-34.

MAP 2.—ANNUAL AVERAGE TUBERCULOSIS DEATH-RATE 1931–41, MALE, AGES 15–34, ALL FORMS OF T.B.



The question obviously arises in connection with these tables whether we can compare the rates of the different counties with one another. The main reason alleged for denying the comparability of rates inside Éire is the social stigma attached to Tuberculosis, which, it is said militates against correct registration, in the West and North-West especially. The maps all show clearly that rates tend to run low in these regions, and it is therefore extremely important to determine what degree of comparability in fact exists. We have applied a number of tests which we propose to discuss in some detail We shall present first a test which, we believe, brings out very well without the use of any

MAP 3.—ANNUAL AVERAGE TUBERCULOSIS DEATH-RATE 1931-41, FEMALE, AGES 15-34, ALL FORMS OF TUBERCULOSIS.



advanced statistical technique the comparability of the rates. The facts and assumptions upon which this test rests are :—

1. In the age group 15-34, pulmonary tuberculosis represents a little less than half of the total annual number of female deaths. (See Col. 9, Table IX). It is commonly assumed that one reason for the lower rural rates is the social stigma attaching to Tuberculosis which favours concealment, and prevents correct registration in a sufficient number of cases to influence the rates. This social stigma would operate to a maximum extent against the registration of

Tuberculosis as a cause of a young woman's death. We have therefore chosen to apply the test to the *female pulmonary T D.R 15-34 age group*

2. If such false registration does occur it is clear that deaths due to Tuberculosis will be attributed to some other cause, or entered in the "*other causes*" group It appears extremely likely that concealed Tuberculosis deaths would in fact tend to collect in the "*other causes*" group

TABLE X

Deaths of Females aged 15–34, Years 1931–41

Groups of County Areas	Simple Average P T D R	Simple average ratio of mortality from causes other than tuberculosis and "Other Causes"– to mortality from "Other Causes"
I Seven county areas with lowest P T D R	147	2 85
II Nine county areas with second lowest P T D R	173	2 85
III Eight county areas with second highest P T D R	197	3 08
IV Six county areas with highest P T D R	245	2 78
Simple average thirty county areas	188	2 89

* No 34 of the county list of causes of death in the Annual Reports of the Registrar General

Table X shows a comparison between P.T D R in females 15–34, and the ratio

Causes other than Tuberculosis including "other causes," /other causes, in four groups of counties graded according to increasing P.T D R The results shows that there is no inverse relationship between "other causes" and P.T D.R. such as we might expect to find if concealment by false registration was more widely practised in any county or group of counties than in the rest of the country We do not of course seek to prove that there is no concealment, our object is to show that there is no reason to believe that this concealment is an important cause of differences between the rates in the different regions.

We have applied two other tests to these figures which confirm the result of the first Taking the two dates 1936 and 1941, we have divided the counties and co boroughs into two groups for males and females separately. Table XI shows the result It will be seen that a fall in the deaths from pulmonary tuberculosis was associated with a fall in deaths from all other causes of almost equivalent size both for males and females, while a rise in the number of deaths from pulmonary T B was accompanied by a greatly decreased fall in deaths from other causes This table supports our former conclusion that a fall in T D.R. is not due to a transference of deaths to some other rubric.

Finally we have investigated the relationship between the deaths from pulmonary tuberculosis and bronchitis Since deaths from bronchitis are negligible below the age of 35, we chose for this test the age groups 35 and upwards This test was designed not only to ascertain the general comparability of the different rates *inter se*, but also to determine whether the relatively low rates prevalent in Eire at ages above 35, as compared with other countries, could not perhaps be attributed to false registration A comparison with other countries would of course be necessary to determine this point with certainty , but if registration of Tuberculosis deaths under bronchitis occurs to any extent in Ireland, it would probably be operative also in producing differences in rates between localities For this test we used the correlation technique, and since it is well known that bronchitis prevalence is correlated with urbanization, we used partial correlation to hold urbanization steady. The result is that there is no significant correlation, negative or positive, between Pulmonary Tuberculosis and bronchitis in the death rates at ages 35 and over when urbanization is held constant. (See Table XII, p. 10.)

Table XI

A — Number of Deaths of MALES at Ages 15–34

Area	Deaths from Pulmonary T B		Deaths from Other Causes	
	1936	1941	1936	1941
IA 12 Co Areas in which *decreased* number of deaths of males occurred at ages 15–34 from Pulmonary T B between 1936 and 1941	305	259	511	428
IIA. Remaining 19 Co Areas	322	408	570	551
IIIA Total 31 Co Areas	627	667	1,081	979

B — Number of Deaths of FEMALES at Ages 15–34

Area	Deaths from Pulmonary T B		Deaths from Other Causes	
	1936	1941	1936	1941
IB 16 Co Areas in which *decreased* number of deaths of females occurred at ages 15–34 from Pulmonary T B between 1936 and 1941	400	323	493	389
IIB Remaining 15 Co. Areas	430	540	538	507
IIIB Total 31 Co Areas	830	863	1,031	896

Our conclusions, therefore, are that the Tuberculosis death rates of the counties and county boroughs are statistically comparable *inter se*, that there is no reason to believe that concealment of deaths from Tuberculosis occurs to a significant extent in one part of the country more than in another; and that the low T D Rs. observed in the West and North-West are a genuine, and not a merely apparent, fact which calls for explanation in terms of environmental causes We repeat, however, that it is quite certain here as elsewhere that *some* concealment occurs, the point is, that from the statistician's point of view if the concealment is substantially equal in intensity throughout the country we can use the figures to investigate the social causes of Tuberculosis prevalence

Social Conditions and Tuberculosis Death Rates.

We have used these figures to carry out a series of correlations between Tuberculosis death rates and socio-economic conditions. The details of the variables chosen and the correlation coefficients obtained are set out in the table at the end of this Section. We have discovered some significant correlations The first between Pulmonary Tuberculosis, all ages, and percentages of population in towns and villages $r=+0.731$, is highly significant, thus bearing out the conclusions of the first section 1 that increase in the rate of urbanization would act as a powerful brake in Éire on the decline in T.D.R. The second significant correlation value shows that a slightly stronger relationship $r=+0\,798$ exists between Pulmonary Tuberculosis at ages 35 and over and urbanization; and the third between non-Pulmonary Tuberculosis ages 0–14, and urbanization stands at $r=+0.803$. The total correlation between T.B. mortality as percentage of total mortality, and percentage of the population in towns and villages is also significant —$r=+502$

The connection between urbanization and Tuberculosis in this country is therefore certain, and will be dealt with *in extenso* elsewhere [7]

We next turned our attention to the factors which might be of importance in towns and chose for preliminary investigation housing, real wages and unemployment. D'Arcy Hart[6] in a recent important monograph showed the importance of the first two for prevalence and mortality rates in England Real wages are closely negatively correlated in England over a time series with death rates from Pulmonary Tuberculosis in young women, and housing conditions in the English county boroughs are significantly negatively correlated with T.D R Our results differ from his There is no significant correlation between housing conditions and Pulmonary Tuberculosis in Eire

On the other hand we found a significant positive correlation between real wages in the different urban areas and Pulmonary Tuberculosis death rates at all ages of $r=+0.510$ This correlation was reduced to insignificance when urban unemployment was held steady. The simple correlation between P.T.D R. urban and urban unemployment was also significant, and when real wages were held constant it also was reduced below the level of significance. These results are probably a reflection of the fact that unemployment is more serious in the county boroughs. The matter is under further examination.[7]

There was one other important negative result There is no significant correlation between Non-Pulmonary Tuberculosis, ages 0–14, and Bovine Tuberculosis; and this combined with the positive correlation between Non-Pulmonary Tuberculosis 0–14, and urbanization, suggests that

Bovine Tuberculosis may not be as important a cause of Non-Pulmonary Tuberculosis in Eire as is commonly supposed

In this section the emphasis throughout is on the word significant. It is quite possible, even probable, that if the correlation coefficients were repeated for other groups of years, correlations of the order of 0.3 might be found again, in which case significance might be attached to the results. Thus the relationship between urban unemployment and P.T.D.R., when both housing and real wages are kept constant, is liable to occur once in 8 times as a result of sampling chance and the correlation between Non-Pulmonary Tuberculosis and Bovine Tuberculosis is even less likely to be a result of pure chance. If a real relationship underlies these figures we hope to be able to extract it by further and more detailed enquiry along these and cognate lines.

We are not prepared to draw final conclusions from this preliminary programme of correlations with socio-economic factors. A further detailed examination of the relationship between urbanization and Tuberculosis has been planned and is already in progress under the ægis of the Irish Red Cross Anti-Tuberculosis Section.

Correlation Programme.

The correlation unit was the county The series used were as follows :-

T.B. Series —

1. Pulm. T B , 1939–41 ;
2. ,, ,, 1936–41, Urban ,
3. ,, ,, ages 35 and over, 1935–37 ,
4. Non-pulm. T.B., all ages, 1932–41 ;
5. ,, ,, ages 0–14, ,, ,,
6. T.B. mortality as percentage of total mortality, ages 15–34 1935–37 .

Other Series :—

7. Bronchitis mortality, ages 35 or over, 1935–37 ,
8. Percentage of population in towns or villages, 1936 ,
9. Unemployment rate, urban, 1936–41 ,
10. ,, ,, total, ,, ,, ,
11. Housing (percentage living in housing density of more than 2 persons per room), urban ;
12. ,, (percentage living in housing density of more than 2 persons per room), total ,
13. Number of Bovine T B slaughterings per 1,000 milch cows, 1932-33 to 1941-42 ;
14. Real wages of skilled manual workers and labourers, urban, 1939, (computed from weighted average wages in 12 occupations and retail prices of 13 articles of food).

Total and partial correlation coefficients are as follows —

r (1, 8)	= +·731*(24)	r (5, 13 , 8)	= +·351 (23)
r (1, 10)	= −·073. (24)	r (4, 13 ; 8)	= +·123 (23)
r (1, 12)	= −·020 (24)	r (2, 9)	= +·531*(21)
r (6, 8)	= +·502*(24)	r (2, 11)	= +·216 (21)
r (3, 7)	= +·298 (24)	r (2, 14)	= +·510*(21)
r (3, 8)	= +·798*(24)	r (2, 9 , 14)	= +·292 (20)
r (3, 7 , 8)	= −·082 (23)	r (2, 14 ; 9)	= +·234 (20)
r (4, 13)	= +·182 (24)	r (2, 11 ; 14)	= −·109 (20)
r (5, 13)	= +·326 (24)	r (2, 11, 9)	= −·005 (20)
r (4, 8)	= +·529*(24)	r (2, 9 , 11, 14)	= +·313 (19)
r (5, 8)	= +·803*(24)		

It will be understood that r (1, 8) means the total correlation between series 1 and 8 and r (5, 14 , 8) means the partial correlation series between 5 and 14 with series 8 constant, etc The number in brackets after each correlation coefficient represent the number of " degrees of freedom " n , the numbers are low in the case of the final 8 coefficients because only 23 of the 26 counties contain urban areas The significance of correlation coefficients may be assessed from the following significance table (in which universal normality is assumed) —

Significance Values of r^9.

Probability —

n	·1	·05	·02	·01
19	·369	·433	·503	·549
20	·360	·423	·492	·537
21	·352	·413	·481	·526
23	·337	·390	·463	·506
24	·330	·388	·454	·496

Summary.

1 Ireland's position on the international Tuberculosis Death Rate (T D R) list has disimproved markedly in recent years

2 Urbanization, and particularly the increased flow into Dublin is probably one of the main causes of this diminished decline in T D R

3 Irish Registration of Tuberculosis deaths is not less reliable than that of other countries with comparable rates

4 The County and County Borough Rates in Eire are statistically comparable *inter se*

5 Urbanization is found to be the main environmental factor operating to produce a difference in the T D R as between one region and another in Eire Housing conditions in urban areas have no detectable effect on T D R The main operative factor is probably unemployment in urban areas

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